Assessment Schedule – 2017

Biology: Demonstrate understanding of evolutionary processes leading to speciation (91605)

Evidence Statement

Q1	Evidence	Achievement	Merit	Excellence
	Allopatric speciation describes the formation of a new species as a result of physical separation by a geographic barrier. A physical barrier gradually forms and isolates parts of the population. This barrier prevents gene flow between populations. The environment in each isolated area is different with different selection pressures. These selection pressures favour phenotypes suited to each environment. The allele frequency of favourable alleles increases over time. The most recent common ancestor of moa existed after moa radiation was linked to geographical changes with the uplift of the Southern Alps which caused an increase in habitat diversity such as alpine niches. Niches developed such as wet rainforests to the west, and dryer, warmer climate to the east. Therefore, uplift produced both upland and lowland environments, and wet and dry habitats, forming a mix of forest, shrubland, and grasslands. An additional consequence of the mountainous topography and rain-shadow zones in both islands is that NZ was able to sustain diverse habitats throughout the glacial and interglacial periods. Movement of southern species of moa into the North Island occurred as the Manawatu Strait started to close and land bridges first formed. The subsequent formation of the seaway now known as Cook Strait is a geologically young event that prevented gene flow between each island apart from during periods of lowered sea levels during major glaciations. **Sympatric speciation** is the formation of new species in the same geographical area due to difference is in niche or behaviour. **Sympatric species** are species that previously diverged from a common ancestor (usually by allopatric speciation), and now exist in the same area, but remain reproductively isolated. That some moa existed as sympatric species was likely to have been sustained by partitioning of resources, facilitated through differences in feeding behaviour consistent with differences in bill morphology. ***The high availability of underutilised ecological niches due to accelerated uplift would have led to speciation via adaptive radiation***, which is when a species colonises an area and rapidly	• Describes allopatric speciation. • Describes the **geographical** barrier between North Island and South Island species as either the Cook or Manawatu Strait. **OR** Describes the **geographical** barrier between some South Island species as the Southern Alps or glaciers. • Describes North Island and South Island species as becoming reproductively isolated due to allopatric speciation or geographical separation. • Describes sympatric speciation as occupying within the same geographic range. • Describes the selective pressure on the bill shape as the food source • Describes sympatric speciation as involving reproductive isolation. • Describes niche differentiation. • Describes the pattern as adaptive radiation which is rapid diversification of related species, from a single ancestor, to exploit new niches. • Describes divergent evolution as diversification of an ancestral group into two or more new species (whether by gradual or sudden means).	• Explains allopatric speciation in relation to uplift of Southern Alps or glaciation (different selection pressures in different areas lead to different phenotypes). **OR** Explains allopatric speciation in relation to formation of Manawatu or Cook Strait (different selection pressures in different areas lead to different phenotypes). • Explains how preventing gene flow leads to the processes of speciation and can lead to adaptive radiation • Explains diversity in bill shape providing named examples • Explains how sympatric species may have come about (due to loss of a geographic barrier such as glaciers melting.) • Explains divergent evolution and that adaptive radiation is a form of divergent evolution. E.g. Divergence occurs when two or more species result from a common ancestor – typically, this is by allopatric speciation when two populations become geographically isolated. Different selection pressures in the different environments result in the two moa populations diverging as different phenotypes get selected for to meet	• Discusses allopatric speciation leading to different niches **or** adaptive radiation using named examples E.g.: named species diverged due to separation by the Southern Alps. Different selection pressures in the different areas led to named phenotypic changes which accumulated until reproductive isolation / different species. • Discusses that (sympatric species) species of moa living together may have come about due to loss of a geographic barrier, such as glaciers melting, **OR** that different bill morphologies meant a different diet, (which reduced competition for food and allowed different species to live in the same area.)

	diversifies to fill many of the available niches. ***It appears that each species evolved specialised feeding habits and a corresponding bill shape to exploit the diversity of different foraging and dietary niches available***. The ***response to natural selection based on specific food sources in each new niche led to the evolution of different bill morphologies*** suited to the specific food source. Differences in bill morphology reflect different feeding strategies and diet. For example, *P. australis*, *A. didiformis* and *M. didinus* have relatively narrow bills with pointed bill-tips compared to *D. robustus* and *E.curtus*, which have a relatively rounded bill-tip. *A. didiformis* had a sharp edged mandible that would have been well adapted for cutting twigs. Two apparent extremes in diet are *A. didiformis* and *E. curtus*. *A. didiformis* is thought to have mostly eaten fibrous material from trees and shrubs while *E. curtus* is thought to have fed on leaves and fruit (coprolite evidence suggests that *A. didiformis* was a forest specialist, *P. australis* fed in herbfields and grasslands, the upland *M. didinus* was a habitat generalist and *D. robustus* fed primarily in the transition zone between forest and grassland).		the demands of the different environments. The populations may diverge sufficiently (accumulation of different alleles in the gene pool) that reproductive isolation, hence speciation, results. Divergent evolution has occurred. (Sinclair 266)	

Not Achieved			Achievement		Merit		Excellence	
NØ = no response or no relevant evidence.	N1 = 1 point.	N2 = 2 points from Achievement.	A3 = 3 points.	A4 = 4 points.	M5 = 1 point.	M6 = 2 points.	E7 = 1 point.	E8 = 2 points.

Q2	Evidence	Achievement	Merit	Excellence
	The evolutionary relationship between *T. granulosa (newt)* and *T. sirtalis (snake)* is an example of co-evolution, where both species have exerted selection pressures on each other over time; adaptations in one species have led to reciprocal adaptations in the other. A co-evolutionary relationship develops, where over time, two species develop specific adaptations to enable their existence in the presence of the other organism. In this case, it is a predator-prey relationship where *T. granulosa (newt)* developed higher levels of TTX to survive the impact of predation and *T. sirtalis (snake)* evolved TTX-resistance to gain exclusive access to a food source. A mutation occurred that increased variation in gene pool and afforded some TTX-resistance to some members of the *T.sirtalis* population. Individuals with this advantageous phenotype had increased fitness compared to less suited individuals, so were more likely to reproduce and pass on this favourable allele. This favourable allele increased in frequency within the population over time. The mutation that conferred TTX-resistance resulted in a selective pressure that favours *T. granulosa (newt)* which produce higher levels of TTX. Increases in *T. granulosa (newt)* toxicity then apply a selective pressure favouring *T. sirtalis (snake)* with mutations conferring even greater resistance. This means *T. sirtalis (snake)* with the highest TTX-resistance have the most sodium channel mutations. *T. sirtalis (snake)* is resistant to TXX so has access to a wider range of food and a food source for which there is no interspecific competition. However, the higher the TXX resistance, the slower the speed of *T. sirtalis (snake)*, which makes it more prone to predation. The benefits of TXX resistance must outweigh the reduction in speed, and overall, survival and reproductive success increase. *T. granulosa (newt)* benefits from producing TXX, as it is protected from most predators. However, *T. granulosa (newt)* incurs an energy cost producing TXX that could have otherwise been redirected to activities such as reproduction. The benefits of producing TXX must outweigh the energy cost so that, overall, survival and reproductive success increase.	• Describes co-evolution. • Describes natural selection. • Describes mutation. (Describes one selective pressure = 1 achieve grade and describes two selective pressures = 2 achieved grades) • *T. sirtalis (snake)* is resistant to TTX so has access to a wider range of food / a food source that there is no interspecific competition for. OR *T. sirtalis (snake)* speed reduced so more prone to predation. AND/OR *T. sirtalis (snake)* speed reduced so it is harder to catch newt. AND/OR *T. granulosa (newt)* incurs an energy cost producing TTX. AND/OR *T. granulosa (newt)* is protected by TTX from most predators.	• Explains how the co-evolutionary relationship develops. • Explains the role of natural selection AND the amino acid/ mutation. • Specifies that *T. sirtalis (snake)* food access is dependant on level of resistance linked to speed • *T. sirtalis (snake)* speed reduced so more prone to predation, which decreases survival and reproductive success. • *T. granulosa (newt)* incurs an energy cost producing TTX which decreases reproductive success.	• Links concepts to give a comprehensive explanation of how this co-evolutionary relationship develops. (links in allele frequency/ gene pool, genetic isolation selective advantage etc.) OR • Discusses the role of natural selection AND mutation in this co-evolutionary relationship. (focuses natural selection and role of mutation) • Analyses selection pressures that work for AND against the relationship in *T. sirtalis (snake)* and *T. granulosa (newt)*.

Not Achieved			Achievement		Merit		Excellence	
NØ = no evidence or no relevant evidence.	N1 = 1 point.	N2 = 2 points from Achievement.	A3 = 3 points.	A4 = 4 points.	M5 = 1 point.	M6 = 2 points.	E7 = 1 point.	E8 = 2 points.

Q3	Evidence	Achievement	Merit	Excellence

	Selection pressures are factors that affect fitness / reproductive success and include limits on resources (food, habitat, space, and mates) and the existence of threats (predators, disease, climate change). **Convergent evolution** is the evolution of similar phenotypes by species from different lineages. Convergent evolution in *Shireplitis* and *Paroplitis* resulted in similarity in body form and behaviour and likely resulted from similar selective pressure related to the habitat (moss, litter, or grasses) and characteristics of the host caterpillars. A relatively small size, robust body and legs, and shortened antennae may be adaptive for moving within the litter environment whilst searching for hosts. A dark body form may be an adaptation to increase warmth in an alpine habitat. **Analogous structures** are superficially similar features that have evolved independently in unrelated species due to similar selection pressures in different areas. Analogous features in *Shireplitis* and *Paroplitis* are a relatively small size, robust body and legs, and shortened antennae. The selective pressure imposed by the habitat of the host caterpillar may have selected for that proportion of the population that had these phenotypes. For example, **variation in the population may mean differences in body length. Wasps with a shorter body may have had an advantage moving within the litter habitat and were able to cover more ground and find hosts more easily, which increased their reproductive success.** The frequency of this trait then increases over time in both populations subject to this selection pressure. **Homologous structures** are features similar in structure and origin but different in function. The similarity in structure indicates common ancestry, while differences in function indicate adaptation to different selection pressures in different environments.	• Describes selection pressure. • Describes convergent evolution. • Describes *Shireplitis* and *Paroplitis* as being subject to similar selection pressures in different areas. • Describes relevant selection pressures. • Describes analogous structures (superficially similar features that have evolved independently in unrelated species). • Describes homologous structures: as structures in different species with a common ancestor or developmental origin.	• Explains convergent evolution in terms of similar selection pressures generated by the habitat and / or characteristics of the host. • Explains analogous structures (superficially similar features that have evolved independently in unrelated species due to similar selection pressures in different areas). OR Explains analogous structures by giving examples (superficially similar features that have evolved independently in unrelated species such as small size / abdomen, robust body / legs, short antennae, dark body). • Explains how pattern could arise. Eg. -explains the New Zealand niche for *Shireplitis*is similar to the *Paroplitis* species in Europe and North America. As they are both in moss, litter and require the caterpillar as a host and would require similar structures (need to be identified) • Explains homologous structure.	• Discusses the processes of **convergent evolution** of *Shireplitis* and *Paroplitis*. • Similarity in named phenotypes and behaviour is likely the result of similar named selective pressures in different areas associated with moving within the litter environment looking for hosts. E.g. **Convergent evolution** in *Shireplitis* and *Paroplitis* **resulted in similarity in body form and behaviour and likely resulted from similar selective pressures** related to the habitat therefore increasing the **allele frequencies for these favourable traits** in both the *Shireplitis* and *Paroplitis*.causing them to have a similar phenotype eg. small body size and dark colored bodies. Over successive generations the allele frequencies favoured small dark bodies for both the *Shireplitis* and *Paroplitis*. • Discusses selective pressures involved in *Shireplitis* and *Paroplitis* E.g. Links directional selection for both species to the same or similar selection pressure **Analogous features** in *Shireplitis* and *Paroplitis* a**re a relatively small size, robust body and legs, and shortened antennae.** The selective pressure imposed by the habitat of the host caterpillar may have selected for that proportion of the population that had these phenotypes. For example, variation in the population may mean differences in body length. **Wasps with a shorter body may have had an advantage moving within the litter habitat and were able to cover more ground and find hosts more easily,** which increased their reproductive success. The frequency of this trait then increases over time in both populations subject to this selection pressure. (Moss, litter, or grasses) and characteristics of the host caterpillars. **A relatively small size, robust body and legs, and shortened antennae may be adaptive for moving within the litter environment whilst searching for hosts**. A **dark body form may be an adaptation to increase warmth in an alpine habitat or developed in response to avoiding predation** as the darker colouration camouflages.

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 18	19 – 24