

The Ground is Good: A Numerical Approach to Understanding Acoustic Tool Use in Crickets

Male crickets attract females by producing calls with their forewings. Louder calls travel further and are more effective at attracting mates. However, crickets are much smaller than the wavelength of their call, and this limits their power output. A small group called tree crickets make acoustic tools called baffles which reduce acoustic short-circuiting, a source of dipole inefficiency. Here, we ask why baffling is uncommon among crickets. We hypothesize that baffling may be rare, because like other tools they offer insufficient advantage for most species. To test this, we modelled the calling efficiencies of crickets within the full space of possible natural wing sizes and call frequencies, in multiple acoustic environments. We then generated efficiency landscapes, within which we plotted 112 cricket species across 7 phylogenetic clades. We found that all sampled crickets, in all conditions, could gain efficiency from tool use. Surprisingly, we also found that calling from the ground significantly increased efficiency, with or without a baffle, by as much as an order of magnitude. We found that the ground provides some reduction of acoustic short-circuiting but also halves the air volume within which sound is radiated. It simultaneously reflects sound upwards, allowing recapture of a significant amount of acoustic energy through constructive interference. Thus, using the ground as a reflective baffle is an effective strategy for increasing calling efficiency. Indeed, theory suggests that this increase in efficiency is accessible not just to crickets, but to all acoustically communicating animals whether they are dipole or monopole sound sources.