Species-level comparison of litter invertebrates at two rainforest sites in Tasmania

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Abstract

Litter macroinvertebrates were collected with equal sampling effort at rainforest sites 200 km apart in north-eastern and north-western Tasmania. Both sites carried oldgrowth Nothofagus–Atherosperma–Dicksonia *forest on a north-west facing slope at 650–690 m elevation. One-third of the 7205 invertebrates collected were unidentified spirostreptidan millipedes. Of the remaining specimens, nearly 80% were referrable to 153 known or new species of flatworms, nemertines, velvet worms, snails, centipedes, millipedes, harvestmen, spiders, slaters, landhoppers, neanurid springtails, and carabid, lucanid and tenebrionid beetles. Just under two-thirds of the species at either site were unique to that site, but an analysis which progressively discounts the importance of low-abundance species suggests that the unique proportion is closer to one-half.*

Introduction

Because a species-by-species approach to conserving the huge diversity of forest invertebrates is impractical, it is sometimes argued that if we conserve a sufficiently broad range of forest vegetation types, we will maximise our chances of conserving the full range of invertebrate species living in those forests. Implicit in this argument is the notion that invertebrate diversity follows plant diversity: similar vegetation, similar fauna; different vegetation, different fauna.

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Nevertheless, Mesibov (1993) showed that very different vegetation types can be home to quite similar invertebrate faunas. Evidence was presented indicating that 80% or more of the litter invertebrates at oldgrowth rainforest sites in north-western Tasmania were also present in nearby eucalypt woodland and riparian tea-tree forest. In the present paper, I show that similar vegetation types can be home to significantly different invertebrate faunas. Oldgrowth rainforest was again the habitat sampled, this time at sites 200 km apart matched for elevation and aspect.

As in the previous study (Mesibov 1993), I also present details of hand-sampling results. Mesibov *et al.* (1995) have shown that methodical hand-collecting is an effective and highly efficient alternative to pitfall trapping in the sampling of millipedes in wet eucalypt forest. Results of the present study suggest that searching defined plots for defined time periods is a useful approach to sampling a wide range of litter macroinvertebrates in rainforest.

Methods

Study area

Locations of study sites and sampling plots are shown in Figure 1. The north-east (NE) site, near Weldborough, is on Rattler Hill on the headwaters of the East Cascade River. The north-west (NW) site, near Waratah, is on Wombat Hill and drains into the headstreams

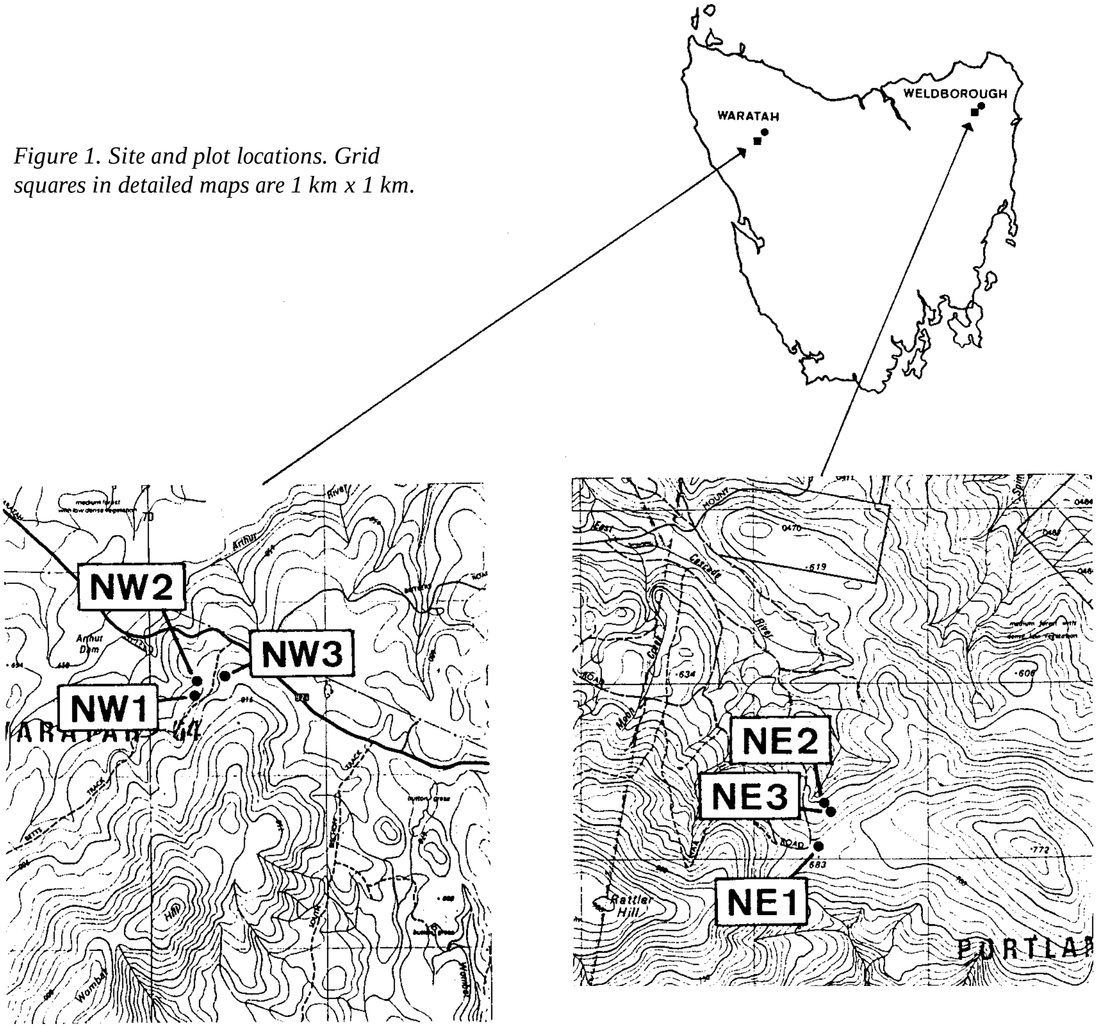

Figure 1. Site and plot locations. Grid squares in detailed maps are 1 km x 1 km.

of the Arthur River. Both sites are on north-west facing slopes at 650–690 m elevation. The NE site is on coarse-grained, Upper Devonian – Lower Carboniferous granodiorite, while the NW site is on fine-grained mudstone of probable Cambrian age. At both sites there are scattered fragments of broken rock in an overall cover of clay topsoil, with rounded pebbles in flowlines.

Summary weather statistics for Waratah, which is 8 km from the NW site at a comparable elevation (624 m), are 2201 mm annual rainfall with a February minimum and a July maximum; mean daily maxima and minima of 18.4·C and 7.6·C respectively in February, and 7.0·C and 1.7·C in July; and at least one frost day per month, peaking at 15–16 frost days in July–August (Bureau of Meteorology (1975) and unpublished Bureau of Meteorology data).

Comparable data are lacking for the NE site. The Bureau of Meteorology has rainfall records from temporary stations at Cascade Dam, Frome Dam and Upper Cascade, all in the neighbourhood of the NE site but at much lower elevations (e.g. 180 m at Frome Dam). The time-weighted average of the three records is only 1166 mm, but rainfall is undoubtedly higher at 600+ m on Rattler Hill. As at Waratah, the three north-eastern stations

Table 1. Plot locations and features. Slope was measured to the nearest 5· across a diameter of the plot.

North-east site: 41·14'S, 147·53'E; Rattler Hill, 4 km SSW of Weldborough			
plot	NE1	NE2	NE3
AMG grid reference	EQ744351	EQ744353	EQ745353
elevation (m a.s.l.)	680	650	660
landform unit	ridgetop	flowline	midslope
slope N–S	+ 5·	- 10·	+ 30·
slope E–W	flat	- 15·	- 25·
North-west site: 41·29'S, 145·27'E; Wombat Hill, 8 km SW of Waratah			
plot	NW1	NW2	NW3
AMG grid reference	CQ702064	CQ703065	CQ704066
elevation (m a.s.l.)	680	670	690
landform unit	midslope	flowline	ridgetop
slope N–S	+ 5·	flat	flat
slope E–W	- 5·	- 10·	flat

recorded a pronounced rainfall minimum in mid summer and a maximum in July–August. Unpublished maps prepared by the Bureau of Meteorology show mean daily maxima and minima near the NE site of 20·C and 8·C respectively in February and 10·C and 0·C in July. In summary, the available data suggest that the NE site is significantly drier and somewhat warmer than the NW site.

Both sites carry myrtle–sassafras–soft tree-fern forest: the callidendrous C1.1 rainforest of Jarman *et al.* (1991). Plot structure and floristics are detailed below (see 'Plots'). The NE site is on the western edge of a block of oldgrowth rainforest covering nearly 400 ha on Rattler Hill. Rainforest almost certainly extended further up Rattler Hill before the upper slopes were cleared and burned to access tin deposits in the nineteenth century. Downhill from the NE site is a first-rotation *Pinus radiata* plantation and, to the north-east, a patch of fire-regenerated myrtle regrowth was thinned by the Forestry Commission in the 1980s. The NW site lies on Betts Track, which is dated '1929' on an old Department of Mines chart; the track has since been used for mineral exploration and light selective logging. Just downhill from the NW site is the Arthur Dam of *c.* 5 ha. Despite these nearby disturbances, I had little trouble at either site in finding groups of healthy oldgrowth trees, well clear of forest edges, among which to locate the sampling plots. There was no evidence of fire or machine-caused damage to trees on any plot, and only plot NW3 (see plot map, Figure 2) had been affected by cutting.

Plots

Three 0.05 ha circular plots (diameter 25.2 m) were located at each site to cover the available variation in topography: ridgetop, midslope and flowline (Figure 1, Table 1). The flowline on the NE site is an intermittently flowing stream, while the flowline at the NW site is a moss-carpeted soak. Table 2 gives structural and floristic data for vegetation on the six sampling plots. Stem locations and other features are shown in Figure 2.

The ground at both sites was covered by a thin layer of leaf and twig litter overlying a dense mat of fine roots. The surface root mat at the NW site was distinctly richer in sassafras roots than that of the NE site, and seemed to be richer in non-fibrous 'peat' (coarsely particulate organic matter). Fallen roundwood at both sites formed an age series from 'just fallen' to 'nearly soil'. Bark fragments were concentrated around the

*Table 2. Structure and floristics of plot vegetation. All six plots had a closed canopy of myrtle (*Nothofagus cunninghamii*); a subcanopy of myrtle and sassafras (*Atherosperma moschatum*); a shrub layer of soft tree-fern (*Dicksonia antarctica*), myrtle seedlings and sassafras sprouts; and a ground layer of the fern* Polystichum proliferum. *Other species: ArPe* = Aristotelia peduncularis, *AsBu* = Asplenium bulbiferum, *BlWa* = Blechnum wattsii, *CoQu* = Coprosma quadrifida, *GrBi* = Grammitis billardierei, *HiIn* = Histiopteris incisa, *HyAu* = Hymenophyllum australe, *HyCu* = Hymenophyllum cupressiforme, *HyRu* = Hypolepis rugosula, *PhPu* = Phymatosorus pustulatus, *MoGl* = Monotoca glauca, *PhAs* = Phyllocladus aspleniifolius, *PiBi* = Pittosporum bicolor, *PoVe* = Polyphlebium venosum, *RuAd* = Rumohra adiantiformis, *TaLa* = Tasmannia lanceolata, *TmBi* = Tmesipteris billardierei.

Plot	NE1	NE2	NE3	NW1	NW2	NW3
canopy height (m)	25	20–25	25	25	25	25
subcanopy height (m)	15–20	10–15	10–15	15–20	15	15–20
canopy + subcanopy cover (%)	> 80	80	> 80	> 80	60	> 80
myrtle:						
stocking (stems / ha)	140	140	220	280	170	260
diameter range (m)	0.1–2.8	0.3–1.5	0.1–1.0	0.1–1.5	0.1–1.8	0.1–1.5
basal area (m^2 / ha)	210	80	90	110	120	80
sassafras:						
stocking (stems / ha)	240	280	100	500	210	530
diameter range (m)	0.1–0.4	0.1–0.4	0.1–0.2	0.1–0.4	0.1–0.4	0.1–0.4
basal area (m^2 / ha)	13	9	2	15	10	23
other small trees (no.)	PiBi(1)	PiBi(2)	PiBi(2), TaLa(1)	-	-	-
soft tree-fern:						
stocking (stems / ha)	400	330	30	150	910	450
median height (m)	1.5	1.0	0.5	1.0	2.0	1.5
maximum height (m)	3.0	2.5	0.5	3.0	4.0	3.0
other shrubs	CoQu, TaLa	TaLa	CoQu, MoGl, PhAs, TaLa	ArPe, TaLa	TaLa	ArPe, TaLa
other ground ferns	HiIn, HyRu	HiIn, HyRu	HiIn, HyRu	BlWa, HiIn	HiIn, HyRu	HiIn
epiphytic ferns	GrBi, HyAu, PhPu, PoVe, RuAd, TmBi	AsBu, BlWa, GrBi, HyAu, PhPu, PoVe, RuAd, TmBi	AsBu, BlWa, GrBi, HyAu, PhPu, RuAd	GrBi, PhPu	GrBi, HyCu, RuAd	GrBi, HyCu, RuAd, TmBi

bases of dead myrtles. Rotting fern litter was close to *Dicksonia* and *Polystichum* bases.

Invertebrate sampling

Sixteen groups of litter invertebrates were targeted for collection: flatworms, nemertines, earthworms, snails, velvet worms, symphylans, centipedes, millipedes, pseudoscorpions, harvestmen, spiders, slaters, landhoppers, springtails (neanurids), ants and beetles (carabids, lucanids and tenebrionids). All 16 groups are represented by relatively large, readily collected forms in rainforest litter and can be found as adults in rainforest at any time of year. They are now being studied, or have recently been studied, by taxonomists with an interest in the Tasmanian fauna.

Invertebrates were sampled in August and September 1990 by the method described in Mesibov (1993). In brief, I searched for the targeted groups in the available micro-shelters (e.g. rotting wood, leaf litter accumulations, fern frond litter) in the daytime and looked for 'emerged' and active invertebrates by torchlight at night. All targeted invertebrates which were seen were collected, apart from landhoppers and philosciid and styloniscid slaters. When a group of these fast-moving crustaceans is uncovered in the litter, a number of individuals invariably evade capture.

Searching continued for about 16 hours by day on each plot (4 h / day on one-quarter of the plot) and three hours at night (1 h / night

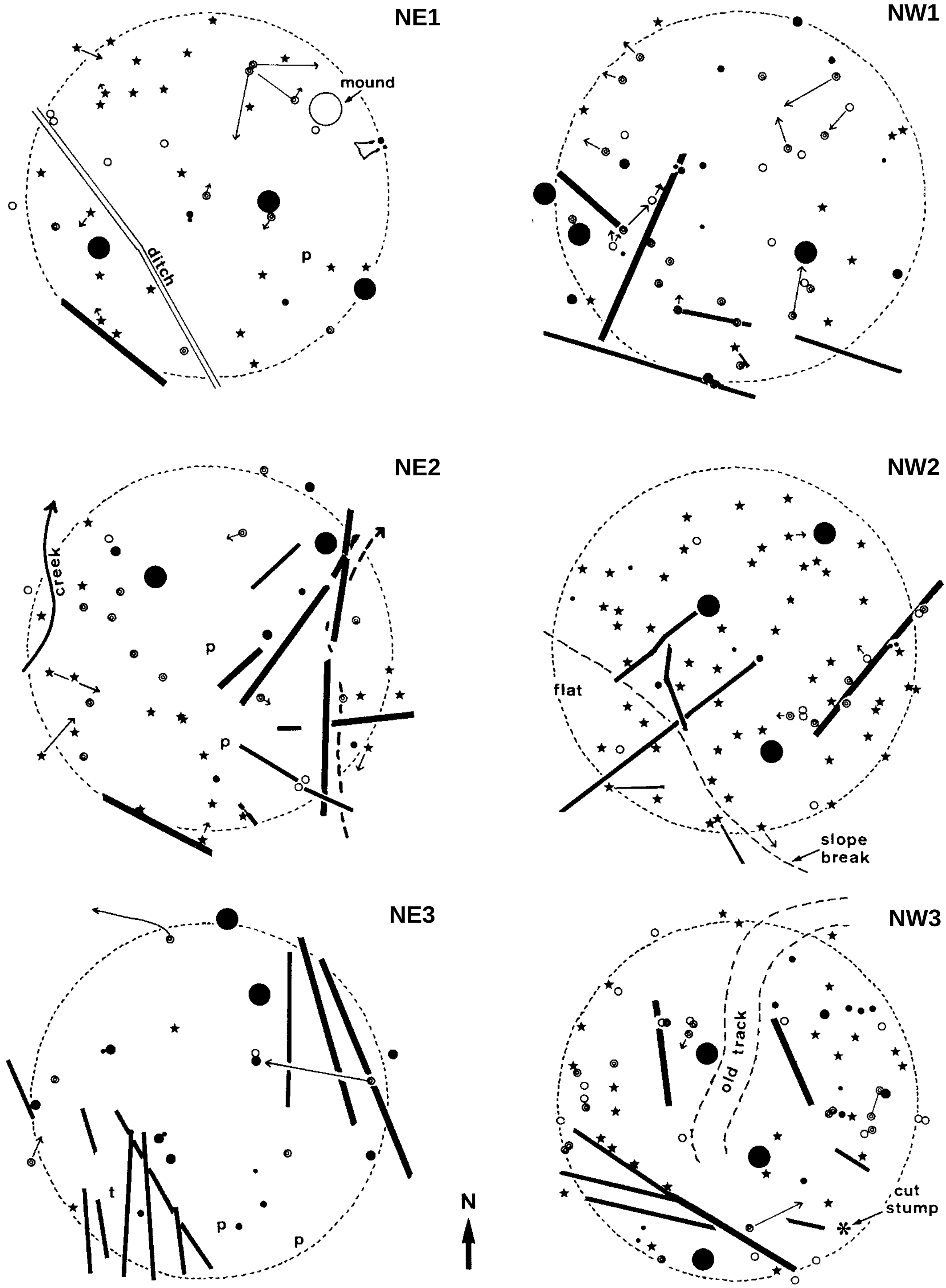

Figure 2. Plot maps showing stems larger than 10 cm in diameter. Each plot is 25.2 m in diameter. Fallen logs are shown as solid bars, stars are Dicksonia, *p* = Pittosporum bicolor, *t* = Tasmannia lanceolata. *Arrows indicate direction of stem lean.* Atherosperma *stems larger than 20 cm are shown as open circles, 10–20 cm stems as two nested open circles.* Nothofagus *stems are shown as solid circles in four diameter classes (smallest to largest circles): 10–20 cm, 21–50 cm, 51–100 cm, >100 cm. Dashed, arrowed line on plot NE2 is an ephemeral creek.*

Table 3. Numbers of specimens collected, and collecting rates (in brackets, as specimens/hour).

Plot	Field hours	Spirostreptidan millipedes		Other invertebrates		All invertebrates	
NE1							
day	16	473	(30)	697	(44)	1170	(73)
night	3	4	(1)	51	(17)	55	(18)
NE2							
day	16	164	(10)	805	(50)	969	(61)
night	3	13	(4)	147	(49)	160	(53)
NE3							
day	16	1019	(64)	686	(43)	1705	(106)
night	3	241	(80)	65	(22)	306	(102)
NE							
day	48	1656	(34)	2188	(46)	3844	(80)
night	9	258	(29)	263	(29)	521	(58)
NE total	**57**	**1914**	**(34)**	**2451**	**(43)**	**4365**	**(77)**
NW1							
day	16	58	(4)	790	(49)	848	(53)
night	3	22	(7)	144	(48)	166	(55)
NW2							
day	14	199	(14)	606	(43)	805	(58)
night	3	21	(7)	104	(35)	125	(42)
NW3							
day	14.5	70	(5)	716	(49)	786	(54)
night	3	9	(3)	101	(34)	110	(37)
NW							
day	44.5	327	(7)	2112	(47)	2439	(55)
night	9	52	(6)	349	(39)	401	(45)
NW total	**53.5**	**379**	**(7)**	**2461**	**(46)**	**2840**	**(53)**

over the whole of the plot, beginning shortly after sunset), but bad weather reduced the total daylight search time at the NW site from 48 h to 44.5 h. The habitat sampled on each plot can be visualised as a disk 25 m in diameter and about 2 m high, with the base of the disk just below the litter layer. I did no digging in the soil, apart from chasing the shallow-burrowing landhopper *Keratroides albidus* at the NW site.

At field bases in Weldborough and Waratah, captured snails were drowned and relaxed in menthol-saturated water before transfer to 70% alcohol. Flatworms and earthworms were relaxed for 20 minutes in 5–10% alcohol; flatworms were then fixed and stored in Tyler's solution, while earthworms were fixed overnight in 4% formaldehyde prior to storage in 70% alcohol. All other invertebrates were handpicked in the field directly into 70% alcohol.

Identification of taxa

The following specialists very kindly identified specimens: Alison Green, Tasmanian Museum and Art Gallery (TMAG) (slaters); Dr Penelope Greenslade, CSIRO Division of Entomology (neanurid spring-tails); Ron Kershaw, Queen Victoria Museum and Art Gallery (QVMAG) (snails); Denis

Table 4. Number of specimens collected, by group.

	NE1	NE2	NE3	NE	NW1	NW2	NW3	NW	Total
flatworms	6	26	24	56	11	11	4	26	82
nemertines	2	7	10	19	2	3	-	5	24
earthworms	55	68	61	184	45	46	63	154	338
snails	34	45	48	127	39	58	40	137	264
velvet worms	4	5	3	12	1	1	-	2	14
symphylans	54	27	5	86	32	23	28	83	169
centipedes	103	86	92	281	101	79	117	297	578
millipedes									
spirostreptidans	477	177	1260	1914	80	220	79	379	2293
other	72	210	127	409	131	85	193	409	818
total	549	387	1387	2323	211	305	272	788	3111
pseudoscorpions	1	1	-	2	1	-	-	1	3
harvestmen	61	78	51	190	63	37	61	161	351
spiders	79	181	70	330	171	124	102	397	727
slaters	18	17	26	61	186	126	116	428	489
landhoppers	125	55	49	229	62	68	42	172	401
springtails	22	71	15	108	20	11	19	50	158
ants	20	44	64	128	42	-	-	42	170
beetles	92	31	106	229	27	38	32	97	326
Total	**1225**	**1129**	**2011**	**4365**	**1014**	**930**	**896**	**2840**	**7205**

Black, La Trobe University (polyzoniidan millipedes); Dr Mark Harvey, Western Australian Museum (pseudoscorpions); Dr Glenn Hunt, Australian Museum (harvestmen); Dr Peter McQuillan, University of Tasmania, and Dr Barry Moore, CSIRO Division of Entomology (beetles); Dr Alastair Richardson, University of Tasmania (landhoppers); Dr Robert Taylor, CSIRO Division of Entomology (ants); Elizabeth Turner, TMAG (spiders); and Leigh Winsor, James Cook University of North Queensland (flatworms). All nemertines were recognised colour forms of *Argonemertes australiensis* (Hickman 1963; Winsor 1985) and all velvet worms were referrable to the species group *Ooperipatellus* cf. *insignis* (Ruhberg and Mesibov 1996). Centipedes and non-polyzoniidan millipedes were sorted to morphospecies by the author. Earthworms and symphylans have been deposited at the QVMAG but have not yet been identified to species.

Apart from specimens retained by specialists for further study, the collection has been lodged at QVMAG as sorted taxa.

Results

Overview of the collection

I collected 4365 specimens at the NE site and 2840 at the NW site (Table 3). The difference in totals is attributable to a single group of invertebrates, the spirostreptidan millipedes, which made up 44% and 13%, respectively, of the NE and NW collections. The collecting rates for other invertebrates at the two sites were very similar: about 45 specimens per hour of searching (Table 3). For most groups, the variation in catch from plot to plot was small, as was the difference in total captures between NE and NW sites (Table 4). Two notable exceptions were spirostreptidan millipedes (five times more specimens captured in the north-east) and slaters (seven times more specimens captured in the north-west).

Species overview

About 45% of the 7205 specimens collected have not yet been identified to species (Table 5).

Table 5. Specimens not yet identified to species.

Group	No. of specimens	Remarks
flatworms	1	fragment
earthworms	338	-
symphylans	169	-
millipedes	2293	Spirostreptida
	110	female or immature Polydesmida
harvestmen	4	immature *Nunciella*
	2	immature *Odontonuncia*
	1	immature *Spinicrus*
	4	immature, unknown
spiders	53	Amaurobiidae
	66	Amphinectidae
	2	Dictynidae
	16	Lycosidae
	2	Micropholcommatidae
	7	Nicodamidae
	3	Orsolobidae
	30	Salticidae
	8	Toxopidae
	4	Zodariidae
	5	unknown
slaters	1	unidentified *Styloniscus*
beetles	34	unidentified *Notonomus*
	2	unknown
Total	**3155**	

These not-yet-identified specimens have been omitted from the species comparisons (below). I also ignore *Pholcus phalangioides*, the only non-native species captured (an introduced spider represented by one specimen at the NW site), and the 170 ant specimens referred to *Prolasius* spp., due to difficulty in assigning individuals to species. The remaining 3879 specimens were identified as belonging to 153 described or undescribed species (Table 6). A full tally and systematic list of identified specimens are given in the Appendix.

Night collecting versus day collecting

As shown in Table 3, the overall collecting rate at night was 70–80% of the rate by day. However, the collecting rates for flatworms, snails, velvet worms and spiders were higher at night (Table 7). In total, about one-third of the identified species were found outside their daytime shelters during the one-hour searches just after sunset. The flatworm *Artioposthia mortoni*, the harvestman *Spinicrus nigricans* and several unidentified spiders were found only at night.

Collection of identified species

Collector's curves for identified species at the two sites are shown in Figure 3. A trend not obvious in these curves is a very rapid diminution in returns for relatively abundant species. Of the identified species represented by 10 or more specimens in the collection, all of the 31 species at the NE site and all the 31 species at the NW site were captured on the first plot searched. Species represented by only a single specimen, on the other hand, appeared more inconsistently: plot NE1 had 11; NE2, 9; NE3, 5; NW1, 7; NW2, 6; and NW3, 12.

Within-site variation

At both sites, the lists of identified species from the three plots were very similar. A simple way to demonstrate this result is to consider only those species represented in the collection by 10 or more specimens. There were 31 such species at each site, of which 30 in the north-east and 29 in the north-west were found on all three plots. A more sophisticated comparison is possible using the Ochiai index of similarity (Bolton 1991), S_o, where

$$S_o = N_{ij} \; / \, (N_i N_j)^{-1/2},$$

and N_i = the number of species on list *i*,
N_j = the number of species on list *j*, and
N_{ij} = the number of species common to the two lists.

The results of pairwise comparisons of plot species lists are shown in Table 8. Bolton (1991) has argued that the Ochiai index has a critical value, below which two lists can be regarded as being drawn from different species assemblages. This critical value is a function of the the total number of species being compared and, for the pairwise

Table 6. Identified species, by group.

Group	North-east		North-west		Total	
	No. of species	No. of specimens	No. of species	No. of specimens	No. of species	No. of specimens
flatworms	9	55	7	26	14	81
nemertines	1	19	1	5	1	24
snails	14	127	12	137	20	264
velvet worms	1	12	1	2	1	14
centipedes	7	281	8	297	11	578
millipedes	12	322	7	386	18	708
pseudoscorpions	2	2	1	1	3	3
harvestmen	10	180	15	160	24	340
spiders	19	192	17	338	25	530
slaters	4	61	5	427	8	488
landhoppers	2	229	3	172	4	401
springtails	3	108	4	50	6	158
beetles	9	228	11	62	18	290
Total	**93**	**1816**	**92**	**2063**	**153**	**3879**

Table 7. Results from night collecting versus day collecting, by group. 'Night/day rate ratio' is the average number of specimens collected per hour at night divided by the average number of specimens collected per hour by day.

Group	No. of specimens		Night/day rate ratio
	Night	Day	
flatworms	46	36	6.6
nemertines	2	22	0.5
earthworms	3	355	< 0.1
snails	47	217	1.1
velvet worms	3	11	1.4
symphylans	1	168	< 0.1
centipedes	3	575	< 0.1
millipedes	329	2782	0.6
pseudoscorpions	-	3	-
harvestmen	17	334	0.3
spiders	432	295	7.5
slaters	3	486	< 0.1
landhoppers	9	392	0.1
springtails	-	158	-
ants	-	170	-
beetles	15	311	0.2

comparisons in Table 8, the critical value is about 0.3 (Bolton 1991: Table 2). All the Ochiai index values greatly exceed this value, and it seems safe to conclude that the three NE plot lists are samples from a single NE species assemblage, and that the three NW plot lists are samples from a single NW species assemblage.

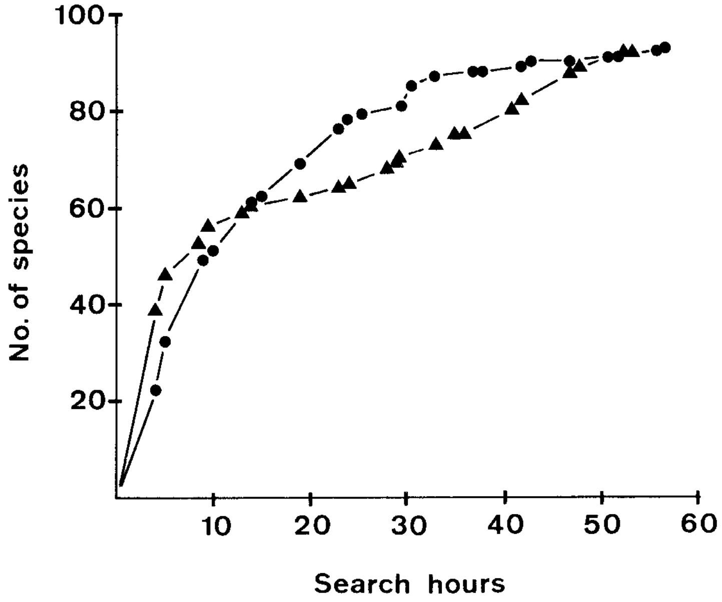

Figure 3. Collector's curves for identified species at the north-east site (dots) and the north-west site (triangles). 'Search hours' begins with the first visit to the first plot (NE1 or NW1) and ends with the last visit to the last plot (NE3 or NW3) and includes both day and evening visits.

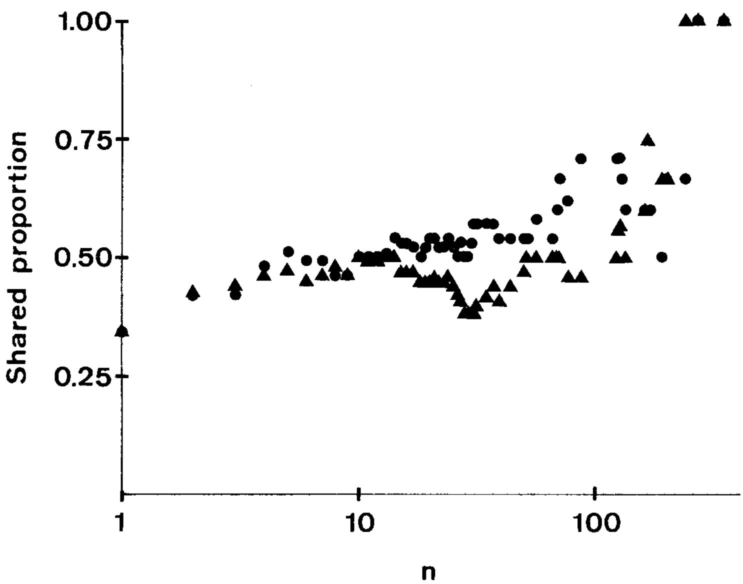

Figure 4. Plot of the 'shared proportion' data in Table 9 for the north-east site (dots) and the north-west site (triangles). Note logarithmic abscissa.

Between-site variation

The Ochiai index for a comparison of the NE versus NW species lists is 0.35, which is close to the appropriate critical value of Bolton (1991) and indicates that the two species assemblages may be different. A null hypothesis can also be considered, although, for statistical reasons, it is difficult to test rejection of this hypothesis in a rigorous manner. We can suppose that the NE and NW site litter faunas are the same, and that the pool of invertebrates I sampled was 153 species, the total of identified species. If the 93 species recorded from the NE site were drawn randomly from the pool of 153, then the probability that a given species was present in the NE sample is 93/153. The corresponding probability for a given species in the NW sample is 92/153. The probability that a given species appeared independently in both samples is 93/153 x 92/153, or 0.37. The expected number of shared species in the collection is therefore 153 x 0.37 or 56 species, compared to only 32 species actually found in common between the two sites.

Measuring the difference between the faunas from the two sites is difficult because more than half of the species in the collection were represented by four or fewer specimens. Were absences of these low-abundance species real, or an artifact of insufficient sampling? No statistical test for 'false absence' is possible, but the abundance data can be examined for trends. Table 9 and Figure 4 show how the proportion of shared species (present at both sites) varies as low-abundance species are progressively excluded from consideration. At both sites, roughly half the identified species were shared over a wide range of 'threshold' abundances. I conclude that roughly half the identified species at each site are likely to be unique to that site.

Table 8. Ochiai index comparisons within sites (see text).

	S_o
NE1 versus NE2	0.72
NE1 versus NE3	0.69
NE2 versus NE3	0.68
NW1 versus NW2	0.69
NW1 versus NW3	0.70
NW2 versus NW3	0.69

Discussion

Two extreme results of this study could have been imagined at the outset. If the NE and NW species lists were almost identical, we could suspect that there is a characteristic assemblage of litter invertebrate species inhabiting oldgrowth *Nothofagus–Atherosperma–Dicksonia* forest wherever that forest occurs in northern Tasmania. The consequence for litter invertebrate conservation would be that any suitably large patch of such forest which had been set aside as a vegetation reserve could also be regarded as a litter invertebrate fauna reserve. Another extreme possibility would be that the two site lists had almost no species in common. It would then be clear that conserving apparently suitable habitat *per se* would be a very poor strategy for conserving litter invertebrates. Further sampling would be needed to locate a set of habitat reserves, scattered over the full range of rainforest in northern Tasmania, which would contain as complete a representation as possible of this geographically variable litter fauna.

The real situation seems to lie halfway between these two extremes, in that 'regionally unique' species in this study made up roughly half the total of identified forms. Regional differences were already known to be important in at least three litter invertebrate groups: landhoppers (Friend 1987), centipedes (Mesibov 1986) and land snails (Smith and Kershaw 1981). It has recently been recognised that there is considerable congruence in these regional differences, and that there are sometimes sharp boundaries between 'invertebrate regions' in Tasmania (Mesibov 1994). It is also now clear that the Rattler Hill site

Table 9. Proportion of shared species (present at both sites) at either site when considering only species represented by 'n' or more specimens in the collection as a whole.

n	No. of NE species	Shared proportion	No. of NW species	Shared proportion
1	93	0.34	92	0.35
2	76	0.42	75	0.43
3	67	0.42	64	0.44
4	54	0.48	56	0.46
5	49	0.51	53	0.47
6	47	0.49	51	0.45
7	45	0.49	48	0.46
8	43	0.46	42	0.48
9	41	0.46	41	0.46
10	38	0.50	38	0.50
11	36	0.50	37	0.49
12	36	0.50	37	0.49
13	35	0.51	36	0.50
14	33	0.54	36	0.50
15	30	0.53	34	0.47
16	30	0.53	34	0.47
17	29	0.52	32	0.47
18	26	0.50	29	0.45
19	25	0.52	29	0.45
20	24	0.54	29	0.45
21	24	0.54	28	0.46
22	23	0.52	27	0.45
23	23	0.52	27	0.45
24	22	0.54	26	0.46
25	21	0.52	25	0.44
26	20	0.50	24	0.42
27	17	0.53	22	0.41
28	16	0.50	21	0.38
29	16	0.50	21	0.38
30	15	0.53	21	0.38
31	14	0.57	21	0.38
32	14	0.57	20	0.40
35	14	0.57	19	0.42
37	14	0.57	18	0.44
39	13	0.54	17	0.42
44	13	0.54	16	0.44
50	13	0.54	15	0.47
51	13	0.54	14	0.50
56	12	0.58	14	0.50
66	11	0.54	12	0.50
69	10	0.60	12	0.50
71	9	0.67	12	0.50
78	8	0.62	11	0.46
88	7	0.71	11	0.46
123	7	0.71	10	0.50
125	7	0.71	9	0.56
129	6	0.67	7	0.57
136	5	0.60	6	0.50
161	5	0.60	5	0.60
167	5	0.60	4	0.75
190	4	0.50	3	0.67
200	3	0.67	3	0.67
238	3	0.67	2	1.00
267	2	1.00	2	1.00
343	1	1.00	1	1.00

selected for this study lies within an area of high local endemicity in north-eastern Tasmania called 'Plomley's Island' (Mesibov 1994); among the forms known to be restricted to Plomley's Island and collected in this study are the snail *Anoglypta launcestonensis* and the millipedes *Lissodesmus* sp. NE4 and *Gasterogramma* sp. 5.

The faunal differences noted in this study may also be due, in part, to the soil/ geological and climatic differences between the two study sites (see 'Methods'). If so, rainforest vegetation cannot be said to 'integrate' soil and climatic determinants of faunal distribution, and the structural and floristic characters of a forest cannot be used as surrogates for other environmental parameters. In any case, as this study has shown, vegetation mapping alone is a poor substitute for faunal mapping. For effective conservation of litter invertebrates, the 'habitat' selected for reservation or other special treatment needs to be chosen with an awareness of the underlying patterns of faunal regionalisation in Tasmania.

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Appendix. Specimen tally for identified species.

	NE1	NE2	NE3	NE	NW1	NW2	NW3	NW	Total
Platyhelminthes: Tricladida: Terricola: Geoplanidae									
Artioposthia diemenensis (Dendy 1894)	2	5	7	14	-	-	-	-	14
Artioposthia dovei (Steel 1900)	-	-	-	-	2	-	1	3	3
Artioposthia mortoni (Dendy 1894)	-	3	-	3	-	-	-	-	3
Artioposthia sp. N1	-	1	-	1	-	-	-	-	1
Artioposthia sp. N2	1	-	-	1	-	-	1	1	2
Artioposthia sp. N3	-	-	-	-	3	8	1	12	12
Australoplana alba (Dendy 1891)	-	1	2	3	-	2	1	3	6
Australoplana typhlops (Dendy 1893)	1	-	-	1	-	-	-	-	1
Australoplana sp. N1	-	-	1	1	-	-	-	-	1
Fletchamia sugdeni (Dendy 1891)	-	-	-	-	-	1	-	1	1
Pelmatoplana sp. N1	-	1	-	1	-	-	-	-	1
Reomkago flynni (Dendy 1915)	2	14	14	30	-	-	-	-	30
Reomkago quadrangulatus (Dendy 1891)	-	-	-	-	4	-	-	4	4
Tasmanoplana flavicincta (Steel 1900)	-	-	-	-	2	-	-	2	2
Nemertinea: Enopla: Urichorhynchocoela: Plectonemertidae									
Argonemertes australiensis (Dendy 1892)	2	7	10	19	2	3	-	5	24
Mollusca: Gastropoda: Stylommatophora									
Caryodidae									
Anoglypta launcestonensis (Reeve 1853)	1	4	3	8	-	-	-	-	8
Caryodes dufresnii (Leach 1815)	4	4	11	19	-	1	1	2	21
Charopidae									
Allocharopa kershawi (Petterd 1879)	1	-	-	1	-	-	-	-	1
Dentherona subrugosa (Legrand 1871)	3	8	7	18	-	-	-	-	18
Elsothera limula (Legrand 1871)	4	11	14	29	-	-	-	-	29
Geminoropa hookeriana (Petterd 1879)	-	-	-	-	2	1	4	7	7
Pernagera cf. *kingstonensis* (Legrand 1871)	-	-	-	-	-	-	3	3	3
Pernagera officeri (Legrand 1871)	1	-	1	2	-	-	-	-	2
Roblinella gadensis (Petterd 1879)	2	-	-	2	-	-	1	1	3
Roblinella sp.	-	-	-	-	11	4	1	16	16
Stenacapha hamiltoni (Cox 1868)	2	4	-	6	7	3	1	11	17
Thryasona diemenensis (Cox 1868)	4	-	1	5	-	2	1	3	8
Cystopeltidae									
Cystopelta bicolor Petterd and Hedley 1909	-	-	-	-	12	1	19	32	32
Cystopelta petterdi Tate 1881	4	11	8	23	-	-	-	-	23
Helicarionidae									
Helicarion cuvieri Ferussac 1821	2	-	-	2	1	2	-	3	5
Punctidae									
Trocholaoma parvissima (Legrand 1871)	-	1	-	1	1	-	-	1	2
Rhytididae									
Prolesophanta dyeri (Petterd 1879)	-	-	-	-	-	-	2	2	2
Prolesophanta nelsonensis (Brazier 1871)	-	2	-	2	-	-	-	-	2
Victaphanta lampra (Reeve 1854)	6	-	3	9	-	-	-	-	9
Victaphanta milligani (Pfeiffer 1853)	-	-	-	-	5	44	7	56	56
Onychophora: Peripatopsidae									
Ooperipatellus cf. *insignis* (Dendy 1890)	4	5	3	12	1	1	-	2	14
Chilopoda									
Lithobiomorpha: Henicopidae									
anopsobiine sp. 1	-	-	-	-	6	-	3	9	9
anopsobiine sp. 2	36	14	16	66	-	-	-	-	66
Haasiella n.sp.	-	-	-	-	2	3	2	7	7
Henicops maculatus Newport 1845	1	-	-	1	8	10	8	26	27
Paralamyctes n.sp.	-	-	-	-	2	-	1	3	3
Craterostigmomorpha: Craterostigmidae									
Craterostigmus tasmanianus Pocock 1902	1	-	-	1	24	16	30	70	71

Appendix continued.

	NE1	NE2	NE3	NE	NW1	NW2	NW3	NW	Total
Scolopendromorpha: Cryptopidae									
Cryptops sp. A	-	-	-	-	29	29	30	88	88
Geophilomorpha: ?Geophilidae									
Tasmanophilus sp. A	22	37	41	100	6	6	13	25	125
Tasmanophilus sp. B	3	-	-	3	-	-	-	-	3
Zelanion cf. *antipodus* (Pocock 1891)	32	33	33	98	24	15	30	69	167
Zelanion sp. B	8	2	2	12	-	-	-	-	12
Diplopoda									
Polyzoniida: Siphonotidae									
siphonotid sp. 1	2	6	11	19	-	-	-	-	19
Chordeumatida: Metopidiotrichidae									
Australeuma jeekeli Golovatch 1986	2	1	-	3	-	-	-	-	3
Australeuma simile Golovatch 1986	-	-	-	-	15	2	-	17	17
Australeuma mauriesi Shear and Mesibov 1997	-	-	1	1	3	-	-	3	4
Reginaterreuma tarkinensis Shear and Mesibov 1995	-	-	-	-	48	33	44	125	125
Polydesmida: Dalodesmidae									
Gasterogramma psi Jeekel 1982	-	-	-	-	-	-	1	1	1
Gasterogramma n.sp.	16	10	-	26	-	-	-	-	26
Lissodesmus adrianae Jeekel 1984	20	120	98	238	-	-	-	-	238
Lissodesmus perporosus Jeekel 1984	-	-	-	-	39	35	126	200	200
Lissodesmus sp. NE1	1	1	-	2	-	-	-	-	2
Lissodesmus sp. NE2	1	10	2	13	-	-	-	-	13
Lissodesmus sp. NE4	-	3	-	3	-	-	-	-	3
Lissodesmus sp. NW1	-	-	-	-	12	8	19	39	39
dalodesmid sp. A4	-	1	-	1	-	-	-	-	1
dalodesmid sp. ER1	4	5	-	9	-	-	-	-	9
dalodesmid sp. ER2	2	1	1	4	-	-	-	-	4
dalodesmid sp. ER3	-	1	2	3	-	-	-	-	3
dalodesmid sp. ER4	-	-	-	-	-	1	-	1	1
Arthropoda: Arachnida: Pseudoscorpionida									
Protochelifer n.sp.	1	-	-	1	-	-	-	-	1
Pseudotyrannochthonius sp. A	-	-	-	-	1	-	-	1	1
Pseudotyrannochthonius sp. B	-	1	-	1	-	-	-	-	1
Arthropoda: Arachnida: Opiliones									
Caddidae									
Austropsopilio sp.	-	-	-	-	1	-	-	1	1
Megalopsalididae									
Spinicrus nigricans Hickman 1957	-	-	-	-	2	-	-	2	2
Spinicrus thrypticum Hickman 1957	1	1	1	3	-	-	-	-	3
Triaenonychidae									
Allobunus distinctus Hickman 1958	-	-	-	-	2	-	5	7	7
Allonuncia grandis Hickman 1958	-	-	-	-	15	-	8	23	23
Calliuncus vulsus Hickman 1959	-	-	-	-	-	-	1	1	1
Glyptobunus signatus Roewer 1915	2	1	-	3	-	-	-	-	3
Lomanella atrolutea Roewer 1915	-	-	-	-	19	13	18	50	50
Lomanella raniceps Pocock 1903	7	7	1	15	1	-	-	1	16
Mestonia acris Hickman 1958	-	-	-	-	-	1	2	3	3
Nucina silvestris Hickman 1958	-	-	-	-	6	1	13	20	20
Nunciella tasmaniensis Hickman 1958	17	50	11	78	-	-	-	-	78
Nunciella n.sp.	-	-	-	-	9	-	-	9	9
Nuncioides sp.	-	-	-	-	-	-	2	2	2
Odontonuncia saltuensis Hickman 1958	19	8	24	51	-	-	-	-	51
Paranuncia gigantea Roewer 1914	-	-	-	-	5	21	9	35	35
Phoxobunus ?n.sp.	-	-	-	-	1	-	1	2	2
Pyenganella n.sp.	1	-	-	1	-	-	-	-	1
Rhynchobunus arrogans Hickman 1958	5	1	-	6	-	-	-	-	6

Appendix continued.

	NE1	NE2	NE3	NE	NW1	NW2	NW3	NW	Total
Tasmanobunus ?n.sp.	-	2	-	2	-	-	-	-	2
Thelbunus mirabilis Hickman 1958	1	3	-	4	-	-	-	-	4
Thelbunus n.sp.	5	5	7	17	-	-	-	-	17
Triaenobunus pilosus Hickman 1958	-	-	-	-	-	-	1	1	1
Triaenobunus sp.	-	-	-	-	2	-	1	3	3
Arthropoda: Arachnida: Araneae									
Amaurobiidae									
Badumna ?insignis (Koch, 1872)	-	-	1	1	-	-	-	-	1
Stiphidium facetum Simon 1902	-	-	-	-	-	1	2	3	3
amaurobiid sp. A	4	1	1	6	1	-	-	1	7
amaurobiid sp. B	17	67	14	98	81	49	39	169	267
amaurobiid sp. C	-	1	3	4	-	-	-	-	4
amaurobiid sp. D	2	2	-	4	9	5	7	21	25
amaurobiid sp. E	-	-	-	-	2	3	2	7	7
Amphinectidae									
Amphinecta milvina (Simon 1903)	2	1	-	3	-	1	1	2	5
Amphinecta sp. B	-	-	-	-	1	2	3	6	6
Anapidae									
anapid sp.	1	-	-	1	-	-	-	-	1
Araneidae									
Araneus sp. A	-	-	2	2	-	-	1	1	3
Araneus sp. B	5	12	5	22	4	-	-	4	26
Clubionidae									
Clubiona sp. A	-	1	-	1	-	-	-	-	1
Clubiona sp. B	-	1	-	1	1	-	-	1	2
Ctenizidae									
Misgolus crispus (Karsch 1878)	-	-	1	1	-	1	-	1	2
Cycloctenidae									
Cycloctenus sp. A	8	16	10	34	29	40	26	95	129
Cycloctenus sp. B	2	3	-	5	4	6	2	12	17
Dysderidae									
Ariadna segmentata Simon 1893	-	-	-	-	-	1	-	1	1
Hexathelidae									
Teranodes montana (Hickman 1927)	-	-	-	-	-	5	1	6	6
Hickmaniidae									
Hickmania troglodytes (Higgins and Petterd 1883)	1	-	-	1	-	-	-	-	1
Linyphiidae									
linyphiid sp.	-	-	-	-	-	-	1	1	1
Mimetidae									
Mimetus maculosus Rainbow 1904	-	3	-	3	5	1	1	7	10
Mysmenidae									
mysmenid sp.	1	-	-	1	-	-	-	-	1
Orsolobidae									
Tasmanoonops fulvus Hickman 1979	2	1	-	3	-	-	-	-	3
Theridiidae									
Steatoda livens (Simon 1895)	-	1	-	1	-	-	-	-	1
Arthropoda: Malacostraca: Isopoda									
Armadillidae									
cubarine sp. HEC-1	-	-	-	-	32	67	24	123	123
Philosciidae									
Plymophiloscia notleyensis Green 1961	10	4	17	31	5	-	1	6	37
Styloniscidae									
Notoniscus n.sp.	2	1	-	3	-	-	-	-	3
Styloniscus sp. '*hirsutus* large form'	-	-	-	-	63	27	46	136	136
Styloniscus maculosus Green 1961	6	12	8	26	-	-	-	-	26
Styloniscus sylvestris Green 1971	-	-	-	-	84	32	45	161	161

Appendix continued.

	NE1	NE2	NE3	NE	NW1	NW2	NW3	NW	Total
Styloniscus sp. HEC-3	-	-	-	-	1	-	-	1	1
Styloniscus n.sp.	-	-	1	1	-	-	-	-	1
Arthropoda: Malacostraca: Amphipoda: Talitridae									
Keratroides albidus Friend 1987	-	-	-	-	13	25	6	44	44
Keratroides angulosus (Friend 1979)	3	6	1	10	-	-	-	-	10
Keratroides vulgaris (Friend 1979)	122	49	48	219	48	43	33	124	343
Neorchestia plicibrancha Friend 1987	-	-	-	-	1	-	3	4	4
Arthropoda: Collembola: Arthropleona: Neanuridae									
Acanthanura n.sp.	9	49	11	69	-	-	-	-	69
Australonura wellingtonia (Womersley 1936)	13	20	3	36	8	3	9	20	56
Ceratrimeria sp.	-	2	1	3	-	-	-	-	3
Megalanura tasmaniae (Lubbock 1899)	-	-	-	-	11	8	7	26	26
genus near *Notachorudina*, sp.	-	-	-	-	1	-	1	2	2
Womersleymeria bicornis (Womersley 1940)	-	-	-	-	-	-	2	2	2
Arthropoda: Insecta: Coleoptera									
Carabidae									
Agonica simsoni Sloane 1920	-	-	-	-	-	-	1	1	1
Chylnus ater (Putzeys 1868)	2	4	3	9	-	-	-	-	9
Lestignathus cursor Erichson 1842	-	-	-	-	9	9	13	31	31
Lestignathus simsoni Bates 1878	1	-	3	4	-	-	-	-	4
Lestignathus sp.	-	-	-	-	-	-	1	1	1
Percodermus sp.	-	-	-	-	-	1	-	1	1
Percosoma sulcipenne Bates 1878	-	-	-	-	3	3	3	9	9
Phersita convexa Sloane 1920	-	1	-	1	3	6	4	13	14
Promecoderus sp.	1	-	-	1	-	-	-	-	1
Pterocyrtus rubescens Sloane 1920	-	-	-	-	-	-	1	1	1
Pterocyrtus sp.	-	-	-	-	-	-	1	1	1
Theprisa sp.	-	-	-	-	-	-	1	1	1
Lucanidae									
Hoplogonus simsoni Parry 1876	2	-	-	2	-	-	-	-	2
Lissotes rudis Lea 1910	1	1	1	3	-	-	-	-	3
Lissotes sp. A	-	-	-	-	-	1	-	1	1
Tenebrionidae									
Adelium abbreviatum Boisduval 1835	77	23	90	190	-	-	-	-	190
Coripera deplanata (Boisduval 1835)	5	2	6	13	-	-	-	-	13
Licinoma commoda (Pascoe 1869)	2	-	3	5	-	-	2	2	7