The Journal of Experimental Biology 212, 3935
Published by The Company of Biologists 2009
doi:10.1242/jeb.040113

Editorial

Invertebrate sound and vibration

Ever since the 1970s, biologists studying mechanical perception and signaling, i.e. sound and vibration, in insects and other arthropods have assembled at an independent conference held every 2–3 years to report their recent findings. The most recent conference, the XIIth International Meeting on Invertebrate Sound and Vibration (ISV), was held in Tours, France in October 2008 and was organized into five specific areas: neurobiology (neuroethology and neurophysiology), systematics and phylogenetic analysis, evolutionary genetics and speciation, biomechanics of signal reception and transmission, and sensory ecology. Some of these areas are traditional and formed a major part of the early ISV meetings, but others, particularly phylogenetic analysis and sensory ecology, have emerged as major themes in recent years.

This issue of *The Journal of Experimental Biology* features four articles based on experimental studies reported at that conference. These articles address questions on the production and perception of mating signals in acoustic insects and on the vibration signals of a social parasite of ants.

Biologists have known for many years that the perception, as well as the production, of ultrasound plays a significant role in the defensive strategies of moths against insectivorous bats. The role of ultrasound in sexual communication in moths is also known in a few species. We now learn that the role of ultrasound in moth communication may have been underestimated. Nakano et al. (p. 4072) report that males in several species of crambid moths produce extremely low amplitude ultrasound signals during courtship. This 'whispering' behavior, which could be a means of avoiding eavesdropping by neighboring males, appears necessary for successful mating. Because this behavior is so inconspicuous, Nakano et al. speculate that it could be more widespread.

At the other end of the amplitude spectrum, and in a pyralid moth species where ultrasound communication has been studied for a long time, Limousin and Greenfield (p. 4091) investigated the way in which females evaluate the loudness of male song. As expected, females discriminate song on the basis of amplitude, but they also evaluate the way in which song fluctuates over time. Given songs of equivalent acoustic power, females prefer those that attain brief amplitude maxima (fortissimo notes), discrimination being all the more remarkable when considering the simplicity of the species' ear: four neurons per tympanum.

In another acoustic insect, the female cicada, which is distinguished by the complexity of its ear, Windmill et al. (p. 4079) describe the biomechanics of sound transduction. Using laser Doppler vibrometry operating at a picometer scale, they report the first study measuring movement of the cuticular structure responsible for transmitting vibration from the tympanum to the sensory neurons. Their measurements of a cicada ear exposed to sound show that vibrations are greatly dampened following transmission from the tympanum to that intermediate structure and, moreover, are filtered such that only vibrations in the frequency band found in male song reach the sensory neurons.

Insects do not use sound and vibration only for advertisement and courtship but may rely on these modalities for parasitism and predation. Barbero et al. (p. 4084) studied the larvae of species of lycaenid butterflies that intrude within ant colonies and either receive nourishment from the colony (cuckoo behavior) or actually prey on colony members. As is well known in Wasmannian mimics, the lycaenid larvae gain acceptance within the ant colony by virtue of chemical mimicry, but they also improve their acceptance by stridulating. These stridulations yield vibrations that mimic the specific vibrations of the ant colony's queen, and the lycaenid intruder is thereby afforded enhanced status within the colony.

Overall, the four studies revisit traditional topics in neuroethology, biomechanics and behavior but, through precise measurements and novel questions, they offer new insights to the field.

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