Manaaki Whenua
Landcare Research

Landcare Research
DISCOVERY

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An inventory of all species – is it 'do-able'?

What's Inside:

"It's potentially do-able" says Lord May of Oxford, president of Britain's Royal Society, claiming that with the right commitment a comprehensive inventory of all living species could be produced, "...possibly [taking] a decade and very concentrated research." (New Zealand Herald 17/10/02).

Could New Zealand compile its inventory of indigenous species in that time frame? Well, the mammals are certainly 'do-able', indeed done: two species of bat and that's it. The birds likewise: there is much more concern over losing species than finding new ones. Similarly for the reptiles and amphibians: they are pretty well all known unless new DNA analyses cause the split of one species into two. Although we are still finding new species of native fish, thanks again to DNA analysis, like the other vertebrates, fish are 'do-able'.
And the higher plants do not present too much of a challenge, although truly new species are still being discovered. For example, Landcare Research scientist, Dr Peter Heenan, recently discovered a new extremely rare species of small-leafed *Olearia*, or tree daisy, outside Christchurch.

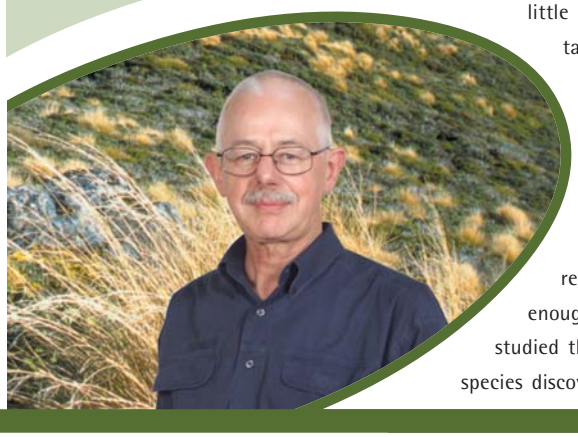
But for the invertebrates and lower plants, fungi and bacteria, real questions must be asked about Lord May's assertion that a complete inventory is 'potentially do-able'. There are just so many undiscovered species in New Zealand. A couple of years ago one of our staff came across a giant slug ('as big as your hand') half way up East Cape's Mt Hikurangi. While it may have been known to local Māori it certainly was new to invertebrate systematics. But perhaps this is not surprising since little priority has been given to the taxonomy of New Zealand slugs.

The insects have been better studied, but entomologists will be quick to point out that although about 10,000 species have been described, an estimated 10,000 remain undescribed. Wētā, some big enough to trip over, have been better studied than some other groups, with one species discovered and described every year since 1980. Overall, our knowledge of the insects, spiders, mites and other arthropods is vastly greater than that of the nematodes (again, thousands of species remain undiscovered).

With algae, fungi, sponges and bacteria, 'potentially do-able' becomes 'probably impossible'.
Our mycologists (fungal scientists) have asserted for years that the 6000 or so named fungi represent perhaps 30% of the total native fungi. As for the bacteria, no one is willing to estimate the ratio of known to unknown; other than to say a teaspoon of forest soil contains 10^6 to 10^9 organisms comprising many thousands of species.

Looking realistically at Lord May's plea for a complete inventory, in New Zealand, the task seems immeasurable, as well as unachievable. This country is acknowledged as one of the world's 15 biodiversity hot spots and hence, arguably, should be a priority area for this daunting task. While several millions of dollars annually *are* spent on biosystematics research, most of the funding goes on the better-studied taxa. Overall, biosystematics has suffered from years of underfunding. The taxa where the 'inventory' is poorest are the very taxa gaining least resource. We have some control over this priority setting, and Lord May is challenging us to rethink those priorities. 'Smart systematics' would see a move from simply measuring and cataloguing (and producing all-taxon inventories) to biosystematics, which, through a focus on priority taxa, underpins and provides insights for informed biodiversity management decisions.

The stories in this edition of *Discovery* provide examples of how the Landcare Research biosystematists are contributing to the major issues of biodiversity and biosecurity in New Zealand.



Robert Lamberts

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Photo credits: left to right, Harley Betts 1, 2, 6, 8, Dave Morgan 3, Landcare Research Slide Collection 4, 5, Peter Buchanan 7.

Hunt begins for elusive 'Phoenix' moth

Is it extinct? Or just waiting to fly back into the light?

Landcare Research lepidopterist Dr Robert Hoare is on the trail of a large mystery moth that has not been seen since 1959. It has been cited as a species in need of urgent conservation[1].

Titanomis sisyrota is (or was) an impressive moth with a wingspan of around six centimetres. Dr Hoare has christened the moth 'the Frosted Phoenix', to describe the pearly surface of its wings, and to reflect the hope that it will 'rise from the ashes' and that the species can be saved.

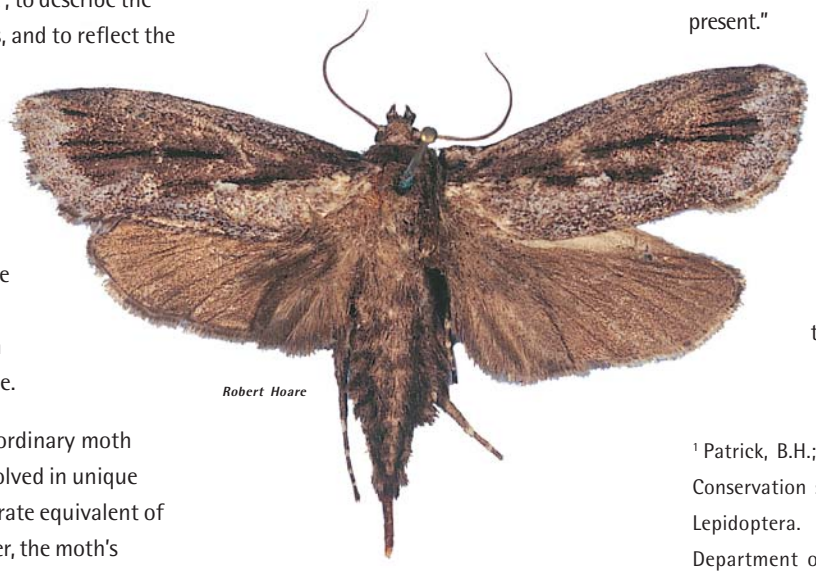
Dr Hoare says the Frosted Phoenix is of special interest, as it appears to be a primitive and unique New Zealand species, with no close relatives anywhere.

"To lose a large and extraordinary moth such as this, which has evolved in unique conditions, is the invertebrate equivalent of losing the kākāpō. However, the moth's existence has passed almost unnoticed by anyone but specialist entomologists.

"To save the species, if we can still save it, we must first rediscover it. To myself and other lepidopterists, such a find would be as sensational as Orbell's rediscovery of the takahē in 1948."

Dr Hoare has prepared a report that gathers together the few available details on the moth for the first time. There have been just ten recorded captures of *T. sisyrota* in New Zealand, and only eight specimens exist. Very little information on the moth's life cycle has been recorded. However, Dr Hoare has compared the moth's anatomical details and wing colour pattern with other species with known life histories, to try to determine the moth's biological and ecological requirements.

"The brown and black wing pattern with white edging on the forewing is typical of forest species that rest, camouflaged, on tree trunks during the day. Also, the females have large ovipositors that suggest that they lay their eggs in rotten wood, among bracket fungi, or by stems and roots of large monocotyledonous plants such as toetoe."



Robert Hoare

Female specimen of the Frosted Phoenix, T. sisyrota. *The Frosted Phoenix can be distinguished from other moths by the white frosting around the forewing, and the black streaks in the middle of the wing, one containing a distinct white spot. The female has a long ovipositor, although this may not be easily visible in a live specimen.*

Dr Hoare has made preliminary approaches to the Department of Conservation and Tūhoe people of the Urewera forest, providing them with details of the moth and asking them to look out for it.

"The Urewera forest is the North Island's largest remaining native forest. Its dead wood and fungus-feeding insects may well include a population of this moth, if it is indeed a forest species, not a wetland species."

And just what is the likelihood that the moth is still out there?

"I have always felt that the moth is unlikely to be extinct, as it has always proved extremely elusive, and there are few people actively seeking moths in New Zealand at present."

Dr Hoare says he would like to hear from anyone who has caught a moth that they believe may be the Frosted Phoenix. Any captured moth should be stored in a jar in a refrigerator to prolong its life.

[1] Patrick, B.H.; Dugdale, J.S. 2000: Conservation status of the New Zealand Lepidoptera. *Science for Conservation.* Department of Conservation, Wellington, New Zealand. *136.* 31 p.

Funding: Department of Conservation.

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Apology

Our article in Discovery 3, " 'Footprints' show regional sustainability" (p3) wrongly indicated the Ministry for the Environment as funder of the ecological footprint research. While the Ministry is completing work on ecological footprints for New Zealand and its regions, our article was based on earlier work by Garry McDonald. We apologise for any confusion or concern caused by this mistake.

Plants 'trigger' new understanding

A Landcare Research study into why some trigger plants are more successful than others is adding to our understanding of why some plants flourish, while others become extinct.

New Zealand's trigger plants are members of the Southern Hemisphere family *Stylidiaceae* and arrived millions of years ago from Australia or South America. They derive their name from a complex trigger mechanism in the flowers, which deposits pollen on probing insects and ensures cross-pollination.

Landcare Research molecular systematist Dr Steve Wagstaff joined forces with Australian scientist Dr Juliet Wege to trace the ancestry or whakapapa of New Zealand trigger plants by comparing their DNA sequences to their South American and Australian relatives and tracking the evolutionary changes. They predicted that new migrants that were forced to adapt would be less successful than those already well suited to New Zealand conditions.

Drs Wagstaff and Wege focussed on three genera of trigger plants: *Phyllachne* (which includes the ubiquitous alpine cushion plant *P. colensoi*), *Forstera*, and *Oreostylidium*. *Oreostylidium* is unique to New Zealand with just one uncommon species that is found in sphagnum bogs.

The research showed that *Phyllachne* and *Forstera* had more time to become established in New Zealand, arriving here about six million years ago, compared to *Oreostylidium* which arrived two million years ago. But the main advantage the first two have is that their ancestors were white-flowered cushion plants that looked like them. In contrast, *O. subulatum's* bright pink ancestors looked very like its sister plant, *Stylidium graminifolium*.

"Its ancestors arrived here dressed in bright pink showy blossoms that were designed to attract specialist bees. Cross-pollination was necessary to produce viable seeds. However, in New Zealand there were fewer potential pollinators," Dr Wagstaff says.

"The species had to adapt quickly, losing its pink colour and trigger mechanism in favour of the small, white flowers so common in New Zealand plants. These flowers have a more general appeal to a wider range of pollinators.

"It is likely that *Oreostylidium* has been struggling to become established in an ecological niche."

Systematic studies of the New Zealand flora reveal a remarkable history of dispersal, adaptation and extinction. As an island nation, our indigenous flora has evolved in isolation and we are constantly exposed to undesirable new plant arrivals. Knowing how our plants have evolved may help us to predict the future impacts of new arrivals.

"This research adds another piece to a fascinating puzzle," Dr Wagstaff says. "Our findings add weight to the theory that evolutionary success can be partly attributed to where the ancestors came from, what they looked like, and how long their descendants have been able to adapt to New Zealand's unique environment."

The results of Dr Wagstaff and Dr Wege's research have just been published in the American Journal of Botany.

Funding: FRST (Foundation for Research, Science and Technology)

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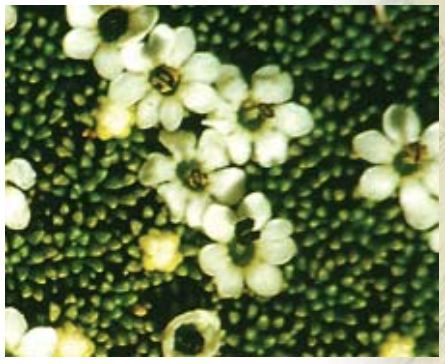

Margaret Aiken

Phyllachne colensoi, *a common alpine cushion plant in New Zealand.*

Adrienne Markey

Oreostylidium subulatum, *a rare denizen of sphagnum bogs.*

Steve Wagstaff

Its sister, Stylidium graminifolium, *is found in eastern Australia.*

New system streamlines environmental monitoring

Landcare Research scientists have developed a unique computer-based tool that improves the efficiency of environmental monitoring, in response to greater demand for research that helps assess and protect native biodiversity.

KOIORA-BIOASSIST™ helps to capture, store and record the thousands of pieces of information collected in biological surveys. BIOASSIST stands for **BIO**diversity **ASS**essment using **I**nformation **S**ystems and **T**axonomy. KOIORA means 'life', and also 'a quick or sharp mind'. In this case, the 'sharp mind' is the computer system and the microscopes and digital image technology that support it. Scientists and researchers are using the technology to build up an information database of New Zealand's invertebrate diversity.

KOIORA-BIOASSIST™ project leader Dr Marie-Claude Larivière says work on the system began in 1999, to address difficulties in meeting the increasing demand for insect identification and information services for biodiversity and environmental restoration projects. The system is loosely based on the BioTrack™ model developed by Macquarie University in Sydney, the only other system of its type in the world.

Traditionally, researchers assessing biodiversity (for example, of beetles as an indicator of forest health) follow a slow, painstaking process of writing labels for the thousands of beetles and other insects, detailing where, how and when they were collected. Once back at the lab, the thousands of pieces of data are laboriously typed into a computer. Researchers then face the immensely difficult job of identifying enormous numbers of species based on drawings or descriptions. This process can take many months.

Birgit Rhode

Dr Marie-Claude Larivière at one of the KOIORA-BIOASSIST™ workstations, checking identifications and entering data.

Dr Larivière says KOIORA-BIOASSIST™speeds up the process of such surveys by about a third. It uses three complementary systems involving barcodes, a database, and imaging technology. These are used with rapid diagnostic procedures that allow non-specialists to sort species. Their results can be checked by trained taxonomists.

"Using KOIORA-BIOASSIST™, researchers head into the field with especially assigned barcodes that reduce the need for hand-writing labels for samples and specimens, and keying all the details into the computer. Barcodes are simply scanned, which saves time and reduces data-entry errors. The system also uses the biodiversity database manager software, BIOTA (R. Colwell, University of Connecticut, USA), which helps to store and sort the information on the specimens.

"But perhaps most importantly, KOIORA-BIOASSIST™ includes thousands of sophisticated images of invertebrates, which greatly assists in identification."

The quality of the image at left is low, due to reduced depth of field at high magnification. The image on the right was prepared using Auto-Montage software to increase the depth of field.

The KOIORA-BIOASSIST™ team is at the forefront of world expertise in the use of AutoMontage software to capture digital images of invertebrates. This system takes many partly focussed images of a specimen and collates them into one perfectly focussed image, thus giving greater detail to aid in identification. Head and dorsal shots of an insect are

taken, as well as close-ups of key features that may help in identification.

"We take these images of new specimens if they are not already in our database. This is complemented by images of specimens stored in the New Zealand Arthropod Collection, the country's largest collection of invertebrates, which is housed by Landcare Research.

"Access to this resource has been crucial to our success thus far, as is the taxonomic expertise of staff who verify the identifications."

KOIORA-BIOASSIST™ has an exciting future. It is now being used in FRST (Foundation for Research, Science and Technology) and commercially funded research projects, and is expected to prove extremely useful for archiving and auditing museum collections, and for teaching purposes. Future plans may involve online access to KOIORA-BIOASSIST™'s databases and procedures. It is also hoped that plants, fungi, and possibly also micro-organisms will be added to the tool.

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www.bioassist.co.nz

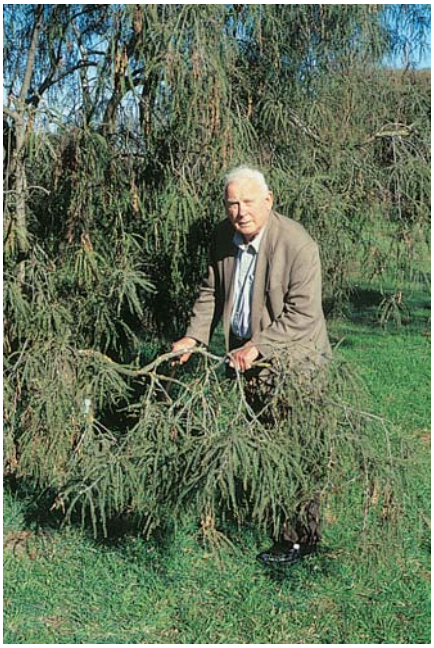
Discovery leads to changing views of kōwhai

The discovery of five new species of kōwhai has fascinated the public, and is beginning to influence which species are planted, and where.

Last year, Landcare Research plant taxonomist Dr Peter Heenan and Department of Conservation scientist Peter de Lange published their intriguing new finding that there were in fact eight species of kōwhai, rather than three, as previously thought. These new species have different growth habits, leaves, flowers and flowering times, as well as different habitats.

The new species are: *Sophora molloyi*, a rare, long-flowering shrub found on exposed headlands in the lower North Island; *S. fulvida*, a rare, hairy-leaved variety on volcanic outcrops from Marlborough to Waikato; *S. godleyi* from the central North Island; *S. chathamica*, found mainly in coastal areas of the North Island and on Chatham Island; and *S. longicarinata*, which was previously thought to be a variety of the common *S microphylla*.

Dr Heenan says he has fielded many hundreds of phone calls about the new species of kōwhai from people wanting to find out more. Even now, 18 months after the findings were published, there are still weekly enquiries.



Peter Heenan

Renowned botanist Dr Eric Godley with his namesake kōwhai, Sophora godleyi, *which grows in the central North Island.*

"The degree of interest has been staggering. I have been particularly pleased to receive calls from nurseries and specialist growers of native plants wanting more information, and starting to use the new names.

"All of this will eventually help to conserve the kōwhai, particularly the more rare species. If people are aware of the characteristics and use local genetic material for planting, their kōwhai will grow better and there is less risk of hybridisation between the species."

Recently Dr Heenan made new discoveries concerning other native plants. He discovered a rare new species of *Olearia* or tree daisy, known only in Canterbury. He has also discovered a new species of the iconic herbaceous native plant, the rengarenga lily (*Arthropodium*), which is present in many gardens. Dr Heenan's findings will be published in coming months.

Funding: FRST (Foundation for Research, Science and Technology)

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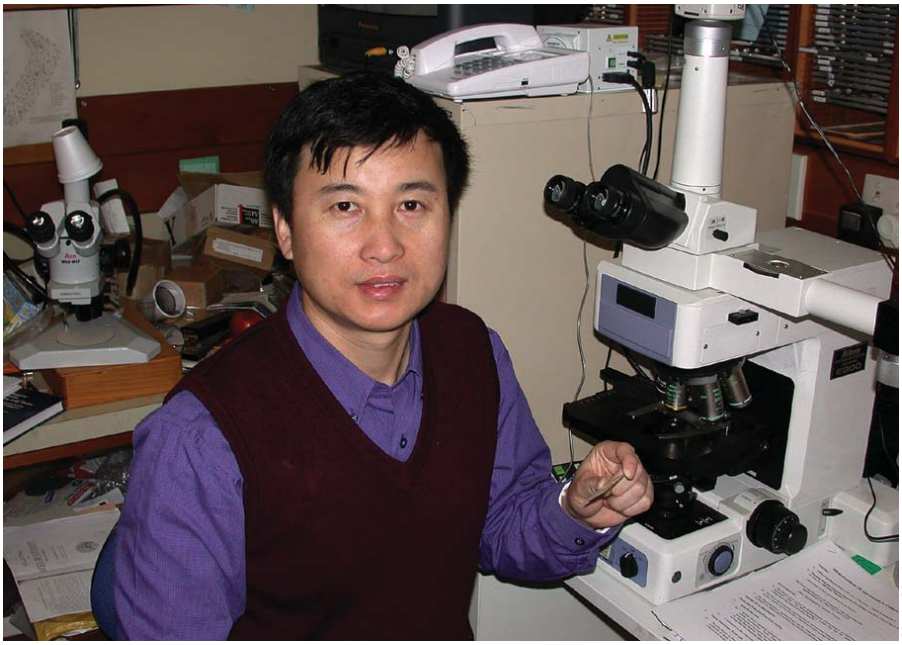
Speed the key in fight against mites

Landcare Research has produced a set of user-friendly identification keys to help equip the Ministry of Agriculture and Forestry (MAF) for its job of protecting New Zealand and its trade relationships against tiny but mighty enemies.

Mites are a highly diverse group of flightless spider-like creatures, and most are too small to be seen with the naked eye. Despite their small size, they can create big biosecurity problems; the varroa bee mite, for example, arrived undetected and will cost the country millions of dollars.

While some mites are parasites on insects, animals and humans, many others are pests that live off plants and stored foods such as grains and cheeses. Because of their extremely small size and incredible diversity, mites are notoriously difficult to identify.

Landcare Research acarologist (mite scientist) Dr Zhi-Qiang Zhang has been contracted by MAF Biosecurity to produce keys for identifying selected high-risk groups of mites that contain damaging pest species. Dr Zhang and his assistants studied thousands of new and existing mite specimens from plants, museums and collections including the New Zealand Arthropod Collection held by Landcare Research. They used microscopes capable of up to 5000x magnification to identify specific anatomical features, and then described and illustrated them.



Birgit Rhode

Dr Zhi-Qiang Zhang at work studying mite specimens in his laboratory.

The identification keys are crucial tools that are enabling MAF's National Plant Pest Reference Laboratory to quickly determine if mites intercepted by MAF are from high-risk groups, and then to pinpoint their genus and species.

Dr Zhang says the keys not only help avoid the expense caused by new mites becoming established as pests, but also save importers crucial time and money. "Not all mites are pests, so it is important to identify them before deciding whether to fumigate.

"Failure to identify mites correctly and rapidly creates delays in processing, and may lead to the return or destruction of a complete shipment. The keys speed up the identification process."

MAF National Plant Pest Reference Laboratory entomology group leader Alan Flynn says the keys also help save exporters money.

"Knowing what species of mites are present in New Zealand is crucial to negotiating continuing market access for exports. The use of the keys also aids New Zealand's efficiency in reassuring importers of New Zealand goods that we do not have particular mites."

Mr Flynn says the keys have proven to be extremely valuable tools for the laboratory.

"MAF has invested in four of them and has found them most useful. We want to continue this investment and build up our library of keys, to expedite identification of other mites."

Funding: MAF Biosecurity

Landcare Research slide collection

Brown wheat mite (Petrobia latens) *of the spider mite family* Tetranychidae, one of the 'high risk' families of mites.

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Forays build up 'big picture' of fungi

Highly relevant but often ignored, fungi are arguably New Zealand's 'forgotten' biodiversity. The New Zealand Fungal Forays, organised in part by Landcare Research, are slowly but surely providing a profile of where to find different New Zealand fungi, and what they can tell us about forest health.

The Fungal Foray, now in its 16th year, is held in a different part of the country each autumn, most recently in Haast this May. With the permission of the Department of Conservation and local landowners, fungal fanciers, both scientists and enthusiastic amateurs, scour a selected forest for good quality fungal specimens. Each night at base camp, specimens are identified and preserved. Specimens are then stored in recognised herbaria (plant and fungi libraries), where they can be used by researchers worldwide.

Landcare Research mycologist (fungal scientist) Dr Peter Johnston says the Fungal Forays are a means of getting to grips with the vast array of New Zealand fungi. About 6,000 species have been recorded and described here, but an estimated 14,000 are yet to be discovered. Dr Johnston says that even for those that have been described, few details may be available.

"Most of the recorded species have been seen at just one or two sites throughout the country. Knowledge about the ecology of a fungus, such as the kinds of plants, animals, and forests with which it is associated and diseases it may cause, is needed to understand its biology, and the role it may play in maintaining forest health.

Peter Buchanan

At the end of a day, specimens collected on the Fungal Foray are spread out for identification.

"At every new forest we go to, up to 90% of the fungi collected have not previously been recorded in that part of the country. This apparently high number reflects nothing more than a lack of distribution data."

"Over the next 10 to 20 years, we will develop an overview of the fungal species present in a healthy forest.

"We may be able to tell if a forest is under stress by the presence or absence of particular kinds of fungi. In healthy forests, fungi perform essential functions such as decomposing and recycling nutrients, and providing a food source for invertebrates. This helps to maintain the health of the whole forest."

At every Fungal Foray discoveries are made. One fungus found in Haast in May was the introduced and invasive orange pore fungus (*Favolaschia calocera*), a species that may be an 'indicator' of a forest under stress.

"This is the first time the orange pore fungus has been recorded so far south," Dr Johnston says. "Records from the Foray and other sources suggest that this species is most commonly found in highly modified sites, such as forest margins and small forest remnants.

"It may be that the orange pore fungus is invading these sites because the native species normally expected there have been lost, as they are sensitive to such forest disturbance. Therefore, the presence of the orange pore fungus may indicate a forest with an impoverished native fungal biota."

Dr Johnston says Fungal Forays also turn up many entirely new species. "One of the most striking examples in Haast was a large 'brain'

Peter Buchanan

The 'brain fungus', an Ascotremella*-like species, found in Haast for the first time.*

fungus. This type of fungus has never been seen in New Zealand before. It is almost certainly a new species, if not a new genus."

Dr Johnston is confident that the Fungal Forays will continue to grow in success for many years. The 50 or so faithful fungi foragers this year were helped by pupils from a local primary school, and attracted welcome attention from television, radio and print media.

"As well as building up our own scientific knowledge of fungi, we are very keen to increase the public's understanding and appreciation," Dr Johnston says. "Also, knowledge about New Zealand's fungi is limited, and public input on distribution, for example, can make a real contribution."

Funding: FRST (Foundation for Research, Science and Technology)

The 17th annual Fungal Foray will be in Katikati in the Bay of Plenty, in May 2003. For more information on the Foray see www.landcareresearch.co.nz/research/biodiversity/fungiprog/foray/.

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Staying up to speed with weeds

Landcare Research and key collaborators are keeping track of pest plants which have established in New Zealand, with the publication of checklists of weeds.

The lists provide up-to-date information on introduced plants that have 'naturalised', and become self-sustaining in the wild and in urban areas. The lists are important for biodiversity and biosecurity, and are used by the Department of Conservation, biosecurity officers, local authorities, scientists, agriculturalists, horticulturists, and members of the public.

Landcare Research plant taxonomist Dr Peter Heenan says the lists update the Flora of New Zealand Volume IV, the definitive taxonomic guide to weedy conifers, ferns and dicotyledons, published in 1988.
Dr Heenan says more than 260 new weed species have been recorded since then, including common horticultural vines, shrubs and trees such as olive and banksia.

Some weeds have the potential to become serious environmental pests, such as *Euryops chrysanthemoides*, a daisy bush, and *Pittosporum undulatum*, a forest tree and aggressive coloniser that has become uncontrollable in South Africa, California, Norfolk Island, Lord Howe Island, the Azores, and upland Jamaica.

"The checklists provide early warnings of new weeds before they become widely distributed and difficult to eradicate," Dr Heenan says. "The number of new weeds being found highlights the need to continually monitor new plant naturalisations, and New Zealand's susceptibility to pest plants."

Funding: FRST (Foundation for Research, Science and Technology)

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