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Level 3 Biology, 2017

91605 Demonstrate understanding of evolutionary processes leading to speciation

9.30 a.m. Thursday 16 November 2017
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.

Achievement

TOTAL 09

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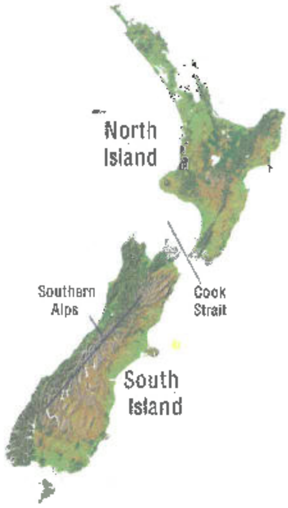
QUESTION ONE

Distribution, dimensions, habitat preference, and bill morphology of moa



Adapted from: Bunce M, et al. 2009. 'The evolutionary history of the extinct ratite moa and New Zealand Neogene paleogeography'. *Proc. Natl. Acad Sci. USA.* 106: 20646–20651; and Attard M, et al. 2016. 'Moa diet fits the bill: virtual reconstruction incorporating mummified remains and prediction of biomechanical performance in avian giants'. *Proc. R. Soc.* 283: 2015–2043

Moa were the dominant group of herbivores in ecosystems in New Zealand / Aotearoa until their extinction about 550 years ago. Moa species had a wide diversity of sizes and significant differences in the structure, strength, shape, and biomechanical performance of the skull and bill. Evidence suggests a single lineage of moa existed 25 million years ago (mya) in the South Island. Recent genetic analysis indicates new species started emerging about 5.8 mya, and by 1.4 mya, all nine known species existed. Fossil evidence indicates many of these species overlapped in geographical range.

Analyse the events that may have led to evolution of the moa.

In your answer you should:

- describe the terms allopatric speciation and sympatric speciation - same
- describe the pattern of evolution shown by moa, AND explain how this type of pattern can arise - adaptive radiation - fills different niches
- discuss the evolutionary significance of the diversity in moa bill shape - food source
- analyse the evolutionary processes that contributed to moa speciation.

Allopatric speciation occurs when species are subjected into different ~~a~~ geographical areas which means they evolve and adapt to their new environment. Sympatric specition occurs in the same area and can occur when populations occupy different niches or through polyploidy which results in instant speciation.

The pattern of evolution shown by moa is adaptive radiation where moa have occupied different niches and evolved into different species. This arises when there is a lack of food source, ~~so~~ so to improve survival different groups within a population occupy different niches to increase their chance of survival.

When moa splits from it's common ancestor into different niches it's food source ~~mo~~ usually changes which in return has ~~evoted~~ evolved the moa's bill shape. This evolved bill shape helps to process their new food source and is a form of natural selection as those who can eat the ~~new~~ new

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

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food source are likely to survive. The evolutionary process that contributed to the ~~moas~~ moa's speciation is natural selection which meant there was a lack of food source and those who favoured ~~other~~ alterative niches were preffered. These alleles were then passed onto offspring which eventually created a new species.

The candidate demonstrates understanding of allopatric speciation, adaptive radiation and sympatric speciation.

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QUESTION TWO

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https://vtnews.vt.edu/articles/2016/06/fralin-garter.html

The rough-skinned newt (*Taricha granulosa*) is distributed throughout North America. Many populations contain the poison tetrodotoxin (TTX) in the skin, which acts as a defence against predation. Despite TTX being one of the most powerful neurotoxins known, the garter snake (*Thamnophis sirtalis*) is able to prey on the rough-skinned newt. The levels of toxicity of newts and the resistance of the garter snakes vary geographically.

TTX Resistance vs Speed at which the garter snake can move

TTX resistance	Number of amino acid mutations	Speed at which the snake can move
Least resistant	1	fast
Intermediate resistant	2	intermediate
Most resistant	3	slow

Analyse the evolutionary relationship between the rough-skinned newt and the garter snake.

In your answer you should:

co evolution

- describe the **pattern of evolution** shown by the relationship
- explain how this kind of relationship develops
- discuss the role of **natural selection and mutation** in the evolution of the features shown
- analyse the selection pressures that work both for AND against the relationship.

This pattern of evolution is coevolution which in this example has occured in a predator - prey

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form. Since the Garter snake is the only snake able to develop an immunity to the toxin it means it has a constant food source that won't be eaten by other animals and therefore no competition occurs. This kind of relation ship develops when for example the Garter snake has too much competitions for food source and therefore, in order to survive must develop an immunity to the newts toxins to create a new food source. Mutations can be silent, harmful or benefitial, in this case with the Garter snake it is benefitial as the mutation means it is immune to the toxins. This new allele is favoured over those who don't have the toxin immunity and shown through natural selection as it is those with the mutation that survive and pass the new allele onto their off spring.

The selection pressures that work ~~too~~ for the relation ship was the initial lack of food source

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which in return favoured the mutation. However the snake that has the highest resistance to the toxin is at the slow end of the table so therefore those with the mutation struggle to catch a newt.

The candidate demonstrates understanding of speciation by describing co-evolution, natural selection and the importance of competition for food and TTX resistance.

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QUESTION THREE

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Shireplitis is a newly discovered genus of wasp endemic to New Zealand / Aotearoa. These species are mostly found in moss, litter, or tussock grasslands, at moderate altitude on mountain ranges.

Paroplitis is an unrelated genus of wasp, mostly distributed in Europe and North America, with some species living at moderate altitudes.

Shireplitis and *Paroplitis* look similar, with shared features being their relatively small size with a body length of about 2 mm, short and smooth abdomen, dark colour, short and robust legs, and short antenna. *Shireplitis* and *Paroplitis* both parasitise caterpillars. Host caterpillars are only known for the European species *Paroplitis wesmaeli*. One of these host species feeds on moss while another feeds on moss and grasses. Biologists hypothesise that *Shireplitis* may parasitise caterpillars that feed on moss, leaf-litter, dead wood, or fungi.

Shireplitis bilboi Shireplitis frodoi Shireplitis meriadoci

Shireplitis peregrini Shireplitis samwisei Shireplitis tolkieni

The six species of *Shireplitis.*

http://microgastrinae.myspecies.info/microgastrinae/shireplitis

Paroplitis wesmaeli

http://microgastrinae.myspecies.info/gallery?f[0]=im_field_taxonomic_name%3A28649&f[1]=im_field_taxonomic_name%3A28644

Discuss the evolutionary pattern AND selection pressures that have contributed to this pattern for *Shireplitis* and *Paroplitis.*

In your answer:

convergent

- describe selection pressure AND the pattern of evolution shown by *Shireplitis* and *Paroplitis*
  same structure different mimal
- describe homologous structures and analogous structures
  wings
- using the information above, explain how analogous structures are related to the pattern of evolution shown by *Shireplitis* and *Paroplitis*
- discuss, using the evidence from the resource material, how this evolutionary pattern could arise.

Selection pressures forcing Shireplitis and Paroplitis to occupy similar environments have lead to convergent evolution where they both ~~originate~~ ~~oh~~ originate from an unrelated

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ancestor but have evolved to display similar phenotypes. Homologous structures are the same bone make-up ~~up~~ but has evolved fore different purposes which suggests they come from a common ancestor. for example bones found in hands and arms of most mammels. Analogous structures are a different make up of a structure that serves the same purpous for example wings in insects.

Analogous structures relate to the convergent evolution of ~~w~~ both wasp species as they have both evolved wings that serve the same purpous aswell as similar features. This evolutionary pattern could've ~~ara~~ arisen ~~arisen~~ from very similar environments and selection pressures which in order to survive has led them to evolve very similar to each other.

The candidate demonstrates understanding of speciation by describing similar selective pressure as foraging. Analogous structures are also described as well as convergent evolution.

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