Flies All the Way Down:

A Summary of Dethier and Clark's "To know a fly"

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Vincent Gaston Dethier wrote *To know a fly* (1962), to explain the steps involved in proper experimentation. He also wanted to provide insight on social division between scientists and the public. While some societies may put scientists on a pedestal, others may figuratively toss them out the window. This dichotomy is just as present today as it was in 1962 when the book was published. The spread of the Covid-19 virus revealed people either commit to an unquestioning belief in the word of scientists, or a persistent attitude of mistrust and suspicion. When Dethier wrote this piece, scientists were often being dismissed on matters of the environment. The average citizen at this time did not care to listen much until Racheal Carson published *Silent Spring* (1962), which garnered national attention. Part of her success is she did not just write the book from the perspective of a marine biologist, but as an everyday person living in the same world as her fellow Americans. This very idea is what *To know a fly* encompasses. The scientist is just like anyone else, thus the scientist both should write and be treated like a normal person.

Why the fly?

The first two chapters pinpoint why Dethier chose a fly as the subject of their research. Chapter one covers subjective reasons flies interested the author; some of the reasons reflected the relationship between flies and humans as species, while others were simply the product of human curiosity. Chapter two covers logistical reasons flies are an ideal subject to study, which stem from both economic and ethical aspects.

In Chapter one, the first reason the author chose flies as a subject was their persistence in human life. Where one can find people, there is likely a fly close by, as well. Flies also require very little and reproduce quickly, so it is unlikely they are going away. Dethier then goes on to mention stigmas surrounding the fly. From the human perspective, a fly is dirty, diseased, and fit for extermination. This

identity built around the fly is persistent across cultures. Because of the stigma and resilient nature of flies, Dethier sees it fit to better understand the creature. He is also fascinated by the fly's nimbleness and natural abilities, which have already had semi-famous disputes.

In Chapter two, the reasons are less speculative. Initially, Dethier mentions in a way they didn't choose to work with the black blowfly. Instead, they let the black blowfly choose them by waiting for a fly to lay eggs in a liverwurst sandwich. Then Dethier explains why flies as a subject have economic benefits. Flies take up very little space, their breeding grounds and housing can be confined to simple cages sitting on counters. Flies are also free, and since there are no laws protecting them from being caught in the wild, Dethier's team simply needed to wait for a fly to show up. There are also no laws prohibiting disposal of dead flies into a waste bin, which makes disposal a breeze, compared to other live subjects. Ethical questions are also brought up. Testing on animals is frowned upon even at the time of writing this, yet the same empathy which is shown for other animals isn't shown towards most insects, if any at all. He also talks about a few downsides to using flies. One being the bureaucratic process of buying things with grant money made procurement of liver, their favorite material to lay eggs in, rather challenging for his team.

Experimenting on a fly

Throughout the book, Dethier explains the procedure and thought involved in each experiment. With each one, he explains the importance of doing the experiment properly. Each experiment introduces different variables and issues which could skew the results, but each time they carefully consider how to isolate variables. By doing this, he is explaining the scientific method in relation to each question they are trying to answer.

Experiment One

Chapter three explains the first experiment they performed on the fly. The point of this experiment was to devise a way to extract information from a fly. By observing how and when a fly decides to lower its probiscis, the scientist can determine information about a fly's senses.

In this experiment, the researchers attach a fly to a pencil, then maneuver the fly so it's legs are dipped into varying solutions. Starting with plain water, they allow the fly to drink until the probiscis stops lowering, which signals the fly is no longer thirsty. Then they move onto solutions with varying amounts of sugar and salt. The fly will drop its probiscis for sugar water, but no longer for plain water as its thirst is quenched.

This, alone, shows the mouth of the fly is not involved in its ability to taste, since the probiscis doesn't drop unless it knows there is something other than just water. While the experiment showed insight about the fly, it doesn't answer the full question of how a fly tastes it's food. The experiment only confirms it must be connected to their legs in some way.

Experiment Two

The second experiment detailed is a test to clarify which component of the fly's leg handles sensation. A close look reveals the fly's exoskeleton is covered in hair-like protrusions. If one thinks through the idea, they could come to a reasonable assumption flies use these hairs to sense the world. However, a hypothesis is not enough. To know for sure, we have to get the fly to tell us.

To interrogate such a creature needs precision. Dethier uses a sewing needle dipped into different solutions to interact with the fly. By gently rolling a solution from the base of the hair to the tip, he observed the probiscis only extended when the very end of the hair was touched. This part of the experiment also revealed not only does the hair sense taste, but it also has the capacity to sense a variety of things.

To understand the complexity of this organ, Dethier decided to use the concept sensory adaptation. Sensory adaptation is the idea that as one is exposed to a stimulus repeatedly, the sensitivity to the stimulus decreases, eventually ending in the brain being able to block out the stimuli altogether. This trait appears in all species with sensory systems, and the fly is no exception. Dethier harnessed this to find the depth these hairs provide. He would repeatedly expose the same hair to a stimulus until it stops eliciting a response, then add a new stimulus and repeat. This process allowed for Dethier to determine the types of sensory cells on each hair. He concluded there are at least four different types of cells. The first being a cell for detecting when the hair is bent, and another for sensing water. The other two cells the fly equivalent of taste, one for sugar and the other for salt.

Experiment Three

The third experiment tries to assess the mechanism flies use to determine whether they are full or not. To figure this out, they must ensure they are isolating different variables to alter as to not allow confounding variables to influence outcome.

First, they consider the diet and biological traits of a fly to come up with points of entry. For their first idea, they suggested the fly may use blood sugar content to determine its hunger. They decided to inject sugar into the flies directly and found this didn't affect the hunger of a fly.

They then considered the facets of their digestive system to try and investigate whether an organ is involved in the process. They removed different sections of their gut on different flies, and even removed their stomach and still the fly still showed no change in hunger. They also tried feeding the fly by putting food directly into its stomach, which also failed to satiate the fly. This told them whatever controls their hunger must be before the food reaches its gut. They decided the esophagus of the fly was the next thing to attempt.

Since the esophagus cannot be directly injected with food, they devised another way to test it. By snapping the nerves responsible for communicating from the esophagus to the brain, they could observe changes in a fly's hunger after the operation. What they saw was the fly would start to eat, and it would never be full. Even so far as to keep eating until its body began to change shape and it became incapable of walking.

Minor Experiments

Dethier does other smaller, less hands-on experiments throughout the book. For example, one experiment was to determine the correlation between hunger and activity. Basically, is a hungry fly an active fly? Common sense would point to yes, but they still wanted to measure the activity of a fly to be sure. They also tested food preferences of the flies. What they found, was while all flies need sugar as their primary food source, female flies need protein as an important ingredient for gestation. Another procedure was conducted to ensure the flies were actually hungry. To do this, they tied a leash around the fly and made it fly around to expend energy.

Author Commentary

For the most part, Dethier is very direct about the message he is trying to send to the reader. He wants to reader to understand even though the scientist is committed to a search for the objective truth, they are still just people. As humans are creatures prone to subjectivity, a scientist is guaranteed to make some mistakes, despite their commitments. Dethier even goes to imply it is necessary for the scientist to make mistakes. Since mistakes are how people learn, and scientists are just people, they, too, must make mistakes to expand the library of human knowledge.

Dethier (1962) says "All knowledge, however small, however irrelevant to progress and well-being, is part of the whole" (p. 118). This message, combined with his thoughts about the true nature of

the scientist, shows anyone can take part in this expansion. In other words, anyone can be the scientist if they choose to.

References

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