AN ACOUSTIC TECHNIQUE FOR RECORDING LEMON TREE BORER ACTIVITY IN THE LABORATORY

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Lemon tree borer (*Oemona hirta*) infests citrus, tamarillo, and grape (Clearwater 1981), and persimmon (Rohitha *et al.* 1992). Rather than having a direct impact on the fruit, this pest can be a prolonged threat to the viability of the plant by reducing its vigour or longevity. Young larvae invade small citrus twigs causing them to die. Serious damage also results from the larvae tunnelling in mature stems where they spend many months feeding during development. This weakens branches, and under heavy fruiting, or in strong wind, the stressed branches can break (Clearwater 1981). Prophylactic measures may contain this pest (Clearwater and Mugglestone 1985). However, once the insect is inside the branch control is more difficult.

Insecticidal or fumigant natural products can control larvae in the tunnels. In order to bioassay these natural products, insect activity within the tunnel needs to be monitored, with and without the treatments applied, without disturbing the branch in which the insect larva lives. Activity of insects in similar situations has been monitored using the very low level sound generated by the insects - eg. recording of insects feeding in stored grain (Shuman *et al.* 1993). In this research note we demonstrate a technique based on sound detection as a means of non destructive sampling of stem borer activity inside the tunnel.

Figure 1: Schematic diagram of the acoustic isolation chamber (not to scale).
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Because the sound produced by the larva feeding within the branches is of extremely low intensity, a high level of acoustic isolation was required. This was achieved in a low cost isolation chamber constructed as in Fig. 1. The isolation characteristic of an acoustic barrier is proportional to the mass per unit area perpendicular to the incident acoustic energy (Sound Research Laboratories 1976). The isolation efficiency is increased by duplication of layers, and by an air gap between layers, but is compromised by sound leakage around edges and joints.

A tubular, high mass, barrier was constructed using two concrete drainage pipes by resiliently suspending the smaller (o.d. 300 mm) inside the larger (o.d. 600 mm). The lower ends were sealed with concrete, cast inside them, and the upper ends were sealed with precast concrete lids and moulded sealing strips (Fig. 1). Additional vibration isolation was obtained by mounting the assembly on airmount isolators. This gave sufficient acoustic insulation when installed in a quiet building. A variety of microphones were tested but the Electret (tie clip type, Source: Dick Smith Electronics, Hamilton) type was selected for its small dimensions, low price (\$30), and high sensitivity. Its signal to noise ratio was sufficient, and its small size allowed it to be directly placed onto the stem inside which the insect was feeding. This maximised the acoustic coupling efficiency. An exceptionally low-noise, balanced input, recording-studio preamplifier, coupled to a conventional microphone preamplifier/mixer, provided the required 94dB (x50,000) gain (Fig. 2). The resultant signal in the form of noise was recorded on magnetic tape for permanent storage of data. The signal to noise ratio obtained allowed easy interpretation of the insect's actions by the listener who was familiar with insect behaviour.

The following larval activities were identified;

1. Chewing i.e., scraping sound made while closing the jaws. The chewing rate is one per 2-3 seconds
2. Breaking wood fibre (snap). This occurs every 2-5 discernible chews.
3. Wriggling along the gallery.
4. Manipulating/thrusting long (10-20 mm) chewed-off fibres into the gallery entrance to block it with a loose tangle of fibres.

Figure 2: Amplification system block diagram.

Signal characteristics in snap sound are shown in Fig. 3. The signal to noise ratio achieved was about 10-20 at a recording level of -20dB. The signal frequency range observed was 500 to 4000 Hz when chewing, and the snaps extended this to 8000 Hz.

The insect was still highly active in branches maintained for 3 weeks in water. The noise and vibration created by handling during setting up or being in a closed environment did not appear to affect its activity in the tunnel. This method was successful with large active larvae in early summer (December). Detectability at other times of the year is not yet known, but small larvae are likely to be less audible. The value of the signals for data logging purposes is being studied. Any voltage produced above a preselected threshold will be of value as a guide to the amount of activity of the insect within the tunnel. This study indicates the potential for the acoustic recording of larval activity in wood under different treatments, without destructive sampling of the larval tunnel.

For future bioassay studies, a horizontal concrete acoustic isolation chamber in which a number of treatments applied onto branches (with borer larvae) placed in

water, each with microphones attached will be investigated. A common amplifier will be used with a switch to sample the signal from each microphone in turn, to record the signals at 1 sec intervals. This will readily provide access to computer analysable data on the activity of larvae under different treatments within the tunnels without destructive sampling.

Figure 3: Output voltages in the 'snap' sound caused by the larvae feeding in the tunnel. Snap sound waveform (a), and frequency distribution of snap sound (b).

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REFERENCES

- Clearwater, J.R., 1981. Lemon tree borer, *Oemona hirta* (Fabricius), life cycle. *DSIR Information Series No. 105/33*, ISSN 0077-9636, 3pp.
- Clearwater, J.R. and Muggleston, S.J., 1985. Protection of pruning wounds: favoured oviposition sites for the lemon tree borer. *Proc. 38th N.Z. Weed and Pest Control Conf.*: 199-202.
- Rohitha, B.H., Hartley, T., and Franklin, S.J. 1992. Lemon tree borer damage on persimmon. *Proc. 45th N.Z. Weed and Pest Control Conf.*: 141-142.
- Shuman, D., Coffelt, J.A., Vick, K.W., and Mankin, R.W., 1993. Quantitative acoustical detection of larvae feeding inside kernels of grain. *J. Econ. Ent.* 86(3): 933-938.
- Sound Research Laboratories, 1976. *Practical Building Acoustics*. Sound Research Laboratories. Hallstead Press New York. 226pp.