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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, 2016

91605 Demonstrate understanding of evolutionary processes leading to speciation

2.00 p.m. Thursday 10 November 2016
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 2–12 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.

TOTAL

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QUESTION ONE: MEXICAN SPADEFOOT TOAD

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The Mexican spadefoot toad (*Spea multiplicata*) is found in southwestern United States and Mexico. In ponds with low abundance of food resources and high density levels of tadpoles, two populations predominate. One population (called the omnivore morph) has a round body with a long intestine, small jaw muscles, smooth mouth parts, and has a generalist omnivorous diet of algae and small crustaceans found on the bottom of the pond. The other population (called the carnivore morph) has a narrow body with a short intestine, enlarged jaw muscles, teeth-like mouthparts, and has a specialist carnivorous diet of fairy shrimps found in the water column.

On the other hand, in ponds of high abundance of food resources and low density levels of tadpoles, only one population, of intermediate phenotype, is found.

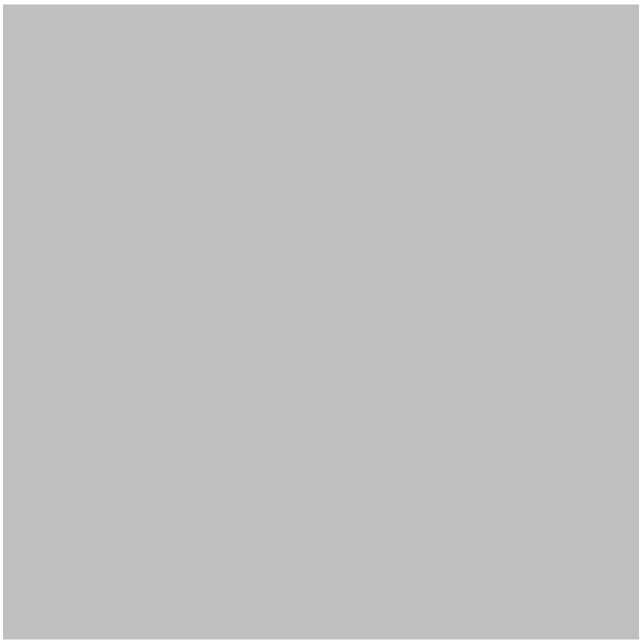

Figure 1: Mexican spadefoot toad tadpoles from a high density, low food resource pond. *Top:* the omnivore morph. *Bottom:* the carnivore morph.

http://labs.bio.unc.edu/pfennig/LabSite/Photos.html

Compare and contrast the impact of disruptive and stabilising selection on genetic diversity AND discuss how speciation could occur in the Mexican spadefoot toad.

In your answer you should:

- describe genetic variation
- describe the terms disruptive and stabilising selection, and describe which population(s) of Mexican spadefoot toad tadpole is associated with each type of selection
- explain the selection pressures that promote disruptive selection, AND the selection pressures that promote stabilising selection in the Mexican spadefoot toad tadpole.

Well labelled diagrams can be used to support your answer.

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

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QUESTION TWO: THREE-SPINED STICKLEBACK

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The three-spined stickleback (*Gasterosteus aculeatus*) is a small (30 – 90 mm) fish found in the Northern Hemisphere. Some populations live in coastal marine habitats, while other populations live in freshwater.

Three-spined sticklebacks lack the scales typical of most fishes; instead they possess (protective) bony plates and spines. Three-spined stickleback populations living in a marine habitat have high numbers of bony plates and long spines, whereas freshwater populations typically have low numbers of bony plates and short spines. Genetic evidence suggests that a mutation in the Ectodysplasin (EDA) gene causes variation in plate number, and a mutation in the PITX1 gene causes variation in spine length.

The main predators of three-spined stickleback in marine habitats are larger fish. In freshwater habitats, grasping insects (such as dragonfly larvae) are the main predators, especially of juvenile three-spined stickleback. Marine habitats typically have low amounts of shelter suitable for the three-spined stickleback, whereas freshwater habitats have high amounts of shelter. The growth rate and acceleration / burst speed of three-spined sticklebacks is highest when the bony plate number is lowest.

Figure 2. *Top:* Typical three-spined stickleback from a marine population. *Bottom:* Typical three-spined stickleback from a freshwater population. Fish have been stained with alizarin red to highlight bony plates and spines.

http://unews.utah.edu/wp-content/uploads/sticklebackfigure1.jpg

Figure 3. Typical three-spined stickleback predators in ocean and freshwater habitats.

http://learn.genetics.utah.edu/content/selection/stickleback/

Discuss how EDA and PITX1 gene mutations AND natural selection have affected evolution in three-spined stickleback.

In your answer you should:

- describe the terms mutation AND natural selection
- explain how selection pressures in marine AND freshwater habitats act differently on bony plate number and spine length
- discuss the roles of mutation AND natural selection on three-spined stickleback evolution.

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

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QUESTION THREE: KAKARIKI

Kakariki are the most common species of parakeet in the genus *Cyanoramphus* and are distributed throughout the South Pacific (Figure 5). Aotearoa has the largest number of species. Kakariki live in a wide range of habitats, including subantarctic tussock (Antipodes Island kakariki and Reischek's kakariki), beech forests in mainland Aoteoroa (yellow-crowned kakariki and orange-fronted kakariki), and tropical rainforests (New Caledonian red-crowned kakariki).

Figure 4. Forbes' kakariki, Chatham Island.

www.nzbirdsonline.org.nz/species/forbes-parakeet

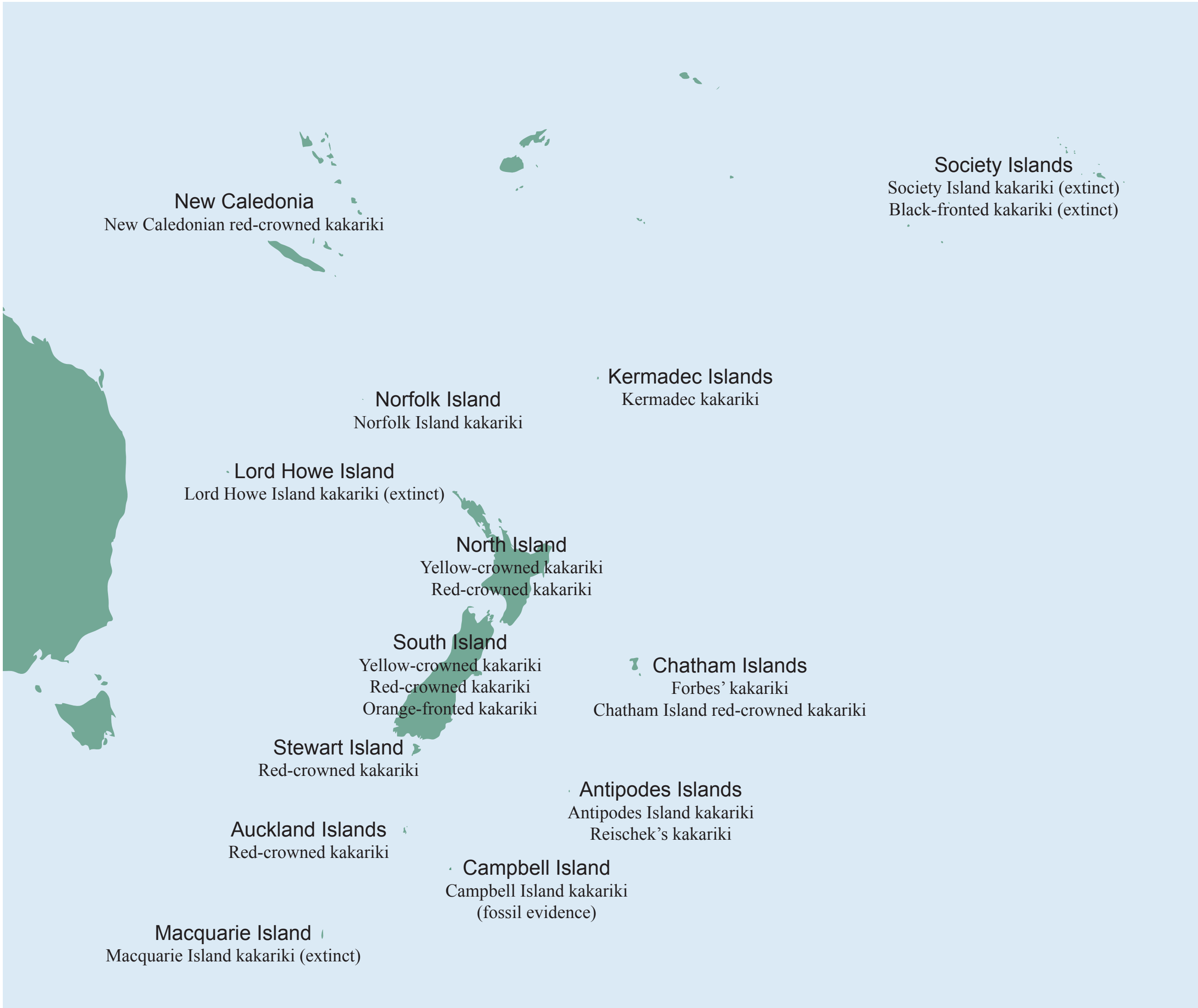

Figure 5: Kakariki distribution in the South Pacific.

The evolutionary relationships of kakariki species have been determined using mitochondrial DNA sequence analysis. The phylogenetic tree based on this analysis is shown in Figure 6. The climate during this period is shown in Figure 7, and the reconstructed vegetation cover at the height of the last glacial period is shown in Figure 8.

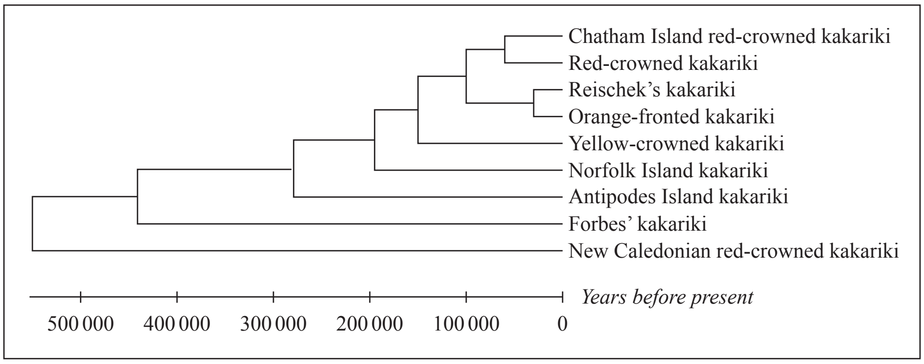

Figure 6. Phylogenetic tree for *Cyanoramphus*.
The time scale for evolutionary divergence is indicated above.

Adapted from Boon, W. M. *et al*. (2001). 'Molecular systematics and conservation of the kakariki (*Cyanoramphus* spp.)', *Science for Conservation*, 176 (Department of Conservation, Wellington).

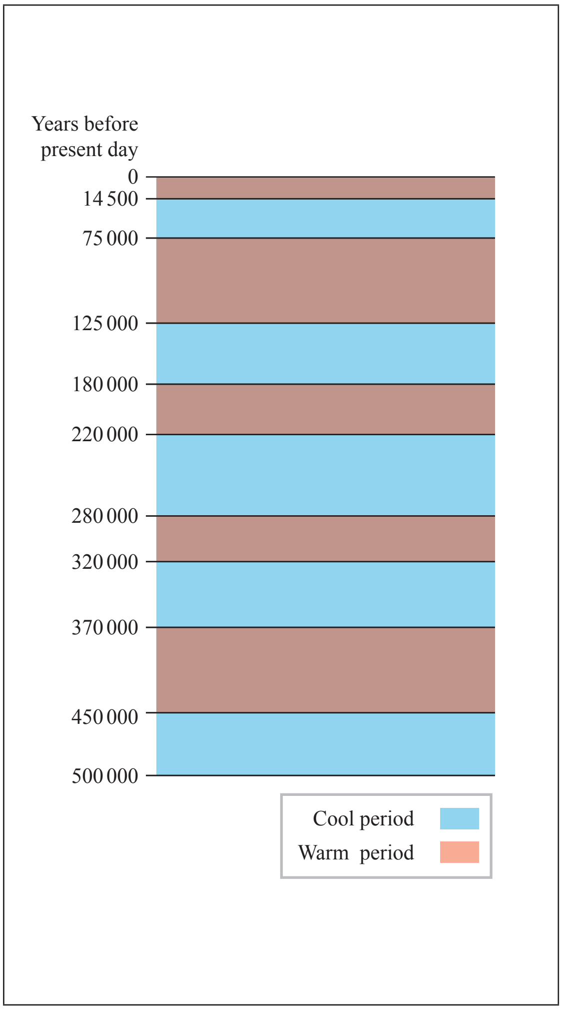

Figure 7. Glacial periods in Aotearoa.

Adapted from www.teara.govt.nz/en/diagram/10741/glacial-periods-in-new-zealand

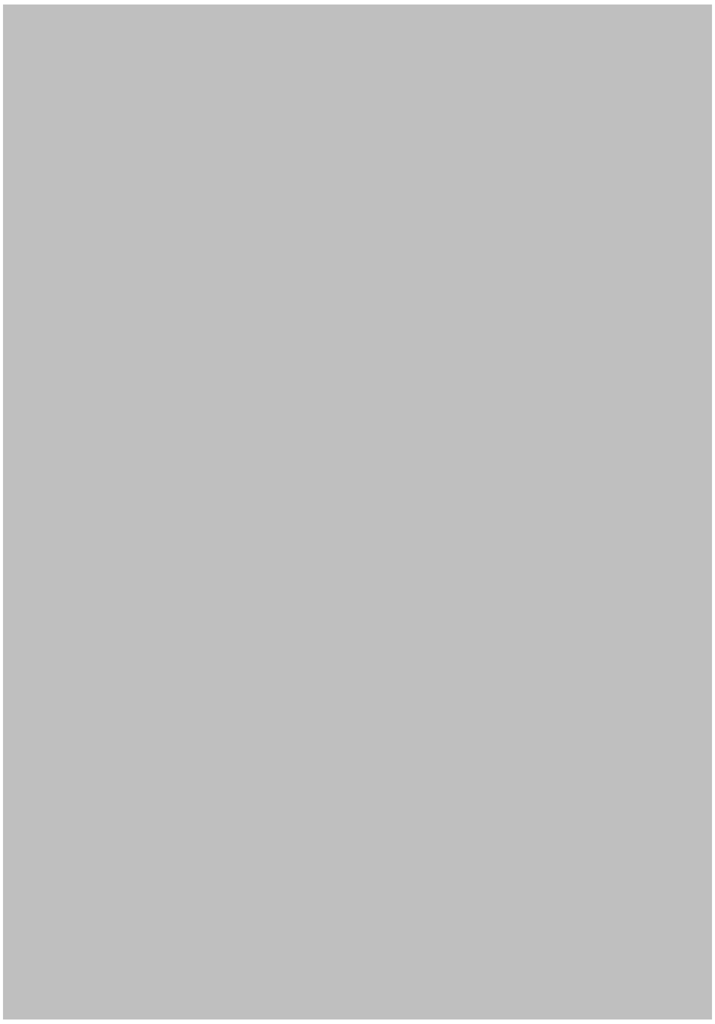

Figure 8. Aotearoa vegetation cover 19 000 – 29 000 years b. p. as reconstructed from pollen, macrofossil, beetle and geographic evidence.

Adapted from: Newnham, R, *et al*. (2010). 'The vegetation cover of New Zealand during the last glacial maximum', *terra australis*, 32, p. 59 (ANU E Press, Canberra). http://press.anu.edu.au/wp-content/uploads/2011/02/ch0417.pdf

Discuss the pattern of evolution in kakariki, and the factors that have affected kakariki evolution.

In your answer you should:

- describe the evolutionary pattern AND type of speciation indicated by the resource material
- explain the origin and distribution of kakariki in Aotearoa with reference to the phylogenetic tree
- using the information provided, discuss how biological and geographical factors have contributed to kakariki speciation.

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

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