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NZQA
Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Biology 2024

91605 Demonstrate understanding of evolutionary processes leading to speciation

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of evolutionary processes leading to speciation.	Demonstrate in-depth understanding of evolutionary processes leading to speciation.	Demonstrate comprehensive understanding of evolutionary processes leading to speciation.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in the margins (////). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Achievement

TOTAL 10

QUESTION ONE: Kōura

Kōura (freshwater crayfish) have inhabited New Zealand for millions of years. Their exoskeletons are dark and blend into the environment (e.g. between logs and in mud), giving them good camouflage to protect them from predators. They often live in small populations, where mating among relatives leads to inbreeding. At night, they search for food, finding fish, plants, and snails.

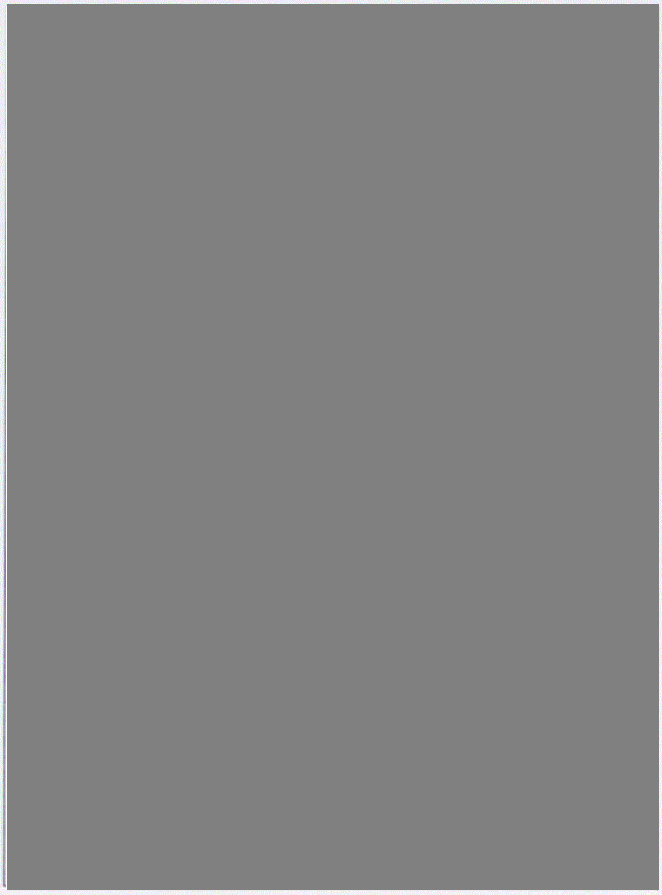
Kōura are a species valued by Māori as kai. In the past, they were also traded for other food items. Māori used to move some kōura between areas, and this was found to help with the success of each of the populations.

When looking at mitochondrial DNA (mtDNA), scientists found three major groups, indicated on the map below. The West Coast group (green) is more closely related to the southern group (yellow) than the northern group (purple). The groups were thought to diverge around the time of mountain building that formed the Southern Alps and before the formation of the Cook Strait.

Although there are two named species (*Paranephrops planifrons* and *P. zealandicus*), there are three distinct groups shown by genetic evidence. This suggests that the morphology used to classify the two species could be misleading.

In 2016, scientists at the University of Canterbury measured the genetic diversity of kōura populations. Results showed low genetic diversity **within** kōura populations but high genetic diversity **between** populations. This means populations were highly inbred but had strong genetic differences between the populations.

An adult kōura from Lake Rotomā.



Distribution of the three major mtDNA groups.

Discuss factors affecting the evolution of kōura. In your answer, include discussion of:

- the terms founder population and gene flow
- how the formation of the Southern Alps may have helped lead to divergent evolution by allopatric speciation
- why moving kōura between areas prevents speciation.

- A founder population is one that has left a bigger population or been geographically isolated. Gene flow is the movement of individuals between populations stopping speciation from occuring.

- Divergent evolution is a pattern of evolution that gives rise to two or three species due to different selective pressures. Allopatric speciation is speciation where ~~two popu~~ a population has scattered due to physical or geographical barriers that restrict gene flow and through selective pressures create two or more species. The formation of the Southern Alps restricted gene flow through geographical barries such as mountain building causing the ~~two~~ West and Southern group to experience different selective pressures and form new, seperate species.

- Moving kōura between areas prevents speciation because it brings in new alleles into the ~~gene pool~~ gene pool establishing these alleles making the two species similar because gene flow has not been restricted through ~~out~~ any pre/post-zygotic reproductive isolating mechanisms.

QUESTION TWO: Patterns of evolution in wallabies

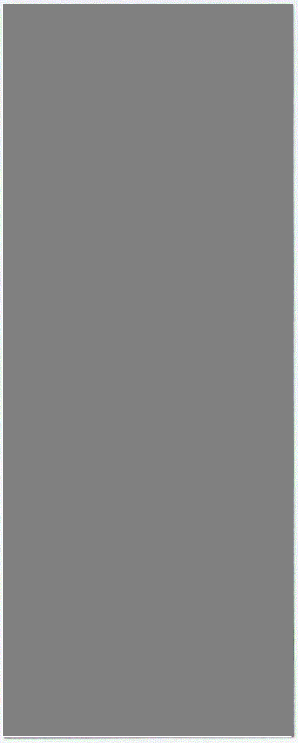
In their native Australia, tammar (*Notamacropus eugenii*) and parma (*N. parma*) wallabies are allopatric and have very different habitat use, social structure, and mating times.

ecological behavioural temporal

A tammar wallaby.

Parma wallabies grazing.

In New Zealand, they occur sympatrically on Kawau Island because of introductions in the late 19th century. Both species show differences, as seen in Australia. *N. parma* is more solitary and is frequently found in bush areas, while *N. eugenii* tend to be found in open grass areas. Genetic data shows no evidence of hybridisation despite living together in a new environment.



Kawau Island, 60 kms north of Auckland.

Figure 1: Phylogeny showing adaptive radiation of wallabies in Australia.

Discuss factors of the evolution of wallabies in Australia and New Zealand.

In your answer, include discussion of:

- the terms sympatric and species, including definitions
- the rate of evolution shown in Figure 1, identifying if it is either gradualism or punctuated equilibrium
- why adaptive radiation is seen in wallabies in Australia, but not in New Zealand
- TWO reproductive isolating mechanisms (RIMs) that may keep the wallabies from hybridising despite being sympatric on Kawau Island.

- Sympatric means in the same place, in this case wallabies are sympatric on Kawau Island because they are in the same area/place. A species is a interbreeding population that can produce fertile offspring.

- Figure 1 shows an example of punctuated equilibrium where there are long periods of stasis then sudden speciation where new species arise due to selective pressures.

- Adaptive radiation is when a common ancestor gives rise to multiple new species due to the availability of new niches. This is seen in Australia and not Kawau island because Australia is much bigger allowing for more niches to be available compared to a small island like Kawau.

- The information given provides us with three but the two I've chosen are the mating times/temporal and the social structure/behavioural. Different mating times means the two species are unlikely to see each other ~~as~~ during these times causing isolation and different social structure means they're less likely to interact minimising the chance of mating to occur.

QUESTION THREE: A case of convergent evolution

Flight has evolved numerous times in different animal groups, and those different groups have evolved different mechanisms for flight. For example, the honeybee wing is not made of bone, but it does serve the same function as the bird wing. The pattern of muscle attachments is different in the honeybee and the bird, and the way in which the wing is used to achieve lift is also different. However, due to the demanding nature of flight, there are distinct similarities between bee and bird wings.

Honeybee wing.

Bird wing.

A bird catching a beetle while both are in flight.

Discuss how convergent evolution is linked to selection pressures.

In your answer, include discussion of:

- selection pressures, including descriptions with examples
- how genetic data is used to show convergent evolution
- how the process of natural selection has resulted in analogous structures.

- Selection pressures in this case is the necessity for both the Honeybee and the bird to fly in order to get food, ~~and~~ migrate etc.

- Convergent evolution is when [redacted] different species have similar adaptive features due to exposure to the same selective pressures or environment. Genetic data is used to see anatomical structures of both the Honeybee and the bird as well as what is not visible in the phenotype that

allows scientists to determine whether their structures are similar, which they are in function but not in origin.

- Natural selection is where individuals who have favourable genetics, pass them on and also survive better. Natural selection in this case has favoured those ~~which~~ who are able to fly for both the Honeybee and the bird causing their wings to become similar in function ~~and slightly~~ but not in origin or anatomically, leading them to become analogous ~~stru~~ structures.

Achievement

Subject: Biology

Standard: 91605

Total score: 10

Q	Grade score	Marker commentary
One	A3	This response demonstrates an understanding of speciation by describing the evolutionary concepts of divergent evolution and allopatric speciation. It also identifies that the movement of kōura between populations prevented speciation.
Two	A4	This response demonstrates an understanding of speciation by describing the evolutionary concepts of sympatric speciation and punctuated equilibrium. In addition, it correctly states that the graph displays punctuated equilibrium in the evolution of the wallaby.
Three	A3	This response demonstrates an understanding of speciation by describing the evolutionary concepts of convergent evolution and natural selection. It also identifies a selection pressure appropriate to the given context.