SHORT COMMUNICATION

Tracking tunnels: a novel method for detecting a threatened New Zealand giant weta (Orthoptera: Anostostomatidae)

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Abstract: Several species of giant weta, including wetapunga (*Deinacrida heteracantha*, Orthoptera: Anostostomatidae), New Zealand's largest terrestrial invertebrate, have high conservation value, yet no methods for detecting and monitoring them have been developed. Here we show that rodent tracking tunnels set over three consecutive nights can be used to detect wetapunga on Little Barrier Island. Adult wetapunga footprints had significantly longer tarsal pad lengths than subadult wetapunga and Auckland tree weta, but tarsal pad length does not distinguish between subadult wetapunga and adult Auckland tree weta. Results suggest that setting tunnels on the ground is more effective than setting them on tree branches and that peanut butter as an attractant bait increases the detection rate of adult wetapunga. Future research is required to determine if the footprints of ground weta, tree weta and giant weta of different ages can be distinguished and to determine how tracking rates of giant weta relate to the population density.

Keywords: *Deinacrida heteracantha*, habitat use, monitoring tool, wetapunga

Introduction

Giant weta in the genus *Deinacrida* (Anostostomatidae: Deinacridinae) are large-bodied, relatively slow moving, flightless Orthoptera that are restricted to New Zealand (Johns 1997; Gibbs 2001). Eleven species have been described (Gibbs 1999) and several are of high conservation value (Gibbs 1998). Giant weta are iconic species and are the flagship for New Zealand insect conservation. However, there are currently no standard monitoring tools for detecting these insects or assessing their abundance, and confirming their presence takes considerable effort, usually involving searching through vegetation by day or spotlight searching by night. When densities are low, such search effort may still fail to detect them.

In New Zealand, footprint tracking tunnels (King & Edgar 1977; Brown et al. 1996; Blackwell et al. 2002; Gillies & Williams 2002) are used widely to index the density of introduced small mammals. Tracking tunnels currently rely on ink and card/paper to record target species' tracks (Blackwell et al. 2002). Many tracking tunnels also record the prints of insects, so we explored whether they could be used to confirm if weta are present and if giant weta could be identified from their footprints, as this could constitute a monitoring method with wide application in the conservation management of these cryptic insects.

The main objective of this study was to determine whether the largest giant weta, wetapunga (*D. heteracantha*), an arboreal forest-living species, could be detected using tracking tunnels set on the ground or in tree branches on Little Barrier Island. Secondary objectives were to determine whether detection could be improved by using peanut butter as an attractant bait and whether, using the lengths of their footprints alone, wetapunga could be distinguished from the two other weta species also present on the island – Auckland tree weta (*Hemideina thoracia*) and ground weta (*Hemiandrus* species).

Methods

Study area and species

Wetapunga roost in epiphytes and cavities during the day and feed mostly on fresh foliage at night (Richards 1973; Gibbs 2001). They were formerly widespread over Auckland, Northland, Waiheke Island and Great Barrier Island (Watt 1963), but now only survive on Little Barrier Island (Hauturu; 36°12´S, 175°7´E), a 3083-ha nature reserve that is now free of introduced mammalian predators. The island is situated in the Hauraki Gulf off the north-eastern coast of the North Island. Wetapunga numbers were originally thought to be declining (Gibbs & McIntyre 1997), but are now slowly increasing following the eradication of kiore (*Rattus exulans*) in 2004 (CJG, unpubl. data).

Distinguishing weta species from their footprints

Weta were captured on Little Barrier Island and held in captivity overnight while their footprints were recorded. Footprints were recorded for adult (9–10th instar, $n = 8$) and subadult (5–8th instar, $n = 8$) wetapunga; and adult ($n = 8$) and subadult Auckland tree weta ($n = 8$). No ground weta, juvenile (< 5th instar) wetapunga or juvenile tree weta were found to record their footprints. The size (mm) and arrangement of the tarsal pad prints of adult and subadult wetapunga and adult and subadult Auckland tree weta were recorded after they had walked over tracking cards in controlled conditions. This was repeated five times for each weta and the two cards with the clearest prints were used to obtain average tarsal print lengths from up to five prints per card. The lengths (mm) of the tarsi from each right leg of the weta were also measured and a record made of the species, sex and age class.

Tracking tunnel field trial

Eight transects of tracking tunnels were set up, 200 m apart, in two series of four, along two different loop tracks (Hamilton–Valley Track and Thumb–Waipawa Track) that followed ridges on the lower slopes on the south-western side of Little Barrier Island. In both cases, the two lower transects (15–145 m a.s.l.) were in second-growth forest dominated by kānuka (*Kunzea ericoides*), and the higher two transects (205–335 m a.s.l.) were in predominantly tall kauri (*Agathis australis*) and hard beech (*Nothofagus truncata*) forest. Each transect comprised 10 'Black Trakka' (Gotcha Traps, 2 Young Street, RD2, Warkworth) footprint tracking tunnels placed 1–2 m off the track and 50 m apart. Each was provided with pre-inked tracking cards using a specially formulated ink (Gotcha Traps) that improves the definition of insect footprints. Alternate tracking tunnels were baited with 4 g (approximately ½ teaspoon) of peanut butter. Peanut butter was chosen as bait because it is routinely used in rodent tracking tunnel surveys throughout New Zealand and weta footprints have been reported on cards from Maungatautarui (CHW unpubl. data), Red Mercury Island (De Monchy 2006) and Little Barrier Island (CJG pers. comm.).

Those in transects on the Hamilton–Valley Track were set for three consecutive nights between 11 and 14 May 2007. The tunnels were then moved to the Thumb–Waipawa Track and set for another three nights between 14 and 17 May 2007. The tracking cards were checked the day after they were first set, and were collected after the third night. Digital photographs were taken of each tracking card with weta footprints after the first and third nights.

In addition, two transects of tracking tunnels were set up on a third track (Shag Track) to determine whether weta would walk through tunnels situated on tree branches. These transects were in regenerating forest dominated by kānuka, following the same protocol. The tunnels were stapled to the upper surface of horizontal kānuka branches (15–20 cm in diameter) approximately 1.5 m above ground for three nights between 11 and 14 May 2007 on one transect and then moved further along the Shag Track and set for another three nights between 14 and 17 May 2007. The tracking cards were collected after the first and third nights, as for the tunnels on the ground, and digital photographs were taken of any tracking cards with weta footprints.

Statistical analysis

Tracking rates are expressed as the average percentage (±95% CI) of tunnels with weta footprints per transect (a total of 10 tracking tunnels in each of the 10 transects). Differences in tracking rates between baited versus unbaited tunnels and lower versus higher altitudinal transects were compared using a non-parametric unpaired *t*-test (GenStat version 8.1, VSN International 2007).

Means ± 95% CI were calculated for the length of the right protarsal, mesotarsal and metatarsal pads and the associated right tarsal pad prints for each species and age class of weta so that differences ($P = 0.05$) between species and age class were apparent by inspection.

Results

Distinguishing between footprints of wetapunga and Auckland tree weta

Adult wetapunga had significantly larger protarsal, mesotarsal and metatarsal pad lengths than either subadult wetapunga or Auckland tree weta (Fig. 1a–c), but there was no difference between subadult wetapunga and adult Auckland tree weta, and subadult Auckland tree weta were substantially smaller than subadult wetapunga (Fig. 1a–c). Tracking tunnel results from the field trial were therefore recorded as prints of adult wetapunga or as 'other weta'.

The actual length of the tarsal pad was larger compared with the length of the tarsal pad printed on the card for all 32 weta footprinted, regardless of species, sex and age class. Only 54% (±1%), 65% (±3%) and 81% (±3%) of the actual length of the protarsal, mesotarsal and metatarsal pads were recorded on cards.

Tracking tunnel field trial

Weta footprints (Fig. 2) were detected in 72% of tracking tunnels set on the ground over three nights. The tracking

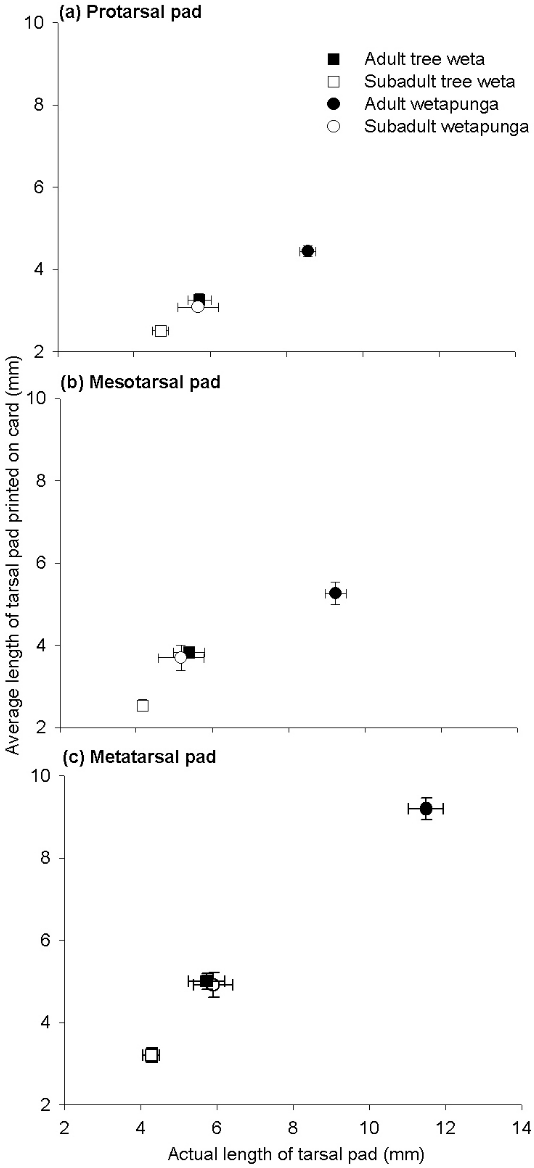

Figure 1. Relationship between actual length of tarsal pad and average length of tarsal pad printed on card ($n = 8$). Adult wetapunga prints were significantly larger than 'other' weta prints recorded. Bars show 95% confidence intervals.

rate over all transects was 35% (±13.4%) for adult wetapunga and 65% (±12.6%) for other weta, with 75% of cards having both adult wetapunga and other weta prints. When adult wetapunga footprints were present, 89% of these appeared during the first night and few additional tunnels that did not have wetapunga tracks the first night had them after the third night. The majority (71%) of tracking cards with wetapunga footprints had large numbers of prints passing through the tunnels (Fig. 3). When the footprints indicated large adult wetapunga, the prints of the protarsi, mesotarsi and metatarsi were clearly distinguishable as were body drag marks (Fig. 3).

Adult wetapunga tracked significantly more often in tunnels on the ground baited with peanut butter (mean = 55 ± 21.4%) than in unbaited tunnels (mean = 12 ± 12.4%; $t_{2,14} = 4.05$, $P = 0.0012$). The tracking rates for other weta were similar in baited and unbaited tunnels ($t_{2,14} = 1.74$, $P = 0.16$) and there were no differences in the tracking rates for tunnels set in the lower and higher transects for either adult wetapunga ($t_{2,6} = 1.12$, $P = 0.30$) or other weta ($t_{2,6} = 0.73$, $P = 0.49$).

Weta footprints were detected in 50% of tracking tunnels on tree branches after three nights. Of the tunnels tracked, 20 ± 10.0% detected adult wetapunga, 80 ± 15.5% detected other weta. No cards had both adult wetapunga and other weta prints. All adult wetapunga prints were recorded during the first night and no additional wetapunga prints were detected after that. The majority (80%) of tracking cards with wetapunga footprints had only a single set of prints and all weta footprints were found in tunnels baited with peanut butter (adult wetapunga: mean = 40 ± 10.0%; other weta: mean = 80 ± 15.0%).

Discussion

The results of this study suggest that, using tracking tunnels, adult wetapunga can be detected quickly (overnight). Also through the use of tracking tunnels, we have clearly demonstrated that wetapunga are present both in kānuka and kauri forest habitats, confirming results of previous surveys for wetapunga (CJG unpubl. data). An unexpected result was that adult wetapunga tracking rates were higher in tunnels set on the ground than in trees, given that wetapunga are considered an arboreal forest species that spend most of their time above ground (Gibbs 2001). Richards (1973) originally recorded finding adults under mats of *Muehlenbeckia complexa* on the ground on Little Barrier Island, but Gibbs & McIntyre (1997) later found them above ground under loose bark of kānuka and inside cavities in māhoe (*Melicytus ramiflorus*) and pōhutukawa (*Metrosideros excelsa*).

It is possible that the present study may have been undertaken at a time of year when the adults were sexually active and females were ovipositing on the ground so both were spending more time on the ground

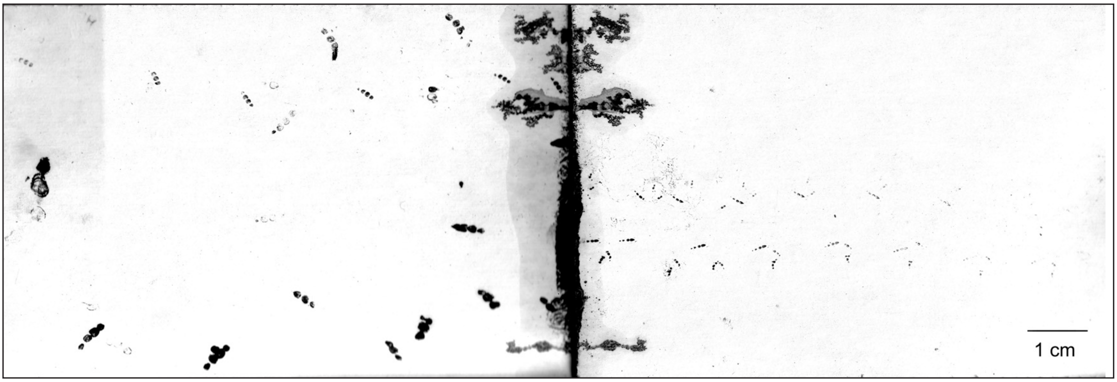

Figure 2. Weta footprints on a tracking tunnel card baited with peanut butter on Little Barrier Island. After the first night (11 May 2007), only adult wetapunga prints (left-hand side of tracking card) were present. When the tracking card was checked again on 14 May 2007, another set of weta prints were present (right-hand side of tracking card); these were consistent with an adult Auckland tree weta. The ink section is not shown but was in the middle of the tracking card.

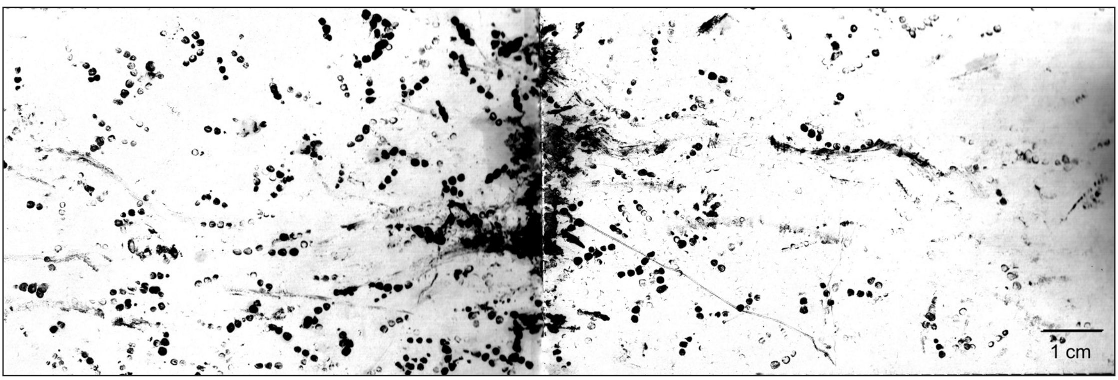

Figure 3. Adult wetapunga footprints in a baited tracking tunnel card set for three consecutive nights (14–17 May 2007) but no extra prints were recorded after the first night. Note the body drag marks down the centre of the card.

(Richards 1973). The result might differ at other times. The present investigation coincided with an annual survey of wetapunga that has been carried out at the same time over the last three years. During all these surveys only an occasional wetapunga was found on the ground; the great majority were well above ground (CJG, unpubl. data). It is also possible that the behaviour of wetapunga may have changed during the three years following kiore eradication from the island as reported for tree weta that roosted closer to the ground and were more active on Nukuwaiata (Chetwode Islands) four years after the eradication of kiore (Rufaut & Gibbs 2003).

Baiting tracking tunnels with peanut butter clearly increased the tracking rates of adult wetapunga, so baiting provides a much better indication of whether wetapunga are present. Further work is required to determine if this bait also increases the tracking rates for other species of weta, given that our results indicated peanut butter might not attract some species, as evidenced by the non-significant difference in tracking rates for 'other weta'. We also do not know why weta tracks were only present in those tracking tunnels in trees that were baited with peanut butter. As we could not distinguish juvenile weta species, it is possible that the footprints classified here as other weta were those of juvenile wetapunga. It is also possible that volatiles within the peanut butter attracted wetapunga into the tracking tunnels because the peanut butter was noticeably drier after the first night and this was when wetapunga tracks first appeared in most tunnels. In addition, weta may have been attracted by the smell of the peanut butter, but then learned that it was not a palatable food source.

Tracking tunnels are widely used to determine an index of the density of small mammals in New Zealand, but there have been no published accounts of this method being used for insects, particularly weta. Previously, tracks of an adult Middle Island tusked weta (*Motuweta isolata*) were reported on one tracking tunnel card from a routine rodent tracking tunnel survey on Red Mercury Island (De Monchy 2006), and the footprints of Cook Strait giant weta (*D. rugosa*) appeared in tracking tunnels after the weta were released into Karori Wildlife Sanctuary (CHW unpubl. data). Both species live predominantly on the ground and their footprints were recognised because they were much larger than other weta present. This also applies to the present study because there were significant size differences between adult wetapunga and both adult and subadult Auckland tree weta, and subadult and juvenile wetapunga. This technique is applicable to the field situation on Little Barrier Island because protarsal, mesotarsal and metatarsal prints greater than 4.3, 4.9 and 8.9 mm in length respectively, indicate the footprints are those of an adult wetapunga. However, more work is clearly required before tracking tunnels can be used for other species. We are presently investigating if the different growth stages of ground weta, tree weta and giant weta can be distinguished from their footprints by examining whether there are species-specific variations in tarsal pad arrangement, pattern of tarsal placement, and stride length. Results from footprinting 32 weta suggest they do not place their entire tarsal pad down when walking, as only 54%, 65% and 81% of the actual length of the protarsal, mesotarsal and metatarsal pads were recorded. At present, tracking tunnels certainly have the potential for monitoring adults of the largest species in a weta community. Thus, they are appropriate for monitoring giant weta adults after translocation to a new locality.

We acknowledge that there are many potential factors that could affect the use of tracking tunnels to index the density of giant weta populations because much about weta behaviour and ecology remains unknown. One immediate problem is that we do not know how far weta are likely to travel at night and thus we do not know how far apart tracking tunnels should be spaced to reduce the chances of weta tracking multiple tunnels. Giant weta have been referred to as 'invertebrate mice' because their characteristics –biomass, nocturnal foraging, omnivorous habits, use of diurnal shelters, polygamy, and even their droppings – are more typical of small introduced mammals (Ramsay 1978). This study has clearly highlighted that tracking tunnels can be used to detect and monitor large weta species, and could potentially be used for other weta species.

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