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high pitched rasping sound, almost a hissing sound. This sound is produced on both the reverse, and forward strokes when agitated, and whilst upside down or right side up.

While upside down if the aggressor (e.g. a finger) touches the middle of the body, the weta will envelop it with its legs and bite hard. This is followed by two or three additional good bites before the weta will release and kick away to once again assume the upside down defensive posture. The weta may persevere with the biting or it may freeze or, having first kicked away, it may run to escape.

Eggs and Egg Laying

The adult female laid many eggs. These were cigar shaped, greyish black and 4.5 to 5 mm long. They are positioned vertically like those of other weta species. The eggs were laid in the soil of the ice cream container. An adult male was present with the female previously so it was hoped that the eggs would be fertile. They were laid during April as was the case with with *Hemideina crassidens* and *H. thoracica.*

ARTICLE 5. Raising *Hemideina* wetas from egg to adult

This article describes the methods and materials I used to raise the nymphs of four species of *Hemideina* wetas. I have written the article to explain the best way to accomplish this fascinating aspect of weta husbandry. The methods discussed are 'tried and true' and I found them applicable to all the *Hemideina* species I have bred.

The article is divided into two sections. The first deals with the hatching of nymphs and their growth up to the 5th instar. The second section covers the 6th instar to adult stages. Feeding, accommodation, moulting, behaviour of nymphs, and the management of new adults in preparation for the next generation are covered.

From egg to fifth instar

Housing and Habitat

Two methods can be used to house the nymphs. The first is to use a glass tank similar to that for keeping adult wetas measuring 60 cm by 30 cm by 30 cm which would be a minimum size. Soil should be spread on the floor, (depth is unimportant), leaf litter sprinkled on top, and plenty of twigs and branches provided for climbing.

The wetas can be given 20 mm lengths of 5 mm diameter plastic tube for sheltering in. These can be attached to the walls of the tank. They not only provide shelter but are good for observation of the nymphs and are convenient during servicing. These tubes work well up to the 3rd instar but after this the nymphs become more sensitive to daylight and prefer dark shelter. The tubes should be either painted or dark-coloured tubes used. The diameter of the tubes should be increased as the nymphs grow. The second method is to employ plastic food containers as described below.

Rearing Techniques

The communal enclosure has one serious disadvantage. Weta nymphs are highly cannibalistic. This behaviour is very common in nymphs, beginning soon after hatching and continuing to 5th instar. Although cannibalism occurs in the older instars, it is less serious then. Right from hatching, nymphs will be competing with each other for available food and shelter, both in the field and in captivity. Cannibalistic predation in the early instars may be a strong incentive to disperse. In later instars cannibalism occurs mainly when newly moulted nymphs are eaten.

With this problem in mind I opted for the second method of accommodation. This involved using plastic food containers such as are used for margarine, cottage cheese and so on. The lids of these containers were perforated with a hot wire to give good ventilation. Soil, leaf litter and a few twigs were supplied to make a mini-environment for the nymph. Initially I used hollowed-out blackberry and raspberry canes of 90 to 100 mm long. Later I used plastic tubes until the nymphs reached the 3rd instar. Then they simply hid in the leaf litter on the bottom of the container.

Whilst the nymphs sheltered in the tubes, servicing the containers was very straight forward. The nymph could be seen, food could be replaced and the droppings removed without disturbance. Droppings were deposited all over the container and the nymphs were not upset when they were removed. Once the nymphs started hiding in the leaf litter, care had to be taken as the wetas were camouflaged and the risk of removing them, along with the rubbish, was high. I found the nymphs considerably more amenable to disturbance during cleaning and servicing than the adults. Food was the main problem until the preferences were discovered. The main disadvantage of keeping wetas in separate containers is the considerable work-load servicing them involves.

Food

The nymphs should be fed every second day and the container cleaned out as well because insect food, when dead, quickly becomes mouldy if left for more than two days. Water is necessary and easily provided by misting the plant food prior to placing it in the containers, and by misting the container.

Plant Food

Feeding nymphs from the 1st to the 5th instar is easy. Clumps of the common weed *Hydrocotyle americana* (wax weed), which is a mat plant growing in shady or sheltered parts of lawns and grassy areas, were dug up, divided into small pieces with soil attached, and placed in each container. The wetas in their early instars were very fond of it and the plant is readily available at the time the nymphs hatch, from October onwards. Chickweed, puha, dandelion and plantain are all useful as they are tender enough for the wetas to manage. All of these plants wilt quickly and so must be replaced each day.

Animal Food

Insect food is very popular and appears to be essential. Animal protein is very important in early instars. Midges, houseflies, small caterpillars, aphids, and small moths are all acceptable. Generally I feed maimed or freshly dead insects. In the field I have seen *Hemideina crassidens* nymphs of various sizes feeding on thrips, aphids and moths. Weta nymphs of all species I have kept scavenge for dead or injured insects and some deliberately kill healthy ones. The feeding behaviour is described on page 28.

Unnatural Food

Unnatural foods such as dog sausage, apple and lettuce can also be used to good affect. However these items should be used in moderation as they can cause indigestion and scouring. Often a nymph will die from having prolapsed its rectum if the wrong food has been administered. Apple is liable to do this but, when fresh, is very popular. Unnatural foods are best fed once or twice a week only and then fed together with a natural food item. As the nymphs easily become addicted to an artificial diet, moderation is important.

Eggs

The eggs of the four *Hemideina* weta species I have reared to date range from 4.5 to 7mm long. They are all cigar-shaped, various shades of grey to black and are laid singly in soil in an upright position. The egg may be buried from a few mm to as much as 10 or 20 mm deep when laid.

Hatching

The mature embryo splits the egg shell or chorion by building up pressure inside the egg. This is done by the large pulsating dilations of the neck membranes behind the head and the spine or egg-tooth on the front of the head. The split in the egg chorion is usually longitudinal passing over the top of the egg, and enables the embryo to escape and wriggle up to the soil surface. Here it moults for the first time so that the first instar nymph appears, leaving behind its embryonic cuticle. The pronotum has a bluish grey film over it which is retained for a few hours after the nymph has hatched. The nymphs range in size from 6 to 8 mm depending on the species. Hatching occurs usually at night and the nymphs disperse quickly around the enclosure.

Behaviour

The newly hatched wetas have a strong urge to climb upwards, and in my enclosures were conveniently hiding, massed together, under the lid each morning. It is best to remove the adult wetas during the hatching period as predation of the nymphs by the adults is inevitable.

Sixth instar to adult

By the 6th instar, *Hemideina* wetas can be treated as adults as far as feeding and general care are concerned. They are easily handled now, being larger and stronger. Their threat display is used with vigour and the nymphs will bite to defend themselves. They should be placed in 2 litre ice-cream containers or larger at this stage to accommodate their greater size. If left in accommodation lacking in space the nymphs continue to grow but their antennae and legs become bent and distorted.

The nymphs are easier to find in the leaf litter now and are much easier to weigh ind measure. Ideally they should still be kept separate as cannibalism remains a problem and, as well, disturbance to a moulting weta can be just as lethal as cannibalism.

Harems

[n captivity, adult wetas should be given the opportunity to organise themselves into harems, or breeding groups. All four *Hemideina* species I have kept - *crassicruris, crassidens, maori,* and *thoracica* - do this. Occasionally a 9th instar female will be accepted into such a group but only at the bottom of the pecking order - she is invariably the last to be allowed back into the gallery.

Large adult males have little difficulty in holding their gallery and harem against smaller males, but smaller ones cannot gape their mandibles as wide and therefore cannot win ritualised fights such as occur between evenly sized males.

Artificial galleries as described in the first article of this series should be supplied. Only one male and a maximum of four females should be housed together. Replacement males and females can be kept in separate containers such as 2-litre ice cream cartons. This nucleus is viable and capable of producing the next generation.

Food

From the 6th instar onwards nymphs are fed in the same way as adults. The *Hydrocotyle* should be discontinued as the nymphs now have digestive problems with it and start scouring. At this stage also many nymphs go off *Hydrocotyle* and prefer more coarse foliage. Food suitable for the nymphs is taupata, karamu, *Hebe, Euonymus*, willow, ngaio, plantain, *Buddleia,* kowhai, mahoe, apple and pear leaves. After sixth instar, lettuce should be left out of the diet but apple and carrot can be fed in moderation.

The insect food given is the same as that fed to 1st to 5th instar nymphs except that larger insects can now be added to the menu - crickets, katydids, cicadas and mealworms for instance. Dog sausage, new-born mice and ox-heart will be appreciated from time to time.

Although after the 6th instar nymphs can be given water in soaked cotton-wool wads, it is still better administered in the separate containers by spraying the foliage. Consumption of bark and leaf litter becomes apparent at this stage and should be encouraged.

Moulting

Good feeding and ideal conditions are crucial to a successful ecdysis or moult.

Up to the 5th instar, *Hemideina* wetas moult approximately every 4 weeks. After this the duration between moults lengthens to 2 to 3 months. The nymph increases in weight and size, the abdomen in particular continuing to enlarge and lengthen until it reaches a maximum. At this point the nymph prepares to moult. The stated intervals between instars occur only if the nymph has experienced good and varied food availability and if no health complications have occurred. Otherwise the intervals are longer.

The nymph goes through a number of changes just prior to ecdysis. It becomes subdued and unwilling to defend itself. The exoskeleton becomes slightly paler in colour. The hind tibiae have the most noticeable change in colour. The thorax and abdomen develop fine wrinkles and the exoskeleton has a stretched appearance. At this stage the nymph will be due to moult in 1 to 2 days.

Ecdysis normally takes place at night. 1st to 5th instar nymphs will sometimes moult during the day but the sequence of events leading up to ecdysis are usually timed for nocturnal moulting. The nymph in *Hemideina* wetas has a distinct fine ecdysial line which begins on the cranial part of the head and passes down the middle of the thorax, ending on the third thoracic tergite, the metanotum. The exoskeleton splits open at this point.

In preparation for ecdysis the weta will climb onto the twigs provided and will hang head down. The twigs are gripped with all or most of the legs. Ecdysis occurs after some hours of quietly remaining in this position. It is imperative that the nymph remains undisturbed.

The moult itself will take from 2 to 6 hours to complete. This is variable according to temperature, humidity and individual variability. The skin splits along the pronotum first and then continues down the rest of the thorax. The line on the head also splits. The weta pushes, pulls and extends itself out of the old skin writhing the abdomen and arching the thorax. This continues until all that remains to be done is the pulling of the limbs from the exuvia. The weta is then free.

Immediately after ecdysis the nymph hangs from the exuvia by its hind legs. At this point whilst still quite soft and while the exuvia is soft and damp the nymph pulls itself up onto the old skin and begins to eat it. Generally the whole exuvia is eaten but the hind tibiae and other fragments are often left. This behaviour is of special interest as other insects such as cockroaches, earwigs, katydids, crickets, and praying mantis often abandon their moulted exuviae uneaten. I have observed this behaviour in *Hemiandrus, Deinacrida* and rhaphidophorid (cave) wetas as well as in *Hemideina.*

A newly moulted weta is easily recognised by its larger size and somewhat telescoped withdrawn abdomen. The new cuticle is soft and immediately after ecdysis it is a creamy brown colour.

The compound eyes and the tips of the mandibles are conspicuously black. After 24 hours although the new instar has assumed its usual colours they will darken even more as the cuticle fully hardens. The new instar does not feed for 2 to 3 days as it waits for its cuticle to completely harden.

The feeding urge in 1st to 5th instar nymphs recommences sooner, often within 24 hours, so food must be available at all times to ensure strong even growth. A *Hemideina* weta can attain adulthood from hatching in 13 to 18 months.

Regeneration of appendages

Regeneration of limbs, palps, cerci, antennae, tarsi etc., can only occur during the nymphal stages. If a leg is lost it can be gradually regrown with each ecdysis. If it is lost one or two instars before the adult moult the new adult will have only a small partly regenerated limb. This limb ceases to grow when the weta is adult. Repair of damaged joints is achieved at each ecdysis. The extent to which a weta can repair itself is remarkable. Antennae can be almost totally regenerated during one moult.

Behaviour

Aggression

The typical threat posture, the raising of hind legs and their subsequent slashing down movement and associated stridulation is apparent from the 3rd instar on. Sometimes 2nd instar nymphs threaten too but they usually prefer to run away or freeze. Nymphs will use a kick-back action of the hind tibiae from the 1st instar onwards. This is to discourage another weta from evicting it. It is also used against other enemies. The threat posture is readily used from 4th instar onwards and stridulation is clearly audible by this stage. By the 3rd instar *Hemideina* wetas can communicate with each other and with older wetas.

The eviction behaviour has brought about an adaptation in *Hemideina* weta nymphs and adult females. The hind tibiae are thicker with heavier spines in nymphs and females. Due to the fact that male wetas carry out most evictions by taking hold of the hind tibia in the mandibles and that nymphs and adult females are less assertive than males, the more robust hind tibiae prevent too much damage being done. The thickness of the hind tibiae is different in male and female nymphs also except that in the female this does not become obvious until the 7th instar.

Hemideina Maori uses its unique rolling over threat display from 4th instar onwards. It will readily face an attacker with exposed mandibles and raised front legs from this stage on also. The nymphs of all *Hemideina* wetas start biting to defend themselves from the 5th instar but this is only useful against small enemies such as predatory insects or spiders. The bite of an 8th or 9th instar nymph can be effective against such predators as lizards or mice.

Feeding

Weta feeding behaviour varies from one species to another. The *Hemiandrus* wetas are the most predatory of the species I have kept and thoroughly search their enclosure in a slow deliberate manner, investigating leaf litter, excavating the ground beneath, looking into nooks and crannies on branches, beneath bark, amongst foliage and so on. Having located an insect the weta lunges and quickly overpowers and encircles it with its first two legs, biting repeatedly. I have seen them capture healthy vigorous prey as large and powerful as the black field cricket, *Teleogryllus commodus.* Once captured, the prey is often carried away by *Hemiandrus* wetas. Other kinds of weta do not do this.

Amongst the *Hemideina* wetas the feeding behaviour varies also. Of the four species I have kept, *H. Maori* is the one most inclined to capture live prey, *H. crassicruris* less so, and *H. crassidens* and *H. thoracica* the least so. Although *H. Maori* feeds on foliage like the other wetas, it actively scavenges for insects, thoroughly inspecting the whole of its enclosure during its nightly forays. Even so it is not as thorough as *Hemiandrus.* If *H. Maori* locates living prey it lunges and encircles the victim with its front and middle legs and sometimes with the hind legs as well. If the prey appears behind, the weta will stamp on it with the hind legs, turn rapidly and then engulf the prey with its legs. Then it will bite repeatedly, moving its head downwards so that each bite is in a different place. This predaceous behaviour is most successful with meal worms, grubs, beetles, and earwigs. Katydids, grasshoppers, crickets, and other large active insects often escape by jumping backwards, so I usually maim them to make their capture by the weta easier. Wetas will follow in the direction of escaping prey but cease the pursuit if they lose the trail.

Deinacrida wetas are rather like *Hemideina* in their feeding behaviour and will make a lunge once a living insect has been located. However they are haphazard and seem rather inefficient. They inspect prospective prey, moving the head with opened jaws and palpating palps over it.

In general wetas are not efficient predators of living insects and scavenge what they can, and make the most of any opportunities that come their way. *Hemiandrus, Hemideina Maori,* and *H. crassicruris* show the greatest preference for live insects.

Sexual Maturity

Adult female *Hemideina* wetas are easily recognisable by their colour and by the shape of their fully-formed ovipositors and cerci. These are finer and sharper than those of the nymphs. It

is similar with adult males no matter how many instars they have been through - their colours are richer tans and browns than in the nymphs; their mandibles are longer, sharper, and slimmer than those of nymphs; and their abdominal cerci are distinctly curved in comparison with the more spikey cerci of the nymphs. *Hemideina* wetas are usually adult by the 10th instar. In both *H. crassidens* and *H. crassicruris*, males can be sexually mature at the 7th, 8th, 9th or 10th (adult) instar. Up to the 6th instar nymphs of both sexes grow at the same rate. Elongation of the male's head does not commence until the 7th instar. Two options face a 6th instar male nymph. It can either become a mature adult after the next moult and cease growing, or it may continue as a nymph and undergo further moults. The factors influencing these courses of events are not understood. However, the phenomenon does provide an explanation for the great variability in the size of males, and for the fact that some adult specimens have only slightly enlarged heads. In some cases a mature adult male is smaller than male nymphs. Temperature, humidity and food quality and quantity probably all have an influence but do not account for the fact that only males are involved. Disease and parasites such as nematodes may also have an influence. A 7th instar adult male can hold a harem provided he is not challenged by a larger adult. Of all the adult stages, 8th and 9th instar males are the most common*.

Females always require 10 instars before they are mature, even though there is variation in their size. At each instar there are large and small individuals but the variation in no way compares with the extent of that occurring in the adult males.

Sexually Maturity of Males

How are adult males distinguished from nymphs apart from by their size and head length? Firstly there arecolour differences - the black etchings of the femora are more pronounced, and the brown colouration of the head, leg joints, and hind tibiae are more strongly tanned in the adult. Secondly there are morphological distinctions, especially the shape of the abdominal cerci. In male nymphs and all females these are relatively straight and rather like spikes whereas in adult males they are always relatively longer, and curved. Thirdly there are differences in behaviour. Although a male nymph will hold a gallery and evict other wetas (smaller than itselfl) it does not form a harem or attempt to copulate with females.

*Variation in the number of moults or nymphal stages taken to reach maturity is not infrequent amongst orthopteroid insects, but invariably individuals which have taken fewer moults to reach maturity exhibit all the morphological characters of adults. Sexual maturity in individuals exhibiting nymphal characteristics (known as neotony) is very rare even though mature spermatozoa may be present in the final instar nymphs. One example of this phenomenon has been reported in stick insects, one in mantids, and one case of several hybrid nymphs of the crickets *Gryllus campestris* x *G. bimaculatus*, and another of three locust specimens, *Locusta migratoria migratorioides* (see Chopard 1938 "La biologie des Orthopteres"). In the latter case it was probably the result of hormonal disharmony and in none of the above cases could it be regarded as normal, as it is with the *Hemideina* wetas mentioned above. Thus if Paul Barrett's interpretation is correct this is the first example of true neotony being normal in orthopteroid insects. - G.W. Ramsay

ARTICLE 6. Keeping the Mahoenui giant weta, *Deinacrida* sp.

At the beginning of 19891 was privileged to receive my first group of Giant wetas. The species, unnamed, came from Mahoenui near Te Kuiti in the King Country. It was the first endangered species I have worked on. These notes are based on the maintenance of the group of 22 wetas at Wellington Zoo as well as a smaller group of six at my home in Raumati, Paraparaumu.

This weta proved to be fascinating to study and it is hoped I will be able to compare it with other *Deinacrida* wetas later. I am very grateful to Mike Meads and Alison Ballance of D.S.I.R. Land Resources, for sharing with me their knowledge of this species.

Fig. 5 illustrates this species showing how different it is compared to the *Hemideina* wetas. Compared to other giant weta species, this one is of medium size. An adult length of 65 to 74 mm is usual for females and 45 to 49 mm for males. This size difference occurs throughout nymphal life also. Her length is increased even more by her ovipositor. Male giant wetas do not possess the elongated heads characteristic of *Hemideina* wetas. Mahoenui giant weta has attained a weight of 15 g in females and 12 g in males in my programme. These weights are far heavier than those of *Hemideina crassidens.*

Mahoenui giant weta hides in trees but frequently feeds on plants on the ground. Mating normally occurs in the bushes or trees which are its refuge. The weta possesses long legs and antennae which suggest a primarily arboreal existence.

The Mahoenui weta has adapted well to living in gorse, *Ulex europaeus*, which is very different from its probable original habitat of native bush. Apart from feeding on gorse i.e. flowers, seed pods, foliage and bark the Mahoenui weta feeds on a wide variety of other plants and considerable amounts of insects. Nymphs in particular feed on insects.

This species is quite unique although it does bear some resemblances to *Deinacrida heteracantha.* It is unusual in that it comes in two different colour phases, the usual dark mahogany brown and an attractive yellowish brown and speckled colouration.

Fig. 5 Mahoenui weta, female *Deinacrida* sp.

The inner tibial spine at the end of the tibia near the tarsus, is movable in the hind leg of the Mahoenui weta.

Housing

The requirements of this species are quite different in many ways from those of *Hemideina* wetas. I opted for cages and fitted them out in a natural setting. I used reptile cages* for the adults, and 2 litre plastic ice-cream cartons for singly accommodated nymphs. Fig. 6 shows the cages in detail.

This weta is not gregarious. Males in particular are prone to territorial disputes. With this in mind I kept the adults in pairs of one male and one female in each cage. The nymphs settled well in their ice-cream cartons but presented two problems in their final instars. They needed plenty of space in order to moult satisfactorily as in a confined space the legs and antennae will not straighten properly. Large sub-adult nymphs disliked the cartons and tended to chew their way out through the plastic lids. In their final instars therefore, the nymphs were placed in cages similar to those of adults.

Nymphs of this species eat more often than do adults, especially younger nymphs, and they tend to eat more animal protein. The behaviour of nymphs regarding shelter and movement around their enclosures is similar to that of adults.

Habitat

In the cages soft friable soil was sifted and mounded to a depth of 80 mm. It was spread throughout the floor area and covered with loose leaf litter. This was changed periodically as it disintegrated. Due to the dryer conditions of the giant weta cages this procedure was not as frequent as it was in *Hemideina* weta enclosures.

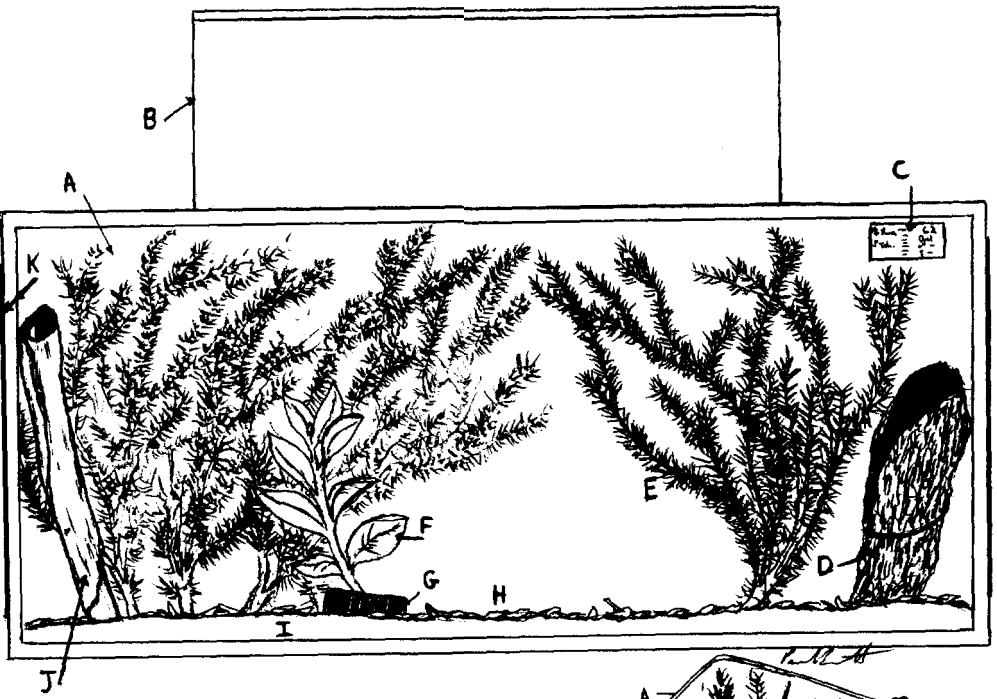
Climbing material consisted of 60 to 70 cm sprigs of gorse. This was put in fresh and new gorse was added periodically. Some of the original gorse was left to avoid unnecessary disturbance.

The ice-cream boxes were furnished with short gorse sprigs i.e. 100 to 120 mm lengths and some shelter. No soil was added as it increased the humidity in the boxes when they were misted with water to an intolerably high level. Giant wetas are known to be susceptible to fungal infections and require much drier conditions than *Hemideina* wetas.

Shelter for the adults comprised pine and gum bark shelters. The gum bark was in naturally curled up rolls and was simply stacked securely in the cage. The pine bark shelters consisted of two pieces of bark approximately 250 mm by 150 mm, joined together and wired in place. One end was open and this allowed easy access inside for the weta. The shelters were leaned vertically against the wall of the cage with the entrance hole facing up, or they were laid on their side against the wall. Both types of shelter were used by the wetas.

* wooden boxes 122 cm long, 61 cm high, and 30.5 cm deep with front of glass or perspex and rear of insect mesh.

Fig. 6 Cage set up for one pair of Mahoenui Giant Wetas



A Glass or perspex front
B Service lid on top or on back
C Stock label gives information on wetas inside
D Pine bark shelter
E Gorse climbing material
F Food plant
G Water dish for drinking and food plant
H Leaf litter spread on soil
I Friable soil. 80 mm deep
J Gum bark shelter - naturally curled pieces
K Ventilation on either side. Steel insect mesh

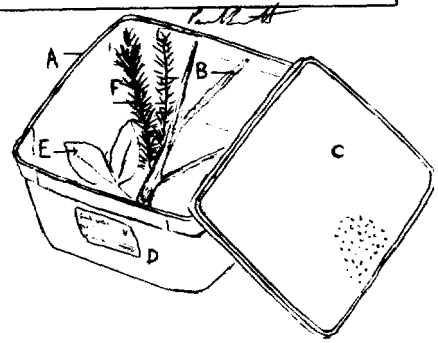


Fig. 6a Container for single nymphs
A 2 litre ice-cream container
B Climbing branch for moulting
C Lid with perforated air holes
D Stock label
E Food plant
F Fresh gorse

Environmental Conditions

I kept the giant wetas in a room at the zoo which had a temperature 5°C higher than the temperature outside. Below 6°C I found this weta would become quiescent, neither moving or eating. It tolerated higher temperatures and even appeared quite content, albeit very active, at 30°C. The adults even remained in the gorse in sunlight on some occasions. I would suggest that a range of between 10°C and 25°C would be optimum. This is the same temperature that is required for the other types of weta I have cared for.

The cages were well ventilated and spraying with water was limited to the soil only in order to minimise fungal infections. A jar-lid of water was provided on the floor of the cages from which the wetas could drink. The wetas prefer to roost in dry elevated positions and are prone to fungal infections if conditions get too damp. I found a humidity level of 40% to 50% was adequate for maintaining this species of giant weta.

Food

This species, like all other wetas I have kept, is omnivorous, feeding on a wide range of plant and insect food. Feeding in wetas is of particular interest to me and I was intrigued to find out the amount of insect food this weta was willing to sample.

It is interesting to note that this weta's relatively new environment, gorse, has a high invertebrate fauna, a large amount of which is diurnal, ideal for a nocturnal weta out foraging.

A wide range of plant foods was tried Those readily consumed are as follows gorse, taupata, karamu, *Hebe*, mahoe *Buddleia*, ngaio, willow, plantain *Euonymus*, and dandelion. Unnatural plant food items offered were apple an carrot. All of these were eaten in varying amounts but gorse, taupata and willow were the firm favourites. Dead leaf litter was eaten in varying amounts and some leaves were preferred dead rather than alive e.g. gum and karaka. Bark of ngaio and *Coprosma* was consumed also.

Insect food eaten consisted of various species of moths (particularly noctuids), cicadas, katydids, crickets, mealworm larvae and adults, grass grubs both larvae and adult beetles, locust nymphs, some spiders and caterpillars. This weta was more inclined to eat beetles than were the *Hemideina* wetas. Unnatural animal material eaten consisted of raw ox-heart, dog sausage and new born mice. The ox-heart was the most popular out of these items.

Foliage other than gorse was presented in sprigs of two to eight leaves and placed in the jar lids of drinking water. This kept the foliage fresh and it was replaced each day. Usually, two insect foods were offered simultaneously, the insects being injured or killed and placed on a prominent leaf in the cage. This enabled the wetas' consumption to be accurately monitored. The nymphs definitely ate more insect food than adults. The wetas usually fed every 2nd to 3rd day.

Water was available in the jar lids but foliage food was sprayed before being

placed in cages and ice-cream cartons. Both methods of administering water were satisfactory to the wetas. Cotton wool wads soaked in water, as used with other weta species, were not used because the increased surface area of the wads increased the humidity.

Behaviour

The habits of the Mahoenui weta are quite different from *Hemideina* species. I found it to be easily disturbed at night and once upset it would sit for very long periods. It took a great deal of patience to observe this weta at night.

Activity

The nymphs of the Mahoenui weta are more active than the adults. They still move about in a deliberate manner but are more willing to jump and will run from place to place on occasion. At night the adults often don't become active until long after dark. Nymphs are earlier risers but this is quite variable. The wetas moved round the enclosure in a fairly ritualised pattern. After emerging from the shelter, the wetas would locate food and eat if hungry. If not they would simply travel about the enclosure. The Mahoenui weta is a very capable traveller and will walk about for hours at a time if it is not disturbed.

Movement

This weta is interesting to watch when in motion. When undisturbed it moves in a slow deliberate manner and walks with its body held in an elevated position. Each step is taken by first releasing the large claws and freeing the tarsus, and then lifting the leg. The extremities - legs and tarsi - actually tremble whilst in motion. The weta is capable of running quite fast but only does this in short bursts, particularly when disturbed. In spite of its weight this species can jump short distances. It will jump across to a new area or, more readily, jump downwards. These jumps do not compare to those even of *Hemideina crassidens* which is not a good jumper. Small nymphs of this species, like other wetas, jump freely.

Grooming

Nymphs clean themselves more than adults which is a common trait in other species of weta also. Antennae and palps receive the greatest attention but legs and ovipositor in females are also cleaned.

Aggression

It has been said that giant wetas do not bite. The Mahoenui weta defends itself differently from *Hemideina* wetas. It is not as assertive as the *Hemideina* wetas but displays the same threat posture with the raised hind legs and rasping sounds. It should be remembered that the behaviour of *Hemideina* wetas is geared towards social interaction with members of their own kind, and that the biting of enemies is only an extension of the normal assertiveness towards each other. The Mahoenui weta will not bite when threatened under normal circumstances. It will however bite when severely provoked e.g. when it is weighed and measured, and occasionally it will nibble or even chew the skin on hands. This trait it shares with other species of weta. This biting cannot be compared to the powerful nip of *Hemideina* wetas, but the mandibles on Mahoenui wetas are nevertheless very strong and the weta is capable of chewing plastic as readily as any other species.

Shelter

The Mahoenui weta appeared to have no particular preference as to which kind of shelter it favoured. The shelters provided were the most popular but it would also hide in the gorse or in the leaf litter on the floor. The wetas would invariably return to the same hiding place as long as it was not disturbed. The weta's ability to reposition itself in the same hiding place be it in a shelter or in the gorse, is uncanny. Even the legs and tarsi are placed in virtually the same position they were previously. If disturbed in its usual hiding place the weta will abandon it. The hide-out will be re-used again after a few days if it has previously been used for a prolonged time however. Immediately after moulting this species always hid in the gorse for several days even if it had previously used a shelter. It only used a shelter again after its cuticle had fully hardened.

Stridulation

Stridulation is extremely varied in the Mahoenui weta. When under threat the weta will raise its hind legs. These are brought down swiftly along the sides of the abdomen. With this down-stroke a harsh grating call is made. This is quite different from the sharp rasp produced by *Hemideina crassidens.* One reason is that the ridges on the inside of the femora are much coarser and the sound organ on the abdomen is made up of one raised area instead of a series of ridges, like a file, on the *Hemideina* wetas.

Apart from this sound the Mahoenui weta can produce a rubbing sound by 'telescoping' its abdominal segments, and it can tick quite audibly. These sounds are similar to those of other *Deinacrida* wetas and the abdominal sounds of *Hemideina crassicruris.*

Like other *Deinacrida* and *Hemideina* wetas this species has a prominent auditory tympanum on the front tibiae, below the 'knee' joint. I have not as yet heard this species use stridulation as a method of communication like the *Hemideina* wetas, but with such a varied repertoire this must surely be so.

Mating

The Mahoenui weta's breeding behaviour is very interesting. When receptive, the female probably secretes pheromones in her droppings. Pheromones are obviously deposited on the climbing material, in the cages also, as wetas can find their hiding places with ease whether droppings are present or not. The sex pheromones are not produced all the time but when they are, the male attends the female, otherwise he is solitary and keeps to himself. Once the female is receptive and the male is aware of this he continues in attendance for the duration of her condition.

Mating normally occurs in the early hours of the morning and can last for hours into the following day. Mating appears to be spontaneous in this species. When the

wetas were first introduced into their new accommodation, one pair mated only an hour after being introduced. However, this may have been a reflex response to a stressful situation, ensuring that if all else fails, the female has at least been fertilised.

The prolonged mating is quite different to the relatively fleeting copulation of *Hemideina crassidens*, but similar to that of the cave weta, *Gymnoplectron longipes.*

Copulation was carried out in the gorse or on the ventilation material, either with the female facing up and the male orientated horizontally to her, or with the female facing down. Copulating wetas were easily disturbed, and once disrupted would not re-connect.

Yellowish-coloured spermatophores are deposited on the female's abdomen, on or near her subgenital plate. These can be seen a few hours after copulation but soon disappear. I have not seen the female turn and eat the spermatophores like the katydid, *Caedicia simplex*, does, but then the spermatophores are not as large as those of the katydid.

Courtship behaviour has not been seen apart from observing that the male will constantly touch the female with his antennae prior to copulation. The female is normally quiet and, when receptive, simply sits still. The male initiates copulation and will connect without any assistance from the female. Once the female ceases to deposit pheromones, the male shows no more interest in her and appears quite oblivious to her presence. He will roam the enclosure instead of following her around and when he does come in contact he will be rebuffed by the female with a swift kick or push of her hind leg.

Eggs and Egg Laying

The eggs were laid throughout autumn. The female is very cautious on the floor of the enclosure. She will sit immobile for long periods. Oviposition is similar to that of other species of weta. Eggs are laid at various depths, the shallowest being 9 mm deep and the deepest 23 mm, which is the average length of the ovipositor in this species. The eggs were laid throughout the soil area particularly in the moist patches under or near the water dish. The eggs are cigar-shaped, brown in colour and 6.5 to 7mm long. They are positioned vertically. The female shows no interest in the eggs after laying them and, having spent some time ovipositing, makes her way unhurriedly back into the gorse or to her shelter before day-break. To date the eggs have not hatched but I would raise the nymphs in the same way as those of *Hemideina* nymphs except that their accommodation would be kept drier (see raising *Hemideina* wetas, No. 5, page 30).

Parasites

Several bright orange parasitic mites, larger than the mobile species found commonly on *Hemideina* wetas, were present on specimens of this weta when first received. The mites were attached to the softer tissues of the wetas' exoskeleton but they disappeared after a couple of months. The mites were not mobile and were present on the thorax and abdomen of adults and nymphs, males and females alike. They appeared to have little effect on the wetas, and were possibly larval erythraeid mites.

ARTICLE 7. Raising the Mahoenui giant weta in captivity

The article is based on the captive rearing of 40 Mahoenui wetas. Twenty five of these were hatched by Mike Meads (DSIR) and were kindly placed in my care. The other 15 specimens were nymphs of varying ages, collected in the wild at Mahoenui during 1989.

The Mahoenui weta was fascinating to raise as in many ways it is quite different from the other wetas I have kept. I am extremely grateful to Mike Meads and Alison Ballance for help they have given. Much more information and study are essential before this weta can be properly managed.

As the Mahoenui giant weta is the first *Deinacrida* species I have raised, I have made comparisons between this species and the raising of *Hemideina* wetas.

From egg to fifth instar

The eggs of this weta are tan to dark brown in colour, 6 to 7 mm long and cigar-shaped. They are laid in soil of varying textures particularly during or after rain (heads, pers. comm.). The eggs can be located a few millimetres below the soil surface or up to 21 to 23 mm down. The eggs in the Wellington Zoo enclosures were laid in April but in Mike Meads' enclosure in the Hutt Valley, in March.

Housing and Habitat

Because of their cannibalistic tendencies newly hatched Mahoenui nymphs were separated into containers like those used for *Hemideina* nymphs. Plastic containers, 100 mm high and 100 mm wide were used. Each was furnished with a sprig of gorse for the nymphs to climb in as well as a clump of *Hydrocoryle* (wax weed) with soil attached, for food. At the third instar the nymphs were re-housed in 2-litre plastic ice-cream containers using the same furnishings.

Newly-hatched Mahoenui weta nymphs measured 7.5 to 8 mm long and, once feeding started in earnest, filled out to 10 mm in length. By the 3rd instar they were already 12 to 13 mm long so the larger containers were needed.

Environmental Conditions

This weta is less tolerant of damp conditions than *Hemideina* wetas but it did nevertheless prefer to hide under the damp *Hydrocoryle* clump rather than in the drier gorse sprigs. The containers were not misted as was done for *Hemideina* nymphs. Instead, as fresh *Hydrocoryle* was added, this was misted beforehand and then placed in the container. This method kept humidity to

the optimum i. e. 40 to 50%. A temperature between 10 and 25°C was preferred. The nymphs would become torpid under 10°C, and above 25°C displayed distress by hiding deeper in the *Hydrocotyle* or actively moving about.

Food

The Mahoenui wetas in my care proved to be quite omnivorous. Like the nymphs of *Hemideina,* they ate soon after hatching and would search for food if it was not provided for them. *Hydrocotyle* in clumps was relished as was willow and young mahoe and ngaio leaves. Animal protein was offered in the form of small moths, flies, leaf hoppers and midges. Dog sausage and apple were offered in moderation once or twice a week.

By the third instar the nymphs were going off the *Hydrocotyle,* preferring to feed on the willow and insects etc.,

instead. Gorse was offered constantly but little was eaten. Even tender parts like flowers were only occasionally eaten. Up to the 5th instar the nymphs would feed each night but after this feeding became more sporadic although more food was consumed on each occasion. They fed every 48 to 72 hours although there were exceptions with individuals eating each night from time to time.

Food items were changed every second to third day and any mouldy faeces were removed. Fresh droppings were retained as the wetas were more settled when fresh faecal material was present. Other food items offered were *Buddleia,* taupata, chickweed and plantain. Water was provided by misting *Hydrocotyle* and the other foliage was misted before placing it in the containers as well. This proved quite satisfactory.

Behaviour

Newly hatched Mahoenui weta nymphs are highly cannibalistic and will attack and begin feeding on any sibling nymph they come upon. They have the same pressure to disperse as the nymphs of other weta species and leave the ground and climb into foliage or to the top of the enclosure immediately after hatching. This behaviour ensures that they disperse as widely as possible in the wild, but in captivity it is undesirable.

Sixth instar to adult

The care of the nymphs from 6th instar onwards differed in that accommodation and food were changed and the treatment was altered.

Housing Habitat and Environmental Conditions

After the 7th instar two problems may occur. As this species achieves considerable length in its legs it needs room to stretch them after each ecdysis while they are still soft but without putting weight on them. This is important as the legs simply bend under the wetas weight and once the cuticle hardens the legs remain in this deformed shape. The antennae also suffer from distortion if allowed to rest on the container floor or against the walls whilst they are hardening. This problem can be avoided by providing a sturdy gorse sprig or stick from which the weta can hang during ecdysis.

The second problem is even more serious. In a confined space a newly ecdysed nymph or adult can impale itself on the gorse spines, which can cause serious bleeding. Infection quickly sets in.

To ensure these problems did not arise, the nymphs were placed in cages similar to those set up for adult Mahoenui Giant wetas (page 40). As each nymph became ready to moult i.e. became very plump and ceased eating, it was placed in the larger enclosure. This was carried out from the 7th instar onwards. With added space no problems occurred as long as the nymph was able to prepare itself properly and hang securely in the gorse or branches. The nymphs were kept in separate enclosures during this process.

The larger enclosures were furnished to accommodate adult Mahoenui wetas, with soil laid to 70 mm deep, large gorse sprigs and leaf litter laid on the floor. This suited the large nymphs well. The enclosures were successfully kept at between 40 to 50% humidity by using dishes of water for standing the food plants in. The nymphs were kept in these enclosures until mature, after which they were separated into pairs for breeding.

Food

Having reached the 5th instar, the Mahoenui nymphs were treated in the same way as adults as regards food. The only difference was that a greater quantity of insect food was offered to nymphs as at this stage the Mahoenui giant weta eats more animal protein than the adult.

Hydrocoryle was abandoned by the fifth instar and such food items as karamu, *Hebe*, *Euonymus* and

dandelion were added to the plant items already mentioned. Insect food was the same except that larger items were fed i.e. katydids, locust nymphs, mealworms (larvae and beetles), crickets and large moths (noctuids and porina). The insect food was placed in prominent places so its consumption could be observed. The foliage was placed in the jar lids and comprised sprigs of 8 to 15 leaves.

Antennae

The antennae of early instar Mahoenui wetas are interesting. They can be over three times the length of the body but are extremely brittle. The antennae are used constantly as are those of *Hemideina* nymphs, but the incidence of the nymphs getting them trapped and breaking them is quite high. *Hemideina* nymphs retain

long antennae more readily than do Mahoenui nymphs. The fact that *Hemideina* nymphs live in tightly packed holes probably explains this, as they would need more resilient antennae.

The Mahoenui nymphs are able to regenerate the antennae at each moult. If an antenna is broken, even at the base, it regenerates up to 3/4 of its original length at the next moult. Perhaps this indicates the importance of long antennae to the species.

The palps of the Mahoenui nymphs are also of interest. The clubbed apical segment of the maxillary palp is larger than the same organ on *Hemideina* nymphs from 1st to 5th instar. After this the palps are comparable. The larger palps may compensate for the frequently broken, more 'brittle antennae, as breakage of antennae does not occur as readily once the nymphs reach their 6th instar.

Colouration

Mahoenui weta nymphs are beautifully marked in their early instars. The head is always very dark but the body varies from a yellowish brown to dark brown. The antennae are dark brown but have light brown to yellowish patches throughout their length.

The legs also have these patches of colour which highlight the spines on the hind tibia as well as the tips of the femur. The abdomen has dark stripes in a lighter brown background but the background varies from yellowish brown to dark brown.

This colour variation occurs from 1st to 6th instar. After this the nymph assumes a more uniform colouration of dark brown. The nymph, after 6th instar, is distinctly different in colour shade to adults however, being consistently duller.

There are two colour phases in Mahoenui wetas and some individuals are coloured in such a way as to appear intermediate between the two. The more usual colour is a dark mahogany brown. The other phase is a pale yellowish brown with dark speckles and markings all over the body. I observed no distinction amongst 1st to 5th instar nymphs as far as these colour phases are concerned. Early instar nymphs have colours which are extremely variable. The lighter colour phase makes itself apparent at the 6th or 7th instar which is when the usual mahogany colour is assumed.

The Mahoenui weta nymphs differ from *Hemideina* nymphs in lacking an obvious ecdysial line. This line is seen on the head and the three thoracic terga of *Hemideina* nymphs. It is sometimes apparent when a Mahoenui nymph is within a few hours of ecdysis, but otherwise there is little sign of it.

Behaviour

Aggression, Defence, Stridulation, Movement, Grooming

By the 2nd instar the traditional defence posture of 'true' wetas (raised hind legs) can be seen in this species. First instar nymphs simply run or jump away or kick back when disturbed without employing the hind leg-raising display. Stridulation can be heard at 3rd instar but the ticking sound is hard to hear until the weta reaches 5th or 6th instar.

Mahoenui weta nymphs are not as active as those of *Hemideina* wetas. The nymphs in their 1st instar scuttle about like tree weta nymphs but from second instar onwards they are more relaxed and adopt the slow deliberate walk which is characteristic of this species. When disturbed the nymphs will run but they tend to freeze more readily than do *Hemideina* nymphs. This changes to some degree by 6th instar when the nymphs will quickly take to deeper cover or assume their defensive position. From 1st to 7th instar Mahoenui weta nymphs jump freely and will repeatedly test with their antennae, a likely place to jump to before leaping. Jumping is not carried out as readily as it is with *Hemideina* nymphs however. From the 7th instar onwards jumping is not common but does occur.

Mahoenui wetas clean their appendages more often than do *Hemideina* wetas. As nymphs they are very thorough and all appendages receive attention. Once the weta reaches 9th instar less cleaning takes place although palps and antennae are still regularly attended to.

Unlike *Hemideina* nymphs the Mahoenui weta does not usually moult during the winter when kept at ambient temperatures.

Feeding

Capturing and feeding on insects by Mahoenui wetas is of interest. Unlike some of the *Hemideina* species this weta does not have a catching and holding technique. The weta simply locates food and will move quickly to begin feeding. Mahoenui wetas, particularly when they are in their nymphal stages, are fond of insects, and will eat surprisingly large amounts. The weta will sometimes use one or two legs to hold insect food but this behaviour is not nearly as developed as it is in *Hemideina* wetas.

Insect consumption is most marked in the 1st to 6th instar which is also the case with *Hemideina* wetas. In these early instars Mahoenui wetas eat aphids and scale insects as well as tiny caterpillars and small moths. Individuals differ from each other as to their food preferences but the Mahoenui giant weta is truly omnivorous.

Shelter

Mahoenui weta nymphs are extremely variable as to where they choose to hide. In their separate containers they had a variety of potential hiding places, e.g. amongst gorse, under folded leaves, and so on, but the favourite place was under the *Hydrocotyle clumps.* After the 4th instar, when *Hydrocotyle* was not provided, the most common place was under folded leaves. The habit of jamming themselves among the spines of gorse was the least popular, and was most often adopted by newly ecdysed nymphs or adults.

As the nymphs reached their 7th to 10th instars, the 10th being the adult stage, places used for hiding were rolled up eucalyptus bark, pine bark shelters and leaf litter on the floor. Again the gorse was used only occasionally. In Mike

Meads' enclosure the later instar nymphs frequently used little shelter boxes he designed for them. Often there would be more than one weta in each box!

Mahoenui weta nymphs are quite uncommitted and will utilise the range of choices available to them, but by the time they reach their 9th instar, the wetas start showing the hiding behaviour peculiar to this species i.e. that of hiding in the same place day after day, to the point where even their legs and tarsi are virtually always in the same position. This behaviour is remarkable and does not occur in *Hemideina* wetas. This species, like others, deposits pheromones in faeces and on foliage and will follow these trails around the enclosure. It would appear that this technique is not used until at least the 9th instar as prior to this stage the nymphs are inconsistent as to where they hide and where they travel about their enclosure.

Social Interaction

Up to the 9th instar Mahoenui wetas have little to do with each other. This was not evident in the Wellington Zoo's breeding programme because the nymphs were kept separate due to the risk of cannibalism. One pair of nymphs were kept together from the 7th instar onwards to adult in a large enclosure. These two nymphs had little to do with each other and would move away from each other when contact was made. Cannibalism occurs chiefly during the early instars but later instars are vulnerable to attack when ecdysing. As earlier stated, some nymphs in Mike Meads' enclosure rested together during the day in their shelters but otherwise they led separate lives. This behaviour is similar to that of *Hemideina* nymphs but the *Hemideina* nymphs interact with each other more directly, evicting each other from their holes and shelters. This gives them a closer physical contact.

ARTICLE 8. Keeping the ground weta, *Hemiandrus similis*, Ander, 1938

The information in this article is based on the study of 12 *Hemiandrus similis, 6f, 6m*, caught and kept in captivity at my home in Raumati. This weta offered more challenge than the others as its behaviour and some of its captivity requirements are very different from those of other wetas. It exploits a niche unoccupied by *Hemideina* and *Deinacrida* wetas.

Hemiandrus similis is a small weta that can attain a length of 30 mm, see Fig. 7, p.53. This species lives in burrows in the ground, and juveniles may occupy holes of Porina moth or tiger beetles although both juveniles and adults are quite capable of excavating their own burrows. It is nocturnal but can be found out during the day in rainy weather (usually flooded out of its burrow) or at dusk. Although this species is omnivorous, a large part of its diet consists of living and dead insects. The female is slightly larger and she is plumper than the male.

Housing and Habitat

For this species I used a 90 cm by 43 cm by 43 cm glass tank. This was fitted with a lid that was half plastic and half insect mesh. I chose a large enclosure as this Weta is strongly territorial in spite of its small size.

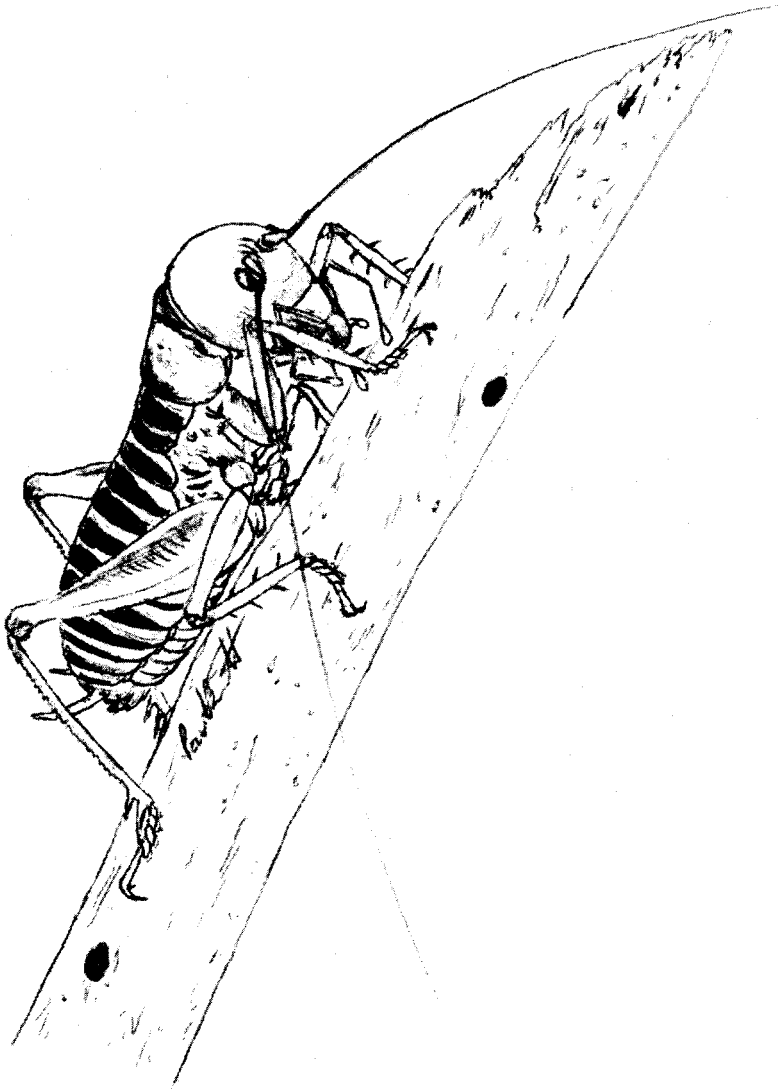
The floor was furnished with a graded depth of soil from 200 mm tapering to 150 mm towards one end of the enclosure. Some leaf litter was added to the top of the soil and *Coprosma* twigs were provided for the wetas to climb on.

No special shelters were provided as this weta preferred to dig into the soil and the behaviour of the females prevented the use of artificial burrows such as those provided for *Hemideina*. I have found this species as deep as 60 cm underground in the field. The burrows of the wetas in captivity varied from 55 mm deep to 180 mm deep in the soil of the enclosure.

Environmental Conditions

I kept this weta at temperatures between 10°C and 25°C. The species dug deeper with the higher temperatures; colder temperatures simply slowed it down. This weta did not become quiescent at any time during my rearing programme. *Hemiandrus similis* has a wide humidity tolerance. It could survive well at 40 % to 50% but was inclined to abandon its burrow when the levels rose above 85% and would then hide under the leaf litter. I found 60 % to 80 % was quite acceptable. This humidity level was easily maintained by misting with my usual spraying

Fig. 7 Ground weta
Hemiandrus similis Ander, 1938



routine, every 2 days in dry weather and every 5 days in damp, humid weather. The soil and leaf litter were sprayed directly.

Food

Feeding this species presented some difficulties initially. As I was unaware of its full dietary requirements some experimentation was required. Some individuals ate a small amount of foliage while others never did. Some fruit was popular e.g. apples, grapes, cherries and kiwi fruit. The foliage eaten was plantain and chickweed.

This weta was particularly fond of animal protein. It readily ate dead moths, nymphs of crickets, locusts, katydids, aphids, mealworm larvae and grass grubs, as well as oxheart and dog sausage.

Feeding was sporadic and the weta often ate once every three days.

Water was administered by providing a misted piece of foliage. The wetas accepted this readily. Cotton wool wads were unsatisfactory as they tended to attract the wetas to one area which caused skirmishes.

Behaviour

Hemiandrus similis proved to be a fascinating weta to study. Its behaviour is quite complex and there is still much to be learnt from observation.

Activity

Although this species hides in the ground and activity centres around the burrows it is quite at home in trees. The specimens in captivity constantly climbed about the branches at night, moving slowly except when disturbed, capturing prey, or hastening to some other location. They were surprisingly dextrous climbers and could reach the thinnest twigs without difficulty.

Movement

Hemiandrus similis is a powerful jumper. It can leap a metre with ease. It usually jumps when disturbed or provoked but will also jump up to or over to a branch etc. The antennae are relatively short being similar in length to those of *Hemideina maori* in relation to its body as is the case with ground-dwelling wetas. The palps, antennae and front legs receive the greatest amount of attention when *H. similis* cleans itself.

Burrowing

The burrows were dug by the wetas themselves but in the field this species commandeers exit holes of burrowing insects as well. Some *Hemiandrus* species even construct lids to their burrows. Watching *H. similis* construct a burrow is fascinating. The hole is started with the head and front legs. The head is moved in a nodding motion. The mandibles are partly opened and a lump of soil is shifted under the wetas' thorax with each nod. At the same time the front legs are splayed outwards which pushes soil sideways. As the weta

progresses, each new load of soil pushes the previous load further under and along the body. Soil is eventually kicked away from beyond the end of the abdomen by the hind legs.

The weta turns round in the new hole to remove soil from all sides. If roots are in the way and are manageable they are cut by the mandibles. If not they are dug around and the burrow continued. Stones, bits of wood or other debris are removed by the wetas as they are met with. The weta can remove a stone similar to its own size by taking it in the mandibles and either pushing it under the body like a load of soil or by pulling it out of the burrow backwards. The stone is then discarded near the entrance of the burrow.

Fig. 8 illustrates the plentiful spines of the tibiae of this weta. When observing the construction of a burrow by *H. similis* one can see that the spines are strategically placed and quite efficient for soil movement. The weta displays surprising power considering its size whilst excavating. The tarsi are folded up towards the tibiae to avoid damage but otherwise they are very supple and dextrous.

Feeding

When searching for food, the habits of this weta are quite different from those of its *Hemideina* cousins. It is considerably more thorough in its searching. It will hunt, literally searching over and under leaf litter, poking into nooks and crannies around branches and foliage and beneath bark, and easily reaching the stems of trees and shrubs where aphids occur. The weta will dig under leaf litter in search of grubs. The feeding behaviour is similar to that described on page 28.

Defence

Each weta had its own burrow which was fiercely defended. Defence was most evident after the first hour of darkness and a couple of hours before day-break. The owner of a burrow would sit at the entrance with its head facing out. Males were more territorial than females. A small territory (maximum radius 50 mm) around the burrow was guarded as well.

If a weta intruded into a burrow, the owner would not hesitate to fight. The two wetas would raise their front legs and expose their mandibles. They would then rush at each other snapping their mandibles shut on anything they could get hold of. The fights were very brief, typically with the loser, usually the intruder, running or jumping away. Injury to legs or antennae was possible but fortunately only occasional. No stridulation was apparent.

Mating

The female, when receptive, would allow the male into her burrow. Mating occurs inside the burrow as well as outside. The male normally backs underneath the female for copulation but occasionally it is achieved virtually side by side with the wetas facing the same way. The female can mate with several males over the summer-autumn period and each male shows no preference for a particular female.

Eggs and Egg Laying

Eggs are laid during the following summer in a chamber to one side of the burrow. The female of this species has a very short blunt ovipositor which is only just visible from above. The eggs are fat and almost cylindrical, smooth, glistening, pale cream-coloured and thin-walled, and are laid in the egg chamber, not in the ground as with other wetas. They are clumped together and guarded by the female who continues to live in the burrow. Occasionally individual eggs are found partly embedded in the walls of the egg-chamber and burrow. These may have become accidentally detached from the egg clump and embedded in the walls by the normal activity of the mother. The young apparently hatch more or less simultaneously and, at least initially, remain crowded together and guarded by the female*.

* This is the only known case of parental care amongst the wetas, and indeed amongst the Orthoptera (sensu stricto). It sometimes occurs amongst the cockroaches and earwigs and there is one case of a mantid looking after its egg case and newly emerged young (see Chopard 1938 "La biologie des Orthopteres", and Hinton 1981 "Biology of Insect Eggs" Volume 1) - G.W. Ramsay

ARTICLE 9. Keeping the cave weta, *Gymnoplectron longipes* (Colenso, 1887)

This account is based on the maintenance of a group of *Gymnoplectron longipes* from the Orongorongo Valley. The wetas were kept for 11 months and successfully laid eggs in captivity. The methods used proved to be quite capable of maintaining this species for an indefinite period. This was the second species I attempted to rear under the Wellington Zoo weta breeding programme.

Gymnoplectron longipes, as can be seen from Fig. 8, is an impressive insect. The females can attain a body length of 65 mm which includes their long ovipositor and males average 35 mm long. It is the antennae and legs which increase this weta's length to 190 mm or more. It is tan brown in colour with a velvety appearance on the body, particularly the abdomen. The female has a pronounced sword- like ovipositor.

The species lives in rotten logs and branches. These are usually on the ground but can be in an elevated position or protruding from a bank for instance. The wetas live in large holes which have rotted out or have been excavated by other insects. This species will occupy abandoned holes of *Hemideina crassidens. Gymnoplectron longipes* is found in small groups crammed into the holes, but will hide singly as well. Nymphs and adults will share shelter and they usually face inwards.

species will occupy abandoned holes of *Hemideina crassidens*. *Gymnoplectron longipes* is found in small groups crammed into the holes, but will hide singly as well. Nymphs and adults will share shelter and they usually face inwards.

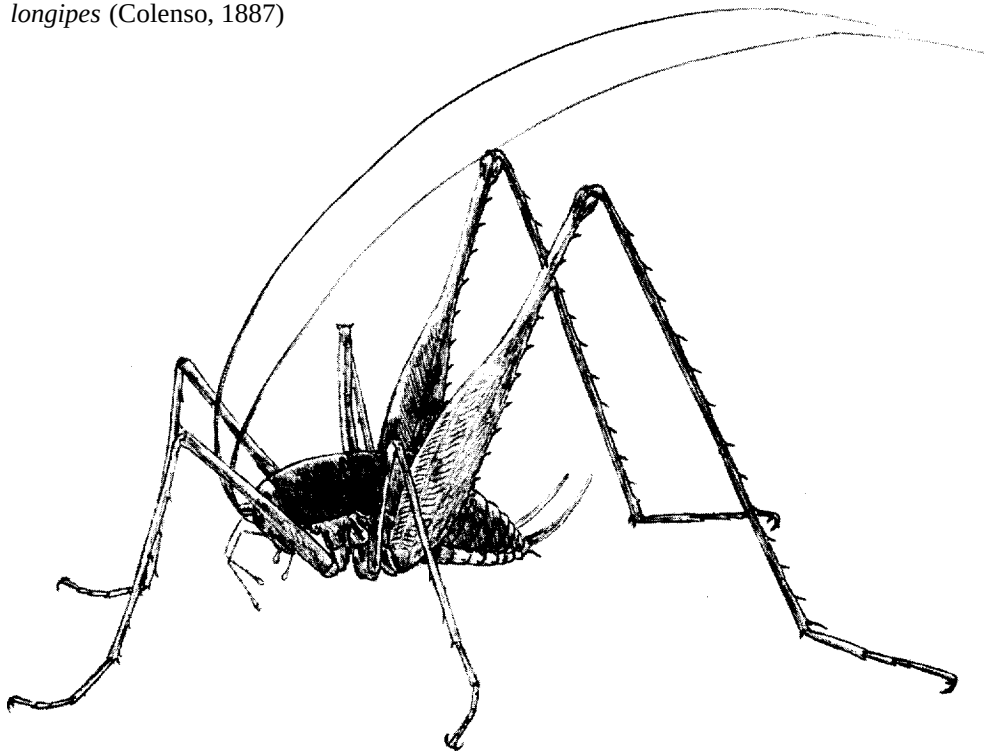
After 11 months in captivity, in late summer, all four wetas died within a few weeks of each other. The males were first to perish. As all four were of unknown age the longevity for this species is unknown.

Housing and Habitat

I used a glass tank, measuring 60 cm x 30 cm x 30 cm. Being quite large wetas I would suggest this should be a minimum. The enclosure had a metal lid with one third of its area taken up by steel insect mesh. These wetas do not chew materials like tree wetas so plastic or wood would be satisfactory for lids.

Soft friable soil mounded to 60 mm deep was added to the floor and loose leaf litter was sprinkled on top of this.

Fig. 8 Cave weta *Gymnoplectron longipes* (Colenso, 1887)



Climbing material in the form of *Coprosma* twigs was added as these wetas preferred to spend most of their time off the floor. A hollow branch 400 mm long and 70 mm wide was used for shelter and all the wetas crammed themselves in without hesitation. The wetas were reliably out and about each night so a special shelter with inspection window, such as that used for *Hemideina crassidens'* harem gallery (see pages 12 and 13, Fig. 2) was not required. *G. longipes* proved to resent disturbance intensely.

Environmental Conditions

I kept this species at the same temperature as *H. crassidens.* This was an optimum of 10° to 25°C. *G. longipes* was quite content at this temperature range. Humidity differed in that it was tolerated at slightly higher levels by this cave wetaf. A level of 65 % to 85 % was found to be satisfactory. This higher preference is substantiated by the fact that *G. longipes* is found in damp or rotten logs whereas *H. crassidens* is often found in drier conditions.

Food

These cave wetas proved to be almost entirely carnivorous. They ate a small amount of apple and tiny portions of moss. They readily ate dead or injured insects and were particularly fond of tinned cat food. They ate varying amounts but never a large amount at one sitting. They would normally locate the food, feed briefly and then move on.

A feeding weta would be easily disturbed by another weta or any vibration. An amount of food comprising, two field crickets *(Teleogryllus commodus)* or the equivalent sized piece of cat food would normally be consumed in a night by four adult *G. longipes.*

Water was provided by using soaked cotton wool wads or by spraying the enclosure. The wetas would ingest the water droplets.. Both methods were acceptable to the wetas.

Behaviour

These wetas behaved surprisingly like the *Deinacrida* species. They moved about in a careful, deliberate manner and were easily disturbed. Once disturbed, for example, by a vibration,. they would freeze for considerable lengths of time. There are no obvious auditory organs present but this species will freeze in response to sound.

Activity

The usual pattern of behaviour each night was for the wetas to leave the shelter, usually only an hour after dark, locate food and feed and move around the enclosure. They were very curious and would explore every aspect of their enclosure. They feed perhaps three to four times and then finally make their way to the lid of the enclosure. Here they would climb onto the lid and remain with their legs spread out. There was very little interaction between the individuals and each would space itself away from the others on the lid. The wetas stayed in contact with each other by touching with their long antennae.

Grooming

This species is like other cave wetas in that it is fastidious about cleaning itself. The palps and antennae receive most attention, and all the legs are cleaned. The female regularly cleans her ovipositor - most cleaning was carried out whilst the wetas were upside down on the lid. They remained thus for prolonged periods.

Mating

Mating commenced in the early hours of the morning. It would often continue in broad daylight at least until 10.00 or 10.30 am the next day. The male initiated copulation and after locating the female, moved backwards underneath her. Whilst in this position the male would then lift his abdomen so his cerci contacted the venter of the female's abdomen. He would accomplish this with a series of quick flicks of the abdomen. After a while the male would then connect. Throughout this period the female, if receptive, remained passive and stationary. Connection would then last well into the morning of the next day, but the pair were easily disturbed in which case the connection was broken. Otherwise the male would simply release the female and move out from under her. Both wetas would then make their way unhurriedly to the shelter for the rest of the day. Spermatophores were not seen on the female. Mostly copulation took place with the wetas upside down clinging to the mesh of the lid.

Eggs and Egg Laying

The females laid eggs sporadically each night during the summer. The eggs are greyish brown, cigar shaped 3.5 to 4mm long and laid singly in the soil. As with all other activities, the female would be easily disturbed during oviposition. I had to be very quiet and not move in order to successfully observe the females while they were out laying eggs. The ovipositor was sunk into the ground up to its base and withdrawn after mild contraction of the abdomen. Gravid females became quite plump and were considerably larger than the males.

The nine separate articles in this booklet detail the keeping in captivity of several kinds of weta and the techniques of breeding them - the Wellington weta *(Hemideina crassidens)*, the Stephens Island hemideina (*H. crassicruris)*, the Auckland weta (*H. thoracica)*, the ground hemideina (*H. maori)*, the Mahoenui giant weta *(Deinacrida* sp.*)*, the ground weta *(Hemiandrus similis)*, and the cave weta *(Gymnoplectron longipes)*. These articles are an outcome of Project Weta at the Wellington Zoo.

Each article is packed with information about the space, shelter, temperature, humidity, and food requirements of these wetas, both nymphs and adults, as well as many observations and notes about their behaviour and biology.

"Project Weta" is ongoing and as more information and data about additional species is gathered, supplementary articles and up-dates will be produced.

PAUL BARRETT lives at Raurnati near Wellington and has a deep and long-standing interest in the keeping of captive animals. He has a particular interest in insects and his enthusiasm for wetas began when he was a small child. He was educated in Wellington and, on leaving Wellington High School, joined the staff of the Wellington City Council as a gardening labourer at the Botanical Gardens before transferring to the Wellington Zoo, where he has been employed for nine years. During this time he has completed an animal science technicians' course in animal management and a London City and Guilds course in Zoo management.

At the Zoo Paul works with a wide range of animal species as well as with insects and spiders. He has responsibility for the aquaria and for some reptiles including the tuatara and geckos. In addition, he looks after the Zoo's Hospital and Quarantine Unit, and is involved with the development of a new reptile, fish, and insect facility. All this and "Project Weta" take up most of his time. With what is left he enjoys tramping, drawing, and bird- and insect-watching. He even keeps some birds (including racing pigeons and a harrier hawk) - and wetas - at home!