Effects of Meiotic Drive on Developing Eye-Stalks in Stalk-Eyed Flies

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Abstract

Teleopsis dalmanni, commonly known as Stalk-Eyed flies, are known for their sexually dimorphic eye-stalks which females use to pick mates. Within the Gombak-12 population, some individuals contain meiotic drive which is known to influence eye-stalk length and sex ratios. Our goal was to identify genes in developing eye tissue that play a role in causing meiotic drive. To identify these candidate genes, we determined the sex and meiotic drive status of individuals by dissecting 3rd instar larvae for their carcasses. After finding that Qiagen Puregene and Qiagen DNeasy columns DNA extraction techniques worked best—determined by using gel electrophoresis—we prepared our samples, ran PCR, then sent them for fragment analysis. From genomic analysis, we identified 31 male and 66 female Stalk-Eyed larvae and approximately one third of males and females within the population had meiotic drive. Based on this information, we plan on using the larvae’ eye-antennal imaginal discs from our dissections to measure the differential gene expression using RNA in meiotic and non-meiotic drive individuals.

Methods

- Gombak-12 fly stocks were kept under standard conditions and samples were dissected in their 3rd instar larval stage for their eye-antennal imaginal discs
- To prevent the degradation of the eye-antennal discs, we used RNase Displace to create an RNase free environment before starting the dissection.
- We placed the larvae in a drop of Phosphate-buffered saline (PBS) on a petri dish to protect the sample from desiccation.
- Using a dissecting scope and fine forceps, we tore the heads of the larvae off of their bodies and further dissected out the brain from the heads.
- From the brain—comprised of a central nervous system with two optic lobes—we separated the eye-antennal discs that rest right on top of the optic lobes, and then stored them in a -80°C freezer for future use.
- We used squish buffer DNA extraction, ethanol precipitation of DNA, Qiagen DNeasy columns (DNeasy) and Qiagen Puregene DNA extraction protocols to prepare samples for genomic analysis in RStudio to reveal sex and meiotic drive status of our samples.

Results

From genomic analysis (figures 4 and 5), we determined that we dissected 41 female and 31 male larvae, and that 36.6% of females had meiotic drive and 35.5% of males had meiotic drive—roughly the same amount for both sexes (table 1). From the larval dissections, we were able to get 83 different larvae’ eye-antennal discs.

From gel electrophoresis (figures 6, 7, and 8), it showed that DNeasy resulted in more bands than any other DNA extraction protocol. This was because the other protocols failed and the DNA in the Puregene samples was too concentrated preventing PCR from working effectively. From the DNA spectrometer data (table 2) Puregene—on average—produced more DNA by weight than DNeasy. From genomic analysis (table 1) we found that DNeasy extracted DNA out of ~10% more samples than Puregene, indicating that DNeasy was most effective.

Introduction

T. dalmanni (figure 1) are insects native to Malaysia and belong to the fly family Diopsididae. They are characterized by their sexual ornamentation: long eyestalks protruding from their head with an eye attached to the end. Studies show that females favor males with longer eye-stalks—whose length is influenced by meiotic drive. Meiotic drive—carried on the X chromosome—violates the law of segregation since in male meiotic drive flies they will always pass on their X chromosome and not their Y chromosome (figure 2). This could cause a population to go extinct because this results in not enough male progeny to sustain the population.

To study the effect of meiotic drive on developing eye-stalks, we looked at the larvae’ imaginal discs—tissues that develop into parts of an adult fly—specifically the eye-antennal discs. We plan to first genotype individual flies for their sex and meiotic drive status, then look at their RNA to study gene expression in the eye-antennal discs. We will compare differences in gene expression between non-meiotic and meiotic drive individuals, leading to possible gene candidates that contribute to meiotic drive.

Figure 1: Stalk-Eyed fly exhibiting long eye-stalks, a sexual ornament.¹

Figure 2: Punnett square showing the effect of meiotic drive on offspring, where X* represents a meiotic drive allele.

Future Research

- Eye-antennal discs from non-meiotic drive and meiotic drive individuals will be analyzed for their RNA to look at differential gene expression to find genes likely influencing meiotic drive.
- Other future research could include the study of Stalk-Eyed fly brains—specifically the eye-antennal discs. We plan to first genotype individual flies for their sex and meiotic drive status, then look at their RNA to study gene expression in the eye-antennal discs.

Acknowledgements

- Special thanks to Dr. Jose Ramirez, Dr. Travis Bailey, Amy Farnham, Amie Library staff, and the McNair program for their guidance and support.
- Funded by the Ronald E. McNair Post-Baccalaureate Program.