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DISTRIBUTION, HABITAT AND CONSERVATION STATUS OF *HEMIDEINA RICTA* AND *H. FEMORATA* ON BANKS PENINSULA, NEW ZEALAND

Summary: Two tree weta *Hemideina ricta* and *H. femorata* are predominantly allopatric on Banks Peninsula (South Island, New Zealand) except for four small areas of overlap. *H. ricta* was found over the outer eastern portion of Banks Peninsula including the eastern slopes of Akaroa Harbour whereas *H. femorata* was usually lower down on the eastern edge of Akaroa Harbour and west of this. *H. ricta* ranged from 20 m to 806 m in altitude whereas all *H. femorata* were found below 450 m. Ninety-four per cent of *H. femorata* occupied holes in *Kunzea ericoides* and the remainder were in four other tree species and in logs. Forty-one per cent of *H. ricta* were in logs and old fenceposts, 20% were in *Hoheria angustifolia*, 19% were in *K. ericoides*, 16% were in seven other broadleaf hardwood species and 4% were under rocks.

Key words: *Hemideina ricta*; *Hemideina femorata*; Stenopelmatidae; weta; distribution; habitat preferences; conservation status; Banks Peninsula; New Zealand.

Introduction

The Banks Peninsula tree weta, *Hemideina ricta* Hutton, is the rarest of the seven species of tree weta. Prior to our study it was known from only two locations on Banks Peninsula: Okains Bay (R. Bigelow, formerly Canterbury University, *pers. comm.*) and in totara (*Podocarpus totara* (G. Benn ex D. Don.)) logs near Purple Peak (P. Johns, Canterbury University, *pers. comm.*). The only other published localities were given as "Banks Peninsula" and "South Canterbury" (Hutton, 1897). The Canterbury tree weta, *H. femorata* (Hutton), also occurs on Banks Peninsula but its range extends over a large area north and west of this (Meads, 1990). *Hemideina ricta* was ranked at the top of the New Zealand Department of Conservation protected animal species list by Molloy and Davis (1992) because of its very restricted known distribution and because virtually nothing was known about its population status. In 1992 the Department of Conservation commissioned a detailed survey of the distribution, population status and habitat of *H. ricta* on Banks Peninsula and the results of this are given here. The study included both Herbert and Akaroa Ecological districts as described by McEwen (1987). This paper reports on the occurrence and habitat of *H. ricta* and *H. femorata*, because the latter was also present in some of the survey sites.

Methods

Identification of weta

Weta were usually identified in the field by their colour patterns. The abdomen of *H. femorata* appears distinctly banded with a cream-yellow transverse region in each segment flanked with a broad anterior area of dark reddish brown and a narrow posterior band of lighter reddish brown. It also has irregular black markings on the prothorax and on the hind femora. The abdomen of *H. ricta* has a much more uniform appearance because the brown areas extend as mottling over the lighter yellow regions (Townsend, 1995). *Hemideina ricta* generally lacks black marks on the prothorax and hind femur although some individuals do have them (Morgan-Richards and Townsend, 1995). A retrolateral apical spine is present on the hind femora of some *H. femorata* but this is never present on *H. ricta*. Six weta of intermediate appearance between *H. ricta* and *H. femorata* were captured and identified from the number of ridges per file in their stridulatory apparatus. *Hemideina ricta* has a total of 20 or more stridulatory ridges on both files (Field, 1993a) whereas *H. femorata* has a total of 16 or fewer of these ridges (Field, 1992). Two additional specimens that were intermediate in both appearance and number of stridulatory ridges were shown to be

hybrids when the identities of all the intermediate forms were confirmed by allozyme analysis (Morgan-Richards and Townsend, 1995). Small juvenile weta were difficult to identify and were assumed to be the same species as nearby adults. Voucher specimens of *H. ricta*, *H. femorata* and two hybrid individuals are deposited with the Museum of New Zealand, Wellington.

Searching for weta

Searches were carried out in daylight by inspecting all holes encountered in trees, fenceposts and logs. A small torch with a focusable beam was used to examine these holes. We did not enlarge or open holes to inspect parts hidden from view because of the conservation status of *H. ricta*. Our results are therefore minimal counts. Whenever a weta was found, the search was interrupted while an attempt was made to extract it for identification. The altitude and direction of slope (aspect) of each locality were recorded.

Systematic survey

Banks Peninsula was surveyed systematically after partitioning it into 35 five by five km areas (Fig. 1). Eleven areas by the coast were not surveyed because they were mostly sea cliffs or bare farmland (stippled areas in Fig. 1). At least one 10 x 10 m plot was then searched within each of the habitat types listed below, in each five by five km area. The general region where each plot was taken was chosen for ease of access then the plot was located by taking a random distance of up to 100 m in a random direction. Details of plot locations are deposited with the Department of Conservation (Brown and Townsend, 1994). A timed 5-min search was also made in the same habitat type as the survey plots but outside the plots.

Broad habitat types were modified from the vegetation categories of Wilson (1992). These were (1) dense stands of kanuka (*Kunzea ericoides* (A. Rich)) forest together with kanuka treeland comprising isolated or small groups of trees surrounded by pasture, (2) mixed hardwood forest and treeland, (3) podocarp forest, (4) podocarp/mixed hardwoods, (5) beech (*Nothofagus* sp.) forest, and (6) open scrubland. We used additional habitat types of (7) logs in pasture, and (8) old weathered totara fenceposts on farmland. Hardwood species were predominantly fuchsia (*Fuchsia excorticata* (J.R. et G. Forst.)), mahoe (*Melicytus ramiflorus* J.R. et G. Forst.), fivefinger (*Pseudopanax arboreus* (Murr)), lemonwood (*Pittosporum eugenioides* A. Cunn.), ribbonwood (*Plagianthus regius* (Poit.) Hochr.), lacebark (*Hoheria angustifolia* Raoul), pigeonwood (*Hedycarya arborea* J.R. et G. Forst.), kowhai (*Sophora microphylla* Ait.), kaikomako (*Pennantia corymbosa* J.R. et G. Forst.), pepperwood (*Pseudowintera colorata* (Raoul)) and broadleaf (*Griselinia littoralis* Raoul). Open scrubland consisted of bracken (*Pteridium esculentum* (Forst. f.)) and shield fern (*Polystichum vestitum* (Forst. f.)) together with a variety of rushes and a scattering of small shrubs (predominantly *Coprosma*).

All channels, holes and other possible weta refugia found in trees, fenceposts and logs were searched systematically with a small torch in each 10 x 10 m plot. The location of every tree weta found was marked and an attempt was subsequently made to extract them. All weta were oriented head first in their holes. A bent wire was inserted past the weta and then tapped on the front of the wetas' heads to encourage them to reverse out. All weta were returned to their holes after being identified. Destructive sampling of logs was minimized given the conservation status of *H. ricta*. Any logs that were broken were reassembled as far as possible. Interspecific differences in refugia use were investigated using χ^2 analysis.

Results

Distribution

Most *H. ricta* and *H. femorata* were found in separate areas of Banks Peninsula (Fig. 1). In total 170 *H. ricta* were identified from within an area of approximately 200 square kilometres on the eastern end of Banks Peninsula. This area included west facing slopes on the eastern side of Akaroa Harbour. *Hemideina ricta* extended to the north-west as far as Pigeon Bay (Fig. 1). In contrast, 84 *H. femorata* were identified from the area predominantly west of Akaroa. Both species were found in close proximity immediately east of Akaroa township (Fig. 1, A; NZMS 260 N36 084109), north of Nikau Palm Gully (Fig. 1, B; NZMS 260 N37 064060), in an isolated stand of kanuka in the Takamatua Valley (Fig. 1, C; NZMS 260 N36 091134) and at upper Pigeon Bay (Fig. 1, D; NZMS 260 N36 033202). Both species were found in the same tree only once. This occurred at Pigeon Bay where two juvenile *H. femorata* shared the same kanuka tree as an adult female *H. ricta*. Two hybrid weta were also found in the same patch of kanuka as 11 *H. femorata* behind Akaroa township (Fig. 1, E; NZMS 260 N36 087121). One of these hybrids was an adult male that occupied a large hole with an adult female *H. femorata*.

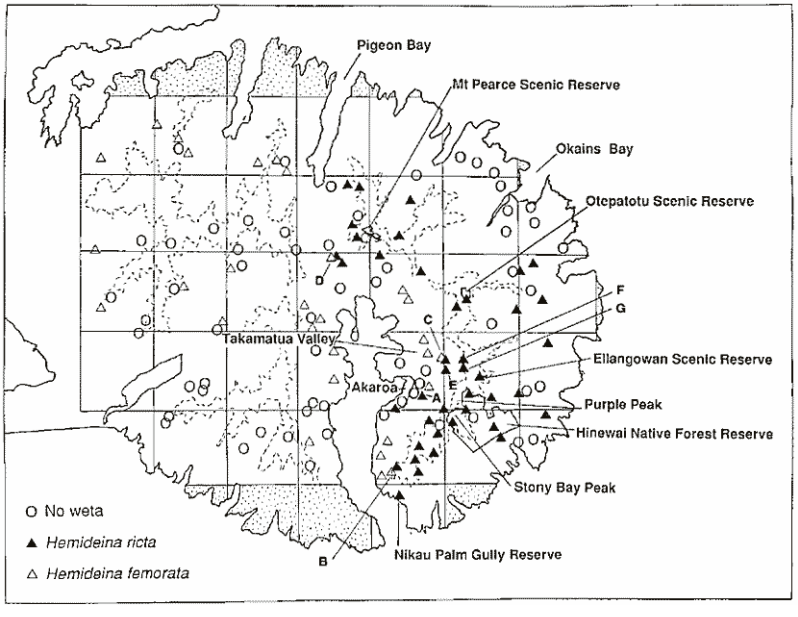

Figure 1: *Distribution of* Hemideina ricta *and* Hemideina femorata *on Banks Peninsula showing 5 x 5 km search grid. Sites labelled A-G are referred to in the text. Areas not searched are stippled. The 500 m contour is indicated by a dashed line.*

Occurrence in relation to altitude

All *H. femorata* specimens were found below an altitude of 450 m and 97.1% of these occurred below 400 m. In contrast, *H. ricta* ranged from 40 m to 806 m a.s.l. (Fig. 1) but 76.9% of them were found above 400 m. The altitudes where both species occurred in the same patch of vegetation were at 375 m (Nikau Palm Gully), 150 m (Takamatua Valley), and 300 m (Pigeon Bay).

Occupation of refuges by weta

A total of 2,994 apparently suitable holes for weta to occupy and 2,712 other apparently suitable refuges were searched during the systematic survey of Banks Peninsula. The latter refuges were elongated splits or channels in wood, rotten cavities in wood, spaces under lose bark, and crevices formed by forked tree branches. Only 59 holes (three with two weta and one with three weta) and 14 other refugia contained *H. ricta* whereas 30 holes (four with two weta) and 14 other refugia contained *H. femorata* (Table 1). These represent minimum counts as parts of some holes could not be inspected. The occupancy rate of holes, splits and other refugia did not differ significantly between species (χ^2=2.78, df=2, *P*=0.25). Twelve weta of both species could not be removed from their refuges but were identified *in situ* and a further 11 weta that were not extracted

Table 1: *Occupation of holes and other refuges by weta on Banks Peninsula. Data are from quadrat searches and timed searches.*

	Species in refuge					
	H. ricta		*H. femorata*		unknown	
Refuge	No.	(%)	No.	(%)	No.	(%)
Hole	64	(82.1)	34	(70.8)	9	(81.8)
Split	9	(11.5)	7	(14.6)	0	(0)
Under bark	4	(5.1)	5	(10.4)	1	(9.1)
Rotten cavity	1	(1.3)	0	(0)	1	(9.1)
Fork of branch	0	(0)	2	(4.2)	0	(0)
Total no. weta	78		48		11	

could not be identified. Four of the latter occurred in quadrats with *H. ricta* and seven occurred in quadrats with *H. femorata*.

Location of refuges

Hemideina ricta was found in a range of trees, posts, logs and rocks whereas all *H. femorata* except one were found in trees (Table 2). Both weta were found in similar holes, crevices or under lose bark. Forty-one per cent of *H. ricta* were found in either fenceposts or logs on the ground. The trees they were most often found in were narrow-leaved lacebark (20%) and kanuka (19%) whereas they occurred only occasionally in broadleaf, mahoe, five-finger, *Calystegia* sp., pepperwood, and *Coprosma* sp. Only one *H. ricta*, a juvenile, was found under totara bark (Table 2). Compared with *H. ricta*, *H. femorata* were significantly more likely to be found in kanuka than in all other habitats combined (χ^2=129.3, df=1, P<0.0001), with 94% being found in these trees. The remaining few *H. femorata* were in live trees of narrow-leaved lacebark, pate (*Schefflera digitata* J.R. et G. Forst.), mahoe, and in vines of *Calystegia* sp. (Table 2).

Table 2: *Numbers of weta found in different plant species and other habitats on Banks Peninsula.*

Location	*H. ricta*	*H. femorata*
K. ericoides	32	79
H. angustifolia	34	1
M. ramiflorus	13	1
P. colorata	4	0
Coprosma sp	5	0
P. totara	1	0
P. arboreus	1	0
G. littoralis	1	0
S. digitata	0	1
Calystegia sp	2	1
Logs	44	1
Fenceposts	26	0
Rocks	7	0

Table 3: *Density (mean±SE) of H. ricta and H. femorata in 10 x 10 m plots on Banks Peninsula. Habitat numbers refer to habitat types described in methods. Numbers of quadrats are given in parentheses.*

Habitat	*H. ricta*	*H. femorata*
(1) Kanuka	1.67±0.54 (15)	2.95±0.5 (20)
(2) Mixed Hardwood	2.56±1.29 (18)	0.07±0.07 (14)
(3) Podocarp	0 (1)	0 (2)
(4) Podocarp/broadleaf	0 (2)	0 (8)
(5) Beech	0 (3)	0 (0)
(6) Scrub	1.67±1.67 (3)	0 (2)
(7) Logs	2.13±0.72 (8)	0 (3)
(8) Fenceposts	1.33±0.88 (3)	0 (2)

The density of weta was estimated from the number found in each 10 x 10 m plot (Table 3). *Hemideina ricta* reached its highest density where mixed hardwoods or logs were present although there was no significant difference between their densities in all of the habitats where they occurred (Table 3). *Hemideina femorata* occurred at slightly higher densities than *H. ricta* although it was restricted almost exclusively to kanuka forest and treeland.

Occupation of habitat and relationship to altitude

Hemideina femorata was observed in only kanuka up to an altitude of 320 m even though *K. ericoides* extended above 500 m in the study area. Only one *H. femorata* was recorded higher than 320 m and this was in an *H. angustifolia* gallery at 440 m. *H. ricta* was generally located in either mixed hardwoods or kanuka up to an altitude of 670 m. At higher elevations they were mainly found in totara or hardwood logs but they were also found in holes excavated in the ground under rocks at four sites; Ellangowen and Hinewai Reserves and two farm sites (Fig. 1, F and G; NZMS 260 N37 117127 & 115133).

Occurrence in relation to aspect

Weta were found on slopes in all directions but the number of *H. ricta* and *H. femorata* per quadrat differed significantly in relation to aspect (χ^2=29.4, df=7, P=0.0001). The highest densities of *H. ricta* occurred on north and west facing slopes (0.025 and 0.031 weta m^{-2} respectively) whereas the highest density of *H. femorata* was on north-east facing slopes (0.018 weta m^{-2}) (Table 4).

Discussion

Habitat and altitude

The distribution of vegetation on Banks Peninsula affects weta distribution because these insects use trees and logs for refuges. Weta will eat a wide variety of plants including some pasture species (Townsend, 1995) so food is unlikely to limit their distribution. Banks Peninsula is now a mosaic of pasture and low scrubland, with isolated stands of kanuka and mixed broadleaf hardwoods in the wetter gullies (Wilson, 1992). The summit road area, between an altitude of 500 to 840 m a.s.l., is mainly

Table 4: *Number of weta found in relation to direction of slope on Banks Peninsula.*

	N	NE	E	SE	S	SW	W	NW
H. ricta	25	6	16	6	16	8	28	12
H. femorata	6	21	13	3	3	5	13	13
Quadrats with weta	4	5	7	2	5	3	4	6
Quadrats without weta	6	7	17	8	10	4	5	5
Total number of weta	31	27	29	9	19	13	41	25

farmed but decaying totara and broadleaf logs together with scattered shrubs are often locally abundant and can contain numerous weta especially if the logs are adjacent to shrubs. Some of the bush remnants may be too far apart for weta to move between but the only information on dispersal distances over pasture for Stenopelmatidae are for Mahoenui weta (*Deinacrida* sp.). Richards (1994) reported that late instar Mahoenui weta usually remained within 1 m of their original position over periods of one to seven months but they may on occasion travel more than 70 m over pasture during one night.

All tree species present on Banks Peninsula have distributions that encompass the entire Peninsula with the exceptions of red and black beech (*Nothofagus fusca* (Hook. f.) and *N. solandri* (Hook. f.)). The latter is restricted to small isolated stands within a small south-eastern portion of the Peninsula (Wilson, 1992) but we found no tree weta in this forest. The rainfall in the Mt Herbert and Akaroa Ecological Districts are similar although Wilson (1992) reports that the climate of the latter is more mild, moist and oceanic. This includes the area where *H. ricta* occurs so it is possible that climate may affect the distribution of this weta.

Banks Peninsula has a distinct vegetational transition at 500 m a.s.l. where lowland podocarp forest changes to montane forest dominated by thin bark totara (*Podocarpus hallii* Kirk), mountain five finger (*Pseudopanax colensoi* (Hook. f.)), broadleaf and pepperwood (Wilson, 1992). This altitudinal change corresponds approximately with the upper altitudinal limit of *H. femorata* on Banks Peninsula but it bears no relation to the upper altitudinal limit of *H. ricta*. Above the vegetational transition scattered totara and broadleaf logs are common and many *H. ricta* were found in these. Such a distribution of logs added to the greater number of *H. ricta* we discovered between altitudes of 400 and 700 m a.s.l. Kanuka occurs throughout Banks Peninsula (H.D. Wilson, *pers. comm.*), and its altitudinal limit exceeds that of *H. femorata* so it probably does not significantly affect the distribution of *H. femorata*.

Our results suggest that *H. femorata* shows a very strong association with refuges in kanuka trees and that *H. ricta* is associated with a much broader range of plants, logs, fenceposts and even rocks. There is no other published information for *H. ricta* but Little (1980) and Sandlant (1981) reported finding *H. femorata* elsewhere in Canterbury in a much wider range of plants than we did. These plants included kanuka, beech (*Nothofagus* sp.), lacebark, *Fuchsia* sp., mahoe and broadleaf. In contrast, we found no *H. ricta* or *H. femorata* in either beech or *Fuchsia* on Banks Peninsula although they were present in the other species. It is possible that our results were biased by us not inspecting parts of holes hidden by bends.

It is relatively unusual for tree weta to be found under rocks and in crevices between rocks yet we found *H. ricta* in this situation at four sites on Banks Peninsula. One of these weta was even found on the summit of Stony Bay Peak (806 m a.s.l.) under a rock with its gallery tunnelled into the soil beneath. The only other tree weta reported to use refuges in rock crevices and under rocks is the alpine tree weta (*Hemideina maori* (Pictet et Saussure)), and this lives in alpine fell fields above the timberline (Field, 1993b). In addition, the alpine giant weta (*Deinacrida connectens* (Ander)) is also found under rocks above the tree line (Field, 1980). *Hemideina crassidens* (Blanchard) was reported to live in holes in clay banks when their population density was very high (Moller, 1985) but the only burrows of *H. ricta* that we found were closely associated with rocks. In contrast, ground weta in the genera *Zealandrosandrus* and *Hemiandrus* normally live in burrows (Wahid, 1978; Cary, 1981; Sandlant, 1981; Butts, 1983; van Wyngaarden, 1995).

It seems likely that *H. ricta* occupies refuges amongst rocks only in situations where they face a shortage of refuges in trees or logs. Certainly this occurred on the summit of Stony Bay Peak where there were no logs or trees although low growing gorse bushes containing possible refuges were present. Staff at Hinewai Reserve reported finding *H. ricta* when clearing gorse from boundaries within the reserve (H.D. Wilson, *pers. comm.*) but we did not find any in gorse.

Hemideina ricta and *H. femorata* were found in only three habitat patches where they could be considered to overlap. In all other situations where these weta were found within 0.5 km of each other, *H. ricta* was at a higher altitude than *H. femorata*. Altitude also appears to be an important factor for separating *Hemideina thoracica* (White) and *H. crassidens* in the Taranaki region (Trewick and Morgan-Richards, 1995). They found *H. thoracica* and *H. crassidens* occupied a zone of overlap at 800-900 m a.s.l. on Mt Taranaki with *H. thoracica* extending below this and *H. crassidens* extending up to the bush line at 1100 m a.s.l. Levins and Culver (1971) and Hanski (1983) suggest that two species can coexist by occupying different patches when environments have a patchy, island-like pattern of occurrence. Each would have little effect on the other because their co-occurrence would be an extremely rare event. Granot (in Abramsky, 1981) suggested that two closely related species can co-exist if they prefer slightly different habitats or by resource partitioning, even though both species may be found at the same sites.

Aspect

The only published information concerning the relationship between weta and land aspect was by Sherley and Hayes (1993). They found Mahoenui weta (*Deinacrida* sp.) mainly on north-eastern slopes at Mahoenui Reserve, King Country, and suggested that these slopes were preferred because they were warmer than south-eastern slopes. This is also possibly why the highest densities of *H. ricta* and *H. femorata* occurred on north to west facing slopes.

Conservation status

Our survey has greatly extended the known distribution of *H. ricta* and as a consequence its conservation status has been downgraded to category B by the Department of Conservation (Molloy, Davis and Tisdall, 1994). *Hemideina ricta* still has the most restricted distribution of any tree weta although it is locally abundant. Habitat loss and degradation seem to be the most obvious immediate threats to this species. Apart from Hinewai Reserve and Ellangowen Scenic Reserve, *H. ricta* were found in only three other reserves: Nikau Palm Gully, Otepatotu and Mt Pearce Scenic Reserves. The latter two are both above 500 m altitude and include native bush and open tussock grassland with scattered totara logs adjacent to low shrubs. We believe that this habitat makes these two reserves particularly high in conservation importance to *H. ricta*. In addition, both reserves are above the altitude where *H. femorata* occurs. We note that the logs present on farmland at higher altitudes represent a diminishing resource for *H. ricta* because they will eventually disappear both because of decay and by removal for firewood. We recommend monitoring to determine if the range and abundance of *H. ricta* is changing, and what influence *H. femorata* may have.

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References

Abramsky, Z. 1981. Habitat relationships and competition in two Mediterranean *Apodemus* spp. *Oikos 36*: 219-225.

Brown, B.; Townsend, J.A. 1994 (unpublished). A distribution survey of *Hemideina ricta* on Banks Peninsula. Report to The Department of Conservation, Wellington, N.Z. 24 pp.

Butts, C.A. 1983 (unpublished). *The biologies of two species of weta endemic to the Snares Island* Zealandrosandrus subantarcticus *Salmon (Orthoptera: Stenopelmatidae) and* Insulanoplectron spinosum *Richards (Orthoptera: Rhaphidophoridae)*. B.Sc. Hons. Thesis. University of Canterbury, Christchurch, N.Z. 99 pp.

Cary, P.R.L. 1981 (unpublished). *The biology of the weta* Zealandrosandrus gracilis *(Orthoptera: Stenopelmatidae) from the Cass Region*. M.Sc. Thesis, University of Canterbury, Christchurch, N.Z. 92 pp.

Field, L.H. 1980. Observations on the biology of *Deinacrida connectens* (Orthoptera: Stenopelmatidae), an alpine weta. *New Zealand Journal of Zoology 7:* 211-220.

Field, L.H. 1992. The stridulatory apparatus of New Zealand wetas in the genus *Hemideina* (Insecta: Orthoptera: Stenopelmatidae). *Journal of the Royal Society of New Zealand 8:* 359-375.

Field, L.H. 1993a. Structure and evolution of stridulatory mechanisms in New Zealand wetas (Orthoptera: Stenopelmatidae). *International Journal of Insect Morphology and Embryology 22:* 163-183.

Field, L.H. 1993b. Observations on stridulatory, agonistic and mating behaviour of *Hemideina ricta* (Stenopelmatidae: Orthoptera), the rare Banks Peninsula tree weta. *New Zealand Entomologist 16:* 68-74.

Hutton, F.W. 1897. The Stenopelmatidae of New Zealand. *Transactions and Proceedings of the New Zealand Institute 29:* 208-242.

Hanski, I. 1983. Coexistence of competitors in a patchy environment. *Ecology 64:* 493-500.

Levins, R.; Culver, D. 1971. Regional coexistence of species and competition between rare species. *Proceedings of the National Academy of Sciences (USA) 86:* 1246-1248.

Little, G.A. 1980 (unpublished). *Food consumption and utilisation in two species of weta* (Hemideina femorata H. maori: *Stenopelmatidae*). B.Sc. Hons. Thesis, University of Canterbury, Christchurch, N.Z. 66 pp.

McEwen, W.M. 1987 (Editor). *Ecological regions and districts of New Zealand*. New Zealand Biological Resource Centre Publication No. 5: part 3. Department of Conservation, Wellington, N.Z. 105 pp.

Meads, M. 1990. *The weta book. A guide to the identification of wetas*. DSIR Land Resources, Lower Hutt. N.Z. 36 pp.

Moller, H. 1985. Tree wetas (*Hemideina crassicruris*) (Orthoptera: Stenopelmatidae) of Stephens Island, Cook Strait. *New Zealand Journal of Zoology 12:* 55-69.

Molloy, J.; Davis, A. 1992. Setting priorities for the conservation of New Zealand's threatened plants and animals. Department of Conservation, Wellington, N.Z. 64 pp.

Molloy, J.; Davis, A.; Tisdall, C. 1994. Setting priorities for the conservation of New Zealand's threatened plants and animals (Second Edition). Department of Conservation, Wellington, N.Z. 64 pp.

Morgan-Richards, M.; Townsend, J.A. 1995. Hybridisation of tree weta on Banks Peninsula, New Zealand, and colour polymorphism within *Hemideina ricta* (Orthoptera: Stenopelmatidae). *New Zealand Journal of Zoology 22:* 393-399.

Richards, G.E. 1994 (unpublished). *Ecology and behaviour of the Mahoenui giant weta,* Deinacrida *nov. sp*. M.Sc. Thesis, Massey University, Palmerston North, N.Z. 184 pp.

Sandlant, G.R. 1981 (unpublished). *Aggressive behaviour of the Canterbury weta (*Hemideina femorata*) (Orthoptera: Stenopelmatidae). Its adaptive significance in resource allocation*. M.Sc. Thesis, University of Canterbury, Christchurch, N.Z. 79 pp.

Sherley, G.E.; Hayes, L.M. 1993. The conservation of a giant weta *(Deinacrida* n.sp, *Orthoptera: Stenopelmatidae)* at Mahoenui, King Country: Habitat use and other aspects of its ecology. *New Zealand Entomologist 16:* 55-68.

Townsend, J.A. 1995 (unpublished). *Distribution and ecology of the Banks Peninsula tree weta,* Hemideina ricta. M.Sc. Thesis, Massey University, Palmerston North, N.Z. 114 pp.

Trewick, S.A.; Morgan-Richards, M. 1995. On the distribution of tree weta in the North Island, New Zealand. *Journal of The Royal Society of New Zealand 25:* 485-493.

van Wyngaarden, F. 1995 (unpublished). *The ecology of the Tekapo weta (*Hemiandrus *new sp.; Orthoptera, Anostostomatidae) and recommendations for the conservation of a threatened close relative*. M.Sc. Thesis, University of Canterbury, Christchurch, N.Z. 102 pp.

Wahid, M.B. 1978 (unpublished). *The biology and economic impact of the weta,* Hemiandrus *sp. (Orthoptera: Stenopelmatidae) in an apricot orchard, Horotane Valley*. M.Sc. Thesis, Lincoln University, Lincoln, N.Z. 231 pp.

Wilson, H.D. 1992. *Banks Ecological Region*. Survey report for the New Zealand protected natural areas programme. Survey report No 21. Department of Conservation, Christchurch, N.Z. 342 pp.