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Book review of Vibrational Communication in Animals by Peggy S.M. Hill

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Animal communication has always been a popular topic in behavioral ecology research. However, while visual, auditory, and chemical signaling systems have enjoyed the bulk of research attention, vibrational communication has remained a distant fourth. In her book *Vibrational Communication in Animals*, Hill attempts to overturn this long-standing bias. She reveals how ubiquitous this method of communication is across animals, and shows its potential as a model system for investigating questions about the causes and consequences of signal evolution. Hill hints at an opinion (which I share) that the reason vibrational communication is less studied than other modalities, is researchers paying attention only to the senses most important to our human lives — vision and hearing. The idea that vibrational communication is not very common or important in the lives of animals is quashed by Hill, replaced by the assertion that as students of animal behavior we have much to learn from this, underappreciated form of communication.

The book opens with a short chapter that nicely sets the tone. Hill argues that knowledge about vibrational communication often developed as a result of investigations into other phenomena, but that some scientists soon realized there was a "goldmine" of information to be gleaned from studying this communication channel in its own right (*e.g.*, Narins *et al.*, 1997). Science often progresses in gradual steps, and Hill acknowledges our familiarity with vibrational communication has accumulated at a slower rate than other signaling modalities. However, as she also shows us, the last twenty years or so has seen a dramatic increase in the number of scientists interested exclusively in the vibrational channel: strong evidence of its growing popularity and relevance as a focus of research. The remainder of the book is divided into seven chapters, each focusing on a different aspect of vibrational communication. Chapter 2 is devoted to a review of the physics of vibrational waves in various transmission media (water, soil, plants, and spider webs, just to name a few), while chapters 3 and 4 discuss the diversity of mechanisms used by animals to receive, and produce vibrational signals. Chapters 5, 6 and 7 offer extensive reviews of the available evidence for the use of vibrational signals in mediating predator-prey interactions (5), mating behavior (6), and group information transfer (7), in both vertebrate and invertebrate taxa. The eighth chapter provides ideas for future research, and some final thoughts on potential selective forces that may have favored the evolution of vibrational communication.

Hill does an excellent job in her review of the literature. She leaves no stone unturned in a search for species that use vibrational communication, whether the accounts be anecdotal or scientific. Some of the anecdotes are fascinating – for example, just prior to the 2004 tsunami that devastated southeast Asia, elephants in Thailand broke free from their handlers and escaped to higher ground, long before the initial tidal wave made landfall: it is thought that they responded to the low-frequency seismic vibrations generated by the offshore earthquake.

It comes as no surprise that invertebrates far outnumber vertebrates in the quantity of species known to use vibrational communication; however, the list of vibrating vertebrate species compiled by Hill is impressive and will undoubtedly grow. A goal of any science book should be to foster more communication among scientists sharing similar research interests, so hopefully this book will encourage such dialogue. Vertebrate and invertebrate researchers have tended to overlook each other's contributions in this area. Perhaps biologists studying seismic communication in fiddler crabs may appreciate some problems shared by their colleagues examining foot drumming in tunnel-living kangaroo rats (and *vice versa*). The plethora of studies provided in this book may stimulate researchers to modify techniques used in other experiments and to apply these to their own systems.

Most of the book focuses on how vibrational signals are used to mediate behavioral interactions between individuals (Chapters 5, 6, 7), and this is its main strength. Chapter 5 is devoted to predator-prey interactions and is the shortest of the three chapters suggesting there is still much to learn here. The use of vibrations to detect prey or avoid predators is arguably universal across animals — but most research to date has focused primarily on snakes, parasitoid wasps, scorpions and spiders. It is not too surprising to learn that many other species — mammals, frogs, caterpillars and even nematode worms — also use vibrational cues in these contexts. What is surprising is the diversity of ways animals use relatively simple vibrations, often produced as incidental by-products of other behaviors, as a means of capturing prey or avoiding becoming a meal themselves.

The use of vibrations for mating (Chapter 6) is by far the best studied aspect of vibrational communication, and Hill's review is extensive. Current knowledge appears concentrated on purely descriptive accounts of the kinds of vibrational signals used to attract and court females and on how female choice influences variation in vibrational signal traits. Little is known about how vibrational signals convey reliable information about male attributes such as quality, beyond a few species of insects and spiders. The next step in this research must be to examine vibrational mating signals to the same extent as for other kinds of sexual traits. For example, I am unaware of any published study incorporating selection analyses to examine the strength or forms of selection acting on vibrational

mating signals. In contrast, the last few years has seen an explosion of studies measuring the strength of both natural and sexual selection on acoustic and visual mating signals (*e.g.*, Hall *et al.* 2008, Bussière *et al.* 2008, Weissman *et al.* this JOR issue).

Vibrational signaling and group information transfer (Chapter 7) was an extremely interesting read. Hill explains how many social species (*e.g.*, mole-rats, ants, termites, and honeybees) are able to use vibrational signals to mediate a suite of complex colony-level behaviors: she includes an analysis of how structural characteristics of a colony's home or nest may have influenced the types of vibrational signals used. Many nonsocial but group-living species also utilize a diverse array of vibrational signals to communicate with each other. How group signals were modified from incidental vibrations produced in the context of feeding or locomotion is also discussed. One conclusion from this chapter: researchers have only scratched the surface, and as they continue to examine more social species and build more phylogenies, the use of the comparative method will increase in the quest to answer some important questions regarding the co-evolution of vibrational communication and sociality (*e.g.*, Lin, 2006).

This book, however, is not without some limitations. Although the review of how vibrational signals are received by animals is thorough (Chapter 3), I was hoping for some additional insight into some unresolved questions. For example, how are different vibrational wave components recognized by an individual's nervous system? A vibrational wave travelling through a medium has three components to it: acceleration, velocity, and displacement, and the relative amplitudes of these components typically vary with frequency (Speaks 1999). Very little has been published to explain how receptor mechanisms interpret this information. For example, do the vibration-detecting subgenual organs of insects respond to displacement, velocity, acceleration, or a combination of these (*e.g.*, Cökl 1983, Kilpinen & Storm 1997)? A more thorough evaluation and assessment – beyond just a retelling of previous work – might have helped to stimulate new thoughts in this area.

I was anticipating some fresh ideas in the final chapter, where Hill offers suggestions for future research. Three promising avenues are proposed, but the explanations of their importance are brief. I was left wanting more! An additional discussion of vibrational communication from an ultimate (evolutionary) perspective would have complimented this section nicely. For instance, can vibrational communication offer new insights into mechanisms of speciation or adaptation that cannot, or have not, been answered by studying other signaling modalities?

Finally, I feel that readers of this book might have enjoyed an additional chapter that explained the diversity of equipment currently available for studying vibrational communication. There is a multitude of devices available for examining substrate-borne/seismic signals. For recording signals there are laser vibrometers, accelerometers, phonograph cartridges (record needles), and paper-thin piezo-electric strips. Similarly, for playback there are minishakers, electromagnets, piezoelectric stacks, and a number of simple custom devices (*e.g.*, gluing an insect pin to a speaker membrane). Each type of transducer has its own advantages and disadvantages with respect to cost, frequency range, and ease of use. Novice researchers in this area might have benefited from a concise source of information that compared and contrasted the diversity of equipment available for measuring vibrational signals.

In summary, *Vibrational Communication in Animals* rightfully takes its place alongside similar volumes on animal communication (*e.g.*, Ewing 1989, Gerhardt & Huber 2002), whose primary aim is to provide a comprehensive review of current knowledge. This work will make a useful addition to the bookshelf of any biologist interested in how animals communicate, and its price of $39.95 American is certainly affordable. The book has just the correct mix of introductory explanation and advanced technical jargon to satisfy novice and expert alike. Whether it stimulates additional interest in vibrational communication remains to be seen. Hopefully, as Hill concludes, the "torch is being passed" to a new generation of scientists.

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