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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Level 3 Biology, 2019

91605 Demonstrate understanding of evolutionary processes leading to speciation

2.00 p.m. Tuesday 12 November 2019
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 and clearly number the question.

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

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

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QUESTION ONE

The loud and often shrill singing of cicadas makes them one of New Zealand's most familiar insects. There are 42 species and subspecies in five genera that have been formally described. All are unique to New Zealand.

The most closely related species are found in Australia, Norfolk Island and New Caledonia. Studies show that the New Zealand cicadas came about from several colonisation events across the Tasman Sea from Australia and New Caledonia. They arrived within the last 11 million years, well after New Zealand became isolated from Australia.

During the peak of summer, the massed chorus of cicadas can be deafening. Only the males sing, mainly to court females.

Cicada songs vary widely between species, ranging from harsh screeches to others having only faint chirps. These are sometimes so distinctive that individual species may be identified by song alone. Some New Zealand cicadas also make a sharp clapping or clicking sound by rapidly tapping their wings against the branch on which they are resting.

Two species, *Kikihia laneorum* and *K. subalpina*, are similar and only identifiable by their very different songs.

Kikihia laneorum *Kikihia subalpina* *Kikihia angusta*

Maoricicada alticola *Maoricicada oromelaena* *Notopsalta sericea*

Fig. 1: Some cicada species found in New Zealand

Adapted from: www.landcareresearch.co.nz/science/plants-animals-fungi/animals/invertebrates/systematics/hemiptera/auchenorrhyncha/cicadas

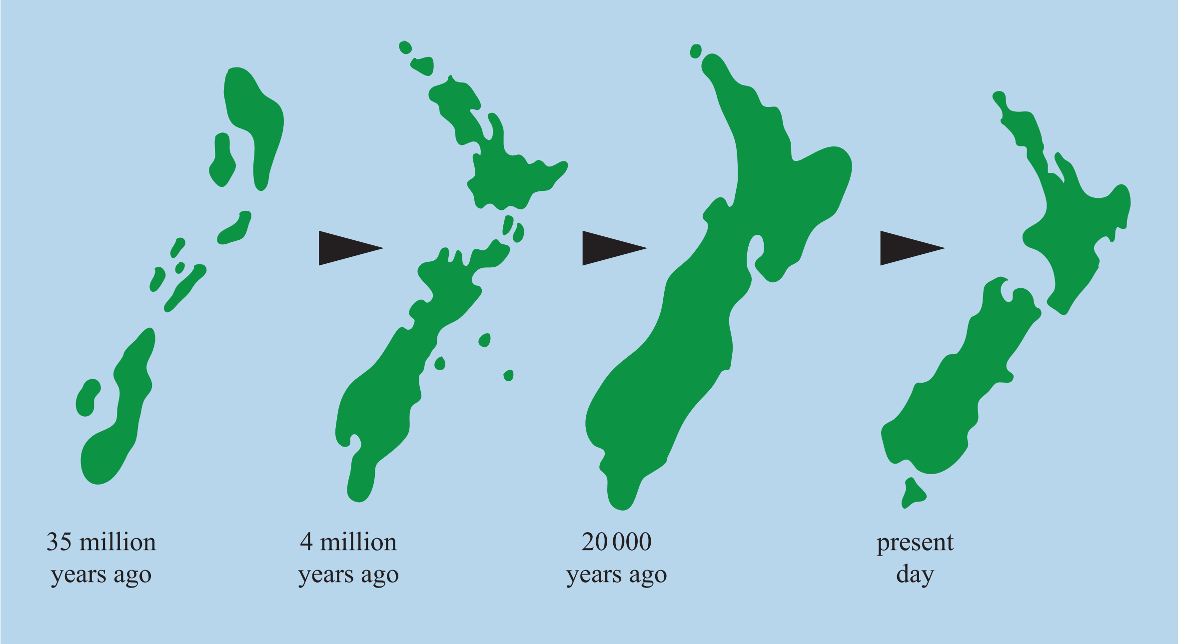

Fig. 2: Map of New Zealand's coastline over the last 35 million years

Discuss the speciation of the cicada species in New Zealand.

In your answer:

- describe speciation and the conditions that are required for it to occur
- explain how allopatric speciation and sympatric speciation could have led to the formation of different cicada species
- using the information provided, discuss divergent evolution and compare it to adaptive radiation that could have led to the formation of the present-day cicada species.

There is more space for your answer to this question on the following pages.

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QUESTION TWO

The tūī (*P. n. novaeseelandiae*) is one of the main pollinators of flax (*Phormium spp.)*, kōwhai (*Sophora spp.*), and kākābeak / ngutu kākā (*Clianthus spp.*). These plant species are unrelated. Note that the flowers of the three unrelated plant species mentioned are similar in shape to the tūī's beak. The flowers provide nectar for the tūī and when it reaches the nectary, it gets pollen on its head and transfers it on to other plants of the same species when visiting their flowers in search of nectar.

Fig. 1: Tūī beak shape
http://nzbirdsonline.org.nz/species/tui

Fig. 2: Tūī and flax (*P. cookianum*)
www.terrain.net.nz/friends-of-te-henui-group/plants-native-botanical-names-m-to-q/flax-mountain-phormium-cookianum.html

Fig. 3: Tūī and flax (*P. tenax*)
https://commons.wikimedia.org/wiki/File:Tui_Eating_Phormium_Tenax.JPG

Fig. 4: Tūī and kōwhai flowers
www.krystaldew.co.nz/tui-in-the-kowhai-7/

Fig. 5: Tūī and kākābeak flowers
www.myfathersworld.net.nz/galleries/NZ_birds/slides/Tui_on_KakaBeak_120809_14e3.html

There are two species of New Zealand flax. *Phormium tenax*, also known as harakeke or swamp flax, has stiff leaves and red flowers. *Phormium cookianum*, also known as wharariki or mountain flax, has softer leaves and yellow flowers. These two species of flax are related.

Compare and contrast the evolution of the colour and shape of the flowers of the flax, kowhai and kākābeak and the shape of the tūī's beak.

In your answer:

- describe co-evolution and convergent evolution as well as analogous and homologous structures
- explain how all the flowers have evolved similar shapes and bright colours
- compare and contrast the processes of convergent and co-evolution on the tūī beak shape and the flowers of flax, kōwhai, and kākābeak plants.

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QUESTION THREE

Woodworthia maculata is the common New Zealand gecko. A study was conducted and found that less than 15 km separates populations of small and large adult common geckos found on the south coast of the North Island of New Zealand. Five collecting sites were spaced along 15 km of coastal habitat. The main coastal vegetation at Turakirae (site 1) is *Muehlenbeckia complexa* (pohuehue), which provides ideal gecko habitat, which changes gradually along the coast, until at Ocean Beach (site 5), the small trees kanuka, *Kunzea ericoides*, and tutu, *Coriaria arborea*, dominate. The snout-vent length of the common gecko was measured and compared along the 15 km area.

Fig.1: Sampling sites of the common gecko. Sites are approximately 4 km apart on a coastal transect.

Fig. 2: Body size variation (snout–vent length phenotypes) among samples of adult common geckos collected from five sites on the south coast of the North Island. Mean, SE, and range shown.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3298942/

Fig. 3: Snout–vent length, measured from the tip of the mouth to the beginning of the tail.

lis-upmc.snv.jussieu.fr/xper2/basesHtml/varanus/web/descriptors/SVL_snout_vent_length.htm

Discuss how natural selection and genetic drift could cause speciation in the common gecko using the information and data provided.

In your answer:

- describe the trends in snout–vent length of the common gecko and the vegetation of the sample sites
- explain how directional and stabilising selection and genetic drift could play a role in speciation of the common gecko
- analyse the prezygotic and postzygotic isolating mechanisms that could lead to speciation in the common gecko.

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