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QUALIFY FOR THE FUTURE WORLD
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Level 3 Biology, 2018

91605 Demonstrate understanding of evolutionary processes leading to speciation

2.00 p.m. Monday 19 November 2018
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.

TOTAL

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QUESTION ONE

There are two indigenous eel species in New Zealand: the shortfin eel (*Anguilla australis*) and the longfin eel (*Anguilla dieffenbachii*). The longfin eel is unique to New Zealand and is found in rivers and streams well inland, while the shortfin eel is limited more to coastal areas. Young eels (elvers) migrate from the sea into freshwater streams, where they live as adults for many years (up to 100 years for longfins) before migrating back to sea to reproduce in the Pacific Ocean.

Migration in eels

	Timing of migration	**Age of migration in females**	**Age of migration in males**
Longfin eel	males in April and females follow soon after	females at 34 years (75–180 centimetres)	males at an average of 23 years (48–74 cm)
Shortfin eel	males in February–March and females follow soon after	females at 22 years (50–100 cm)	males at an average of 14 years (38–58 cm)

NB for both the longfin and shortfin eels, the females soon follow, and both males and females die after spawning.

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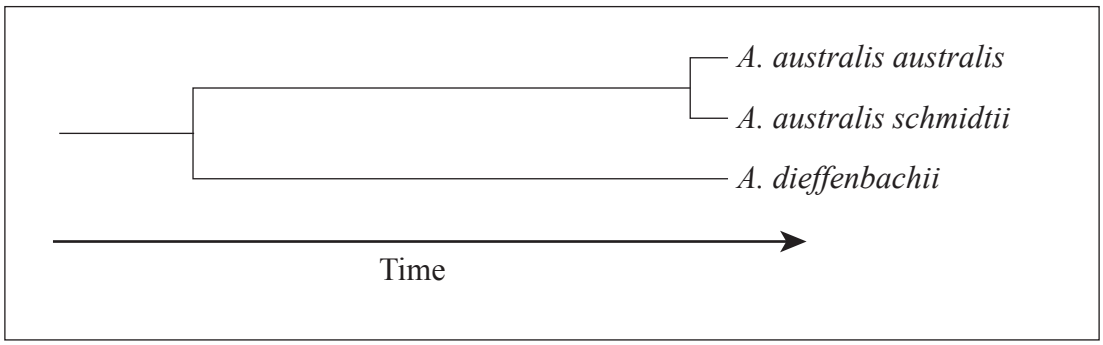
The dorsal fin of a shortfin eel extends only a little further forward than the anal fin.

www.sciencelearn.org.nz/resources/441-longfin-eels

***Anguilla* phylogeny**



Adapted from http://rsbl.royalsocietypublishing.org/content/11/3/20150014.

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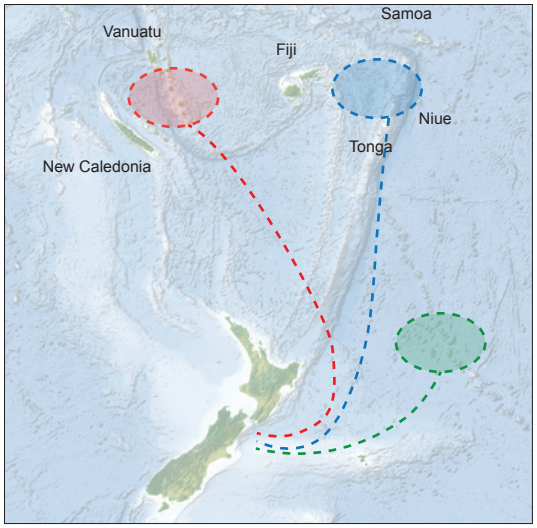
Suggested breeding grounds of the longfin and shortfin eels

The breeding area for shortfin eels is thought to lie to the northeast of New Zealand near Samoa. Evidence obtained by satellite tracking of the eels indicates that the longfin breeding area is in the southwest tropical regions of the Pacific Ocean – somewhere near Fiji and New Caledonia.



The females release their eggs, the males fertilise them, and the adults die after spawning. The eggs hatch into larvae that float to the surface and drift back towards New Zealand. They may take about 17 months to arrive. Larvae then change into glass eels – transparent juvenile eels.

	Migration	Breeding grounds
Longfin eel		
Shortfin eel		
Parent (ancestor) eel		

Adapted from: https://www.niwa.co.nz/te-k%C5%ABwaha/tuna-information-resource/biology-and-ecology/spawning-grounds and https://goo.gl/TDNSn2.

It is thought that the ancestor species had a shorter migration, which was genetically programmed and has changed to provide the migrations seen in the shortfin and longfin eels today.

Discuss the processes and patterns that could lead to the speciation of the shortfin eel *Anguilla australis* and the longfin eel *Anguilla dieffenbachii.*

In your answer:

- describe what is meant by the term **species**
- explain the process of natural selection that leads to speciation
- explain the patterns and mode of speciation that could have occurred to cause the speciation of the shortfin eel *Anguilla australis* and the longfin eel *Anguilla dieffenbachii*
- discuss how the processes and mode of speciation could have caused physical and behavioural differences in both the shortfin and longfin eels.

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

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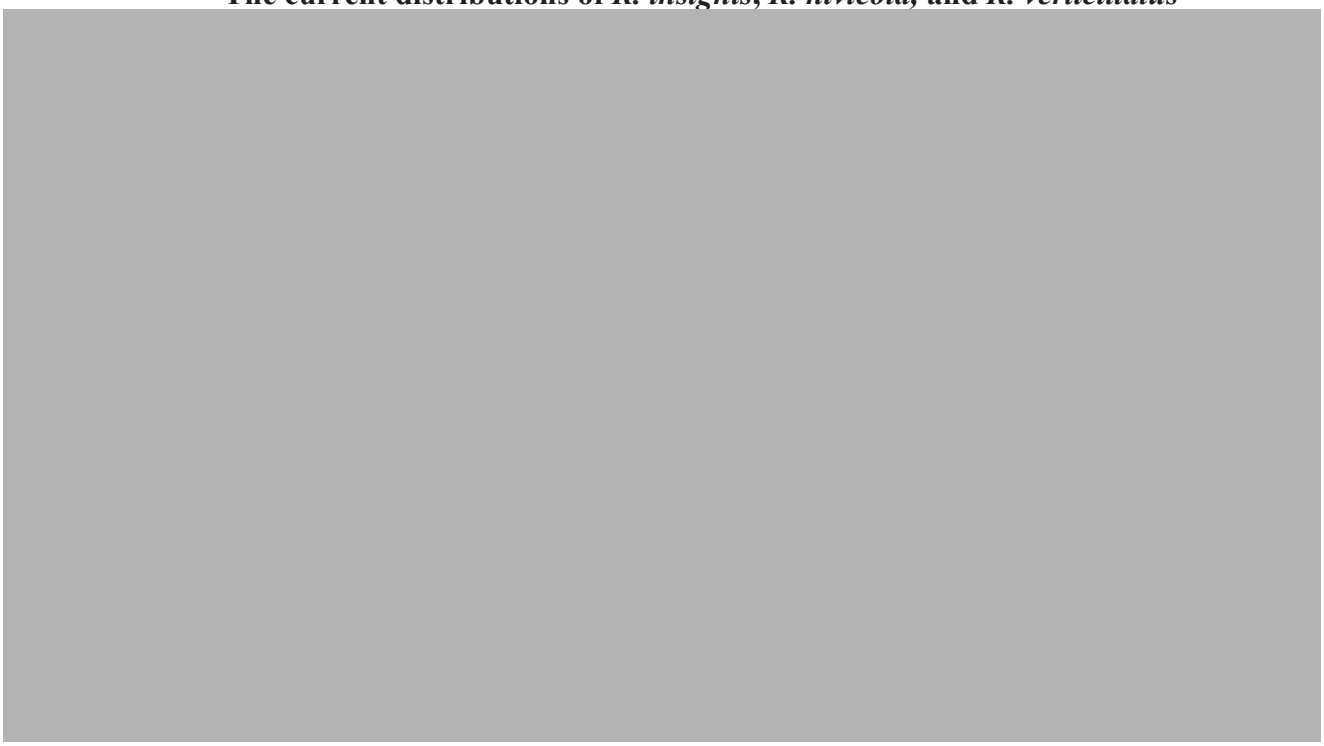
QUESTION TWO

There are three species of alpine *Ranunculus* in the North Island, namely *R. insignis*, *R. verticillatus*, and *R. nivicola*.

It has been hypothesised that *R. insignis* and *R. verticillatus*, which are thought to have originated in the South Island, expanded their range across Cook Strait and into the North Island when lower sea levels occurred. It is further hypothesised that *R. nivicola* formed in the North Island as a result of polyploidy.

The current distributions of *R. insignis*, *R. nivicola,* and *R. verticillatus*



Leaf and floral morphology of *R. insignis*, *R. nivicola*, and *R. verticillatus*

Adapted from Fisher, F. J. F. (1965), *The Alpine Ranunculi of New Zealand* (Wellington: R.E. Owen, Government Printer).

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Density of *R. insignis*, *R. nivicola*, and *R. verticillatus* in relation to mean annual temperature

Adapted from https://goo.gl/aaRRFj

Discuss the evolutionary process and patterns leading to the formation of *Ranunculus nivicola*.

In your answer:

- describe sympatric species and sympatric speciation
- explain how polyploidy could have occurred to form *R. nivicola*
- discuss why this is an example of punctuated equilibrium and not gradualism AND using the information above, justify what type of selection could happen if the climate changes.

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

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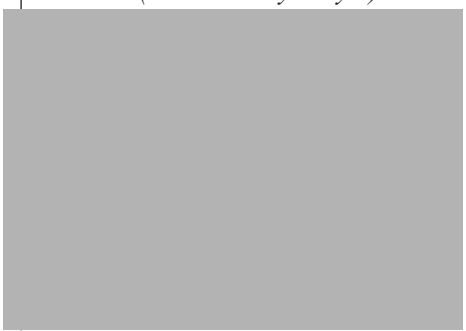
QUESTION THREE

The New Zealand wrens, Acanthisittidae, are a family of birds that has evolved from an unknown primitive ancestor. This family, including the rifleman, the rock wren, and the bush wren (as well as several extinct species), consists of small, poor-flying and flightless insect-eating birds that were previously widely distributed up and down the length of New Zealand, but are now much more restricted. The wrens' ancestor is thought to have been present since New Zealand separated from Australia over 50 million years ago (50 mya). 20 million years ago there was a cline that extended from Stewart Island up to the top of the North Island.

In the UK, a bird with a similar niche is the short-toed treecreeper.

Species	Distribution	Habitat
Rock wren (*Xenicus gilviventris*)  http://nzbirdsonline.org.nz/species/rock-wren	Rock wrens are widely but patchily distributed through alpine and sub-alpine areas of the South Island.	They are found from 900 m to 2500 m in altitude where the habitat may vary from dense sub-alpine scrub, through talus where stable rock falls are interspersed with low shrubbery to bare rock in very exposed situations.
Bush wren (*Xenicus longipes*)  http://nzbirdsonline.org.nz/species/bush-wren	North and South Islands, plus Kapiti Island, Stewart Island and the three nearby South Cape islands (Taukihepa / Big South Cape Island, Rerewhakaupoko / Solomon Island and Pukeweka).	Bush wrens were formerly found in forest and scrub in mountainous areas. On the mainland they were reported to feed among branches. On islands off Stewart Island, bush wrens kept among low dense vegetation, and spent much time on the ground.
Rifleman wren (*Acanthisitta chloris*)  http://nzbirdsonline.org.nz/species/rifleman	Mainly confined to higher altitude forest throughout both the North and South Islands.	Rifleman wrens are found predominantly in mature forest, especially beech, kauri, kamahi, and podocarp forest. They typically move through the forest using short flights, mainly from canopy to canopy. The majority of time is spent foraging for small insects in the canopy or on tree trunks.
UK Short-toed treecreeper *(certia brachydactyla)*  https://commons.wikimedia.org/wiki/File:Short-toed_Treecreeper_(Certhia_brachydactyla)cropped.jpg	Found throughout the United Kingdom	The short-toed treecreeper typically seeks invertebrate food on tree trunks, starting near the tree base and spiralling its way up using its stiff tail feathers for support.

Dendrogram showing possible evolutionary relationships

https://goo.gl/hwQBUe

Paleographic maps of changes in shorelines in the New Zealand region over the last 45 million years

https://goo.gl/gZ8DWu

Compare and contrast divergent and convergent evolution of the wren in New Zealand, outlining the patterns and conditions leading to speciation in the wren and the UK treecreeper.

In your answer:

- describe what is meant by the terms cline, adaptive radiation, and divergent evolution
- explain how biogeography and natural selection have led to speciation of the wrens in New Zealand
- compare and contrast the processes of convergent and divergent evolution, using the example given.

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