Why Female Moths are Big and Beautiful

March 11 2010, By Daniel Stolte

A giant hawk moth blends in with the bark of a tree. Credit: Photo by Jacob Lockey

(PhysOrg.com) -- In most animal species, males and females show obvious differences in body size. But how can this be, given that both sexes share the same genes governing their growth? University of Arizona entomologists studied this conundrum in moths and found clues that had been overlooked by previous efforts to explain this mystery of nature.

Take a look around in the animal world and you will find that, in most organisms, individuals of one sex are larger than the other of the species.

Even though evolutionary biologists have long recognized this discrepancy, called sexual dimorphism, they have struggled for decades

to solve a major paradox: How can males and females of one species be of different sizes, given that they share the same genetic blueprints dictating their development and growth?

Researchers from the University of Arizona have discovered that the key to unraveling this mystery lies in the early developmental stages during which the sexes begin to grow apart and that females can respond to selection on size almost twice as fast as can males.

Their findings are published online before print in *Proceedings of the Royal Society of London, Series B*.

"In mammals, the males tend to be larger because there is an advantage in being bigger and stronger when it comes to fighting over who gets the female," explained Craig Stillwell, lead author of the study and a UA Center for Insect Science postdoctoral fellow in the lab of Goggy Davidowitz, an assistant professor of entomology at the UA.

"In most arthropods, on the other hand, we find the opposite: the females are bigger than the males. Think of spiders, for example. In some species, the female can be hundreds of times larger than the male.

"The question we asked was, 'how do females and males come to be different in size?'"

Many biologists have tried to solve this puzzle over time, but when Stillwell and Davidowitz looked at the literature, they realized something was missing in the picture.

"Since there is no difference - at least that we know of - between the male and female genes controlling growth, nobody could figure out why we see what we see in nature: differently sized males and females," said Stillwell.

Scientists have known that growth rates do not differ between female and male caterpillars and thus cannot account for the observed size difference. Rather, the sexual dimorphism observed in the adult animals more likely has to do with differences in the time the two sexes spent as growing larvae. Even in light of that, nearly all research has focused on the adult animals.

Sexual size dimorphism: Female hawk moths (left) are larger than their male counterparts. Credit: R. Craig Stillwell

"We are the first ones to look at the larvae with this question in mind," Stillwell said.

Stillwell and Davidowitz chose the giant hawk moth (Manduca sexta), a species native to Arizona, as a model organism, mostly because this insect species is well-studied, easily bred in the lab and large enough to allow for ease of handling and measuring.

The researchers followed more than 1,200 caterpillars from the time they hatched, all the way through four molts and until they pupated. They weighed and measured the animals at different times during development and fed the data into a complex statistical model they developed.

For most of their lives as caterpillars, females and males do not appear much different.

"The final larval stage is when it all happens," Stillwell said. "There is a point in the caterpillar's life when an inner clock and environmental cues tell the animal it's time to become an adult. Hormonal changes make them stop feeding and wander around looking for a place to pupate. Within a few hours they develop into a pupa, from which the adult moth will emerge a few weeks later."

Stillwell and Davidowitz discovered that female caterpillars initiate this fundamental change a bit later than the males. By the time the female caterpillars pupate, they are larger, making for larger moths when they emerge.

So where is the advantage in being larger if you're a female insect?

"Biologists think selection favors large females because they can produce more offspring," Stillwell said.

"Another exciting result of this study is that we found a lot more variation in the physiological makeup of the female caterpillars compared to male individuals. Therefore, over generations, the females are able to respond to selective pressures nudging them toward large body size much faster than the males."

More information: R. Craig Stillwell and Goggy Davidowitz, A developmental perspective on the evolution of sexual size dimorphism of a moth. Proceedings of the Royal Society of London, Series B, published online before print on March 10, 2010.

Provided by University of Arizona