

ACOUSTICS2008/1986

The statistics of plant echoes as perceived by echolocating bats

Yossi Yovel^a, Matthias Franz^b, Peter Stilz^a and Hans-Ulrich Schnitzler^a

^aEberhard-Karls-Universität Tübingen, Zool. Institut, Abt. Tierphysiologie, Auf der Morgenstelle 28, 72076 Tübingen, Germany

^bUniversity of Applied Sciences, Konstanz, Germany, HTWG Konstanz, Brauneggerstr. 55, D-78462 Konstanz, Germany

To explore the statistics of complex natural plant echoes, we emitted bat-like downsweeps (200-0 kHz) and recorded the echoes of various tree species. A Hilbert transform was used to calculate the envelope of the echoes impulse responses. This corresponds to a one-dimensional representation of the spatial reflector arrangement of the plant. We then calculated the envelope's power spectrum to assess the amount of periodic structures. In control experiments we compared power spectra of a single leaf, a branch and a few branches, and tested the effect of systematically decreasing the leaf density of a plant. On a bi-logarithmic plot, the averaged power spectra of all trees have a sigmoid shape with three approximately linear domains that represent different scales of structure, but differ between species. We hypothesize that the first domain is influenced by the gross skeleton of branches, while the others are associated with smaller scale structures. The control experiments showed a similar dependence between leaf density and power spectrum. Modeling plants as simple three-dimensional textures with stationary statistics was sufficient to predict the characteristics of the spectra. Our findings suggest an interpretable relation between the power spectrum of the echo's envelope and the spatial statistics of the plant.