

91605



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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.

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.

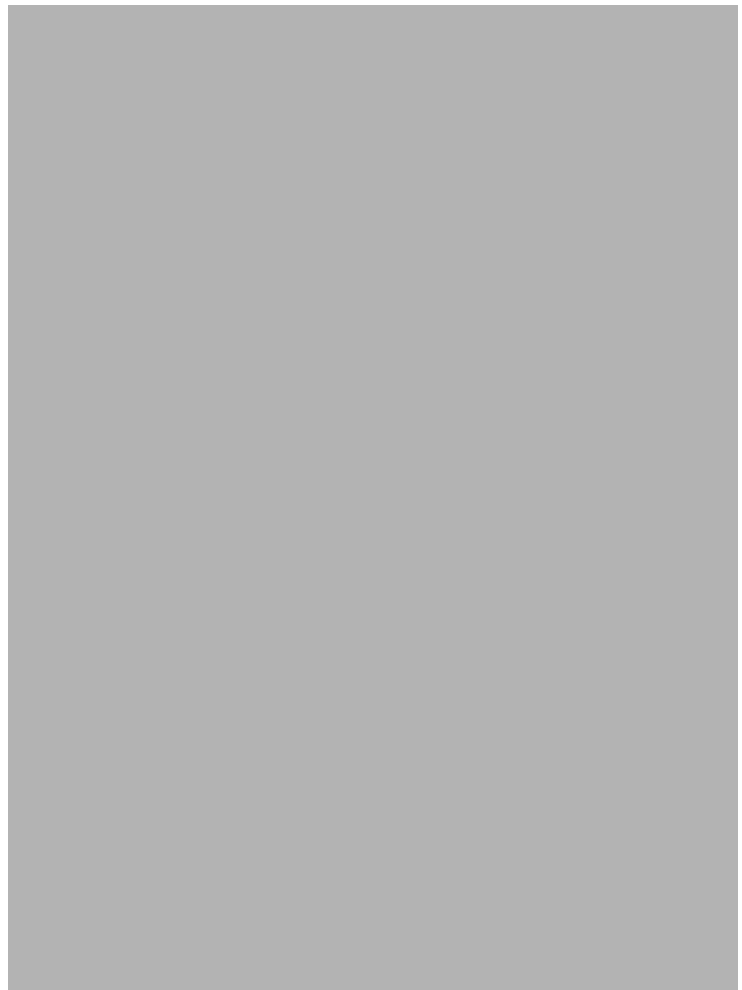
When looking at mitochondrial DNA (mtDNA), scientists found three major groups, indicated on the map below. The West Coast group (green) is more closely related to the southern group (yellow) than the northern group (purple). The groups were thought to diverge around the time of mountain building that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

- 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.

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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.

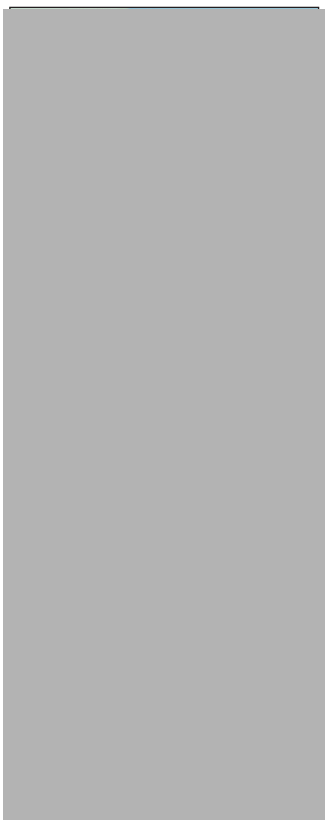


A tammar wallaby.



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.

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.

Extra space if required.
Write the question number(s) if applicable.

QUESTION
NUMBER

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Acknowledgements

Material from the following sources has been adapted for use in this assessment:

Page 2

<https://niwa.co.nz/te-kuwaha-and-maori/taonga-species-series-koura>
<https://docs.niwa.co.nz/library/public/NIWAis88.pdf>
<https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-294X.2007.03224.x>

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<https://www.sciencedirect.com/science/article/pii/S0169534722002932>
<https://stock.adobe.com/290844130>
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<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5758907/>

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<https://raider.pressbooks.pub/biology2/chapter/9-trait-evolution/> (images 1 and 2)
[https://en.wikipedia.org/wiki/Hawking_\(birds\)](https://en.wikipedia.org/wiki/Hawking_(birds))