Ruakumara tusked weta: Field and captive observations

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1. Introduction

An overview of the Raukumara tusked weta (n.g. n.sp.) is provided by Gibbs (1998). This supplementary account presents data obtained on a Department of Conservation expedition into the Motu River area 9-13 April 1996, from specimens sent to Dr G. Gibbs (Victoria University) prior to this, and from observations on weta kept in captivity, April 1996 July 1997. Some aspects of seasonal phenology are further clarified, and comparisons made with the related giant Mercury Islands tusked weta (*Motuweta isolata* Johns 1997). Measures for monitoring and areas for further research are suggested.

2. Field observations

2.1 SURVEY COUNTS

More than 100 Raukumara tusked weta were recorded from five sites within the East Coast Conservancy by May 1996 (Table 1). The location of sites is given by Gibbs (1998, Fig. 2).

The April 1996 expedition involved three days' search for weta in mild damp weather conditions, Table 2. The total of 115 weta from three sites (Table 1) included a size range from very small nymphs (instar 2-3) to adults,Table 3.

Larger individuals (adults and large juveniles) and very small hatchlings of a size usually missed in field counts of weta, were the most prominent part of total numbers. The very small weta (Plate 1) were fairly uniform in body length (9-11 mm) and probably included a mix of the second & third instars. These would have hatched in the preceding months and moulted once or twice but not yet overwintered. Males and females are indistinguishable at this stage.

Body weights and size measurements were recorded for representative hatchling wets and all others above hatchling size at the Mangakirikiri Stream sites, and size measurements for a sample from the Mangatutara site, Table 4. A description of size measures and data summary are given in Appendix 9.1.

Typical adult body length (excluding appendages) seems to be in the range 30-40 mm. Adult males may reach up to about 4.5 g live weight, but vary in size and some males also have conspicuously longer tusks than others. However, weights are not available for the two largest field-caught specimens seen to date. The only adult female held in captivity reached a peak of 6.1 g in a gravid state. Two females held in captivity from mid-juvenile-adult stages reached 3.8 g (but with one hindleg missing) and 4.3 g as adults, and may have become heavier with the development of eggs.

Information from several weta held captive April 1996 July 1997 made it possible to verify the indicators of adult status. In juvenile males the tusks are

symmetrical but become asymmetrical, and meet or cross at the tips and also curve slightly downward in adults (Plate 2.). Appearance of this tusk form corresponds with a tendency of otherwise solitary young males to associate with females (even if the females are not yet mature). There are a few males in which the asymmetry is minimal and adult status is difficult to tell, except by their association with females. The distinctive bright orange-tan saddlemarks on the pronotum (area behind head) of some mid-sized to larger juveniles of both sexes are not present in small juveniles and fade in adults. An adult with saddlemarks is likely to be recently moulted.

There is no tusk or ovipositor visible until juveniles reach about 0.6 g, which is a little less than mid-sized between hatchling and adult. The tusks are first recognisable as "knobs" on the front of the mandible, while a very short ovipositor becomes discernible on the underside of similar-sized females. The ovipositor length increases disproportionately in the final moults and this provides a good indicator of maturity (adult range 14-17 mm; sub-adult range 6-8 mm). Ovipositor length is the best indicator of adult status for females. This upper valves of the ovipositor also appear to overhang the lower ones by 2-3 mm in adults, while in juveniles both upper and lower valves extend to the tip.

2.2 SEARCH MODE AND NOCTURNAL ACTIVITY

The finding of two very different and well separated life stages in relative abundance to some extent relates to search mode, Fig. 1A. Day searches at the Mangakirikiri site involved turning over stones at a range of sites in various kinds of damp habitat. Most weta were found in cavities excavated under stones of medium size (about 15-40 cm on longest axis; larger ones difficult to move) along the edges of small fast-flowing side streams draining into the Mangakirikiri Stream. A few were also found in a seepage enclosed by canopy, although this seemed to be marginal kind of habitat. Searches at other damp sites away from streams were unsuccessful. DoC staff (pers.comm.) also reported finding larger individuals among mosses hanging behind a waterfall on a previous occasion, although we searched several likely sites but did not find any in this kind of habitat.

Weta found by day searching were predominantly small hatchlings, Fig.1B. This search mode seemed to cover the habitat of the smaller instars and largely missed the adults, while the smaller instars seem to have been missed at the Lower Mangatutara site, although undoubtedly would have been present, Fig.2.

The largest specimen found at the Mangakirikiri site was the intact body of a recently dead (estimate within 1-2 days) adult female which seemed to have died of natural causes. This was lying upright on vegetation under a small rock overhang on a stream bank. Experience with weta elsewhere is that it is very unusual to find whole bodies, as these are rapidly scavenged by other invertebrates

The search at the Mangatutara site included night counts of weta. Finding weta at night depends on them being out of their burrows and accessible to

an observer on lower vegetation or on the ground. The mild damp conditions were probably also an important factor, as is the case with the Mercury Island tusked weta. Night searching tends to focus on larger individuals which are easy to see. There was also a bias toward females among the larger weta - perhaps because they spend more time feeding and range less widely than males.

One night search in a stream bed below the Mangakirikiri but was unsuccessful. In hindsight the habitat, enclosed by forest canopy with Hochstetter's frogs present, was very different from the more open places where we did find weta. The search also focused in the stream bed rather than on adjacent vegetation where most sightings were made at the Lower Mangatutara site. There was no further night searching in this area.

The damp nature of the environment is a conspicuous feature in the ecology of this species. Gibbs (1998), observing nocturnal behaviour, noted a particular readiness to fall into water and remain submerged on the bottom for several minutes at least, which appears to be a deliberate means of escape from disturbance. This, together with the discovery of weta refuges under stones along stream banks, distinguishes the species from the other two species (Northland tusked weta - a miniature species, and the Mercury Island tusked weta - a giant species) for its semi-aquatic behaviour and riparian habits.

2.3 WETA CAVITIES

Weta were found during the day in distinctive oval-shaped cavities excavated in the fine silt lodged behind stones of small-medium size along the banks of fast-flowing side streams draining into the Mangatiritiri Stream, Table 5. The cavities were typically several times larger than the occupant, with the stone forming part of the cavity wall. All were within about 1.5 m of the waters edge, and most within about 50 cm, and some clearly below the level of recent flood debris (Plate 3.).

For some of the larger ones an entrance tunnel several centimetres in length (max. -10 cm) was clearly visible, and sealed with a plug of silt at the outer end (Plate 3). The plug is easily destroyed in dislodging the stone.

The inside walls of the weta cavities appear to be worked smooth by the weta. I have seen the Mercury Island species working around the inside of a cavity with the top of its head, possibly also adding a salivary cement. I suggest these refuges can withstand temporary submergence at times of flood, protected by the stone and trapping air inside. However, the finding of bodies (one adult male, two juveniles) inside cavities suggests that they might also be occasionally drowned inside by floods.

The smallest cavities were remarkably uniform in size, measuring about 3 cm on the longest axis. At first sight most of these appeared to be unoccupied, although the cavities are distinctive in appearance and clearly made by weta. It was necessary to probe gently (with a piece of twig or leaf stalk - finger too bulky) under the silt near the more rounded entry end to find the occupant

curled up under a silt overhang. The very small instars were recognised from experience with the related Mercury Island tusked weta. Microscopic examination was needed to confirm the presence of an eardrum or tympanum on the fore tibia. This distinguishes tusked weta from other ground weta (*Hemiandrus spp.*) which have no eardrum. It is indistinct in the small instars and was confirmed by holding a captive specimen though at least one moult (possibly two) in captivity until the eardrum became clearly visible.

Two other weta were in unusually large cavities which were probably vacated by larger weta. The the largest cavities were up to 9 cm in length and considerably larger than any of the weta. Several large unoccupied cavities were identified in stony soil along the side of a steep waterfall running over a steep bank about 5 m above the main stream. These were partly broken and, in two cases, may have been behind stones which were dislodged.

2.4 SEASONAL PERSPECTIVE

Information from several weta held captive April 1996 July 1997 provides an interim seasonal time-frame for growth and development when viewed with the field data.

Body measurements from the field expedition and other weta sent to Dr Gibbs (Fig-3) indicate a range for adult size, and a cohort of sub-adult juveniles which were distinguished from adults by markers other than size alone. Apart from the large male discovered in August 1995, and presumably adult before the onset of winter, these were all obtained in March or April. There were few smaller juveniles between the hatchling and intermediate size, but it is possible that these are mainly present later in the year (perhaps mid-spring - early summer) after further moults of those which were hatchling size in April. The small hatchlings are represented in both Fig-3 plots by the same individual (gender unknown) as a point of reference. Assuming similar numbers of males and females, there would have been about 23-25 of each. The eggs from which they came would have been laid over autumn-winter 1995 by a previous cohort of adult weta.

For three of these weta (2 male, one female) taken captive as larger juvenile instars and successfully reared to maturity, it took about 10 months to reach adult stage (see Fig. 3). This matches well with the growth rates for the giant Mercury Island tusked weta (unpubl. field data; C.Winks, Landcare Research, unpubl. lab data) in which two winters are passed as a juvenile, and the third as an adult. Mating and egg-laying take place during autumn-winter of the third year. Of the adults taken captive in April 1996, one died shortly afterwards, and the others survived 3-5 months. On the basis of experience with the Mercury Is. species I suggest that some adults survive through the winter, and perhaps a few survive to the end of the year. Those seen on the field expedition would have matured within the previous 6 months, while the larger juveniles were expected to overwinter then become adult 6+ months hence (and before the next winter), as was confirmed with captive juveniles.

The rugged inland habitat is probably subject to frost in winter. It is my experience with other native orthopteroid insects (tree weta, field crickets,

woodroaches) in captivity that development is suspended during winter, even in a laboratory environment where they are not exposed to winter conditions. It therefore seems, on the basis of timing of maturity and of adult size, that the captive weta were not unduly retarded in growth by the conditions of housing or food quality.

3. Comparison with Mercury Island tusked weta

3.1 SURVEY COUNTS AND HABITAT

The Mercury island tusked weta, *M. isolata*, is much larger (body length up to 70 mm; max. recorded weight in field 25 g, captive 28 g) though it has a similar body form and burrowing habit in the soil. As far as is known, this species is confined to Middle Mercury Island (13 ha), located off the eastern Coromandel coast (Fig.4). There is also a large order of difference between the species in local abundance (Table 6), although counts and the mode of search are not directly comparable.

The Mercury Island data were obtained from 10 field expeditions of 7-18 days' duration spread over a four year period and a range of seasonal and weather conditions. Yet a sum of less than 250 tusked weta was found in this time. These counts involved a timed nocturnal search, with only a few individuals incidentally found by probing cavities in the soil during the daytime (McIntyre 1991, 1992, 1994, unpubl. reports to Department of Conservation).

Night surveys focus on larger individuals. Large Mercury Island weta are easy to see on the bare soil, which is extensively undermined and mostly swept clear of leaf litter and undergrowth by burrowing seabirds. It seems that the hatchlings and smaller juveniles were almost entirely missed, as the unstable ground limited opportunities for day searching. Furthermore, there are no stones which weta can burrow under, and which can be removed and replaced without damaging the habitat, and thus no convenient markers to locate likely sites. There was only one small hatchling (right hind femur 7.0 mm cf. ~6 mm for Raukumara weta, Table 4) which was equivalent in development stage to the small Raukumara hatchlings. This was found by chance at night under a leaf on the ground. Observations of captive weta indicate that the small juveniles of the Mercury Island species tend to stay buried in the soil for long periods (C.Winks, Landcare Research - pers. comm.) and their nocturnal emergence is difficult to predict.

Monitoring of some larger individuals by radiotelemetry for periods up to about 16 days enabled the location in soil of daytime refuges not otherwise recognisable to an observer. These are shallow chambers just below the surface, often constructed where there is some small change in topography, or under tree roots. There is no long exit tunnel, and exit hole is sealed with a plug of earth, possibly with the grains of soil glued together with saliva. The

chambers are often in open unstable ground where they are vulnerable to disturbance. Refuges of the Raukumara weta have more protection, with entrance tunnels up to 10 cm leading to a weta cavity behind a stone.

Another noteworthy difference seems to be that, for juveniles and most adults, the size of the chamber closely fits the size of the occupant, while for even the very small instars of the Raukumara species the cavity is consistently much larger than the weta. Some Mercury Island weta seemed to be in tuatara burrows or larger chambers, possibly abandoned bird or reptile excavations, but the use of radiotransmitters confirmed that these were invariably enclosed in separate chambers excavated in the side wall inside the entrance of these larger open cavities, where they were probably utilising loose soil thrown out by the birds or tuatara. As for the Raukumara weta, the inside wall of the chamber appears to be worked smooth and compacted by activity of the weta.

Vacant weta holes, especially larger ones, are recognisable by a distinctive round exit hole. These are quickly occupied by other invertebrates, especially spiders, but do not last long in the friable soil, unless the site is somehow protected from seabirds.

The monitoring by radiotelemetry also confirmed that although they sometimes climb trees at night, the adults invariably return to soil by day. Sometimes they stayed in the soil without coming out for up to eight consecutive days. On other occasions they were dectected above in foliage where there would be little chance of seeing them. Males move about more than females, and often dig temporary refuges in the soil which they abandon once they leave, while females show a greater tendency to return to to the same hole.

3.2 APPEARANCE

Morphology of the Raukumara weta is discussed by Gibbs (1998). The Mercury Island weta is typically a lighter matt tan colour and, unlike the Raukumara species, lacks a waxy sheen on the surface of the cuticle. Juveniles are darker than adults and lack the distinctive orange saddle marks of the Raukumara species, although the very small juveniles look similar. The ocelli, instead of being yellow, are a characteristic orange. This provides an easy way to distinguish small juveniles from those of ground weta (*Hemiandrus* sp.- cream ocelli) which otherwise look similar and are common on Middle Island.

There is conspicuous variability among adult males in body size, with an order of size difference between the smallest and largest adults of at least one and possibly two instars: body weight 14.6 ± 3.8 g (ra. 8.6-23 n=45), hind femur length 33.8 ± 2.7 mm (ra. 29-41 n=50). Females are generally heavier than males though vary as eggs develop, av. 18.7 ± 2.6 g (ra. 14.3-25 n=60).

The adult males are easily distinguished from sub-adult juveniles by the form of the tusks. In the late instars the tusks are symmetrical with a smooth surface and do not meet at the tips. At the final moult they become asymmetrical and curve upwards, with the tip of the left tusk crossing over the right. Grooves appear around the tusk, with ridges forming a set of stridulatory

pegs just behind the tip on the upper side of the right tusk and lower side of the left tusk. The top of the ridge is often scraped flat on the right tusk, apparently with wear. The ridges are much reduced and stridulatory pegs absent from the Raukumara weta. The discovery of large-bodied Mercury Island weta with the juvenile tusk form alerted us to the variability in adult size. The size of the tusk also varies among adults. This can be a very robust structure in the larger males, while it is short and more slender in the smaller individuals. The wide range of variation in tusk length (Fig. 5) suggests some behavioural variation in use or effectiveness between the long and shorter-tusked individuals. The available data suggest that there might be a similar situation in the Raukumara males, but because it is a smaller weta in overall body size the differences between larger and smaller individuals are less conspicuous.

3.3 SEASONAL ECOLOGY

The seasonal pattern of growth and nocturnal activity provides a point of reference for the Raukumara weta until further information is available. The adults are relatively short-lived, with a single egg-laying season, spread over about 6-8 months. Mating and oviposition occur through the winter.

There is a minimum of 9 weeks taken for egg incubation, but a period of 6-8 months is more typical, depending on the time of egg-laying, especially where this includes overwintering (C.Winks, Landcare Research - pers.comm.). Field data suggest a strongly seasonal pattern of growth, with juvenile life extending over two winters, and adult life over one winter, contributing to a span for active life stages of more than two and up to about three years. This might be shortened in captivity, depending on when eggs are deposited.

Mid-sized to smaller instars are usually under-represented or missed in nocturnal counts, although, excluding eggs and small hatchlings, there are two age cohorts of weta present throughout the year. These are separated by 2-4 instars in development and become adults in different years. The size range of juveniles in each cohort spreads over about three instars, with modal body size of each cohort depending on time of year. Adult females are found from about February onwards. Those surviving to November-December appeared to be near spent - judging by various combinations of damaged or missing appendages or other wounds to the body, flaccid abdomen and low body weight in relation to size, and generally reduced responsiveness when handled.

Adults found in February-March period by comparison all appeared to be in good condition, presumably moulted to adult status in recent weeks. They are also very energetic and required careful handling. Only larger juveniles have been found in early January.

Large adult males have been found only in February and March, while small-medium-sized males are found from about May-December. The behaviour of large and small males and origin (genetic or developmental trigger for early {small body} or delayed {large body} maturity) and ecological significance of the instar differences at maturity is not understood. This could be an impor-

tant consideration in the selection of individuals for captive breeding. There is also evidence of variable size at maturity in Raukumara males (refer Appendix 9.3).

Some aspects of seasonal timing, and of growth rate in captivity match well with the time frame for growth of the Raukumara weta.

3.4 THREATS TO SURVIVAL

The two species are not widely separated geographically (Fig. 4) but occupy different kinds of environment, and are subject to different ecological threats.

Both are surrounded by vertebrate predators. In the case of the Mercury Island species these are tuatara, several large nocturnal lizard species and morepork. Venemous giant centipedes probably also take them occasionally. They have a long evolutionary association with these animals and seem remarkably sensitive to their habits (M.McIntyre - unpubl. data). The key factor to their survival, and indeed also the survival of their reptile predators, is the absence of introduced mammal predators, in particular rats. There are no tusked weta on four adjacent conservation islands (ra. 26-205 ha) which, until recent eradications (1986+), all had kiore present. Management plans aim to reduce vulnerability of the single weta population by building up captive stocks for establishing the species on at least two nearby islands now free of rats.

It is both a contrast and quite remarkable that the Raukumara tusked weta, although smaller in body size, persists in an environment infested with a range of introduced mammal predators, viz. pigs, rats, feral cats, possum and stoats. The stream bank habitat and semi-aquatic habits appear significant in this regard. Stones provide some protection during the day. Weta also have a characteristic odour (even to the insensitive human nose), and Gibbs (pers. comm.) suggests readiness to jump into water and stay submerged may effectively expunge any odour markers by which predators locate them. Either the species has some physiological requirement restricting it to a damp lifestyle, or was once more widespread but is now limited by predation to riparian habitats, although this might not ever be clearly established. As far as can be anticipated, threats to this species are of a general nature associated with degradation of habitat by introduced pests and the loss of habitat through deforestation of unprotected areas, and perhaps also excessive silting of forest streams from deforestation elsewhere. Conservation management might therefore involve having field staff record new sightings and keeping a database of this information, perhaps with regular monitoring of some selected sites. This would not only build up appreciation of their distribution, but in the longer term also provide a baseline to detect any future contraction of range.

A second major environmental concern for the Mercury I. weta is dryness of the environment. The Mercury Islands are in the lee of the North island and prevailing westerly wind. They are subject to drought in the mid-summer-autumn, especially January to March. The environment is also exposed to wind and salt and Middle Island lacks a source of fresh water. This island has

more seabirds than the islands which formerly had kiore, and the loose friable soil, turned over continually by bird activity, drains readily, while uric acid deposited by the birds probably also contributes to geological degradation of the habitat. There are several clues which suggest that, although the species survives in an unusually dry environment, it may nevertheless be more adapted to wetter conditions, Table 7.

I suggest the weta is limited by availability of sites where the soil retains some dampness through the dry period. By May June, adult weta are seen more widely on the island at night, especially males, apparently searching for females. Seasonally dry conditions may also impose the strong seasonal pattern of growth.

Despite intensive searching, no tusked weta have been found on adjacent Green I. (3 ha), which is also naturally without kiore or other mammal species, though it has high densities of tuatara. I suggest that Green I., which lacks a shaded basin or equivalent sheltered site with forest canopy of large shady trees, is too dry to sustain a viable weta population through any prolonged spell of dry weather.

Discovery of the Raukumara species provides a point of comparison for the critically endangered Mercury Island weta, and an overall impression that it may be "marooned" in an environment which is at least sub-optimal, and perhaps marginal to its survival.

I suggest that the less endangered Raukumara species could be used to examine some of the behavioural and physiological detail of reproduction which might underlie difficulties encountered with captive rearing of the Mercury Island species. In particular there is a lack of information on the association of males and females before and after mating and behaviour of males with regard to occupation of refuges and use of the tusks. My own field studies revealed little of this, yet it may be crucial to finding a way to manipulate them in captivity. Further understanding of water relations in this species may also shed some light on its habitat requirements, with implications for the selection of release sites for establishing new populations.

4. Captive Weta

Larger weta survived in captivity beyond expectation, given limited knowledge of their habits at the time. Their nocturnal activity was observed in the period following field collection and their growth and survival monitored. There were three adult males, four mid-sized juveniles (2 m, 2 f) and two hatchling juveniles collected on the April 1996 expedition and one adult female sent to Dr Gibbs just prior to this.

Most observations were made within 3 hours of dusk, using a nightscope with an infra-red beam. As with the giant tusked weta, the effect of night lighting is to inhibit normal activity. They tend to freeze (thus appearing docile) in the beam of a torch or caving lamp, or if physically disturbed become hyperactive. In the dark they resume activity within minutes of turning a lamp off.

They also seem a lot less disturbed by any small tactile disturbance when observed in the dark.

There is a dilemma in making observations of captive wets, especially with only a few available. Disturbing them (e.g. turning over substrate to confirm where they are or what they are doing, or to find eggs; weighing and measuring) will preclude some later observations and disrupt normal behaviour, but a decision not to interfere requires missing some information. Some data points (exact dates, body size) were missed for this reason, but an overview with approximate time frames was possible.

4.1 HOUSING

The adult and large juvenile weta were housed in two 60 x 40 x 40 cm plastic tubs. The floor was covered to 5-8 cm in fresh damp river silt with a few flat building stones (about 15 x 6 x 3 cm) placed on the surface. A shallow dish of unchlorinated tap water (Hutt Valley domestic supply) with a handful of gravel and small stones in was also supplied. They burrowed readily under the stones (or water dish) which also served as "lids" to check on the occupant of the cavity underneath and replace with minimal disturbance. The top of the tub was covered with a 1 x 1 mm wire mesh attached to a wood frame, to allow air circulation - this is important to prevent buildup of fungus in damp conditions. These terraria were held on a concrete floor in an unheated basement with natural lighting. Ambient temperatures ranged 9.5-14°C.

The water seemed to get a bloom on the surface and was changed at weekly intervals. I am not sure if they were defaecating in it. Unlike the more vegetarian tree weta *(Hernideina spp.)* and giant weta *(Deinacrida spp.)* tusked weta do not leave firm dry faecal pellets. The scats are typically a wet and foul smelling semi-liquid suspension of material, and produced infrequently. Chris Winks (Landcare Research - pers comm.) has also noted giant tusked weta often defaecate in water.

One hatchling juvenile was preserved for examination the other kept similarly in damp silt in a two litre plastic tub with ventilation panels on top and two sides.

Weta were transported in 21 plastic tubs packed closely with damp moss and leaves. They were introduced to the terraria after dark inside the packing material. The emerged from this in their own time, and by the next morning had invariably dug themselves into a cavity in the silt under a stone or the water dish.

4.2 FOOD

The captive weta were offered a variety of food material. Feeding or evidence of feeding (bite marks, chewed edges) was observed on some items, and there was evidently an adequate diet to allow maturation of the three mid-sized juveniles to a body size well within the range of field-collected adults (Fig. 3).

Fresh young foliage of a variety of local native species was replaced regularly. This included taupata *(Coprosma repens)*, karamu *(C.robusta)*, hebe *(Hebe salictfolia, H.* cultivar), mahoe *(Melicytus ramiflorus)*, hangehange *(Gentostoma rupestre)*. They were also supplied with leaf litter from under this vegetation, which also included tree fern *(Cyathea dealbata)* and ngaio *(Myoporum laetum)*. This was enriched with a variety of small invertebrates extracted from the same litter source with a Berlese funnel.

Additional food items were offered at various times. These included house-flies newly emerged from the pupa, and wax moth larvae from insectary-reared stocks. The weta were not seen taking flies (which settle at night on vegetation), although, initially at least, the flies seemed to disappear by the next day. They were also occasionally offered a large noctuid moth captured around an outdoor light, though these became unavailable over winter. These also disappeared by next day.

The wax moth larvae tended to spin a cocoon within a few hours of removal from their culture medium. The weta were immediately attracted to these and males adept at extracting the larva with the tip of tusk, and quickly separating it completely from the silk casing, which was left behind. They then proceeded to slowly eat it taking it into the mouth end-on over a period of 15-20 minutes. Perhaps soil-dwelling larvae are a common item of natural diet. There were no equivalent observations for the female.

They showed only initial interest in tinned cat food, and freshly sliced apple. They were occasionally seen chewing on dead (discoloured) leaves but not seen on fresh green material, seeds or flowers, although they may have taken some of the last two, as evidence of browsing was not readily recognisable. Karamu, taupata and hebe fruit at various stages of ripeness were also offered but did not attract attention, and it is not clear whether any was taken. Fresh sliced carrot seemed the only vegetable item which was consistently eaten.

Dried fish food (Masterpet Community Flakes) was readily taken, and more convenient to handle than cat food, and does not grow mould if left. After about two months a small amount of this was made continuously available and seemed to be readily taken, judging by disturbance and amounts remaining. This is used as a basic diet item for captive Mercury Island weta (Chris Winks, Landcare Research Ltd. - pers comm.).

There was a reduction in feeding activity, and interest in new food items with time. Perhaps this related to the onset of winter and declining daylength, although they were insulated from the outdoor environment.

As for all weta, they take both animal and plant food, but, like the Mercury I. tusked weta and ground weta *(Hemiandrus* spp.) generally, they seem to be mainly predators and scavengers of other invertebrates. They readily investigate novel food items. It is not clear how much plant food was taken but I suggest that a degree of variety of food may be important to them.

4.3 NOCTURNAL BEHAVIOUR

The weta emerge from the soil after dusk, or occasionally in warm weather during dusk. If coming out on a particular night they are likely to be seen at this time, in captivity at least. They are typically alert and active when in the open, but when not moving about tend to sit partly obscured in vegetation or beside some object. Alertness is indicated by erect and mobile antennae (slow->rapid switching, the latter often also with mobile palps) with degrees of alertness recognisable. Activities observed included exploratory behaviour, feeding, occasionally agonistic behaviour and, in the case of adults, reproductive behaviour.

The behaviour of three adults and two mid-sized juveniles was noted on most nights over the first two-months in captivity. Initially two similar-sized adult males, one with long tusks (right hind femur 25.2 mm, right tusk 9.4 mm), the other with shorter tusks (hind femur 25 mm, tusk 7.2 mm) were established in a terrarium on 15 April. The following interactions took place after the adult female was introduced two nights later.

The female in a small holding tub had excavated a chamber in damp sand and plugged the entrance. This container was placed after dark and with the lid off in the terrarium with the males. Within five minutes the antennae of the female appeared and the smaller adult male also emerged from hiding. After about 15 minutes the female climbed out of the small container, defaecated nearby then climbed out into the area with the males. The shorter-tusked male approached immediately and attempted to mate by backing under the female without any preliminary courtship, but was firstly ignored then kicked away. The female moved directly into the open entrance of a hole under a stone where the longer-tusked male was sitting.The first male attempted to follow but was ejected. After this it was seen most nights sitting on foliage on one side of the arena.

The larger male and female mated immediately and were coupled when checked inside the same chamber under a stone at 1000 h and 2230 h the next three days. They remained together and continued to mate intensively until last seen mating on 6 May (19 days). The same male was seen sitting under litter on 9 May, and found dead with a puncture wound on the rear underside of the abdomen on 11 May, while the shorter tusked adult male was coupled with the female in a different cavity under leaf litter nearby.

This male stayed with and repeatedly mated with the female until 18 June (period of mating in captivity 62 days). By this time the female looked markedly distended (weight 6.1 g), as if holding eggs but not depositing them. To explore this possibility she was separated from the male and moved to a separate container with a fresh silt substrate. The second male, now alone, died under litter some time between 10 -30 July. The female survived a further two months.

The reproductive behaviour of this species seems very similar to that of the Mercury Island tusked weta. Males and (or) females seem to sense each other at a distance, probably from olfactory cues. There is little or no preliminary courtship but prolonged and repeated copulatory activity inside a cavity in

the soil. As has been suggested for other giant weta (*Deinacrida* spp.) the prolonged mating may be essential to promote the maturation of eggs or spermatophores.

There were also freshly dead adult males of both species found with puncture wound on the rear underside of abdomen. Such wounds have also been reported in captive male Mercury Island weta (C.Winks, Landcare Research pers. comm.) and on a large free-ranging male found at night in a moribund state on the soil surface. It is not clear whether this is a tusk wound. Perhaps males in a near-spent state become vulnerable to other males in this regard.

4.4 EGGS

There were two small batches of eggs recovered, the first from the field-collected female, and the second from the female captured as a middle-instar juvenile and matured in captivity.

The eggs are an elongate oval shape ranging 5.1-5.5 mm in length, translucent to light-brownish in colour, with the developing embryo (in particular eyes and mandibles) visible in the latter- stages of incubation. They eventually become discoloured if non-viable. Hatching is indicated by a characteristic exit opening, with the egg cuticle cleanly split with the split extending over the top of the egg at one end. The number of eggs was much less than expected, but the time over which they were deposited may have been only a small part of the egg-laying life of the female (cf. 234 recovered from body of one Mercury I. female - but much larger weta).

The substrate in the container with the field-collected males and juveniles was washed through and checked for eggs, but none was found. However, there were 20 eggs recovered from the substrate of the terrarium to which the female was later transferred and kept alone. Two had hatched but the hatchlings were not recovered. Most of the remainder were chewed, probably by other soil invertebrates released in litter for food (or possibly by the weta - although most of the bite marks did not seem typical of wetaf).

Eggs were also unexpectedly recovered from a container occupied by a lab-matured female which died six months earlier in June 1997. This weta was housed with one of two lab-matured males. They mated intensively over several weeks until the female appeared moribund on 30 March. She was transferred to a holding container, with the intent of perserving the specimen, but after two days seemed active again so was transferred alone to a separate terrarium and survived for a further 10 weeks. There were 23 eggs recovered; of these 8 were chewed, possibly by litter invertebrates and 15 still intact and some possibly viable. There were no eggs found in substrate of the original container.

The continued viability of some of these eggs is possible, given that the minimum incubation period for eggs of the Mercury Island weta is about 9 weeks but an extended period of 6-8 months is more typical (C.Winks, Landcare Research - pers. comm.).

Males seem to monopolise females in captivity, and this affects egg-laying, perhaps by stressing the female. They should be separated for captive management purposes, but the timing of receptivity after the final moult and suitable period to allow with the male for mating need clarification. To protect eggs it is important to provide food sources other than live litter invertebrates at this time. It is possible that weta confined in captivity also chew their own eggs.

4.5 JUVENILE ACTIVITY

As for the Mercury I. weta, the nocturnal activity of juveniles is sporadic and difficult to predict. Initially the two mid-sized field-collected juveniles were seen on foliage most nights, retreating usually to separate cavities in the silt substrate by day. Sometimes the entry was left open in the day, on other occasions they were sealed in with the plug of earth.

After initial agonistic encounters the juveniles seemed to avoid the adults when out at night, although they were occasionally found sharing a cavity by day with the smaller unmated adult.

The intermittent timing of nocturnal activity is, in large part at least, related to moulting of the old cuticle. This takes place in the soil and is especially prolonged in tusked weta. The weta stops feeding and stays enclosed in the soil throughout. The old cuticle is eaten so no evidence of moulting remains. Both captive juveniles were seen on the night of 5 May and not again for 41 and 115 days respectively. The latter had completed its moult by 56 days (cuticle tanned, weta sitting upright in cavity) and may have been active in the meantime but not seen, while the former was frequently active at night. The period of disappearance appears to involve quiescent times before and after moulting, when the weta looks normal but is inactive.

Chris Winks (Landcare Research - pers. comm.) recording disturbance of food as an indicator of nocturnal activity, found that captive Mercury I. juveniles feed little in winter, typically going 6-8 weeks and up to a maximum of 10 weeks between about May and August without evidence of feeding. The long disappearance is invariably associated with moulting, while in intermoult periods there is regular evidence of nocturnal activity at intervals of a few days. The non-feeding time is reduced in warmer conditions (summer) to a minimum of about four weeks.

From this reference point the long disappearance of Raukumara weta is not unexpected. It is likely that moulting underground in a damp substrate retards tanning and setting of the new cuticle (chemical oxidation required; white-pale coloured appearance while incomplete), so perhaps this is a cost of the burrowing habit, further prolonged by cooler temperatures over winter. We did not encounter any weta obviously in moult by turning over stones on the April 1996 expedition, which is perhaps surprising given the long periods involved.

The prolonged moult, even if shorter in warm weather, incurs loss of feeding time over the summer and autumn - though this might not be crucial for the

largely carnivorous tusked weta. The more vegetarian tree weta (*Hemideina* spp.) and giant weta (*Deinacrida* spp.) moult suspended upside down on vegetation on mild damp nights. Feeding stops a few days before moulting, but moult is completed in 2-3 hours and the weta resumes feeding within 2-3 days. Moulting of these species is rarely observed in winter, probably because the interval between moults is considerably prolonged.

The moulting state of captive Raukumara weta was confirmed by lifting the stones to reveal the weta enclosed underneath. It moults on its back in a very confined space and is in a vulnerable state while the cuticle is still soft (white/pale colour, untanned). As for other weta, disturbance while moulting can result in deformity of the new cuticle. A sudden drop in humidity with opening of the cavity might be also affect setting of the cuticle, so this should be done with caution. One juvenile (the more active one) emerged with a deformed hindleg which looked like such a moulting "accident".

4.6 SURVIVAL

The field-collected Raukumara weta adults survived 2-5 months in captivity, the female outliving the two males. Two males and a female, captured in April 1996 as mid-sized juveniles, reached adult status in January-March 1997 (refer Fig. 3), taking about 10 months to mature. Such a growth rate is consistent with a juvenile life extending over two winters. These would have passed the previous winter as small juveniles.

The three adults captured as mid-sized juveniles lived for 13-15 months in captivity - the last of these, an unmated male, surviving to the beginning of August 1997. I believe this, with an estimate of about 14-16 months of juvenile life prior to capture, approximates their normal life span.

The one captive hatchling survived about 5 weeks and the few hatched in captivity (perhaps also some not discovered) were not recovered. The early instars are very delicate and vulnerable. They are easily trapped by surface tension of free water, or eaten by larger individuals and probably also other insects. These should be isolated from larger weta and free water in captivity. I am not sure what food items to provide for very small weta. As for weta generally and ground weta in particular, small (or damaged) weta are vulnerable to cannibalism by larger ones especially when confined in captivity.

5. Recommendations

Perceived threats to this weta species are associated with quality of the habitat - viz. loss of habitat by deforestation, excessive silting of streams from deforestation of catchments, possibly also weeds along stream banks and clearing or animal damage to native vegetation along stream banks.

I suggest that an appropriate course for conservation management would be to extend appreciation of their range of occurrence, and set up a plan to monitor numbers at a suitable time interval at 2-3 selected sites. This would eventually provide a baseline which would enable any serious decline or contraction of the range to be detected. Research should be encouraged into aspects of the biology of the species which would underpin this, and also contribute, by comparison to conservation management of the closely related giant tusked wets. This might be carried out as follows.

1. Encourage staff in the field to check for Raukumara tusked weta when in new areas of suitable habitat. Enter sightings into a database which will be accessible in the future. See Appendix 9.2 for search sugges tions and information which should be recorded (perhaps design standard field sheet to incorporate this). Locations to the west (to Mamaku/ Kaimai Ranges?) and south (to Huiarau Ra.?) of the known range would be of particular interest when field parties are in these areas.

2. Put in place a plan to undertake a weta count at two or three sites at suitable intervals (e.g. 10 years, sooner if habitat change is known or suspected). The sites might include one nearer the forest edge that is already subject to some modification and one further away from forest edge with less modification.

3. Encourage research into aspects of the biology of this species which will:

   i enhance appreciation of habitat requirements and habitat use, and threats to survival;

   ii improve monitoring methods and establish an easily implemented procedure for field staff, and provide an ecological framework to interpret survey results;

   iii elucidate, by comparison, some areas of biology crucial to conservation management of the closely related and highly endangered giant Mercury Island tusked weta (see Research Questions - below).

NOTE

A captive breeding programme for Mercury Island tusked weta has had some success but been unable so far to meet requirements for conservation management. I have recommended informally to DoC Hamilton that the more abundant and less endangered Raukumara species could be used to examine aspects of reproductive behaviour which might assist with their management in captivity.

6. Further research

I suggest these areas of interest as a focus for further applied and basic investigation.

1) Monitoring
Establish an ecological framework to interpret field survey data, and develop a monitoring procedure which is easy to implement. Consider possible threats to the species and significance of stream bank habitat and readiness to jump into the water in this context. Note that invertebrate populations are subject to natural fluctuation, so interpreting an apparent decline needs to take this into account if obvious habitat destruction is not occurring.

2) Reproductive behaviour
Examine the normal behaviour involved in association of adult males and females before and after mating, the timing of female receptivity after the final moult and time needed with a male for fertilisation of eggs, and significance of the tusk in interactions among adult males. Use as a model to consider implications for captive management of the Mercury Island species.

3) Male development
It seems possible that males can mature in more than one instar and at different times of the year. The present study deals only with males maturing in late summer and autumn. Examine the seasonal occurrence of larger and smaller males. If some males are maturing early or delaying maturity, consider the ecological context and extent to which any differences might be triggered by environmental or genetic factors. Consider implications for captive rearing of the endangered Mercury Island species.

4) Physiological water conservation and habitat requirements
Examine physiological water conservation in the Raukumara & Mercury Island tusked weta, with regard to their respective very damp and very dry environments. Consider any implications for establishing new populations of Mercury I. tusked weta.

5) Other
Examine food sources.

Pheromone signals are well developed in weta. Consider the conflicting demands of olfactory communication among Raukumara tusked weta and their apparent ability to avoid mammal predators with a well developed olfactory sense.

Examine uses of the of tusk by males with regard to the downturned tip of Raukumara weta and upturned tip of the Mercury Island weta.

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8. Acknowledgements

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9. Appendices

TABLE 1. Summary of tusked weta counts to 1 May 1996. Night searches were undertaken only at the Lower Mangatutara site.

site	no. of weta		
	day search	night search	total
DoC staff 1995-96:			
Moutohora	5	-	5
Saddle Biv	8	-	8
April 1996 expedition:			
Mangatutara Stm	1	-	1
Lower Mangatutara Stm	12[1]	35	47
Mangakirikiri Stm	67[1]	-	67
total	93	35	128

[1]incl. 2 bodies

TABLE 2. Prevailing weather conditions during the weta search, recorded at the Mangakirikiri hut. Max.-min. temperatures refer to the preceding 24 hours, 1800-1800 h.

date	temp. °C, 1800 h			weather
	max	min.	current	
10 April	18.5	14.5	16.5	mild, no wind, steady rain in morning, showers in afternoon
11 April	18.0	16.0	17.5	mild, no wind, fog and showers throughout day
12 April	21.5	17.5	18.0	mild, no wind, overcast, ground damp

TABLE 3. A breakdown of weta numbers from the April 1996 expedition by growth stage.
h = hatchling (nymph not yet overwintered)

growth stage	no. of weta			
	male	female	no record	total
adults	13	21	6	40
$juv._{lge}$	11	13	1	25
$juv._{med}$	0	1	0	1
$juv._{h}$	-	-	49	49
total	23	34	58	115

TABLE 4. The body size of adult and smallest field-caught Raukumara tusked weta (max. and sample size in brackets). nd, no data

	mean ±sd	
	female	male
adult:		
body weight - g	nd	3.3 ±0.4 (3.7; n= 5)
body length - mm	36 (1)	35.0 ±3.4 (39; 7)
length right hind femur	24.5 ±1.8 (28.1; 14)	23.7 ±1.5 (26; 15)
pronotum length - mm	8.2 ±0.4 (8.9; 14)	8.1 ±0.6 (9.2; 15)
ovipositor length - mm	14.7 ±1.3 (17.2; 14)	-
right tusk length - mm	-	6.2 ± 1.8 (11.1; 15)
hatchling juvenile (gender not known):		
body weight -g	<<0.1	
body length - mm	9-11 (8)	
right hind femur - mm	5.9 ±0.4 (2)	
pronotum length - mm	2.5 (2)	

TABLE 5. Typical dimensions of weta cavities located behind small-medium (appox. length ra. 9-45 cm) sized stones along stream banks.

	cavity dimensions - cm	
	typical	other
hatchling:		
max. length	2.9 ±0.2 (7)	8.1 - 8.7 (2)
breadth	1.1 ±0.1	3.0 - 4.2
(90° to length)		
typical depth	~0.8	1.1 - 1.5
adult (incl. 3 unoccupied):		
max. length	6.0 - 8.7 (5)	
breadth at 90°	3.6 - 4.5 (5)	
(plane beneath stone)		

TABLE 6 . Comparison of field counts April 1996 with data for the Mercury Island tusked wets obtained 1991-1994 (M. McIntyre unpubl. data).

	no. of field days		no. of new weta total weta	mean/day
Raukumara tusked weta	total	3	115	~38
	night search	4	35	~ 9
Mercury Islands tusked weta	total*	118	239	2.0±2.6

night search plus 4 found during day

TABLE 7. Features of Mercury I. tusked weta which suggest sensitivity to moisture in the environment.

biological feature	status
very patchy dispersal	* three core sites identified on 13 ha island, total area ~ 0.2 ha; site characteristics: - lower (east-facing) edge of gently sloping ground - well-shaded from direct sunlight by large trees - soil more compacted and relatively stable - seem to be sites where seepage from higher on the slope comes near surface - soil retains some moisture below the surface in dry period Jan.-Mar.
nocturnal activity reduced in dry conditions	* best survey counts on mild, dark humid nights, and still conditions especially when damp after a prolonged dry spell[1] * adults most visible at night May-June (after drought period) when involved in reproductive activity
lack efficient physiological water conservation	* produces semi-liquid foul-smelling faecal slurry * lack robust (waxy or highly tanned) cuticle
hatchlings and small juveniles vulnerable to dry conditions	* first instar very sensitive to moisture, easily lost if too dry (early instars burrow in soil on hatching and remain buried for long periods)
absent from Green I. (3ha)	* too dry?

[1]timing of activity also related to lunar cycle and avoidance of moonlit conditions

9.1 BODY SIZE MEASURES OF FIELD COLLECTED WETA

KEY

Wt - body weight - g
PL - pronotum length - mm (measured along dorsal midline of thorax)
PW - pronotum width - mm (measured across widest part of thorax)
HW - head width - mm (caliper placed across front of head at widest part)
RHF - right hind femur length - mm (caliper placed from top of upper lobe to tibial joint)
RHT - right hind tibia - mm (caliper placed over each end of tibia)
BL - body length - mm (caliper placed along dorsal midline from head to tip of body; excluding ovipositor; subject to soft body parts and posture - approx only)
OV - ovipositor length - mm (measured from point where upper and lower valves meet base on right side->tip)
RT - right tusk length - mm (underside of angle with jaw -tip)
LT - left tusk length - mm (underside of angle with jaw-tip)
Mk - Mangakirikiri area
Mt - Mangatutara area
D95 - original specimen discovered 1995
D96 - collected by DoC staff 1996
A - adult
J2 - large (yr-2) juvenile
J - small- to mid-sized juvenile
nr - no record

NOTE:

1) - measurements are taken on the right side of the weta as a means of standardisation

2) - tusk and ovipositor length measurements are taken from the base-tip; they do not account fully for curvature but are practical for handling live weta

3) - a gap in the table indicates 'no record'

TABLE A. Summary of field measurements

Weta no.	site	sex	status	PL	PW	HW	RHF	RHT	BL	OV	WT	saddlemk
FEMALES (N=27)												
1	Mk	f	A	8.6	10.8	9.8	28.1	27.0	36	26	nd	-
2	Mt	f	A	7.6	8.6	7.3	22.5	21.9	nd	14.9	nd	-
3	Mk	f	J2	6.4	7.2	6.6	19.1	18.0	27	7.7	1.5	++
4	Mk	f	J2	6.0	7.6	5.8	17.2	16.0	26	5.9	1.5	+
5	?	f	J2	6.7	7.3	6.4	18.6	17.8	26	6.2	1.2	+++
6	Mt	f	J	6.1	7.6	6.5	18.0	16.2	29	6.8	1.8	+
7	Mk	f	J	6.5	6.8	5.8	16.1	16.9	21	6.1	0.8	-
8	Mk	f	J	5.8	6.0	5.4	15.0	14.1	21	3.8	0.8	+
9	Mk	f	J2	5.1	5.8	5.4	14.6	13.5	23	3.8	0.9	+
10	Mk	f	J	nr								
11	Mk	f	J2	4.5	5.9	4.7	13.6	12.5	22	3.2	0.7	-
12	Mk	f	J	4.4			13.4	11.6	18			nr
13	Mk	f	J2		6.0				25			nr
14	Mt	f	A	8.9			27.4			17.2		
15	D96	f	A	8.7			26.5			15.2		
16	Mt	f	A	8.0			24.2			15.0		
17	D96	f	A	8.5			24.0			14.5		
18	Mt	f	A	8.5			24.0			14.3		
19	Mt	f	A	8.2			25.5			16.0		
20	D96	f	A	8.0			24.5			14.2		
21	Mt	f	A	8.0			24.8			15.0		
22	Mt	f	A	8.0			22.0			13.0		
23	Mt	f	A?	7.8			22.5			13.2		
24	Mt	f	A?	7.5			23.2			12.5		
25	Mt	f	J	5.3			14.4			4.0		
26	Mt	f	J	5.3			14.3			3.0		
27	Mt	f	J	3.2			11.2			1.0		
MALES (N = 24)										RT/LT		
1	D95	m	A	9.2	10.1	9.3	25.6	24.2	~36	11.1/9.7		-
2	Mk	m	A	8.3	10.7	9.2	23.9	21.8	37	6.8/8.2	3.7	+
3	Mt	m	A	8.3	9.2	8.9	24.8	23.7	38	5.9/-	3.5	-
4	Mt	m	A	8.2	9.2	8.2	22	20.4	29	5.0/6.1		-
5	Mk	m	A	8.1	8.3	8	21.6	20.7	35	4.5/5.4	3	-
6	Mt	m	A	7.8	10	8.8	23.2	22.3	34	5.6/7.0	3.5	-
7	D96	m	A?	7	9	8.2	21.1	18.9	33	2.8/3.4	2.7	-
8	Mk	m	J2	7.7	8.6	8	18.7	16.4	30	1.1/1.1	2.1	+++
9	Mt	m	J2	7.2	7.4	6.8	19	17.7	33	0.4/0.4	2.1	+
10	Mk	m	J2	6.8	7	6.8	16.4	17.2	23	0.3/0.3	1.1	++
11	Mk	m	J2	6.6	7.6	6.5	18.4	15.4	26	0.2/0.2	1	+
12	Mk	m	J2	6.4	7	6.5	18.7	16.4	27	0.2/0.2	0.2	++
13	D96	m	A	8.8			26			7.0/-		
14	Mt	m	A	8.5			25			6.3/-		
15	Mt	m	A	8.5			24.8			6.3/-		
16	D96	m	A	8.5			24.6			5.6/-		
17	Mt	m	A	8			23			5.8/-		
18	D96	m	A	8			23.5			4.5/-		
19	Mt	m	A?	8			22.5			6.5/-		
20	D96	m	A?	7			24			5.0/-		
21	Mt	m	J	7			19.2			'knob'		
22	D96	m	J	6.5			19			?"		
23	Mt	m	J	6.5			18.3			?"		
24	Mt	m	J	6.4			17			'knob'		

9.2 FIELD SEARCH SUGGESTIONS

Searching for weta under stones along stream banks is relatively independent of weather, but the typical size range of weta found will depend on time of year. The time taken for juvenile weta captured in the field to reach adult status will also depend on body size.

While it should be possible to find some weta under stones at any time of year, the best time to find large juveniles and adults is probably in the late autumn-early winter period. Any weta that is white or very pale in colour, possibly sitting on its back, is in moult and should not be disturbed.

Very small juveniles (less than about 15 mm body length) captured autumn-mid-year will require two seasons to reach adult status. Larger juveniles (larger than about 25 mm body length) will require one. A season is best considered with regard to winter, which is a time of quiescence or prolonged moulting for juveniles while it is also the time of reproductive activity (depending on weather) for adults.

Night searching of vegetation (especially shrubs) near stream banks is probably a better way to find adults and large juveniles, but success is likely to depend, initially at least, on knowing where there are weta present, and then on weather and time of year. It is probably a good idea to wait for an hour or so after dusk, leaving time for weta to climb up on to vegetation, where they will be easier to see than on the ground.

Timing from about February-May in mild damp weather is probably best for this. Large juveniles will become harder to find, and possibly also adults as they become spent towards the end of winter. The extent to which adults survive into the later part of the year (September-December) is not known.

Field Kit
Basic:

- waterproof notebook
- weta cloths/bags to catch and handle wets, especially if searching at night *(size of man's handkerchief sufficient, avoids damage to delicate antennae, loss of legs)*
- cm ruler or caliper
- probe light for checking inside weta holes *(maglite will do)*
- ice cream tubs *(if intending to hold/collect weta - pack with damp moss/leaf material)*
- 'twink` - if doing night counts or likely to repeat coverage of area; mark weta to recognise if seen again *(will last for the short term but tend to abrade; avoid gross marking which might attract a predator)*

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