Virginia Commonwealth University
VCU Scholars Compass

Biology and Medicine Through Mathematics Conference

Tympanal asymmetry in a parasitoid fly: small asymmetries produce big gains

Max Mikel-Stites
Virginia Polytechnic Institute and State University, mmikelst@vt.edu

Anne E. Staples
Virginia Polytechnic Institute and State University, aestaples@vt.edu

Follow this and additional works at: https://scholarscompass.vcu.edu/bamm

 Part of the Engineering Mechanics Commons, Integrative Biology Commons, and the Ordinary Differential Equations and Applied Dynamics Commons

https://scholarscompass.vcu.edu/bamm/2020/talk/4

This Event is brought to you for free and open access by the Dept. of Mathematics and Applied Mathematics at VCU Scholars Compass. It has been accepted for inclusion in Biology and Medicine Through Mathematics Conference by an authorized administrator of VCU Scholars Compass. For more information, please contact libcompass@vcu.edu.

Ormia ochracea is a parasitoid fly famous for its ability to localize its hosts phonotactically with a precision of 2° in the azimuthal plane, a level of acoustic precision equal to that of humans. This is in spite of their small size, which should prohibit this degree of accuracy due to fundamental constraints imposed by the physics of sound propagation (Mason et al., Nature, 2001). The enhanced precision is a result of a mechanical coupling between the fly's tympanal membranes, located on the anterior of the thorax underneath the fly's "chin". This coupling allows *O. ochracea* to resolve nanosecond time differences in incoming sound waves by increasing the interaural time delay (ITD) and interaural amplitude difference (IAD) between the fly's two "ears". The tympanal system can be approximated by a simple mechanical model whose physics are well represented by two coupled ODEs (Miles et al., J Acoust Soc Am, 1995). In this work, we modify this mathematical model by introducing an asymmetry between the surface areas of the left and right tympanal membranes. To explore the biological validity of this modification, we measured 38 *O. ochracea* tympanal membranes and found that there was an average tympanal area asymmetry of approximately 5.6%. We show that, in the modified model, an asymmetry of just 5% between the left and right tympanal areas can result in more than a 22-fold gain in ITD and IAD when compared to the symmetric case.