3

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91605

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
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Level 3 Biology, 2015

91605 Demonstrate understanding of evolutionary processes leading to speciation

2.00 p.m. Monday 23 November 2015
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.

Not Achieved

TOTAL 6

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QUESTION ONE

'Land lobsters' are the common name of many species of large, flightless, ground-dwelling insects distributed in New Guinea, New Caledonia, and Lord Howe Island. Land lobsters have a stocky body form. Some males have enlarged and powerfully armed hind legs, and the females have an elongated ovipositor which they use to deposit eggs into the soil. Nuclear and mitochondrial DNA sequence analysis has shown that the different land lobsters species are unrelated to each other, and therefore have undergone convergent evolution.

Different 'land lobster' species, (a) to (f), compared with a winged, canopy-dwelling stick insect, (g).

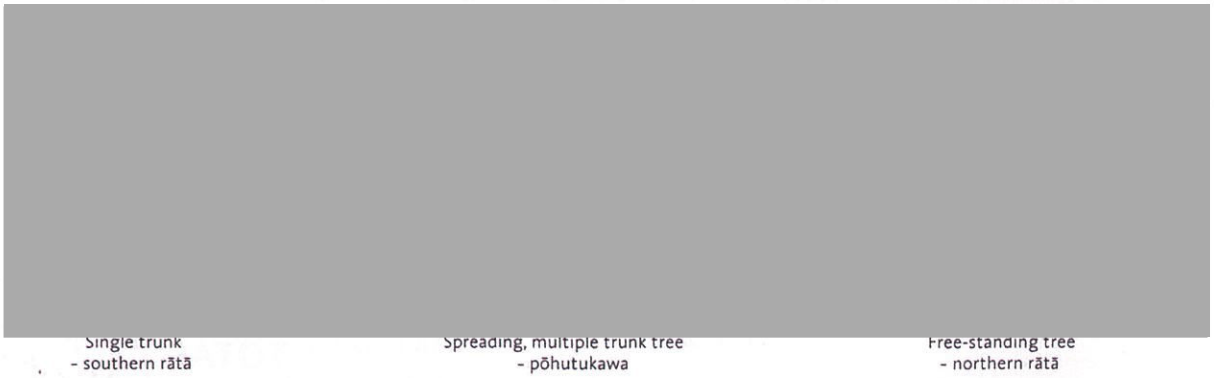
Adapted from Buckley, T.E. et al. (2009). Extreme convergence in stick insect evolution: phylogenetic placement of the Lord Howe Island tree lobster. Proc. R. Soc. 276, 1055–1062.

Pōhutukawa (*Metrosideros excelsa*), northern rātā (*Metrosideros robusta*), and southern rātā (*Metrosideros umbellata*) are all related species belonging to the same genus. These species have undergone divergent evolution during the ice age that occurred between one and two million years ago.

Pōhutukawa has a coastal distribution and is very salt-tolerant. It has multiple trunks, is a coloniser of coastal cliffs and bare volcanic larva, and is susceptible to light frosts.

Northern rātā usually begins life as an epiphyte perched high on another tree. From here it sends down roots to form a trunk that can grow into a 40 m tree. It has moderate frost tolerance.

Southern rātā usually grows from the ground to a 15 m high, single-trunked tree that can tolerate frost and colder climates.



Different forms of *Metrosideros*.

Adapted from: P. Simpson, *Pohutukawa and Rata*, (Wellington, Te Papa Press, 2005), p. 125.

Discuss the evolutionary patterns AND selection pressures that have contributed to these patterns for land lobsters and *Metrosideros*.

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In your answer:

- describe convergent evolution and divergent evolution
- explain, using the evidence given above, how each of these patterns could arise
- explain, by giving examples from the resource material, which pattern is associated with homologous structures AND which pattern is associated with analogous structures
- discuss why land lobsters have a different evolutionary pattern to *Metrosideros*.

Convergent evolution is when different species ~~evolve~~ from different destinations or habitats ~~are~~ contain similiar features or characteristics due to evolving from similiar ecological roles.

Divergent Evolution is when two or more species diverge from one species, or in other words two species are created from one in the same area/habitat.

~~Analogous - wings~~ For Land lobsters it seems that most if not all of the species presented have a hard shell ~~for~~ as protection and a defence mechanism against predators. ~~It seems~~ You could argue that each of these species of Land lobsters are prey to some kind of predator and in their own time would have developed a hard stocky shell and form over thousands of years. Their ~~simili~~ similarities could be ~~to~~ linked to convergent evolution for if they lived in relatively ~~same~~ the same habitats and the same conditions, their bodies may evolve in the same way with no interaction from each other. Sexual reproduction between the species ~~is not~~ has not happened due to evidence from the nuclear and mitochondrial DNA showing that the species are unrelated to each other.

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

The three Metrosideros species have evolved ~~different~~ from the same genus (the same ~~species~~ parent species) but it is clear they all look different. Pōhutukawa has evolved into a multiple trunked, salt tolerant tree that inhabits coastal regions. Northern Rātā has evolved into a tree that is an epiphyte that depends on other trees to grow. Southern Rātā grows from the ground to 15 m with one trunk. Due to ~~the different condition~~ being exposed to different conditions but in the same area these three trees have evolved and developed different features that have made them into three new species. They all seem tolerant to cold temperatures which is understandable for they all evolved during the ice age.

different species of

Land lobsters and Metrosideros have different evolutionary patterns due to Land Lobsters ~~not living in, near or by their other species~~ evolving via convergent evolution and Metrosideros evolving via divergent evolution.

The examples of Land Lobsters ~~there~~ did not ~~cross over~~ interact with each other due to ~~not~~ being located in different areas and being separated from each other by the ~~ocean~~ ocean.

into 3 ~~one~~ species

Metrosideros however ~~could interact with~~ evolved from ~~one~~ the same area but because of the different conditions they were exposed to. It seems Land Lobsters were exposed to the same conditions in different areas and have evolved to look similar to one another.

~~Land lobsters~~ The different species of Land lobsters have evolved via Allopatric speciation and the Metrosideros species have evolved via Sympatric speciation //

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N2

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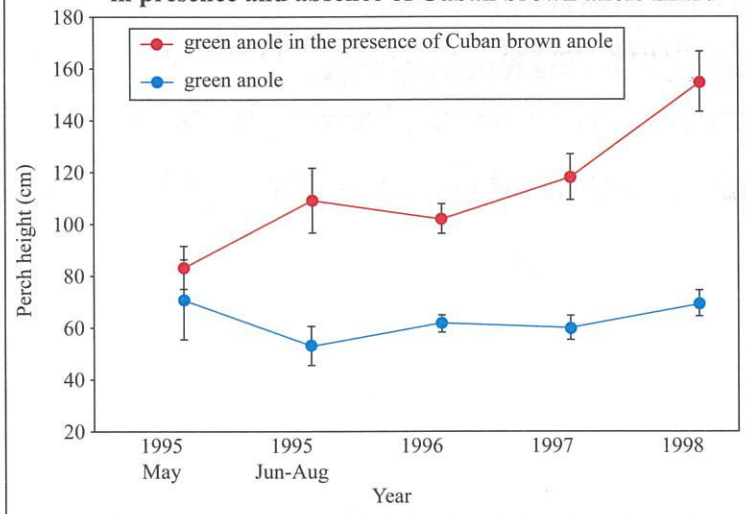
The examination continues on the following page.

Allopatric - geographically
Sympatric - when more than one species evolves from the parent species from the same area / habitat.

QUESTION TWO

The green anole lizard (*Anolis carolinensis*) is the only native anole in the United States. However, since 1940, the Cuban brown anole lizard (*Anolis sagrei*) has been invading the southeastern United States so that both species exist sympatrically in this area. Both species have adhesive scales on their toe pads called lamellae, and are very similar in habitat use, ecology, and dietary preferences. Biologists studying these anole compared the height at which the green anole perched in trees in the presence AND absence of the Cuban brown anole, and their results are shown in Figure 1. Biologists also measured toe pad area and lamella number in the green anole in the presence AND absence of the Cuban brown anole, and their results are shown in Figure 2a and Figure 2b.

Figure 1: Perch height of green anole lizard in presence and absence of Cuban brown anole lizard



Adapted from: Stuart, Y. E., et al. (2014), 'Rapid evolution of a native species following invasion by a cogener', *Science* 346 (6208): 463–466

Green anole and Cuban brown anole lizards.

http://davewelling.photoshelter.com/image/I0000HVzOE-fE2lmQ

Green anole hind foot showing toe pads.

www.utexas.edu/mews/2014/10/23/anole-lizards-evolution-florida/

Figure 2a: Toe pad area in green anole lizard in absence and presence of Cuban brown anole lizard

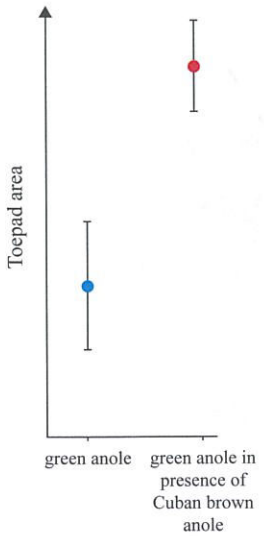
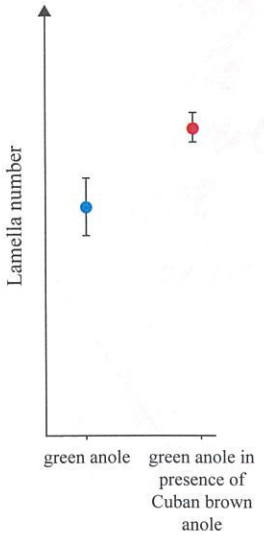


Figure 2b: Lamella number in green anole lizard in absence and presence of Cuban brown anole lizard



Adapted from: Stuart, Y. E., et al. (2014), 'Rapid evolution of a native species following invasion by a cogener', *Science* 346 (6208): 463–466

Discuss the natural selection pressures that have affected evolution in the green anole.

In your answer:

- describe natural selection and the trends shown by the resource material
- explain the type of natural selection occurring in the green anole
- evaluate the impact of competition on the evolution of the green anole.

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Natural selection is the differential survival of organisms due to their phenotypes.

It seems that the Green anole lizard you could say has ~~been~~ become more alert and intimidating over the years due to the Cuban brown anole lizard invading their habitats. From 1995 to 1998 the Green anole lizard's perch height when in the presence of the Cuban brown anole ~~is~~ raises from around 80cm to 150 cm. When not in it's presence the Green anole's perch remains between around 50-60 cm. We can see that perhaps the Green anole lizard species is showing hostile or ~~intimidation~~ intimidation actions towards the Cuban brown anole lizard due to the threat of competition it could bring.

The toe pad areas and the lamella number for the green anole lizard are higher when in the ~~presence~~ prescence of the Cuban brown anole lizard than not.

You would think this relationship to be mutual due to the fact that they both are similiar in habitat use, ecology and dietary preferences. However ~~with the since~~ studies in 1995 to 1998 show that perhaps the green anole lizard is not happy with the Cuban brown anole lizard being there.

Another reason however that the Green Anole lizard would be expanding its

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

size when in the presence of the Cuban brown anole lizard species is to perhaps communicate that they wish to mate. By ~~expanding it~~ looking to expand its size to seem bigger, it may be trying to impress or court ~~potention~~ potential Cuban brown anole lizard females or breeding partners.

If ~~they~~ the Green anole lizards ~~does for~~ is in fact hostile towards the Cuban brown anole lizards, then competition could impact the Green anole lizard ~~negatively~~, in a way in which their species would breed with the Cuban anole lizard. A species may be created from both these species. ~~and soon new traits~~ //

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A3

Autopolyploid - duplication of chromosomes in an organism from one species
Allopolyploid - ~~hybrid~~ duplication of chromosomes in a hybrid.

QUESTION THREE

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The four-wing saltbush (*Atriplex canescens*) is a shrub that has undergone polyploidy. It has a haploid number of nine chromosomes ($n = 9$). Biologists studied four-wing saltbushes with different numbers of chromosomes. Each type of saltbush lives in a slightly different habitat depending on how much water is available. Biologists measured the width of the water transport system (called the xylem) in each type of saltbush, and the results are shown in the table below. The xylem can be blocked by air bubbles in drought conditions.

Type of saltbush	Habitat (relative soil water availability)	Relative Xylem width	Resistance to air bubble blockage
Diploid ($2n = 18$)	High	Low	Low
Tetraploid ($4n = 36$)	Moderate	Moderate	Moderate
Hexaploid ($6n = 54$)	Low	High	High

Source: Hao, G et al. 'Polyploidy enhances the occupation of heterogeneous environments through hydraulic related trade-offs in *Atriplex canescens* (Chenopodiaceae)', *New Phytologist* (2013) 197: 970–978.

Polyploid plants also tend to have lower guard cell density and a thicker epidermal layer in their leaves.

Discuss the implications of polyploidy on the evolution of the four-wing saltbush.

In your answer:

- describe polyploidy and describe why the four-wing saltbush polyploids are fertile
- explain how polyploid formation could occur in the four-wing saltbush
- discuss what processes need to occur for the polyploids to become separate species
- discuss how the change in structure of the polyploids may lead to speciation.

Polyploidy is when in an organism, the chromosomes are duplicated. This usually happens in plants flowers.

Autopolyploid - is an organism from one species who has chromosomes that have been duplicated.

Allopolyploid - is an ~~organism~~ hybrid from two different species who has chromosomes that have been duplicated.

When polyploidy occurs in flower for example, ~~flair~~ the ~~spec~~ organism that

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

contains polyploidy is considered a different/new species. This is a great example of speciation for the polyploidy creates different species. //

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N1

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

QUESTION NUMBER

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Annotated Exemplar Template – Not Achieved

exemplar for 91605 - 2015		Total score	6
Q	**Grade score**	**Annotation**	
1	2	The candidate has not used their biological knowledge to answer the question, instead giving vague and general comments. They have given an acceptable answer for divergent evolution, but the convergent evolution answer would need to include that the 'different species' they refer to are unrelated	
2	3	This candidate has stated two trends shown in the resource graphs. They have not given a definition of natural selection as they omitted reproducing (and therefore passing those characteristics on)	
3	1	This answer has not demonstrated understanding of polyploidy. The candidate has provided partial answers only and to a superficial level. Polyploidy is 3 or more sets of chromosomes; an example of instant speciation; a type of sympatric speciation. Any of these are examples that would have led to a higher grade.	