Courtship in Bang-Sensitive *Drosophila melanogaster*: *A Behavioral Study*

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Abstract

Drosophila melanogaster was used in this study to assess the effects of a Bang-Sensitive paralytic mutation on courtship. Since courtship is recognized as a stereotyped action pattern in *Drosophila* involving orientation, wing extenstion, following behavior, tapping, licking, attempted copulation, and copulation, it is used as a basis to study behavior.

Bang-Sensitive paralytic *Drosophila* exhibit seizure-like behavior following intense mechanical or electrical stimulation. In general, these seizures consist of erratic and uncoordinated wing flapping, leg shaking, and abdominal muscle contractions. Based on the similarity between *Drosophila melanogaster* seizures and those seen in humans, these mutants have recently begun to emerge as a model organism for studying the poorly-understood human seizure disorders.

In this study, comparisons were made among five Bang-sensitive mutants, known as slamdance (sda), easily shocked(eas), technical knockout(tko), bang sensitive(bas), and bang senseless(bss), and the wild type Oregon-R strain. My findings suggest that bang-sensitivity does affect courtship, and that the effects are more marked in some strains than others.

Introduction

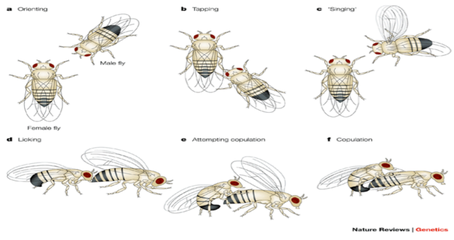
Drosophila melanogaster, otherwise known as the fruit fly, is a popular model organism in the Biological sciences for a number of reasons. For one, *Drosophila* have a short life cycle, lasting approximately 10 days from copulation to eclosion. Because of their size, fruit flies are also easily maintained. This makes it easier for researchers to control for environmental factors that may confound results. Finally, fruit fly genetics are well-known and well-understood in the scientific community.

For this particular study, we worked with a specific class of flies known as the bang-sensitive paralytic mutants. These mutant *Drosophila* exhibit seizure-like behavior following intense mechanical or electrical stimulation. One can induce a "seizure" in these fruit flies by banging their vials against a lab table or by placing them in a lab vortex machine. In general, these seizures consist of erratic and uncoordinated wing flapping, leg shaking, and abdominal muscle contractions. Once the seizure passes, the fly exhibits behavioral paralysis. This immobility following the seizure is believed the be the result of the failure of the Giant-Fiber pathway. Normally, this neuronal pathway is responsible for the "jump-and-flight" response to visual stimuli. Even under intense electrical stimulation, however, no response is evoked.

Despite the relative simplicity of the the fruit fly nervous system in comparison to that of mammals, these seizures have been compared to those suffered by humans. Recently, the bang sensitive fruit fly has emerged as a model for studying epilepsy and other seizure disorders. The purpose of this study, then, is to determine whether this neurological deficiency has any effects on the behavior of the fly. One way to assess for behavioral deficits is to study a well-defined, fixed action pattern in the fly. One example of a fixed-action pattern is courtship.

Courtship in *Drosophila* is primarily governed by the male; however, the female does elicit chemosensory clues that initiate the process. The steps involved in the courtship paradigm are shown in the Figure 1 below. In general, when a male and female are introduced, the courtship ritual begins when the male faces his body toward the female in a step known as "orientation." This step is normally followed by "singing," in which the male extends and vibrates one of his wings at a species-specific frequency. The male does this to ensure the female that he is the proper species with whom she should mate. The male also taps the female's abdomen, follows her around in an attempt to slow her locomotion and accept him, and licks her genitalia with his proboscis. If the female slows her movement enough, the male will attempt copulation and, in some cases, successfully copulates with the female. Normally, copulation lasts for approximately twenty minutes.

Since male flies govern the courtship paradigm, their behavior was the focus of this study.



Experimental Method

This behavioral study necessitated the use of five bang-sensitive paralytic mutant strains of *Drosophila melanogaster*, along with the Oregon-R wild type strain. The mutant strains included bang sensitive (bas), bang senseless (bss), slamdance (sda), technical knockout (tko), and easily shocked (eas). Because it was necessary for the flies to be virgins, they were collected within eight hours of eclosion; the males were housed singly, while the females were housed in small groups. After maintaining these adult flies in the incubator for seven days, I observed their courtship.

A "mating chamber" was used to observe courtship. The apparatus is a 0.25cm thick sheet of Plexiglas with holes 1.27cm in diameter placed on top of glass plates and covered with microscope slide. This provided a completely transparent surface to contain the flies and observe the courtship paradigm. Because low humidity inhibits courtship, I lined the chamber with filter paper dampened with distilled water. Control data was obtained by studying the Oregon-R strain, while experimental data was obtained using the bang-sensitive mutants.

When observing courtship, specific intervals were measured during the process. They are as follows:

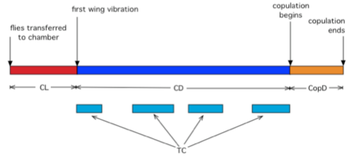
Courtship latency (CL): period between the introduction of the male fly into the mating wheel and the first wing extension

Courtship duration (CD): begins with the first wing extension and ends either with copulation or the conclusion of the 15 minute observation period

Time courting (TC): the amount of time during the CD interval in which the male fly actively courts the female fly

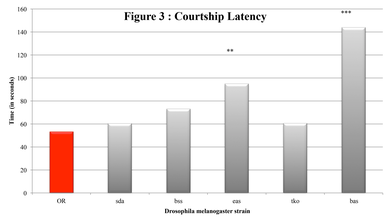
Courtship index (CI): proportion of the observation the male spends courting the female; obtained by dividing the CD by TC

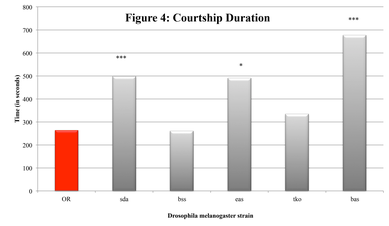
Copulation duration (CopD): time the flies spend copulating,

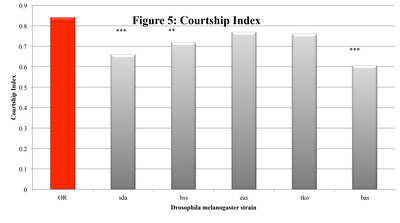


Results

The data obtained suggests that courtship is impacted by bang-sensitivity, as outlined in the figures below.







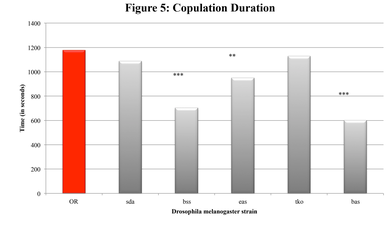


Table 1: Summary of effects of bang-sensitivity

	sda	bss	eas	tko	bas
CL			X		X
CD	X		X		X
CI	X	X			X
CopD		X	X		X

Discussion

Figure 3 demonstrates that the eas and bas mutants differed significantly from the Oregon-R in courtship latency, suggesting it takes these strains longer to initiate courtship. Figure 4 shows that the sda, bss, and bas mutants have significantly longer courtships than the wild type flies, suggesting that it takes these flies longer to begin copulating or that, while active courters, these flies had diminished success with achieving copulation. Figure 5 shows that sda, bss, and bas mutants spend a significantly shorter proportion of time actively courting than Oregon-R. Figure 6 shows that bss, eas, and bas cease copulation after significantly less time than Oregon-R.

Figure 7 summarizes the accumulating effects of bang-sensitivity on courtship. Technical knockout (tko) did not differ significantly from the Oregon-R in any category, while the bang sensitive mutant (bas) differs in all four. (N.B. The bang sensitive (bas) mutants also had the scalloped wing and forked mutations on the X-chromosome; it remains unseen whether these mutations have any effect on courtship.) The majority of the bang-sensitive paralytic mutant *Drosophila* do differ from wild type flies in terms of courtship. Since courtship is a stereotyped action pattern used to measure behavior, it is also fair to say that the neurological deficits contributing to bang-sensitivity do have, to different extents, an effect on behavior.

Despite their prevalence in American society, seizure disorders and, in particular, the reasons some people are more susceptible to seizures than others, are not well-understood. However, the Bang-Sensitive paralytic *Drosophila melanogaster* mutant has recently emerged as a model organism with which to study seizure disorders. Therefore, any study related to these mutants adds to the body of knowledge of seizures. Furthermore, this study can be extended in to a study of learning and memory. It has already been suggested that *Drosophila* courtship is experience dependent, and that wild type males remember the rejection experienced by successive pairings with fertilized female flies for up to two hours. It would be interesting to see if Bang-sensitivity hampers learning and memory as well.

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