Behavioral Ecology Advance Access published December 23, 2012

Invited Commentary

Acoustic communication in plants: do the woods really sing?

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I applaud Gagliano (2012) for exploring the unchartered area of plant bioacoustics, but note that although her paper rightly calls for studies on the subject, it provides no hint of such communication yet. Although in an unexplored area, absence of evidence cannot be taken as evidence of absence, this is not a particularly strong starting point. So, what are the issues?

Can plants benefit from acoustic communication? Gagliano mentions several advantages of acoustic over chemical communication: sounds propagate faster and over large distances, can transmit more complex information, allow estimation of source and distance, and can be sensed at low intensities. All true, but it should be noted that animals enjoy these advantages only by the presence of sophisticated sensory and neural mechanisms: assessing distance of a signaler by sound degradation usually requires knowledge of the nondegraded signal; assessing sound direction requires, at least in the far field, special perceptual mechanisms; and detecting low intensity sounds requires mechanisms for signal amplification and filtering from background noise (Bradbury and Vehrencamp 2011)—mechanisms not known from plants. Of course, plants might perform these tricks in ways not anticipated yet, but the benefits of using sound depend on whether they can. Also, such benefits are most likely higher to organisms moving around and having to find or avoid each other than to plants tied to a particular location. It is thus not immediately clear whether the cost-benefit balance of acoustic communication to plants is positive, either in general or relative to, for example, chemical signaling.

Signals or incidental sounds? Many biological processes produce incidental sounds: in animals, this may be heart beats, breathing, intestinal activity, and body movements, to mention a few, and one should be surprised not to find comparable sounds in plants. Acoustic signals—sounds evolved because of their effect on receivers—are usually characterized by being noticeably different in structure from, and conspicuously louder than, incidental sounds, as they evolved to reach and be noticed by a receiver. Many of the sounds reported for plants, like drought-related cavitation (e.g., Jackson and Grace 1996; Kikuta et al. 1997; Perks et al. 2004) or other processes (e.g., Laschimke et al. 2006), are detectable only by special devises firmly attached to the plants. To be more than byproducts and serve in communication, the sounds should be loud enough to reach and be perceived by others, even in the presence of natural background noise. I agree with the suggestion that some sounds might provide potential cues (and possibly maybe signals) to insects or other organisms on the plant, but remain to be convinced of the potential of the thus far known plant sounds as communication signal to other plants.

Can plants detect sounds? A number of studies have reported responses to sounds, but here the definition of "sound" becomes relevant. For instance, Takahashi et al. (1992), showing growth promotion in rice and cucumber seedlings, put the seedlings on a speaker operated vibrating plate. So, physical vibration might have been the effective stimulus, rather than sound in the conventional definition of pressure fluctuations in the medium. Also the observation of roots growing in the direction of a sound source (Gagliano et al. 2012) may be due to sensing movement of the medium in the near field of the sound source, rather than pressure variation. If "sound detection" is primarily the detection of vibrations at short distance rather than pressure fluctuations, this would severely constrain the potential communication distance and reduce the potential benefits of acoustic communication. Carefully controlled studies are needed that address whether plants perceive sounds (i.e., pressure variation in the far field) at all, or whether the effects reported thus far are attributable to detecting mechanical vibrations.

Finally, if sounds (or vibrations) are used as signal, one would expect a match between characteristics of the sounds that plants produce and those to which they respond. Currently, we lack any hint of this. It calls for play-back experiments examining plant responses to the sounds they produce.

To conclude, although the idea of plants communicating by sound is intriguing, there is still a long way to go before we know whether, and if so to whom, the woods sing!

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Received 7 November 2012; accepted 23 November 2012.

doi: 10.1093/beheco/ars218

Forum editor: Sue Healy

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