

SEF Final Reflection

By: Leif Verace

When I first walked into the lab, I was surprised by what I saw: stacks and stacks of vials, each meticulously labeled with letters and numbers, containing hundreds of small insects. I had heard of *Drosophila* labs, but it was still a surprise to see one in person. To say the least, I was interested. I was fortunate enough to get accepted into the lab, run by Dr. Olivier Devergne, and started working on a project studying a particular gene involved in cell migration.

Sometime later I was generously accepted to be a part of the Student Engagement Fund (SEF). This enabled me to continue the project more freely, having funds to help supply the lab with materials, reagents, etc. The project has been, and continues to be, an incredible part of my academic career. It has not only been a powerful way to engage with biology, but also an excellent learning experience, an exercise in scientific thought and long-term goal setting. In this reflection, I'd like to take some time to discuss the impact the project and SEF have had on my academic career, and give an overview of the current state of the project.

Before we can talk about the impact the project and SEF have had, I think it would be best to give an overview of our research process. The key to our research is a small, seemingly inconspicuous insect: *Drosophila melanogaster*. More commonly known as fruit flies, *Drosophila* are regarded by most as mere pests; yet *D. melanogaster* has established itself as one of the most important model organisms in biological research, garnering 6 Nobel prizes across such topics as hereditary, mutations, viruses, and most recently, circadian rhythms (McKie, 2017). Fruit flies have even been used for research aboard the International Space Station! (Cheung, 2018). *D. melanogaster* is such a useful organism for many reasons: it reproduces quickly, requires

relatively little effort to care for, and has a vast genetic toolbox developed by scientists that allow us to study numerous biological processes.



A male fruit fly

[Photo adapted from KXCI.org]

In the case of my project, we are studying the role of a specific gene in the process of collective cell migration, i.e. when a group of cells move together as a cohesive unit. Specifically, we use the migration of a cluster of cells, known as border cells, in the *Drosophila* egg chamber as our model system. This has established itself as a powerful model system for studying collective cell migration (Prasad et al., 2015). We know this gene plays a role in border cell migration based on the observed effects of mutating the gene, which saw an inhibition of migration. The goal of the project is to get more details on how exactly the gene is working in the process of collective cell migration: What specific role does it play? What pathway is it acting through? In what region of the egg chamber is it active? At what stage of development? Etc.

An imminent question to ask is: why is this important? The first thing to keep in mind is that there is a very strong connection between the *Drosophila* and human genome. As NASA reports, about 77% of human disease genes have analogs in the *Drosophila* genome (Cheung,

2018). Furthermore, many fundamental properties and pathways of biological processes are conserved between mammals and *D. melanogaster* (Pandey & Nichols, 2011). Thus, by better understanding how genes and biological processes in *Drosophila* work, we are better able to understand how those same processes and analogous genes work in our own bodies. In the case



Some of the lab's fly stocks; we routinely transfer fly populations to vials with fresh food to maintain the populations.

of collective cell migration, this is important to such topics as the proper development of tissues and organs (Scarpa & Mayor, 2016), or proper wound healing (Li et al., 2013). Another important implication of collective cell migration is the metastasis of cancer cells from the primary tumor to other areas of the body (Yang et al., 2019).

So, what do we do in the lab in order to investigate the gene? We have many populations of flies with distinct genetic features; this could be a fly population with a certain mutation in their genome, or a transgenic construct that, when crossed with other flies, will affect the gene expression

in some way. Using these genetic tools, we are able to activate or knockdown certain genes in specific cells/tissues within the *Drosophila*. In the case of our project, by knocking down the gene of interest (i.e., reducing gene expression) in certain regions of the egg chamber, and observing the effect on the migration of the border cell cluster, we are able to gather information about where and how the gene is functioning in the process of collective cell migration.

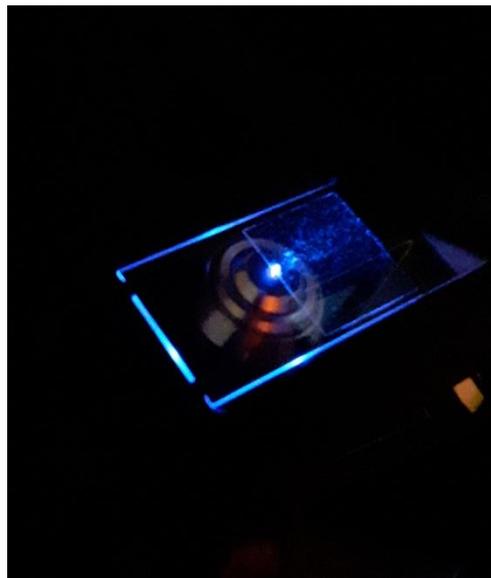
A typical lab session includes taking care of the fly stocks, generally by transferring populations from old vials to new ones with fresh food, and routinely collecting flies in preparation for crosses (where we have two distinct populations create an offspring generation,

which has some genetic result we are interested in.) Once we have a developed offspring generation from a cross, we then dissect the females for the ovaries, which we will later mount on a microscope slide and observe under a confocal microscope. Dissecting such a small organism is tricky at first, but it does get easier after a few times!

With the ovaries dissected, we fix them so they don't degrade, and stain them with certain reagents and/or antibodies, depending on what we need to visualize. We then separate the egg chambers and mount them onto a slide. From there, we can visualize them using the confocal microscope, and gather data about how the cell migration process was affected. Using the data, we make conclusions and decide what experiments we need to perform next.



A sample of drosophila ovaries in dissecting medium.



Egg chambers mounted onto a slide, being observed under a confocal microscope lens.



Drosophila egg chambers. The blue color is a visualization of the DNA, a result of a stain applied to the egg chambers.

The project, aided directly by the SEF, has allowed me to gain novel experience, skills, and knowledge related to biology and science as a whole. It has given me the opportunity to engage in scientific thought, manage long-term goals, and given me a renewed appreciation for the field of biology.

Perhaps the most important skill I have learned working on the project is scientific thought. Scientific thought is, loosely speaking, active thought with the goal of seeking knowledge (Kuhn, 2010). It is a way to plan a route between origin and endpoint, a route which will lead us to some new understanding of the world.

For most of my academic career, I had engaged in scientific *understanding*, taking previously discovered material and seeking to comprehend it; I was hiking along the trails of knowledge built by the great scientific minds over the years. Scientific thought, however, is branching off to blaze a new trail to reach some novel discovery. Thus, while there is a significant overlap, scientific thought requires a whole new skillset. It was through this project I was able to learn those skills.

The key skill involved in scientific thought is creativity. This may come as a surprise, as science is often viewed as a rigid, algorithmic process. We seldom group the scientist together with the musician or the artist, yet scientific thought is an incredibly open-ended process, driven by making new connections between ideas. It is the natural progression of scientific understanding: once we have a foundation of ideas, how can we expand on them? Just as the musician fuses chords into songs, the scientist fuses ideas into discoveries. Both share the same spark of creativity, which can only truly be learned by doing. This is why I feel so fortunate to

have been able to work on this project; it has enabled me to learn, to some extent, that creative process that drives science.



Creativity drives scientific thought.
[Photo adapted from Fevcreate.com]

Another skill I've learned working on the project is how to achieve long-term goals. One lesson I learned quickly was that science does not happen overnight. Especially in a *Drosophila* lab, you have to work around the flies' schedule: it can take weeks before you have a proper sample to analyze. From there you have to evaluate the direction to go forward and begin the process of getting more data, until ultimately you have enough information to make a comprehensive scientific report. Along the way you run into roadblocks, mistakes, and general difficulties. What I've learned working on the project is that the key to overcoming these challenges and reaching the ultimate goal is perseverance.

That may sound cliché, yet in my own life perseverance has often been the roadblock to actualizing long term goals. When you are faced with a long string of challenges, with the reward far in sight, it can become difficult to carry on. This project has put that into perspective, and given me a new mindset on how to make long-term progress.

The key is to focus on the journey, not the destination; to celebrate the small victories, and learn from the mistakes. It is to enjoy the gradual progression, even as the goal has yet to be achieved. This mindset helped to keep the project enjoyable and maintain creativity, even as the ultimate goal of the project was far off. I feel this mentality will help me greatly in both my academic and personal future endeavors.



Perseverance, and an appreciation of the journey, help sustain long-term goals.
[Photo credited to Bishop, J.]

Finally, the project has given me a renewed appreciation for the field of biology. Life is perhaps the most intricate, fascinating system on Earth: this is why I chose to study biology. Yet it's hard to fully appreciate this intricacy in a strictly academic environment. Working on this project has reminded me just how sophisticated and captivating biology is; even a seemingly simple organism such as *Drosophila* reveals itself to be a labyrinth of genes, pathways, and complex behaviors we are left to uncover.

Furthermore, as discussed above, this project has revealed that biology is also a highly creative field. Life is a remarkably elaborate system, yet it's also one we have studied extensively and can interact with in powerful ways. This means we are able to let our minds wander and form new connections between the multitude of ideas that life presents. Whether it's

thinking about how we can modify certain genes, interact with certain pathways, or better understand how some process is working, biology thrives on ingenuity and a good imagination.

We are left to discuss: what is the current state of the project? There is still much work that needs to be done; we had a solid plan for what we wanted to accomplish back in March, but this, like many things, got disrupted by the outbreak of COVID-19. At the moment, we have a good foundation for the characterization of the gene, but we need details. These details can only truly be gained by running experiments. In the meantime, we have been working on collecting our ideas, expanding on them, and thinking things over until we are able to return to the lab.

Overall, the project, aided by the SEF, has been a milestone in my academic career. It has been not only a powerful way to engage with the field of biology, but also a profound learning experience. While there is still work to be done on the project, I feel it has already been an incredible effort, and I look forward to continuing it in the future.

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