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of eastern Banks Peninsula in 2010-2011**

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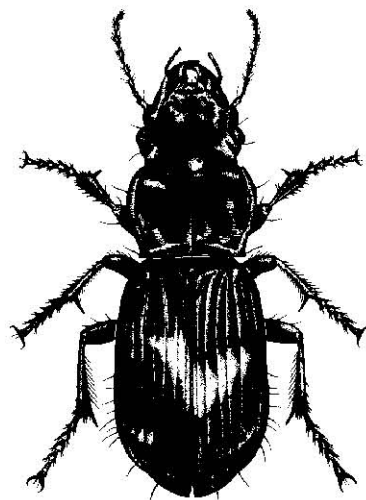
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Abstract

Reserves, covenants and bush remnants of the eastern side of Banks Peninsula were surveyed for invertebrates including ground beetles (carabids), weevils, spiders, moths, earthworms and snails. Sixteen carabid species were found including one new *Holcaspis* species. The six-eyed spider *Periegops suterii* was found in six sites. Light trapping moths identified 202 species with 122 from Hinewai Reserve alone. Soil sampling found 13 endemic species of worms. New species of millipedes (Diplopoda) and crane fly (Tipulidae) were also found. Recommendations for future research on Banks Peninsula are given.

Introduction

The Eastern side of Banks Peninsula was created by eruptions and subsequent erosion of the Akaroa volcano which was active between 9 and 8 million years ago (Wilson, 1992). Before human settlement, this area was completely forested; however when European settlers arrived in the region in the 1840's, approximately 75% of the area was still covered in old growth forest (Wilson, 1992). Over the next 60 years the forest was logged, burned and converted to pasture, until only small fragments of forest remained – approximately 1% of what was there previously.

The current landscape is a mosaic of farmed pasture land, fenced forest remnants, bushy gullies, and areas of introduced gorse and broom. There are some spectacular rock outcrops on ridges, and a series of unique bays along the coastline providing a variety of habitats for invertebrates. The eastern part of Banks Peninsula (known as the 'Wildside') in the Akaroa Ecological District contains some special flora and fauna due to its isolation and significantly higher rainfall at the higher elevations. Only a few significant invertebrate surveys have been completed in the area such as at Hinewai Reserve (Ward et al. 1999) and earlier survey which included Hinewai, Armstrong, Ellangowan, and Otepatotu Reserves (Johns, 1986). In addition, several remnants have been covenanted through the Banks Peninsula Conservation Trust (BPCT) and fencing from stock will afford some protection to larger invertebrates and more delicate plants. Some invertebrate species have not been seen for decades and are thought to be extinct, but may be present but never surveyed and found.

With the planned extension of pest control in the region there is a concern that by targeting the larger predators such as mustelids, cats and hedgehogs may result in an increase in rodent numbers and subsequent increased invertebrate predation. This raises the importance of setting up some long-term monitoring to ensure the invertebrates are being protected.

Aims

1. To survey reserves, covenants and ecologically significant remnant patches for rare or interesting invertebrates.
2. Establish invertebrate baseline data from scientifically replicated plots for long-term monitoring of changes

Methods

Sites

Reserves, remnants and BPCT covenants were surveyed where access was able to be gained. Table 1 shows the site monitored for ground beetles (carabids), spiders, worms, snails and moths and Figure 1 shows the location.

Table 1: Sites and taxa surveyed

Remnant/Reserve	Status	Carabids	Spiders	Worms	Snails	Moths
Armstrong Reserve	DoC	✓	✓	✓	✓	✓
Cloudy Farm	Private	✓	✓	✓	✓	✓
Ellangowan Reserve	DoC	✓	✓	✓	✓	✓
Hancock's Bush	Private					✓
Hay Reserve	DoC	✓	✓		✓	
Hinewai Reserve	M.W. Trust	✓	✓	✓	✓	✓
Little Akaloa Church Res.		✓	✓	✓	✓	
Mt Pearce Reserve	DoC	✓	✓	✓	✓	
Otepatotu Reserve	DoC	✓	✓	✓	✓	✓
Panama Rock	J. L. Trust	✓	✓	✓	✓	✓
Tutakakahikura Reserve	DoC	✓	✓	✓	✓	✓
BPCT Covenants	BPCT Ref					
Cherry Farm	028					✓
Fishermans Bay	013	✓	✓	✓	✓	✓
Flea Bay/Pohatu	036	✓	✓	✓	✓	✓
Haley's Heritage	027	✓	✓	✓	✓	✓
Kaik Hill	003	✓	✓	✓	✓	✓
Okains Bay	038	✓	✓	✓	✓	
Paua Bay	027/004/022	✓	✓	✓	✓	✓
Tititipounamu (de Vires)	032	✓	✓	✓	✓	✓

Figure 1: Map of sites surveyed



Beetles & spiders

A total of 17 sites were surveyed using at least six pitfall traps (Figure 2) comprising of 350ml plastic honey pots. A hole was dug in the soil using a soil corer and the pots inserted in the hole flush with the soil surface. Clear, colourless antifreeze (monopropylene glycol) was poured into the pots to a depth of 2 cm. Galvanized steel roofs with four wire legs were

erected over the pitfall traps (Figure 2), to reduce rain and leaves entering the pots. The traps were left on site for 28 days or as close to that as practicable.

Figure 2: Pitfall trap with roof



Figure 3: Moth trapping at Tititipounamu (Okains Bay)



The invertebrates extracted from pitfall traps were sorted and spiders and beetles were identified and counted.

Worms

Six soil cubes 20 cm x 20 cm x 20 cm were dug (i.e. the width of the spade square, and the same depth). The soil was placed on a sheet of plastic and broken up and searched to extract any worms, or parts of worms, present in the sample. The worms found were packed in plastic pots with soil and leaf litter, and kept cool and moist until they were sorted, weighed, and identified. Complete and damaged parts of worms were weighed to provide a biomass per soil volume. Few adult specimens from each Recognisable Taxonomic Units (RTUs) were conserved in ethanol (80%) as potential type specimens for morphological identification or species description. DNA samples were collected for the purpose of molecular identification through DNA bar-coding.

Moths

A light trap with 160 W mercury vapour UV bulb (Figure 3) was set up at dusk, and left going all night when powered by a battery, or just for 3 hours when powered by a generator. Additionally a 160 W mercury vapour UV bulb was used on a tripod sitting on a white sheet with people present to catch the moths in plastic pots. Moths were caught from first darkness until approximately 1am; approximately three to four hours collecting. The moths were subsequently identified and recorded. Some sites such as at Hinewai Reserve and Panama Rock, Cloud Farm, Fishermans Bay and Cherry Farm moths were collected on more than one night.

Snails

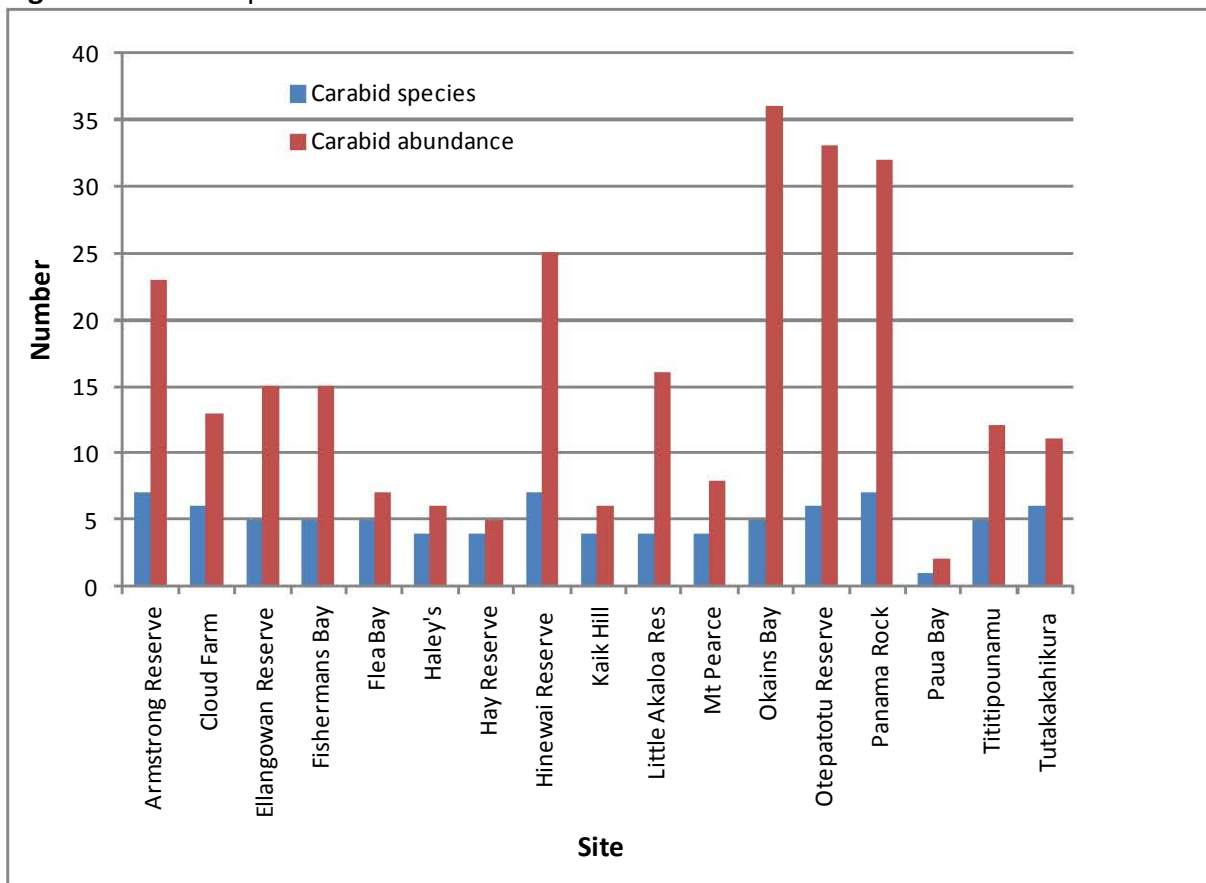
Snails were extracted from the pitfall traps used for beetles and spiders. They were sent to Te Papa for identification by Bruce Marshall.

Results

Carabids

Sixteen species of carabids (or ground beetles) were found in this survey. An undescribed species of *Holcaspis* was found at Armstrong Reserve, Otepatotu Reserve, Little Akaloa and Cloud Farm. Three sites, Armstrong Reserve, Hinewai Reserve and Panama Rock had the equal highest species richness with seven carabid species (Figure 4). In terms of abundance, Okains Bay, Otepatotu Reserve and Panama Rock had the most with over 30 specimens collected from six traps over a four week period. The species thought to be most threatened is the largest carabid, Banks Peninsula endemic *Mecodema howitti* (Figure 6). It was found in nine of the 17 sites with very large numbers at Panama Rock and Ellangowan Reserve (Figure 7b). The most common carabid found, also an endemic Banks Peninsula species, was *Megadromus guerinii*. Only single specimens were found of *Dicrochile whitei* and *Onawea pantomelas* at Armstrong Reserve and Panama Rock respectively.

Figure 4: Carabid species richness and abundance at 17 'Wildside' sites



Snails

Terrestrial snails (Figure 5) were collected at 15 of the 17 sites. Panama Rock had the largest number collected with ten specimens. Ellangowan Reserve had the greatest species richness with five species identified, while at Panama Rock and Otepatotu Reserve four species were found (Figure 7). None of the species were new to science but one species *Therasia* n. sp. (Charopidae sp. 111) is undescribed.

Figure 5: One of the widespread snails found (left) & only found at Tutakakahihura (right)
Charopa pseudocoma (Photo: Te Papa) *Otoconcha dimidiata*



Figure 6: *Mecodema howitti*, *Periegops suterii* and native worms (RTU) found at 17 sites

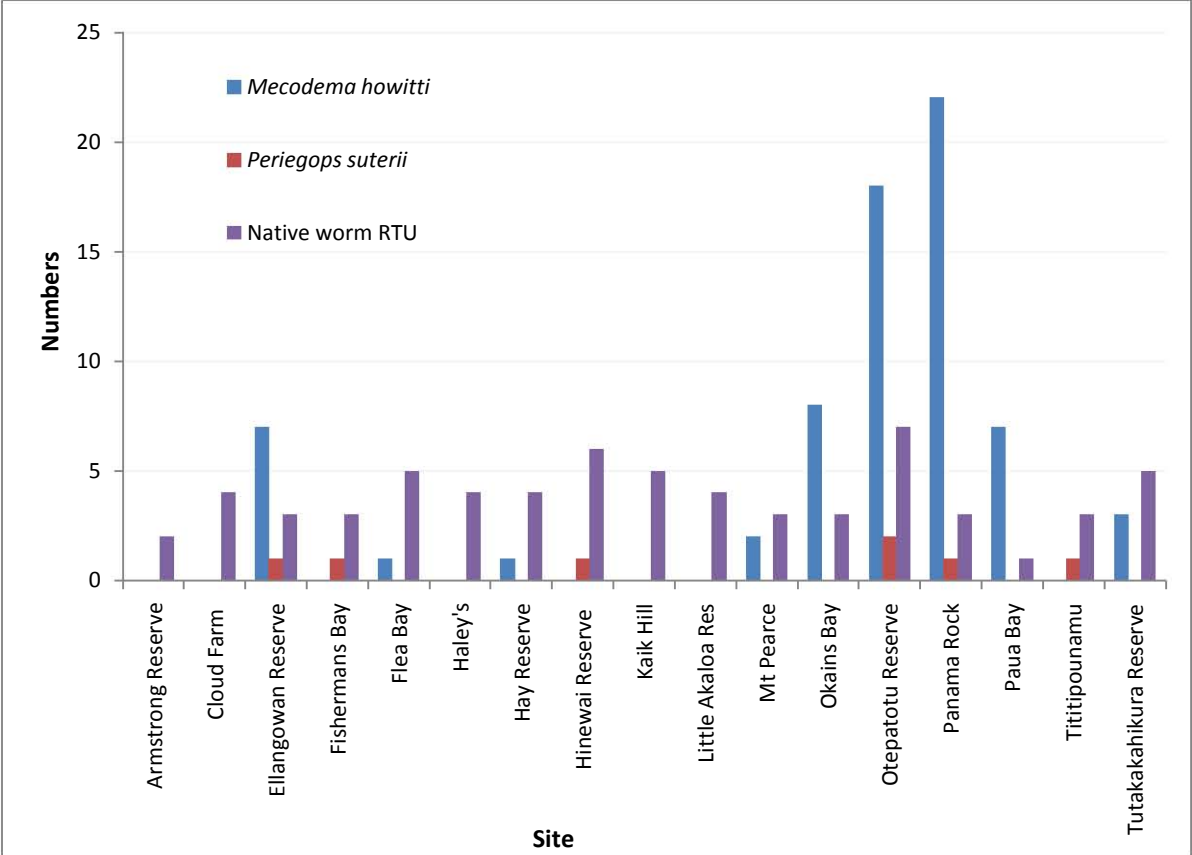
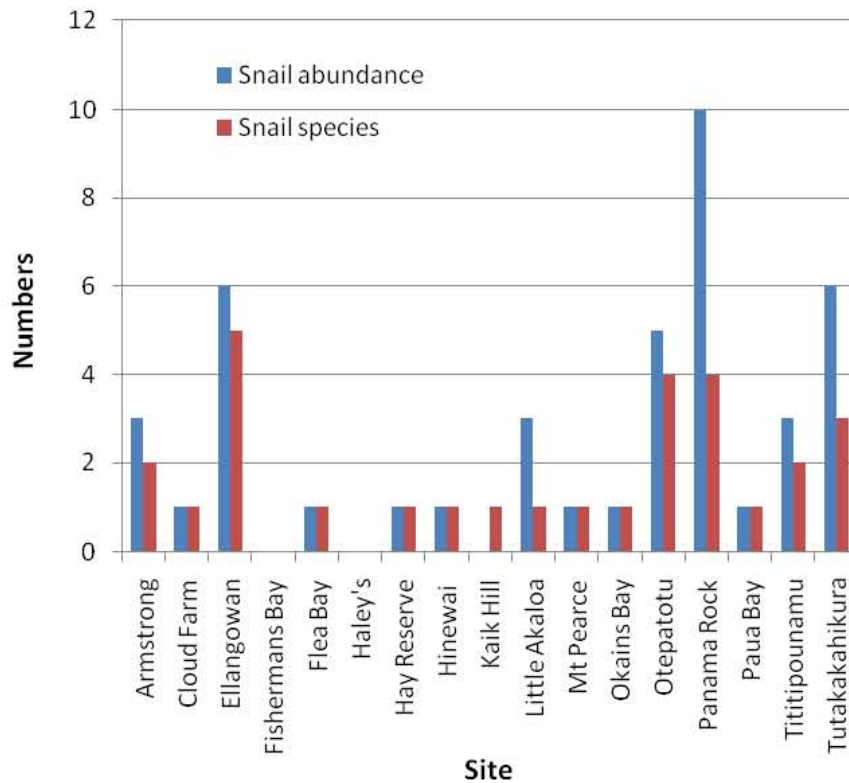


Figure 7: Snail abundance and species richness found at surveyed sites



Earthworms

All sites had endemic earthworms with as many as seven RTU found at Otepatotu Reserve (Figure 6). One of these (a large greenish worm) was morphologically identified as *Maoridrilus suteri*. DNA bar-coding revealed high cryptic diversity in endemic earthworms with at least 13 species present (with interspecific sequence divergence > 4% on COI). DNA analyses also confirmed the presence of three exotic species: *Apporectoda caliginosa*, *Apporectoda rosea*, *Octolasion cyaneum*. These were mainly found at Paua Bay, Fishermans Bay, Titiipounamu and Kaik Hill.

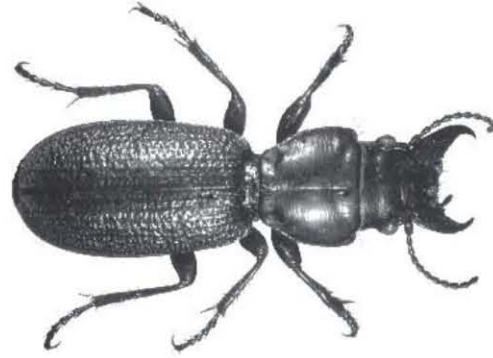
Spiders

The six-eyed spider (*Periegops suterii*) (Figure 8a) thought to be quite rare was found in six sites – Ellangowan Reserve, Fishermans Bay, Hinewai Reserve, Otepatotu Reserve, Panama Rock and Titiipounamu (Le Bons Bay) (Figure 6). This is a significant increase in known locations as this species was only known from Hinewai Reserve in the eastern Banks Peninsula area. The native black tunnelweb spider, *Porrhothele antipodiana* (Figure 8e) was found in 10 of the 17 sites appearing to prefer the sites with vegetation of higher diversity. At least one undescribed species of *Sidymella* (Figure 8f) was found at Tutakakahikura Reserve. Other spiders observed were *Cambridgea quadromaculata* (Figure 8c) and a *Ulioden* species.

Figure 8: Interesting species found during survey work on eastern Banks Peninsula



(a) Female six-eyed spider (*Periegops suterii*)
(Source: Bryce McQuillan)



(b) Carabid *Mecodema howitti* (23-32 mm)
(Source: DoC/Peter Johns' 2005 carabid guide)



(c) *Cambridgea quadromaculata*



(d) *Tectarchus ?salebrosus* (Stick insect)



(e) *Porrhothele antipodiana* with spiderlings



(f) *Sidymella* sp.

Moths

During the study over 5000 moths were collected and 202 species were identified. The number of moth species found at the various sites are shown in Figures 9 and 10. Some sites were surveyed more than others usually because of their convenient locations near accommodation. A total of 122 moth species were collected from Hinewai Reserve. One interesting moth was *Helastia* cf. *christinae* a new species found at Hinewai Reserve. Hancock's Bush and Cloud Farm catches yielded 74 species which is very impressive. More than 50 moth species were represented by a single specimen.

Crane flies (Tipulidae)

At least 17 species of crane flies were identified from the combined sites. A single specimen of *Zelandotipula* ?n. sp. was found at Okains Bay.

Millipedes

Three new species of millipede were found: large numbers of *Pseudopriopeltis* n. sp. were found in at Panama Rock and Tiritipounamu; a new genus on millipede tentatively called “fine knobs” was found only at Hinewai Reserve; and an undescribed genus of Habrodesmidae was found at Haleys, Otepatotu Reserve, Ellangowan Reserve and Tutakakahikura Reserve.

Weta

The cave weta *Pleiolectron simplex* was by far the most common weta but strangely found at all sites except for Ellangowan Reserve. Another cave weta species *Isoplectron armatum*, was not so common. The Banks Peninsula endemic ground weta *Hemiandrus* n. sp. was found at all sites with Kaik Hill and Flea Bay having very high numbers.

Weevils

Two covenants, Okains Bay and Haleys had the highest weevil species diversity with 13 and 11 species respectively. None of the crown fern weevils *Megacolabus sculpturatus* were found from hand collecting or pitfall trapping. Only one introduced species was found; *Otiorhynchus ovatus*, the strawberry root weevil, was found in Okains Bay. Two undescribed species, *Crisius* ‘banks’ and *Epitimetes* ‘banks’ were the most widespread species – found in 13 of the 16 sites.

Figure 9: Moths collected from 15 sites in the Banks Peninsula ‘Wildside’

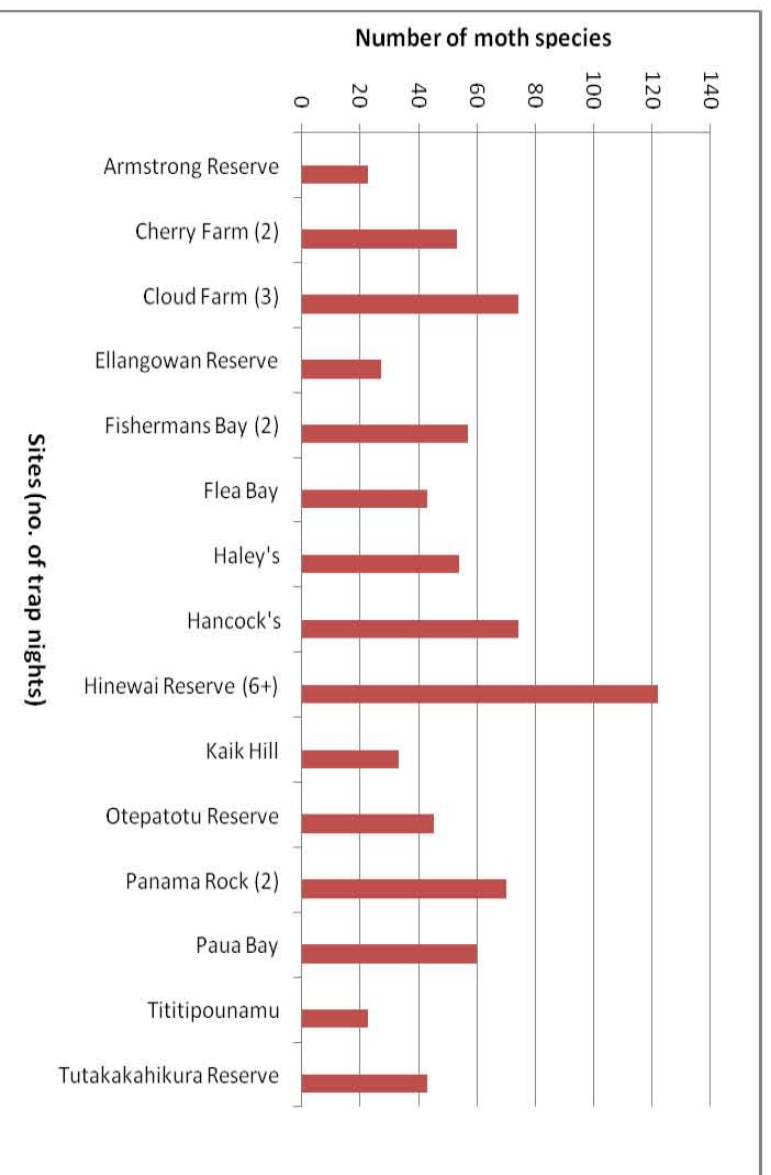


Figure 10: Twelve of the 202 moth species collected during the survey (and their host plants)



Lichen moth *Izatha huttonii* (dead wood)



Pseudocoremia productata (polyphagous)



Graphania plena (native & exotic herbs)



Graphania mollis (forest species)



Austrocidaria gobiata (*Coprosma*)



Declana egregia (*Pseudopanax*)



Declana junctilinea (polyphagous on shrubs)



Asaphodes chlamydota (Clematis)



Declana floccosa (polphagous)



Declana leptomera (polphagous)



Feredayia graminosa (Mahoe)



Ischalis fortinata (*Polystichum* fern species)

Conclusions

This invertebrate survey has been the most comprehensive one since Johns (1986). It also includes additional taxa such as moths and worms which have been poorly surveyed on Banks Peninsula.

A total of 16 species of carabids were collected. The new species of *Holcaspis* has only been previously collected from Mt Bradley (pers. comm. Peter Johns), so the knowledge that it is also at four other Banks Peninsula locations is significant. Other species such as *Onawea pantomelas* and *Dicrochile whitei* were only found as single specimens, and may indicate that these two carabid species are in trouble. Certainly *Onawea pantomelas* has been a species of taxonomic interest given it is the sole species of its genus. An interesting absence was that of the large green ground beetle (*Megadromus antarcticus*) at any of the sites sampled, although it has been recorded previously from the Hinewai Reserve area (Ward et al. 1999; Bowie, unpublished data). This species is certainly common in more western parts of Banks Peninsula, including in modified sites. In contrast, the Banks Peninsula endemic *Megadromus guerinii*, a closely related species, was easily the most common carabid and was found at every site. A positive discovery was the presence of the large threatened endemic carabid *Mecodema howitti* at nine of the sites, with very high numbers at Panama Rock and Otepatotu Reserve. It is interesting that this species was not found at Hinewai Reserve during this survey or in previous surveys (Ward et al. 1999; Bowie and Malumbres Olarte, unpublished data).

Ten species of native snails were collected, but none were species new to science. It is likely that other species are present but hand collecting rather than pitfall trapping may yield the presence of more interesting species.

Only three endemic earthworm species were previously known from Banks Peninsula (*Plutellus parvus*, *Maoridrilus modestus* and *Neochaeta forsteri*) (Lee, 1959). Our survey revealed the presence of at least 13 species, with Otepatotu Reserve having the greatest diversity (at least seven co-occurring species). Because of their similar morphology, these cryptic species can only be separated by morphological characteristics only accessible by dissection. They are therefore likely to have remained unnoticed in previous studies. Type specimens have been conserved for eight of the collected species and preliminary observations indicated that they do not match any of the currently known species (Lee, 1959, Boyer et al. 2011). They are therefore likely to be new to science and will require formal taxonomic description. Additional sampling is also necessary to collect the missing type specimens for the remaining five species.

This survey has collected the six-eyed spider in five new sites. The presence of this species at other known sites means that this species is perhaps not as rare as it was once thought.

More than 122 moth species were collected at Hinewai Reserve. Comparison of sites is very difficult as factors such as temperature, time in the season, moonlight, wind, the range of host plants and habitats present, and the number of nights collecting will all contribute to how many species will be collected. This record of moth collections is the most significant of its type and when published will provide an extremely valuable inventory by documenting

species present in the area and can compliment a recent moth survey by Patrick et al. (2011).

There appears to be some sort of interesting altitudinal segregation between weevil species; in particular *Epitimetes 'banks'* are abundant in higher altitude sites, but in lower altitude sites *Brachyolus* sp. becomes the most numerous species. None of the fern-feeding *Gromilus* sp. were found. This weevil species has been found previously in Otepatotu Reserve during night searches there (Sam Brown, pers. comm.). Its absence from samples may indicate that pitfall trapping may not be a good method for collecting fern weevils, and therefore that absence of evidence for *Megacolabus sculpturatus* in this survey does not necessarily mean evidence for its absence.

Perhaps the greatest surprise was the diversity of invertebrates found at Panama Rock. This site was almost completely cleared of vegetation going by an old photo on the hut log book, yet this site had the equal highest carabid biodiversity, the most *Mecodema howitti* and *Holcaspis suterii* (both Banks Peninsula endemics), the only specimen of *Onawea pantomelas*, the highest numbers and second highest species of snail, and one of only six sites that had the six-eyed spider *Periegops suterii*. If regenerating sites such as Panama Rock can have such good invertebrate diversity, then it should bode well for many of the invertebrates in the future. However, careful management of introduced predators is essential to conserve the invertebrate community as removal of larger predators can lead to pest outbreaks of smaller species such as rodents which would target invertebrates more readily.

Recommendations for future research on Banks Peninsula

1. Survey work in remnants forest areas not previously searched e.g. Nikau Palm Gully/Dan Rogers Creek, Lavericks Bay, Misty Peaks and remaining BPCT covenants
2. Long-term study on the effects of predator trapping with and without rodent control on invertebrates, lizards and bird species
3. More research on earthworms is urgently required. This study found 13 endemic species from a limited sample of sites
4. Rocky outcrops contain specialised plant species some of which have been protected from the ravages of fire, goats and possums. This habitat is likely to host invertebrates on these native shrubs not found in bush habitats.
5. Two large weevils thought to be extinct on Banks Peninsula but may still survive in isolated populations are *Hadramphus tuberculatus* (Canterbury knobbed weevil) and *Megacolabus sculpturus* (Banks Peninsula fern weevil). The habitat of these two species should be intensively surveyed.
6. Extremely interesting distribution patterns of endemic invertebrate species occur within Banks Peninsula. Molecular and behavioural studies would help explain the drivers of these distributions and help with management to conserve these species.

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