Geophone Detection of Subterranean Termite and Ant Activity

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Summary

A geophone system was used to monitor activity of subterranean termites and ants in a desert environment with low vibration noise. Examples of geophone signals were recorded from a colony of *Rhytidoponera taurus* (Forel), a colony of *Camponotus denticulatus* Kirby, and a termite colony (undetermined *Drepanotermes* sp.) under attack by ants from a nearby *C. denticulatus* colony. The geophone recordings were compared with signals recorded from accelerometers in a citrus grove containing *Solenopsis invicta* Buren workers. Several different types of insect-generated sounds were identified in the geophone recordings, including high-frequency ticks produced by *R. taurus* and *C. denticulatus*, and patterned bursts of head bangs produced by *Drepanotermes*. Although these sounds were weak, they had distinct frequencies and temporal patterns that facilitated their identification. Similarly, the *S. invicta* produced easily identified stridulations. Overall, both systems performed well in enabling identification of high-frequency or patterned sound pulses. The geophone was more sensitive than the accelerometer to low-frequency signals, but such signals were more difficult to distinguish from background noises than high-frequency pulses. The low cost of multiple-geophone systems may facilitate development of future applications for wide-area subterranean insect monitoring in quiet environments, particularly when the insects produce distinctive or patterned sound pulses.

Methods

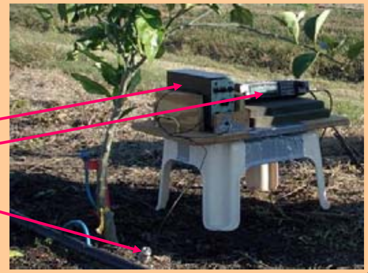
Three different insect colonies were monitored with a geophone probe system (**Fig. A**) near the campus of the Arid Zone Research Institute in Alice Springs, Northern Territory, AU. The signal output was monitored by headphones and recorded on a portable Walkman model MZ-R700 (Sony Corp, New York, NY). *S. invicta* were monitored with an accelerometer system in an experimental field near Ft. Pierce FL (**Fig. B**).

Fig. A. Geophone system (model GS-32CT, Geo Space LP, Houston, TX)

Fig. B.. Accelerometer system for monitoring of *S. invicta* activity:

a. Bruel and Kjaer amplifier
b. Recorder with headphones
c. Accelerometer

See Mankin et al. (2001)



Results

Examples of signals recorded from *R. taurus*, *C. denticulatus*, *Drepanotermes*, and *S. invicta* colonies are shown in **Fig. 1**.

Fig. 1. Oscillograms of signals recorded from ant and termite mounds with a geophone (1.1-1.3) or an accelerometer (1.4). Insets show: two ticks recorded from mound with *R. taurus* (1.1.A); three ticks recorded from mound with *C. denticulatus* (1.2.B); 16 head bangs recorded from a mound of *Drepanotermes* under attack by *C. denticulatus* (1.3.C); and two series of slow and rapid stridulations (1.4.D1 and D2, respectively); and two isolated ticks (1.4.D3 - D4) recorded near a mound with *S. invicta*.

To enable visual identification of insect sounds, signals below 0.24 kHz were filtered in oscillograms 1.1-.3, and signals below 0.1 kHz in 1.4.

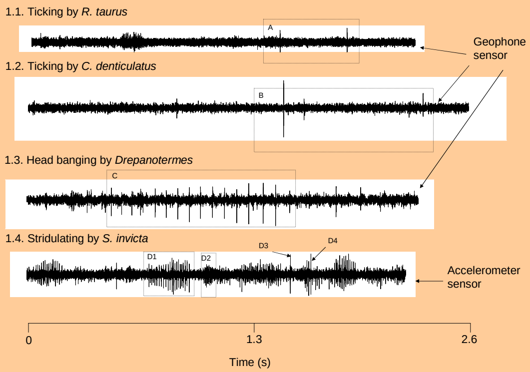


Fig. 2. Mean spectra of background noise in periods with no insect sounds. The geophone (2.C) and one accelerometer profile (2.A) were obtained during quiet periods with no listener-identified sounds. The second accelerometer profile (2.B) was obtained during a period that contained a wind burst.

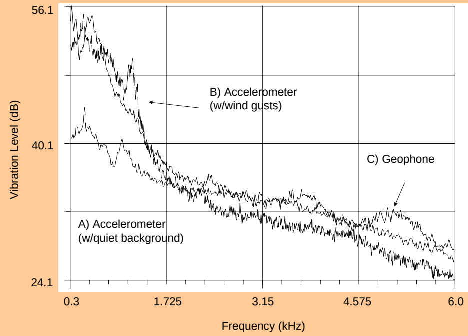


Fig. 2 shows the levels of background noise present in the Australian and Florida field environments. The geophone is very sensitive to low-frequency signals, but background noise levels increase rapidly below 500 Hz and weak insect signals cannot be detected at these frequencies except in very quiet environments.

Fig. 3. Examples of spectral profiles of *Drepanotermes* head bangs, *C. denticulatus* and *R. taurus* ticks, and patterned (stridulation) and unpatterned (ticking) sounds by *S. invicta*.

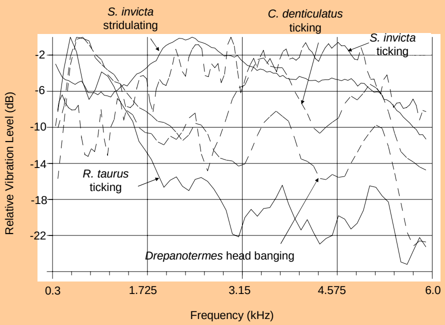
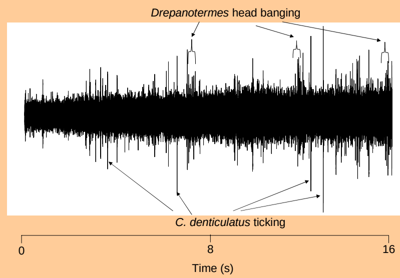


Fig. 4. Example of a period of concurrent head banging by *Drepanotermes* and ticking by *C. denticulatus* (head bangs and ticks were identified by least-squares matching of individual pulse spectra to profiles in Fig. 3).



The most reliable procedure to distinguish low-level insect sounds from background noise involved identification of high-frequency ticks and head bangs (**Fig. 3**). Even these were sometimes difficult to identify except where they occurred in distinct patterns, e.g., the *Drepanotermes* head bangs (**Fig. 1.3.C**) and the *S. invicta* stridulations (**Fig. 1.4.D1 and D2**). **Fig. 4** shows an oscillogram of a 16-s period where termite head bangs and ant ticks could be distinguished by spectral and temporal pattern differences.

Acknowledgments

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References

Mankin, R. W., S. L. Lapointe, and R. A. Franqui. 2001. Acoustic Surveying of Subterranean Insect Populations in Citrus Groves. J. Econ. Entomol. 94: 853-859.