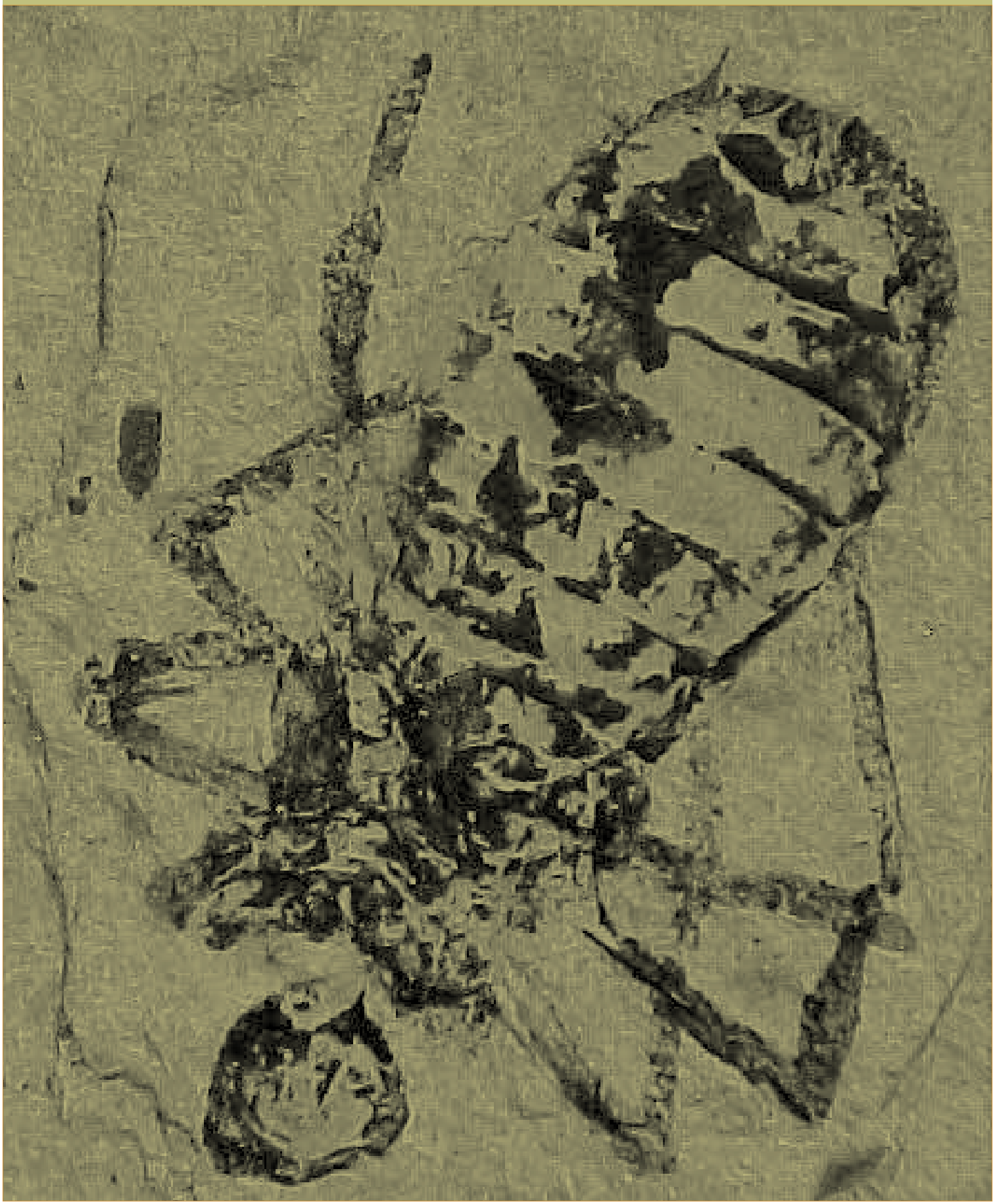
insects

BACKGROUND NOTES

TAMAKI PAENGA HIRA
AUCKLAND MUSEUM



insects

contents

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AUCKLAND MUSEUM

INTRODUCTION TO THE RESOURCE:

The education resources provided by Auckland War Memorial Museum focus on specific galleries or on specific exhibitions in those galleries. There are a small number of resources that were developed for exhibitions that are no longer present but which have been maintained on the website by popular demand.

Visiting education groups may book to request the following learning opportunities:

- Self-conducted visits based on supporting resource materials.
- Gallery Introduction with a Museum Educator or trained guide (approx 15 minutes), using resource materials. Longer gallery tours and Highlights Tours are also available.
- Hands-on activity session for school groups with a Museum Educator (approx 45–50 mins), using resource materials. Students have the opportunity to handle real or replica items from museum collections,

Sessions will be tailored to suit the level and focus of the visiting group.

ABOUT THIS EDUCATION RESOURCE:

This kit has been designed to meet the needs of a wide range of education groups.

The kit is in three separate sections and includes:

BACKGROUND NOTES suitable for all levels

CURRICULUM LINKS from Pre-school to Adult
[these are still under development]

ACTIVITIES Pre-visit, Post-visit and Gallery Activity Sheets

BOOKING INFORMATION

All education group visits must be booked.

Phone: 306 7040 Fax: 306 7075

Email: schools@aucklandmuseum.com

Service charges apply to education groups depending on the level of service required.

Numbers and Adult/Child ratios:

Pre-school	1:3 or better
Y 1–6	1:6
Y 7–8	1:10
Y 9–13	1:30

All groups including Adult groups ought to be accompanied by their teacher or educator.

Adult/child interaction is vital to maximize the value of the museum experience. Group leaders need to have some background knowledge of what the students are expected to cover and they do need to participate in the introduction process on arrival. Knowing about the expectations of the class teacher and the museum will make the visit smoother for everyone.

www.aucklandmuseum.com

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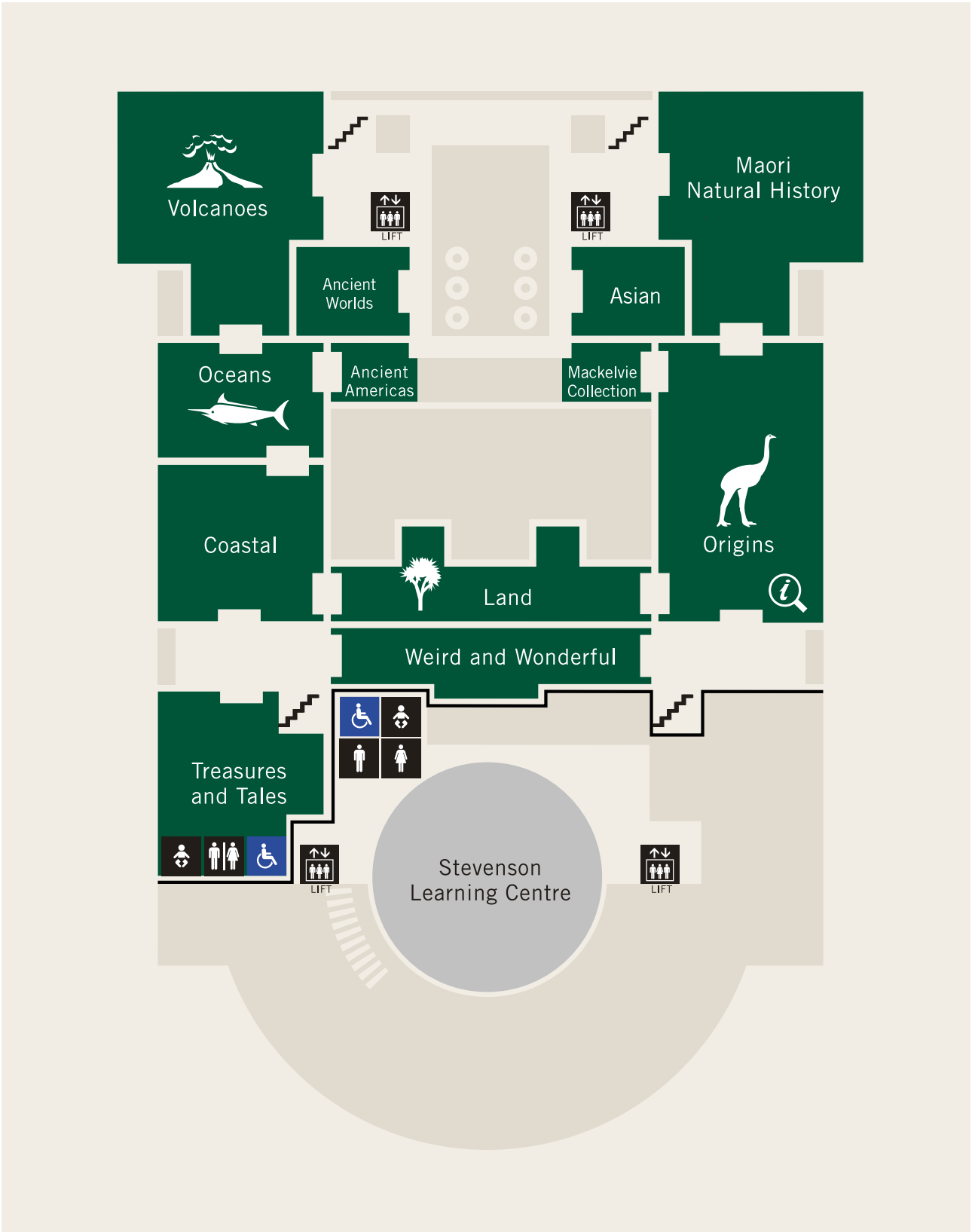
SOME EDUCATION SERVICES AT AUCKLAND MUSEUM ARE PROVIDED UNDER A CONTRACT TO THE MINISTRY OF EDUCATION UNDER THE LEOTC PROGRAMME AND MINISTRY SUPPORT IS GRATEFULLY ACKNOWLEDGED.

This resource traces insect history in New Zealand, from its origins as part of Gondwanaland to the present day nightmare of accidental interlopers. Its content follows the layout of Auckland Museum's Natural History galleries: through habitats from the mountains down to the oceans. The gallery displays end with a glimpse of human impacts on our native flora and fauna.



BUGS AND CREEPY CRAWLIES

Insects and other small animals have both fascinated and repelled humanity throughout recorded history and, undoubtedly, long before that. They are fascinating because of their endless variety, brilliant colours and intriguing shapes. They produce silk, waxes, dyes and honey, and also pollinate many of our crops. At the same time, their incredibly antisocial habits of stinging and biting, infesting food crops and stores, and spreading some of the worst plagues imaginable, are abhorent to humans.

They are everywhere; the most successful and numerous organisms on earth. Virtually any statistic concerning insects defies belief. It has been estimated that virtually any square kilometre may house some 10 billion individuals. The weight of insects eaten by spiders per year is greater than the entire weight of the human population on earth. For every living person on earth, there are an estimated 200 million insects. Surveys of tropical forests suggest that there may be as many as 25 to 30 million arthropod species in the world. The majority of these, as yet, unknown to science.

In the face of these bewildering statistics, most scientific effort prior to the last half of the 20th century, has concentrated on the descriptive. More recently, ecological investigations have shown the vital part insects play in the survival of our planet. They dispose of all manner of dead things, thus returning vast amounts of nutrients to the soil. As pollinators, insects play a crucial role in the cycle of plant generations. They are the keystones of the immensely complex and interlinked ecological structure of our planet. An example of such amazing complexity comes from the Amazonian rainforest. One particular orchid requires the pollination efforts of one species of bee, specially adapted to access this one kind of flower. Bizarrely, only the male bee fulfills this role. It visits the flower, not to collect pollen for food but to gather the orchid's aromatic fragrances. In the process, the flower's sticky pollen bundles attach to the bee's body. The male stores the aromatic compounds in special organs on its back legs, where they are altered slightly. The compounds are thought to play some role in courtship and mating but exactly how, is not clear. They may possibly be used as a pheromone to reassure the female that this male is of the right species: thus, making her receptive to mating. Female bees are never attracted to this orchid's flowers and orchid scents; instead they are important pollinators of forestal trees, especially the economically significant Brazil nut. The Brazil nut tree is not cultivated and only grows in the wild. This reinforces the synchronicity of the reproductive cycle of insects, plants and humans. Hence, the growing realization that our own survival as a species may well depend on insights and understanding of the diversity and interdependence of all living things and the need for their conservation.

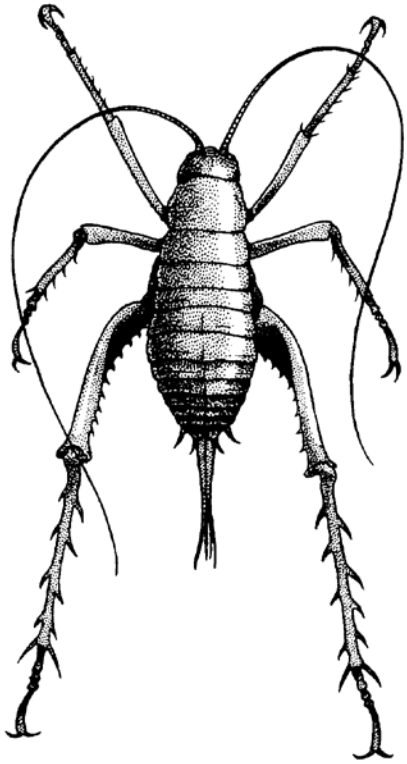
GONDWANALAND INSECTS AND MINIBEASTS

New Zealand is often referred to as an excellent example of "evolution in action". It was perhaps best summed up by U.S. ecologist Jared Diamond who said "New Zealand is as close as we will get to the opportunity to study life on another planet". It is a very important example of an isolated archipelago. While there are other examples of similar oceanic islands (e.g. Hawaii, New Caledonia, Madagascar), New Zealand is the largest and most isolated of them all, and has had dry land for at least 100 million years.

New Zealand has endured many cataclysmic changes since it separated from its mother continent, Gondwanaland some 80 million years ago. The fossil record is therefore far from complete. However, we can still glimpse the past by looking at the present inhabitants and their family links. Despite the passage of 80 million years, modern descendants of ancient Gondwanan animals live on in many groups including insects, earthworms, frogs, lizards and tuatara. These animals all belong to groups which cannot traverse wide stretches of ocean. For example, the extinct New Zealand moa has close relatives which exist on other remnants of Gondwanaland. Over 25 species of peripatus are native to New Zealand and of the 150 species found worldwide, most come from the Southern hemisphere. The peepe tuna (puriri moth or Ghost moth, *Aenetus virescens*) has family in South America, South Africa and Australia. Our pepe pararíki (Common copper butterfly, *Lycaena salustius*) has an extended Gondwanan family.

Unlike our retiring little coastal flier, some of its tropical relations have an interesting arrangement with ants *(Formicidae)*, where the butterfly larvae living in ant nests ooze a sweetish substance as a bribe for their rather antisocial behaviour. The butterfly caterpillars prey on ant larvae.

New Zealand's cool windy climate (especially during



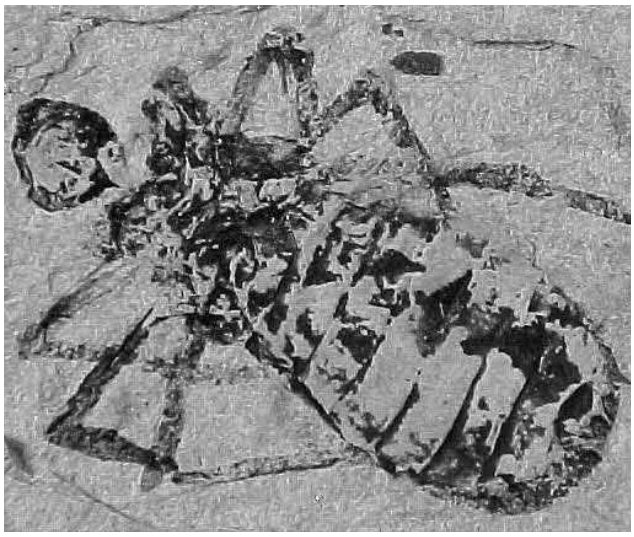
the Pleistocene glaciation) and an absence of mammalian predators have resulted in loss of flight and an increase in size in many insects. Some beetles became large and flightless and restricted to living on a single plant species, e.g. the Flax weevil *(Anagotus fairburni)*.

Giant weta *(Deinacrida*) are the largest insect in New Zealand and can weigh 40–50 grams, which is about the same weight as a thrush. There are 11 species and not all are giant by size — some weigh as little as seven grams. The Giant weta has changed little from its ancestors, which evolved during the Mesozoic era (235–65 million yrs ago).

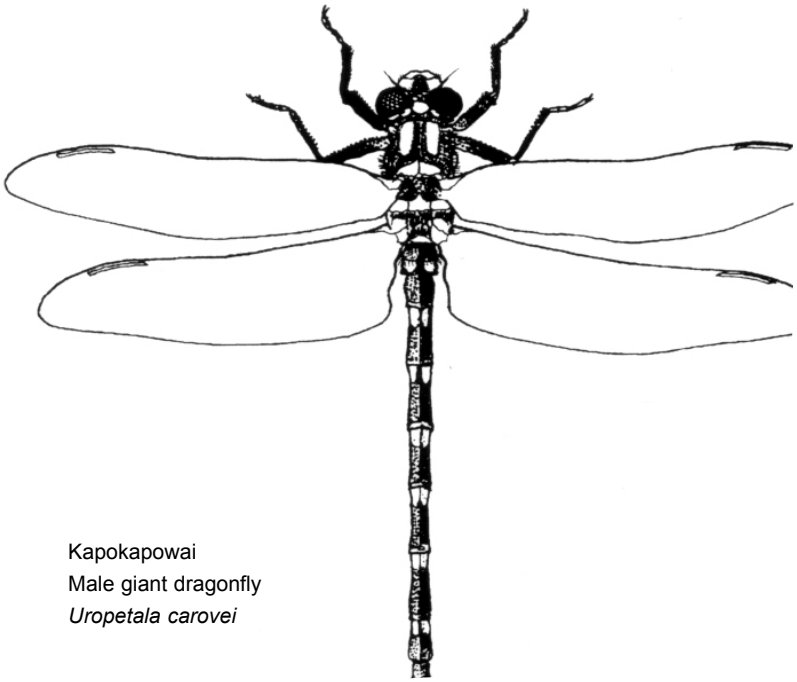
Weta fossils, dating back 190 million years, have been found in Queensland, Australia.

The *Peripatus ngaokeoke* are linked to 550 mil-

lion year-old fossils of similar creatures. During the Carboniferous era, 300 million years ago, insects similar to dragonflies flew through the luxuriant northern coal measure swamps. Some had wing-spans of up to 75cm. This order is now extinct but by the Permian era (between 280 and 235 million years ago) dragonflies, not very different from modern ones, had already become established. A New Zealand example is our own kapokapowai *(*Giant bush dragonfly, *Uropetala carovei*). Dragonflies very similar to this, first appeared in the Jurassic Period and have changed very little since. The family they belong to are notoriously poor at long distance dispersal across oceans, unlike other dragonfly families which fly well. This indicated that our giant bush dragonfly came with the land when New Zealand broke off from Gondwanaland.

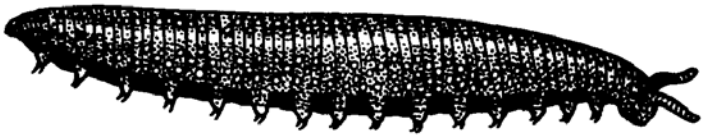


Libellula doris (larval form of dragonfly)
Well-preserved insect fossils such as this 1.6cm specimen from Italy, (approx. 20 million years old) have shown that many insect groups have changed little over millions of years.



Kapokapowai
Male giant dragonfly
Uropetala carovei

Pepe parariki
Common copper butterfly
Lycaena salustius



Peripatus Ngaokeake
Peripatus novaezelandiae

Pepe pouri, Black mountain ringlet
Percnodaimon merula

Speargrass weevil
(Hadramphus spinipennis)

Mountain grasshopper
Paprides nitidus

New Zealand's insect and minibeast diversity can be explored by taking a topographical journey from the alpine zone to coastal wetlands. Insects and other small creepy crawlies show special adaptations to various degrees of environmental pressure and also to the special demands the environment imposes.

MOUNTAINOUS ALPINE ZONE

New Zealand's position on the "Pacific Ring of Fire", a zone of earthquake and volcanic activity, makes this one of the world's most active mountain building regions. The alpine zone is rich in biological diversity, despite alternating conditions of intense cold, heat, wind and dryness. Weta are the largest alpine insects. Of the four alpine weta species, only the smallest, *Hemideina maori*, can survive being completely frozen.

Both moths and butterflies here are adapted to nectar feeding and their evolution has gone hand-in-hand with the development of flowering plants. One that is especially well adapted to harsh mountain conditions is the pepe pouri (Black mountain ringlet butterfly, *Percnodaimon merula*, in some references known by its old name *P. pluto)*.

Its dark colour absorbs every available bit of warmth. It is covered in thick hair for insulation. On sunny days, it sunbathes with open wings, unlike most butterflies whose characteristic resting pose is with closed wings. On cool days, it folds its wings. It also makes use of the heat retaining properties of rock to assist in hatching its eggs. Unlike all other butterflies, which lay eggs on vegetation, this unique specimen lays onto the warm rock. After eating its eggshell, the tiny hatchling needs to crawl off in search of a suitable plant.

Moths are well represented in this environment. Some moths fly during the day to take advantage of the warmer conditions. They can be brightly coloured and patterned but many are small and inconspicuous, flying close to ground level to avoid the high winds. Cicadas are another group of insects, common in the alpine environment. They belong to the genus *Maoricicada*.

Almost all kowhitiwhiti (New Zealand short-horned grasshoppers, *Orthoptera, Acrididae*) are found in this habitat. Eleven out of the 15 native grasshopper species are alpine. They are small insects, whose grayish and greenish-brown colouring blends in well with rocky and tussocky conditions. The females have no wings while the males' wings are rudimentary. Weevils are widespread and dull coloured but can be much larger than their lowland cousins. One species, the Speargrass weevil *(Hadramphus spinipennis)*, can grow to a size of 3cm long. This group of beetles, the weevils, is the most successful of all insects with over 40,000 species throughout the world. There are well over 1,000 species in New Zealand alone! They are often called snout beetles

because of their prominent snout. In the alpine zone they are food for keas, whose sturdy beaks can easily crack the weevils' hard coat.

Various spiders have also become expert at the cold, high and windy life. One highly intelligent and adept group are the jumping spiders *(Araneae: Salticidae)*. They stalk and leap on unwary prey, including other spiders, with fangs unfurled. Experiments have shown that the skills to catch other spiders by surprise are not instinctive but carefully calculated for each new foe. In winter, it spins itself a silken cocoon to retreat under the snow. It uses its sharp eyesight for daytime hunting. Another daytime hunter is the Wolf spider. The female drags her egg sac with her for a month until the spiderlings hatch. The babies then clamber onto her back and ride along until large enough to be independent (about a week). The mother does not feed them and, should they fall off, takes no notice, even going so far as to knock them off purposely when they stray onto her eyes.

CAVES

The most common type of cave in New Zealand is the limestone cave. Other types which exist in New Zealand are marble, lava, sandstone and igneous rock caves. Specialised organisms that are found in these caves include the Cave beetle, which has long antennae and sensory hairs to compensate for its loss of sight. The Harvestman (Order *Opiliones*), often confused with a spider, is a predator foraging on the floor of the cave preying on adult glowworms. This particular one is a common European species. It has stink glands, not poison glands, and cannot make silk.

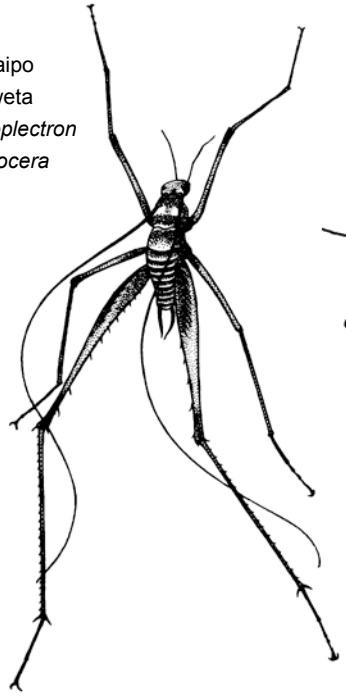
The puratoke (Glowworm, *Arachnocampa luminosa*), larva of New Zealand's most famous fly, casts a luminous glow attracting small insects. The insects become trapped in sticky threads hanging like fishing lines from the top of the cave. Once the victim is trapped, the glowworm pulls in the line and consumes its catch. Emerging from a pupa into brief adulthood, the female continues to emit a light, which attracts a mate.

There are thought to be 60 different species of cave weta, characterized by long antennae, long legs and lack of aggression. Unlike other weta, they neither make sounds with their legs nor can they hear. During the day, they scavenge dead animals on the floor of the cave and venture out at night to forage on plants and fungi.

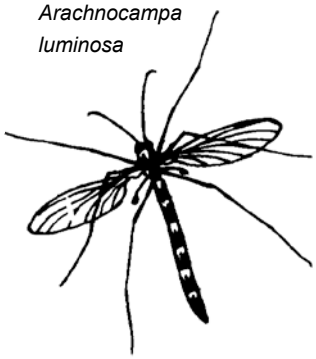
BUSH AND FRINGES

To the casual visitor, the forest may appear to be a rather quiet and restful place but this impression belies the frenetic activity taking place in every nook

Weta taipo
Cave weta
Gymnoplectron acanthocera



Puratoke
Glow worm adult
Arachnocampa luminosa



Harvestman
Megalopsalis

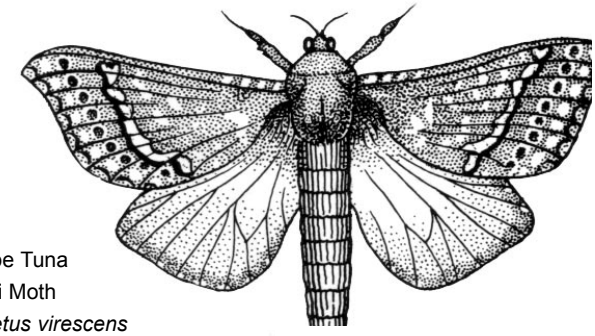
and cranny. The forest is populated from top to bottom, from the canopy to the forest floor and below, with a vast array of insects and minibeasts. By far the greatest bulk of life in a native forest consists of invertebrates of every description. The thick leaf litter with its wealth of decaying vegetation provides a rich source of feeding opportunities for the recyclers, the munchers, hunters and those that scavenge the remains of both. Throughout the year, newly dropped plant material covers the existing rotting layer anew. Below this layer is an oasis of moist darkness where temperatures remain almost constant. This is ideal for those that dry out easily. The most obvious are hoppers that feed on rotting vegetation and are related to the well-known sand hoppers of our beaches.

New Zealand has a great variety of werimano (Native millipedes, *Diplopoda*), herbivores and detritovores that also are prone to desiccation, as they have no waterproof cuticle. Some are around 10cm long but many are tiny like the tufted millipede, which is only about 3mm long. Picking up a millipede can leave a red or yellow stain on the fingers. This results from a chemical which is exuded to discourage predators. Toutouwai (New Zealand robins, *Petroica australis*) have been seen to pick up millipedes, brushing them through their feathers to hamper parasites. Centipedes *(class Chilopoda)* require damp conditions and actively hunt, using poisoned claws behind their heads. They can grow up to 25cm long and are the stuff that nightmares are made of, looking ferocious and able to give a nasty nip when cornered.

Many insect larvae spend the first stage of their lifecycles in the leaf litter and provide excellent meals for the hunters of the dark. Maggots of various kinds consume rotting plant matter while the cicada nymph burrows into the ground to access plant roots for nutrients.

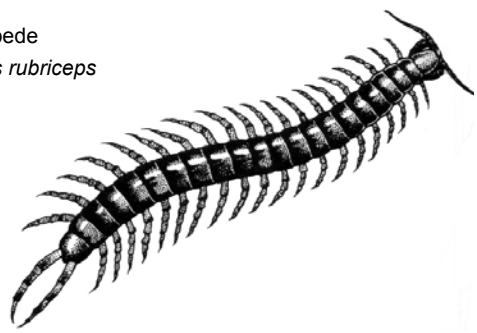
One of the largest moths, the lovely green peepe tuna (Puriri or Ghost moth, *Aenetus virescens)* common in huge numbers at the time of early European settlement, completes its early larval stage in rotting wood on the forest floor. After a year or so it moves to more suitable accommodation in either a larger puriri *(Vitex lucens)*, titoki *(Alectryon excelsus)*, Putaputaweta (marbleleaf, *Carpodetus serratus*) or makomako (Wineberry tree, *Aristotelia serrata*) where it excavates a 7-shaped tunnel. It feeds on bark and tissue around the tunnel entrance while it extends its home, and constructs a beautifully camouflaged trapdoor out of wood chips and silk to hide the tunnel entrance. Several more years pass before it pupates and emerges as an adult with a 15cm wingspan and begins its reproductive phase. The adult moths cannot eat and will die soon after mating and producing 2000 eggs.

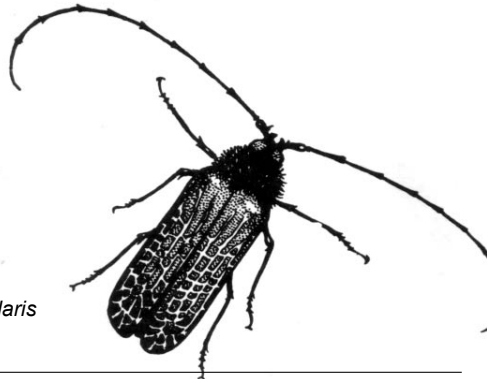
Werimano
Common native millipede
Spirobolellus antipodarus



Peepe Tuna
Puriri Moth
Aenetus virescens

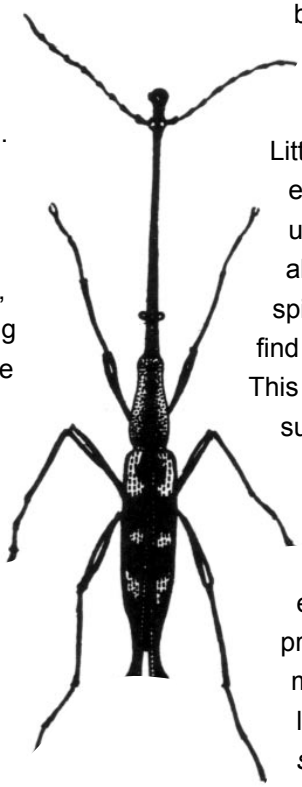
Weri
Common centipede
Cormocephalus rubriceps





Tunga rere
Huhu beetle
Prionoplus reticularis

New Zealand has a variety of beetle larvae that consume rotting wood, while the many species of longhorn beetles commonly bore into living wood. They backfill their long tunnels with frass *(droppings to the uninitiated)*. The large huhu *(Prionoplus reticularis)*, which reaches up to 5cm as an adult beetle, spends 2–3 years as a grub travelling through the dead wood. It was a welcome food item for Maori. The trick was to wait until the grub had finished feeding just before pupating, so that its gut would be empty of sawdust! As an adult it does not eat and lives for two weeks. The most peculiar looking beetle with wood boring larvae is the tuwhaipapa (giraffe weevil, *Lasiorhynchus barbicornis*). It is a weevil with half the length of its body taken up by its snout. The larger male has feelers at the tip of its snout, while the smaller female's feelers are set further back closer to her eyes. This is because she needs her mouthparts unimpeded to bore holes for laying her eggs.



Tuwhaipapa
Giraffe weevil
Lasiorhynchus barbicornis

The strangest animal encountered on the forest floor is the immensely ancient peripatus or velvet worm *(Parectopa miniella)*. Thought to be the evolutionary link between worms and centipedes, it traps its prey by squirting sticky slime from glands by its mouth. Of the 25 species found so far in New Zealand most bear tiny live young.

Little can be seen of the many plant eaters and suckers found throughout the understory and canopy, but evidence is all around. Many caterpillars leave conspicuous holes in leaves. It is a challenge to find any kawakawa leaf that is undamaged. This mysterious damage is caused by the superbly camouflaged kawakawa looper moth *(Cleora scriptaria)* caterpillar.

Others bunch leaves together to create a safety pouch where they can eat undisturbed and, for even greater protection, some tiny moth caterpillars mine between top and bottom surfaces of leaves. The kowhai leaf miner *(Stigmella sophorae)* is one of the world's smallest moths with a wingspan of just 2.5–3.5mm. Its wings beat so fast as to be almost invisible. It spends the first part of its lifecycle in just one of the tiny kowhai leaflets.

Kawakawa moth
Cleora scriptaria

Wetas browse at night on mahoe and lacebark leaves. Smooth and spiny stick insects are other flightless natives which enjoy manuka and kanuka foliage in the obscurity of the night. New Zealand has few pollinating insects, however, pollination is done by flies, beetles, moths and thrips. Even our native bees *(Leioproctus metallicus)* are not as organized for large-scale flower visiting as the introduced honeybees from overseas. They are small, dark, solitary creatures that dig a nest hole in sunny, arid exposed clay banks. Here, they lay eggs and leave the potential offspring with a little cache of pollen and nectar to fend for themselves.

FRESH WATER ENVIRONMENTS

Wetlands form at the indistinct and ever-changing boundary between water and land, covering a number of separate habitats — bogs, swamps, marshes and peatlands. Wetlands are among the most threatened habitats in the world. In New Zealand, ninety per cent have been destroyed since the arrival of humans.

Although insects are usually air breathing and winged, several orders have taken advantage of yet another habitat option and become predominantly aquatic. The adults must still emerge from the water but often during their gilled larval stages live in or near fresh water. As with their land-based relatives, the habitat sustains herbivores, carnivores and scavengers. One of the most common insects near fresh water streams is the Piriwai (Mayfly, *Zephlibia dentate*).

After close to three years as a larva, the emerging adult has only rudimentary mouthparts and cannot feed. All its efforts go into breeding. Clouds of males swarm above the water performing striking aerial dances to attract a mate. Soon its short air breathing life is over. Some Caddisflies *(Trichoptera)* protect their vulnerable larval body by constructing a case to hide in. These are beautifully crafted from small sand grains, pebbles or shell fragments to provide perfect camouflage. Other larvae hide in the mud or under stones. Hunters, like the Dobsonfly *(Archichauliodes diversus)* larva (sometimes called the toebiter) rely on stealth, lurking under stones until darkness falls. The beauty and grace of the dragonfly disguises some gruesome habits. As an adult it is one of the fastest flyers around catching its prey on the wing. It can eat as many as 20 houseflies in an hour. As an unattractive nymph, it lies in waiting in its muddy tunnel entrance by the pond edge ready to lunge at unsuspecting prey.

Some insects have completely adapted to life in the water. The main problem is respiration. Some, like the hoe tuara (Backswimmer, *Anisops wakefieldi*), capture a bubble of air on their hairy abdomen. Others use a specialized siphon to replenish their air supply.

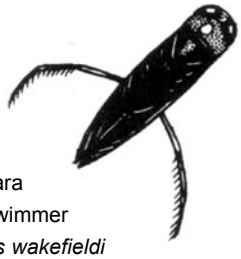
The Nursery-web spider *(Dolomedes minor)* is common around swamps and bush edges. It is a close relative of water spiders. Its web, enclosing a tuft of vegetation, protects the young spiders.

The Cabbage tree moth *(Epiphryne verriculata)* is perfectly camouflaged against the leaves of cabbage trees. Its caterpillars chew young leaves leaving distinctively notched edges.

INTRODUCED INVERTEBRATES AND PASTURE HABITATS

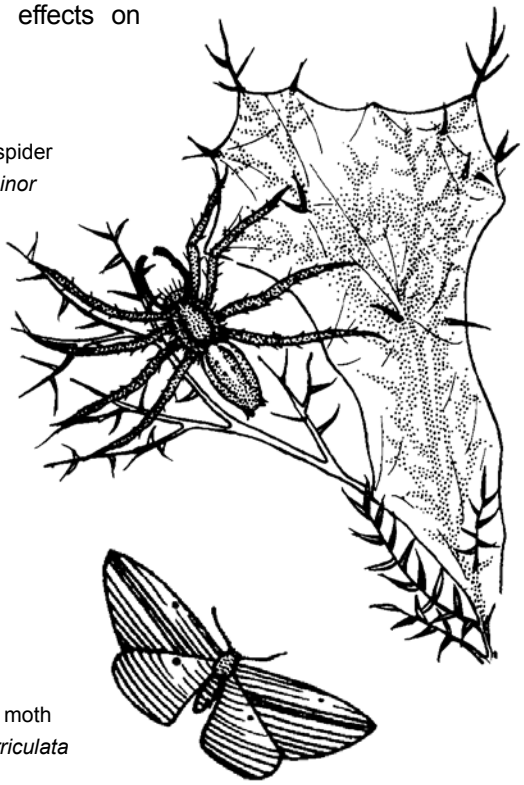
About 2,000 species of introduced invertebrates are now established in New Zealand. Most of these small animals of farm, home and garden were accidentally introduced as stowaways in the plants, soils and cargo that human colonists brought and continue to bring. A few species have penetrated native forest with devastating effects on

Piriwai
Mayfly
Zephlebia dentate



Hoe tuara
Back swimmer
Anisops wakefieldi

Nursery web spider
Dolomedes minor



Cabbage tree moth
Epiphryne verriculata

native insects and birds. Most are restricted to modified habitats. The worst of these are the German wasp *(Vespula vulgaris)*, the Common wasp *(Vespula germanica)* and the Argentine ant *(Linepithema humile)* — an aggressive competitor with popokura (Native ants). Some common introduced moths and butterflies include the Gum emperor moth *(Antheraea eucalypti)*, White butterfly *(Pieris rapae)* and Codling moth *(Cydia pomonella)*. The longterm impact of these organisms on native flora and fauna is unknown at this stage. Introduced bees and wasps include the honeybee *(Apis melifera)*, which pollinates several native plants. Bumblebees *(Bombus terrestris)* also pollinate some native plants.

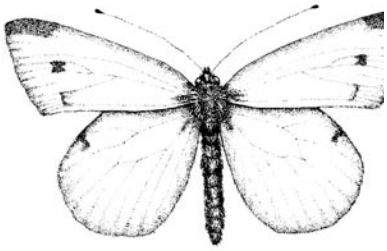
Five species of stinging wasps have been accidentally introduced. The Common and German wasps are the most serious, invading native forest and competing with native birds for honeydew and insects. Twenty-nine of the 38 species of ants in New Zealand were introduced through human activity and others are regularly intercepted at ports and airports. Many are household pests. A few species have adapted to native forest and bush habitats. The Passionvine hopper *(Scolypapa australis)* feeds on several native plants, particularly in open bush and at the bush edge. The nymphs are those irritating little hopping "fluffybums". Its effects can be easily seen on small branches and twigs where the adult female has laid her eggs. She pushes her ovipositor into soft plant stems leaving scarred serrations behind. Its sucking habits have been implicated as a likely contributor to the dramatic decline of the ti kouka (Cabbage tree, *Cordyline australis*).

The springbok mantis *(Miomantis caffra)*, is a voracious predator of all insects. It often survives the winter giving it an advantage over our native species. It is displacing the New Zealand praying mantis in urban environments of northern New Zealand and is still spreading. The egg cases are distinctly different from our native mantid's neat brown case. They are the beige coloured dollops, resembling glue squeezings, that can be seen attached to handrails and fences.

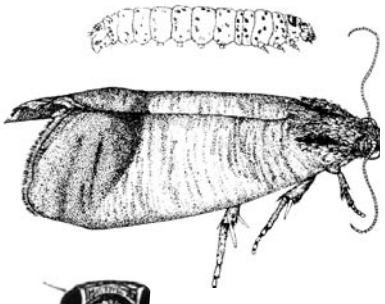
Not all native creatures are disadvantaged by habitat loss. The tutaeruru (New Zealand grassgrub beetle, *Costelytra zealandica*) was able to expand its habitat range enormously. This shiny brown 1cm long beetle often swarms at dusk. As a leaf-eating adult it causes damage to crops and fruit trees, but as a grub it eats the grass plant roots. In improved fields it can be seriously destructive.

To control aphids, the Eleven-spotted ladybird *(Coccinella undecimpunctata)* was introduced from England in 1874. This was the first documented case of biological control in the world.

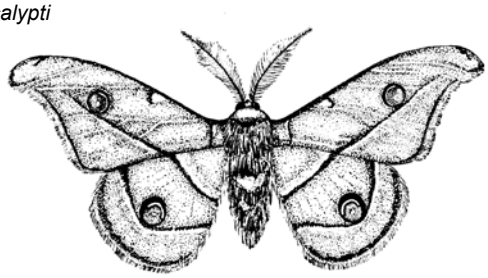
White butterfly
Pieris rapae



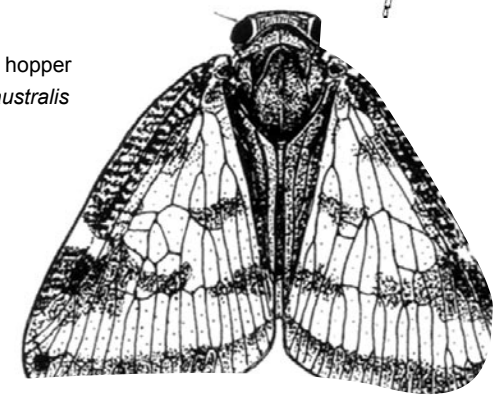
Codling moth
Cydia pomonella



Gum emperor moth
Antheraea eucalypti



Passionvine hopper
Scolypopa australis



SANDY EXPOSED BEACHES AND DUNES

From the strand line *(the high tide mark)* to the dunes, a sandy beach is no place to live unless you happen to be one of a select cluster of insects, spiders and their relatives, who have adapted to the harsh conditions. Here, temperatures vary between extremes. Wind and salt spray suck away the moisture, the sand shifts and wears.

The strand line is a transient environment. Rimurimu *(Seaweed)* and carrion provide food for a specialized group of invertebrates, which help speed up its decomposition. Other invertebrates are eaten by shore birds and lizards. The Tiger beetle *(Neocicindela tuberculata)* is a predator of small insects and is well camouflaged on grey-white sand dunes.

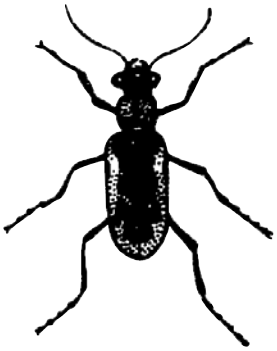
The Sand scarab *(Pericoptus truncatus)* is a bulky beetle which leaves conspicuous tracks in the sand from its nocturnal wanderings. During the day it burrows deep in the sand. The plump larvae can be found under partly buried logs. Sand hoppers *(Corophium acutum)* are amphipod crustaceans that spring up and down when disturbed. Kelp flies *(Coelopa littoralis)* lay eggs in freshly stranded kelp. Their maggots thrive in the kelp and help to break it down.

Woodborers are both destructive and useful. Destructive in that they can cause extensive damage to the wood of boats and wharves, useful because they break down deadwood that has drifted out to sea. Our oceans would be full of wood if it wasn't for these important recyclers boring while adrift at sea. The only clue we find on land is driftwood riddled with holes which has been cast onto our beaches.

The Black spider-hunter wasp *(Pricocnemis nitidiventris)* stings and paralyses small Wolf spiders *(Lycosa hilaris)*, then takes them to its nest in the sand. An egg is laid on the body, which is later consumed by the developing wasp larva.

The Native bee *(Leioproctus metallicus)* burrows through the loose, hot, dry sand above high water in order to nest in the damp sand beneath.

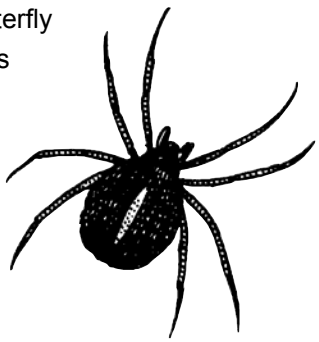
The Pepe pararikiki (Common copper butterfly, *Lycaena salustius*) lives in the dunes where its caterpillars feed on leaves of the tough pohuehue *(Wire vine)*. At most, this butterfly lives for 10 days, so time is limited for egg laying.



Tiger beetle
Neocicindela tuberculata

Sandhopper
Corophium acutum

Sand scarab
Pericoptus truncatus



Katipo
Latrodectus katipo

Black hunter wasp
Pricocnemis nitidiventris

Native bee
Leioproctus metallicus

Common copper butterfly
Lycaena salustius

Earwig
Anisolabis libboria

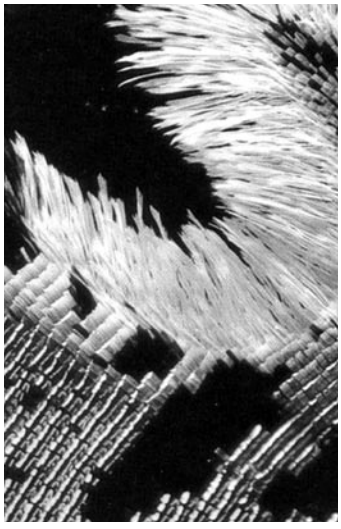
INSECT SPECIALITIES

Why are insects and the rest of the arthropods so successful? The answer lies in their skins. Their hard exoskeleton contains chitin, a feature which keeps moisture in and danger out. Chitin is light, flexible and tough but also limits the size of the creature. The hard skin must be shed before the body grows too large to fit inside. The outside surface is soft for some time after moulting. An animal beyond a certain size would collapse under its own weight before the new skin had had a chance to harden. Consequently, an exoskeleton would seem to pose severe limitations yet small size has some advantages. The number of individuals in a habitat can be much higher, the reproduction rate faster and therefore the evolutionary advances much more rapid. Their size allows them to occupy a far greater range of niches than those required by larger animals.

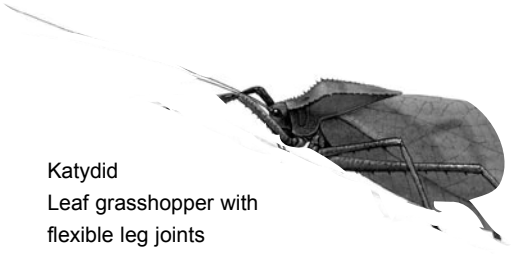
All other adaptations found on insect bodies stem from this hard chitin cuticle. It is an extremely versatile material which can be thick and heavy for strength or light and flexible for wings and joints. Chitin can be brightly coloured in a profusion of shades and shapes for camouflage or warning. It can be shaped into a dazzling variety of mouthparts, from the hard mandibles of predators to the strong piercing or flexible sucking tubes of mosquitoes and butterflies. It provides the means for making noise to attract or to warn others. Chitin forms the protective egg capsule and later can even provide the first hearty meal for the hatchling. Wings, formed from light but durable chitin, give insects an even greater advantage. They have meant that few habitats are out of insect reach.

The ability to fly evolved early in the Carboniferous Period (350–280 million years ago). Success in flight owes much to the development of specialized

Light and flexible wings on a Cranefly



Overlapping scales on a butterfly



Katydid
Leaf grasshopper with flexible leg joints

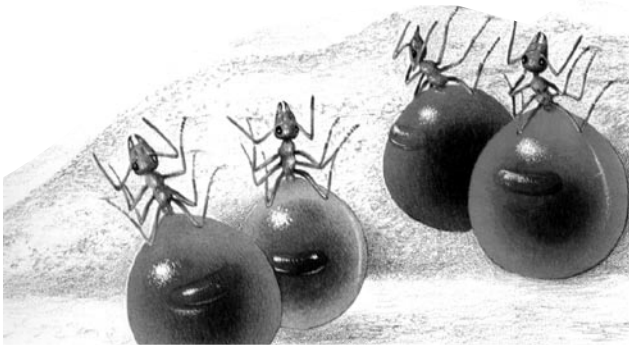
Piercing mouth parts on a beetle snout

Warning colours on Toxic Oil Beetles

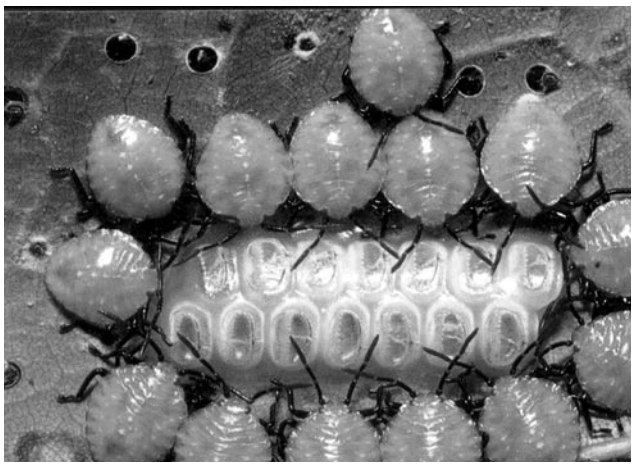
muscle which is able to contract much faster than is normal for other muscle tissue — 1000 times a second in small flies. Flight muscles are adapted to optimum efficiency at temperatures of up to 40ºC. Some insects need to bask in the sun to warm up before flight. Flightless species are to be found in many insect orders, and a few entire orders, such as the fleas *(Siphonaptera),* have become flightless. Some, like ants *(Formicidae)* and termites *(Isoptera)*, discard their wings after mating, while in other groups only males have wings. An example is the case moth *(Oeceticus omnivorous)*, the female of which spends her entire wingless lifespan in her case.

Insects do not necessarily have an easy life despite the advantages of their skins. Many other animals and plants depend on them for their own survival. As insects have no internal temperature regulatory mechanism they are also at the mercy of the weather and, unless specially adapted, may succumb to unseasonable conditions. The damaging effects of human activity may be causing unknown thousands of extinctions, especially in rainforest areas. Finally, like all living things, they are affected by disease and fungal infections. A most bizarre result of fungal infection is the vegetable caterpillar. The caterpillar of the porina moth, which tunnels into the soil, is slowly invaded by fungal growth. The maturing fungus kills its host and produces a spore-bearing stalk which eventually pokes out of the tunnel. Maori collected the woody, transformed caterpillars by the hundreds and burned them to provide the black ash for body tattoo pigments.

Some insect interactions are beneficial to humanity. Ladybird larvae and adults are a gardener's best friend. They are ferocious hunters of Aphids *(Aphididae)*, the scourge of the rose grower. Many wasps use insects as their brooding mechanism. One of interest to gardeners is the wasp, which lays



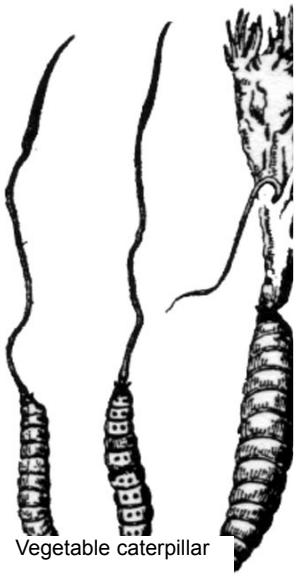
Honeypot Ants, a special group in the nest, which act as preserving jars, storing honey into the lean season



Shield bug nymphs around egg shells. Together they resemble a poisonous caterpillar.

Venus Swift Moth of South Africa

Case Moth *Oeceticus omnivorous*

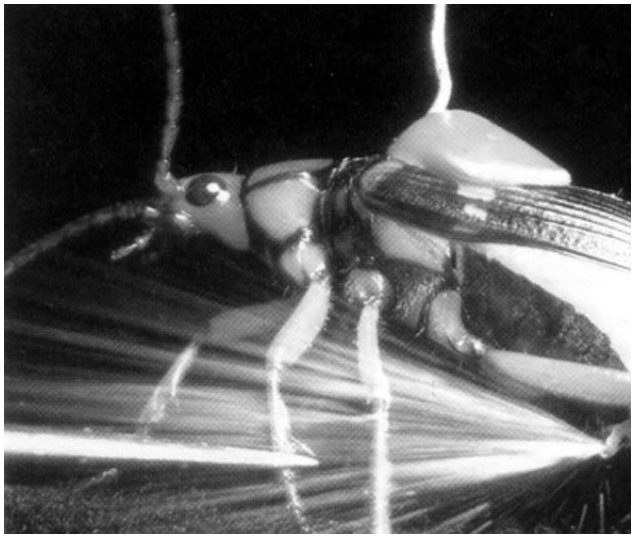


Vegetable caterpillar

eggs into the caterpillar stage of the Cabbage butterfly *(Pieris rapae)*. As with many of these types of parasites, the larvae eat the paralysed host. By the time the parasite is ready to pupate the food source is exhausted. The latest introductions of wasp defences to New Zealand were in 2001. Two tiny parasitic wasps were introduced to combat minute, 1.25mm Greenhouse thrips *(Heliothrips haemorrhoidalis)* and sooty mould producing Mealy bugs *(Pseudococcidae)*. Rigorous testing, research, quarantine procedures and public hearings were conducted before the release. The multimillion-dollar avocado and citrus export sector will benefit from these little parasites although it is too soon to know whether they are successfully established yet.

Insects have developed a host of defences to counter surprise attack. They may kick, jump or use rapid escape flight as plant hoppers do. They may mimic dangerous relatives, plant leaves, stems or flowers. The production of a special toxic or irritant repellent is highly effective.

The African bombadier beetle *(Stenaptinus insignis)*, for example, squirts a combination of aquious benzoquinones, oxygen and steam at its enemies. The inert chemicals combine in an explosive flash. This would be truly startling to any predator. Less dramatic but also effective is the Green shield bug's *(Oncacontias vittatus)* habit of releasing a repugnant scent to confuse its enemies, often innocent gardeners! Some use alarm pheromones to warn closely gathered members to disperse rapidly in the face of danger.



Bombadier Beetle
Stenaptinus insignis

The fact that pheromones are also used to attract a mate has provided apple orchardists with some interesting defensive strategies. They confuse the male Codling moth *(Cydia pomonella)* with an overpowering female scent, totally disrupting the breeding cycle. Some insects gain defences feeding on plants which are toxic to most others. The toxins concentrate in the tissues and are highly unpalatable. The Monarch *(Danaus plexippus)* caterpillar uses this strategy, advertising its dangerous taste in boldly striped colours. Some interesting relationships have developed between different insect species, especially ants, which provide protection in exchange for honeydew. Other insects are also attracted to honeydew; a few beetles, flies and geckos. In New Zealand native animals such as the kaka *(Nestor meridionalis)* supplement their diet with honeydew from the Beech tree scale insect *(Ultracoelostoma assimile)*. This crucial link in the web of life in our beech forests has been interrupted by the plague of honeydew-robbing German wasps.

FOOD AND FEEDING

The sucking habit is widely utilized among insects. Some have piercing mouthparts to access plant saps and others capture and suck the contents from their victims. Butterflies and bees suck nectar while others, such as fleas, rely entirely on warm-blooded prey. These "bloodsuckers" face the problem of their food clotting and introduce an anti-coagulant into their food-source before feeding. Those feeding on live prey may inject toxic saliva, completely paralysing their struggling food. Sponging is a method used by specialized flies. Here the food is bathed in saliva, which is sponged up when it has liquified. Chewing mandibles are utilized successfully by insects such as the grasshopper to access leaves and stem food sources. Yet others, such as the honeybee, combine functions with both a siphon and chewing mouthparts to gain access to the nectar reservoir.

TE AO TUROA : MAORI NATURAL HISTORY

In Maori folklore ngarara (insects) and similar creatures are said to be the children of Tane and Punga, whose children are all ugly. Each had its own character and significance in folklore. Ngaro — flies, mosquitoes and sandflies — are connected with Whiro, the god of evil who was Tane Mahuta's older brother.

When Tane decided to climb to the heavens and gather the three baskets of knowledge (those of rituals, crafts and agriculture), his jealous older brother felt that it was he as the elder who should have the honour of this task. As Tane climbed up the vines, Whiro sent plagues of flies and mosquitoes to sting and poison him. Luckily, Tane's other brother Tawhiri Matea (the god of the wind) blew the insects away.

Ancestral spirits sometimes assumed the forms of spiders when they visited earth, while a man with hidden intentions might be likened to a spider in its web. The stick insect was seen as related to the preying mantis, and if either of these alighted upon a woman it was a sign that she was pregnant. Ants were used as a weather warning. Before bad weather, ants go back into their nest. Thus fishermen were warned not to go out to sea.

As is the case in many other cultures, Maori society used insect habits to teach life skills. One such lesson is provided by the legend of the cicada and the ant.

Kikihi and Popokorua

In the summer the New Zealand bush reverberates with the busy sounds of kikihi the cicada (Amphipsalta zealandica)*. As you listen to the drowsy, buzzing sounds, winter seems far away. In fact that is what the cicada sings. "The winter is past and summer is here. Let us sing our song on the warm bark of trees and be glad, for cold and darkness have gone away for ever."*

However, if you listened very carefully you might hear another, softer song. This is sung by those who work throughout the summer time, close to the ground. It is the song of popokorua, the ants. "Winter is coming" they sing as they busily scurry about gathering food and carrying it for storage underground. "We need food to keep us alive in the cold days of winter. Let us work to live." Winter comes. The cooling wind that blew softly in summer now shakes the leaves ferociously. Icy rain pelts down on the saturated soil. Kikihi, grows thin and hungry and finally dies still clinging to the cold bark. Underground, the ant family is snug and well fed, looking forward to the next fruitful summer.

WETA

Giant weta *(Deinacrida heteracantha)*

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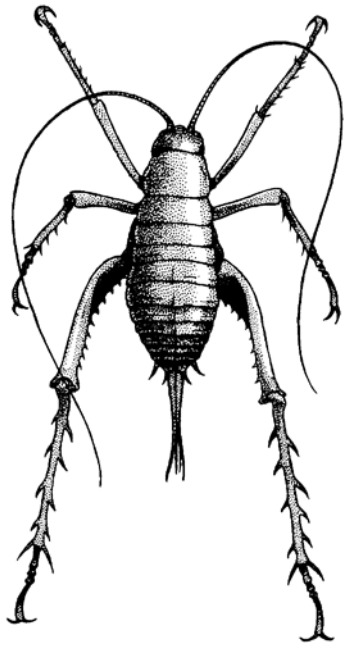
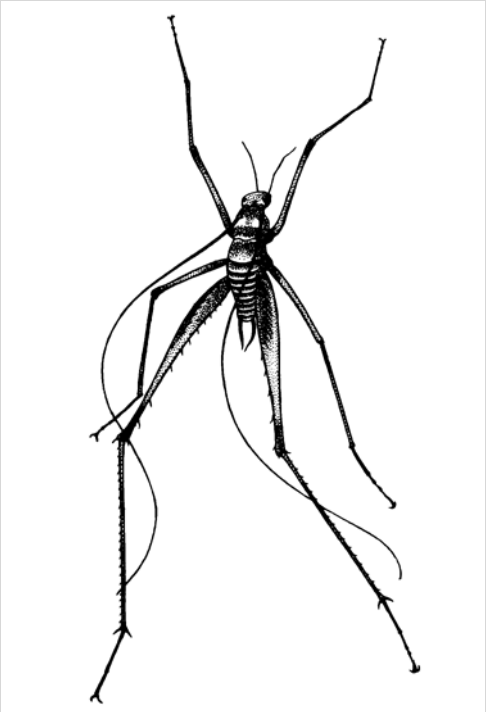


Giant weta *(Deinacrida)* is just one of several giant species. Like all weta, Giant weta are nocturnal and are a type of flightless grasshopper which have been around since the dinosaur age. *"Deinacrida"* means demon grasshopper. Females are larger than males. Weta have ears on their front legs. All make a loud "tsit tsit" noise and have very large spines on their back legs, which they raise over their head to threaten others. These weta live on a few offshore islands and isolated pockets on the mainland. They vary in size according to the species but are generally very large and slow and are often called giants of the insect world. The largest specimen ever recorded was a gravid *(egg carrying)* female wetapunga *(D. heteracantha)* from Little Barrier Island. It weighed about the same as a songthrush, although this weight was unusual. Some giant weta types do not have a "home hole" but wander from place to place. Like other weta, they have a lifestyle similar to mice. They are both nocturnal, eat the same sort of food and even have smelly droppings like mice. Giant weta droppings are the same size as mouse droppings. Weta eat mostly plant material, but will scavenge on dead insects. Their habitats have been destroyed by humans, and introduced animals, particularly rats have eaten them in masses. Giant weta are now almost only found in places where there are no rats.

Cave weta *(Gymnoplectron acanthocerum)* is also known as Tokoriro. There are about 60 different species. They have antennae up to four times the length of their body, with which they pick up the vibrations, smells and tastes made by food and predators. Most live near the entrance of caves, in damp bush and forest. A few alpine species live under stones in the mountains. They are scavengers who also eat insects, fungi, leaves and ferns and have extremely long legs, which they use to jump away from danger. They do not have spines on the back legs and are not aggressive. They don't have ears or make sounds and have close relatives in the other countries that were also part of Gondwana, such as South Africa, Australia and South America.

Cave Weta *(Gymnoplectron acanthocera)*



WETA

Tree Weta *(Hemideina thoracica)*

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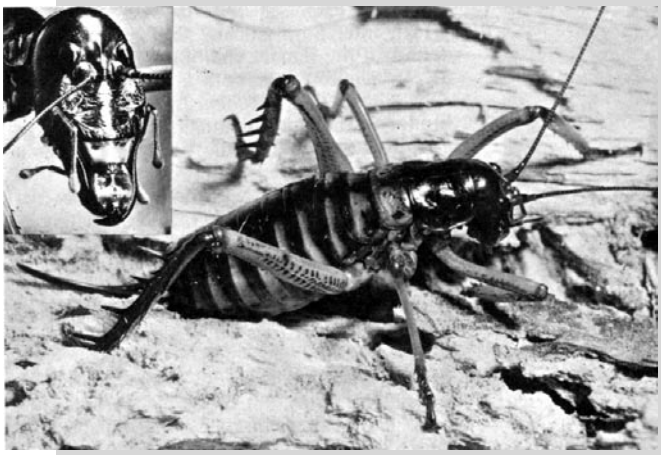


Tree weta *(Hemideina)* is known in Maori as Putangatanga. There are six species, including the Auckland tree weta *(Hemideina thoracica*). They are omnivores, eating insects and plant material. Palps around the jaws help them taste food before they even take a bite. Wetas spend their days in holes in trees or other places like posts. They enter the hole headfirst and leave their spiny back legs, blocking the entrance. At night, they turn around. Males are aggressive with larger heads than females. They will chase away other males but let females into their territory. They threaten other animals by raising their back legs and make rasping noises, scratching their hind legs against the abdomen. They have ears and hollow tubes in their front legs to hear with. Not all tree weta live in trees. The mountain rock weta *(Hemideina maori)* is a tree weta that doesn't live in trees. It can be frozen and remain alive, which helps it live in the mountains. This happens several times every winter. Females have a long egg-layer, or ovipositor. They lay eggs in the soil almost all year round, except mid-winter. A female can lay as many as 300 eggs in her lifetime.

Ground weta *(Hemiandrus)* There are at least 36 species, of this smaller type of weta, which live in tunnels that they dig in the ground. They threaten other animals by raising the front legs and opening their jaws but do not make a sound. They do not have ears and eat mostly insects. Weta seem to have an awful lot of enemies and not all of them are introduced species. Native species such as tuatara, short-tailed bats, birds such as morepork and kaka and most species of lizard are all known to eat weta. Harrier hawks seem to be the main predator of Poor Knights Island giant weta *(Deinacrida fallai)*. However, the biggest threat to weta are rats.

New Zealand is home to three species of rat. The kiore or Pacific rat *(rattus exulans)* was first introduced with the arrival of Maori and is still present in large numbers on Little Barrier Island, home of our largest giant weta. The two European rat species, Norway *(Rattus norvegicus)* and ship rat *(Rattus rattus)* which are widespread throughout the country, have the biggest impact on weta numbers. The only truly successful method of saving weta seems to be moving them to areas where there are no predators. Often, this means offshore islands. Giant weta have benefited greatly from this method of conservation, called translocation. So far Mana Island giant weta *(deinacrida rugosa)* have been transferred to Maud Island (in the Marlborough Sounds) and Somes Island in the Wellington Harbour. Wetapunga *(Deinacrida heteracantha)* now only exist on Little Barrier Island (in the outer Hauraki Gulf) after disappearing from both the mainland and Great Barrier Island. Mercury Island tusked weta *(Motuweta isolata)* have been bred in captivity and released onto another island in the Mercury group.

GLOW WORMS AND DRAGONFLY

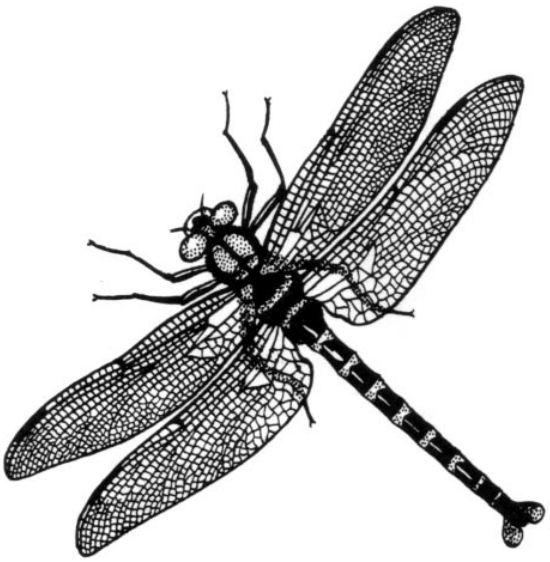
FACT SHEET

Puratoke — Glow-Worms (Arachnocampa luminosa)

Puratoke — Glow-Worms *(Arachnocampa luminosa)* is found along the banks of streams and other damp places in the bush, as well as in caves. The larva is carnivorous. As soon as it is hatched, it begins to construct a tunnel of mucus and silk, which it suspends on silken ropes from the cave ceiling or from another suitable support. It then spins a large number of silken lines, hanging down from the tunnel. At regular intervals along these lines the larva places little beadlets of sticky mucus. Midges and other insects, attracted by the glow-worm's light, rise up and get stuck on the beadlets. The larva hauls up the line immediately and eats the victim. Its lifecycle is about a year, and during this time it casts a luminous glow. As it transforms from pupa to adult fly, the glow-worm glows erratically. Emerging into brief adulthood, the female continues to emit a light which attracts the male to mate.

Kapokapowai — Large Dragonfly *(Uropetala carovei)*. Dragonflies have a very long and narrow abdomen, antennae reduced to a tiny thread, and two pairs of large and veined gauzy wings which glitter in the sunlight. They are predators, taking flying insects on the wing. Their huge compound eyes, linked by nerves to the flight muscles, enable them to locate even very small prey and immediately change direction to capture it. The victim is scooped up by the dragonfly's thin legs, which are armed with spines, and taken to the mouth where it is masticated by the strongly toothed mouthparts. Dragonflies and their relatives the kihitara (damselflies *Xanthocnemis zealandica*) have teeth — hence their family name Odonata, from the Greek for tooth). New Zealand has 11 species of dragonflies and six damselflies. Dragonflies are larger and spread their wings when they are resting, whereas damselflies fold their wings loosely over their body. Dragonflies have incomplete metamorphosis. The eggs hatch into larvae or nymphs which live in fresh water. Nymphs are voracious feeders, eating insects, tadpoles and even small fish; in their turn they are the target of predators such as frogs, birds and trout. After a series of moults the larva leaves the water, the larval skin splits and the adult emerges. The best known native dragonfly is the giant black and bright yellow Devil's darning needle *(Uropetala carovei)*. This large insect has a wing span of 130mm and is found in boggy seepage areas in forests. Dragonflies are the fastest of all insects, capable of cruising at 40km/hr and increasing their speed in bursts to 58km/hr. They can also hover and make quick turns up, down or sideways.

Kapokapowai *(Uropetala carovei)*

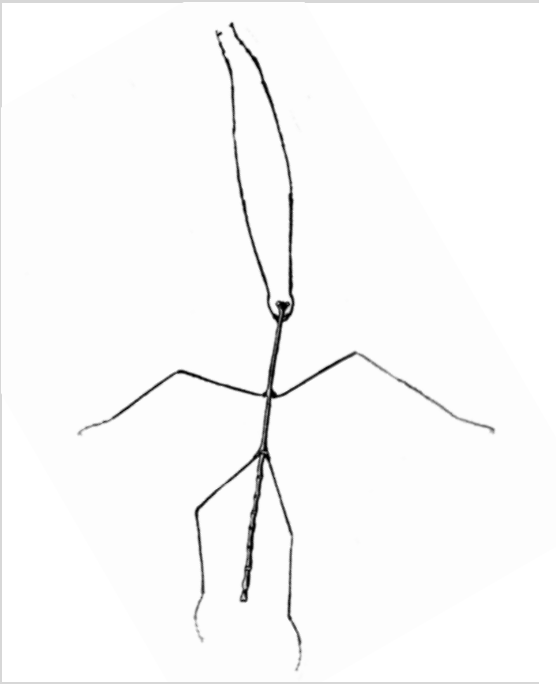


STICK INSECTS

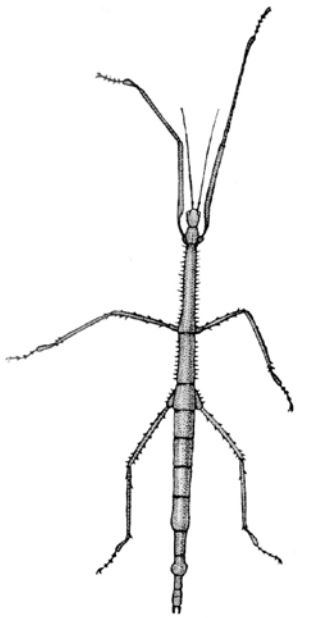
FACT SHEET

Stick Insects Common *(Clitarchus hookeri)* and spiny *(Argosarchus spiniger)* are known as Ro in Maori. These are only two of the 21 species found in New Zealand and of the 2500 worldwide. Their bodies are long, thin and coloured either bright green or light brown. Although it is often assumed that adults can change colour responding to the background hue, this is not so. Some overseas varieties have the ability to become lighter or darker in response to light intensity. It is thought this allows more or less heat to be absorbed. Stick insects are found in tropical and subtropical regions the world over. Many have wings but our New Zealand varieties are flightless. They can walk at about 1km/hr. This makes them easy prey for the invading wasps. Generally their diet consists of a variety of leaves including those of manuka *(Leptospermum scoparium)*, kanuka *(Kunzea ericoides)* and pohutukawa *(Metrosideros excelsa)*. They feed at night and during daylight their stance affords them almost perfect camouflage. They often stretch their front legs forward and may sway slowly side to side to look even more like a wind blown branch, but however excellent their camouflage, many birds still eat them, particularly kotare (kingfishers *Halycyon sancta*). When mating in the autumn the smaller male rides on the female's back and may stay put for up to two weeks, even while the female lays eggs. Some have been known to reproduce parthenogenically, by hatching from unfertilised eggs. The eggs usually resemble plant seeds. The smooth bodied common stick insect lays greyish brown eggs with a corrugated surface texture. She drops them on the ground where they will hatch into nymphs after two or three months. The nymphs which are tiny versions of the adults, moult at least four times before maturity.

Common Smooth Stick Insect (male)



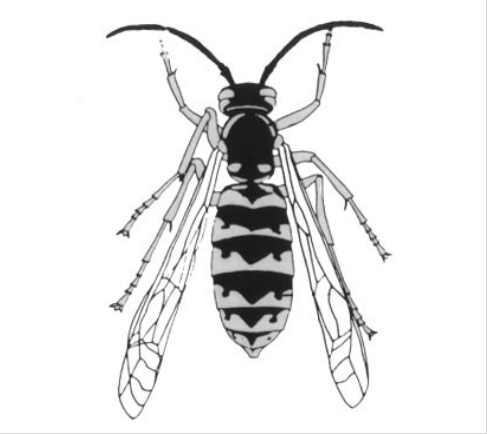
Spiny Stick Insect (female)



WASPS

FACT SHEET

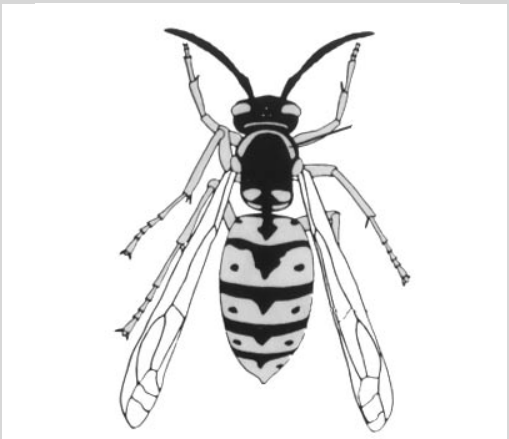
Common wasp *(Vespula vulgaris)*



Wasps German *(Vespula germanica)*, Common *(Vespula vulgaris)*, Australian *(Polistes humilis)*, Asian *(Polistes chinensis)*. German wasps are found throughout the North and South Islands; common wasp throughout the North and South Islands; Australian paper wasp in the warmer parts of the North Island and Asian paper wasp in the warmer north of the North Island.

The four species have been accidentally introduced to New Zealand (although it is likely the Australian paper wasp may have arrived under its own steam). The German wasp arrived in the 1940s carried in aircraft parts from Britain. The Common wasp has been here since 1978. The Australian Paper wasp was introduced in the 1880s. The Asian Paper wasp is a recent arrival but is now very common in Auckland.

German wasp *(Vespula germanica)*



New Zealand has some of the highest densities of common and German wasps in the whole world. Here they have no natural enemies, the winters are mild and there is plenty of food for them to eat. They eat nectar and insects but some have been known to kill and eat baby birds.

Wasps compete with birds and insects for sugar from nectar, causing native and other useful species to starve. They eat honeydew, a sugary liquid excreted by scale insects living under the tree's bark. By eating the honeydew they have resulted in a drop in numbers of korimako (bellbird *Anthornis melanura*), tui *(prosthemadera novaeseelaniae)* and kaka *(Nestor meridionalis)*, which rely on it as an energy source. They have become established in beech and podocarp forests. In some South Island forests they consume as many insects in a summer season as do the native birds in a year.

They are a major pest for the beekeeping industry, as they rob the hives of honey. They are a nuisance to forestry workers and Department of Conservation (DoC) staff. In fact DoC workers may carry adrenalin with them (to administer in case they stumble into a wasp nest) if working in beech forests known to have high wasp numbers. Adrenalin helps the body combat the allergic reactions brought on by wasp stings.

Wasps do not store food the way bees store honey. In their native habitat with much colder winters, the nests die out in late autumn and winter. Only the queen survives, because she hibernates. Numbers peak from February to April. The benign climate in New Zealand, being much more benign, allows some

WASPS

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nests to overwinter. In the last few years, numbers have increased hugely in the Auckland area. Wasps will start raiding fruit crops and scavenging rubbish bins when insect numbers are low. They have caused the death of a seven-year-old girl and can cause allergic reactions in people when they sting. They have even forced schools to close. Wasps are not repelled by insect repellents and attack dark-coloured objects, particularly blue. Therefore, it is safest to wear light coloured clothing where they are present. The underground nests of the common and German wasps can be removed at night by pouring petrol into the entrances. The fumes of the petrol kill the wasps. Do not light the petrol! The nests of paper wasps are usually about 1–5 metres above the ground. They can be killed by spraying lots of fly-spray on the nest at night. This will kill the adults. The larvae can be killed by freezing the nest for three days.

Australian paper wasps are reddish brown in colour and are smaller than the Asian paper wasps.

Asian paper wasps are yellow and black with orangey — tan legs, smaller than the German and common wasps, but bigger than the Australian paper wasp. Males are smaller and more yellow than the females.

DOC have produced a National Wasp Control Plan under the Wildlife Act 1953. As part of that plan, efforts are being made to control German and common wasps with an introduced parasitic wasp called Sphecophaga vesparum burra. It invades their nests and its larvae attack immature wasps in their cells.

Australian wasp
(Polistes tasmaniensis humilis)

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