Acoustic Activity Recorder for Burrowing Animals

Abstract. *The vibrations of animals digging in a dry or moist substratum may be picked up and recorded continuously by a microphone, amplifier, and recorder setup. The apparatus permits a large region, such as an activity cage, to be monitored without disturbance of the animals or special requirements for soil conditions.*

The recording of animal activity cycles is not only interesting of itself but also forms the basis for numerous experimental procedures aimed at modifying the animal's behavior by means of a particular set of stimuli. Various investigators have employed such techniques as time-lapse photography, repeated observations, treadles or foot plates connected to microswitches, and light beams impinging upon photoelectric cells, with more or less success. None of these techniques is applicable when the animal involved is fossorial, or a true burrower.

An accurate record of activity here demands that the animal be given a sufficiently large volume in which to dig, that the soil be of the consistency most advantageous to the animal, and that the sensing setup not disturb the animal. The method of determining animal positions by capacitance proximity sensing (*1*) has been the most promising approach, but it is suitable only for animals that burrow in quite dry soils.

Studies on the visual acuity and cyclic behavior of amphisbaenids and uropeltids (Reptilia, Chordata), animals which are notorious for their requirement for a moist substratum, led us to approach this problem from a different direction. We early determined that it was possible to pick up the vibrations produced by an animal digging in sand or soil substratum, to amplify these, and to hear the animal moving in the tunnel. These observations also indicated that there was a sharp decay of vibration amplitude with distance from the pickup, so that the vibrations of the animal are picked up only within a certain radius of the probe.

We have used the idea in various circuits. Most experiments (*2*) (see Fig. 1) involved further amplifications of the signals received from a crystal contact microphone (Olson M-130, 10K ohm, Harmonica microphone) screwed to a 12-inch piece of 1- by 1-inch aluminum angle, inserted 8 to 10 inches into the substratum. The signal was fed to a Switchcraft "mix-amp" transistorized preamplifier, then to a Stromberg-Carlson Signet/10 model SAU-10, 10-watt universal amplifier. Output from the amplifier was channeled through a Halldorson model 24S45 15-watt output transformer to a modified Sigma 4-F ultra-sensitive relay. This was connected to a Grass dual-channel strip-chart recorder. Sixty-cycle interference was eliminated by shielding and grounding the amplifiers and relay box. It was then easy to use the recorded number of relay triggering pulses per unit time as an approximate indicator of the animal's activity rate, or to determine whether the animal responded by movement to a particular stimulus. Other recording methods are possible and were used for different applications.

The limited spatial pickup of the individual probes, approximately 9 inches for digging noises and 5 to 7 inches for movement in an existing tunnel (*3*), makes it possible to position the probes in a lattice arrangement within an experimental cage and to determine the animal's location by a simultaneous comparison of the several records. Since the sensitivity of pickup of the apparatus may cause it to record building and traffic vibrations, it is useful to run one control pen, in an animal-free container, or to eliminate this noise by comparison of records from different positions in the experimental cage (*4; 5*).

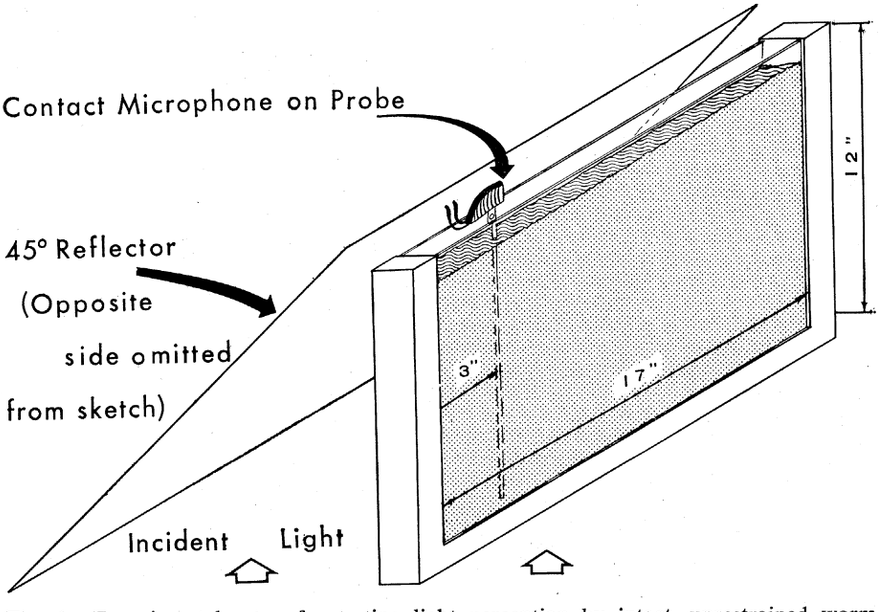

Fig. 1. Experimental setup for testing light perception by intact, unrestrained worm lizards, *Amphisbaena caeca* (Amphisbaenia, Reptilia). The animals are confined in a ¾-inch layer of sand between two plastic panes. Sudden low-level illumination elicits sufficient movement to activate the relay system more than 50 percent of the time ($N > 100$). Response of animals with shielded eyes was less than 15 percent ($N > 40$), or not significantly different from the random movement of unilluminated animals. This disproves the many statements that these animals are blind and do not respond to light (*4*), and confirms preliminary observations (*6*).

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References and Notes

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2. J. J. Bonin, "Histology of the eye and light perception in some amphisbaenids," thesis, State University of New York at Buffalo (1963).
3. The sensitivity radius varies with the nature and moisture content of the substratum, with the size and kind of animal, and with rate of movement or excavation. The data described were obtained with *Amphisbaena caeca* and *Agamodon anguliceps*, species 5 to 10 inches in length and ⅜ to ½ inch in diameter.
4. Compare A. Menacho, *Trabajos Mus. Nac. Madrid Zool.* **21**, 1 (1915) and G. Underwood, *J. Morphol.* **100**, 246 (1957).
5. Supported by National Science Foundation grants G–9054 and 21819. We thank Harold Mix for technical assistance.
6. C. Gans, *Bull. Am. Museum Nat. Hist.* **119**, 188 (1961).

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