Messages from Below: Bugs Biodiversity and Nature Literacy

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If we are serious about the future of our Planet we'll need to reconnect our next generation to the Natural World. With the proliferation of personal devices and social media, "Nature Literacy" is fast becoming a thing of the past and the training of teachers generally does not place much emphasis on science and the biological disciplines. Yet, by using the environment as a context for education we can make a real difference to the way our younger generation engages with their natural surroundings and the ecosystem services we so depend on. And entomology is one of those little topics that makes a big impact!

Could exotic species save us from the pollination crisis?

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Eligible for student prize

Globally, agricultural intensification is a primary driver of declines in critical ecosystem services, such as pollination. However, exotic species are often well-adapted to human-modified environments and could compensate for ecosystem services lost from native species due to agriculture. We measured pollination services provided by wild insects to a mass flowering crop, pak choi (*Brassica rapa*) at 12 sites, across an agricultural intensification gradient. We found that exotic insects over-compensated for loss of pollination services from natives insects as agricultural land-use intensified. This was driven by increased dominance of functionally effective exotic insects in high-intensity agricultural landscapes. Thus we suggest the potential positive impacts of exotic insects on ecosystem services should be considered, particularly in systems subject to strong anthropogenic disturbance where native species have declined. However, management to conserve and enhance natural habitat for diverse native insect pollinator communities should be prioritised to maintain pollination services that are robust to future environmental change.

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Understanding the role of sound in insect communication - insights from bark beetles

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Eligible for student prize

Abstract The golden-haired bark betle, *Hylurgus ligniperda* (Coleoptera: Curculionidae: Scolytinae), imposes a significant threat to New Zealand pine log exports. To date, control strategies against this invasive insect have relied heavily upon fumigation treatments, particularly Methyl bromide. Most bark beetles produce acoustic signlas that have been implicated in defence, courtship, aggression and species location and recognitition. The use of acoustics has already been found to effectively deter some invasive bark beetle species (*Dendroctonus frontalis* and *D. brevicomis*) from entering pine logs. Although the ability to produce sounds by *H. ligniperda* has been acknowledged for decades, nothing is yet known as to the relevance of acoustics in the behaviour of this species. Thus, our main aim was to investigate the functions and characteristics of the acoustic signals produced by *H. ligniperda* and the role of sound in intraspecific communication under various ecological contexts; distress, mating, competition and territoriality. We found that the use of sound in beetle communication is context-dependent. The results of this study and the implications for future research on acoustics as a deterrent or behaviour- modifying tool for *H. ligniperda* control will be briefly discussed in this presentation.

Imidacloprid effects on New Zealand mayfly nymphs: acute and chronic exposure and interactions with natural stressors

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Eligible for student prize

Neonicotinoids, the most widely used group of pesticides worldwide, are perceived to be a safer alternative for wildlife and for humans due to their specificity to insect receptors in the central nervous system, and because their physicochemical properties lend them advantages in terms of ease of application and effectiveness against pest insects. However, these properties also mean they are highly toxic to non-target invertebrate species and readily enter surface waters. Effects of neonicotinoids on freshwater invertebrates have been increasingly investigated in recent years, and mayfly larvae are particularly sensitive. In New Zealand, almost nothing is known regarding the impact neonicotinoids may have on freshwater invertebrates. In this talk I will describe a series of laboratory toxicity experiments, including one 96-hour study and two longer 'chronic' studies using *Deleatidium* spp. larvae and imidacloprid, a neonicotinoid. Results of the 96-hour study showed no difference in toxicity between 'pure' imidacloprid and Confidor, one of its commercial formulations. The two chronic studies together aimed to explore the individual and combined effects of constant low-level imidacloprid exposure, food availability and mayfly density on *Deleatidium* larvae. Low imidacloprid concentrations had severe lethal and sublethal effects on individuals. A prior starvation period had delayed effects on mayfly responses, with some evidence that starvation amplified the effect of imidacloprid on sublethal responses. These findings suggest that periods of food shortage may worsen the impact of exposure to imidacloprid in the stream environment. Worldwide, few studies have explored interactive effects between neonicotinoid exposure and biotic variables on freshwater insects.

Impact of simulated *Paropsis charybdis* defoliation on Growth of Young *Eucalyptus bosistoana* in a Dryland Field Trial

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Eligible for student prize

Eucalyptus bosistoana is being considered as a new plantation species for dryland regions of New Zealand. However, outbreaks of insect pests, like the defoliator leaf beetle *Paropsis charybdis*, have a history of significantly reducing eucalypt growth and productivity to the extent that chemical pesticides are often used to control them. This study aims to assess the impact of simulated *P. charybdis* defoliation on *E. bosistoana* growth in a plantation on a dryland farm in Marlborough. Seven treatments were used to assess growth impact of different severity, frequency and timing of defoliation: control (undefoliated), moderate and severe defoliation in spring, summer and spring plus late summer respectively. Following defoliation in October 2015 (spring) and/or April 2016 (late summer), tree growth was measured over a period of 18 months at one to two month intervals during the growing seasons. All defoliation treatments significantly reduced stem diameter growth rate, except moderate defoliation in spring. However, there was no significant difference between the impact of severe compared to moderate defoliation treatments on stem growth rate. Moreover, Increasing defoliation frequency (i.e. defoliating in both spring and late summer) did have a significantly greater impact on severely compared to moderately defoliated trees. Defoliation impact on tree height growth was similar except increasing frequency of defoliation significantly reduced growth rate of both moderately and severely defoliated trees. Understanding the impacts of defoliation severity, frequency and timing is important for tree growers who want to implement environmentally sustainable pest management such as avoiding or reducing chemical pesticide applications. Our preliminary results suggest moderate defoliation in early spring alone may not warrant pest control.

Pest eradications will be good for human health too! Some pest mammal & invertebrate vector scenarios in NZ.

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The local and proposed national eradication, or control to a low level, of some mammal pests, notably possums, stoats and rats, will benefit NZ by removing potential wildlife reservoirs of some human and livestock pathogens. This in turn will reduce the risk of certain zoonotic and vector-borne infections becoming established here, although NZ already incurs a burden of imported human disease carried by infected travellers. Three NZ scenarios involving invertebrate vectors of zoonotic pathogens and potential vertebrate reservoir species, and for which there are elements of risk already present, are outlined. Climate change and urbanisation effects will be added to this.

A sense of taste

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Gustatory receptors, housed in specialized gustatory sensillae, mediate an insect's decision to accept or reject a host. The dynamics of receptor-ligand associations are largely unknown for gustatory receptors in pest insects. A class of these receptors, the sugar sensing receptors, were studied using the yellow fever mosquito, *Aedes aegypti*, as a model organism. In our two-choice feeding bioassays, 3-4 day old female mosquitoes preferred to feed on the sugar trehalose over water (at all tested concentrations) and trehalose plus an amino acid (at specific concentrations of amino acid – eg., leucine 0.001, 0.01 & 0.1mM) over trehalose alone (trehalose concentration kept constant- 10mM). Interestingly, the tested female mosquitoes didn't show any preference between an amino acid alone (all tested amino acids) and water. Single-sensillum electrophysiological studies revealed that some labellar taste sensillae (eg., RD4) increase their neuronal firing rate on contact with a combined amino acid (e.g., leucine) sugar trehalose diet compared to sugar trehalose alone. Two gustatory receptors expressed in labellar tissues were identified as candidate sugar receptors potentially facilitating a synergistic electrophysiological and behavioural response on contact with sugar plus amino acid diets. These two receptors were initially tested for their sensitivity and specificity for binding to trehalose, through *in vitro* heterologous expression in *Spodoptera frugiperda* cells (*Sf*9 cells) and live cell calcium imaging. One of the two tested receptors showed a dose-dependent response to trehalose and further testing with this receptor revealed that it is more likely implicated in a synergistic response to leucine enriched trehalose diets.

The origin of New Zealand's life: can historical biogeographic research be regarded as scientific?

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All biologists have at least a passing interest in the deep history of the life-form they study – where it belongs in the evolutionary scheme; and especially for those of us here in New Zealand, more than a passing interest in how it has come to be here on these islands of ours. The 'discipline' of Historical Biogeography thus draws on wide interests, yet is frequently fraught with controversy based on entrenched viewpoints and missing data. Can our interpretation of the origins of New Zealand's life be regarded as a verifiable scientific endeavour? Or is it simply a bunch of narratives – the best stories of the day? Are our stories progressive? These questions are at the heart of the recently re-issued book *Ghosts of Gondwana* which reviews ten years of recent research and discovery in this field. Research that is largely molecular phylogenetics and discoveries of new fossils. Selected case studies, especially of insects, will be discussed to highlight the fragility of our hypotheses and the role of empirical evidence in this field. For New Zealand biogeography, it has been the most exciting and progressive decade ever, enabling us to confirm some previous explanations (like the role of the ice ages) and reject others (like the Oligocene drowning) which could have far-reaching effects on our interpretation of the overall evolutionary story.

The spider tree of life. What does it mean for the New Zealand fauna?

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After a gestation period of over ten years, a massive phylogenetic analysis of spiders has been published (Wheeler et al. 2016). The phylogenetic analysis was performed on a dataset of 932 spider species, representing 115 families, 700 known genera and additional representatives of 26 unidentified or undescribed genera. The dataset includes DNA sequences from three mitochondrial genes (12S, 16S, COI) and three nuclear genes (histone H3, 18S, 28S). These were analysed by multiple methods, including constrained analyses using a highly supported backbone tree from transcriptomic data. Most of the higher-level structure of the spider tree was well supported. Of particular relevance to the New Zealand fauna is the support of a large group termed the marronoid clade, which includes the families Amaurobiidae, Desidae, Dictynidae, Hahniidae, Stiphidiidae, Agelenidae and Toxopidae. These families have been redefined and New Zealand genera have been moved around between them. Numerous New Zealand species in the marronoid clade can be a source of misery when trying to identify them to family but now many can be cast into Desidae, which has been redefined to include five subfamilies, four of which are found in New Zealand: Amphinectinae, Ischaleinae, Porteriinae and Desinae. Wheeler WC, Coddington JA, Crowley LM, Dimitrov D, Goloboff PA, Griswold CE, Hormiga G, Prendini L, Ramirez MJ, Sierwald P, *et al*. (2016) The spider tree of life: Phylogeny of Araneae based on target-gene analyses from an extensive taxon sampling. *Cladistics*. DOI: 10.1111/cla.12182

Short- and long-term management options for an introduced parasite of Darwin's finches in the Galápagos Islands

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Philornis downsi is a bird-parasitic muscid fly native to mainland South America. It has invaded the Galápagos Islands where it is seriously diminishing populations of most species of Darwin's finches. We studied and compared the rates of bird parasitism by *P. downsi* in its native range in mainland Ecuador with those found in their introduced range in Galápagos. Parasitism rates were much lower in mainland Ecuador than those found in the islands. We uncovered four parasitoid species attacking *P. downsi* in mainland Ecuador and conducted host-specificity tests on them. One parasitoid species, *Conura annulifera*, exhibited high specificity in quarantine experiments in the laboratory and is being considered as a candidate for importation biological control of *P. downsi* in the Galápagos Islands pending further study. In addition, we are assessing the feasibility of a short-term, stop gap solution to help the Galápagos birds until a more permanent solution is found and implemented.

Quantifying the effect of radio transmitter attachment on bumble bee flight and behavior

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Radio telemetry has become a useful tool for insect studies, but the ratio of transmitter weight to insect body weight remains a limiting factor. Guidelines for transmitter application to invertebrates are generally borrowed from other taxa, and the assessment of transmitter effects has been limited to observations of whether or not a study insect continues to fly and forage. We methodically evaluated the impacts of transmitter attachment on flight mechanics and foraging behavior of queen buff-tailed bumble bees (Bombus terrestris) using a wind tunnel, high-speed camera, and large outdoor flight arena. We detected changes in wingbeat frequency, stroke angle, and body angle associated with transmitter attachment, and corresponding changes in flower handling time. This represents a major first step towards new guidelines for telemetry of insects, particularly load-carrying Hymenoptera.

Filling the gap for community groups

Bryce McQuillan [1], Angela Simpson [*1]

[1] Photographing Nature

97% of the diversity of life is invertebrates. Community conservation groups and citizen scientists have an increasingly important role in managing and protecting our biodiversity. There are 420 groups registered on NatureSpace (as of 30 March 2017). There is currently a limited variety and depth of readily-available resources to assist these groups in identifying live invertebrates or managing invertebrates in their reserves. Consequently, these groups often tend to neglect the importance of invertebrates, or invite specialists to help them understand this group of animals. Benefiting on the night of the event, these groups are then left to figure more out by themselves. There is a gap of resources for them to use, and then our specialists are bombarded by endless low-quality photographs or descriptions of common species. In many cases this leads back to the community group neglecting invertebrates. I will talk about my current project through which I am to improve enable community groups to gain more confidence and efficiency in identifying invertebrates, and therefore make a more meaningful contribution to the science of entomology. Using examples from groups such as slugs and spiders, I will show how I am creating a useful and relevant resource for community conservation groups such as Aongatete Forest Project. This resource will have clear, photographs of each species on a white background. The individuals will be photographed alive, in natural positions on a white background to make them easily identifiable. The photographs will be supported by interesting facts about the general group or family, and comparisons between these groups. The emphasis of the resource will be on identifying a subject to a general level (e.g. “longhorn beetle”, rather than “beetle”) before identifying to species level because this often requires experience with the group.

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Building Bug Lab

Phil Sirvid [*1]

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Te Papa's *Bug Lab* exhibition was conceived as a cross-generational science-based touring exhibition. At time of writing, it has already passed the 100,000 visitor mark. This talk looks at the development of this exhibition including the science behind it and the collaboration with the multi-award winning Weta Workshop that helped bring it to life.

Reviving entomology at the Whanganui Regional Museum

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Whanganui's museum opened in 1895 to display a private collection of Māoritanga and natural history specimens; at the time it was the fifth-largest museum in New Zealand. Until about the 1950s it was actively science-focussed, recovering the Mokoia meteorite in 1908 and excavating thousands of moa bones at Makirikiri in the 1930s. Since then the natural history collection has stagnated, with all subsequent curators concentrating on expanding the social history collections or archives. My position as Curator of Natural History was created in 2013, and much of my work has been sorting and identifying the bird, mammal, reptile, and snail collections. Entomology is represented by several donated private collections, some with data. I've been in the enviable position of developing an entomology collection policy to support the Museum's role in representing Whanganui regional biodiversity, and have embarked on a collection programme with the help of volunteers. The first project is pitfall trap sampling of several forest remnants in the Whanganui area, focussing on carabids in particular, to create species lists that might inform conservation priorities.

Biogeographic observations of the Landhopper genus *Waematau* (Amphipoda: Talitridae)

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Currently, five species of landhopper in the endemic genus *Waematau* Duncan, 1994 are recognised, all in the northern North Island of New Zealand. Recent morphological and molecular phylogenetic studies show a further six species can be added to the genus, bringing the total to 11 species in four clades: *W. manawatahi* clade (1 species, described), *W. kaitaia* clade (2 species, both described), W. reinga clade (5 species, 1 described), and *W. unuwhao* clade (3 species, 2 described). The type species for the genus, *W. manawatahi*, is present on the Three Kings Islands, but it is unclear whether its distribution extends to the Northland mainland. Representatives of the *W. kaitaia* and *W. reinga* clades occur in both Te Paki Ecological District on the northern tip of Northland and in mainland forests between Kaitaia and Auckland. Waematau unuwhao is present in Te Paki ED and the undescribed species in the *W. unuwhao* clade is present on the Poor Knights Islands and Hauturu/Little Barrier Island. *Kanikania rubroannulata* is the third species in this clade on the basis of molecular and morphological data, even though *K. rubroannulata* is currently in a different genus and distinctly coastal in its distribution. Our research indicates that each clade tells a different biogeographical story. The biogeographical events that have led to the current distributions of species in the *W. unuwhao* clade appear particularly difficult to resolve, and suggest that a review of *Waematau* is required.

Phylogenetically conserved courtship signalling in web-building spiders

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Courtship can serve many functions, including the provision of information on species identity, mating status and mate quality. Web-building spiders are an excellent model system for understanding how courtship communication systems evolve, as much of their communication occurs within a clearly defined boundary – the web. However, web-building spiders have very poor vision, and so female spiders cannot visually discriminate a potential mate in the web from potential prey. As a result, a female may attack males when they enter her web. We have identified a vibratory signal (the 'shudder') that reduces female aggressive predatory responses during courtship. Evidence indicates that these shudder signals are phylogenetically conserved, but to date we are unsure of the degree of conservation. This is particularly important to discover, as courtship communication is often a species isolation mechanism. We tested whether courtship shudders can function across family-level boundaries. Results indicate that while shudders are conserved, some identification information also appears to be encoded within these vibrations. We compared the structure of shudder vibrations across web-building spiders, and found several key components that likely to delineate male vibrations from prey vibrations in the web. We also examined the relationship between male courtship characteristics and measures of female aggression (e.g. sexual cannibalism). These results provide insight into the selection pressures facing the evolution of communication systems in web-building spiders.

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Ant-mimicry in reverse by a colourful jumping spider from South-East Asia

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Batesian mimics avoid predators by imitating visual, acoustic or chemical signals of a dangerous or unpalatable prey species. Ants are a particularly common model for mimics to resemble. Many predators have a strong aversion to ants because they have an arsenal of defences such as being able to sting, bite or spray acid. *Orsima ichneumon* is a jumping spider from South-East Asia that has been proposed to be an ant-mimic in reverse. They have elongated spinnerets that resemble insect antennae and mouthparts, and strong abdominal constrictions which gives the appearance of an ant's head and thorax. However, *O. ichneumon* are spectacularly coloured, leading researchers to question their likelihood as ant-mimics. We hypothesised that despite their bright colouration, *O. ichneumon* avoid predation using ant-like shape and movement. We conducted experiments using an ant-averse, spider-eating predator (*Portia labiata*) and compared the probability and time to attack between *O. ichneumon*, a closely related typical jumping spider (*Cosmophasis umbratica*), and an ant (*Camponotus auriventris*) found in association with *O. ichneumon*. We found a gradient in the probability of attack, with the typical jumping spider attacked most frequently, followed by *O. ichneumon*, and the ant attacked least often. *Portia labiata* also took longer to decide whether to attack when presented with *O. ichneumon*, compared to the typical jumping spider or the ant. A comparison of outline shape using Fourier analysis also revealed that *O. ichneumon* resembles an ant when considered in reverse, but in normal orientation looks like a jumping spider. Our results suggest that imperfect ant mimicry confuses predators and allows *O. ichneumon* time to escape.

A comparative analysis of sexually selected male traits in New Zealand sheet-web spiders (*Cambridgea* spp.)

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Eligible for student prize

New Zealand sheet-web spiders (*Cambridgea*; Family: Desidae) are medium to large arboreal spiders distributed throughout the New Zealand mainland and on some offshore islands. This endemic genus possesses several interesting morphological traits which makes it an ideal system for making phylogenetically conserved comparisons of morphology across closely related species. Some features of interest in this system are stridulatory organs, complex web structures and exaggerated male chelicerae, all of which vary widely across the genus. Male chelicerae in particular are likely to be sexually selected and we have demonstrated previously that they play a role in mate defense by males in the North island species, *Cambridgea foliata*. However, leg length and body size are also likely to be sexually selected as these are also used in fights between males. It is reasonable to expect that these three traits, chelicera length, leg length and male body size may covary in some way and comparing these traits across the genus may give us insight into their relative importance and into the conditions allowing their development. We use a preliminary molecular phylogeny to begin examining how these morphological traits vary across a range of *Cambridgea* species while taking species relatedness into account.

Monomorium antarticum, Colony Nesting and Colony Response to Local Environment Perturbation

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Eligible for student prize

Here, we explore the nesting behaviour, internal brood transport and collective decision-making in response to an abiotic environmental disturbance in the common and endemic New Zealand ant, *Monomorium antarcticum*. Nests are located about 5-10cm below the ground surface, in a variety of multilinking tunnels, connecting brood filled cavities of various sizes. Because colonies naturally excavate in areas with damp soil, we asked under a rainfall stimulus 1) does the depth of the brood cavity affect *M. antarcticum* decision regarding which brood to move first; and 2) is this subterranean pattern repeatable over time? In the lab, we constructed three, soil filled (180g) ant-farms for each of the three colonies, and simulated regular rainfall by adding 30mL of water in 3mL increments across the surface of the ant-farm every other day. We recorded the distribution of brood throughout the colony at four different time points; before water, immediately after, 10min and 20min after, on three separate days. We observed great fluctuations in brood distributions across the four time points in most brood cavities and across all three colonies. During a rainfall event, brood-filled cavities near the soil surface quickly flooded and drained, yet we no found evidence that workers preferentially moved brood from chambers closer to the surface first, nor was there evidence of repeatable pattern. We conclude that brood transport in response to a rainfall event, in *M. antarcticum* is not necessarily a product of collective decision-making, but instead is more likely the result of individuals responding to temporary fluctuations in their immediate environment.

When is a harem a harem? Insect aggregations and variation in an uncommon mating system.

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Eligible for student prize

Harem polygyny is a well-defined mating system seen in many mammalian groups. A male will defend a group of females from conspecifics and successful defence leads to greater reproductive success. Among a few species of insects, females group together in aggregations that have been defined as harems. But when comparing these groups to what is seen in mammals they do not seem to follow the same conditions. Insect “harems” tend to be much shorter-lived and, as there is generally no parental care from either male or female insects, both sexes have the opportunity to re-mate during the breeding season. However, one of the defining features of harems in mammals is that because females undertake parental care, they are unavailable for remating. In contrast, males who are not required for parental care have the opportunity to acquire multiple mates. The Auckland tree weta (Hemideina thoracica) and the five-spined bark beetle (Ips grandicollis) are two insect species whose mating system is described as harem polygynous and males and females of both species have the opportunity to remate. Both of these species are associated with holes in wood and it is potentially the lack of suitable habitat that drives these insects to form aggregations. The sex ratio in bark beetles within the wood is largely female biased and this could also be a driver of this type of mating system in some insect species. I will explore the relative influence of habitat availability and sex ratio on shaping insect harem polygyny.

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Cavernicolous Combat and Sexual Selection in the New Zealand Weta Pachyrhamma waitomoensis.

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Eligible for student prize

The Orthoptera comprise many classic study species in the fields of mating system evolution and inter-male fighting behaviour, but the rhaphidophoridae have received relatively little of this research attention despite being a basal family and displaying many fascinating traits. Here, we investigate the mating system of the cave weta Pachyrhamma waitomoensis, a subterranean native of New Zealand's Waitomo district, with a focus on the factors that have lead to the species' remarkable, sexually dimorphic hind leg exaggeration; those of the male weta have developed to extraordinary lengths, being more than 1.5 times longer than those of females. These elongated structures appear to be used in two areas of mating behaviour – aggressive competition between males and guarding of females during pairships. To investigate these behaviours I quantify the reproductive benefit to males in defending females, and test the following hypotheses: that males with longer hind legs are more likely to be victorious in aggressive encounters, that escalation of aggression is greater in contests between males of similar leg-length, and that guarding females results in less disturbance to her and this translates into more enduring pairships. Results so far indicate that there are significant advantages to long-legged males in contests, and that guarding females does result in a reproductive benefit. Interestingly, the benefit of guarding females appears not to stem from preventing access by rival males to the mate, but in fending off nuisance organisms that cohabitate in the weta's aggregations.

Riffles and Mosses: Systematics of New Zealand Hydora (Coleoptera: Elmidae)

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Hydora Broun (Larainae) is the sole genus of Elimidae present in New Zealand, containing 7 described spp. Preliminary sorting of specimens indicate that there may be as many as 15 species, but the material has not been critically examined and exact geographic data are lacking to determine if morpho-taxa or valid species are range-restricted or widespread. Based on two-years of field work the species can be classified into three ecological groups: one group with fully aquatic larvae and adults, one with fully aquatic larvae and riparian adults, and a third group that has larvae that are associated with mosses and adults that are riparian. Recent phylogenetic data indicates that the two subfamilies of elmids are not monophyletic, and the presence of riparian and benthic species in the single genus *Hydora* suggests that the behavioural dichotomy between the “riparian” Larainae and “fully aquatic” Elminae may be arbitrary.

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Behavioral dependence in calling parameters of the red-haired bark beetle *Hylurgus ligniperda* (Coleoptera: Curculionidae: Scolytinae)

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Eligible for student prize

We performed an analysis of the behavioural dependence in the variation of the call parameters of the bark beetle *Hylurgus ligniperda*. To achieve this, recordings of 15 males and 15 females were acquired in six different behavioural contexts, namely, distress, normal (no stimulus applied), and both close and distant male-male and male-female interactions. Each chirp was automatically segmented with a threshold- and power-based algorithm in order to estimate two temporal (duration and inter-syllable interval) and three spectral (minimum, maximum, and centroid frequencies) parameters. An additional hierarchical clustering analysis (average linkage), in conjunction with a distance matrix, was used for the computation of the hierarchies of the calls in a dendrogram with the estimation of pairwise similarities in all behavioural contexts. Females produced no calls, but the calls of males consist of strings of simple (monosyllabic) chirps, whose spectro-temporal parameters vary in accordance with behavioural context. Differences in single male studies were found between the calls obtained with no stimulus applied (normal call) and the distress call. In dual interactions (i.e., male-male and male-female), calls from distant interactions were more similar to each other than to any other type of call. In close interactions, a similar case occurred, with male-male (close) and male-female (close) being more similar to each other. Consequently, direct stimulation by either external sources or other individuals was more relevant than acoustic stimuli *per se*. As bark beetles are frequent pest species, we hope that understanding the behavioural aspects of sound production can underpin the development of acoustic tools for their detection in import pathways.

An integrative approach to investigating male contest behaviour in the New Zealand sheetweb spider *Cambridgea plagiata*

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Eligible for student prize

Males often fight to gain access for reproductive opportunities with females. This struggle for access to females has driven the development of exaggerated morphology in the form of male weapons via the process of sexual selection. While spiders are widely utilised to study male contests, this has often been limited to a few charismatic and well-studied groups, such as jumping spiders. However, the contests of web building spiders which do not rely on vision are less well studied. Additionally, spider contests are often studied in isolated laboratory settings in which local population dynamics are overlooked. My research used the endemic sheetweb spider *Cambridgea plagiata* to explore male contest dynamics. Firstly, I explored the natural history and population dynamics of sheetweb spiders in order to understand relevant contextual information about the broader environment in which male contests take place. Secondly, contests were staged in the field to investigate what determined the winner of a given contest in a natural environment. Finally, I investigated the scaling relationship between weaponry and body size to explore the morphological consequences of contest behaviour between males. This robust scope of methodology provides a solid foundation on which to develop further research on this species.

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An unexpected journey: The evolution and biogeography of New Zealand Idiopidae

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The origins of most New Zealand lineages can be traced back to nearby continents, such as Australia. However, evidence suggests that a few lineages have been associated with New Zealand and its supercontinent, Zealandia, since the breakup of Gondwana. New Zealand's endemic trapdoor spider genus, *Cantuaria* (Idiopidae), is one such candidate for a history of Gondwanan vicariance. *Cantuaria* appears dispersal limited and surprisingly speciose. We set out to use dated phylogenies, phylogeographic analysis, and ecological data to infer the history of *Cantuaria* in New Zealand. Were *Cantuaria* in New Zealand since Zealandia split from Australia 80 million years ago, or did they more recently undertake an unexpected journey?

Reproductive behaviour and population viability: An example using sexual cannibals

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Eligible for student prize

Although behaviours are selected for, owing to the fitness advantages they provide individuals, they may affect how robust a population is to negative environmental processes. Sexual cannibalism is an extreme mating behaviour which typically involves a male being devoured by the female immediately before, during or after copulation. Sexual cannibalism is common amongst predatory invertebrates and has been most thoroughly studied in mantids and spiders. Although the individual-level effects of sexual cannibalism are reasonably well understood, very little work has been carried out to investigate the population-level effects of sexual cannibalism. We constructed both a mathematical model and an individual-based model to predict how sexual cannibalism might affect population growth rate and extinction risk. We found that in the absence of any cannibalism-derived fecundity benefit, sexual cannibalism is always detrimental to population growth rate and leads to a higher population extinction risk. Increasing the fecundity benefits of sexual cannibalism leads to a consistently higher population growth rate and lower extinction risk. However, even if cannibalism-derived fecundity benefits are large, very high rates of sexual cannibalism (>70%) can still drive the population to extinction. Pre-copulatory cannibalism was particularly damaging for population viability and was the main predictor of population extinction risk. Surprisingly, post-copulatory cannibalism had a largely positive effect on population growth rate when fecundity benefits were present and in some cases lowered population extinction risk. This study is the first to formally estimate the population-level effects of sexual cannibalism. We highlight the detrimental effect sexual cannibalism may have on population viability if a) cannibalism rates become high, and/or b) cannibalism-derived fecundity benefits become low.

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Crash-testing spider webs to understand the rare, large prey hypothesis

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Spider orb-webs are the ultimate anti-ballistic devices, capable of dissipating the relatively massive kinetic energy of flying prey. Increased web size and prey stopping capacity have co-evolved in a number orb-web taxa, but the selective forces driving web size and performance increases are under debate. The rare, large prey hypothesis maintains that the energetic benefits of rare, very large prey are so much greater than the gains from smaller, more common prey that smaller prey are irrelevant for reproductive fitness. Here, we integrate biophysical and ecological data and models to test a major prediction of the rare, large prey hypothesis, that selection should favour webs with increased stopping capacity and that large prey should comprise a significant proportion of prey stopped by a web. We find that larger webs indeed have a greater capacity to stop large prey. However, based on prey ecology, we also find that these large prey make up a tiny fraction of the total biomass (= energy) potentially captured. We conclude that large webs are adapted to stop more total biomass, and that the capacity to stop rare, but very large, prey is an incidental consequence of the longer radial silks that scale with web size.

A bacterial – scarab mutualism – sex depends on it !

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The New Zealand grass grub *Costelytra zealandica* (Coleoptera: Scarabeidae) is a univoltine endemic species that has colonised and become a major pest of introduced pastures in New Zealand. Female beetles were previously shown to use phenol as their sex pheromone produced by symbiotic bacteria in the accessory or colleterial gland. In this study, production of phenol was confirmed from the female beetles, while bacteria were isolated from the gland and tested for attractiveness towards grass grub males in traps in the field. The phenol-producing bacterial taxon was identified by partial sequencing of the 16SrRNA gene, as *Morganella morganii*. We then tested the hypothesis that the phenol sex pheromone is biosynthesized from the amino acid tyrosine by the bacteria. This was shown to be correct, by addition of isotopically labelled tyrosine (13C) to the bacterial broth, followed by detection of the labelled phenol by SPME-GCMS. Elucidation of this pathway provides specific evidence how the phenol is produced as an insect sex pheromone by a mutualistic bacteria.

Phenotypic variation in ladybirds (Coleoptera: Coccinellidae)

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Understanding how exotic species establish in novel environments and determining their ecological and socio-economic effects are a major focus of ecologists and conservation biologists. Species with greater phenotypic variation are predicted to be more likely to successfully establish in novel environments. However, there are very limited studies that have investigated phenotypic variation across populations and its effect on introduction/establishment success. Understanding how phenotypic variation contributes to the establishment of an exotic species may provide insights useful for developing more effective mitigation programmes against invasive species. Ladybird beetles (Coleoptera: Coccinellidae) are being introduced around the world for their outstanding use as biological control agents against pest insects in many agricultural crops. Some of these introduced species have become invasive, leading to adverse ecological and evolutionary impacts. Therefore, lady beetles are an excellent model to investigate the relationship between phenotypic variation and establishment success. We compared levels of phenotypic variation within introduced (n = 11 species) ladybird beetle populations in Auckland, New Zealand, focussing on size (including wing length), and colour. Initial results indicate high levels of size variation among introduced ladybirds (*Halmus chalybeus*, *Serangium maculigerum*, *Rhyzobius ventralis*). The sample size of native ladybirds is very low compared to introduced species therefore future work will focus on expanding data on native species.

Does loss of flight affect the sense of smell?

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In insects, flight and a sophisticated olfactory system go hand in hand, and are essential to survival and evolutionary success. However, females of many Lepidopteran species have secondarily lost their flight ability, which could lead to changes in the olfactory system of both larval and adult stages. The gypsy moth, *Lymantria dispar*, is an important forest pest worldwide and has flight-capable and flightless populations making this an ideal system to investigate the relationship between flight and olfaction. In the present study we used next-generation sequencing to obtain female antennal and larval head capsule transcriptomes to investigate the differences in expression of olfaction-related genes among one flightless and two flight-capable populations. We also used multiple behavioural assays to establish the effect of flight loss on the use of chemical cues in host-plant selection. A principal component analysis revealed that the gene expression patterns of female antennal transcriptomes are very similar, whereas those from larval head capsules are different from one another. These differences in olfactory gene expression in the larvae appear to be unrelated to the mother's ability to fly, yet they may indicate unique chemosensory adaptations for each population. Behavioural assays suggest that females (both flight-capable and flightless) are unable to make suitable host-plant choices, transferring this responsibility to their offspring. The larvae of the three populations display distinct behaviours in their search for host-plants making use of olfactory, gustatory, or other cues. The climate and host-plant availability from the sites of provenance of these populations suggest that the observed differences are responses to particular ecological pressures. This work supports the theory that secondary loss of flight only occurs when the females no longer play a role in host-plant selection, but provides no conclusive evidence for changes in the olfactory gene repertoire or its expression as a result.

Love at First Sniff? Antennal Architecture and the Use of Olfaction in Host and Mate Location in the Magpie Moth, *Nyctemera annulata*

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Eligible for student prize

Insects rely on chemical information obtained from their surrounding environment when locating biologically important resources. Detection of these chemicals is mediated by the antennae, which are endowed with various sensory structures called sensilla. Sensilla type, distribution, and density may provide important information regarding an individual's ability to detect and process such external stimuli. Moreover, sexual dimorphism in these characteristics within a species may reflect a divergence in sensory functions and requirements relating to the procurement of different resources. We investigated the link between olfaction and antennal morphology in host and mate location in the endemic New Zealand magpie moth, *Nyctemera annulata*. The primary aims of this study were threefold: to investigate whether larvae and adults of this species are capable of detecting and responding to the chemical volatiles emitted from their host plant; to test if adult males can detect and respond to sex pheromones released from conspecific females; and to quantitatively investigate the sensory architecture of larval and adult antennae. We carried out behavioural trials using glass Y-maze olfactometers to examine the first two aims, and complemented these findings with scanning electron microscopy (SEM) to quantify their antennal architecture. Results obtained from the behavioural trials showed that *N. annulata* are capable of using olfactory stimuli in host and mate location, and SEM revealed that larvae and adults possess a range of different sensilla that would permit them to exploit such olfactory stimuli. Sexual dimorphism was also apparent in the overall antennal morphology as well as in the distribution, density, and morphology of particular types of sensilla in adult *N. annulata*, which likely represents a divergence in sensory functions based on the different resource requirements of males and females.

The influence of personality and cognition on antagonistic interactions

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Eligible for student prize

Cognitive ability and personality influence how animals perform essential tasks, such as foraging, predation and defence. Cognition comprises the mechanisms by which animals acquire, process, store and act on information from the environment; these mechanisms include perception, learning, use of memory and decision-making. Animal personality describes behavioural variation between individuals of a species which is consistent over time and context. Personality traits include aggression, boldness and neophilia, some of which are heritable. To date, personality has predominantly been studied in vertebrates. However, invertebrates also possess personalities and are excellent model species, due to their short life spans, abundance, small size and less complex central nervous systems. My doctoral research will explore the influence of personality and cognition on antagonistic interactions between Aussie bronze jumping spiders (*Helpis minitabunda*), their predators and their prey. Jumping spiders can be trained and are visual hunters, which makes them suitable candidates for vision-based, controlled experiments. I will assess the cognitive abilities and personality traits of laboratory-raised *H. minitabunda*, and subsequently assess how those traits influence the spiders' behaviour in inter- and intra-species interactions. I will also evaluate whether cognitive and personality traits influence individual fitness. Further, I will assess whether communities of animals possess a stable balance of personalities and cognitive styles, comprising a personality and cognitive "landscape", and whether these landscapes differ between populations. Finally, I will ask what part cognitive style and personality play in successful self-introduction of a species to a novel environment.

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Can a spider actually get bored?

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Paying attention to a stimulus is costly in terms of cognitive resources. Given the high number of stimuli (and low salience of many of them), animals filter out irrelevant information, but exactly this is done is not entirely understood. The decision as to which stimuli to ignore is risky, as mistakes can be fatal. Habituation describes a decrease in response to repeated biologically irrelevant stimuli over time. We investigated habituation characteristics of *Trite planiceps*, a New Zealand jumping spider which is an active visual hunter by measuring their response decay to repetitive visual stimuli. Spiders were tethered in front of two stimulus presentation monitors and were given a polystyrene ball to hold. Movement of this ball indicates an attempt to turn towards a visual stimulus presented to a specific pair of laterally-facing eyes (anterior-lateral eyes). Response decay is easily measured, as moving visual stimuli trigger clear responses, which were recorded as four categorical variables: optomotor (very fast); fast response; general movement; no movement. Visual salience (conspicuousness) of the stimulus, biological salience of the stimulus, and spider hunger all affected the rate of decay (response decrement). We then tested whether the observed response decay was likely regulated in the peripheral nervous system (suggestive of classic sensory habituation) or the central nervous system. In paired tests, we gave spiders a drop of either water or caffeinated water to drink. As caffeine is a central nervous system stimulant, we predicted that responses would be higher and last longer in the caffeine treatment if response decrement was centrally regulated - as proved to be the case. These findings support the hypothesis that response decrement in jumping spiders is centrally regulated.

Maternal and nourishment factors interact to influence offspring developmental trajectories in social wasps

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The social and nutritional environment during early development have the potential to affect offspring traits, but the mechanisms and molecular underpinnings of these effects remain elusive. We used *Polistes fuscatus* paper wasps to dissect how maternally-controlled factors (vibrational signals and nourishment) interact to induce different caste developmental trajectories in female offspring, leading to worker or reproductive ('gyne') traits. We established a set of caste phenotype biomarkers in *P. fuscatus* females, finding that gyne-destined individuals had high expression of three caste-related genes hypothesized to have roles in diapause and mitochondrial metabolism. We then experimentally manipulated maternal vibrational signals (via artificial 'antennal drumming') and nourishment levels (via restricted foraging). We found that these caste-related biomarker genes were responsive to drumming, nourishment level, or their interaction. Our results provide a striking example of the potent influence of maternal effects, both nutritionally and socially, in influencing transcriptional activity and developmental outcomes in offspring.

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Molecular determinants of risk-taking in the invasive Argentine ant and behavioural variation along an introduction pathway

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Eligible for student prize

Are we driving the evolution of invasive species to our own detriment? Humans routinely transport invasive species around the globe. It has been suggested that this process leads to selection for traits that promote invasiveness. We tested this hypothesis by investigating a risk-taking behavioural syndrome in the Argentine ant, which has successively colonised most temperate regions around the world, including New Zealand. We studied variation in foraging behaviour and aggression in native as well as introduced Argentine ant populations from California, Australia and New Zealand in order to determine if data was consistent with selection of risk-taking along the introduction pathway. We combined behavioural assays, neurochemical and transcriptomic analysis to investigate the risk-taking behavioural syndrome as well as its molecular basis. Our first results show that octopamine – a major biogenic amine – mediates foraging behaviour in the Argentine ant. Behavioural variation within regions was high, but we found no phenotypic evidence for increased risk-taking along the studied introduction pathway. The next step of this study is to perform a global comparative analysis of the Argentine ant transcriptome in the different regions along its introduction pathway. This will help to investigate underlying mechanisms of how evolution and invasion processes may interact, as well as to understand better the molecular basis of variation in a key behavioural trait in the invasive Argentine ant.

The dance of the damselflies: Starvation and its affect on movement behaviour.

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Eligible for student prize

An organism's activity is often linked to differences in their life histories. Previous studies have shown that fast-slow life history strategy dichotomies exist between multiple organisms and within communities of Odonate assemblages. Slow species display a sit and wait behaviour, waiting for prey to come to them, while fast species actively hunt. It is expected that during periods of starvation, the movement behaviour of slow species will decrease to allow survival for extended periods (such as winter) until food becomes available. On the other hand, when fast species are starved, individuals are expected to increase their movements to look for prey that does not exist as they have higher energy requirements. Naiads of two species of damselflies (Odonata: Zygoptera) were collected from a single site in rural Otago, New Zealand. Movement behaviour was recorded for each individual as they starved. *Xanthocnemis zealandica* (a slow species) took longer to starve and moved less than *Austrolestes colensonis* (a fast species). Differences in starvation tolerance and movement behaviour between the two species are consistent for species exhibiting a fast-slow life history dichotomy. However, contrary to expectations, as starvation occurred *X. zealandica* movement increased and *A. colensonis* decreased. The increase in movement of *X. zealandica* is likely to be due to plasticity in behavioural responses. It becomes advantageous for individuals to abandon the sit and wait behaviour and increase their chances of encountering prey. The higher movement rate of *A. colensonis* uses up valuable resources foraging for non-existent prey, once energy is used up, there is no more available and movement decreases before death occurs.

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Individual foraging specialization in the spider-hunting mud dauber wasp, *Sceliphron caementarium*.

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Eligible for student prize

Individual specialization describes the phenomenon where individuals utilize different resources than others. Despite being conspecifics in the same population, individuals occupy separate niches within the community. Though the individual specialization literature has rapidly grown in recent years, the field remains limited by the inability to thoroughly examine the prey items of predators. Due to their unique natural history, mud dauber wasps provide an exceptional system in which to examine individual specialization. Mud dauber wasp females construct mud cells for their offspring in which they pack paralyzed spider prey (between 5 and 25 spiders per mud cell). In this study, we collected the mud nests of thirty female *Sceliphron caementarium* from a single dense population in Otter Creek, Florida, USA. We identified evidence of individual specialization with respect to spider prey taxa (at the genus and family levels), ecological guild, and size. Furthermore, we found that specialists and generalists coexisted within our population, where some females consistently foraged on a single spider species while others foraged across six spider families (with very different morphology, defensive strategies, and habitat). Additionally, when we looked at multiple foraging bouts of a single female, we found that females remained individual specialists over time. We discuss these results with consideration to intraspecific competition, foraging efficiency, and consequences for biological invasions.

Impact of Vespula wasps on New Zealand pollination networks

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Eligible for student prize

International studies have shown that some species of *Vespula* have significant impacts on pollination networks, providing effective pollination in some cases, while in other cases nectar robbing and pollinator displacement occurs, reducing plant fitness. However, there has been little consideration to the potential impacts of *Vespula* wasps on New Zealand's pollination networks. This research aimed to evaluate the role of *Vespula* wasps within 2 natural pollination networks around the Auckland region. Flowering plants visited by *Vespula* wasps were identified and facial hairiness and body pollen loads were determined to assess the potential of Vespula wasps as pollinators. *Vespula* wasps collected nectar from 22 plant species 14 of which were native species. *Vespula* were most prevalent on *Metrosideros excelsa* (pohutukawa) and interference competition was observed between *Vespula* and other floral visitors. This research suggests that individual *Vespula* wasps may be poor pollinators, although high visitation rates may partly compensate for this.

New Zealand Bee Pathogen Programme

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The New Zealand Bee Pathogen Programme is a 3-year research programme funded by MPI. This research is developing MPI laboratory capability for diagnostics in honey bee viruses, trypanosomes, fungi, bacteria and mites. Diagnostic tests are being developed to match international protocols for microscopic and molecular identification of endemic and exotic pathogens known to affect bee health. While the first goal is to have internationally comparable bee pathogen tests to measure the presence or absence of diseases affecting trade and biosecurity, the more compelling goal is to evaluate the association between the bee pathosphere and bee health as measured by colony survival and productivity. Sixty apiaries are inspected and sampled by trained inspectors throughout New Zealand twice a year for five sampling rounds. Apiary managers are also interviewed for details regarding stock management, colony losses and productivity at each sampling round.

Management of giant willow aphid in New Zealand

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Giant willow aphid (GWA), *Tuberolachnus salignus* (Hemiptera: Aphididae: Lachninae), was first recorded in New Zealand in 2013 and is now distributed throughout the country. GWA feeds primarily on species of *Salix* and *Populus*, but has also been recorded in New Zealand on *Malus*, *Pyrus*, and *Coprosma*. GWA negatively impacts New Zealand's rural environment, apicultural and horticultural industries, and poses a human and health threat because of the elevated numbers of wasps associated with the aphid's honeydew. Together with partners, Scion is leading a 3 year MPI Sustainable Farming Fund programme, focusing on management of GWA via classical biological control, host resistance, and short-term mitigation strategies. An update is provided of our challenges and progress to date (year 1 of the programme).

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Evaluation of hemp oil as an enhancement in Feedbee patties for overwintering honey bees

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Colony starvation has been identified as a significant cause of colony loss by New Zealand beekeepers. Sugar syrup supplementation is a common way providing carbohydrates and protein patties are also given. Our concern is that protein patties are very low in lipids that are important precursors for the honey bee pheromones within the hive. In 2015 we evaluated hemp oil as a suitable supplement and in this presentation we will describe the background to the formulation of how much oil to add and describe the impacts on spring bee and brood numbers along with the interactions with five common hive pathogens. Patties were placed in hives in May and again in August. At the end of these months patty residues were weighed and samples of bees collected. Bees were screened for pathogens and degutted abdomens of the August collection were assessed for lipid values. Bee numbers in each hive were assessed at each entry and brood area was measured in late August.

Honey bee hive collapse associated with invasive Argentine ants and viral pathogens

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Eligible for student prize

Invasive species, emerging infectious diseases and their interaction are major threats to global biodiversity. Following reports of heavy ant infestation in honey bee (*Apis mellifera*) hives in the Northland region, we highlight the role of the widespread and invasive Argentine ant (*Linepithema humile*) in the mortality and disease dynamics of honey bees. Over a six-month period, hive survival in apiaries with Argentine ants was 52.8% compared to 89.5% in apiaries without ants. Bees within these hives were afflicted with *Deformed wing virus*, a globally widespread pathogen contributing to honey bee colony losses. Average *Deformed wing virus* infection levels were always higher in bees when Argentine ants were present. Bees in apiaries with ants acquired viral infections up to 220-fold higher than the maximum infection in apiaries without ants. Argentine ants are likely contributing to honey bee hive collapse through the combined effects of predation, hive robbing, and disease. Invasive species can have known substantial effects as predators, but may also have a significant role in disease dynamics.

Test showing honeybees are secure while controlling wasps with Vespex^{R}

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Introduced wasps (*Vespula germanica* and *V. vulgaris*) remain a major invertebrate pest species in NZ, with large impacts on local ecology and economy. In particular, wasps eat honeybees (*Apis mellifera*) with potentially devastating results upon hive health and downstream effects on our nationally important agricultural and horticultural industries. Control of these wasps by finding and destroying each nest has been superseded by a wasp bait station method - Vespex^{R}. Vespex^{R} contains fipronil insecticide (one tenth of one percent) in a protein matrix and has made significant inroads in controlling wasp populations in a variety of conservation, recreation and farming settings. The potential of off-target effects on native invertebrates has been shown as negligible in a decade of trials and appears very low for bees since the bait has no sugars. In our study we examined the potential for fipronil uptake by bees and hives, including fipronil degradation products produced over time. To do this, a liquid chromatography - mass spectrometry (LCMS) assay was implemented and validated as being able to detect the pesticide at sublethal concentrations. Over the course of two years, 480 different samples of bees, pollen, honey, and brood were tested for the presence of fipronil and its derivatives, with only two returning detectable amounts of pesticide. In each case, upon retesting, these two samples were vindicated as false positives. Our study shows that, as predicted, the use of Vespex^{R} in the vicinity of bees does not result in its uptake into hives and it can be viewed as safe for use around apiaries and other areas without off-traget effects.

Giant willow aphid, *Tuberolachnus salignus* – now a major pest of willow trees in New Zealand and its impact on other insects, especially the honey bee and the honey industry.

John McLean [*1]

[1] ApiNZ Science and Research TG

The Giant Willow Aphid (GWA) was first identified in Auckland in 2013. Detailed surveys over the next six months showed it was widely spread throughout New Zealand. In those regions with severe soil moisture deficits the GWA thrived by piercing the stems of willows and producing copious amounts of honey dew. There are only females in the New Zealand population and after the 4th nymphal moult the new adult is ready to birth young at the rate of 3 to 4 per day. The honeydew is readily consumed by wasps and bees. In the case of bees, the complex trisaccharide melezitose is carried back to the hive where it crystallizes in the honeycomb when the bees condition and dehydrate the honey prior to capping. The melezitose crystals block filters and make extraction difficult for the beekeeper.

Notifiable Apicultural Pests to New Zealand

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The Biosecurity (Notifiable Organisms) Order 2016 came into force on 5 May 2016, revoking the Biosecurity (Notifiable Organisms) Order 2010 (SR 2010/265). The only change to the organisms affecting honey bees is the deletion of a *Varroa* mite (*Varroa destructor*) which has established in both North and South Islands in New Zealand. The listed organisms affecting honey bees on the new order include five mites—*Acarapis woodi* (tracheal mite), *Euvarroa sinhai* (Varroa mite), *Tropilaelaps clareae* (Tropilaelaps mite), *Tropilaelaps koenigerum* (Tropilaelaps mite) and V*arroa underwoodi* (Varroa mite), three insects—*Aethina tumida* (Small hive beetle), *Apis mellifera capensis* (Cape bee), *Apis mellifera scutellata* (Africanised honey bee and its hybrids), and one bacterium—*Melissococcus pluton* (European foulbrood). To raise awareness of these organisms we present information on the diagnosis, habitat, host, damage to bees, symptom recognition, distribution and detection techniques of the notifiable apicultural pests. We also discuss some of the measures in place for early detection and potential prevention of establishment of these apicultural pests.

Beekeeping - The Good, The Bad and The Ugly: An Update on the New Zealand Industry.

Frank Lindsay [*1]

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Beekeeping has come to a prominence in recent years through dramatic hives losses through pathogens and possible pesticide use around the world and with the resulting "save the bees" campaigns. In New Zealand there have been losses in recent years but our mild climate has allowed these to be easily made up and in fact hive numbers have doubled in the last 10 years. This doubling has mostly been achieved on the success of marketing of mānuka honey originally started in the early 1990's. However with this success has come a gold rush mentality and with it all the bad things associated with greed. The Government hasn't helped, establishing a goal for honey exports by 2028 of $1.3 billion. We are not a stand along industry. We are associated with all sections of NZ Agriculture, face a number of challanges with densities of 600 hives per square kilometre in some areas at times. Little research has been undertaken on how this impacts on the natural environment, ecosystems and the long-term health of all bee species.

The marine spider, *Desis marina* (Araneae: Desidae): new observations and localities.

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The marine spider, *Desis marina*, is endemic to New Zealand and lives in the intertidal zone. Despite this spider having such a fascinating habitat and biology, there have been few records of *D. marina* since it was first documented (Robson 1877). We will discuss new observations about the natural history of *D. marina* made during a search for this spider to study its silk. A new population of *D. marina* was found and observed at Kauri Point, near Katikati. About 2.5 hours before high tide (at 3-4am) over 50 individuals were seen wandering over sandstone cliffs during a half hour period. After this, the spiders moved into cavities in the cliffs and became very difficult to collect. We hope that by documenting and sharing these observations we will help other researchers looking for and understanding this species.

Development of quantitative monitoring for an endangered endemic grasshopper, *Brachaspis robustus*.

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Eligible for student prize

Methods which efficiently and quantitatively monitor population trends for threatened insect species are essential for interpreting the value of conservation management actions. However, when the species is small, rare and highly cryptic, it can be difficult to achieve. This is the case for *Brachaspis robustus*, a nationally endangered braided river grasshopper endemic to New Zealand. Since the 1990s, populations have declined and become increasingly patchy. However, monitoring methods used over this time have been varied, and at times limited in the quality of data produced. With new management actions planned for *B. robustus*, this study investigates how to optimise monitoring effort to collect more biologically informative, quantitative data. Specifically, the study assesses 1) changes in visual detectability across the active season (November – March), 2) the advantages and challenges of using mark-recapture, and 3) the possibility of optimising visual searches by limiting them to a specific group (e.g. adult females) or search area. Quantitative monitoring of nymphs was found to be compromised by low visual detectability and frequent moulting. It was found that adult females had highest visual detectability and their abundance was greatest in November and December. We conclude that the current monitoring method (a twin transect walk through one population on a single day in February) is insufficient for generating a quantitative account of true population change over time for this species. We suggest monitoring could be improved by being a) conducted earlier in the season to maximise visual detectability and coincide with when counts of reproductive adults are at a maximum, b) conducted over more than a single day to counter daily variability in visual detectability and, c) limited to adult females which are both the most biologically informative and visually detectable group.

Brachyglutine Rove Beetles of New Zealand

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Eligible for student prize

The tribe Brachyglutini (Pselaphinae) is the only tribe within the supertribe Goniaceritae (Staphylinidae: Pselaphinae) present in New Zealand (Nomura & Leschen 2006). Brachyglutini can be recognised from other groups of Pselaphinae by the following characters: abdominal ventrite I short, often barely visible between the metacoxae, abdominal ventrite II much longer than the first, first visible tergite (T4) often longer or the same length than the remaining tergites, ocular-mandibular carinae present, body often more convex and rounded. There are 8 genera of Brachyglutini in New Zealand (those with asterisks are endemic): *Anabaxis, Eupines, Eupinogitus*, Eupinolus, Gastrobothrus*, Physobryaxis*, Simkinion* and Startes*. The natural history, geographic distribution and morphology of the genera are briefly reviewed.

Effect of forest fragmentation on parasitism on solitary bees and wasps in the Chaco forests of central Argentina

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In this study we evaluated the effects of habitat area on the species richness and abundance of trap-nesting bees, wasps and their natural enemies; and also asses the effects of habitat area and host density on parasitism rates. The research was done on 8 fragments ranging in size from 0.5 to 10,500 hectares of Chaco forest in the province of Córdoba, Argentina. During the years 2004, 2005 and 2006 we placed 20 trap nests in each site in October (spring), and at the end of the growing season (April). All nesting traps were taken to the laboratory until the emergence of the adults. In total we obtained 668 nests from 27 species of solitary bees and wasps. The bees belong to Megachilidae and Colletidae families, and the wasps to Pompilidae, Sphecidae, Eumenidae and Vespidae. The parasitoids belong to four families: Eulophidae, Encyrtidae, Chalcididae and Braconidae; and the cleptoparasites belong to Megachilidae and Chrysididae. In contrast to expectations species richness of bees and wasps did not change with habitat area, this is probably due to the spatial scale at which these insects perceive the environment. Also unexpectedly the mortality due to parasitoids significantly decreased with increasing habitat area, possibly due to the fact that the dominant parasitoid, *Melittobia* sp. is highly generalist and has high dispersal ability. On the other hand and in accordance to expectations, mortality due to cleptoparasites slightly increased with increasing habitat area. In the present circumstances the small fragments are able to maintain high species richness; however the pressure of parasitoidism could affect the community in the future.

Investigating *Eadya paropsidis* (Braconidae) as a potential biocontrol agent for the eucalypt tortoise beetle (*Paropsis charybdis*) in New Zealand

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The introduced eucalypt tortoise beetle (*Paropsis charybdis*, Chrysomelidae) is a major pest of eucalypt trees and plantations. The solitary endoparasitoid *Eadya paropsidis* (Hymenoptera: Braconidae) from Tasmania is under investigation as a potential biocontrol agent to target the larval life stage. Species selected for non-target range-testing have diurnal, exposed, leaf-feeding larvae that are active during the summer. Potential non-target chrysomelid species, including two other exotic pests, six introduced biocontrol agents on weeds, and at least one endemic species, were determined to be high priorities for host range testing with *Eadya*. So far host range testing has been undertaken in containment in Rotorua on all non-target species, with the exception of endemic chrysomelinae species. The parasitism rate on exotic non-target species was generally very low, ranging from 0-2.85% following 24 hour no-choice tests, and parasitoids have only emerged from *Trachymela sloanei* (another exotic pest beetle from Australia). Locating, and learning more about the biology of the endemic chrysomelinae species is a priority for the summer of 2017/2018.

Using black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae) for organic waste conversion

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Eligible for student prize

Worldwide, millions of tonnes of organic waste are dumped into landfills or inappropriately disposed of every year, causing environmental pollution and disease transmission, among others. One of the most effective and economically viable approaches of organic waste management is to use the CORS (Conversion of Organic Refuse by Saprophages) system. This is a bioconversion system using saprophagous invertebrates and their symbiotic microorganisms to turn organic waste into fertile organic residue, and nutritious invertebrate biomass. A large body of research has revealed that the larvae of a cosmopolitan non-pest insect species, *Hermetia illucens* L. (Diptera: Stratiomyidae), also known as the black soldier fly (BSF), is a promising bioconverter to be used by the CORS system. Our research aims to investigate theoretical and applied aspects underlying the potential use of BSF in establishing a value-added organic waste management system in New Zealand. The first BSF lab colony in the country has been established and maintained in a semi-artificial environment. As a part of our research, we have determined the suitability of three types of organic waste (brewer's waste, solid phase of pig manure, and semi-digested grass) for bioconversion by BSF larvae. Preliminary results indicate that, among the tested organic waste, brewer's waste is the most suitable material to be used in a BSF-CORS system, while semi-digested grass is the least suitable. The implications of our results and some highlights for future research will be discussed in this presentation.

Films and Debris of Beetles

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Most beetles keep their surfaces free of particulate matter by active grooming, or simply having slick and smooth cuticular surfaces. Many species, however, may be coated by films of fluids of various viscosities and/or coarse to fine particular material, some of it embedded in waxy material or encrustations. The fluids or waxy secretions that form films or cements are produced from glands within the bodies of the beetles, often distributed by special grooves and attachment accomplished by passive or active methods, held in place often by special setae. The exact mechanisms of secretion and attachment are poorly known and have not been fully characterised or described for beetles. Here a brief and rather ad hoc survey of encrustations is presented and examined in some beetle groups to determine their evolutionary and behavioural significance.

North Island Mecodema new species and redescriptions, i.e. a revision

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The genus *Mecodema* Blanchard 1853 (Carabidae: Broscini) is highly diverse with 70 described species spread throughout mainland New Zealand, and many offshore islands. Only 25 described species are found in the North Island, with some regions poorly represented (e.g., East Cape and Northland). After investigating institute collections and six years of pitfall trapping around the North Island a large number of new species have been found. All North Island species are being described (or redescribed) using 104 external and internal characters to determine species validity. Twenty-seven new species or synonymies have been recognised.

Vava'u Archipelago -Kingdom of Tonga: 2014 moth and butterfly survey

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Moths and butterflies were surveyed across the Vava'u Archipelago as part of a large multi-disciplinary biological assessment. Conducted from 13 to 28 February 2014, it involved 7 terrestrial scientists, 10 marine scientists and 18 Tongan Government staff. Fourteen islands were visited. The work was made possible through cooperation between local land owners and business operators together with agencies including Tongan Government, Secretariat of the Pacific Regional Environment Programme and Vava'u Environmental Protection Agency. While many areas on 'Uta Vava'u and its outlying islands retain natural values worthy of protection, eight terrestrial sites were recommended as priorities for conservation action.

Fake News and Alternative Facts

Franz-Rudolf Schnitzler [*1]

[1] Landcare Research

Tiny aliens taking blood samples - unidentified creatures from the deep - microscopic jellyfish - *Phycosecis limbata* (Coleoptera: Phycosecidae) all have been blamed for feasting on human beings causing sleepless nights from itchy swellings on legs and arms for hundreds of beachgoers in the Bay of Plenty. Fake news? Entomologists and want to be scientists are in disagreement on alternative facts. Having been eaten alive myself by a tiny creature on a New Zealand beach I got caught up in the media hype about these human devouring monsters. After some extensive work in sand dunes where *P. limbata* was abundant I will present some alternative facts. I propose to carry out research in the Bay of Plenty area to uncover the mystery surrounding the MOUNT MAULER.

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Enigmatic but not erratic: systematics of dermanyssoid mites

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The diverse mite superfamily Dermanyssoidea comprises over 2600 described species making it one of the most speciose mite superfamilies. The Dermanyssoidea are ecologically labile and particularly prone to forming phoretic, mutualistic, or parastic relationships with larger animals. Their interrelationships have been enigmatic. Their systematics was built upon ideas of morphological and ecological similarity and rooted according to assumptions about "primtive" forms and their supposedly primitive habits. The most specialised taxa tended to be given high ranks. The first detailed morphological analysis of this group shows that some previous assumptions are unfounded. Contrary to some claims there are consistent characters that diagnose some large groups within this superfamily. Various highly specialised forms (eg. Varroidae, Alphalaelaptinae) share synapomorphies with previously established and better-defined subfamilies.

Can gene drives make wasps extinct in New Zealand?

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Development of gene editing technology has led to the implementation of gene drive ideas, first suggested in the early 2000's. Gene drives are a transgenic strategy to 'drive' a transgene through a population of organisms, in effect cheating genetics. By linking the gene drive mechanism to something that upsets the biology of the organism it is possible to cause local extinction of a population. Gene drives have been described in the popular press as being a great solution for New Zealand's Predator Free aspirations, but are they? In this talk I will discuss the possibilities of using gene drives to target that pernicious New Zealand pest; the common wasp.

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Exploring New Zealanders' attitudes, beliefs, and acceptance of novel pest control methods

Edy MacDonald [*1]

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Public acceptance of innovative technologies to control pest species in New Zealand has occasionally been dismissive and met with strong opposition. In our interdisciplinary NSC-funded research, we will use the pest wasp (*Vespula* species, German and common wasp) and rats (*Rattus* spp) as complementary case studies to explore social acceptance (social license to operate) of novel pest control methods. Our research focuses on two groups: the general NZ public and key stakeholders/partners (e.g., iwi, farmers, commercial bee keeping industry). Quantitative and qualitative methods will be used to develop a segmentation model based on participants' views of novel technologies as they align to their values, psychographics, and demographics. Organisations committed to understanding public opinion and acceptance (or lack of) of novel pest control (e.g., DOC, MPI, local councils) can use the segmentation model as a starting point for public engagement. Building upon the segmentation model, we will test the effectiveness of different messages aligned to different values of each segment on their acceptance of novel technologies.

Think again: *Vespula* biocontrol revisited

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European *Vespula* wasps have become invasive in several parts of the world, but biological control against them has so far only been seriously attempted in New Zealand. Parasitoids of the genus *Sphecophaga* were introduced in the late 1980s and shortly thereafter the biocontrol programme was abruptly discontinued. The parasitoids released up to that point established at a limited range and, in the time passed, did not bring wasp populations down to an acceptable level. Wasp populations probably increased further at least in parts of the range. This talk will describe the journey through the renewed interest in the biocontrol option against wasps, which has seen the programme revived in 2014, first with examination of the new species of mite, *Pneumolaelaps niutirani*, which was first discovered on wasps in New Zealand, followed by re-introduction of *Sphecophaga* from a more suitable geographic range, which is nearing completion. More recently we have been awarded funding to explore new promising candidate agents from the wasps' native range – *Volucella inanis*, *Leopoldius coronatus* and *Metoecus paradoxus*. Although not strictly part of the Biological Heritage National Science Challenge, the biocontrol programme links to, and provides support to the Challenge's wasp programme.

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Modelling the potential for 'Trojan Female Technique' control of wasp populations

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Naturally occurring mitochondrial DNA (mtDNA) mutations that cause reductions in male fertility are passed onto the next generation down the maternal line, and thus generally avoid negative selection pressure. This provides grounds for utilising such mutations to cause persistent suppression of pest populations, through the introduction of females carrying those mutations (the 'Trojan Female Technique'). Here we explore the suppressive effects that could potentially be caused by applying this approach to German and common wasps, investigating optimal release strategies of 'Trojan Female' queens through simple stochastic modelling.

Chasing the Trojan Female: Common wasp mitochondrial DNA variants that are associated with low fitness

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A new and emerging pest control method is based on the use of existing mitochondrial DNA mutations, which impair or inhibit male fertility while having little effect on females. It effectively is a variant of the Sterile Insect Technique with the queens carrying these mutations called Trojan females. Mitochondrial genes are typically involved in the energy metabolism and are passed on by the female line only, which allows male harming mutations to accumulate in these genes. We examined fitness effects of mitochondrial DNA in populations of common wasps (*Vespula vulgaris*) in their home range of Belgium and in the invaded range of New Zealand. Within colonies, there was a significantly positive relationship between worker number and new queen productivity, though the slope of that relationship was significantly lower in the New Zealand population. We suspect that this lower queen productivity in New Zealand is due to higher wasp densities with increased levels of competition here. In New Zealand there were three common haplotypes (mitochondrial genotypes) that frequently had high queen productivities. Genetic diversity was higher in Belgium with no dominant haplotypes. Within both countries there were colonies with no or only few queens being produced. In New Zealand, rare haplotypes were associated with this low queen productivity, as would be expected if a lineage had a reproductive defect. These low-productivity lineages may represent pest control candidates, with only slightly deleterious effects on female but severe effects on male reproduction. Further research on male effects in these lineages will show if we have caught the Trojan female.

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Sequencing and community annotation of the *Vespula vulgaris* genome

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The *Vespula vulgaris* invasion of New Zealand has affected vulnerable native invertebrate populations as well as agriculture, tourism and human health, and effective control is a critical issue. Current strategies are limited to pesticides and other chemicals, but these are not effective against high-density wasp populations or in large areas. Gene silencing or RNA interference (RNAi) is a promising 'next generation' pest control method that can be used to specifically interrupt the function of essential genes. This technique requires high-quality genomic sequence for target design. We have prepared a draft assembly of the *V. vulgaris* genome, consisting of 175 million base pairs on 684 scaffolds. Using *ab initio* and evidence-based gene detection algorithms we have annotated 11,556 putative protein-coding genes. Computational gene prediction algorithms perform well, but manual curation of the resulting gene models improves the accuracy of downstream applications including RNAi, for example by correcting annotations of potential targets such as developmental genes. We are now in the community curation phase of annotation, where researchers can add their expertise to computationally predicted models of their favourite genes. We are hosting the *V. vulgaris* community curation on the Web Apollo annotation editing platform at the University of Otago. I will give a short introduction to the curation process and encourage community participation in the project.

Characterisation of the core and community microbiome of *Vespula vulgaris*

Oliver Quinn [*1], Monica A.M. Gruber [1], Tom Wenseleers [2], Philip J. Lester [1]

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The insect microbiome has a critical impact on host fitness, and may be particularly important for invasive species. The intertwined relationships within the microbiome can have a positive or negative impact on the host, causing a shift in microbial balance. Thus, microbial influences acting on the individual host or at the colony level, can potentially drive the ecological success of a population. For the first time, we investigate the microbiota of the invasive wasp *V. vulgaris* in the native Europe and introduced New Zealand range. This wasp can have detrimental effects on recipient communities, causing ecological changes through overwhelming predation of native invertebrates as well as competing with native species for resources. Here we test for microbiota differences in three distinct life stages across the two ranges. Using next generation sequencing techniques, we compared bacterial, microbial eukaryote and viral communities in larvae, workers and queens. Our results demonstrate a change in community composition between life stages. Larvae had greater bacterial, microbial eukaryote and viral diversity compared with that of workers and queens. Remarkably, queens were largely free of microbial eukaryotes and completely free of known RNA viruses. We also highlight evidence of a microbial shift that may have occurred in the invaded New Zealand range that potentially increases fitness of this invasive wasp. Our results support the hypothesis that the microbiome varies between distinct life stages and provides preliminary data proposing differences between the native and invaded ranges.

Managing *Vespula* Wasp Invasion in New Zealand

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Eligible for student prize

Introduced *Vespula* wasps cause severe problems to New Zealand ecosystems. Though *Vespulid* wasps have successfully invaded most of New Zealand's offshore islands, little is known about their abundance and population development on those islands. Anecdotal observations suggest three offshore islands in the Hauraki Gulf and on the coast of the Coromandel (Little Barrier Island, Korapuki and Tiritiri Matangi) have become *Vespula* wasp free following successful mammal eradication. This study aims to investigate the drivers of successful wasp suppression and the prevention of reinvasion. Wasp monitoring will be conducted on different offshore islands along the northern east coast of New Zealand's North Island to measure the relative abundance of wasps and to collect a database on the island's environmental parameters. The combination of wasp trapping and a molecular analysis of paternity levels will allow us to estimate nest densities on offshore islands. The proposed study is novel because it will use a combination of methods (field based and molecular) to assess the density of *Vespula* wasps in low-density areas, whereas previous work has focussed on honeydew beech forest where wasps reach extremely high densities. This database will also serve as a baseline for future investigations on pest dispersal and colonization processes.

Home and away: long-term wasp population dynamics are similar in native and invaded ranges, with spring weather a key influence on numbers

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Introduced species often experience different population dynamics in their introduced and native ranges. We examined the long-term population dynamics of the invasive common wasp, *Vespula vulgaris*, in its native (English) range and its invaded range in New Zealand. Wasp population time series were examined using partial rate correlation functions. Gompertz population regression models and multivariate autoregressive state-space (MARSS) models were fitted, both incorporating climatic variation. Density dependence in wasp populations was similar in both countries, with previous-year wasp abundance the most important variable in predicting intrinsic rate of increase. No evidence of cyclic population dynamics was observed. Both Gompertz and MARSS models highlighted the role of weather conditions in each country as significant predictors of annual wasp numbers. The temporal evolution of wasp populations at all sites was best modelled jointly using a single latent dynamic factor for local trends, with the inclusion of a latent spring weather covariate. That same parsimonious multivariate model structure was optimal in both the native and invaded ranges. Spring weather in both countries has a major influence on wasp numbers, probably through impact on wasp colony initiation and early development. Invasive species may not exhibit different population dynamics, despite considerable variation in abundance throughout their distribution. Keywords: density dependence, invasive species, multivariate time series analysis, partial rate correlation functions, population dynamics

Evaluation of RNAi as a control method for giant willow aphid *Tuberolachnus salignus*.

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The giant willow aphid *Tuberolachnus salignus* is an abundant pest species found throughout New Zealand. The aphids feed by sucking sap from the stems of willow trees reducing the trees' health and vigour. Aphid feeding activity also produces honeydew that attracts large numbers of vespulid wasps, especially in urban parks which causes a public health and nuisance factor. These wasps also predate on some native insects and bees, and rob honey from hives sited near willow trees. Bees also harvest the aphid honeydew and from it make honey with a different sugar content that crystallises in the comb and is unable to be extracted. Many control methods are under development to reduce aphid numbers, including the manipulation of gene expression by RNAi. Using RNAi, willow trees would be injected or sprayed with dsRNA for a gene critical to *T. salignus* survival, and sap feeding would cause dsRNA uptake and aphid death. However, this method relies on the willow trees both taking up and then circulating foreign genetic material for the aphids to then feed on. To determine if this uptake and circulation is likely, we tested the uptake of a dsDNA construct in *Vicia faba* via qPCR. We found that uptake and circulation of foreign genetic material is significantly assisted by the ligation of a tRNA molecule to the dsDNA, and that the DNA can be detected in plant material following feeding, giving promise for this as a method of aphid control. This study will be replicated in willow trees to determine the efficiency of dsDNA translocation and the ability of *T. salignus* to ingest dsDNA by sap feeding.

Angry wasps vs less angry wasps: Colony-level differences in aggression in *Vespula vulgaris* (Family: Vespidae) wasps

Jennifer Jandt [*1], Kevin Loope [2], Jana Dobelmann [3], Monica Gruber [3], Oliver Quinn [3], Davide Santoro [3], Phil Lester [3]

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Social wasps are probably best known for their aggressive and relentless pursuit of anything (or anyone) that disturbs their nest, yet individuals within and between colonies exhibit considerable variation in aggression. Here, we explored the extent to which colony factors (activity level, colony size, reproductive investment, and viral load) can be used to predict colony level defensive response to a simulated predator attack. We show that, although colonies were consistently more or less aggressive within a population, that aggressive response could not be predicted by activity level or reproductive investment. That is, larger colonies are not necessarily more likely to aggressively defend their nest compared to small colonies. Instead, viral load was the strongest correlate of aggression: colonies with high viral loads in workers were significantly less aggressive compared to those with lower viral loads. The underground / in-nest social environment, therefore, may be more important in influencing colony-level aggressive phenotype above ground than colony size or foraging activity rate.

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Foraging activity and survival of common wasp (*Vespula vulgaris*) workers in relation to their body size

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Eligible for student prize

Common wasp (*Vespula vulgaris*) workers within the same colony can show impressive variation in body size. Yet, it is largely unknown whether and how wasp size is linked to individual activity and survival. We studied four common wasp colonies, and used radio-frequency identification technology to measure the lifelong foraging activity levels and survival of *V. vulgaris* individuals of known size. We found that common wasps are incredibly active foragers, and that there is a striking variability in foraging effort and survival between nestmates. Compared to smaller nestmates, larger wasps tended to perform more trips per foraging day. In general, larger individuals were also more likely to become foragers, tended to start their foraging activity earlier, and showed reduced life expectancy. High mortality was associated to the beginning of the foraging career, and a general trade-off between foraging effort and longevity emerged.

Towards the identification of the alarm pheromone of the common wasp, Vespula vulgaris

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The venom of the queen common wasp, Vespula vulgaris was examined by Gas chromatography/electroantennographic detection (GC/EAD) and Gas Chromatograph/Mass Spectrometer (GC/MS). Two compounds from the queen venom consistently elicited an antennal response in both males and workers. The two compounds were synthesised and their identity positively confirmed by GC/MS analysis on two different capillary columns. One of these compounds is novel and described for the first time from any source. These compounds were tested in field trapping trials in a beech forest for the attraction and repellence of social wasps. Results will be discussed in this presentation.

Grasshoppers and gaps: Approaches to strengthen New Zealand insect conservation

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Conservation of threatened insects is close to the hearts of many New Zealand entomologists. Unfortunately, few of us have the time or resources to take the action we might like to promote the exceptional qualities and importance of insects to the wider community, or reverse the declines in our globally unique and fascinating insect fauna. In an attempt to turn my passion for insects and conservation into action, without re-inventing the wheel, I have visited and collaborated with international conservationists to learn from their work and adapt their skills and knowledge to New Zealand problems. This has included visits to France, Germany and Australia to learn about captive rearing, research, and management programs for species including the endangered Crau plain grasshopper and the Lord Howe stick insect. Here I discuss some of the insights these conservation programmes provide, the benefits of international collaborations for New Zealand threatened insect research, and some of the gaps we need to bridge in order to make real conservation gains. In particular, how can we build on the exciting initiatives many ecologists and entomologists are already taking as individuals, and use them to strengthen insect conservation at a national level?

CHANGES IN SECONDARY METABOLITE PROFILES OF *Lupinus bogotensis* IN RESPONSE TO PHYTOPHAGOUS INTERACTION.

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Eligible for student prize

Plants respond to insect herbivory through multiple strategies to counteract the attack-derived effects. Secondary metabolites could be subdivided into constitutive or induced, so synthesis of defense compounds is considered highly dynamic and structurally diverse, depending on damage plant level closely related to insect feed type. However, our understanding of plant-insect defense mechanisms is still limited. Metabolomics provides an opportunity to study plant secondary metabolism-mediated responses to herbivory. Using a high throughput qualitative metabolic fingerprinting method for untargeted analysis, we found that herbivory by two Lepidoptera larvae species over native Andean plant *L. bogotensis* changes alkaloid and phenolic plant composition. Directly-affected plant material by phytophagous-exerted mechanical damage showed the lowest ethanolic extraction yield, however, it globally presented greater abundance and quantity of alkaloids. On the other hand, unaffected leaf samples showed greater abundance of phenolic compounds, whereas localized attack induces alkaloids production (spartein and hydroxyisospartein). Larvae were found to be capable to structurally alter the major alkaloid composition (lupanin dehydrogenation and sparteine monooxygenation/dehydrogenation) or they were able to consume defensive compounds and eliminate them through excretory system without any transformation. On both cases, greater abundance of tetrahydroxystilbene in *L. bogotensis* after phytophagous interaction can be associated to a herbivory-induced response. Present work is the first evidence of this metabolic-mediated behavior against herbivores from a native Andean legume.

Diet-dependent life history of a wolf spider *Pardosa pseudoannulata*

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The wolf spider *Pardosa pseudoannulata* is a generalist predator that inhabits aquatic-terrestrial interfaces, where it preys on a wide variety of insects and an important natural control agent in rice, since it can feed on multiple pest species. Differences in both availability and quality of prey lead to differences in the fitness of the spiders. Mixed-prey diet could improve the fitness of a generalist predator by adding complimentary nutrients to the diet, however, there are few studies investigating the effect of mixed diet on spider fitness. We investigated the survival and growth of spiderlings fed on different prey combinations. Laboratory feeding assays included the following treatments: a single species of Collembola, green leafhopper (*Nephotettix virescens*), whiteback planthopper (*Sogatella furcifera*), and all possible pairwise combinations of these. A starvation treatment was included as a control. The total duration of the experiment was 188 days, carapace width (growth indicator) was measured weekly; survival and frequency of moulting were measured on a daily basis. Compared to single prey diets, provision of mixed diets generally enhanced the fitness parameters of spiderlings, but a mixed diet consisting of two homopterans resulted in early high mortality of spiderlings. The highest survival, frequency of moulting and growth rate were seen in spiderlings fed on mixed diets “Collembola-leafhopper” and “Collembola-planthopper”. Spidelings fed on “Collembola only” diet developed and grew poorly. Spiderlings reared on a monotypic diets “planthopper only” or “leafhopper only” developed only to the third instar and experienced slow growth. The effects of mixed-prey “leafhopper+planthopper” diet were similar to “planthopper only”, but resulted in higher frequency of moulting than “leafhopper only” diet. The results of this study demonstrate that mixed diets can enhance spider fitness, but this enhancement depends on the combination of prey species, which may differ in nutritional quality for a generalist predator.

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Life’s a Beach: A proposal for investigating New Zealand’s wrack communities.

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Eligible for student prize

The distinctive band of seaweed that can be found washed up on most coastlines at the high tide mark, known as wrack, is home to an entire community of invertebrates. Many of these species are unique to this habitat and live very specialised lives due to its transient nature. These invertebrates provide a crucial link in the coastal food chain, as food source for birds, fish, and other invertebrates, and by contributing extensively to the decomposition of seaweed washed ashore. Despite this there has been little work investigating these communities. This is an oversight not only due to their ecological importance, but also because one gets to spend all their days at the beach investigating them. As part of my project I am proposing to investigate the diversity and composition of New Zealand’s wrack communities in two different ways. First, I hope to survey wrack communities throughout the country to build up an image of their diversity and how they might vary across New Zealand. Second, I plan to carry out a more intensive and localised study focused on temporal variation within a wrack community. My main group of interest are New Zealand’s Coelopids, known commonly as seaweed flies, of which New Zealand has a number of native species. The Coelopid mating system involves extreme sexual conflict and scramble competition, a dynamic system that is dictated by the population dynamics present at any given time. Therefore, within this temporal study, along with surveying the invertebrates present and their variation over time, I plan to focus specifically on the population dynamics of the Coelopids, including gathering information on their sex-ratios, abundance, and size variation.

Where The Giant Weta Are: Survival, behaviour and habitat use of the Mahoenui giant weta.

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The last remaining individuals of the original Mahoenui giant weta (*Deinacrida mahoenui*) population are currently restricted to a 187ha mainland reserve in Mahoenui, southern King Country, New Zealand. These weta have survived here in the presence of introduced mammalian predators for almost 6 decades, having found refuge in the introduced woody shrub gorse (*Ulex europaeus*). However, due to natural succession, the reserve is gradually reverting to native bush and monitoring of weta shows potential signs of population decline. Concerns for the species' future survival have been raised as it is unknown how weta will cope with mammalian predators in an altered habitat. We assessed survival rates of Mahoenui gaint weta and predator presence across the reserve, specifically gorse and native vegetation, via radio-tracking of 14 weta and 32 baited tracking cards for predators. We additionally assessed weta behaviour and the use of both habitats. Over the period of observation (3 weeks) no weta were preyed upon in either habitat, however, predator composition differed between habitats: possums dominant in gorse and hedgehogs in native vegetation. Average distance weta moved per day was not significantly different between habitats regardless of sex. Weta in gorse bushes, averaging 3m tall, tended to be found much closer to the ground (1.12m +/-0.09m) than in native vegetation (5m +/-0.34m, in ~5m trees). This result importantly indicated the most probable location of weta, if present, in native vegetation. We recommended further research using a larger sample size and over an extended period to gather conclusive results on survival rates between habitats. Continued predator monitoring was also advised.

The Black Soldier Fly, *Hermetia illucens*: Optimising conditions for production of insect protein as livestock feed

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Eligible for student prize

Insect derived proteins have been proposed as a potential solution to feeding a rapidly growing human population. However, the process of producing insects on an industrial scale is in its infancy and there is a clear need for scientific guidance to support development and growth. One species that is of commercial importance for insect growers is *Hermetia illucens* Linnaeus, the black soldier fly. I am investigating the uptake of omega-3 polyunsaturated fatty acids by the larvae of *H. illucens*. The omega-3 uptake study will focus on the the ability of the larvae to bioaccumulate fatty acids from a microalgal feedstock. Utilising a microalgal feedstock will allow for quality control by the industry, minimising the risk of accumulating heavy metals that may be present in the current practice of feeding the larvae fish offal. The outcome of this study will help guide the techniques used by commercial black soldier fly growers, assisting in the efficiency and uptake of the technology.

Learning and discrimination of cuticular hydrocarbons in ants

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Eligible for student prize

Complex social insect colonies require complex communication strategies. Most notably, the ability to identify friends from foes and discriminate individual roles within the colony are central to their social organisation. Cuticular hydrocarbons (CHCs) are known to be key compounds in nest-mate, caste and species recognition in social insects. Despite our growing knowledge of the nature of these cues, we have very little insight into how social insects actually perceive and discriminate among these chemicals. In this study, we used differential olfactory conditioning with custom-designed synthetic hdrocarbons commonly found on CHC profiles to analyse compound discrimination and learning in the Argentine ant, *Linepithema humile*. Our data show that tri-methyl alkanes are more easily learned than single-methyl or straight-chain alkanes. In addition, we reveal that Argentine ants can discriminate between hydrocarbons with different branching patterns, but that backbone chain length alone is not always a discrimination factor. These results demonstrate that the molecular structure of CHCs influence those compounds that ants can discriminate between and learn better, which are thus likely to play a prominent role in chemical signalling and nest-mate recognition.

Effect of alpha-pinene and *cis*-pinonic acid on host-plant selection and feeding of *Hylobius abietis* on Scots pine

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The large pine weevil, *Hylobius abietis*, is an important pest of forest plantations. The adult weevils feed on young coniferous plants causing significant economic losses. Volatiles emitted by plants are known to influence the interactions between plants and other organisms, including insects. Scots pine, *Pinus sylvestris*, is an important emitter of the monoterpene alpha-pinene. In the atmosphere, alpha-pinene undergoes photo-oxidation leading to the production of *cis*-pinonic acid. Fine particles of *cis*-pinonic acid can be deposited on the plant's surface through precipitation. Alpha-pinene is known for its attractiveness to *H. abietis*, yet it is unknown whether this compound also promotes feeding of the weevil on the emitting Scots pine. Furthermore, the influence of *cis*-pinonic acid deposition on the surfaces of pine trees on the orientation and feeding of the weevil is unknown. The aim of this study was to investigate the effect of alpha-pinene and *cis*-pinonic acid on the behaviour of *H. abietis* on Scots pine. To determine host selection and feeding behaviour we used Scots pine stems treated with four different concentrations of both compounds. We used a multiple choice test between the test compound, a negative control (water) and a positive control (ethanol) to establish the weevil's first choice (for the first hour), and measured the total feeding damage after 48 hours. The results of the study suggest that higher concentrations of both chemical compounds repel the weevil, whereas lower concentrations are attractive. Alpha-pinene had no effect on feeding, but lower concentrations of *cis*-pinonic acid enhanced feeding of *H. abietis* on Scots pine. These results indicate that both compounds play important roles in mediating plant-insect interactions between weevils and their host-plants. Further studies are required to elucidate the critical concentrations at which behaviour changes from attractiveness to repellence and the ecological significance of these concentration changes under natural conditions.

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Honey bee hive collapse associated with Argentine ants and viral pathogens

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Eligible for student prize

Honey bees are at risk from many threats, including invasive species and viral pathogens. Infestations of invasive Argentine ants in the Northland region are reported to cause hive death in both commercial and hobby apiaries. Hives in sites with and without infestation were monitored for five months - those with ants had only 52.8% mean survival compared to 89.5% at control sites. Argentine ants are also hosts to *Deformed wing virus* (DWV), a key player in global honey bee decline. Mean DWV infection was always higher in bees where ants are present. Current management of movement of honey bee hives requires reform to reduce ant spread as no effective eradication method currently exists.