Sexual selection and morphological diversity: What can New Zealand Invertebrates tell us?

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Sexual selection is responsible for some of the most extravagant, exaggerated and complex traits that we observe in the animal kingdom. It has driven the evolution of extreme mandibles in stag beetles, spectacular iridescent colour in butterflies and ludicrous eye-stalks in stalk-eyed flies. While we know a great deal about how sexual selection promotes exaggeration within a species, the reason why sexually selected traits are so diverse is more perplexing. From the horns of dung beetles to the complex genitalia of plant bugs, sexually selected traits are the most diverse morphological structures, and yet we don't really know why. I will present recent and current research on sexual selection in New Zealand invertebrates, highlighting our extraordinary fauna as ideal for addressing many of the big questions surrounding sexual selection. I will explore the exaggerated rostra of male giraffe weevils which are used a weapons to fight for females, and see how weapon evolution has panned out across the whole brentid family. I will discuss a remarkable polymorphism in the animals with perhaps the most extreme weaponry in the animal world: our native monoscutid harvestmen. And I will present convincing evidence that a coevolutionary arms race between males and females has driven the evolution of spectacularly complex genitalia in our lichen tuft moths of the genus *Izatha*. There is so much to discover about our native invertebrates. I champion the view that aiming to understand these most fascinating aspects of their biology, and communicating this to the wider public can generate a greater appreciation for invertebrates in the community, and simultaneously contribute to our understanding of how the natural world works.

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Life in the Clouds: New Zealand's Alpine Beetle Fauna

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Insect diversity above the timberline has, in general, been poorly documented in New Zealand and limited to certain taxonomic groups. What is known about alpine beetles is confined to secondary observations in ecological studies and information contained in taxonomic works documenting species and genera. Examination of material held in museum collections, specimens derived from survey work, and insights from naturalists, indicates an unexpected and little appreciated richness in beetle species in alpine areas with low vegetation and exposed, rocky environments. Almost every survey of microcoleoptera above the tree-line produces species new to science and not seen in collections. To summarise on-going phylogenetic, ecological, and survey work: 1) some species have a wide altitudinal range, while some lineages contain species that are range-restricted and/or alpine-specific; 2) high altitude specialists may have lowland counterparts and may be older in age than alpine plants or, rarely, may be of ancient origin with sister taxa outside New Zealand; 3) morphological adaptations include darker colouration and the absence of hind wings.

Spider Odds and Ends

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Many New Zealand spiders have been described from only one sex. This isn't always a problem, but is when the missing sex has been collected elsewhere and described as a different species, or placed in a different genus. In extreme cases even the family is in doubt. *Pacificana cockayni* is a Bounty Islands endemic described in 1904 from the female alone, and family placement was uncertain. Males were finally collected last year. Hopes the male would make family placement obvious have been dashed. We think it might be a cycloctenid, but if so, it's an odd one. Alas, we have no cycloctenid DNA to compare it with, and there is some doubt members of this family really belong together. In short, the discovery of the male of *Pacificana* has led to more questions than answers. A linyphiid, *Drapetisca australis*, from the Antipodes Islands, is a "female only" species and the sole NZ representative of a northern hemisphere genus. It looks to be a species of *Diplopecta*, possibly *Diploplecta proxima*, another "female only" species, from the Antipodes. The theridiid, *Pholcomma antipodiana* from Antipodes Island, is a "male only" species, and *P. hickmani* from Campbell Island, "female only". Forster (1964) suggested that it might be as the female of *P. antipodiana*, a view supported by Vink's study of specimens of both sexes from the Antipodes (in Marris 2000). We also suspect that a *Pholcomma* species from mainland NZ is conspecific with *P. antipodiana*. Another theridiid, an undescribed species of *Coleosoma*, is found in twiggy litter and on shrubby plants in northern parts of New Zealand. We think it may be a recent arrival from Australia, although no *Coleosoma* species have been described from there.

The damselfly genus *Xanthocnemis* in New Zealand (Odonata: Coenagrionidae)

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The damselfly genus *Xanthocnemis* is endemic to New Zealand with four described species: *zealandica* distributed all over the North, South and Stewart Islands, *sobrina* restricted to forested shady streams in the North Island only, *sinclairi* discovered around the South Island mountain tarns and *tuanuii* identified in the Chatham and Pitt Islands only. The variations in morphological features used for species distinction are nimor and largely confined to the male genitalia with only *X. tuanuii* showing distinction in external morphology. A new approach was developed to tackle taxonomic difficult groups like *Xanthocnemis*. It relies on integration of geometric morphometrics and molecular analyses. The first uses morphological landmarks assigned to areas considered important in damselfly diagnostics and the seconds targeted mitochondrial and ribosomal genes utilised in other taxonomic studies. The four taxonomic entities were analysed in two separated studies using both tests. The results showed support for separate status of two species only: *X. zealandica* and *X. tuanuii*. The other two *X. sobrina* and *X. sinclairi* are proposed as junior synonyms of *X. zealandica*.

New genera of New Zealand broad-nosed weevils (Coleoptera: Curculionidae: Entiminae)

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Eligible for student prize

The broad-nosed weevils (Coleoptera: Curculionidae: Entiminae) form a significant part of the New Zealand weevil fauna, particularly in alpine areas. The *Brachyolus*-group of genera are characterised by possessing a long ovipositor, and contain the focal taxa of my PhD research. In this, the first major revision of the group since Broun, a number of new genera are revealed, based on morphological examination, and a comprehensive phylogeny inferred from 28S gene sequences. *Irenimus* is restricted from its current broad definition, to a genus of six species, most of which are undescribed. Most species currently considered in *Irenimus* belong to an undescribed genus, with great ecological diversity. A second undescribed genus is especially speciose in the northern South Island, with host associations with various Asteraceae. A fourth genus is restricted to high alpine areas in Central Otago ranges. The status of other genera in the *Brachyolus*-group will also be discussed.

Review of the Pictrotini (Cryptophagidae)

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The family Cryptophagidae is a worldwide group with cryptic habits. There are few taxonomic specialists and the beetles are small, brown and often confused with other fuzzy beetles in collections. Taxonomic study requires careful dissections, patience and verve. One student of the group, Tapan Sen Gupta, never published on cryptophagids and instead dealt mainly with look-a-likes now in Erotylidae. All said, we like them, maybe as a form of self-punishment and self-denial to avoid working on other charismatic groups that could attract funding. The gondwanan Picrotini were defined by Roy Crowson (1980) and have been treated in larger family-group reviews and systematic studies by John Lawrence. The Juan Fernandez species were revised (Leschen and Lawrence 1993) and a catalogue of the tribe has been published (Leschen and Gimmel 2012). We are revising the genera and recognize 22 genera with 13 genera described as new from Australia, Papua New Guinea, New Zealand, and South America (Chile, Ecuador). Several members of Picrotini depart from primitively fungal feeding habits to feeding on fern spores (*Cryptothelypterus* Leschen & Lawrence) or plant pollen (some *Ostreacryptus* Leschen). Most members are flight-capable, but several lack hind wings (e.g., *Picrotus* Sharp (New Zealand), *Neopicrotus* Leschen (Chile and Australia), *Thortus* Broun (New Zealand)), or contain species that are both winged and apterous (e.g., *Ostreacryptus*). Gigantism occurs in the apterous genus *Thortus* with most mainland New Zealand species rather small (ranging from 1.5 to 2.0 mm) and one species from the subantarctic Auckland Islands with a length of 3 mm. Features of the group that are used to define generic limits include the pronotal margins with a glabrous space, pronotal tumidities, evaporative areas that are associated with glandular ducts and pores, postcoxal lines, connation of the abdominal ventrites, and abdominal spiracle diverticulae and texture.

Exotic longhorn beetles (Coleoptera: Cerambycidae) established in New Zealand

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Over the past 175 years, 10 species of exotic longhorn beetles have become established in New Zealand. Despite considerable increases in travel and transport of goods and materials throughout this time, the rate of establishment of exotic longhorn beetles in New Zealand shows no associated pattern. What is notable, although not surprising, is the high percentage of species that originate from Australia. These are mostly *Eucalyptus* feeders which are presented with ample resources in New Zealand. These 10 Cerambycidae species are presented and discussed.

Itchers with Glitches: resolving polyphyly in the phylogenetically important genus *Androlaelaps*

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The cosmopolitan mite genus *Androlaelaps* Berlese, 1903 (ca 86 spp) has been given a central position in hypotheses of the evolution of vertebrate parasitism within the family Laelapidae (1320 spp). This genus of parasites, predators and hemiparasites occurs on small mammals and birds and has been hypothesised to "represent the ancestry" for nearly all the vertebrate parasites in the Laelapidae. Apart from translation into testable phylogenetic concepts, this hypothesis also requires defining what *Androlaelaps* actually is. The concepts of *Androlaelaps* used since Berlese (1911) are shown to be polyphyletic. Three wholly separate groupings in former *Androlaelaps* are diagnosed and described incorporating key morphological features such as male mouthparts. This example shows convergence can be detected even in regressed characters and provides fresh insights into the evolution of parasitism.

Basalt and Balaustiinae (Acarina: Parasitengona: Erythraeidae)

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The larvae of *Balaustium* mites are non-parasitic members of the Parasitengona. *Balaustium* larvae feed on pollen and small arthropods. Although the genus is poorly known in New Zealand, it is a widespread saxicole on Banks Peninsula and in Canterbury braided river beds. Recent work on Banks Peninsula revealed communal egg-depots in rock crevices. Rock crevices under basalt rinds are particularly well suited to holding 1,000+ eggs. In addition, these sub-rind refuges are used for moulting. Basalt rinds are often easily removed with a small steel lever allowing the collection of large numbers of eggs or prelarvae as well as pupa I & II. The collection of pupa I with their adhering larvae pelts is providing a way to link the heteromorphic larvae with post larval forms. The collection of large numbers of prelarvae near eclosion in our austral 2014 Spring from many locations in Canterbury and Banks Peninsula has provided material for taxonomy and other studies. Other Balaustiinae genera found as pupae under basalt rinds included *Abrolophus* and *Wartookia*. Rind refuges may be ancient: they are often replaced with an adhesive.

Resolving taxonomy of *Mecodema* (Carabidae: Broscini) populations in the greater Auckland area

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Mecodema are medium to large (10-45 mm) carabids that are nocturnal, polyphagous, olfactory and tactile predators or scavengers. They are associated with a wide range of habitats that correlate to vegetation assemblages, microclimates and habitat heterogeneity. Currently, the greater Auckland area (Wellsford to the Franklin District) has four described *Mecodema* species from three different species groups: '*curvidens* species group', '*ducale* species group' and '*spiniferum* species group'. I am focussing on resolving the taxonomy of populations of the *spiniferum* group, of which *M. spiniferum* is the only described species and is found throughout the Waitakere and Hunua Ranges. Pinned specimens were obtained from a number of institutes and museums, including NZAC, Auckland Museum, Lincoln University and Te Papa. Fresh specimens were collected using pitfall traps set during September 2013 to April 2014, these specimens were used for molecular analyses and dissection. Taxonomically, the greater Auckland area encompasses the Coromandel Peninsula as species there are closely related to northern Auckland species. *Mecodema spiniferum* is the species found throughout the Waitakere Ranges, plus there are a number of new species in the following localities: northwest Hunua Range; Mt Auckland; and two sister taxa are found in almost all of the small forest fragments in the Rodney District, including Logue's Bush S.R. in Wellsford.

Spiders! An exhibition coming soon to Canterbury Museum

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A sneak peek will be presented of an upcoming exhibition on spiders at Canterbury Museum. The exhibition will be based on the book “A Photographic Guide to Spiders of New Zealand” by Cor Vink and Bryce McQuillan and will have information on spider biology, photographs of 40 spiders that can be found in Canterbury and a feature on the invasive redback spider (*Latrodectus hasseltii*). A public programme aimed at primary schools will be based on the exhibition; this will involve lessons on spiders at the Museum and schools exploring the diversity of spiders found in Canterbury through a NatureWatch project.

The Royal Society's panel on National Taxonomic Collections in New Zealand: ESNZ's response

Samuel Brown [*1]

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In early March, the Royal Society announced the convening of an expert panel to identify the significance of NZ's national taxonomic collections, review the guidance of national collections and to review taxonomic training in NZ. The Entomological Society of New Zealand has offered to assist the Royal Society in providing a commentary on the state of entomological taxonomy in New Zealand, and supplying case studies showing the importance of taxonomy. An overview of the Society's input to the panel will be presented; and discussion on additions to the report will be encouraged.

The unimportance of Diptera and introducing Karsing Megu.

Franz-Rudolf Schnitzler [*1]

[1] Landcare Research/MPI

The taxonomic impediment has been lamented for many years and by many researchers. Given the decrease in opportunities for training of young taxonomists and the increase in what I would call pseudo-taxonomy, it is timely to reflect on the important part taxonomists have played and still play in the recognition of species. Taxonomy, being arguably one of the least expensive sciences, is experiencing less funding across a wide spectrum of taxa. Thus even major groups such as Diptera seemingly become unimportant in spite of the economic impact they may have (e.g. fruit fly). On this note I will introduce Karsing Megu, a young scientist keen to learn about insect systematics.

How good are collection records at representing New Zealand environments?

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Entomology Collections play a central role as sources of data for biodiversity and conservation. Yet, few collections have examined whether the data they contain is adequately representative of local biodiversity. I examined over 15,000 databased records of Hymenoptera from 1435 locations across New Zealand collected over the past 90 years. These records are assessed in terms of their geographical, temporal, and environmental coverage across New Zealand. Results showed that the spatial coverage of records was significantly biased, with the top four areas contributing over 51% of all records. Temporal biases were also evident, with a large proportion (40%) of records collected within a short time period. The lack of repeat visits to specific locations indicated that the current set of records would be of limited use for long-term ecological research. Consequently, analyses and interpretation of historical data, for example, shifts in community composition, would be limited. However, in general, collection records provided good coverage of the diversity of New Zealand habitats and climatic environments, although fewer collection records were represented at cooler temperatures (less than 5C) and the highest rainfalls (over 5000 mm/yr). Analyses of collections can be greatly enhanced by using simple techniques that examine collection records in terms of environmental and geographical space. Collections that initiate a systematic sampling strategy will provide higher quality data for biodiversity research than ad hoc or point samples, as is currently the norm. Although collections potentially provide a rich source of information they could be far better utilised in a range of large-scale ecological and conservation studies.

Male-male competition and chelicera morphology in New Zealand sheet-web spiders (*Cambridgea foliata*)

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Eligible for student prize

Animal weaponry has long captured the imagination of researchers and they can occur with varying degrees of exaggeration in different taxa. This phenomenon is particularly common in species in which males defend females from potential rivals. While sexual selection is generally credited with their exaggeration, the particular processes and drivers are far from uniform. In particular, exaggerated jaws, horns and teeth may evolve through selection for males who can physically defend females (armaments) or they may develop as badges of status, warning rivals off and advertising the male's quality to the female (ornaments). New Zealand sheet-web spiders (*Cambridgea foliata*) are one such species in which male chelicerae (jaws) are substantially larger than those of female conspecifics. We use both behavioural and morphological analyses to pinpoint the selective pressures acting on male chelicerae and to examine how chelicera morphology varies among males. We randomly paired males on female webs and recorded their behaviours. Then, we compared morphological traits of males and females of varying sizes to see how traits were distributed and how they covaried. We found that male jaws are positively allometric while female jaws are not and will present preliminary analyses examining the relationship between *C. foliata* morphology and fight success.

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Specialisation of a leaf-feeding beetle is explained by phylogeny and specific resistance traits of its host plants

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The majority of phytophagous insects are specialised feeders restricted to a plant family, genus, or species. The evolution of specialised insect-plant interactions is generally considered to be a result of trade-offs in fitness on a range of possible hosts. An important selection pressure resulting in specialisation is the resistance properties of host plants. We tested the survival (naive 1st instar to adult) of the oligophagous leaf-feeding beetle, *Cassida rubiginosa*, on 16 selected representatives of the Cardueae tribe (thistles and knapweeds). Putative resistance traits were measured and the phylogenetic signal of the traits were examined, and related to the survival of the beetle. In addition, the influence of specific resistance traits of closely related congeneric thistle species were tested by experimental manipulation and showed that differences in beetle survival were explained by a common physical resistance trait that varied in magnitude. By elucidating the plant traits that explain insect fitness in a phylogenetic context, we might better understand the evolutionary processes of specialisation, and the proximate mechanisms determining host-plant utilization.

Elevated carbon dioxide impairs the performance of a specialized parasitoid on Brassica plants

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Elevated concentrations of atmospheric carbon dioxide (CO_2), a consequence of anthropogenic global change, may profoundly interfere with tritrophic interactions. Such effects have rarely been investigated. We used the system composed of Brassica plants, the cabbage aphid *Brevicoryne brassicae* and the endoparasitoid *Diaeretiella rapae* to compare effects of elevated CO_2 (800 ppm) versus ambient CO_2 (400 ppm). Plants were exposed to the CO_2 concentrations for up to 10 weeks, aphids for 2-3 generations, and parasitoids for 1 generation. Concomitant bioassays with herbivore-infested plants exposed to parasitoids were also conducted. A significantly lower proportion of aphids were parasitized under elevated compared to ambient CO_2. Parasitoid progeny emerged earlier but offspring adults were shorter lived under elevated CO_2. Plant glucosinolate concentrations were higher under elevated compared to ambient CO_2. However, contrary to expectations, aphid glucosinolate concentrations were significantly lower under elevated CO_2. Likewise aphid body mass remained approximately 20% lower under elevated compared to ambient CO_2. Thus, elevated CO_2 seems to have enhanced plant direct defense through an increase in natural plant defense compounds, but also led to a reduction in indirect defense through decreased parasitism and parasitoid longevity. Our results indicate, for the first time, a conflict between bottom-up and top-down control under elevated CO_2.

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Role of olfaction in host-habitat and host finding of *Cotesia urabae* (Hymenoptera: Braconidae)

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Eligible for student prize

Olfaction is acknowledged as the primary mechanism used by parasitic wasps to detect and locate a number of resources (e.g. a food source, hosts, mates), where they make use of chemical cues to orient first towards a host habitat and secondly towards their host. *Cotesia urabae* is solitary larval endoparasitoid that was introduced into New Zealand as a biological control against the gum leaf skeletoniser, *Uraba lugens*. A series of bioassays using Y-shaped and four-arm olfactometers were conducted to investigate the response of *C. urabae* to volatiles emitted by its host-plant, host, host by-products and male and female conspecifics. In a Y-tube olfactometer, males exhibited a significant positive response only to conspecific females. Mated females exhibited a significant positive response to *E. fastigata* leaves, *E. fastigata* leaves with feeding damage caused by *U. lugens* larvae, *U. lugens* larvae, *U. lugens* larvae feeding on *E. fastigata* leaves, but not to *U. lugens* frass on its own nor conspecific males. The multiple comparison bioassay conducted in a four-arm olfactometer clearly shows that *C. urabae* females were significantly more attracted to *U. lugens* host larvae feeding on *E. fastigata* leaves than any other of the odours tested. This study made it clear that *C. urabae* respond only to chemical cues with a high reliability of what they are searching for, for males it is a female, for females it is cues closely associated with their target host. Frass is not a chemical cue used by foraging *C. urabae* females as it is generally shed from the plant, and therefore does not reliably indicate the presence of host larvae.

Increasing concern about Gum Leaf Skeletoniser, *Uraba lugens*, causing contact dermatitis in humans

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Gum Leaf Skeletoniser (*Uraba lugens*) is a pest lepidopteran from Australia whose larvae attack and defoliate eucalyptus trees. Eucalyptus trees form a prominent component of New Zealand's urban and rural landscape, as well as being important to the forest industry. The larvae of Gum Leaf Skeletoniser are covered in urticating hairs which cause a harmful rash to human skin called contact dermatitis. This occurs when either larvae, or the shed skins of larvae touch bare human skin. Upon contact an instantaneous raised rash develops accompanied by a painful burning itch that can recur for up to 4 weeks at a time. Gum Leaf Skeletoniser has been in New Zealand since approximately 1995. It was initially subject to a successful eradication (in Tauranga), but once found to be well established in Auckland in 2001, biological control became the focus of pest management efforts. Gum Leaf Skeletoniser is now distributed throughout the upper North Island above Tokoroa/ Rotorua/ Whakatane, as well as in the Hawkes Bay. A limited population exists in Nelson. Very high populations of the pest in public parks have this summer been observed in Auckland, Hamilton, and Napier cities. As well as mass releases of the specialist parasitoid *Cotesia urabae* against these infestations, Scion will be talking to councils and the public to increase awareness of the dangers of the larvae and their exuviae as causative agents of contact dermatitis in humans.

Preparing for invasion: how MPI is preparing for the arrival of the Brown Marmorated Stink Bug (*Halyomorpha halys*)

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The brown marmorated stink bug (*Halyomorpha halys*) is an invasive species causing significant economic and social concern in the United States, and now expanding in distribution in Europe and Canada. The Ministry for Primary Industries (MPI) has been aware of the threat of this pest for some time. There have been numerous border interceptions of BMSB in New Zealand, and MPI has been working to understand and manage all possible pathways of entry. Additionally MPI has been planning for how to respond to an incursion or establishment event. This talk will cover the work that MPI has done towards management, surveillance and communication.

MPI in Response

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A globally transient human population can result in the displacement of small invertebrates and plants. Away from their natural predators these organisms may multiply in numbers difficult to control. The Ministry for Primary Industries (MPI) is tasked with developing and implementing strategies that keep New Zealand free of unwanted pest organisms. Key components to achieving that goal include early detection of a pest organism achieved by community surveillance, vigilant stakeholders and urgent response to detections by highly trained MPI staff. MPI has an Exotic Pest and Diseases hotline (0800 80 99 66) and email channels monitored 24 hours a day, 365 days a year to report suspected exotic pests and diseases. The report is investigated and depending on the degree of risk identified a response can be initiated to mitigate or eradicate a risk organism. In November, 2014 one suspected Yellow Spotted Stink Bug (YSSB) was found in Temuka, South Canterbury. The YSSB is one of MPI's unwanted pests because of the physical and economic impact its establishment would have to New Zealand. A Response was initiated to provide effective and efficient decision-making and to ensure sufficient measures were in place to assess and mitigate the risk. Response teams work in conjunction with staff from MPI's Investigation and Diagnostic Centres (IDC). These Centres assist with field investigation, laboratory screening and diagnosis of suspect exotic pests and diseases.

The Great White Butterfly Eradication Programme

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The first record of Great White Butterfly (*Pieris brassicae*) (GWB) in Nelson was on 14 May 2010 as caterpillars feeding on nasturtium. The property was 1.5km from the Port of Nelson where it was presumed to have entered the country. The GWB lays eggs in clusters of 30 to over 100 on host plants and caterpillars feed gregariously with the possibility of complete defoliation before moving en masse to neighbouring host plants. Overseas records show that GWB caterpillars feed on a broad range of species but mostly within the cosmopolitan family Brassicaceae (cresses). As well as brassica species grown commercially as crops, there are 79 species of native cresses, 92% of which are endemic and 71% are classified as “Threatened” or “At Risk” with 18 species being “Nationally Critical”. Many of our endemics are known hosts for the small white butterfly (*Pieris rapae*) and overseas records show an overlap in the host range between the two butterfly species. The arrival of the GWB represented a significant additional threat to many endemic cresses. In November 2012 the Department of Conservation (DOC) took over the response initiated by the Ministry for Primary Industries (MPI). The 2012-2013 season saw GWB spread out to a maximum of 12 km, both north and south, from the Port. However, by late autumn 2013 the distribution had been reduced to about 7 km from the Port and this was maintained through to mid-2014. Computer modelling has facilitated a targeted approach to particular life stages at certain times of the year. This has maximised the efficiency of the available resources leading to a massive decline in GWB counts over the spring – summer period of 2014-2015. The programme appears to have achieved “knock-down” and entered the “mop-up” phase. But how close are we to eradication?

The Ministry for Primary Industries emerging risk system

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Identifying potential and emerging threats is an important component of biosecurity risk management. While staff from across MPI have historically kept watch on new and emerging pests and diseases for some time, an independent review of import requirements and border processes following the inadvertent introduction of *Pseudomonas syringae* pv. *actinidiae* (Psa) into New Zealand in 2010 recommended that we "renew efforts to centralise the identification and management of emerging risks". In response, MPI has now developed the Emerging Risks System. The emerging risks system creates "alerts", and systematically evaluates new information about biosecurity risks emerging around the world in the areas of plant, animal, and aquatic health, and will soon expand to include food safety risks. For some emerging risks it is found that the potential pathways are already managed in a way that will prevent entry of the pest. For others it is necessary to modify the existing Import Health Standards, or modify risk management in another way. The emerging risk system reports on any risk management actions taken, including implementation of specific control measures where needed. In some cases information is passed on to Quarantine officers at the border. In the current talk the MPI emerging risks system is described and examples of risks involving invertebrates are given.

Assessing risk associated with exotic ants in New Zealand

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Eligible for student prize

Globally, invasive species are widely recognised as causing negative impacts on social, economic and environmental sectors. Expansion of international trade and movement of people worldwide has increased the likelihood of species moving out of their native areas and into novel environments. The ability to identify species that pose significant risk is therefore critical, so that managers can determine which species should be targeted based on resources available. Ants play a dominant role in many different ecosystems through their interactions with the local environment. Invasive ants often disrupt such interactions with negative consequences for native biodiversity, which in some cases can lead to ecosystem-wide effects. Whilst there are more than 12,000 described species of ants worldwide, New Zealand is unusually depauperate, having only 11 native species. There are, however, 29 introduced species established in New Zealand, for the most part with unknown consequences. Although ants are known to be capable of invading many different native New Zealand ecosystems, their impacts are poorly understood. The ant communities of native ecosystems (6 open and 6 closed canopy sites) around the wider Auckland area were characterised 10 years ago by baiting and hand-collecting along a transect from disturbed into intact habitat. The sampling was repeated in 2015 and data will be presented on how ant distribution has changed over a temporal scale. Future research will focus on assessing the impacts of exotic ants on native biodiversity, retrospectively testing the predicted impacts of several exotic ant species based on existing risk assessments. This information will ultimately be used to improve risk assessment frameworks for assessing the potential impacts of exotic invertebrates in native New Zealand ecosystems.

Assessing the potential ecological impacts of the Hadda Beetle (*Henosepilachna vigintioctopunctata*)

Jessica Devitt [*1], Margaret C Stanley [1]

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Eligible for student prize

The decision to eradicate invasive phytophagous insects in New Zealand appears to be predominantly based on the estimated potential damage to commercial crops (production and pest management costs) versus the estimated cost of eradication. As a result, incursion responses may be stood down for phytophagous insects when the potential for native plants to be hosts is not fully accounted for within the risk assessment process. Hence, the lack of a thorough assessment could result in a decline of native plant populations. The hadda beetle (*Henosepilachna vigintioctopunctata*) incursion is one such instance where the eradication response was stood down without full assessment of the risk to native plant species. This herbivore feeds on three plant families for which New Zealand has ecologically important native representatives. However, the specificity of the beetle and its ability to fully develop through its life cycle on native New Zealand plants is unknown. In my study, I retrospectively determine the risk to New Zealand native plants by establishing if the hadda beetle will feed and fully develop on native plants from the Solanaceae family. The beetle's host specificity is determined through no-choice and multi-choice feeding tests, with results to date indicating a wide host range within New Zealand Solanaceae, with larvae and adults feeding on *Solanum aviculare var. aviculare,* currently listed as At Risk/Declining under the New Zealand Threat Classification System. This study will highlight the importance of adequate assessment of risk to New Zealand native species.

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Sex, lies and rock'n'roll: signal function and evolution in spider webs

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The physical environment in which communication occurs heavily influences the form and function of animal signals. A striking example of this is found in web-building spiders. The *Umwelt* of web-building spiders is dominated by web vibrations. The spider can gain information about the presence of potential prey, conspecifics and even predators by interpreting the vibrations travelling through the silk. However, relying on web vibrations to provide information about the world can also create major constraints on signal form. For example, potential mates may be misidentified as prey, and attacked, if their vibratory signals are not sufficiently differentiated from the vibrations generated by prey. Predators can also exploit the reliance of web-building spiders on vibratory information by generating deceitful signals that trick the spider into mis-identifying their presence. In this talk, I will outline the vibratory behaviour of prey in spider webs, and how assassin bugs exploit these vibrations to lure their spider prey within range. The unique challenges faced by male web-building spiders will also be described, and how male courtship signaling has been shaped by the behaviour of prey in spider webs. Web-building spiders are an extraordinary model system with which to study signal evolution and communication dynamics.

Motuora 10 years on: Restoration trajectory of a native beetle community.

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Revegetation is one of the most widely used interventions in terrestrial restoration, as the structure and extent of vegetative cover profoundly shapes both the physical and biotic features of a landscape. Such projects typically proceed on the premise that there is a causal link between re-establishing native forest cover and restoring native biodiversity, even though there have been relatively few assessments of the success of replanting native forest. This study assesses the response of the beetle community to native re-forestation on Motuora Island, an 80-ha island about 40 km north of Auckland City, New Zealand. The island has been actively restored by a community-led group since 1991. We measured the beetle communities on Motuora in 2004 and in 2014, comparing the successional trajectories of unmanaged natural restoration (c. 80 years old), native tree planting, and retired pasture. Both the diversity and abundance of beetles has increased in all three vegetation types. Beetle assemblages in planted forests have converged toward those found in unmanaged forest, while the assemblage in retired pasture has remained distinct. Based on the current literature and restoration rate of flighted beetles we predict complete convergence in another 20 to 40 years for the ground-dwelling beetle community.

Giant Willow Aphid: a new-comer (?) to New Zealand

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The Giant Willow Aphid, *Tuberolachnus salignus*, was first formally identified in Auckland in 2013. Large populations were reported throughout New Zealand in 2014 on willows in drought areas. Willows are important trees on farms for shade and stabilisation of wet seeps on erosion prone hills. Willows also provide valued pollen and nectar for bees in the spring. The collection of GWA honeydew in summer and autumn creates a difficult honey to extract from combs. The honey has an unpleasant taste but is readily collected by several wasp species. What are the current options for managing this new pastoral pest?

Elitism, specialisation and the foraging behaviour of common wasps (*Vespula vulgaris*)

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We examined the foraging behaviour of common wasps (*Vespula vulgaris*). Using RFID tags glued onto newly emerged adult workers we asked three questions related to variation in foraging effort and patterns within nests. Firstly, we examined the variation in foraging effort between nestmates: is there evidence for ‘elite foragers’ or highly active workers doing a disproportionate number of foraging trips? Our results demonstrated that some workers indeed undertook many hundreds of foraging trips during their lifetime, while other workers were exceedingly lazy. Secondly, we examined how foraging behaviour changes with age. Does the foraging effort change over the lifespan of a wasp? Our adult wasps lived for up to 49 days. The peak in foraging effort was for 26 day-old wasps, but there was considerable variation between workers within a nest. Finally, we examined for evidence of specialisation in foraging behaviour. Some wasps specialised throughout their adult life in collecting prey items. Approximately a quarter of foragers were only observed to collect fluid or pulp for nest building. Our work demonstrates considerable variation between related individuals in the same social and environmental context, both in their foraging activity and level of specialization. We observed a degree of age-related polyethism, but not to the extent observed in bees.

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Using Bayesian networks to model insect flight activity

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Insect development and activity are weather-dependent processes. Flight behaviour in particular is strongly mediated by meteorological conditions and the form of this relationship is normally species-specific. To predict the activity of forest insects, their flight patterns, and the subsequent likelihood that a wood commodity may be subjected to the potential presence of a pest during a particular time period requires an understanding of the relationship between key meteorological conditions and flight. We test key parameters (temperature, humidity, wind speed, rainfall) and their influence on the flight activity of key forest insects (*Hylurgus ligniperda, Hylastes ater,* and *Arhopalus ferus)* over a twelve week period at a temporal resolution of 1 hour. We will demonstrate a Bayesian network that models the probability of insect flight activity given past weather conditions and can predict the likelihood of flight activity given forecast weather data.

Return of the heat: Restoration of a geothermal ecosystem

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New Zealand has a range of geothermally-influenced ecosystems with distinctive ecological features and biotic communities. Recent studies of geothermal ecosystems in New Zealand have determined the diversity,charcteristics and function of aquatic geothermal environments. The Waikite wetland and associated Otamakokore Stream occupies approximately nine hectares close to the centre of the Waikite Geothermal Area. The system has undergone major hydrological changes in the last 80 years; land clearance, grassing, draining the wetland and diverting the Otamakokore Stream around the wetland are some of the works carried out since the 1930's. Several geothermal springs discharge along the stream and into the wetland in the southeast corner providing a source of hot water to the wetland. In recent years attempts have been made to return the wetland and the Otamakokore Stream to its former geothermal activity. This paper describes the restoration that has occurred and is planned for the area, presents the initial results of chemical, physical, microbiological and invertebrate monitoring of the Waikite geothermal area and reveals the response to the change in the management of the area.

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Land-use intensification effects on the pollination services provided by insects

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Eligible for student prize

Habitat degradation and destruction, particularly due to the expansion and intensification of agricultural systems, are the primary drivers of global biodiversity loss, causing the reduction of many ecosystem functions and services. Biodiversity is predicted to enhance ecosystem function and resilience to environmental disturbance. Insect-mediated pollination is a critical ecosystem function and service, and provides a tractable model for investigating biodiversity-ecosystem function relationships. This paper reports on a landscape scale experiment, using targeted mass plantings along a land-use intensity gradient, to assess differences in insect pollinator communities and subsequent variation in pollination services. Pak choi was planted out in 25 x 25 m plots at 12 sites in 2014. Insect pollinator communities were measured at each site using floral visitation observations. For all sites, non-*Apis* pollinators accounted for approximately 40% of floral visits, and preliminary analyses suggest that insect communities responded to the land-use intensity gradient. The next step will be to determine if these community changes resulted in different seed set rates and thus, pollination services.

Lessons from the Monarch

Jacqui Knight [*1]

[1] Moths and Butterflies of New Zealand Trust

What’s so special about monarch butterflies? Shouldn’t we focus on endemic species? How can the Monarch help New Zealanders appreciate our distinct and fascinating biodiversity? Many children are growing up with no appreciation of the outdoors. In some parts of Auckland whole families of children have never seen bush such as Manurewa’s totara glades. A phenomenon called ‘nature deficit disorder’ describes humans spending less time outdoors due to the increased attraction of technological devices and perceived dangers, risks and fears of leaving a man-made environment. Combine this with statistics that fewer New Zealand residents grew up here: fifty years ago children inherited an appreciation for nature from family outings. Insects in the home and workplace are feared. Rather than preventing a build-up of cockroaches, ants and flies people seek to ‘exterminate’ them. In the garden pesticides are seen as the quick and convenient solution to a proliferation of an insect. How does the Monarch butterfly help? It is a universal illustration of the word ‘butterfly’. It may be common but in NZ it is also revered. Plant a swan plant and you have an interactive example of biodiversity in your garden. You don’t just learn about the monarch. You learn about metamorphosis and ecosystems and the interdependence of insects and plants, birds, diseases and soil. You develop compassion and empathy, management and observation skills. You begin to understand that moths and wasps have their place in the cycle of nature too. And appreciate the need for biosecurity. Jacqui Knight from the Moths and Butterflies of New Zealand Trust has been on such a journey over the past fifty years. She will talk about the ten year adventure since she formed the ‘Monarch Butterfly New Zealand Trust’, and how the Monarch is changing the lives and attitudes of many people.

Healing the invisible masses? Responses of insects to restoration

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The indigenous fauna of New Zealand is exceedingly distinctive, with high levels of endemism, expanded niches, gigantism, extended life histories, flightlessness, and ground-dwelling habits. These attributes make taxa vulnerable to human disturbance (e.g., habitat loss and degradation) and to predation by rodents and other introduced mammals that accompanied human settlement in the 13th Century. Ecological restoration aims to halt and potentially reverse these population declines and has become a major tool in conservation management in New Zealand. Recently, many new community conservation projects have set goals to restore indigenous communities, primarily focusing on birds and plants; few consider insects, which contribute considerably to biodiversity and perform key roles in many ecosystem processes. However, responses of insect taxa and communities to habitat restoration have been measured at wetland sites and biodiversity sanctuaries where mammals have been controlled or eradicated. The Ecological Integrity framework developed primarily for birds and plants may prove helpful for studying the recovery of insect communities. This framework uses indigenous dominance and species occupancy to evaluate biotic response to restoration.

Predicting the amount, quality and location of dead wood in the forest landscape - A modelling approach to predict saproxylic insect abundance

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The area of planted forest is increasing worldwide, bringing higher demand on modern forestry to conciliate timber production with progress towards sustainable forest management such as the conservation of biological diversity. Saproxylic species, which are mainly fungi and insects, are considered particularly valuable forest biodiversity indicators. They represent the wide spectrum of different habitat requirements and species' ability to utilise decaying wood. Earlier studies have demonstrated a significant positive correlation between the amount and quality of dead wood and the richness of saproxylic species, so that the richness of species inhabiting dead wood is usually greater in natural than in managed forests or in less intensively managed forests than in intensively managed ones. Using New Zealand highly productive and sustainably managed *Pinus radiata* plantations as a model system, we explored how monitoring of decaying wood may be a useful tool in the management of saproxylic insects. By merging existing forest industry data with an existing Scion model that predicts woody debris production we modelled the amount, quality and location of dead wood in the forest landscape. It shows that different forestry practices not only change the amount of decaying wood, but also influence the size, the quality, and the spatial distribution of available saproxylic habitats. In well characterised forests such as NZ intensively managed plantations, such a modelling approach using the amount of source habitat as a surrogate for saproxylic insect abundance could prove a useful alternative to regular forest inventories. This may be a tool for conservation purposes, as it could support recommendations to improve the continuity of dead wood and availability of recently produced dead wood. Another application is to use the model to quantify the distribution and abundance of some targeted market access species.

Getting a return on science investment: Early steps enabling pest wasp control on public conservation lands

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Science engagement partners, including Landcare Research, Auckland University, Entecol Ltd, Victoria University and DOC, have refined a bait station method of control for *Vespula* spp. wasps. This is the only tool that has been developed for wide-scale wasp control. A recent licence agreement and cooperation among scientists and partners is enabling a pilot at 5 South Island sites totalling 5000 hectares. Preliminary levels of success will be reported but at the time of writing appear better than 90% target reduction in wasp activity. The science investment for this tool has been more than a million dollars. The return on that effort is likely to make this very worthwhile on public conservation lands but more tools are needed to mitigate wasp impacts at much broader scales than can be achieved by bait stations alone.

Seaweed, kelp flies, wasps and global warming.

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Rise in sea temperature of the East Australian Current is having profound effects on marine life along the coast of New South Wales, Victoria and Tasmania. We postulate that its effect on reducing the brown alga *Durvillaea potatorum* will have a flow on effect on the specialised insect community that uses it as a food source when it is washed up on the beach. This study looked at the kelp flies and their parasitoids along the eastern Tasmanian coastline, which is strongly influenced by the EAC, and King Island in Bass Strait where introgression of the EAC is less pronounced. Results are preliminary and may be used as a baseline to monitor changes over time.

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The potential global distribution of the Bronze bug, Thaumastocoris peregrinus (Hemiptera: Thaumastocoridae)

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Eligible for student prize

Thaumastocoris peregrinus is a sap-feeding insect native to Australia that has become a serious global pest of *Eucalyptus* species. In 2012 *T. peregrinus* has been found in more than ten countries across Europe, Africa, South America and Oceania. In this study, we used the climate modelling software CLIMEX and *T. peregrinus* geographic range in Australia and Brazil to predict its potential distribution globally, and in New Zealand. CLIMEX parameters were based on experimental data obtained on thermal development and from records collated from its native and invasive distribution. Our model of the potential native geographic distribution closely agrees with the known distribution of *T. peregrinus* and also predicts potential expansion into more tropical areas of Australia. In New Zealand, the predicted potential distribution of *T. peregrinus* matches with its current distribution and it is predicted that the species will be able to establish in most of the warmer areas of the North Island and in northern and eastern regions of the South Island. Globally, the model predicts that *T. peregrinus* has the biological potential to establish in many more of the world's temperate, mediterranean and subtropical areas. CLIMEX projections of potential suitability for *T. peregrinus* presented here may prove useful for risk assessments and for the identification of areas susceptible to invasion by this pest.

Temporal dynamics activity of invasive *Vespula* spp. workers in Argentina.

Maité Masciocchi [*1], Juan Carlos Corley [1]

[1] CONICET-INTA

The fluctuations in activity levels of insects depend on the success of reproductive individuals, which in turn are affected by a combination of endogenous and exogenous factors. In social insects however, the abundance of individuals is largely explained by the activity of workers outside the nest. This is because the population defined as the number of nests, usually associated with one or a few reproductive females or queens, may not explain the considerable variation that can be observed in the number of workers among them and during nest phenology. For invasive social wasps, such as *Vespula germanica* and *V. vulgaris* in several countries and regions of the Southern Hemisphere, the drivers of worker abundance are important because they can determine the impact these species have on the native systems and, as they have become urban pests that may sting, how and when the pose a major risk to people and their goods. Our aim was to understand, the activity of workers of invasive populations of *Vespula* spp., by analysing the relative importance of endogenous and exogenous factors on worker local abundance, in Southern Argentina. This is the first attempt to model the activity levels of *Vespula* spp. over time. We show that in, as expected, the annual worker activity of *Vespula* spp. wasps presents fluctuations over the years, showing no periodicity within the time window studied, and mainly influenced by the mean atmospheric pressure. However, within a flight season, the levels of wasp activity are influenced by the workers abundance in a previous time. This work provides useful information to understand the fluctuations and driving factors that affect *Vespula* spp. worker activity in an invaded area. This could be a necessary step to develop and revise plans to control and/or management this invasive species.

Cryptic diversity in Northland landhoppers

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Landhoppers (Crustacea: Amphipoda: Talitridae) are a conspicuous element of the leaf litter fauna of New Zealand. Currently, six endemic and two introduced genera are recognised in New Zealand. The endemic genus *Waematau* has five described species, all restricted to the northern North Island. A large-scale pitfall trapping survey of ground-dwelling invertebrates was conducted in the Te Paki Ecological District at the northern tip of the North Island. Examination of numerous specimens of *Waematau reinga* from the survey revealed variation in this species. Three subgroups of *W. reinga* could be identified from subtle differences in a set of morphological characters. The characters included differences in body size, length of the second antenna, depth of the palm on the propod of gnathopod 1, shape of the sixth coxal gill, and the number of spines on uropods 1-3. Although the three taxa otherwise bear a very close morphological resemblance to each other, molecular analysis of samples collected in sympatry strongly suggests that they constitute distinct gene pools, indicating the presence of cryptic species. These findings have consequences for conservation management as one of the new taxa has only been recorded from one location, and in very low numbers. Further investigations in Northland have revealed cryptic diversity in other species of *Waematau*; for example, an undescribed species from the Poor Knights Islands is morphologically almost identical to *W. unuwhao* from Te Paki, but molecular analyses again suggest they are distinct. Observations from further afield also indicate that crytpic diversity is likely to be a general characteristic of New Zealand landhoppers, suggesting that the talitrid fauna in this country is considerably richer than previously thought.

Temporal responses of spider communities to mammal pest control

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Eligible for student prize

Introduced mammals are known to have extensive impacts on New Zealand invertebrates, but community-level responses to mammal control remain largely unknown. It is unclear whether the levels of pest control applied within sanctuaries on the New Zealand mainland are sufficient to allow recovery of these communities. Those sites where invertebrates have been sampled following pest mammal control are frequently unanalysed or unreported. This study aims to investigate the response of spider communities to sustained pest control by examining 15 years of pitfall trap samples collected each summer at Boundary Stream Mainland Island (BSMI), Hawke's Bay, New Zealand. This will be compared to nearby communities where no pest control has been undertaken. Spiders will be extracted from these samples and will initially be sorted using observation of external morphology into recognisable taxonomic units. From here, genera or species identifications will be determined with the assistance of taxonomic experts. Changes in spider species composition and abundance over time and variation between sites will be analysed using multivariate methods. We predict that mammal pest control at BSMI has resulted in an increase in spider abundance and diversity over time relative to sites with no pest control. We also expect that the specific responses of spider species will vary, and that these data will suggest which spider species suffer most from the impacts of invasive mammals. This will be the first known study to examine the temporal dynamics in spider communities in New Zealand over an extensive time period. It will provide important insight into the way mammal pest control affects these communities and whether control regimes are sufficient to increase spider abundance and species richness. This has important implications for conservation management of invertebrates and the restoration of ecological communities in New Zealand.

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How effective are different lights for collecting adult aquatic insects?

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Eligible for student prize

Light-trapping is a common method used to collect flying insects, including adult stages of aquatic species. Most commonly, a light for attracting insects is suspended over a dish of liquid into which they fall, or the light is positioned inside a trap and insects are directed into a container of preservative. The light used to attract insects ranges from low-intensity fluorescent tubes run by batteries, to high-intensity vapour lamps run by a generator. Light in the ultraviolet spectrum is preferred, and an assumption of 'the brighter the better' is generally made. A literature review revealed little useful information on the effectiveness of differing wavelengths or intensities of light for trapping aquatic insects. We therefore decided to examine the effect of differing light configurations on capture rates of adult stages of aquatic insects. In a field trial using five Northland forest streams, over eight consecutive nights in late October 2013, we tested the effectiveness of different lights – Blacklight (BL), Blacklight-Blue (BLB), Cold White light (CW), and a BL/CW combination – to attract adult aquatic insects. We tested these at two low intensities (16 or 32 watts). Catches were analysed for species richness and abundance of Ephemeroptera and Plecoptera, and abundance only for Trichoptera (caddis identification still in progress). All light types attracted adult Ephemeroptera, Plecoptera and Trichoptera but BLB and BL lights were most effective. 32 watt lights were more effective than 16 watt, however differences were not significant ($P > 0.05$). Also, in the interest of reducing non-target taxa we investigated the abundances of terrestrial Coleoptera, Lepidoptera and Diptera. Terrestrial insect results mostly mirrored those of the aquatic taxa, however BL outperformed BLB for Lepidoptera. This may indicate that BLB could be more useful in aquatic studies, producing good aquatic insect catches with less by-catch, though more testing is needed.

Translocation of the endangered braided-river grasshopper *Brachaspis robustus*

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Brachaspis robustus is a nationally endangered grasshopper found only on riverbeds and associated terraces in the Mackenzie Basin braided river systems. They are cryptic and specialised in their habitat use and have small, patchy, declining populations. Invasive weeds and introduced predators are thought to be the main factors threatening *B. robustus* survival, and populations are expected to continue to decline without management. Unfortunately we know little about *B. robustus* ecology or the exact nature of threats to its survival, and have no effective tools for its recovery. Canterbury University, the Department of Conservation and Environment Canterbury have commenced a project to better understand grasshopper ecology and the importance of predation and disturbance on grasshopper persistence and population growth. Here we showcase the first stage in the study; the implementation of a wild-wild grasshopper translocation to learn about the importance of predation on grasshopper populations. Six 15m^2 riverbed habitats were created on the Lower Ohau River terraces using local mixed river gravels. Three plots were located inside a predator-proof fence and three others in an adjacent area without an active predator-proof fence. 186 grasshoppers were collected from five wild populations. Individuals were sexed, measured and marked before being distributed between the six plots. Initial monitoring indicates grasshoppers survived the translocation and are continuing to develop all in the release sites. Predator density, grasshopper survival and grasshopper dispersal are being assessed fortnightly. Monitoring and research will continue in the plots for several years to fully understand predation dynamics and to assess the suitability of methods for future successful translocation of this species into natural habitats within the historic range of *B. robustus*. Outcomes will be used to support management strategies to promote long term species recovery and persistence.