DATA Nugget

How to Escape a Predator

Featured scientists: Amy Worthington and John Swallow from Washington State University and University of Colorado, Denver

Research Background:

Stalk-eyed flies are insects that have their eyes on the ends of eyestalks, or long projections from the sides of their head. Eyestalks are a **sexual signal** that males use to attract females. The longer the eyestalks, the more attractive a male is to females and the more mates he gets. For these flies, this process, called **sexual selection,** leads to an elaborate trait, just like a peacock's tail. Males with longer eyestalks have more babies and pass their traits on. Over generations, sexual selection leads to longer and longer eyestalks in males.

However, these eyestalks may come with a cost. Males with longer eyestalks may not be able to move easily and quickly. If they can't move as fast, males with long eyestalks may be worse at escaping predators. **Natural selection** may select against long eyestalks if males with more elaborate traits are killed and eaten more often by predators. If predators eat males with longer eyestalks before the flies reproduce, they will not get to pass on their traits, regardless of how attractive they are to females.

In addition to eyestalk length, other traits could affect survival in male stalk-eyed flies. Perhaps a fly's behavior is more important than its eyestalk length when faced with a predator. When biologists Amy and John first started researching how eyestalk length affected survival, they noticed something intriguing! The flies showed many different behaviors when face to face with a spider predator. Some examples of behaviors included grooming, walking or flying towards the predator, quickly walking or flying away from the predator, displaying forelegs, and bobbing their abdomens. When prey use these **antipredator behaviors**, predators must put in more work to catch prey, and they will sometimes give up. Therefore, antipredator behaviors may influence the predator's choice of prey, and certain behaviors that make prey harder to catch could lead to increased survival.

A stalk-eyed fly and spider interacting in the arena.

To test whether differences in eyestalk length and/or antipredator behavior were important for survival, male stalk-eyed flies were put in cages with predators. Amy and John filmed the fly behaviors and analyzed the footage. They calculated the frequency and proportion of time that flies were displaying antipredator behaviors. If males with longer eyestalks have lower

survival than males with shorter eyestalks, it suggests that longer eyestalks make it harder to avoid predators. However, if eyestalk length has no effect on survival, it suggests that male flies with long eyestalks are able to compensate for their lack of speed through behavior.

Check for Understanding: After reading the introduction, students should be able to:
- Describe how sexual selection and natural selection differ.
- Describe the hypothesized tradeoff of eyestalk length for males.
- Describe how behavior traits could potentially help males compensate for long eyestalks.

Scientific Question: How do differences in eyestalk length and antipredator behavior affect predation risk in male stalk-eyed flies?

What are the two alternative hypotheses? Find the two alternative hypotheses in the Research Background and underline them. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data below to answer the scientific question:

Table 1: Traits for surviving and dead male flies after predator trial.

Trait	Surviving Males	Standard Error	Dead Males	Standard Error
Average eyestalk length (mm)	7.95	0.08	7.94	0.13
Average Body Width (mm)	1.84	0.02	1.87	0.02
Percent of males	24.59%		75.41%	

Table 2: Behavior of male stalk-eyed flies in the presence of a predator.

Behavior	Surviving Males	Standard Error	Dead Males	Standard Error
Abdomen bobbing (proportion of time involved in behavior)	0.80	0.05	0.69	0.09
Jabbing predator (number/ minute)	0.07	0.03	0.05	0.02
Flying retreat (number/ minute)	0.25	0.04	0.78	0.32
Walking retreat (number/ minute)	0.50	0.05	0.80	0.29

What data will you use from Table 1 to answer the question?

Independent variable: Male survival (dead or alive)

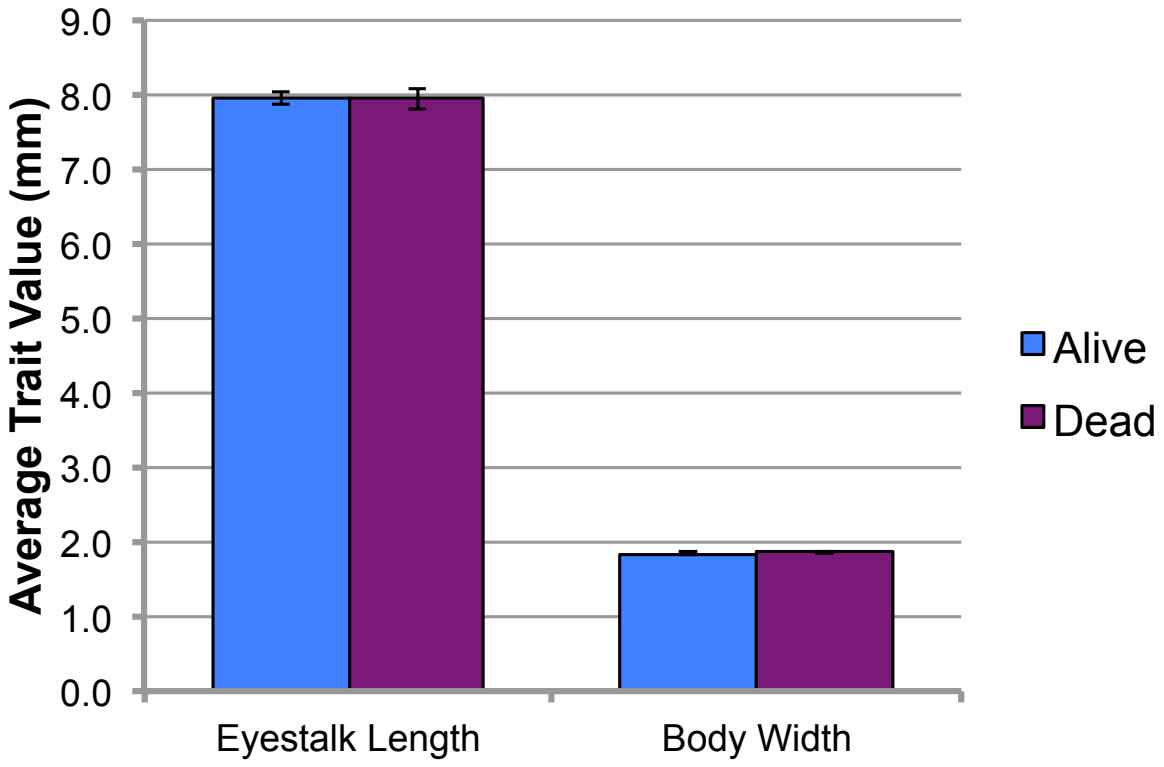
Dependent variable: Average eyestalk length (mm)

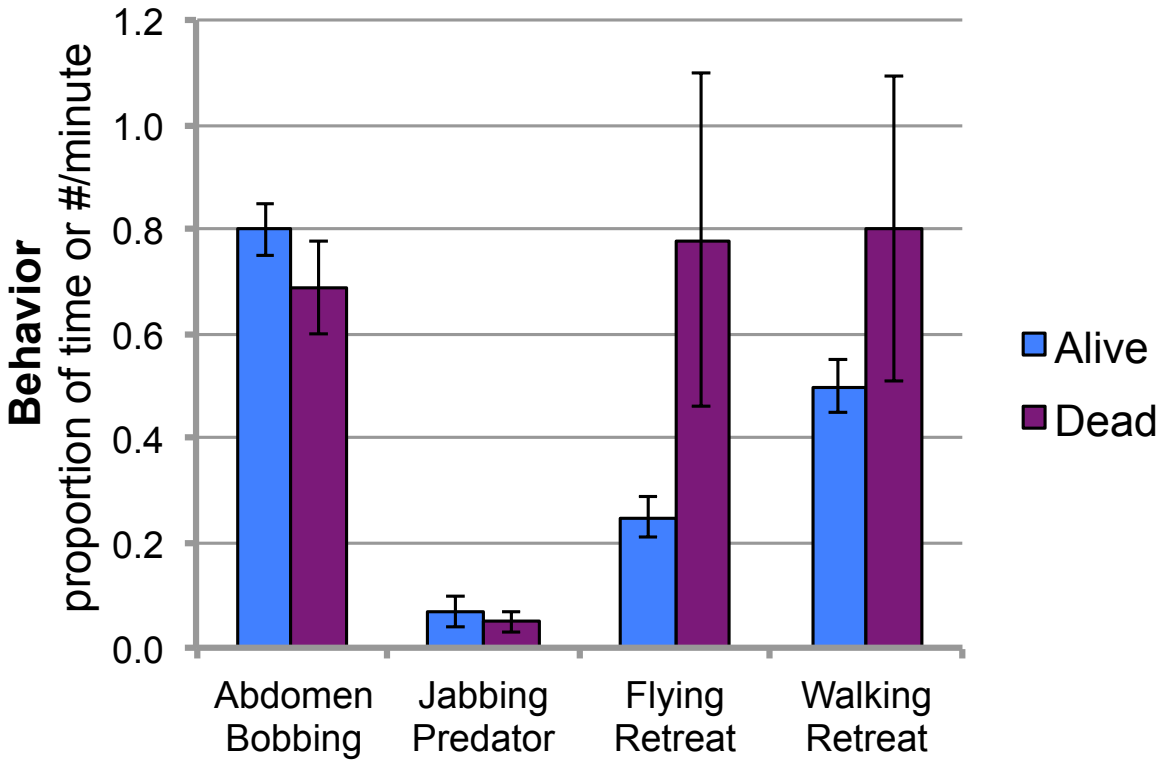
What data will you use from Table 2 to answer the question?

Independent variables: Male survival (dead or alive)

Dependent variable: Amount of time/ # of times performing each of the antipredator behaviors (abdomen bobbing, jabbing, flying, walking)

Draw your graph(s) below: Teacher note – students will have to choose the data they want to graph. It might not be necessary to graph the traits in Table 1 since the table makes the comparison between surviving and dead males quite easy to interpret. Students may choose to graph the behaviors since this table is harder to interpret without a visual representation.





Interpret the data:

Make a claim that answers the question, how do differences in eyestalk length and antipredator behavior affect predation risk in male stalk-eyed flies?

Eyestalk length had no effect on predation risk in male stalk eyed flies. Some behaviors affected predation risk – there was no affect of abdomen bobbing or jabbing on survival, but males that performed a flying or walking retreat more often were more likely to be killed by the spider predator. The body width data is not needed to make this claim.

Support your claim using data as evidence. Describe the relationship between the dependent and independent variables. Refer to specific parts of the table or graph.

Eyestalk length was very similar for males that survived and those that did not. Males that survived had an average length of 7.95mm, while males that were killed had an average length of 7.94mm. Some behaviors were also very similar for surviving and dead males. Males that survived bobbed their abdomens 80% of the time, while males that died bobbed their abdomens 69% of the time. There is a lot of variation in this data (overlapping SE bars), so these two values probably do not differ statistically. Males that survived jabbed at the predator 0.07 times per

minute, while males that died jabbed at the predator 0.05 times per minute. Again, these values are very close. The performance of a flying or walking retreat were the only differences observed between males that survived and those that did. Males that survived performed fewer retreats per minute than did males that were killed by the predator.

Describe your scientific reasoning and explain how the evidence supports your claim.

This study was able to answer the first question, if eyestalk length affects survival. The data collected showed that surviving males did not differ from non-surviving males in eyestalk length or body width. The study was also able to answer the second question, if antipredator behaviors can affect survival. The data shows that there were some behavioral differences between surviving and not surviving males.

According to the data, is there sexual selection or natural selection operating on any of the measured traits in male stalk eyed flies?

From this experiment we cannot determine if sexual selection is operating. There is no female choice and we cannot determine if males with longer eyestalks or certain behaviors will be more attractive to females. As for natural selection, behavioral traits do differ for males that survive and those that did not. There is selection against the behaviors of flying and walking retreat. Over time, males that do not retreat will have higher survival, potentially leaving behind more offspring. There is no evidence of natural selection operating on the abdomen bobbing and jabbing traits, as survival was the same regardless of performing the behavior.

Teacher Note: You can expand this question to include a discussion of how evolution might play out in this system. Once students have identified traits under natural selection, bring in the other things that must be present for evolution to occur. Remember **VIST** – **V**ariation, **I**nheritance, **S**election, and **T**ime. We see evidence that selection is acting on the flying and walking retreat traits because of the differences in survival. Ask students if they see evidence of variation in the traits (students can refer to the SE bars and show that all values do not fall right on the mean, therefore there is variation in the trait). From this study we cannot determine if behavior traits are heritable, but students could ask the scientist if they know if males that retreat leave behind offspring that are more likely to retreat. Finally, time, in the form of several generations, would be needed to observe evolution. Over generations, males that did not retreat may leave behind more offspring, and the retreating behaviors would become less common in the population.

Your next step as a scientist: Science is an ongoing process. Did this study fully answer your original question? What new questions do you think should be investigated? What future data should be collected to answer them?

Because the question is focused on answering if differences in eyestalk length affect predation risk, it was important to attempt to control other variables, like selecting flies with similar body widths to use in this experiment. Data for body width was included here, but students could discuss other traits that might vary in the population of stalk eyed flies and how those might contribute to survival when faced with a spider predator.

Additional teacher resources related to this Data Nugget:

A scientific paper published using the data in this activity:
http://datanuggets.org/wp-content/uploads/2015/10/Worthington-Swallow-2010.pdf

Video showing how the long eyestalks of males form! Once the male flies pupate, the fill their heads with air and blow air into the eyestalks, making them longer.
https://youtu.be/bGX7zZk0Eo4

Videos of trials performed by Amy. Students can observe the male flies performing some of the behaviors mentioned in this activity.
https://youtu.be/nSRgbYce_2g
https://youtu.be/uJ7agA8ISLk
https://youtu.be/Auy3bPs8tJg