Active hearing process in mosquitoes

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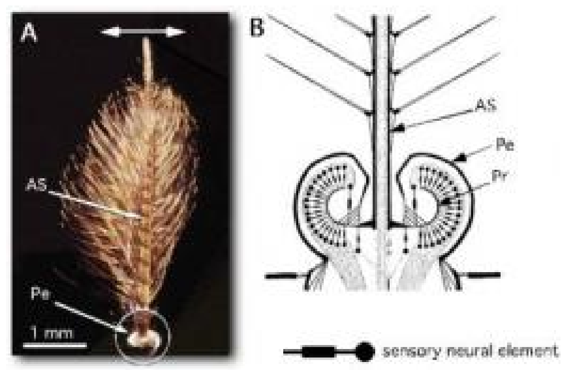

This is a mosquito hearing organ. Credit: University of Bristol

A mathematical model has explained some of the remarkable features of mosquito hearing. In particular, the male can hear the faintest beats of the female's wings and yet is not deafened by loud noises.

The new research from the University of Bristol is published in the *Journal of the Royal Society: Interface.*

Insects have evolved diverse and delicate morphological structures in order to hear the naturally low energy of a transmitting sound wave. In mosquitoes, the hearing of acoustic energy, and its conversion into neuronal signals, is assisted by multiple individual sensory units called scolopidia.

The researchers have developed a simple microscopic mechanistic model of the active amplification in the Tanzanian mosquito species *Toxorhynchites brevipalpis*.

The model is based on the description of the antenna as a forced-damped oscillator attached to a set of active threads (groups of scolopidia) that provide an impulsive force when they twitch. The twitching is controlled by channels that are opened and closed if the antennal oscillation reaches critical amplitude. The model matches both qualitatively and quantitatively with recent experiments: spontaneous oscillations, nonlinear amplification, hysteresis, 2:1 resonances, frequency response, gain loss due to hypoxia.

The numerical simulations also generate new hypotheses. In particular, the model seems to indicate that scolopidia located toward the tip of the Johnston's organ are responsible for the entrainment of the other scolopidia, and that they give the largest contribution to the mechanical amplification.

Dr Daniele Avitabile, Research Assistant in the Bristol Centre for Applied Nonlinear Mathematics in the Department of Engineering Maths, said: "The numerical results presented also generate new questions. In our description of the system, for instance, all threads have the same material properties, but their impact on the dynamics of the antenna varies according to the spatial location of the threads: intuitively, an external thread induces a much larger torque than an internal one.

"However, the true physiology of the threads is more complex, due to the curved arrangement of Johnston's organ, and further research into the effect of the subsequent mechanical variation of each thread needs to be carried out."

Source: University of Bristol (news : web)