**91605M**

916055

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

**3**

**SUPERVISOR'S USE ONLY**

# Koiora, Kaupae 3, 2015

## 91605M Te whakaatu māramatanga ki ngā tukanga o te kunenga mai e whakaputa ai i te whakamomotanga

2.00 i te ahiahi Rāhina 23 Whiringa-ā-rangi 2015
Whiwhinga: Whā

| Paetae | Kaiaka | Kairangi |
|---|---|---|
| Te whakaatu māramatanga ki ngā tukanga o te kunenga mai e whakaputa ai i te whakamomotanga. | Te whakaatu māramatanga hōhonu ki ngā tukanga o te kunenga mai e whakaputa ai i te whakamomotanga. | Te whakaatu māramatanga matawhānui ki ngā tukanga o te kunenga mai e whakaputa ai i te whakamomotanga. |

Tirohia mēnā e rite ana te Tau Ākonga ā-Motu (NSN) kei runga i tō puka whakauru ki te tau kei runga i tēnei whārangi.

**Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.**

Mēnā ka hiahia whārangi atu anō mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka, ka āta tohu ai i ngā tau tūmahi.

Tirohia mēnā e tika ana te raupapatanga o ngā whārangi 2–19 kei roto i tēnei pukapuka, ā, kāore tētahi o aua whārangi i te takoto kau.

**ME HOATU RAWA KOE I TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.**

**TAPEKE**

**MĀ TE KAIMĀKA ANAKE**

## TŪMAHI TUATAHI

MĀ TE KAIMĀKA ANAKE

Ko ngā ngārara e whakaahuahia ana puta noa i Niu Kini, Kanaki, me Te Motu o Lord Howe hei ‘kōura noho whenua’ he tūmomo ngārara nui, rerekore. He hanga pūngerungeru te tinana o te kōura noho whenua. He nui ake, he kaha ake hoki ngā waewae o muri o ētahi toa, ā, he whai pūtukuhua tino roa ngā uwha ka whakamahia hei whakaū hua ki te oneone. E whakaaturia ana e ngā tātaritanga raupapa pītauira karihi, punaraungao hoki kāore he pānga o ngā momo ‘kōura noho whenua’ tētahi ki tētahi, nō reira he kunenga[1] ūngutu tōna.

*I runga i ngā here manatārua,*
*kāore e whakaaetia te*
*whakaaturanga o tēnei*
*rauemi i konei.*

Ngā momo ‘kōura noho whenua’ rerekē, (a) ki (f), ka whakatauritehia ki tētahi rō[2] whai parirau, noho rō taumarutanga (g).

He mea urutau mai i 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.

He whanaunga katoa ngā momo o te pōhutukawa (*Metrosideros excelsa*), te rātā o Te Ika-a-Māui (*Metrosideros robusta*), me te rātā o Te Waipounamu (*Metrosideros umbellata*) nō te puninga kotahi. I tihoi te kunenga o ēnei momo i te wā tio i pā mai i ngā tau kotahi ki te rua miriona ki mua.

He tuaritanga takutai tō te pōhutukawa, ā, he tino rata ki te pāhare[3]. He maha ōna kahiwi, he tipu ki ngā matapari takutai me ngā rangitoto puia, ā, he mōrearea te hukapapa māmā ki te pōhutakawa.

I te nuinga o te wā ka tipu pipiri mai te rātā o Te Ika-a-Māui ki runga ake i tētahi atu rākau. Mai i konei ka torotoro haere atu ana pakiaka kia tipu hei kahiwi, ā, ko te mutunga atu he rākau 40 m te teitei. Ka āhua kaha i roto i te hukapapa.

I te nuinga o te wā ka tipu te rātā o Te Waipounamu mai i te papa ki te 15 m te teitei, kotahi te kahiwi, ā, kāore e kaha pāngia e te hukapapa me ngā āhuarangi makariri ake.

*I runga i ngā here manatārua,*
*kāore e whakaaetia te*
*whakaaturanga o tēnei*
*rauemi i konei.*

Ngā momo rerekē o te *Metrosideros*.

He mea urutau mai i: P. Simpson, *Pohutukawa and Rata*, (Te Whanganui-a-Tara, Te Papa Press, 2005), wh. 125.

[1] kukuwhatanga
[2] whē
[3] tote

## QUESTION ONE

ASSESSOR'S USE ONLY

'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).

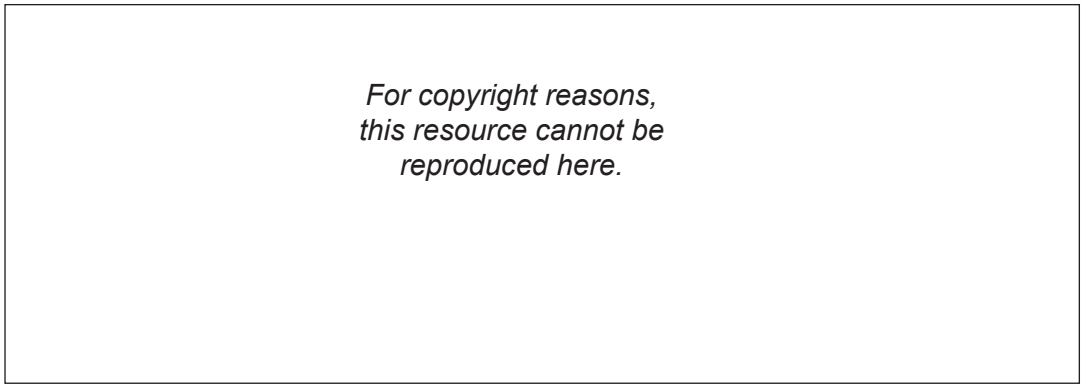
Adapted from Buckley, T.E. et al. (2009). Extreme convergence in stick insect evolution: phylogenetic placement of the Lord Howe Island tree lobster. Proc. R. Soc. 276, 1055–1062.

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 lava, 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.

Matapakitia ngā tauira kunenga ME ngā pēhanga whiriwhiri i whai wāhi ki ēnei tauira mō te ‘kōura noho whenua’ me te *Metrosideros*.

MĀ TE KAIMĀKA ANAKE

I tō tuhinga, me:

- whakaahua i te kunenga ūngutu me te kunenga tihoi
- whakamārama mai, mā te whakamahi i ngā taunakitanga i runga ake, he pēhea te puta o ēnei tauira
- whakamārama mai, mā te homai tauira mai i ngā rauemi, ko tēhea te tauira e hāngai ana ki ngā hanganga pūira huirua, Ā, ko tēhea te tauira e hāngai ana ki ngā hanganga ōrite
- matapaki he aha i rerekē ai te tauira kunenga o te ‘kōura noho whenua’ ki te *Metrosideros.*

**He wāhi anō mō tō tuhinga mō tēnei tūmahi kei te whārangi 6.**

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

ASSESSOR'S USE ONLY

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.*

**There is more space for your answer to this question on page 7.**

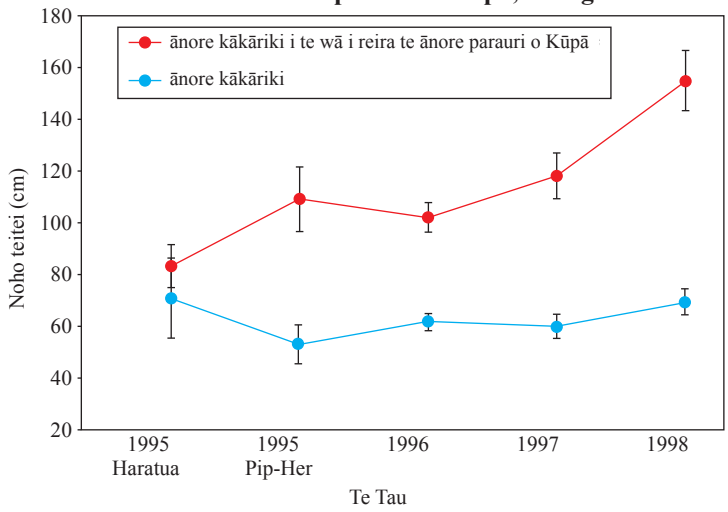
MĀ TE KAIMĀKA ANAKE

ASSESSOR'S USE ONLY

## TŪMAHI TUARUA

Ko te mokomoko ānore kākāriki (*Anolis carolinensis*) anake te ānore tūturu i Te Hononga o Amerika. Engari, mai i te tau 1940, e urutomo ana te mokomoko ānore parauri o Kūpā (*Anolis sagrei*) i te paeroa o Te Hononga o Amerika kia noho tata ai ngā momo e rua i tēnei rohe. He unahi hāpiri tō ngā momo e rua ki ō rāua kapu matiwae e kīia ana ko 'lamellae', ā, he tino ōrite tā rāua noho, hauropi, kai hoki. I whakatauritehia e ngā kaimātai koiora e mātai ana i ēnei ānore te teitei o te noho a te ānore kākāriki i runga rākau i te wā i reira te ānore parauri o Kūpā, ME ngā wā kāore ia i reira, ā, e whakaaturia ana ngā otinga ki te Hoahoa 1. I inea anō hoki e ngā kaimātai koiora te horahanga o te kapu matiwae me te maha o ngā lamellae i roto i te ānore kākāriki i te wā i reira te ānore parauri o Kūpā, ME ngā wā kāore ia i reira, ā, e whakaaturia ana ngā otinga ki te Hoahoa 2a me te Hoahoa 2b.

**Hoahoa 1: Teitei o te noho a te mokomoko ānore kākāriki i te wā i reira te mokomoko ānore parauri o Kūpā, me ngā wā kāore ia i reira**




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

*I runga i ngā here manatārua, kāore e whakaaetia te whakaaturanga o tēnei rauemi i konei.*

Te mokomoko ānore kākāriki me te mokomoko ānore parauri o Kūpā.

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

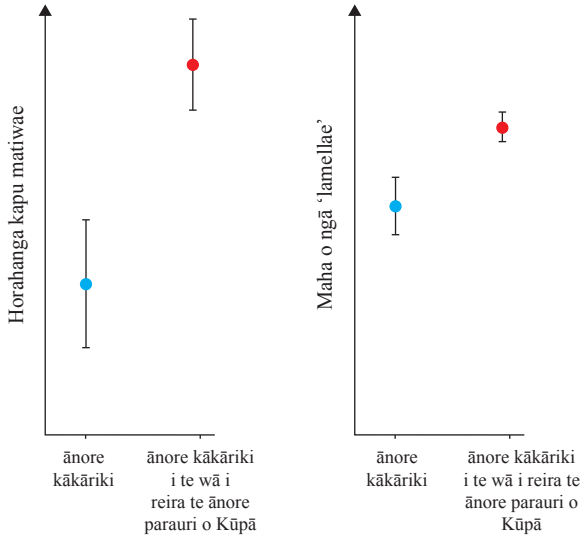
*I runga i ngā here manatārua, kāore e whakaaetia te whakaaturanga o tēnei rauemi i konei.*

Te waewae o muri o te ānore kākāriki e whakaatu ana i ngā kapu matiwae.

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

**Hoahoa 2a: Te horahanga o te kapu matiwae o te mokomoko ānore kākāriki i te wā i reira te mokomoko ānore parauri o Kūpā me te wā kāore ia i reira**

**Hoahoa 2b: Te maha o ngā 'lamellae' o te mokomoko ānore kākāriki i te wā i reira te mokomoko ānore parauri o Kūpā me te wā kāore ia i reira**

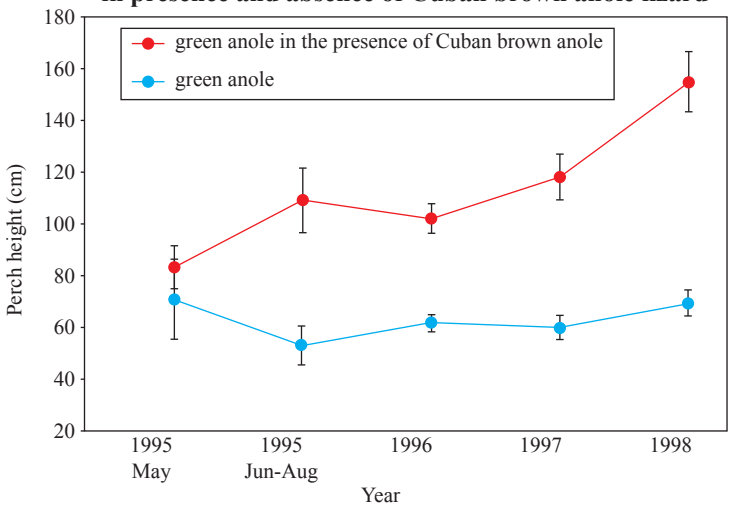



He mea urutau mai i: Stuart, Y. E., et al. (2014), 'Rapid evolution of a native species following invasion by a cogener', *Science* 346 (6208): 463–466

## 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

*For copyright reasons, this resource cannot be reproduced here.*

Green anole and Cuban brown anole lizards.

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

*For copyright reasons, this resource cannot be reproduced here.*

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**

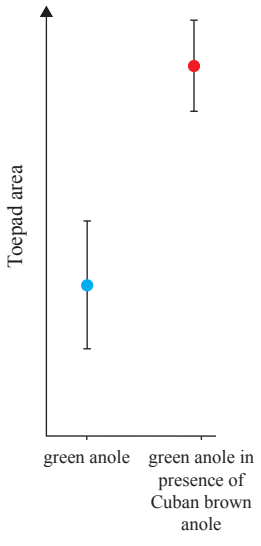
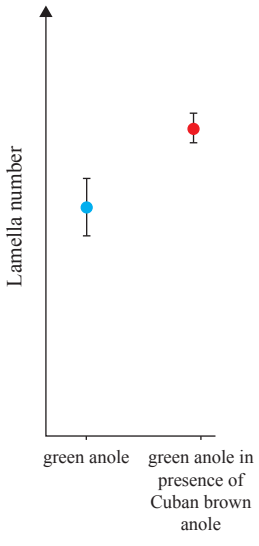



**Figure 2b: Lamella number in green anole lizard in absence and presence of Cuban brown anole lizard**




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

Matapakitia ngā pēhanga whiringa māori i whai pānga ki te kunenga o te ānore kākāriki.

I tō tuhinga, me:

- matapaki i te whiringa māori me ngā ia e whakaaturia ana e te rauemi
- whakamārama mai i te momo whiringa māori e mahi ana i roto i te ānore kākāriki
- aromātai i te pānga o te whakataetae ki te kunenga mai o te ānore kākāriki.

MĀ TE KAIMĀKA ANAKE

**He wāhi anō mō tō tuhinga mō tēnei tūmahi kei te whārangi 12.**

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.

ASSESSOR'S USE ONLY

**There is more space for your answer to this question on page 13.**

MĀ TE KAIMĀKA ANAKE

ASSESSOR'S USE ONLY

## TŪMAHI TUATORU

MĀ TE KAIMĀKA ANAKE

He mauwha te mauwhatote parirau-whā (*Atriplex canescens*) kua whai pūirareamaha (polyploidy). E iwa ōna pūira, he tau pūirareatahi ($n = 9$). I mātaitia e ngā kaimātai koiora ngā mauwhatote parirau-whā kua whai maha rerekē o ngā pūira. E noho ana ia tūmomo mauwhatote i tētahi nōhanga āhua rerekē e ai ki te rahinga o te wai kei reira. I inea e ngā kaimātai koiora te whānui o te pūnaha kawe wai (e kīia ana he tariwai[4]) i ia momo mauwhatote, ā, e whakaaturia ana ngā otinga ki te tūtohi i raro. Ka taea te tariwai te ārai mā ngā mirumiru hā i ngā āhuatanga tauraki.

| **Momo mauwhatote** | **Nōhanga (e ai ki te whiwhi wai o te oneone)** | **Whānuitanga hāngai o te tariwai** | **Ātetenga ki te purunga mirumiru hau** |
|---|---|---|---|
| **Pūirarearua ($2n = 18$)** | Teitei | Pāpaku | Pāpaku |
| **Pūirareawhā ($4n = 36$)** | Waenga | Waenga | Waenga |
| **Pūirareaono ($6n = 54$)** | Pāpaku | Teitei | Teitei |

Mātāpuna: 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.

Kei te nuinga o ngā tipu pūirareamaha he iti ake te kiato pūtau pare ka mutu he mātotoru ake te apa kiritai[5] o ōna rau.

Matapakitia ngā pānga o te whai pūirareamaha ki te kunenga mai o te mauwhatote parirau-whā.

I tō tuhinga, me:

- matapaki i te whai pūirareamaha ka whakaahua i te take he aha i mōmona ai ngā mauwhatote parirau-whā whai pūirareamaha
- whakamārama he pēhea te hanganga whai pūirareamaha i roto i te mauwhatote parirau-whā
- matapaki he aha ngā tukanga e hiahiatia ana kia tutuki kia puta ai ngā tipu whai pūirareamaha hei momo rerekē
- matapaki mō te puta pea o te whakamomotanga nā te huringa o te hanganga o ngā tipu whai pūirareamaha.

**He wāhi anō mō tō tuhinga mō tēnei tūmahi kei te whārangi 16 kei te whārangi 17.**

[4] kōtai
[5] kiriwaho

## QUESTION THREE

ASSESSOR'S USE ONLY

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.

**There is more space for your answer to this question on pages 16 and 17.**

MĀ TE KAIMĀKA ANAKE

ASSESSOR'S USE ONLY

**He whārangi anō ki te hiahiatia.**
**Tuhia te (ngā) tau tūmahi mēnā e tika ana.**

TAU TŪMAHI

MĀ TE KAIMĀKA ANAKE

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

QUESTION NUMBER

ASSESSOR'S USE ONLY

*English translation of the wording on the front cover*

# Level 3 Biology, 2015

## 91605M Demonstrate understanding of evolutionary processes leading to speciation

2.00 p.m. Monday 23 November 2015
Credits: Four

91605M

| 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 2–19 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.**