

# **The effect of mutant genes on the phenotypes of *Drosophila melanogaster*, and how linkage can cause the offspring to break from traditional inheritance patterns.**

**A. Logan**

## **Introduction**

*Drosophila melanogaster*, commonly known as fruit flies, are often used in experiments due to the fact that they have quick life cycles, only four chromosomes, and are not difficult to breed or take care of (Lab Handout, 2016). Fruit flies with five different mutant traits were used in the experiments for this class. These included vestigial wings, ebony bodies, yellow bodies, sepia eyes and white eyes, in comparison to the typical wild type fruit fly with extended wings, tan-striped bodies and red eyes. Each group performed two crosses with two of the mutant genes involved, with one cross being the reciprocal of the other in terms of the sex of the parents with each trait. The goal of the experiments was to determine the linkage of genes for a particular cross, as well as the crosses performed by other students. My group performed a yellow body x white eye cross and we found out that they are x-linked genes.

## **Methods**

This lab took approximately six weeks to complete from start to finish, although it could be completed in five. If time is an issue, the first steps of the lab may be completed on the same day as the next steps, as they are practice to get used to handling the flies. A vial of wild type fruit flies was anesthetized using FlyNap in order to become comfortable sexing the flies and determining the phenotypes when using a microscope. A mixed vial of flies was then

used to determine the potential mutant phenotypes that we could use in the experiment. The flies from both vials were discarded in the morgue before they woke up from the anesthesia.

Food was prepared in each of two milk bottles by mixing the food flakes (Carolina Biologicals) with an equal amount of distilled water and adding a few grains of yeast on top of the mixture. Males and virgin females with the desired traits were anesthetized. The traits and sex of each fly were confirmed, and ten of each sex were put into each bottle. Labels were applied to keep track of which bottle was white males and yellow females and which bottle was yellow males and white females. Bottles should be stored on their sides when the flies are unconscious.

One week later the adult flies were removed to make sure that the F1 generation would not breed with the P generation. These flies were not immediately anesthetized, but rather transferred to an empty bottle without food, and then anesthetized in order to prevent them from sticking to the food. The P generation flies were discarded into the morgue. Water was added to the food mixture if it was too dry.

The following week required two additional bottles to be set up with food as done previously. Adult flies were transferred to empty bottles and anesthetized in order to determine the phenotypes present in each

sex. Ten flies of each sex were put into the bottle for each cross. Labels had to include the parental generation in order to maintain clarity throughout the experiment. All flies, except the ones placed into these new bottles were discarded. At this point we could determine if each mutant allele was dominant or recessive, and autosomal or sex linked.

After one week the adults were removed using the same steps as before when food was present in the bottle two weeks ago.

In the final week the sex and phenotype of all, or most, of the flies needed to be recorded. The flies were removed in a way that they would not get stuck in the food and they were counted before being discarded (Lab Handout, 2016).

## Results

The results of the F1 generation are straightforward. Each sex had one set of traits for each cross. Two mutant phenotypes were not viewed in any individuals, but two wild type phenotypes occurred in all females (Table 1). Our data was consistent with the provided *Drosophila* data for this lab.

| F1 Results of Crosses |                                 |                                    |
|-----------------------|---------------------------------|------------------------------------|
| P Generation          | Male Offspring                  | Female Offspring                   |
| White ♂xYellow ♀      | Yellow bodies<br>Wild type eyes | Wild type bodies<br>Wild type eyes |
| Yellow ♂xWhite ♀      | Wild type bodies<br>White eyes  | Wild type bodies<br>Wild type eyes |

Table 1: The results of our parental cross and its reciprocal cross. All offspring of each sex had the same phenotypes for its respective cross.

## F2 Results of Crosses

| P Generation     | Male Offspring                                                                 | Female Offspring                       |
|------------------|--------------------------------------------------------------------------------|----------------------------------------|
| White ♂xYellow ♀ | 7 w eye, y body<br>43 w eye, wt body<br>46 wt eye, y body<br>3 wt eye, wt body | 49 wt eye, wt bod<br>86 wt eye, y body |
| Yellow ♂xWhite ♀ | Unable to collect data                                                         |                                        |

Table 2: The results of our F1 cross and its reciprocal cross. Offspring of each sex had varying phenotypes.

Our results for the F2 generation were a little more complex. Each sex had multiple possible traits for each cross. Two mutant phenotypes were viewed for some individuals, which should not have occurred (Table 2).

## Discussion

We learned that genes for eye color and body color are both recessive and X-linked. We could determine this because each sex in the F1 generation had different traits. If it were autosomal the trait would be split about evenly between the offspring of each sex. As seen in the Punnett Squares, each group of F2 offspring can have only two phenotypes for each sex in this generation for each cross (Figures 1-3).

### F1 Offspring

|                       |                   |             |
|-----------------------|-------------------|-------------|
| White ♂ x<br>Yellow ♀ | $X^{wy+}$         | Y           |
| $X^{w+y}$             | $X^{wy+}/X^{w+y}$ | $X^{w+y}/Y$ |

Figure 1: Punnett Square outlining the expected results of the F1 generation for a cross between white males and yellow females.

### F2 Offspring

|                       |                   |             |
|-----------------------|-------------------|-------------|
| White ♂ x<br>Yellow ♀ | $X^{wy+}$         | Y           |
| $X^{wy+}$             | $X^{wy+}/X^{wy+}$ | $X^{wy+}/Y$ |
| $X^{w+y}$             | $X^{wy+}/X^{w+y}$ | $X^{w+y}/Y$ |

Figure 2: Punnett Square outlining the expected results of the F2 generation for a cross between white males and yellow females.

### F1 Offspring

|                       |                   |             |
|-----------------------|-------------------|-------------|
| Yellow ♂ x<br>White ♀ | $X^{w+y}$         | Y           |
| $X^{wy+}$             | $X^{w+y}/X^{wy+}$ | $X^{wy+}/Y$ |

Figure 3: Punnett Square outlining the expected results of the F1 generation for a cross between yellow males and white females.

### F2 Offspring

|                       |                   |             |
|-----------------------|-------------------|-------------|
| Yellow ♂ x<br>White ♀ | $X^{w+y}$         | Y           |
| $X^{w+y}$             | $X^{w+y}/X^{w+y}$ | $X^{w+y}/Y$ |
| $X^{wy+}$             | $X^{w+y}/X^{wy+}$ | $X^{wy+}/Y$ |

Figure 4: Punnett Square outlining the expected results of the F2 generation for a cross between yellow males and white females.

Ebony and sepia are autosomal recessive and occur close to each other on the same autosome. No double mutants were present.

Vestigial and sepia are autosomal recessive and occur a little farther apart on the same autosome. Some crossing over occurred, resulting in double mutants.

Ebony and vestigial are autosomal recessive and occur some distance apart on the same autosome. Some crossing over occurred, resulting in double mutants.

Yellow and white are X-linked recessive genes. There are no double mutants, so no crossing over occurred. They are likely close to each other on the chromosome.

Ebony is autosomal recessive and yellow is X-linked recessive, so various phenotypes in the offspring were not present in individuals of certain sexes.

| X-chromosome | Autosome  |
|--------------|-----------|
| Yellow       | Sepia     |
| White        | Ebony     |
|              | Vestigial |

Figure 5: Relative locations of the five mutant traits studied on the X-chromosome and one autosome of *Drosophila*.

Some errors were made during our lab. We were not able to collect data for our F2 cross of yellow males to white females in the P generation. There also should not be any white eyed, yellow bodied males or any wild type males, but we viewed both. They could have been mistaken for another phenotype when viewed under the microscope, or there could have been an error when another lab partner was recording the data.

In order to confirm the results viewed in the Punnett squares, I would recommend viewing the F2 flies from the white male / yellow female cross to see if we made mistakes when counting, but the offspring had been disposed of as soon as we finished counting. When trying to remove the yellow male / white female flies from the bottle they got caught in the food because it was too liquidy, so counting these flies would have been difficult.

Analyses could not be performed on my group's data due to the misidentifying of some flies and the loss of the second cross.

I would recommend repeating this experiment if possible for the crosses that our group individually did in order to get the results that we should have expected.

### References:

Lab Handout, *Drosophila melanogaster* Genetics, Shippensburg University Department of Biology, 2016.