

# 3

91605



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## 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**

ASSESSOR'S USE ONLY







## QUESTION TWO: THREE-SPINED STICKLEBACK

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.

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.



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/>

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





### 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 Aotearoa (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](http://www.nzbirdsonline.org.nz/species/forbes-parakeet)

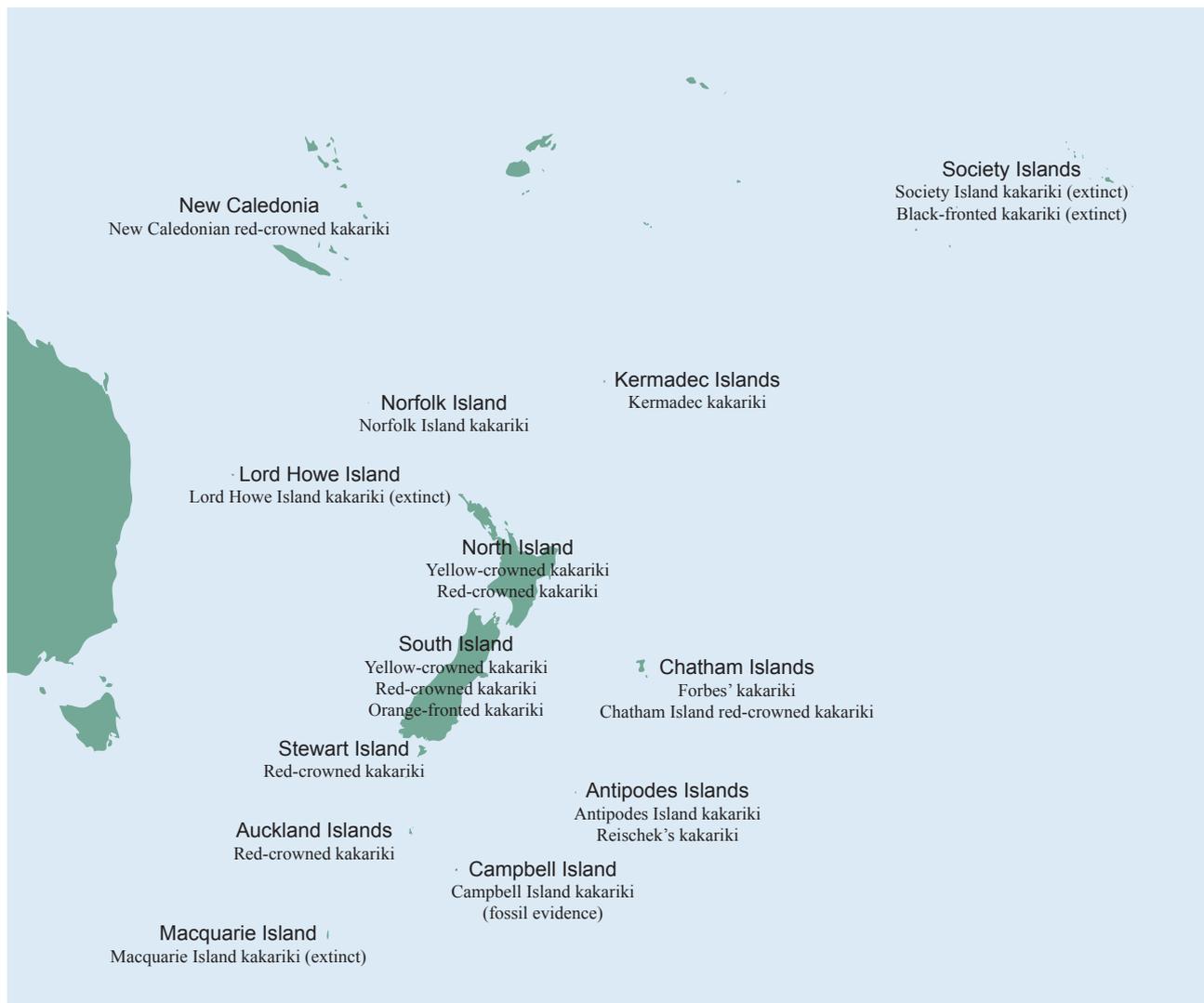


Figure 5: Kakariki distribution in the South Pacific.

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.

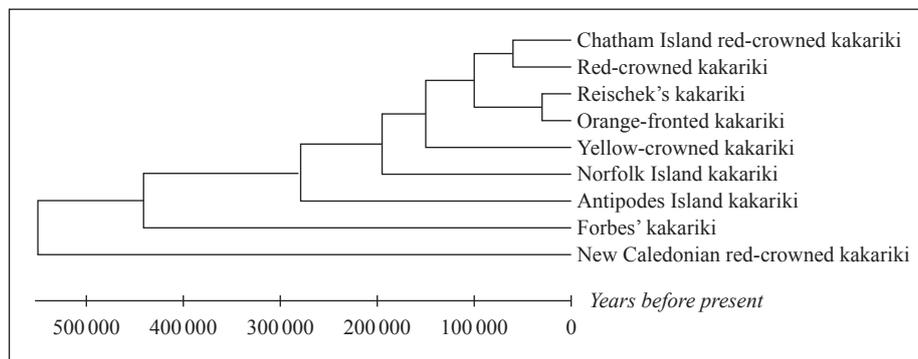


Figure 6. Phylogenetic tree for *Cyanoramphus*.  
The time scale for evolutionary divergence is indicated above.

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).

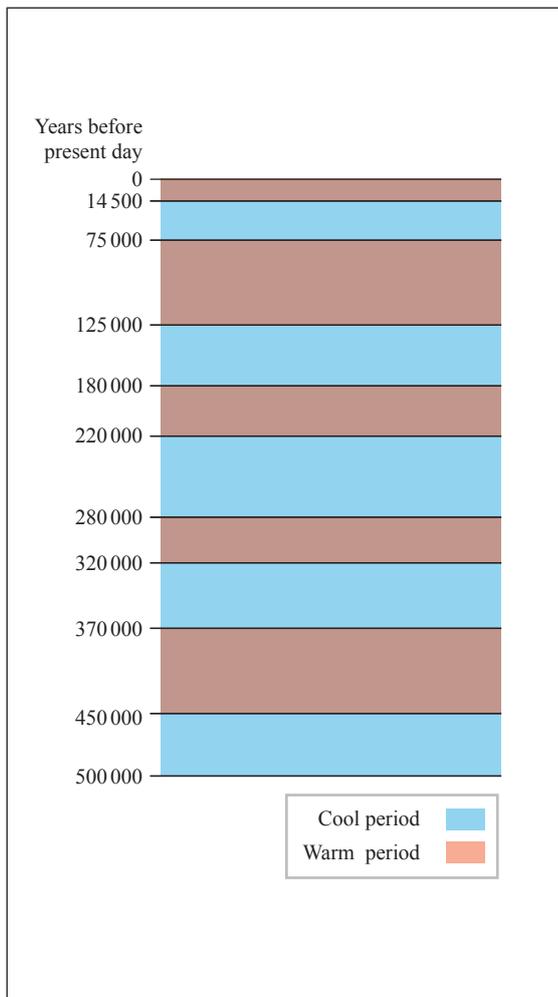


Figure 7. Glacial periods in Aotearoa.  
Adapted from [www.teara.govt.nz/en/diagram/10741/glacial-periods-in-new-zealand](http://www.teara.govt.nz/en/diagram/10741/glacial-periods-in-new-zealand)

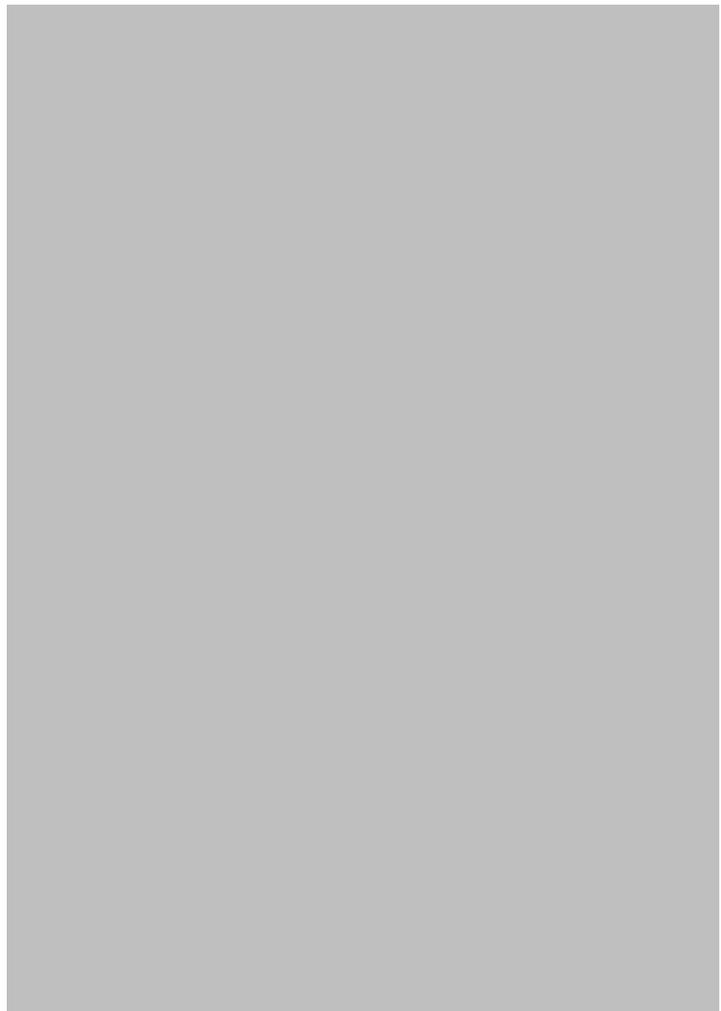


Figure 8. Aotearoa vegetation cover 19 000 – 29 000 years b. p. as reconstructed from pollen, macrofossil, beetle and geographic evidence.

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>





