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The Locust's tympanal mechanics

James Windmill[a], Samuel Bockenhauer[b], Thomas McDonagh[c] and Daniel Robert[a]
[a]University of Bristol, D34 School of Biological Sciences, Woodland Road, BS8 1UG Bristol, UK
[b]Stanford University, 208 Rosse Ln, #305, Stanford, 94305, USA
[c]University of Bristol, School of Biological Sciences, Woodland Road, BS8 1UG Bristol, UK

In the ear of the desert locust frequency analysis arises from the mechanical properties of the tympanal membrane. Incident sound is spatially decomposed into discrete frequency components through a tympanal travelling wave that funnels mechanical energy to specific tympanal locations, where distinct groups of mechanoreceptor neurones project. Initial analysis of the travelling waves employs conventional, steady state FFT, allowing a detailed analysis of the spatial composition of different frequencies onto the membrane. To further understand the exact mechanics of the tympanal travelling wave, its motion was also measured in the time domain to characterise its response to single impulse and single frequency stimuli, with a resolution of 390 ns. This allows the measurement of instantaneous wave velocity and the direct observation of wave compression across the tympanum. The locust tympanal membrane locust exploits tonotopic frequency analysis, in a similar sense to that of the travelling waves of von Békésy on the mammalian basilar membrane. However, von Békésy's wave is born from interactions between the anisotropic basilar membrane and surrounding incompressible fluids, whereas the locust's wave rides on an anisotropic membrane suspended in air. The locust's tympanum thus combines the functions of both sound reception and frequency analysis.