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91605



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Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Biology 2025

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 2–16 in the correct order and that none of these pages is blank.

Do not write in the margins (//////). This area will be cut off when the booklet is marked.

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

Achievement

TOTAL 10

QUESTION ONE: The apple maggot fly and the hawthorn fly



Figure 1: Apple maggot fly laying eggs in apple fruit.

Figure 2: Hawthorn fly on a North American hawthorn tree.

Rhagoleti pomonella is a fly species native to North America. The species originally laid its eggs on the red fruit of the hawthorn tree (also native to North America) as a food source for larvae.

Approximately 200 years ago European settlers introduced apples to North America, and *R. pomonella* evolved into two distinct groups – the apple maggot fly and the hawthorn fly. These groups are physically similar and are still considered to be the same species. There is no geographic separation between the two groups.

The hawthorn fly lays its eggs in the native North American hawthorn fruit as a food source for its larvae, while the apple maggot fly now prefers to lay its eggs in apples. Apples ripen earlier in the season than hawthorn fruit, so apple maggot flies emerge earlier. Females and males prefer to mate and lay their eggs in the same type of fruit they are hatched in.

Data shows that the two groups have differences in their enzymes. They also differ genetically in their development time: maggots in apples develop in about 40 days, while maggots in hawthorn fruit develop in 55–60 days.

Discuss speciation and the mechanisms leading to the formation of the two different groups of fly.

In your answer, include discussion of:

- speciation and reproductive isolating mechanisms, with definitions ✓
- how TWO named isolating mechanisms may have caused the formation of the two groups of fly ✓
- a suggestion as to why the two groups are not yet considered separate species.

• Speciation is the formation of a new species when populations become reproductively isolated, and can no longer interbreed to produce fertile offspring.

• Reproductive isolating mechanisms also known as RIMs can be prezygotic (before fertilisation) and postzygotic (after fertilisation). Prezygotic RIMs include: geographical which is physical barriers, ecological

which is different habitat/niche, temporal which is different mating seasons/times, behavioural which is different courtship behaviours, mechanical which is incompatible reproductive structures, and gametic which is ~~to~~ gametes can't fuse.

- Post zygotic (after fertilisation), RIMs include: hybrid inviability which is when the embryo dies or fails to develop, hybrid sterility which is when offspring are infertile, and hybrid breakdown which is where future generations/offspring are weak and infertile.

- One RIM which may have caused the formation of these 2 fly groups is temporal which is the flies having different mating times/seasons. Also, ecological RIM, where the fly species have different habitats/niches.

QUESTION TWO: Lamprey and eels

The lamprey (*Petromyzontiformes*) is an ancient fish. Adult lamprey look like eels physically even though they have been separate species for millions of years. The similarities between the two include:

- a long flexible body that can move through narrow spaces
- swimming in an undulating (wave-like) motion
- no paired fins
- covered in mucus
- tolerance of low oxygen environments.

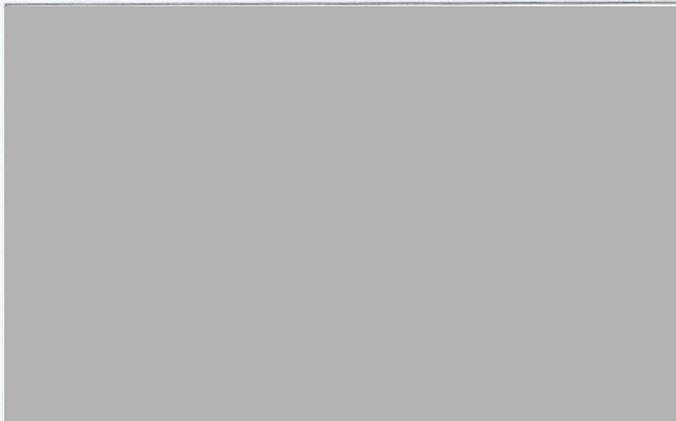


Figure 3: Phylogenetic tree for the lamprey.



Figure 4: Adult lamprey.



Figure 5: Longfin eel.

However, there are many differences, as listed in Table 1 below.

Table 1: Differences between lamprey and eel.

Lamprey	Eel
Cartilage skeleton	Bony skeleton
No jaw; mouth is a circular sucker, filled with hundreds of small teeth and a rasping tongue	Bony jaw and teeth
Continuous dorsal (back) fin only	Dorsal (back), pectoral (arm), anal fins
Seven gill openings on each side of head with no gill cover	Single gill opening on each side of head covered by a bony gill cover
No scales, skin is smooth and slimy	Tiny scales, which are hard to see
No backbone	Has a backbone
Many parasitic species that use sucker-like mouths to attach to fish for feeding or to scavenge	Most species are predators or scavengers
Live in the ocean and reproduce in rivers	Live in rivers and reproduce in the ocean

Discuss the evolution of lamprey and eel using the information provided.

In your answer, include discussion of:

- ✓ convergent evolution and an analogous structure, including descriptions
- ✓ how TWO named selection pressures influenced the similarities between lamprey and eel
- TWO examples of scientific evidence that can be used to determine that the physical similarities between the lamprey and the eel are an example of convergent evolution, not divergent evolution.

• Convergent evolution is when different species have similar traits due to living in similar environments. Analogous structures are things which have mostly the same functions but are structured differently due to independent evolution and selection pressures.

• Selection pressures are environmental factors affecting / influencing an organisms survival and reproduction.

• In this example, we can see that the different species (Lamprey and eel) have very similar traits including: long bodies to move through ~~re~~ narrow spaces, swimming in wave-like motion, no paired fins, covered in mucus, and tolerance in low oxygen environments. These are all the similar traits the eel and lamprey have, due to living in similar underwater oceans / seas (environment).

• An analogous structure of these 2 species could be their flexible body which is used for the same function, i.e. to move through narrow spaces, but are structured differently (the lamprey has cartilage skeleton and the eel has bony skeleton).

• Selection pressures can be abiotic or biotic → non-living or living. ~~A living~~ One selection pressure could be predators. So, for example the eel and lamprey have long flexible bodies which allows them to move into narrow space when and if they are being

hunted by predators (sharks or other predators). This selection pressure influenced the similarity in both species flexible body which ensures they are able to get into narrow spaces to avoid big predators. Another selection pressure influencing the similarities between the 2 could be ~~swimming in an undulating motion. This could be a non-living selection pressure i.e. weather.~~ tolerance in ~~o₂~~ low oxygen. This allows both species to go deep into the waters when the weather is harsh - causing changes in the intensity of waves/water flow.

- This is not divergent evolution as there is no geographical barriers stopping gene flow, leading to the alleles independently evolving through genetic drift, mutations, selection pressures, etc. This therefore means that there is no divergent evolution, leading to ~~the~~ reproductive isolation, and finally the formation of a new species / speciation.

QUESTION THREE: Tetraploid treefrogs

The gray treefrog (*Dryophytes versicolor*) and Cope's gray treefrog (*Dryophytes chrysoscelis*) are identical in physical characteristics and behaviour. However, the two species can be identified by different mating calls and chromosome numbers.

The tetraploid gray treefrog is related to the diploid Cope's gray treefrog and is thought to have evolved through multiple hybridisation events, with different diploid ancestors. Gray treefrogs have double the number of chromosomes. This has caused their mating call to be a slower musical call than that of Cope's gray treefrog, which is faster and more high-pitched.

The treefrogs share similar habitats, but the two species do not interbreed.

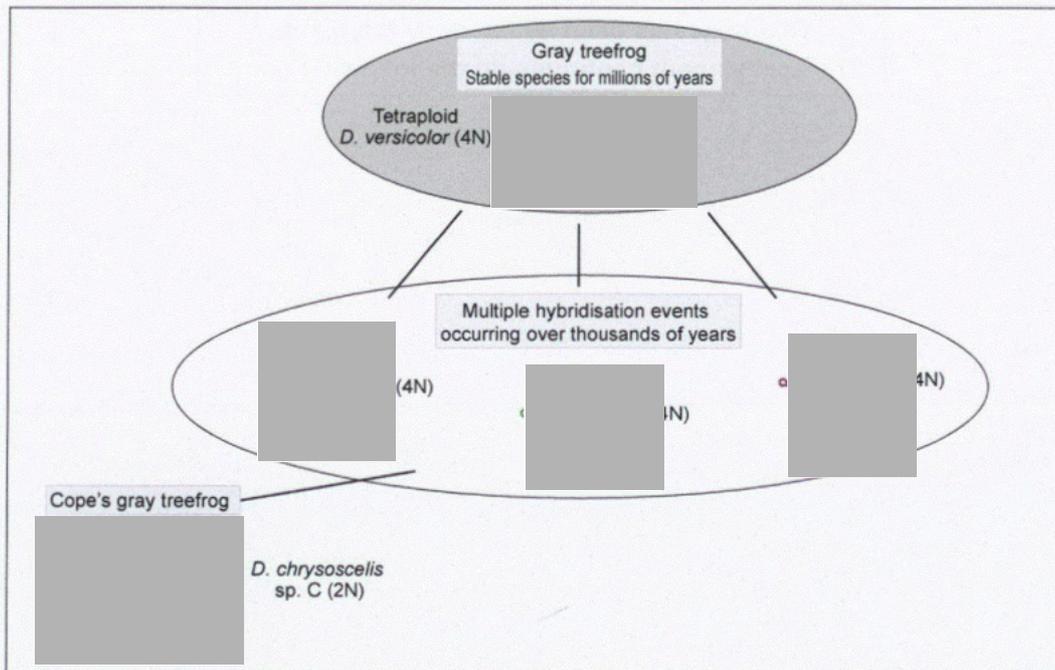


Figure 6: Polyploid speciation in treefrogs.

Discuss processes that caused the gray treefrog and Cope's gray treefrog to become separate species with different evolutionary patterns. You may use diagrams to support your answer.

In your answer, include discussion of:

- hybridisation and polyploidy, including definitions ✓
- how polyploidy can produce hybrid frogs ✓
- why the process of speciation in treefrogs is an example of sympatric speciation and not allopatric speciation ✓
- why this is an example of punctuated equilibrium and not gradualism.

• Hybridisation is when two different species mate, and produce a hybrid offspring. Polyploidy is instant speciation when organisms have more than two sets of chromosomes.

- There is two different types of polyploidy. There is autopolyploidy and allopolyploidy. Autopolyploidy is when chromosome duplication occurs in one species, and allopolyploidy is when hybridisation between two species occurs, which is followed by chromosome doubling. Polyploidy can produce hybrid frog through the process of allopolyploidy. The tetraploid gray tree frog which is ~~related~~ related to the Cope's gray tree frog ~~is~~ shows that hybridisation events have occurred, and this is done through the process of allopolyploidy.

- Sympatric speciation is when two related species are living in the same geographic area. ~~This~~ Sympatric speciation is caused by polyploidy, niche differentiation, etc. Whereas, allopatric speciation is when ~~the~~ related populations are geographically isolated from each other (mountains, river, lakes, etc). If this continues it could lead to reproductive isolation and therefore the formation of a new species.

Since the treefrogs are living in the same geographic area it means that this is sympatric speciation as the treefrogs have not been isolated from each other through and physical barriers / geographical barriers.

- Punctuated equilibrium is when there is a long period of time where no changes occur, and this is followed by rapid bursts of change. In contrast, gradualism is slow, continuous changes over a long period of time.

QUESTION
NUMBER

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

Process :

Geographical barrier → stopping gene flow → alleles independently evolve through mutations, genetic drift, selection pressures, etc → divergent evolution → reproductive isolation → formation of a new species / speciation occurs.

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Acknowledgements

Material from the following sources has been adapted for use in this assessment:

- Figure 1: <https://phys.org/news/2017-01-apple-maggot-flyhow-formation-species.html>
 Figure 2: <https://www.barbless-flies.co.uk/pages/match-a-hatch-hawthorn>
 Figure 3: <https://www.odt.co.nz/lifestyle/magazine/blood-sucking-fish-its-own-league>
 Figure 4: <https://www.nzgeo.com/stories/blood-suckers/>
 Figure 5: <https://www.sciencelearn.org.nz/resources/441-longfin-eels>
 Figure 6: <https://www.frogpets.com/gray-tree-frog/>
https://www.sdherps.org/species/hyla_chrysoscelis
<https://www.sciencedirect.com/science/article/pii/S096098220601253X>

Achievement

Subject: Biology

Standard: 91605

Total score: 10

Q	Grade score	Marker commentary
One	A3	The response defined: <ul style="list-style-type: none">• speciation• temporal and habitat isolation (both identified as pre-zygotic).
Two	A3	The response: <ul style="list-style-type: none">• defined the term selection pressure• described TWO relevant selection pressures from the context provided (low oxygen levels and narrow spaces).
Three	A4	The response defined: <ul style="list-style-type: none">• polyploidy• sympatric and allopatric speciation• punctuated equilibrium• gradualism.