Eavesdropping on White Grubs

Minling Zhang, Robert Crocker (TAMU, Dallas, TX, r-Crocker@tamu.edu)
Richard Mankin (CMAVE, Gainesville, FL, rmankin@gainesville.usda.ufl.edu)
Kathy Flanders (Auburn Univ., Auburn AL)
Jamee Brandhorst-Hubbard (Univ. Kentucky, Lexington, KY)

Summary

Subterranean white grubs make incidental sounds that betray their presence to researchers and pest managers listening with sensitive acoustic instruments. We are "eavesdropping" on white grub infestations, thereby estimating their population densities. The goal is to determine efficiently whether an insecticide is needed to avoid turf damage. White grub sounds are being analyzed to make it practical for a listener or a hand-held computer to distinguish between them and other sounds encountered in the soil. We also are eavesdropping on white grubs for basic information about how they travel, feed, and develop in turfgrass.

Laboratory studies have revealed several different types of sounds, including repeated pulses, snaps, and rustles that may reflect different behavioral activities. The rate of sound pulses is strongly affected by soil temperature and the larval weight. Larger instars and larger species produce detectable sounds at greater rates than smaller instars and smaller species.

Field testing of several different acoustic detection systems suggests that eavesdropping is faster and more accurate than traditional sampling based on white grub counts in soil cores.

Methods

In the laboratory, individual white grubs were placed in small pots (15-cm-dia. by 15-cm-height) and monitored over several day periods. Sounds were detected with custom built microphones (Mankin et al. 2000). The signals were recorded on digital audiotape and monitored using a headphone and a digital oscilloscope. The recorded sounds were analyzed using custom-written signal processing software (Mankin 1994). At a golf course (see below), white grub sounds were estimated using a modified golf-cup cutter and an acoustic detection system (Mankin et al. 2000).

Detection devices in field experiment

Characterization and Interpretation of Grub Sounds

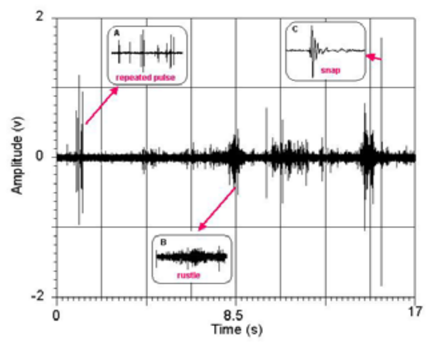

Fig. 1. Sample of typical white grub sounds containing: repeated pulses (A), rustles (B), and a snap (C).

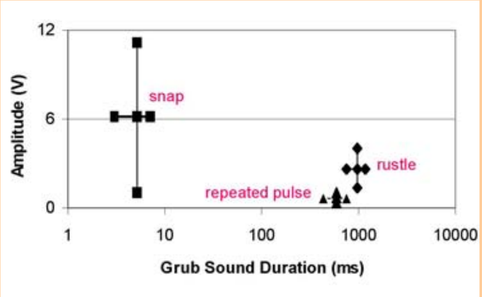

Fig. 2. Distributions of duration and loudness of snaps, repeated pulses, and rustles.

Based on the signal characteristics and limited behavioral observations, it appears that:

Repeated pulses could be produced by scraping across a root or other hard surface.
Rustles could produced by digging activity or small movements.
Snaps could be produced by feeding on or breaking a root or other stiff object.

However, we are only at the beginning stages of classifying and interpreting the different types of sounds produced by subterranean insects.

Sound Rate, Temperature, and Weight

White grubs produce detectable sounds at rates that are proportional to temperature and weight. Under controlled conditions in the laboratory, the relationship was described by the equation:

$$Sounds/min = -4.36 + 0.45\ T + 6.3\ W,$$

where T is the temperature in °C and W is the weight in g. The effect of temperature can be seen clearly in Fig. 3 below.

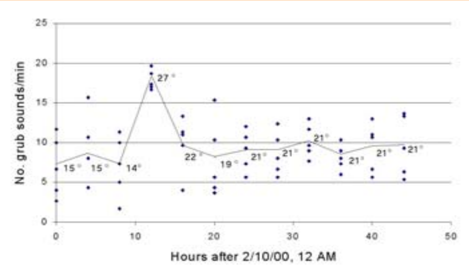

Fig. 3. Rates of sound production by 5 3rd instar white grubs exposed to various temperatures over a 2-day period.

Acoustic and Cup-Cutter Predictions

In field studies at a golf course, the likelihood of infestation within a 1'-radius of a recording site was estimated by a computer algorithm (sound rate) and an experienced listener (see Mankin et al. 2000). A cup-cutter sample was taken and the site was estimated *High* likelihood if grubs were found and *Low* if not. The 1'-area was excavated after recording. The acoustic sound rate and listening methods located more infestations than the cup-cutter method (Table 1).

Table 1. Numbers of uninfested (uninf.) and infested (inf.) golf-course recording sites assessed at *Low* and *High* likelihoods of infestation by sound rate, listening, and cup-cutter rating methods

Like-lihood	Sound rate		Listening		Cup-cutter	
	uninf.	inf.	unin.	inf.	uninf.	inf.
Low	6	3	6	4	8	21
High	2	31	2	30	0	13

References

Mankin, R. W. 1994. Acoustical detection of *Aedes taeniorhynchus* swarms and emergence exoduses in remote salt marshes. J. Am Mosq. Cont. Assoc. 10: 302-308.

Mankin, R. W., J. Brandhorst-Hubbard, K. L. Flanders, M. Zhang, R. L. Crocker, S. L. Lapointe, C. W. McCoy, J. R. Fisher, and D. K. Weaver. 2000. Eavesdropping on insects hidden in soil and interior structures of plants. J. Econ. Entomol. 93:1173-1182.

Acknowledgments

We thank Everett Foreman and Betty Weaver for recording sounds and preparing graphics.