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91605

916050

NEW ZEALAND QUALIFICATIONS AUTHORITY
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QUALIFY FOR THE FUTURE WORLD
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Level 3 Biology 2022

91605 Demonstrate understanding of evolutionary processes leading to speciation

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.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area. This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Merit

TOTAL 15

QUESTION ONE: POISON

Pufferfish
Source: www.scienceabc.com/nature/animals/what-are-pufferfish-and-are-they-toxic.htm

Blue-ringed octopus
Source: www.nhm.ac.uk/discover/blue-ringed-octopus-small-vibrant-deadly.html

Rough-skinned newt
Source: www.sciencenewsforstudents.org/article/toxic-germs-on-its-skin-make-this-newt-deadly

The most important poison found in newts, the blue ringed octopus, and pufferfish is tetrodotoxin (TTX). It is one of the most dangerous toxins known. It acts on the nervous system of prey, and can result in muscles not being able to work, leading to death. It is used by the animals as an antipredator defence.

An adaptation of extreme resistance to this chemical has come about in several species of snakes that eat newts.

Snakes living in areas where there are prey who make TTX, have a protein expressed with a different amino acid which prevents nerve and muscle tissue being affected. Some snakes, such as the garter snake (*Thamnophis sirtalis*), are able to eat highly toxic newts because they have developed resistance to TTX, due to changes in a number of protein coding genes.

Researchers studied the success of snakes in eating newts in an area. They gave a percentage performance score based on the survival of the snake population in the survey area, as shown in the graph below. A score of 85% meant that 85% of the snakes in the area survived and reproduced.

Source: www.newscientist.com/article/dn13438-toxic-newts-lose-war-against-super-immune-snakes/

Source: https://evolution4e.sinauer.com/exercise1301.html

Discuss how both coevolution and convergent evolution are demonstrated in this example of animals with TTX- producing genes and those with resistance to TTX.

In your answer

- define the terms coevolution, convergent evolution, and mutation
- explain how the octopus, the pufferfish and the newt each having TTX is an example of convergent evolution
- using data from the graph, discuss how coevolution has led to an increase in TTX production in newts, and evaluate the implications of this for the survival and success of the newt species.

Co evolution is the process of a species acting as a selection pressure on another ~~diff~~ species.
Convergent evolution is when two species experience similar or the same selection pressure/s which lead to anologous structures, ie. different physical structures which have the same function and purpose.
A mutation is a permanate change in the base sequence of DNA.
Blue-ringed octopus, pufferfishs, and rough-skinned newts ~~all~~ ~~ex~~ as species all experience similar selection pressures ie predation from other species, which lead to individuals within the three species devoloping TTX due to a mutation to be selected for. They were selected for because they had an antipredator defense which led to them being more likely to survive predation and pass on their genes to the next generation. Blue-ring octopi, pufferfishes and rough-skin newt all devoloped TTX as a result of similar selection pressures therefore this is an example of convergent evolution.
Garter snakes act as a selection pressure on rough-skin newts, and rough-skin newts act as a selection

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pressure on Garter snakes. This is because as the garter snake species develops a TTX resistance they are able to eat more newts ~~bath~~ therefore decreasing the population of newts. However snakes without the TTX resistance arent able to eat the newts and are more likely to die off.

In the graph intially, the newts produced low amounts of TTX but as the population of newts decrease due to snake predation, the amount of TTX produce by the newts tended to increase as the newts with more TTX were more likely to survive and pass on there genes. However similarly snakes with stronger TTX resistance were more likely to survive. Therefore as newt TTX amounts produced increased, the snake TTX resistance would increase. However as the TTX of newts increases, the population of garter snakes decrease leading to more newts. However snakes with stronger TTX resistance will reproduce and increase the population leading to the newt population to decrease as they are being preyed on.

QUESTION TWO: TRIPLE-FINNED FISH

Source: www.researchgate.net/figure/Triplefin-species-used-in-this-study-and-their-respective-distributions-Bellapiscis_fig2_351878084

Approximately 130 species of triplefin have been identified worldwide living in many habitats, such as in tropical, subtropical, temperate, subantarctic, and the Antarctic Peninsula polar sea regions. In New Zealand, we see a large diversity of triplefin species. New Zealand has over 20 species of triplefin, all of which are endemic.

Discuss how the New Zealand triplefins are an example of adaptive radiation.

In your answer:

- describe what is meant by the terms endemic and species
- explain how temperature may act as a selection pressure, and leads to different species being found at different zones of the beach, such as the three species of triplefin that are shown in the diagram above
- discuss how the process of natural selection has resulted in such a large number of species of triplefin here.

Adaptive radiation is when a species (the ancestral species) quickly and rapidly evolves into many different specie due to inhabiting a wide area with different ecological niches.
A species is a group of similar organisms who can ~~reproductiv~~ reproduce and create fertile offspring.
Endemic is when something (in

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this case triple fin fish) can be found in one area/location only.
Temperature can affect habitats which the triple fins live in. Temperature is an abiotic condiction which may affect size of a triple fin as larger triple retain heat better than smaller triplefin due to there surface area to volume ratios, therefore they are more adapted to live in the cold,
The waters around NZ have many different condiction such as temperature, light level, and Food avaliablity for triple Fins. Because the water condictions around NZ are all different the triplefin inhabiting each area will experience a different selection pressure leading to the endemic species found around NZ. All 20 species of triplefin live in different ecological niches, each with its own selection pressures which are independent.

Or vice versa, where smaller triple-fin are adapted to live in the heated water.

QUESTION THREE: POLYPLOIDY AND SPECIATION

When Māori arrived in New Zealand from tropical Polynesia around AD 1250, they brought with them a number of tree and root crops. Polyploidy is inferred in the origins of three of these species – kūmara (sweet potato), tī pore (the Pacific cabbage tree, now only found on Raoul Island, approximately 1000 km from New Zealand), and uwhi (yams). Polyploids are often larger than the species they are formed from, and are reproductively isolated from them.

Kūmara
Source: www.nature.com/articles/nature.2013.12257

Tī pore
Source: www.nzpcn.org.nz/flora/species/cordyline-fruticosa/?web=1&wdLOR=c5453C15F-CE62-0243-961A-E58D334D15C8

Uwhi
Source: https://teara.govt.nz/en/photograph/17506/uwhi

Discuss processes that result in new species.

You may use a diagram to support your answer.

In your answer:

- define the terms polyploid and reproductive isolation
- explain how polyploids are formed
- discuss how the process of polyploidy is an example of sympatric speciation, and explain how two **other** reproductive isolating mechanisms (RIMs) could have contributed to the speciation of the kūmara, tī pore, and uwhi.

A polyploid is an individual (or species) which has been produce with more chromosomes than the parents due to non-disjunction of the spindle fibres during meiosis. I.e. more than 2n ("n" is the haploid number of chromosomes) sets. Reproductive isolation is when an individual cannot reproduct or produces infertile offspring. This ~~the~~ is due to reproductively Isolating mechanisms (RIM~~&~~s). There are two types of RIMs, prezygotic (before)

and post-zygotic (after fertilisation).
Sympatric speciation is when ~~to~~ two or more species live in the same geographic are but cannot reproduce with each other due to RIMs.
Polyploidy is an example of sympatric speciation due to the produced ~~pho~~ polyploid not being able to reproduce fertile offspring with individuals from the parent's species, due to RIM's, therefore they are two species.
A RIM which may prevent the kūmara, tī pore, and uwhi from reproducing with each other may be different flowering / reproducing seasons. For example the tī pore may flower at a different time than Kūmara.
Another RIM which may have led to the speciation of the Kūmara, tī pore and Uwhi may have been different structures of the pollen / stigma. Perhaps the pollen produced by the cabbage tree's flowers does not fit the structure of the kumara and uwhi to fertilise them.

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Write the question number(s) if applicable.

QUESTION NUMBER

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QUESTION NUMBER

91605

Standard	91605	Display ID	61640916	Total score	15
		NSN	136210830		
Q	**Grade score**	**Annotation**			
1	M6	The candidate shows in-depth understanding by explaining **both** convergence and co-evolution using the context given. In addition, the candidate used data (from the graph) to link TTX resistance to increased survival and reproductive success in snakes.			
2	A4	The candidate demonstrates an understanding of speciation by describing the following evolutionary concepts: mutation, endemic, selection pressure and species.			
3	M5	The candidate shows in-depth understanding of speciation by explaining sympatric speciation with linked examples **and** provided an in-depth explanation of a relevant RIM.			