

Natureland provides a place to view New Zealand endemic species and to use them as examples to illustrate genetic and evolutionary concepts.

The following notes are provided to use as background for the Natureland programme. The programme is suitable for students in years 11 – 13.

Kakariki – Parakeets

Speciation

A species is a group of organisms that normally interbreed. Individuals that can interbreed may form new groups called subspecies.

Kakariki eat a wide range of fruits and seeds. On 10 January 1885, *The Colonist* reported:

The farmers of the Waimeas are suffering severely from paraquets. At the early part of this week a field of oats was cut in the lower part of Waimea West, and immediately these mischievous and destructive birds covered the place in swarms.

There are several species of parakeet described in New Zealand including Red crowned parakeets, *Cyanoramphus novaezelandiae*, Yellow crowned parakeets *Cyanoramphus auriceps*.

These species in New Zealand and on New Zealand's outer islands have developed in isolation from each other.

This could be because they don't willingly fly across the sea unless their habitat changes and they need to find a new place to live. We call these allopatric species and we don't always know if they can interbreed.

If animal species develop adaptations for different foods and different ways to locate a mate they become ecologically isolated and even if they come in contact with other populations they will not interbreed.

Populations of parakeets have been studied on Little Mangare Island, south east of Chatam Island.

In the early 1900s, when Little Mangare Island was still forested, yellow crowned parakeets were common. Occasionally there were a few red crowned parakeets visiting from nearby Pitt Island.

Little Mangare is a very small island and later it was completely cleared for farming. The parakeets disappeared, presumably to Pitt Island.

The farming venture failed and scrub and regenerating forest started to take the island back. Back came the parakeets but this time both red and yellow crowned parakeet populations colonised the island. In 1968 Little Mangare was declared a Nature Reserve. Researchers in 1970 found hybrid forms as well. These have orange on their crowns.

Sample question

They found 8% yellow crowned, 32% red crowned and 60 % orange crowned . Orange crowned would appear to be the heterozygous condition. Yellow and red crowned parakeets may be the homozygous individuals.

- a. Are the percentages described above typical of a freely interbreeding population? How have you decided on your answer here?
- b. Describe factors that may be operating to cause these percentages.

Possible answers

- a. *Percentages are not expected. Expected percentages would be 25% : 50%: 25%. $pp + 2pq + qq = 1$ (The distribution of genes in a freely breeding population).*
- b. *The founding population may have had many more red crowned individuals than yellow crowned ones.
There may be a negative selection factor working against yellow crowned individuals eg more easily seen by predators.*

Kakariki and the Eastern Rosella

Australian Eastern rosellas that have been kept in aviaries in New Zealand. Some of these have been accidentally or purposely released into forests. In the North island there are some populations of birds that are believed to be hybrids between Kakariki and Rosella.

The Eastern Rosella occupies a similar ecological niche to kakariki. They nest in holes in trees and have greater breeding success which results in faster growing populations than those of kakariki. This results in competition for food and breeding sites.

Large populations of eastern Rosella could potentially affect regeneration of forest as they particularly like to eat seeds and fruit.

Kea and Kaka

Adaptive Radiation

Kea are found only in the South Island. Their favourite area is just below the bush-line but they visit snow grass areas above the bush, and lower scrub areas and river flats, especially in the winter. They have a distinctive call "Keaaa"

The Keas minimum breeding age is usually 3 years, and breeding occurs from July through to January. The nest sites are usually in a crevice under rocks, among the roots of a tree or in a hollow log on the ground.

Kaka will breed at 2 years, and breeding occurs from October – February. The nest sites are in large hollow trees with the entrance hole being about 3-9m from the ground. Kaka are found in both North and South islands

About 100 million years ago the super continent of Gondwana broke up and an unknown Australian parrot ancestral group became separated from other Australian parrots. Fossil remains of a proto kaka/kakapo dated at 60-80 million years ago have been found. After this period two groups Kakapo and Proto-kaka developed.

It is thought that both kea and present day kaka descended from a common ancestor Proto-Kaka. The fossil record shows that Proto-kaka lived in New Zealand during the Miocene period, 15 million years ago. New Zealand was all one landmass then and Proto-kaka was widely found.

About 5 million years ago the Southern Alps began to develop producing New Zealand's first alpine environments providing the opportunity for the kea to evolve from the proto-kaka species.

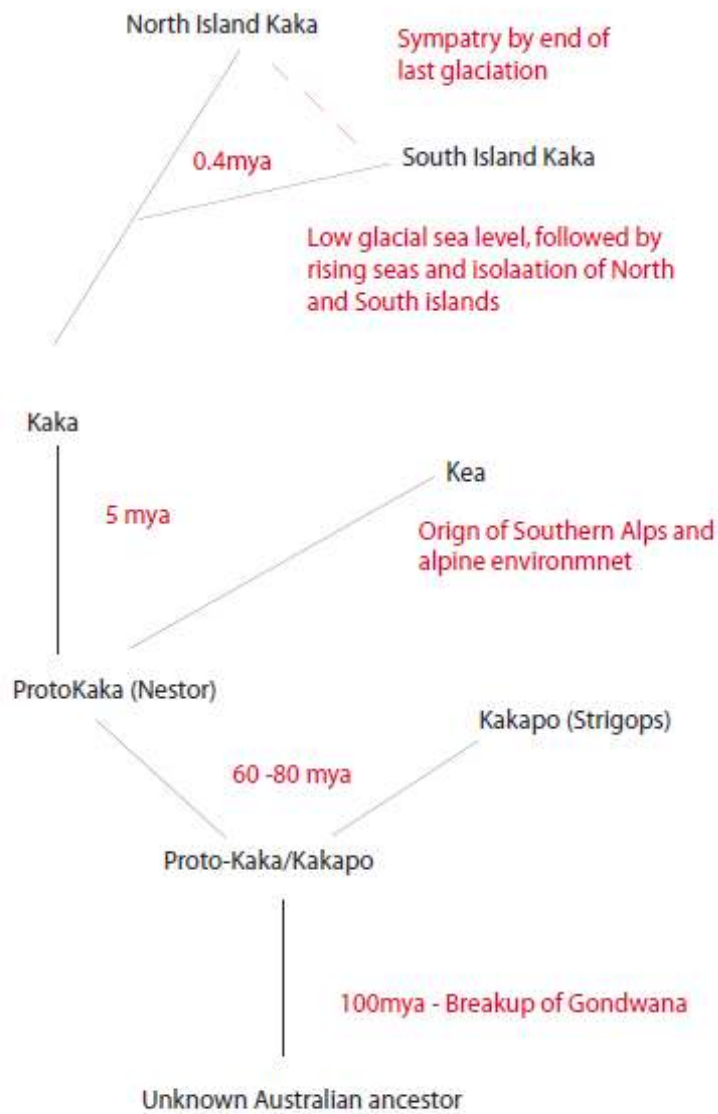
About 2 million years ago New Zealand was in two parts so the population of Proto-kaka was split up. The two groups could not breed with each other and so they developed in different ways. In the north of New Zealand there was lots of forest and this is where Kaka developed. In the south there was hardly any forest and it was very cold. There was a lot of alpine grassland and this is where Kea developed. Allopatric speciation is the formation of a new species after a population has been separated geographically. This is what happened to Kea and Kaka.

Over time the two isolated populations grow apart genetically and can no longer interbreed. Kaka inhabiting both the north and south of New Zealand 0.7 million years were later isolated when New Zealand was divided into two islands when seas rose at the end of the most recent ice age.

The climate changed, things warmed up and the South Island became forested. There was more land, so the distance between the North Island and South Island got smaller. Kaka flew to the South Island and became established in the forests around Nelson and the West Coast. In these areas Kea and Kaka are now sympatric species in the South Island occupying the same habitat but not interbreeding.

*Task: Draw a diagram to explain the development of Kakapo, Kea, and Kaka.
(Possible answer on following page)*

Evolution of Kaka, Kea and Kakapo



Powelliphanta

Speciation – Geographic and Genetic isolation

Giant land snails, *Powelliphanta* can be seen in the Nelson Marlborough region. Our snails are endemic to our region.

‘What’s endemic mean?’ It means they are found there and no where else.

Powelliphanta are under serious threat of extinction, from predation and habitat loss.

(Map showing where Powelliphanta are found)

The largest species is *Powelliphanta superba prouseorum*, found in Kahurangi National Park. It can be 9cm across, weighing 90g.

Powelliphanta gilliesi brunnea survives in a tiny remnant of coastal forest on old sand dune country where cattle graze. The snails are on the south side of the dune under flax bushes in the only leaf-litter they can find. In 2001 there were estimated to be only about 500 left but because DOC has fenced the area to keep out stock and rodents the numbers have now doubled.

On Mt Arthur in 1993, searchers could only find about three *Powelliphanta hochstetteri hochstetteri* snails in each of three sampling plots. By 2003, after ten years of ground control of possums, about 15 snails were found in each plot. In a near-by site where there is no possum control, less than three snails per plot were found. The focus is now on stoat control by Doc and organizations such as Friends of Flora.

Powelliphanta are found in moist places. They are more common in high-altitude forest than in lower drier forests. They live buried in leaf mould or under logs, only coming out at night to find food and to mate. *Powelliphanta* eat earthworms and sometimes slugs.

Powelliphanta are hermaphrodites, which means that they have both male and female reproductive organs and therefore can mate with any other adult *Powelliphanta* of the same group. They lay about 5-10 eggs a year in deep leaf mould.

The main predators are possums, pigs and rats, although weka, will also eat them. Possums have recently developed a taste for snails and they are including them in their diet over increasing areas.

Over thousands of years groups of *Powelliphanta* have become separated from each other by geographic features such as mountains and drowned river valleys. More recently they have been separated by forest destruction.

Shells of the following species are available but at present there are no live snails.

P. superba from the Karamea coast, *P. gilliesi* from Maungarakau, Collingwood and Mt Burnett, *P. lignaria* from Lodestone or Karamea river.

And the sub-specific set

P. hochstetteri hochstetteri from Takaka and Mt Arthur,

P. hochstetteri anatokiensis from west of the Takaka river,

P. hochstetteri obscura from D'Urville Island to Pelorus,

P. hochstetteri consobrina between Queen Charlotte and Pelorus Sound,

P. hochstetteri bicolor from East of Queen Charlotte Sound.

Sample question:

Identify and discuss the processes that cause genetic change and are likely to have caused the distinct shell characteristics of the species and subspecies of *Powelliphanta*.

Possible answer

The Founder effect

The divided (Founder) population probably had non-representative sample of alleles from the parent population. The group has been geographically isolated by Mountain building, and drowning of river valleys. The gene pool has been divided and restricted because all groups of snails can no longer interbreed. These groups may become genetically isolated.

Genetic drift:

The gene pool in the restricted habitat is much smaller than that of the original population resulting in genetic drift. Random changes in allele frequency would have had a significant effect on a small Founder population.

Genetic variation

Sexual reproduction and mutation introduces new characteristics to a group

Speciation

Offspring in the new population are more like each rather than showing the range of characteristics of the original group. Members of the new groups no longer breed with each other. Scientists have described sub-species and species that have been formed in this way.

Weka

Natureland is also a home for Chetwode island weka. These birds were removed from Chetwode when giant weta were introduced and weka predation was thought to be a threat. These weka have white markings thought to be an inheritable factor preserved in this population due to a very small founding population and few mating choices. For this reason DOC thought it unwise to introduce the group to other small island populations and they were given to various zoos.

Other Natureland species

Tuatara can also be seen in the summer months and these can form the basis for discussion about remnant populations, development in predator free isolation and current conservation status. Separate notes are available from museum.

Natureland also has tui, kereru, ruru, and several species of green gecko.