Researchers uncover that moths talk about sex in many ways

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Moth: This is the Asian corn borer. Credit: Ryo Nakano

Moths are nocturnal, and they have one major enemy; the bat. As a defense many moths developed ears sensitive to the bat´s echolocation cries, and they have also developed different behaviors to avoid bats. Now it turns out that many moths are able to use both their hearing and their avoidance behavior to an entirely different purpose: to

communicate about sex. According to a Danish/Japanese research team the various moth species probably talk about sex in a great number of different ways. This sheds new light on the evolution of sound communication and behavior.

Moths have probably developed ears for the sole purpose of hearing if their worst enemy, the bat, is near. It has long been thought that moths were dumb, but many of them actually produce sounds - just so softly that bats cannot hear them. The moths use the sounds to communicate sexually. This scientists have known for a few years, and now new research reveals, that moths have developed different ways to not only use their sense of hearing, but also their avoidance behavior that was originally developed as a defense against bats.

"We have examined two different moths and seen that they use their ears and behavior quite differently when they communicate sexually. There is no reason to believe that other moths do not do it in their own way, too. The variation in how to use these skills must be huge", says sensory physiology researcher, Annemarie Surlykke from Department of Biological Sciences, University of Southern Denmark (SDU).

She and her Japanese colleagues from University of Tokyo have studied the two species, Asian corn borer moth (*Ostrinia furnacalis*) and Japanese lichen moth (*Eilema japonica*). Both species, like many other moths, developed ears to hear the bats, but they have also managed to get more out of their sense of hearing. Males of both species have developed a method to court females with sound - but the methods are very different.

The Asian corn borer moth's technique is the simplest: It produces sounds similar to the echolocation cry of a hunting bat. Thus the male fools the female to believe that a bat is nearby. She responds by sitting perfectly still in an anti-bat freeze position to avoid the bat's attention -

and now the male can mate with her, because it is much easier when she sits perfectly still. When the researchers played first the sound of a hunting bat and then the sound of a courting male mating in the laboratory, females responded in both cases by freezing. Females simply could not hear the difference, the researchers conclude.

Moth: This is the Japanese lichen moth. Credit: Ryo Nakano

The male Japanese lichen moth is more advanced. He, too, emits a sound that sounds like a hunting bat. But when the researchers played first the sound of the bat and then the sound of a courting male, the females in the laboratory had no doubt: They could hear the difference in the details of the sounds and would only mate if the sound came from a courting male. This means that the evolution of bat defense to sexual communication has gone one step further with the Japanese lichen moth:

It has developed a specific recognizable mating signal, while the Asian corn borer moth does not distinguish between sounds from a bat and a courting male.

"The acoustic communication between bats and moths is a textbook example of the interaction between predator and prey. However, our studies show how such a system can evolve, so also moths use their ability to hear and produce sounds to communicate sexually and that they have developed many different ways of doing it. It is a beautiful example of evolutionary diversity", says Annemarie Surlykke.

Moths have not always been able to hear. The ability occurred when bats began to fly in the night sky and used echolocation for orientation 50 - 60 million years ago. Ever since, moths and bats have been locked in an eternal arm's race with the bats trying to find the moths and moths trying to avoid the bats.

Moth ears are quite simple constructions with just one, two or four sensory cells, but it is enough to capture the cries of a bat.

"Moths could have limited themselves to use their hearing for that one purpose alone. And until a few years ago it was believed, that the vast majority of moths did not use their ears for anything else", explains Annemarie Surlykke.

But in 2009 she and some colleagues showed that far more moths than previously thought actually produce sounds. The researchers selected a sample of 13 species, and it turned out that the males in 70 per cent of the species produced different sounds as a way to communicate with females. Almost all sound made by moths, is ultrasound, so it cannot be heard by the human ear, but for sure by bats.

"At first glance it seems like a bad idea to produce sound when your

worst enemy almost exclusively use the sense of hearing to hunt with - to produce a sound is the same as calling the bat", says Annemarie Surlykke.

But it does make sense, she explains further. Moths only produce sounds when they are quite close to each other. Often, they are not further apart than two centimeters, and they "whisper" so that their signals are so weak that the bats flying at a distance cannot register them.

"I am convinced that there is a lot of whispering communication among moths, which is so quiet that it is difficult to detect and therefore we mistakenly think it does not occur. Or results offer a whole new understanding of the many directions, evolution of sound communication can lead to, on a basis of system that was originally developed for defense against an enemy. This leads to a new understanding of evolutionary processes", she explains.

More information: *Scientific Reports*: Evolution of deceptive and threaten courtship songs in moths, published on June 20, 2013.

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