Proposal of Master Research Project (MRP) for the Academic Year 2026-27

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Title of the MRP: Dissecting the Genetic Variability in Feeding Decisions

Summary of the MRP:

The ability to detect poisonous food, typically signaled through bitter taste, is essential for animal survival. Failure to detect such compounds can lead to the ingestion of food contaminated with harmful bacteria or plant-derived toxins, resulting in intoxication or death. Yet despite this universal selection pressure, various *Drosophila* species have evolved adaptive mechanisms enabling them to thrive in environments where primary food sources contain toxins. These species have developed tolerance mechanisms that allow them to detect toxins yet continue feeding, subsequently processing these compounds without lethal consequences. A striking example is *Drosophila sechellia*, a specialist species capable of feeding on noni fruit, which contains toxins that the generalist *Drosophila melanogaster* typically avoids. Such cases represent clear examples of ecological speciation, where species evolve to exploit environments with limited food resources that competitors cannot access.

Our recently published work (Mollá-Alabaldejo et al., 2025) demonstrates that internal physiological states can modulate how animals respond to bitter compounds, shifting decisions toward consuming toxic food when nutritional demand is sufficiently high. Strikingly, we have observed that this capacity to adapt behavioral responses varies substantially *within D. melanogaster* itself. Using genetically and geographically distinct strains from the Global Diversity Lines (GDL) collection, our preliminary data using a high-throughput two choice assay reveal dramatic differences in preference for bitter-laced food across inbred lines. This variation provides direct evidence that flies differ in their capacity to evaluate and respond to bitter compounds at the population level, while maintaining individual variation within strains.

Building on these precedents, the project will investigate the neural and genetic mechanisms underlying intra species variation in bitter food preference using a collection of inbred lines (GDL collection). Those mechanisms can be used by insect pests to tolerate the ingestion of insecticides that typically taste bitter for them, adapting to those threats. Our preliminary behavioral data demonstrate robust, reproducible strain-specific phenotypes, providing a solid foundation for mechanistic investigation. Our staged hierarchical strategy—from sensory receptors to central processing—will identify at which level(s) variation emerges. If variation occurs at a single level, this provides clear mechanistic insight; if at multiple levels, this reveals the distributed genetic architecture underlying complex behaviors, an important finding mirroring patterns in other behavioral traits. Systematically characterizing variation across the taste circuit will generate essential data—behavioral phenotypes, receptor expression profiles, and neuronal response properties across strains—launching a productive research program on how natural genetic variation sculpts neural circuits to produce behavioral diversity.

Objectives:

- Screen the GDL collection for variability in feeding discrimination of bitter food.
- Study the variability in bitter sensing, by measuring the response of gustatory sensilla to bitter compounds.

Methods and technology involved in the MRP:

- ***Drosophila* genetics. Crosses and management of transgenic stocks.**
- **Feeding Behavior Techniques (flyPAD, PER, Activity Monitors)**
- **Single Sensilla Recording (Electrophysiology)**

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