DECODING THE BIOMECHANICS OF FLIGHT-TONE BASED ACOUSTIC COMMUNICATION IN MOSQUITOES

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The aerial courtship dance of mosquitoes involves controlled variations in the frequency and intensity of flight-tones, with concurrent changes in flight speed and direction. This behavior enables detection of conspecifics, leading to competitive flight and acoustic displays of fitness, with successful copulation under the right circumstances. However, despite >150 years of research, it is not clear how the 6-D soundscape (3D space, time, intensity, and frequency) generated by flying mosquitoes is actively modified during courtship. Also, not known are the energetic costs of this courtship behavior, nor the degree to which exogenous sounds can alter and even disrupt courtship. In the current phase of the project, we integrate computational biomechanics and acoustics with biological assays and measurement of sensory-controlled behaviors, to generate unprecedented data and provide insights into courtship-associated acoustic communication in mosquitoes.

We have developed a computational tool to predict the aerodynamics, energetics and soundscape mapping of mosquito flight-tones. Wing kinematics extracted from high-speed images of flying mosquitoes have provided input for simulations. The current focus is on comparison of simultaneous measurements of wing-kinematics, flight-tone intensity and directivity from tethered and free-flying mosquitoes, male and female alone or in pairs.

Analysis of the computational and experimental results will provide insights into the mechanisms of flight control and scaling of energetic costs, and efficiency of flight-tone generation. 6D sound maps of flight-tones for flying mosquitoes are being constructed to enable quantitative analyses of acoustic communication between mosquitoes during each stage of mating: from the onset of male mating-swarms to the interactions within male-female dyads.

The success of this novel approach could be transformative for many pest species of flying insects that employ similar modes of mating communication; our results could form the scientific foundation for exploitation of sound-stimuli that we now know control the success/failure of mating for each generation of mosquitoes. Such technologies have the potential to significantly reduce vector populations and lead to environmentally friendly strategies by diminishing mating success in vectors of malaria, Zika fever and other devastating mosquito-borne diseases.

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