

EXHIBITION WALKTHROUGH

A TOURING EXHIBITION FROM
MUSEUM OF NEW ZEALAND TE PAPA TONGAREWA
DEVELOPED WITH WETA WORKSHOP





WHAT IF THE PLANET'S SMALLEST GENIUSES COULD SHARE THEIR SECRETS?

Bug Lab is a science exhibition like no other, presented not by humans but by the incredible bugs themselves.

Leave the museum behind you, and step into a world beyond your imagination.





IMMERSIVE, MAGICAL, MEMORABLE

Weta Workshop's Academy Award-winning creative vision and Te Papa's bold interpretive approach have pushed *Bug Lab* far beyond the realm of a regular natural history exhibition.

- ▶ Marvel at ultra-detailed, large-scale models of bugs.
- ▶ Experience the world as bugs do, through immersive sensory experiences.
- ▶ Explore cutting-edge science.





TRANSFORMING TREPIDATION INTO INSPIRATION AND AWE ...

Not everyone loves bugs. Some fear them, some don't understand them, some are ambivalent.

The main goal of *Bug Lab* is to transform attitudes and open up hearts and minds to new learning.





LEARN ABOUT BUGS THE WORLD OF BUGS IS FULL OF AMAZING ADAPTATIONS

Zoom in on six dramatic stories from the bug world. Marvel at what each micro master can do, witness it in action, and uncover the secrets behind its success.

Then, explore the related secrets of other bugs, and glimpse the astounding diversity of arthropods.



Audience goals:

- ▶ Feel awe for bugs and the natural world through dramatic encounters with their adaptive genius.
- ▶ Experience the world as bugs do, and test your abilities against theirs.
- ▶ Understand that bug traits have developed over millions of years through adapting to selection pressures.





LEARN *FROM* BUGS BIG IDEA: BUGS ARE INSPIRING CUTTING- EDGE SCIENCE AND TECHNOLOGY

The bugs have a challenge for you:

Can you learn from their genius?
Precision flight, swarm intelligence,
mind control ... bugs did it all first, and
they're still doing it better.
What would the future look like if we
could match their brilliance?

Audience goal:

Discover how humans are applying
bug genius to solve complex problems,
and imagine what could be possible in
the future.





AUDIENCES

- ▶ **Multi-generational families:**
Explore, discover, and learn together.
- ▶ **Educators and learners:**
Experience STEM education like never before, and discover bug-inspired technologies, including swarm intelligence and nanotechnology.
- ▶ **Millennials:**
Encounter an immersive world inspired by movies, sci-fi, and fantasy.





EXHIBITION SUMMARY

SIX ZONES showcase bug adaptations.

- ▶ DISPLAY
- ▶ FLIGHT
- ▶ VENOM
- ▶ EXOSKELETON
- ▶ SWARMS
- ▶ SILK

ZONES are made up of:

IMMERSIVE BUG CHAMBERS AND UNIQUE EXPERIENCES

Encounter large-scale, ultra-realistic bugs in four themed bug chambers, capturing dramatic moments that reflect their adaptive 'genius'. A large-screen looping video on each chamber's exterior showcases the bug's story.

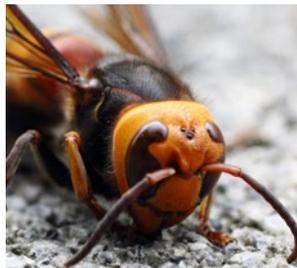
For the silk and venom zones, the unique experience is placed among lab tables.

INTERACTIVE ADAPTATION STATIONS

Around each chamber, explore the master bug's adaptive genius in detail, through physical interactives, graphics, and text – and test your abilities against theirs.

HANDS-ON LABS

Dig deeper into cutting-edge bug science and bio-inspiration through hands-on activities at tables. Explore real bug specimens and 'talk' with experts from around the world.





HIGHLIGHTS

UNFORGETTABLE, LARGER-THAN-LIFE ENCOUNTERS

Each chamber is uniquely themed and crafted both inside and out by Weta Workshop, and contains a vivid glimpse into the 'genius' of bugs.

Feel wonder in the presence of the deceptive orchid mantis, and exhilaration before an ultra-detailed 3-D zoetrope of dragonfly flight. Dare to witness the jewel wasp's scary 'surgery', and join with your fellow exhibition-goers to save a swarm of honeybees.



A FULLY IMMERSIVE EXPERIENCE

Every part of the exhibition was conceived from a single 'what if': 'what if bugs created a way to show off their world to humans?' The result is a flowing, organic 'bug nouveau' style that is both alien and familiar.



All exhibition text is written from the point of view of a bug narrator. This confident, wry companion is always ready to offer a playful challenge to 'you humans'.

Music in the chambers gives each a unique emotional tone, blending seamlessly throughout the space.

CUTTING-EDGE SCIENCE MADE ACCESSIBLE

Bug Lab showcases the work of the humans who are learning from bugs. Explore bio-inspired objects such as bee-like flying robots, nanotechnology based on butterfly wings, and 3-D printed objects created from silk.

Delve into 16 interactive conversations with international experts, and hear the myriad ways that bugs have inspired their work.



REAL SPECIMENS

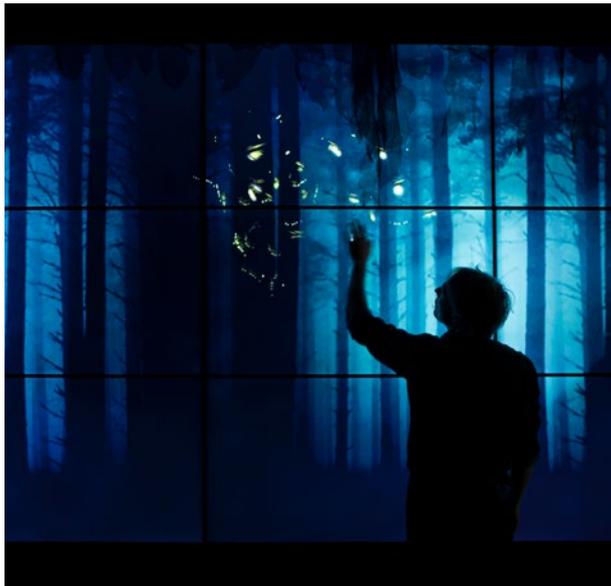
Simple, attractive displays showcase a range of bugs, and are accompanied by matched digital labels containing a wealth of layered secrets to discover.



EXHIBITION WALK-THROUGH

Firefly experience

Enter the world of the bugs through a forest of fireflies that follow your movements, swarming with you into the exhibition.



BUGS – WHO ARE WE?

Learn what an arthropod is (the land-dwelling ones are what the lab calls 'bugs'), and understand the difference between insects, arachnids, and myriapods – the three groups you'll encounter here.





DISPLAY ZONE

Why do bugs look the way they do? Their world is teeming with deceptions based on display. From them, we humans are learning how to make better displays of our own.

The master bug of this zone is the stunning orchid mantis. It's so attractive to pollinators that it doesn't need to hunt – dinner comes right to it! The insect's shape is impressive, but its real secret lies in its colour, which its prey sees as even brighter than a real flower's.



Bug chamber

Encounter a large-scale model of the orchid mantis, blending into a garden of luscious flowers. Shifting light effects show how it's perceived by its prey, and why its 'advertising' is irresistible to its hapless 'target audience'.

Accompanied by video: 2:10





DISPLAY ZONE

Adaptation stations

Where's the mantis?

Physical interactive

Try and spot the mantises in the graphic. Then, use the UV torch to see them as other bugs do – shining brighter than the flowers.

Think you're quick?

Physical interactive

Flying bugs are fast. To catch them, a mantis needs to be faster. How many targets can you hit in 30 seconds? A high-energy physical challenge.





DISPLAY ZONE

LAB

Large table

Bug basics

An introduction to four key ways that bugs' appearances help them survive.

Bio–inspiration from fireflies

Taxidermied white lab rat (object), firefly illustration, and digital label

Digital label content:

Medicine: Scientists are using firefly light as a way of testing medicines. They can insert the firefly's light-making gene into toxic bacteria to make them glow, then use the bacteria to infect lab mice. They then monitor the effects of antibiotics – if they kill the bacteria, the light goes out.

Bio–inspiration from morpho butterflies

Morpho butterfly (object), items printed by Nanotech Security Corp (objects), and digital label

Digital label content:

Nanotechnology: The blue morpho's colour isn't made from pigments – it's created from light interacting with tiny nanostructures on its wings. Structural colour has inspired banknotes and documents that are almost impossible to forge. Read about how it works.





DISPLAY ZONE

Meet a display expert

Digital interactive

Dr James O’Hanlon, Postdoctoral Research Fellow, Macquarie University, Australia

Get the full story of the orchid mantis’ ‘scam’ from one of its leading researchers.

Dr Janine Williams, Lecturer in Marketing, Victoria University of Wellington, New Zealand

The orchid mantis ‘advertises’ using its bright colour. What’s the link with human advertising?

Doug Blakeway, CEO and Chairman, Nanotech Security Corp, Canada

Hear how the morpho butterfly has inspired anti-counterfeit technology, and why tech companies are looking to nature for ideas.

Total video length: 15:35

Specimens and digital label content

New Zealand giant stick insect, air commodore butterfly, owl butterfly, narrow-bordered bee hawk-moth, heliconid butterfly, royal jewel butterfly, Priam’s blue birdwing butterfly (male and female), double-drummer cicada

Digital label content:

For each bug, read about a remarkable display-related adaptation, and examine detailed close-up images of the specimen. Most specimens also feature ‘bonus secrets’ relating to bio-inspiration or further adaptive ‘genius’.





DISPLAY ZONE

Small table 1

Peppered moth: natural selection in action

Graphic

Follow a timeline to track the changing appearance of the peppered moth as its environment changes due to pollution. Understand the key principles of natural selection.

Small table 2

Colour your bug

Activity

Choose your colours.
Will your bug blend in or stand out?





FLIGHT ZONE

Bugs were the first animals to take to the air, over 300 million years ago. Uncover the secrets of insect flight, and be inspired by the humans who are attempting to understand and copy it.

The master bug is the dragonfly – an ancient hunter with a 95 percent success rate.

Bug chamber

A huge chrome sphere encases a 3-D zoetrope (stroboscopic animation) showcasing dragonfly flight. Seventy 3-D printed dragonfly models, 24 frogs, 22 swimming fish, and 378 drifting lily pads create a single second of seamlessly looping animation. See how a dragonfly's wings beat, and understand how dragonflies see the world, as if in slow motion.

Accompanied by video: 1:59





FLIGHT ZONE

Adaptation stations

Focus on flight

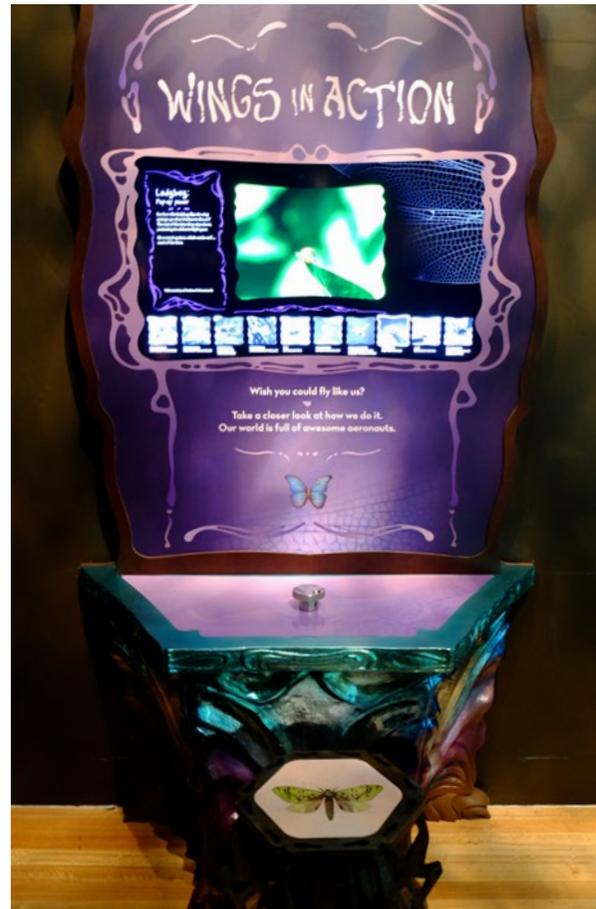
Digital interactive

Use a FrameGlide system to control and study the flight styles of 10 insects.

Hunting in 3-D

Graphic panel

Dragonflies are highly successful hunters – they can predict the flight paths of their prey. See what it takes to intercept flying bugs.





FLIGHT ZONE

LAB

Large table

Bug basics

Discover what makes bugs such good flyers, and the advantages that come with being airborne.

Bio-inspiration from dragonfly wings

3-D printed 10:1 scale dragonfly wing, 1:1 scale dragonfly, and digital label

Digital label content:

Discover why dragonfly wings are 'prehistoric high tech', and how they have inspired engineers.

Bio-inspiration from flying insects

RoboBee micro flying vehicle, Elios insect-inspired drone, and digital label

Digital label content:

Robotics: Harvard's RoboBee is humankind's best attempt at copying insect flight at insect scale. Elios is a collision-tolerant drone modelled on bees and flies. See videos of these two bug-inspired flying machines in action, and explore how they work.





FLIGHT ZONE

Meet a flight expert

Digital interactive

Dr Stacey Combes, Assistant Professor, Department of Neurobiology, Physiology and Behavior, University of California, Davis

How do insects fly, and what makes the dragonfly such an ace?

Dr Anthony Leonardo, Group Leader, Janelia Research Campus, Howard Hughes Medical Institute

Hear about dragonfly hunting strategies, and how tiny wireless backpacks can be used to study their brain function.

Elizabeth Farrell Helbling, PhD Candidate, Harvard University

Learn about how the RoboBee was constructed, and why humans find it hard to match insect flight.

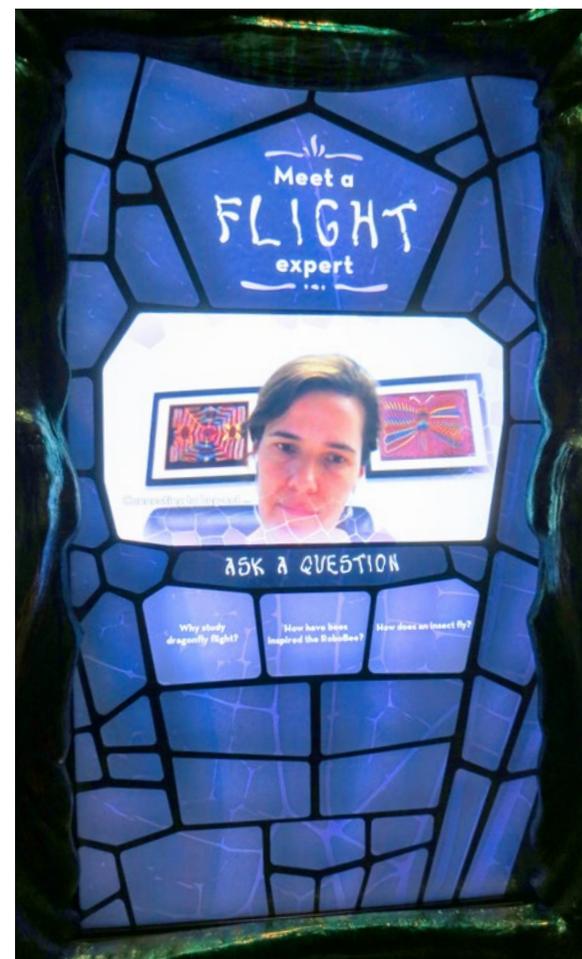
Total video length: 19:53

Specimens and digital label content

Atlas moth, giant New Zealand bush dragonfly, monarch butterfly, clapping cicada, bumblebee, scarab beetle, winged mantis, pepetuna (püriri moth), winged stick insect, housefly, Madagascan sunset moth

Digital label content:

For each bug, read about a remarkable flight-related adaptation, and examine detailed close-up images of the specimen. Most specimens also feature 'bonus secrets' relating to bio-inspiration or further adaptive 'genius'.





FLIGHT ZONE

Small table 1

Flight test

Activity

Bugs use their wings to create lift, but this wind tunnel gives you the boost you need. Can you create a bug that soars or hovers? Choose from two origami butterfly patterns, or design your own flyer.

Small table 2

Giant of the skies

Model (Te Papa collection)

This full-scale model of a griffinfly (Meganeura monyi) shows how dragonflies have remained nearly unchanged for 300 million years.





VENOM ZONE

Venom is a powerful weapon and a complex chemical compound. Explore how bugs use it for attack and defence, and how humans are 'bio-prospecting' for useful medicines.

The master bug is the jewel wasp, which performs precise 'brain surgery' on cockroaches as part of its life cycle. It uses its live target as an incubator for its young.

Bug chamber

See the jewel wasp entwined with the cockroach at the moment of the crucial sting that subdues it. A lighted sequence shows the effect of the venom on the roach's system. Panels around the chamber lay out the procedure, step by step.

Accompanied by video: 2:06





VENOM ZONE

Adaptation stations

Brain surgery

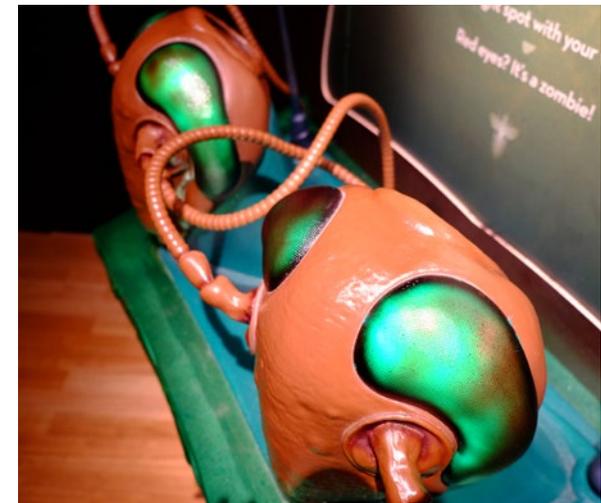
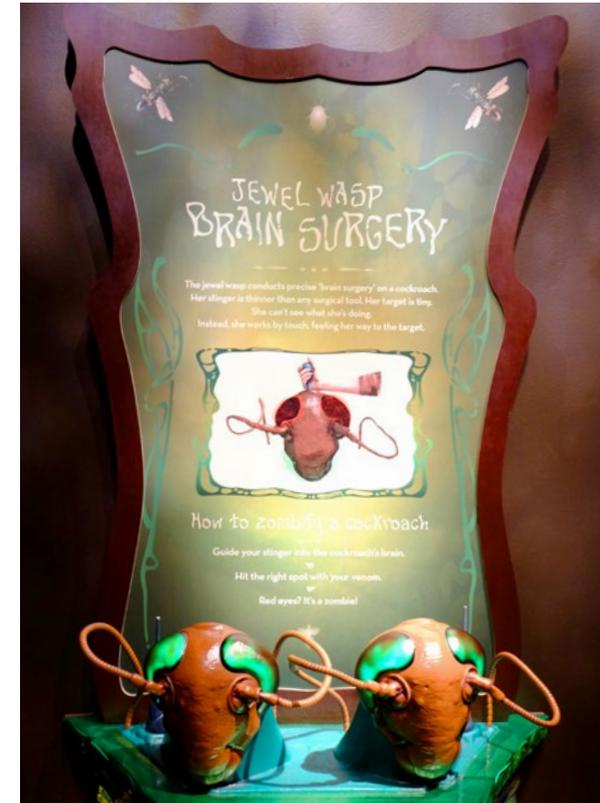
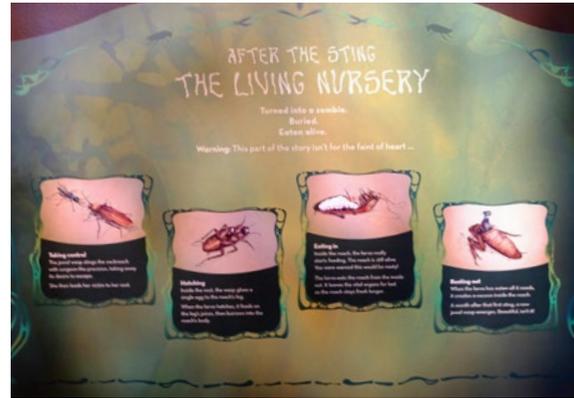
Physical interactive

The jewel wasp's target is tiny, and she can't see what she's doing. Instead, she works by touch, feeling her way to the target. Can you hit the right spot to 'zombify' your cockroach?

After the sting: the living nursery

Graphic panel

What happens when the cockroach and egg are sealed away together in the dark of the nest? Find out here – if you dare.





VENOM ZONE

LAB

Large table

Bug basics

Graphic panel

What is venom, what does it do, and how do different bugs inject it?

Unlock the secrets of venom

Physical interactive

Venom can be used to help as well as harm. Match a venom with a target to find out what benefits it can have – from bee-friendly pesticides to cancer treatments.

Could you take the pain? Highlights from the Schmidt Pain Index

Graphic panel

Justin Schmidt has been stung by 83 different Hymenoptera. He recorded what each sting felt like. Get a taste of his pain.





VENOM ZONE



Meet a venom expert

Digital interactive

Dr Justin O Schmidt, Research Biologist, University of Arizona, Tucson

Talk with Justin about how bugs benefit from venoms, and hear about his worst-ever stings.

Professor Glenn F King, Institute for Molecular Bioscience, University of Queensland

Hear more about how venom can help humans, and how scientists find its useful compounds.

Dr Frederic Lieberstat, Professor of Neurosciences, Department of Life Sciences, Ben-Gurion University of the Negev

The world's leading researcher on the jewel wasp and cockroach shares his discoveries.

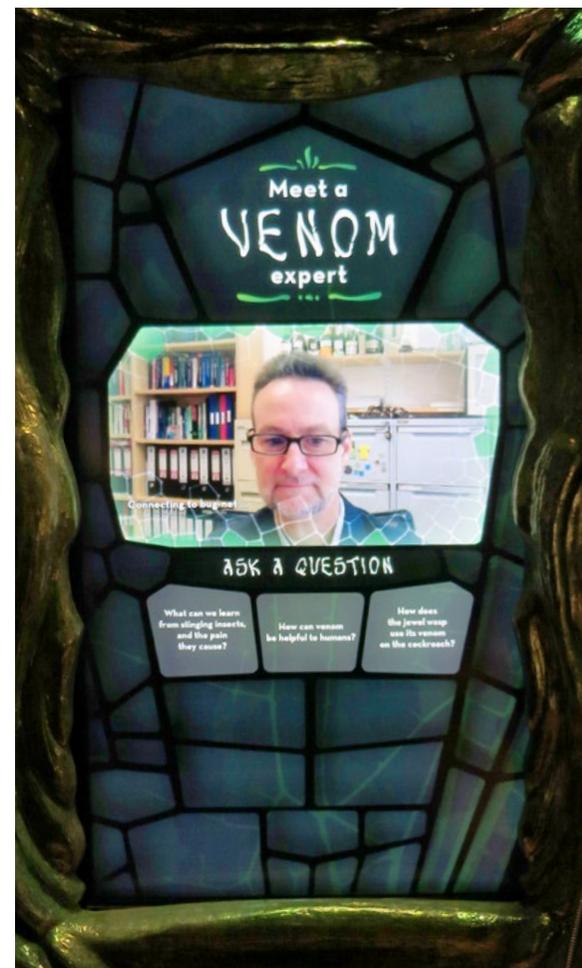
Total video length: 17:23

Specimens and digital label content

Dondale's water spider, New Zealand giant centipede, Chilean rose tarantula, tarantula hawk, Malaysian forest scorpion, velvet ant, bullet ant, eastern cicada killer, king baboon spider, io moth

Digital label content:

For each bug, read about a remarkable venom-related adaptation, and examine detailed close-up images of the specimen. Most specimens also feature 'bonus secrets' relating to bio-inspiration or further adaptive 'genius'.





SWARM ZONE

When bugs work together, big things can happen – like termite towers built without blueprints. Humans are learning how to create systems based on swarms and social insects.

Here, the master bug is the Japanese honeybee. It's adapted a unique way of defending its nest from otherwise invulnerable giant hornets. The bees trap invading scouts by engulfing them in a quivering ball of bees, and defeat them with heat and CO₂.

Bug chamber

Scramble! The bees need your help. Rub the pads to raise the temperature of the fearsome hornet until you achieve victory. You can't do it alone! Features stunningly detailed bee models and a 'thermometer' to let you know how you're tracking. A dramatic, social climax to the *Bug Lab* experience.



Accompanied by video: 2:31





SWARM ZONE

Adaptation stations

Think you're hot?

Physical interactive

Can you make the giant hornet glow using your body's warmth? Learn more about the 'heat balling' technique by using a heat-sensitive surface.

Invisible messages

Graphic panel

A step-by-step guide to the Japanese honeybees' defensive strategy, showing how they use pheromones to organise their defence.





SWARM ZONE

LAB

Large table

Bug basics

Graphic panel

An introduction to the way bees and other insects work together.

Bio-inspiration from swarming insects

Kilobot robots (objects) and digital label

Digital label content:

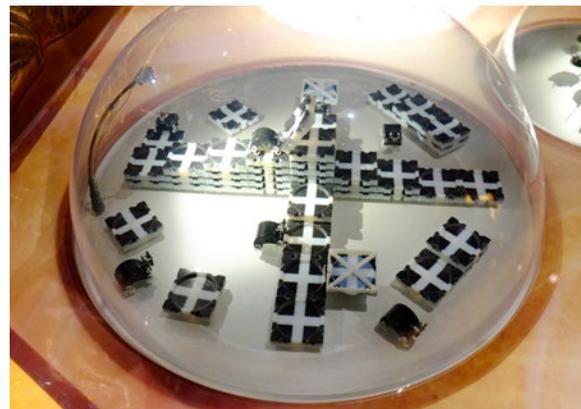
Swarm robotics: Researchers at Harvard University designed a simple robot bug, and built more than 1,000 of them. It's the largest robot swarm ever, and it might help humans learn how bugs work together. See a video of it in action.

Bio-inspiration from termites

TERMES robots (objects) and digital label

Digital label content:

Swarm robotics: Termites seem like master architects, but they don't need a plan or a boss to make air-conditioned structures over 5 metres (16 feet) high. TERMES work using the same principles, and are able to build one structure multiple ways. Watch them on the job.





SWARM ZONE



Meet a swarm expert

Dr Thomas D Seeley, Professor of Biology, Cornell University, USA

Hear about how bees work together, and what humans could learn from their harmonious lifestyles.

Dr Justin Werfel, Senior Research Scientist, Wyss Institute, Harvard, USA

Talk with a swarm robotics expert about TERMES and kilobots, and about how social insects could inspire humans in the future.

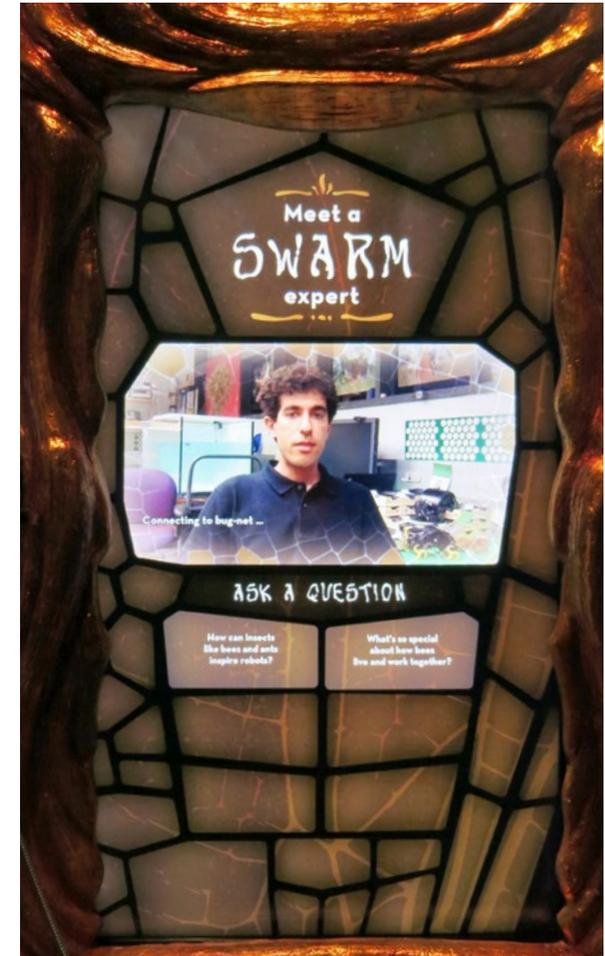
Total video length: 1:32

Specimens and digital label content

Honeybees, German wasp, dark blue tiger butterfly, American cockroach, Asian paper wasp, bull ant, painted lady butterfly, migratory locusts

Digital label content:

For each bug, read about a remarkable swarm-related adaptation, and examine detailed close-up images of the specimen. Most specimens also feature 'bonus secrets' relating to bio-inspiration or further adaptive 'genius'.





EXOSKELETON ZONE

Bugs' body plans make them powerful and ready for anything. Humans are studying what makes them so tough, and experimenting with exoskeletons of their own.

The bombardier beetle is this zone's master. It defends itself by firing a near-boiling spray at aggressors. The same tough cuticle that forms its exoskeleton protects it from the blast.

UNIQUE EXPERIENCE

Younger visitors can trigger the bombardier beetle's blast by sliding through a giant model.



Accompanied by video: 1:32





EXOSKELETON ZONE

LAB

Large table

Bug basics

Graphic panel

How exoskeletons work, and why they are so effective.

Bio-inspiration from exoskeletons

Exoskeleton leg part (object) and digital label

Digital label content:

Robotics: REX Bionics has built the world's only self-supporting exoskeleton for humans. Like a bug's exoskeleton, it serves as a framework for the attachment of muscles. See a video of it in use.

Bio-inspiration from fog-basking beetles

Dew Bank model and digital label

Digital label content:

Design inspiration: This experimental object mimics the Namib Desert beetle's ability to collect water on its body. Other beetle-inspired coatings could keep windows clear after rain or keep ice off wind turbines.





EXOSKELETON ZONE

Meet an exoskeleton expert

Dr Eric M Arndt, Materials Scientist and PhD graduate from the Department of Materials Science and Engineering, MIT, USA

A leading expert on the bombardier beetle explains why this bug is inspiring engineers.

Richard Little, Chief Technical Officer and Co-founder, REX Bionics, New Zealand

Hear about the challenge of making exoskeletons for humans, and how they can change lives.

Total video length: 10:41

Specimens and digital label content

Harlequin beetle, jewel beetles, dung beetles, diving beetle, Japanese snail-eating beetle, giant Fijian longhorn beetle, tiger beetles, stag beetle, Wakefield's click beetle, true weevils

Digital label content:

For each bug, read about a remarkable exoskeleton-related adaptation, and examine detailed close-up images of the specimen. Most specimens also feature 'bonus secrets' relating to bio-inspiration or further adaptive 'genius'.





SILK ZONE

Silk is bugs' best-kept secret. Humans have used this remarkable material for thousands of years, but are only now discovering its potential uses in medicine and technology.

Katipō model

The final master is the katipō – New Zealand's relative of the black widow spider, and an expert silk spinner. It stands watch over the silk lab, its web linking to the 'bug debate' area.





SILK ZONE

LAB

Bug basics

Graphic panel

Discover the many ways that spiders use their silk.

The wonders of spider silk

Physical interactive

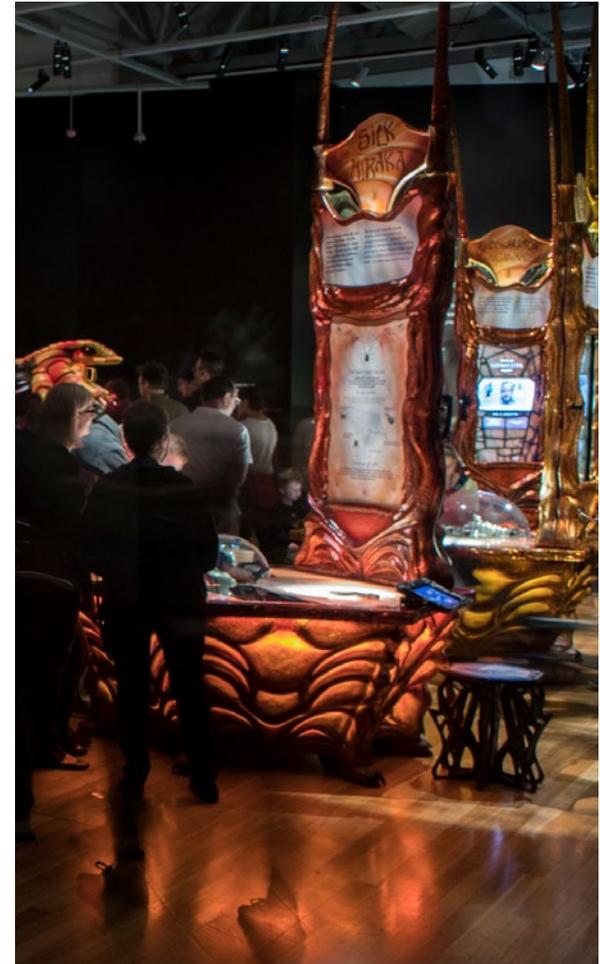
Explore eight properties of silk. Learn how spiders benefit from each, and how humans might be able to copy them. Information lights up via touch.

Bio-inspiration from silk

Silk-derived objects from Tufts University and digital label

Digital label content:

Biomaterials: Is silk the high-tech material of the future? These objects demonstrate the wide range of potential applications for silk-derived materials, from eco-friendly disposable cups to edible sensors and optical films.





SILK ZONE

Meet a silk expert

Cheryl Hayashi, Director of Comparative Biology and Curator of Invertebrates, American Museum of Natural History, USA

Find out how tough spider silk is, and why scientists bio-prospect among different silks.

Dr Jessica Garb, Associate Professor, Department of Biological Sciences, University of Massachusetts Lowell, USA

Hear about how spiders make their webs, and the research connection between silk and venom.

Professor David Kaplan, School of Engineering, Tufts University, USA

Get a taste of how silk could be used in medicine and surgery, and hear why it's so well suited for high-tech applications.

Total video length: 22:41

Specimens and digital label content

Silk moth and its cocoon, cecropia moth, Chinese oak tussar moth, golden orb-weaver, nursery-web spider, tunnel-web spider, common orb-web spider, cricula silk moth, bag moth cocoon

Digital label content:

For each bug, read about a remarkable silk-related adaptation, and examine detailed close-up images of the specimen. Most specimens also feature 'bonus secrets' relating to bio-inspiration or further adaptive 'genius'.





BUG DEBATE

Can bugs and people get along? Hear different perspectives, and have your say in this interactive zone.

Magnet wall and table

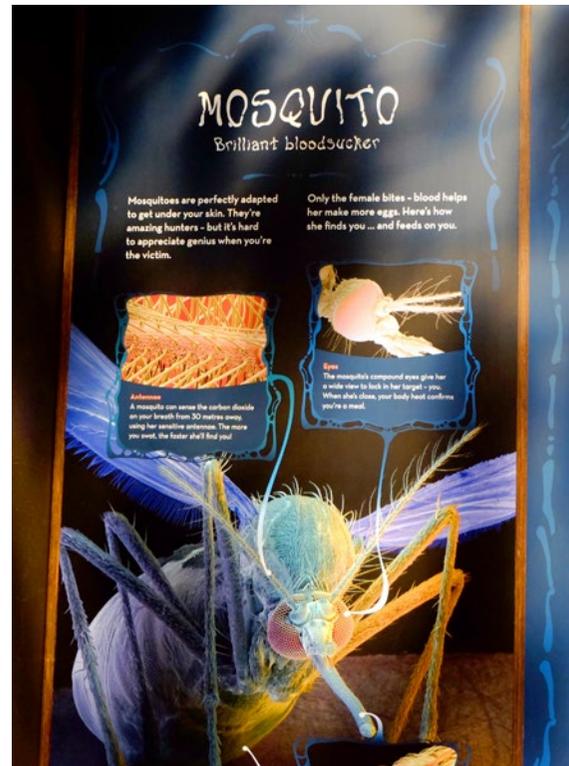
What do you really think of bugs? Write a response or draw a picture, and post it on the 'web'. Three short prompts can be changed by host venues.



Mosquito dilemma

Graphic panel

If you could get rid of all the world's mosquitoes, would you? Read arguments for and against, and understand how a mosquito tracks down its target so effectively.



Ask the bugman

Digital interactive

Ruud Kleinpaste is on a mission to change how you see bugs. He thinks that there are two sides to every bug's story, even unpopular ones like flies, cockroaches, and mosquitoes. And perhaps he'll convince you that bugs are good to eat!

Four videos, total duration: 7:07



TE AO PEPEKE THE MĀORI WORLD OF BUGS

Discover a unique perspective on the bug world, through the eyes of New Zealand's indigenous people. Bugs, humans ... for Māori, we're all part of the same web of life, and connected through whakapapa – the great family tree. See how bugs have inspired art, music, and stories.

Life cycle of a pepetuna moth and photo wall

Graphic panel

Follow the life stages of this striking insect, and pose for a photo as a grub or adult moth.

Pūtōrino flute

Object and audio interactive

See a musical instrument inspired by the shape of a bag moth's tapered cocoon, and hear its three different voices.

Takarangi spiral carving

Touchable object

The Māori word for carving, whakairo, literally means 'to make like a bug', after the way grubs leave patterns in wood. Run your fingers over the grooves of a spiral representing the endless cycle of all living things.

Wētā

Specimen

This fearsome-looking native cricket embodies the show's challenge – can you look past bugs' appearances to find wonder and understanding?

Rātā and the multitude

Graphic panel

Read the inspiring story of a young man who learned respect for nature from the insects and birds of the forest.





EXIT

Interactive video wall

The fireflies guide you back into the human world. An associated text panel offers a final challenge: when you next see a bug, will you look closer?





EXHIBITION SPECIFICATIONS

Size

7,500–8,000 square feet (700–750 square metres) – size flexible

Language

English, with provision for a second language if venues require

Exhibition layout

Modular in design, travels with all components

Venue content

Venues are encouraged to add local content, including live bugs

Environmental requirements

Flexible, non-environmentally controlled option available

Support

Education resource

Copyright-cleared media and marketing materials

Experienced Te Papa installation and deinstallation team

Photo credits

Pages 8, 33: Katipō spider by Tom While, Crown Copyright: Department of Conservation Te Papa Atawhai (2008).

Page 8: Orchid mantis by Frupus

Page 8: Japanese giant hornet by T-mizo

Page 8: Bombardier beetle copyright (1999) National Academy of Sciences, U.S.A - PNAS Spray aiming in the bombardier beetle: Photographic evidence - Thomas Eisner AND Daniel J. Aneshansley

Page 8: Jewel wasp by Johan J Ingles-Le Nobel

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For more information, contact

Te Papa Touring Team

Museum of New Zealand Te Papa Tongarewa

Email: touringexhibitions@tepapa.govt.nz

**Absolutely
Positively
Wellington**
New Zealand



This exhibition was made possible through the support of the Wellington City Council

This exhibition has been developed by the Museum of New Zealand Te Papa Tongarewa with Weta Workshop Limited



BUG LAB TEAM



TE PAPA

Content, interpretive expertise, and design skills were provided by Te Papa. Our subject expert, Dr Phil Sirvid, was supported by spider biologist and writer Dr Simon Pollard. They worked with entomological educator Ruud Kleinpaste and an international panel of scientific advisors to incorporate the latest science from a wide range of fields.

BLOCKBUSTER EXHIBITIONS FROM A WORLD-LEADING MUSEUM

Te Papa is New Zealand's groundbreaking national museum, renowned for being interdisciplinary, participatory, bicultural, and fun. In 2015, it attracted 1.8 million visitors to its exhibitions – that's nearly half the country's population – and its satisfaction ratings are second to none.

WETA WORKSHOP

Weta Workshop's team is headed by Academy Award-winning Sir Richard Taylor as Creative Director. Around the *Bug Lab* table were many of the creative thinkers and artists who collaborated with Te Papa on *Gallipoli: The scale of our war* – our most successful exhibition ever.

