

Assessment Schedule – 2015

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

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE	<p>Convergent evolution is the evolution of similar phenotypes by species from different lineages.</p> <p>Divergent evolution is the diversification of a common ancestral species into two or more species.</p> <p>Convergent evolution in land lobsters resulted in similarity in body form (and behaviour) and likely resulted from similar selective pressure associated with adaptations to ground-dwelling life. Such phenotypic similarity between unrelated species is likely to have been generated by extrinsic selective pressure, e.g. the greatly enlarged and armed hind legs of males probably evolved as a response to ground-hunting predators which may have found land lobsters easier to find due to their size compared to the smaller arboreal stick insects. The elongated ovipositor is also an adaptation that evolved independently in response to ground-dwelling life. Depositing eggs in the soil increased reproductive success by improving the survival chances of the eggs compared to being deposited on the soil surface.</p> <p>Divergent evolution in <i>Metrosideros</i> resulted from different selection pressures associated with the ice age. Ice ages 1 – 2 Mya caused sea level to drop and Zealandia became one island at peak of ice age. At the end of the ice age, warmer temperatures melted ice sheets, causing sea levels to rise, which separated Aotearoa’s single land mass into many islands. This increased the range of habitat types, and the different selection pressures in each location would have stimulated divergent evolution by reproductive isolation.</p> <p>The morphology of the different land lobster species is similar but not the same. Therefore, these relatively inconspicuous but significant anatomical differences between the different land lobster lineages mirror their</p>	<ul style="list-style-type: none"> • Describes convergent evolution – evolution of similar phenotypes from different lineages/no common ancestor /unrelated • Describes divergent evolution – diversification of a common ancestral species into two or more species • Homologous structures are associated with divergent evolution / <i>Metrosideros</i> OR analogous structures with convergent evolution / Land lobsters • Land lobsters in different areas were subjected to similar selection pressures. • <i>Metrosideros</i> were subjected to different selection pressures. 	<p>Explains how each pattern could arise:</p> <ul style="list-style-type: none"> • Explains convergent evolution in terms of similar selection pressures in similar island environment / ground dwelling niche. • Explains analogous structures are associated with convergent evolution. Ovipositor / powerful hind legs / stocky body form • Explains divergent evolution (or adaptive radiation) in terms of different selection pressures associated with ice age / climate change, e.g. warmer in north / colder in south. • Explains homologous structures are associated with divergent evolution. Must explain homologous structure as trunk / salt tolerance / frost tolerance. 	<p>Discusses the evolutionary patterns AND selection pressures:</p> <p>Discusses convergent evolution of land lobsters:</p> <ul style="list-style-type: none"> • Similarity in body form (and behaviour) is likely the product of similar selective pressures associated with named adaptations to ground-dwelling life. (Similar selection pressure = ground dwelling / island habitat) <p>Discusses divergent evolution of <i>Metrosideros</i>:</p> <p>Divergent evolution in <i>Metrosideros</i> resulted from different selection pressures associated with ice age. This resulted in (named adaptations) differences in trunk shape / salt tolerance / frost tolerance</p> <p>Discuss the formation of homologous and analogous structures</p> <ul style="list-style-type: none"> • Discusses a named analogous feature of land lobsters and link this to convergent evolution. <p>AND</p> <ul style="list-style-type: none"> • Discusses a named homologous feature of <i>Metrosideros</i> and link this to divergent evolution.

	<p>separate origins, which is indicative of analogous structures typical of convergent evolution. <i>Metrosideros</i> share certain basic structures such as shoot system (e.g. stem / trunk) but diversification has led to a variety of forms (e.g. multiple branches in <i>M. excelsa</i>, hemi-epiphytic in <i>M. robusta</i>, single stem in <i>M. umbellata</i>), which are indicative of homologous structures typical in divergent evolution.</p>			
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Not Achieved			Achievement		Merit		Excellence	
NØ = no response; no relevant evidence.	N1 = partial point(s)	N2 = 1 points from Achievement.	A3 = 2 points from Achievement.	A4 = 3 points from Achievement.	M5 = 1 point from Merit.	M6 = 2 points from Merit.	E7 = 1 point from Excellence.	E8 = 2 points from Excellence.

Q	Evidence	Achievement	Merit	Excellence
TWO	<p>Variation of alleles / phenotypes exists in populations. Individuals with better adapted phenotypes (larger toe pad area and more lamellae) will have increased fitness compared to less suited individuals, so are more likely to reproduce and pass on their favourable alleles. Favourable alleles will increase in frequency within the population.</p> <p><i>A. carolinensis</i> showed significant perch height increase relative to controls and, in response, adaptively evolved larger toe pads and more lamellae.</p> <p>Directional selection occurs when a phenotype towards one end of the range is favoured over other phenotypes, causing the allele frequency to shift over time in the direction of that phenotype. Under directional selection, the advantageous allele increases in frequency as a consequence of differences in fitness among different phenotypes and over time may become fixed.</p> <p>Competitive interactions with <i>A. sagrei</i> drive an increase in <i>A. carolinensis</i> perch height, which selects for increased toe pad area and lamella number. Larger toe pads with more lamella improve clinging ability, allowing them to climb higher. A shift to this habitat reduces competition for resources such as food.</p> <ul style="list-style-type: none"> • Divergence between these sympatric species is due to character displacement in which resource competition is the selection pressure. A behavioural change with regards to perch height reduces competition for similar food sources. <i>A. carolinensis</i> has increased its perch height, and this character displacement may lead to greater divergence / evolution. 	<ul style="list-style-type: none"> • Describes natural selection – Individuals with better adapted phenotypes / characteristics are more likely to survive and reproduce • Identifies directional selection • Phenotype at one end of range is favoured / selected for OR accept suitable diagram – see below. • Describes trend in perch height – green anole lizard has increased perch height when brown anole is present • Describes trend in toe pad area OR lamella number when brown anole is present. <div data-bbox="846 831 1326 1078" data-label="Figure"> </div> <p>http://img.sparknotes.com/figures/A/a3aa6bb95c7d70781cc0089d17f9160f/direct.gif</p>	<ul style="list-style-type: none"> • Explains natural selection – “A” plus favourable alleles will increase in frequency within the population / in next generation. • Explains directional selection – “A” plus causing the allele frequency to shift over time. • Explains that moving to higher perches selected for larger toe pads / more lamellae. • Explains that moving to higher perches reduces competition for named resources, e.g. food. 	<p>Evaluates the impact of competition E.g.:</p> <ul style="list-style-type: none"> • Competitive interactions (for a named resource) with <i>A. sagrei</i> drive an increase in <i>A. carolinensis</i> perch height, which selects for increased toe pad area / lamella number. Larger toe pads with more lamella improve clinging/climbing ability. • As a result of competition between green anole and brown anole there will be an increase in the differences in perch height AND toe pad area / lamellae number, thus ensuring that both obtain sufficient named resources to survive. Over time this will lead to greater divergence / evolution of the green anole.

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Q	Evidence	Achievement	Merit	Excellence
THREE	<p>Polyploidy is where an organism has more than two homologous sets of chromosomes in their somatic cells. The polyploids are fertile because they have homologous pairs / even number of chromosomes so can form viable gametes.</p> <p>Polyploidy can be caused by the spindle pulling an incorrect number of chromosomes to one end. This non-disjunction may result in 2n gametes. If two 2n gametes fuse, a tetraploid (4n) may result.</p> <p>Postzygotic RIMs such as hybrid infertility / hybrid sterility may keep polyploids isolated. E.g. tetraploid with 18 chromosomes in gametes + hexaploid with 27 chromosomes in gametes results in hybrid with 45 chromosomes, which cannot form viable gametes because the chromosomes cannot pair at meiosis because some have no homologues.</p> <p>Changes in morphology resulting from polyploidy contribute to habitat / niche differentiation. These new physiological tolerances allow them to exploit novel niches. Different habitats / niches have different selection pressures such as water availability which may lead to (sympatric) speciation. For example, polyploids have lower stomata density and thicker epidermis which reduces water loss / transpiration and maintains turgor. The wider xylem reduces the chances of air blockage in drought conditions, which gives an adaptive advantage in these conditions and allows photosynthesis to be maintained.</p>	<ul style="list-style-type: none"> • Describes polyploidy as having more than two sets of chromosomes • Identifies or describes non-disjunction. • Why polyploids fertile described – because they have pair of / even number of chromosomes • Describes speciation (formation of a new species) OR species (a population that can interbreed and produce fertile offspring) • Identifies polyploidy as an example of instant speciation / in one generation • Identifies polyploidy as an example of sympatric speciation • Identifies that polyploidy can result in hybrid vigour. 	<ul style="list-style-type: none"> • Explains non-disjunction – chromosome pairs are not pulled apart correctly resulting in diploid gametes • Explains how tetraploid OR hexaploid forms - Tetraploid – two diploid gametes fuse Hexaploid – a diploid and a tetraploid gamete fuse • Polyploids have resulted in a new named feature (Guard cell density/thickness of epidermal layer/xylem width) • Explains likely postzygotic RIM, e.g. hybrid sterility due to odd number of chromosomes in the new hybrid. • Explain that polyploids can result in hybrid vigour giving them an increased survival advantage. 	<p>Discuss a likely polyploid process.</p> <ul style="list-style-type: none"> • Chromosome pairs are not pulled apart correctly giving diploid / multiploid gametes which may lead to a new polyploid species (at fertilisation). <p>Discuss the adaptive advantage of polyploidy.</p> <ul style="list-style-type: none"> • Polyploids have a unique named feature and link this to survival advantage and reproductive success. <p>Discusses how change in structures may lead to speciation.</p> <ul style="list-style-type: none"> • Named changes in phenotype resulting from polyploidy contribute to niche differentiation by giving adaptive advantages in named habitat. Different habitats have different selection pressures such as water availability, which may lead to speciation. <p>Discusses that this is an example of sympatric speciation.</p> <ul style="list-style-type: none"> • Formation of two different species in the same area due to polyploidy (instant speciation). This results in named different phenotypes. <p>Discusses a likely post-zygotic process.</p> <ul style="list-style-type: none"> • E.g. tetraploid (18 chromosomes in gametes) + hexaploid (27 chr in gametes) results in hybrid with 45 chromosomes, which cannot form viable gametes because the chromosomes cannot pair at meiosis because some have no pair.

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Cut Scores

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