Automated system for recording emerging puriri moths, *Aenetus virescens* (Hepialidae: Lepidoptera)

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**Introduction**

The puriri moth, *Aenetus virescens* (Doubleday, 1843) is a widespread forest species in the North Island of New Zealand (Dugdale 1994). Eggs are deposited on the forest floor where early instars feed on fungi growing on dead wood or emergent polypore fruiting bodies, such as bracket fungi, for about three months. They then transition to boring into various trees and shrubs where they feed on callus tissue around the entrance of tunnels that extend into the wood (Grehan, 1987a). Larval and pupal development varies from one to four years in putaputaweta (*Carpodetus serratus*), and may be even longer on other hosts and localities (Grehan 1987b).

Prior to pupation, the larva dismantles the central region of the silk web covering the feeding area around the tunnel, sometimes resulting in a perforated appearance. Most adults emerge in the spring months of September-November with another smaller peak sometimes occurring in March. Emergent adults may be found resting by their tunnels in the late afternoon from at least 2.00 pm (1400 hrs) and before nightfall. This is probably a general feature of wood-boring Hepialidae as it has been reported in *Zelotypia* and other species of *Aenetus* Grehan (1987b) and also in the South American *Phassus* emerging 1400-1700 hrs (Schaus 1888). Grehan (1987b) attempted to observe adult emergence by searching host trees in the afternoon but the only specimens found had already emerged and were resting on the host trunk.

The problem of locating emergent adults was recently solved by setting up an automated imaging process that was initiated by movement of the pupa at the tunnel entrance. Photographic documentation of puriri moth emergence is part of an ongoing project recording much of the natural history the Nga Manu nature Reserve, a 13 ha area of mixed wetland, swamp forest, and coastal forest that is part of a larger forest remnant comprising about 30 ha bordering the urban area of Waikanae. The scope of this project expanded with the advent of digital photography which offered the opportunity for many new techniques to record natural history events (see:ngamanuimages.org.nz). Puriri moth emergence was chosen for digital observation because this insect represents a prominent natural biotic element of the reserve presented to visitors and educational groups, and it was suspected that imaging complete emergence in the natural habitat had not been previously attempted.

The forest at Nga Manu is largely regeneration following clearance during the early 1900’s. There are some small areas of original forest represented by a small number of mature kahikatea (*Dacrycarpus dacrydioides*) and pukatea (*Laurelia novae-zelandiae*). The more mature regenerating forest is predominantly kahikatea, puketea and swamp maire (*Syzygium maire*) in the wetter areas, and tawa *Beilschmiedia tawa* and kohekohe *Dysoxylum spectabile* on the drier sand dunes. Marginal to these areas are mahoe *Melicytus ramiflorus*, putaputaweta *Carpodetus serratus*, lancewood *Pseudopanax crassifolius*, manuka *Leptospermum scoparium* and kanuka *Kunzea ericoides*, cabbage tree *Cordyline australis*, tree fern species, flax and rapo. Puriri moths occur mainly in putaputaweta with some also being found in manuka and kanuka and several other native species planted in the reserve: puriri (*Vitex lucens*), lacebark (*Hoheria populnea, H. angustifolia*) and *Fomaderris sp.*

**Photographic technique**

The technical procedure is fairly simple but refinements were made after each attempt to improve the reliability and success of the setup. There are three main components: the trigger, the controller and the recording system.
Trigger: This is a narrow infrared (IR) beam positioned so it passes just in front (5-10mm) of the point of the screen where the moth is most likely to emerge. The IR unit is a standard design often used in the security industry to trigger an alarm (Jayar CE LA - 5193). These units are modified to narrow the beam and are placed within a weatherproof housing. The transmitter and receiver units are modified and waterproofed by removing the covers and lens and placing them in a 200ml Sistema food storage container that has been painted black. A 6 mm hole is drilled in the lid of the container directly in front of the IR LED/Receiver and a 6 mm rigid plastic tube is inserted through the hole so it covers the IR LED/Receiver.

Controller: An electronic chip is programmed to respond to a trigger impulse from the IR unit by, either turning on a digital camera and a set of two or three flash units or immediately firing a live camera/flash unit setup with a predetermined sequence of exposures. The chip is a PicaXe 18M, developed by Revolution Education Ltd in the UK for use in schools (see www.rev.ed.co.uk), mounted on a AXE021 project board. The camera(s) are fired by means of a standard Canon remote release cable connected to the output of the PicaXe 08M chip through a FRT2-S DPDT 12V Relay.

Recording system: This comprises the digital camera and two or three flash units. Several different types of camera were used, the most common being a Canon 20D which is normally matched with two Sunpak 3600 flash units, each mounted either side of the camera to give even light. This setup was used for the first emergence sequence. Where higher quality images are required a higher quality camera such as a Canon 5D or 1Ds MkII is used, and sometimes a third flash is necessary to improve lighting. The second sequence was taken with a Canon 5D.

The setup was powered by 12v deep cycle batteries and voltage regulators running the various components. The camera regulator is a standard 7808 +8v fixed and the controller regulator is a 7805 +5v fixed, both mounted in the control box. The flash units require 9v with a peak load of about 10amp, this is achieved by placing two 35 amp bridge rectifiers in series in the power supply cord (this is not particularly satisfactory as we often burn out the units but it is the only solution we have come up with). A galvanised pipe frame was constructed around three sides of the site and the IR transmitter & receiver units were secured to the frame with brackets that allow them to be positioned accurately and securely on either side of the hole. The camera and flash units are usually mounted on the centre of this frame with the flash units mounted to either side.

Results
Two emergences were recorded, both from the same tree. All times are NZ Standard Time (UTC +12). Due to the nature of the chip programme, the longer intervals are imprecise.

First emergence: 5 December, 2009 (Fig.1, a-c ) Emergence began at 1926hrs, 15 minutes before sunset, which was at 1941hrs. The wings were fully expanded at rest by 1937 hrs with flight taking place at 2100 hrs. Camera: Canon 20D. Lens: Canon EF 35 – 80mm . Exposure: 125 sec at f/22 using 2 x 3600 Sunpak Flash units. ISO: 400. Focal Length: 57mm. Exposure Sequence intervals: Ten at 10 s, ten at 20 s, ten at 45 s, ten at 1 min, ten at 5 min , ten at 10 min.

Second emergence: 10 December, 2009 (Fig. 1d) Emergence began at 1823 hrs, an hour and twenty three minutes before sunset at 1946 hrs. Wings were fully expanded at rest within 11 minutes at 1834 hrs. At 2007 the moth was observed to suddenly change its wing position and at 2013hrs it began flapping its wings rapidly and within two seconds it had flown.

Camera: Canon 5D. Lens: Canon EF 17-40mm L. Exposure: 125 sec at f/18 using 2 x 3600 Sunpak Flash units . ISO: 100. Focal Length: 40mm. Exposure Sequence: as for first emergence.

Comments
Puriri moths may be found at any time of the year, but the great majority of
moths emerge in the spring and early summer, particularly from October to December (Grehan 1987b). They are often seen on warm nights with light misty rain, but a few are seen on cool, clear nights. This pattern would suggest that the pupae are sensitive to temperature and humidity and respond to a threshold that results in emergence. The partial dismantling of the web by the larvae prior to pupation would allow external temperature and humidity to be detected by the pupa. Pupae may be seen at night resting at the top of the vertical tunnel at the junction to the entrance tunnel tunnels during the emergence period. (John Grehan personal communication).

Until this technique was developed, there was no practical way to observe and document puriri moth emergence other than by chance encounter. This photographic technique could be used to identify the range of times when emergence may start, and also determine if the apparent higher number of moths seen at light on warm, humid, and overcast nights is also correlated with more frequent emergence and that fewer moths emerge on dryer and cooler nights. In addition it may have much wider application in recording activities in the field.

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References


Grehan, JR. 1987b. Life cycle of the wood-borer Aenetus virescens (Lepidoptera: Hepialidae). New Zealand Journal of Zoology


Fig. 1. Emergence of puriri moth, Aenetus virescens, from putapataweta on 5 December 2009 (1a-c) and moth expanding wings prior to rest on 12 December, 2009 (1d).