1-1-2017

Invertebrate Neurophysiology: Testing the Efficacy of Natural Insecticides

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Introduction

Insecticides are widely used in agriculture. While there are several classes of synthetic insecticides that are highly effective against insects, there is data suggesting that these compounds are also toxic to non-target species. However, compounds like caffeine have been shown to act as natural insecticides. Here we investigate the effects of a well-known class of insecticides, pyrethroids, as well as natural compounds such as caffeine. Since insecticides work at the level of the nervous system we propose to measure neural activity in crickets (*Acheta Domestica*) after exposure to synthetic and naturally occurring insecticides. Here we show our approach and preliminary experiments which demonstrate successful neuron recordings from the cricket.

Approach

Neural activity is recorded using a signal amplifier (Fig. 1, Backyard Brains) and the data is analyzed offline (Spike Recorder).

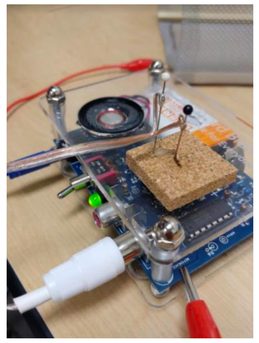

Figure 1: The spike data is acquired by a signal amplifier and can be streamed to a smart phone, tablet or computer for analysis.

Cricket Model

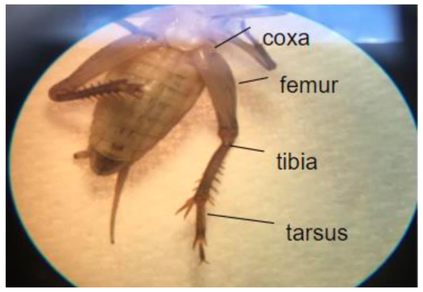

Figure 2: The Cricket is the invertebrate model used. The recording electrode can be placed in different locations of the leg and body (For example, Fig. 4 shows differential responsiveness of the tibia and femur to air stimulation).

Response to Tactile Stimulation

Neural activity (action potentials) in response to sensory stimuli, and neuroactive compounds can be recorded in the cricket.

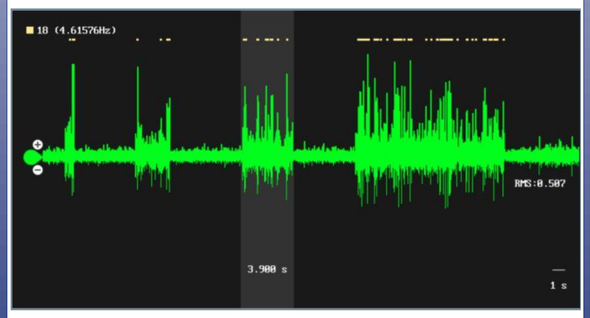

Figure 3: Evoked responses to tactile stimulation. Neural activity recorded continuously from the cricket femur and the spiking response to 1, 3, 5, and 10 seconds of tactile stimulation can be seen over top of baseline activity.

Neural Response to Stimulation

To ensure we are able to detect changes in neural activity we ran a pilot study where we recorded from the tibia and femur (Fig. 2) in order to measure the sensitivity of each each structure to air stimulation.

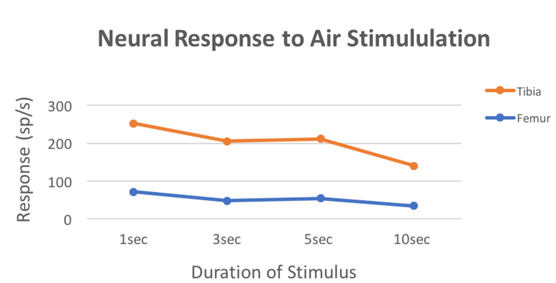

Figure 4: The tibia is more sensitive to air stimulation than the femur. This is corroborated by previous anatomical studies showing that wind sensitive mechanoreceptors innervate the tibia.

Response to Drug Stimuli

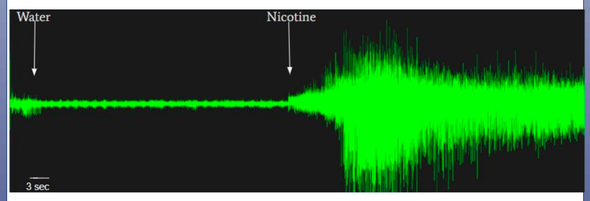

Figure 5: Effect of nicotine on neural activity recorded from the cricket femur. Injection of saline into the cricket has little effect on neural activity. A short while later, during the same recording, an injection of a solution containing nicotine induced a sustained increase in spiking activity.

Experimental Design

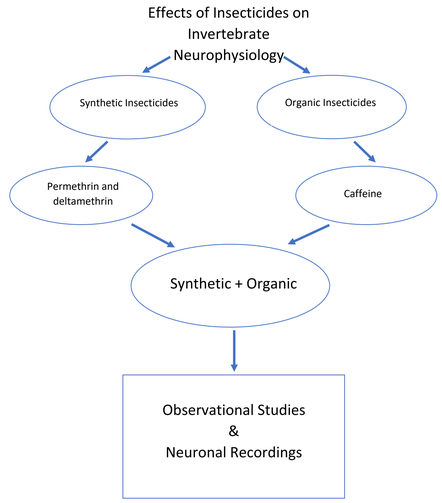

Figure 6: Schematic showing our experimental design for investigating the effects of organic and synthetic insecticides on neuronal activity. We will be performing behavior experiments alongside neuronal recordings.

Conclusions/ Future directions

1. Our pilot experiments have confirmed we can successfully record neuronal activity in crickets and can measure changes in neural activity in response to sensory stimulation and drug exposure.
2. We plan to measure the effect of common insecticides on neuronal activity and compare them to natural alternatives, which are thought to have insecticidal properties.
3. The overarching goal is to reduce the amount of harmful insecticide in the environment. We aim to determine if natural insecticides can be as effective a synthetic or if combinatorial compounds could be effective.