New Zealand ecology

By Linda Jane Keegan

In order to understand New Zealand's ecology it is useful to have an understanding of its natural history. New Zealand's present ecological state resulted from its Gondwanan origins, geological and climatic history, isolation from other land masses, and the relatively recent arrival of humans. These factors have contributed to species' immigration, extinctions, and speciation. Considered a biodiversity hotspot, New Zealand hosts around 56,500 taxa, of which 70% are terrestrial (including fresh water species, which comprise only 9% of the total) and 30% marine.

As a consequence of its past connection to Gondwana, New Zealand shares biotic relationships with other land masses of the Gondwanan supercontinent, including South America, Australia, New Guinea and New Caledonia. The New Zealand land mass separated when mammals and flowering plants started to flourish, although why herbivorous and predatory mammals did not reach or establish in New Zealand is complicated and uncertain. Nonetheless, their absence significantly affected the evolutionary outcomes of species there.

New Zealand's links to Gondwana helped shape its present biota but other geological and climatic events also influenced these communities. The New Zealand Geosyncline (a large oceanic depression) and various orogenies (mountain-building episodes) affected which species could reach or survive in New Zealand, and had an impact on speciation. For example, the tectonic movement which forced land upwards forming the Southern Alps (the Kaikoura Orogeny), created habitat at higher altitudes into which alpine flora could radiate. In fact, they could only do so following prolonged exposure to an alpine zone. Other opportunities for speciation were the result of changes in sea level, existence of islands, glacial and interglacial periods, climate, and the emergence or loss of habitat. For instance, a submergence event known as the Oligocene drowning put much (some have argued all) of New Zealand underwater, which would have caused extinctions and limited new species colonising during that time.

New Zealand's isolation from other land masses and the almost complete absence of terrestrial mammals has conferred a high level of endemism – species have evolved in a unique environment. This is particularly apparent in the case of birds and invertebrates. Gigantism is common and appears in numerous species both extinct (e.g. Haast's eagle, moa), and still living (e.g. wētā, giant land snails). Numerous bird species are also flightless, ground dwelling and nocturnal, with some exhibiting melanism (where a darker coloured form of a species occurs, due to higher melanin levels). Most of the terrestrial vertebrates are endemic, and with only three species of native terrestrial mammal (all bats, one of which is extinct), birds and invertebrates fulfil the functional role that mammals provide in other countries.

Regarding plant life, early New Zealand was widely vegetated with ferns, podocarps, and Araucarian pines. The fossil record reveals a number of primitive terrestrial plants from the Jurassic and Cretaceous periods which still occur in New Zealand

today. *Sphagnum* moss, umbrella ferns (*Gleichenia*), and filmy ferns (*Hymenophyllum*) are a few such examples. Prominent vegetation assemblages in New Zealand now include kauri forest, podocarp forest, beech forest, tussock grasslands, coastal forest, and alpine flora.

Angiosperms (flowering plants) first occurred during the Jurassic and Cretaceous as Southern beeches (*Nothofagus*). Believed to be vicariant, and therefore Gondwanan, they are unable to disperse over the ocean. Present-day native angiosperms number close to 1900 species and several genera have undergone wide speciation. A lot of New Zealand's flowering plants comprise herbaceous species or shrubs, with *Veronica* (previously known as *Hebe*) one of the most speciose and ecologically diverse genera. Dioecism, where male and female reproductive parts occur on separate individuals, prevails among New Zealand's angiosperms and has been suggested to link to pollination or seed dispersal. Generalist pollinators predominate in New Zealand, though a few specialised relationships do exist.

It is likely that conifers, like beeches, also occurred vicariantly in New Zealand and other land masses due to the poor adaptation of their reproductive parts for oceanic dispersal. *Agathis* is one such example in the Araucariaceae family, with species occurring in New Zealand (kauri, *Agathis australis*), Australia, Southeast Asia and the western Pacific. It has also been shown through molecular evidence that their ancestors were present on Gondwana. Other conifer families now occurring in New Zealand include Podocarpaceae (e.g. rimu, kahikatea), Phyllocladaceae (e.g. tānekaha) and Cupressaceae (e.g. kawaka). Kererū, tūī and bellbirds are important avian dispersers of podocarp seeds via their fleshy fruit-like parts. Seeds of Araucariaceae and Cupressaceae are winged and wind-dispersed.

New Zealand contains a high diversity of bryophytes (mosses, liverworts and hornworts), with a high representation of liverworts in particular. All three are important components of carbon and water cycling and can occur in abundance on the forest floor, stream edges and tree trunks.

Of the pteridophytes (ferns and fern allies), 45% of native species are endemic, with their closest links in Australia and the tropics, and likely having arrived after separating from Gondwana.

An interesting group to mention is the divaricating shrubs and heteroblastic (differing juvenile and adult forms of the same species) plants. Divaricating shrubs make up 10% of the native woody genera. It is uncertain why New Zealand has such a high proportion of these types of plants but three hypotheses have been put forward: adaptation to moa browse (with the most compelling evidence), evolution of a microclimate due to glacial climate, and a photoinhibition avoidance strategy.

Unlike plants, the fossil record for terrestrial animals in New Zealand does not provide much evidence to determine founder species. Even for species considered to have ancestors of Gondwanan origin, fossils have only been found from as far back as the Tertiary period, after New Zealand's departure from other Gondwanan land

masses. Extant species of Gondwanan origin include tuatara (*Sphenodon*), frogs (*Leiopelma*), velvet worms (family Peripatopsidae), and carnivorous snails (*Paryphanta, Wainuia* and *Rhytida*). New Zealand wrens are also considered to be Gondwanan, with only two extant species: the rifleman (*Acanthisitta chloris*) and rock wren (*Xenicus gilviventris*). It was previously thought that ratites – in New Zealand, kiwi and moa – were vicariant. However, recent research contradicts this, suggesting that flighted dispersal and parallel evolution were the primary factors in ratite evolution. This indicates that flightlessness and gigantism evolved independently in ratites in different locales.

Our bat fauna consists of the long-tailed bat and the lesser short-tailed bat, with the greater short-tailed bat believed to be extinct. The long-tailed bats are aerial insectivores, while the short-tailed bats primarily forage on the ground. The latter are thought to be a pollinator for the now rare wood rose (*Dactylanthus taylorii*), New Zealand's sole fully parasitic flowering species.

New Zealand's herpetofauna includes geckos, skinks, and frogs. Geckos have Gondwanan links while skinks are believed to be more recent arrivals. Both show considerable adaptive radiation with at least 37 living species in total. Endemic frogs, in the genus *Leiopelma,* are particularly interesting due to their unusual breeding biology; eggs hatch into froglets with developed legs rather than free-swimming tadpoles.

Freshwater and marine environments host a range of notable species. In freshwater, galaxiids are the most speciose of the fish families, and New Zealand is home to the largest growing freshwater eels known. Both galaxiids and eels spend part of their life cycle in the marine environment. Of the marine fish, New Zealand's triplefins (commonly known as cockabullies) make up a third of global triplefin species. Marine mammals in New Zealand waters include seals, sea lions, dolphins and whales.

Two waves of extinctions and mass deforestation occurred following the arrival of Māori ancestors around 1300 AD and European settlers around 1800 AD. Humans brought species both intentionally and accidentally; plants and animals to sustain populations, numerous species introduced via acclimatisation societies, and countless unintentional pest animals and weedy plants have arrived via sea and air travel. Rats, stoats and possums are the most well-known threats to our native species, predating on birds, eggs, invertebrates and stripping native vegetation. New Zealand's wildlife evolved in the absence of mammalian predators and therefore lack effective defence mechanisms against these animals. The decrease in population of such species has ongoing effects. For example, the introduction of predators decimated seabird populations on both the mainland and offshore islands. Seabirds play an important role in bringing marine nutrients to the terrestrial environment, a cycle now disrupted.

The flora and fauna of New Zealand and their interactions between each other and the environment have been shaped by the country's history. Existing species are Gondwanan in origin or have dispersed there since separating from the

supercontinent. Being isolated from other land masses has resulted in a large proportion of species which exist nowhere else, and having evolved without mammalian predators they are vulnerable. While individual species are at risk of extinction, it is ecological interactions that are under threat.

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