Animal Bioacoustics:

SEEING THE WORLD THROUGH SOUNDS

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The Animal Bioacoustics Technical Committee (ABTC) supports technical and theoretical developments in the general area of how animals use sounds to perceive their worlds. In 2003, the ABTC and ASA co-sponsored, with the Center for Comparative and Evolutionary Biology of Hearing at the University of Maryland, the First International Conference on Acoustic Communication by Animals. The conference featured lecture and poster presentations on uses of sounds by a variety of organisms, from moths to songbirds to baboons. The conference was well-attended (over 150 presentations), with excellent participation from students and from international colleagues, and the local organizing committee of Allison Coffin, Robert Dooling, Cynthia Moss, Arthur Popper, Lisa Press, Shiva Sinha and David Yager did a superb job with logistics. Stay tuned for an announcement of the Second International Conference, to be held in 2007.

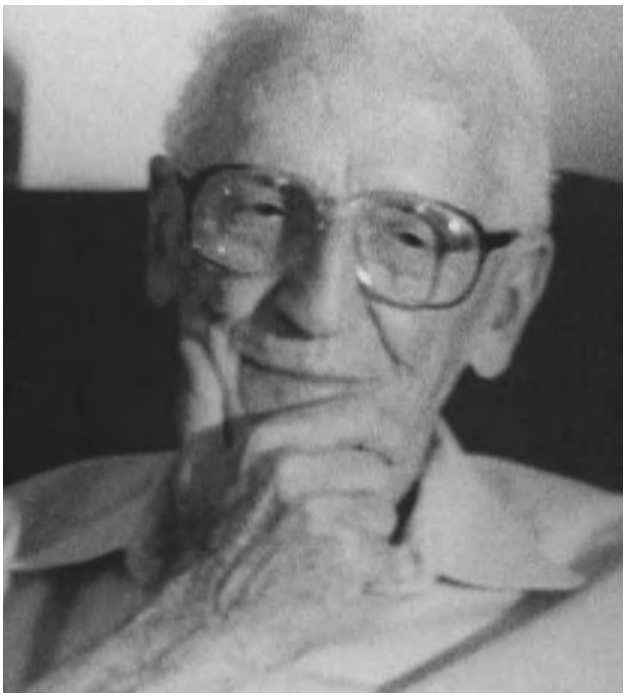

Fig. 1. Donald R. Griffin. (Photo © Jessica Simmons)

A topic of much interest to many ABTC members is the biosonar system, or echolocation, of insect-eating bats. The term echolocation (for orientation by emitted energy) was coined in 1940 by Donald R. Griffin who, with Robert Galambos, performed the first controlled experiments showing that bats emit ultrasonic signals and use the echoes from these signals to capture insect prey and to avoid obstacles while flying in the dark. This was an extraordinary finding that opened our eyes to hitherto unsuspected sensory worlds of animals, and it galvanized students of animal behavior to delve into these worlds. Griffin and his colleagues[1] initiated behavioral experiments to characterize the sonar sounds of different kinds of bats and physiological experiments to analyze how the bat's auditory system receives and interprets the ultrasonic stimuli associated with echolocation. The discovery of biosonar also has had enormous technological impact on the applied mathematics of signal processing for sonar and radar. This combination of behavioral and physiological work with a technological focus was instrumental in establishing an enduring pattern of interactions among different communities within the Acoustical Society, including psychological and physiological acoustics, acoustic signal processing, underwater acoustics, and animal bioacoustics.

Early studies of how the bat pursued its insect prey painted a picture of a relatively stereotyped sequence of acoustic events beginning with an unfocused search strategy, to a detection and approach phase, and culminating in a terminal capture[2]. In the initial search phase, different species of bats emit different kinds of sounds (constant frequency or frequency modulated), correlated with the acoustic density of their environment (open or cluttered). As the bat approaches nearer and nearer its prey, its sonar sounds decrease in duration and increase in repetition rate, producing a feeding buzz. Many bats use frequency modulated sounds in the approach and terminal capture phases, suggesting that echoes from these types of sounds convey detailed information about the shape and size of the target, allowing the bat to separate the image of the target from the background.

In these early studies, methods of direct observation were limited to the recording of echolocation sounds of single or small groups of bats with bat detectors. Recently, advances in stroboscopic photography, video recording at low light levels, and infrared video recording have opened new windows onto the behavior of bats, both in the field and in the laboratory. Studies of bats in natural conditions already had revealed that different kinds of sonar sounds are used by different species, but we now know that the types of sounds used in insect pursuit can vary depending on the bat's specific habitat.[3] Indeed, some species are capable of using multiple strategies in different foraging conditions, revealing the operation of a more opportunistic sonar strategy than previously realized.[4] The detailed actions of bats intercepting insect prey are also now exposed to view in laboratory recordings using sophisticated video techniques. Animations of a pursuit

sequence involving a big brown bat and a flying insect by ABTC member Cynthia Moss and Kaushik Ghose of the University of Maryland won first prize in the 2004 National Science Foundation Science Visualization Challenge for Multimedia (http://www.bsos.umd.edu/psyc/batlab). These animations effectively show how the bat keeps its sonar beam centered onto the insect throughout the pursuit sequence. They further indicate that changes in the bat's beam-forming pattern may serve as an index of the switch from search to approach to terminal phase, and thus as an indicator of selective attention.

Donald R. Griffin died on November 7, 2003, leaving an enormous void in the world of animal bioacoustics. Up until a few weeks before his death, he was out in the field with collaborators Gregory Auger, an accomplished videographer and photographer, and ABTC members Seth Horowitz and James Simmons, deciphering new clues about the bat's acoustically-mediated hunting behavior. Using a combination of night vision devices and infrared cameras, the team discovered that the rapid burst of sonar broadcasts accompanying successful captures (the feeding buzz) is more variable in length and in intensity than had been evident from laboratory recordings. Moreover, infrared photography showed that bats were flying and echolocating in dense swarms, raising new questions about their group behavior and ability to avoid jamming each other. Video footage of Don Griffin and the teams of which he was part was featured in the television program *Superbat* (Gedeon Programmes, Paris France), broadcast in 2004 in Europe on both French and British television. The program will be aired in the U.S. later this year on the National Geographic International Channel. *Superbat* won the World Gold Medal for science documentary in the New York Festivals' 2005 International Film and Video Competition.

"Advances in stroboscopic photography, video recording at low light levels, and infrared video recording have opened new windows onto the acoustic behavior of bats."

Please visit the ABTC website at: http://cetus.pmel.noaa.gov/Bioacoustics.html.**AT**

References

[1] D. R. Griffin, *Listening in the Dark* (Yale Univ. Press, New Haven CT, 1958; reprinted by Cornell Univ. Press, Ithaca NY, 1986).

[2] J. A. Simmons, M. B. Fenton, and M. J. O'Farrell, "Echolocation and pursuit of prey by bats," Science **203**, 16-21 (1979).

[3] H.-U. Schnitzler, C. F. Moss, and A. Denzinger, "From spatial orientation to food acquisition in echolocating bats," Trends in Ecology and Evolution **18**, 386-394 (2003).

[4] J. A. Simmons, K. M. Eastman, and S. S. Horowitz, "Versatility of biosonar in the big brown bat, *Eptesicus fuscus*," ARLO, **2**, 43-48 (2001).

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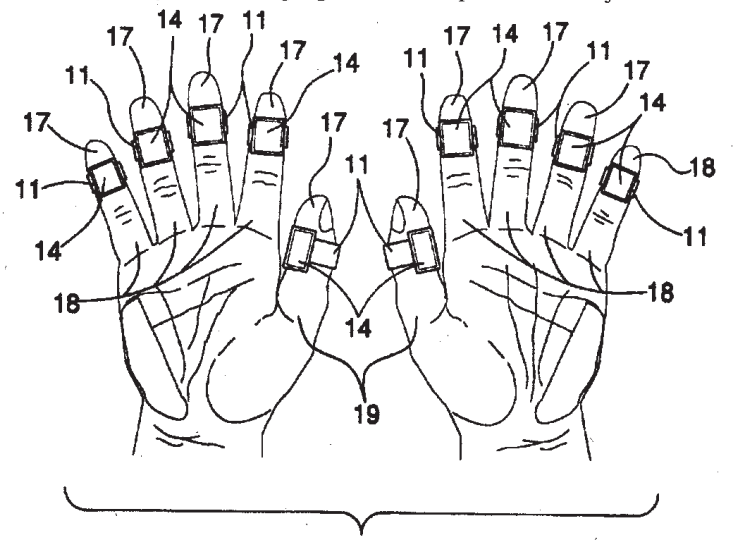
43.58.Wc FINGERTIP MUSICAL TAP ASSEMBLY

Conrad Adams, New York City, New York
11 May 2004 (Class 84/322); filed 21 March 2003

Do you like drumming your fingertips on the desktop? If so, then this invention is for you. Each finger gets a hard strap that can be adjusted for fat



or thin fingers. The rest is up to you. However, fingernails are cheaper.—MK

Andrea M. Simmons is the current Chair of the Animal Bioacoustics Technical Committee of the Acoustical Society of America (ASA). She is Professor of Psychology and Neuroscience at Brown University, and a Fellow of ASA. Her research interests are in acoustic communication in anuran amphibians, and in the structure and function of the auditory and vestibular systems across metamorphic development.