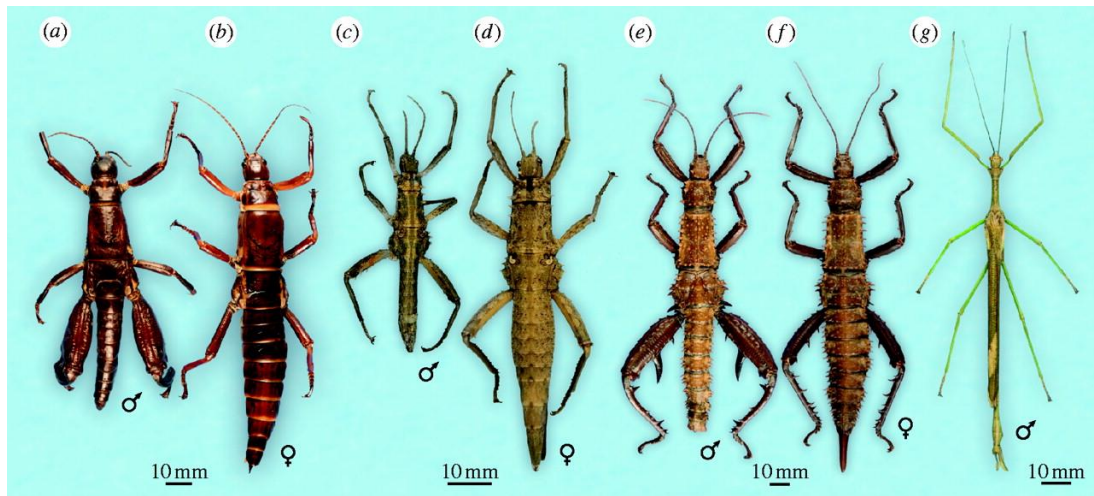


Demonstrate understanding of evolutionary processes leading to speciation

Evolutionary Patterns

(2015, 1)

‘Land lobsters’ are the common name of many species of large, flightless, ground-dwelling insects distributed in New Guinea, New Caledonia, and Lord Howe Island. Land lobsters have a stocky body form. Some males have enlarged and powerfully armed hind legs, and the females have an elongated ovipositor which they use to deposit eggs into the soil. Nuclear and mitochondrial DNA sequence analysis has shown that the different land lobsters species are unrelated to each other, and therefore have undergone convergent evolution.



Different ‘land lobster’ species, (a) to (f), compared with a winged, canopy-dwelling stick insect, (g)

Pōhutukawa (*Metrosideros excelsa*), northern rātā (*Metrosideros robusta*), and southern rātā (*Metrosideros umbellata*) are all related species belonging to the same genus. These species have undergone divergent evolution during the ice age that occurred between one and two million years ago.

Pōhutukawa has a coastal distribution and is very salt-tolerant. It has multiple trunks, is a coloniser of coastal cliffs and bare volcanic lava, and is susceptible to light frosts.

Northern rātā usually begins life as an epiphyte perched high on another tree. From here it sends down roots to form a trunk that can grow into a 40 m tree. It has moderate frost tolerance.

Southern rātā usually grows from the ground to a 15 m high, single-trunked tree that can tolerate frost and colder climates.



Single trunk – Southern Rata



Spreading multi-trunk - Pohutukawa



Free standing – Northern Rata

● BIOLOGY

Discuss the evolutionary patterns AND selection pressures that have contributed to these patterns for land lobsters and *Metrosideros*.

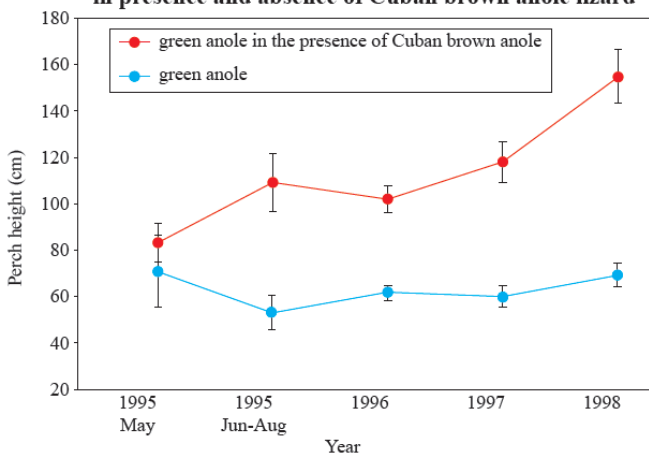
In your answer:

- describe convergent evolution and divergent evolution
- explain, using the evidence given above, how each of these patterns could arise
- explain, by giving examples from the resource material, which pattern is associated with homologous structures AND which pattern is associated with analogous structures
- discuss why land lobsters have a different evolutionary pattern to *Metrosideros*.

(2015, 2)

The green anole lizard (*Anolis carolinensis*) is the only native anole in the United States. However, since 1940, the Cuban brown anole lizard (*Anolis sagrei*) has been invading the southeastern United States so that both species exist sympatrically in this area. Both species have adhesive scales on their toe pads called lamellae, and are very similar in habitat use, ecology, and dietary preferences. Biologists studying these anole compared the height at which the green anole perched in trees in the presence AND absence of the Cuban brown anole, and their results are shown in Figure 1. Biologists also measured toe pad area and lamella number in the green anole in the presence AND absence of the Cuban brown anole, and their results are shown in Figure 2a and Figure 2b.

Figure 1: Perch height of green anole lizard in presence and absence of Cuban brown anole lizard



Cuban brown anole and Green anole lizards



Green anole hind foot showing toe pads

Figure 2a: Toe pad area in green anole lizard in absence and presence of Cuban brown anole lizard

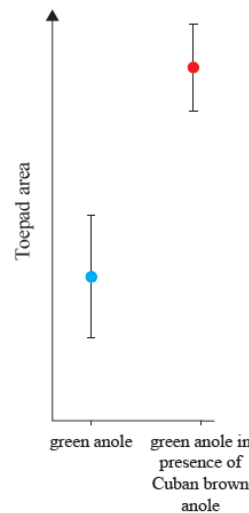
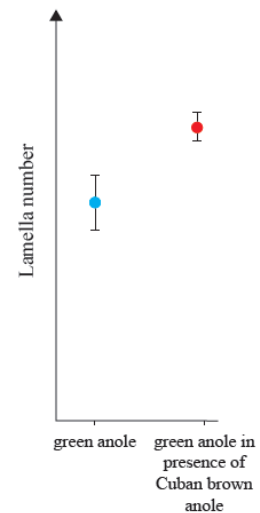


Figure 2b: Lamella number in green anole lizard in absence and presence of Cuban brown anole lizard



Discuss the natural selection pressures that have affected evolution in the green anole.

In your answer:

- describe natural selection and the trends shown by the resource material
- explain the type of natural selection occurring in the green anole
- evaluate the impact of competition on the evolution of the green anole.

● BIOLOGY

(2014, 2)

Monarch butterfly caterpillars (*Danaus plexippus*) are specialist herbivores, feeding only on plants belonging to the milkweed family (*Asclepias spp*), on which the monarch butterfly lays its eggs.

Milkweeds produce poisonous alkaloids, which the caterpillars absorb. This makes the caterpillar poisonous to many animal predators. Monarch butterfly caterpillars eat around the base of the plant's leaf veins to cut off the flow of sticky toxic latex that can paralyse the caterpillar and glue its mouth parts shut.

Recently scientists found that some milkweed plants have developed a decrease in their toxicity levels but an increase in their ability to rapidly re-grow plant tissue after they have been damaged by browsing monarch caterpillars.



Adult monarch butterfly



A monarch caterpillar feeding on milkweed

Evaluate the evolutionary relationship between the monarch butterflies and the milkweed plants.

In your answer you should:

- describe the term co-evolution
- explain how this kind of relationship develops
- evaluate the selection pressures that work both for and against the milkweed – monarch relationship.

● BIOLOGY

The questions below are collated from the now expired AS 90717 Describe processes and patterns of evolution.

However they may still be useful for AS 91605 Demonstrate understanding of evolutionary processes leading to speciation

(2012, 1)

The bullhorn acacia is a small swollen-thorn tree native to Mexico and Central America. Colonies of stinging ants occupy its hollowed-out thorns and defend the tree against harmful insects, browsing mammals and epiphytic or hanging vines. The ants also cut and clear vegetation from around the tree. The host supplies the ants with protein-lipid Beltian bodies from its leaflet tips and carbohydrate-rich nectar from glands on its leaf stalk. There is no known function for the Beltian bodies, except to provide food for the ants that share a mutualistic relationship with the tree.

Bullhorn acacia plant with ant emerging from thorn.



Evaluate the **evolutionary** relationship between the bullhorn acacia and the stinging ants and how this relationship may have developed.

In your answer you should:

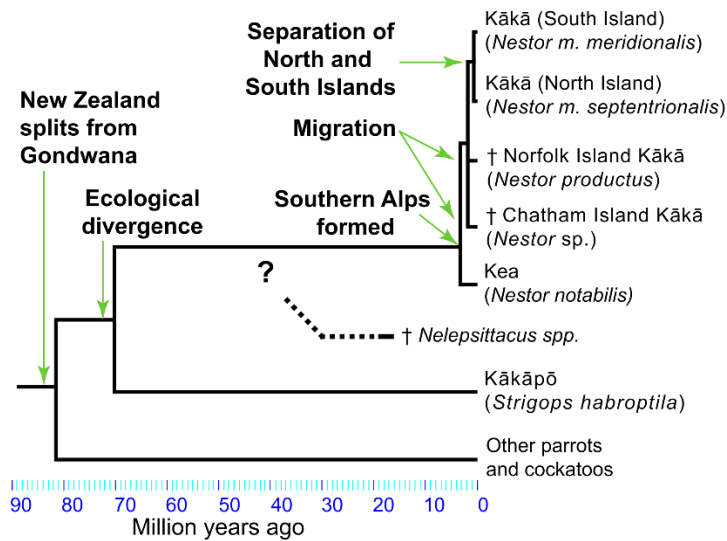
- describe this pattern of evolution
- explain why this mutualistic relationship may have developed
- discuss a possible evolutionary outcome, should the ants become reduced in numbers over time.

(2011, 1)

The New Zealand parrot family (Strigopidae) consists of two genera of parrots, *Nestor* and *Strigops*. The genus *Nestor* consists of the kea, kākā, Norfolk Island kākā and Chatham Island kākā, whilst the genus *Strigops* contains the flightless ground-dwelling kākāpō.

Nestor and *Strigops* diverged from the proto-kākā / kākāpō ancestor 60 – 80 million years ago. Since then *Nestor* has gone through further divergence, as shown below.

Phylogeography of the superfamily Strigopoidae



- (a) Describe the pattern of evolutionary change shown in the diagram, and explain how this type of pattern can arise.
- (b) Discuss the reasons for divergence of *Nestor*, and why the same evolutionary processes have not been evident in *Strigops*.

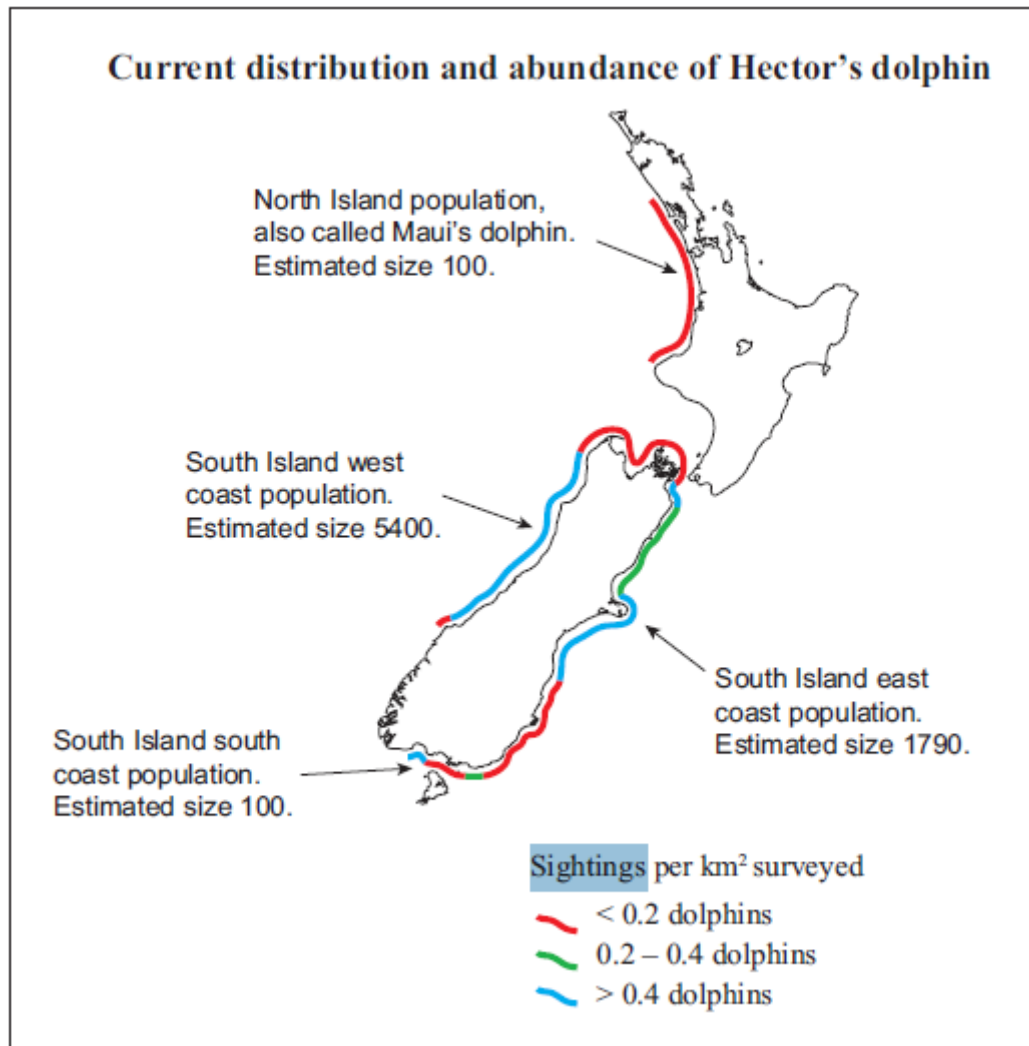
In your answer consider:

- the events likely to have caused ecological divergence of *Nestor*
- the processes that have led to speciation in *Nestor*
- reasons why there has been little evidence of speciation in *Strigops* (the kākāpō).

(2011, 3)

Hector's dolphins are found only in New Zealand waters. DNA studies have verified the existence of four regional populations.

The North Island and South Island populations are reproductively isolated, as measured by DNA differences. Levels of gene flow between the three regional South Island populations are very low. Evidence suggests that the south coast population is a founder from the west coast South Island population. It appears the populations are isolated by distance, and dispersal happens only between immediately adjacent populations.



Discuss the evolutionary processes that appear to be happening between the three **South Island** populations of Hector's dolphin.

In your answer consider:

- the selection pressures acting on the individual populations that contribute to their isolation
- the type of evidence that would suggest the south coast population is a founder from the west coast population
- the significance of the finding that there appears to be little or no gene flow between the three populations.

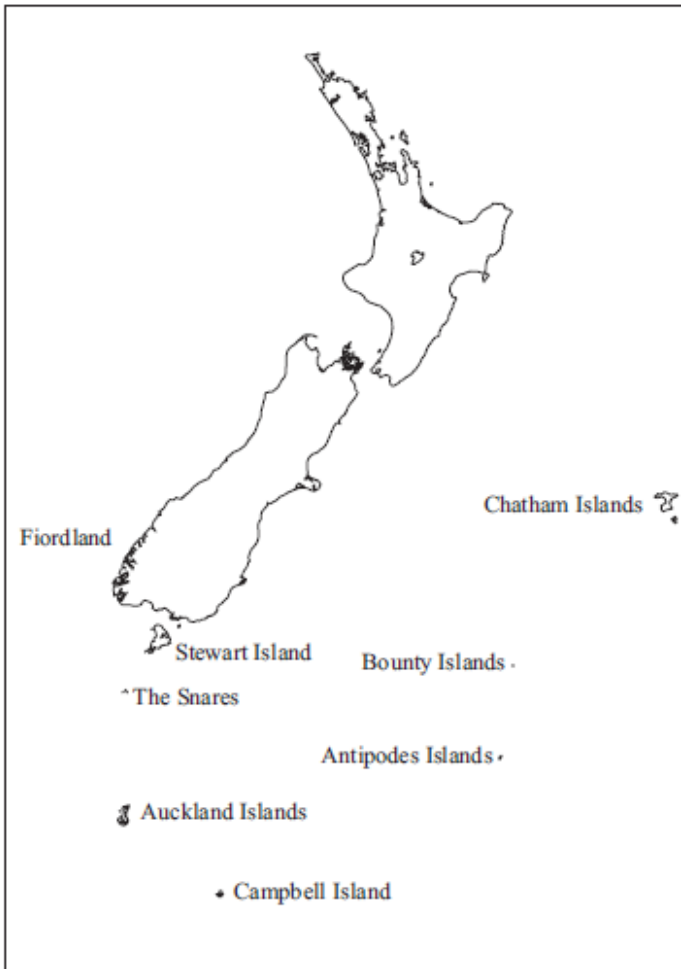
● BIOLOGY

(2010, 1)

Four species of crested penguin are found on various New Zealand islands, which range in climate from temperate to sub-Antarctic and have differing environmental conditions.

Some information on crested penguins is included opposite.

New Zealand's Islands



Crest Examples



Rockhopper penguin



Erect-crested penguin

Crested penguin information

| Species | Size | Distinguishing Features | Distribution in New Zealand |
|---------------|-------------|--|--|
| Snares | 40 cm, 3 kg | Black, with white belly. Bright yellow crest above the eyes droops down back of head. Eyes are slightly red. | The Snares |
| Fiordland | 40 cm, 4 kg | Black, with white belly. Bright yellow crest above the eyes droops down back of head. | Fiordland, and Stewart Is. |
| Erect-crested | 50 cm, 4 kg | Black, with white belly. Yellow crests above the eyes stick straight up. | Antipodes Is., Bounty Is. and Auckland Is. |
| Rockhopper | 40 cm, 4 kg | Black, with white belly. Yellow crests above the eyes stick out at an angle, and almost straight down. Red eyes. | Antipodes Is., Bounty Is., Campbell Is. and Auckland Is. |

● BIOLOGY

- (a) Using examples from the table, discuss the different **reproductive isolating mechanisms** that may operate among the New Zealand penguin species.

Include in your answer:

- how **speciation** may have occurred
- the role of **reproductive isolating mechanisms**
- how **pre** and **post zygotic** isolating mechanisms can work together.

- (b) Penguins and seals both have flippers and streamlined bodies for swimming.

Seal Swimming



Penguin swimming

Name and describe the **pattern of evolution** that this shows, and using the examples above, **explain** how this type of evolution can occur.

- (c) Leopard seals are a predator of Antarctic species of penguin, and it is possible that these seals and penguins may have **coevolved**.

Explain **coevolution** and how it may have occurred in this example.