SL Paper 3

a. Compare sympatric speciation and allopatric speciation. [2]

c. Discuss the concept of punctuated equilibrium. [3]

Markscheme

a. both involve reproductive isolation / separation of gene pools;

sympatric is speciation due to isolation of populations living in the same geographic area whereas allopatric is speciation due to geographic isolation;

c. long periods of stability;

environmental change / sudden change;

leads to rapid speciation/evolution;

helps to explain absence of intermediate forms;

competing theory is gradualism;

Examiners report

a. As in most compare questions, candidates failed to make comparisons and just described each type of speciation.

c. Although there were some weak answers, many candidates answered this question correctly.

a. Compare convergent and divergent evolution. [2]

b. Explain how polyploidy can contribute to speciation. [4]

Markscheme

a.

	convergent	*divergent*
a.	different origin	same origin;
b.	results in similar structures/ adaptations / analogy	results in different structures/ adaptations / homology;
c.	both are processes happening over time as a result of environmental change/selection pressure;	

Reject unqualified statements to the effect that both are types of evolution.

b. *Polyploidy:*

a. having more than 2 (complete) chromosome sets/description of polyploidy;

b. happens through chromosome mutation / non-disjunction;

c. occurs more frequently in plants than animals;

Contribution to speciation
d. polyploids cannot reproduce with original species / meiosis fails / chromosomes cannot pair;
e. creates reproductive barrier;
f. but can self-fertilize / reproduce with similar individuals;
g. thus forming a new species;
h. new species formed by sympatric speciation;

Examiners report

a. D3 (a) was reasonably answered by most candidates, though many answers in (b) were very vague.

b. D3 (a) was reasonably answered by most candidates, though many answers in (b) were very vague.

Discuss gradualism and punctuated equilibrium as ideas about the pace of evolution.

Markscheme

gradualism is the slow change from one form to another;

requires long periods of time with relatively constant rate of change;

with punctuated equilibrium short periods of rapid evolution occur followed by long periods without change;

punctuated equilibrium fits with sudden environmental change/violent environmental conditions/volcanic eruptions/meteor impact;

in punctuated equilibrium, adaptations needed to cope with new environmental conditions/directional selection;

fossil record does not support gradualism / mass extinctions support punctuated equilibrium;

if no change in environment, then natural selection would oppose changes in gene pool;

Examiners report

Good candidates were able to get three of the four marks available for a discussion of gradualism and punctuated equilibrium. Again, many candidates were only able to get one or two marks for actually describing the two rather than discussing them which requires a range of arguments for or against an idea such as the fact the fossil record does not support gradualism and mass extinctions support punctuated equilibrium.

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a. Outline the process of adaptive radiation. [3]

b. There has been a change of thinking; moving from gradualism to punctuated equilibrium demonstrates the changing nature of science. Discuss these two ideas about the pace of evolution. [4]

Markscheme

a. varied members of a single species occupy a variety of niches / migration of a species to an area with a variety of niches;

natural selection/selection pressure will be different in various niches causing adaptation of groups to the varied niches;

results in many species from one ancestral species;

reproductive isolation enhances adaptive radiation;

adaptive radiation results in speciation;

b. in gradualism evolution occurs at a constant pace;

fossil records of gradual change with intermediate forms support this theory;

evolution of modern horse/another suitable example seems to support this view;

in punctuated equilibrium evolution proceeds rapidly for short periods of time intermittent with long periods of little change/stability;

gaps in the fossil record/lack of intermediate forms support the idea of punctuated equilibrium;

strata in the fossil record with appearance of many new species following a mass extinction supports the idea of punctuated equilibrium;

Examiners report

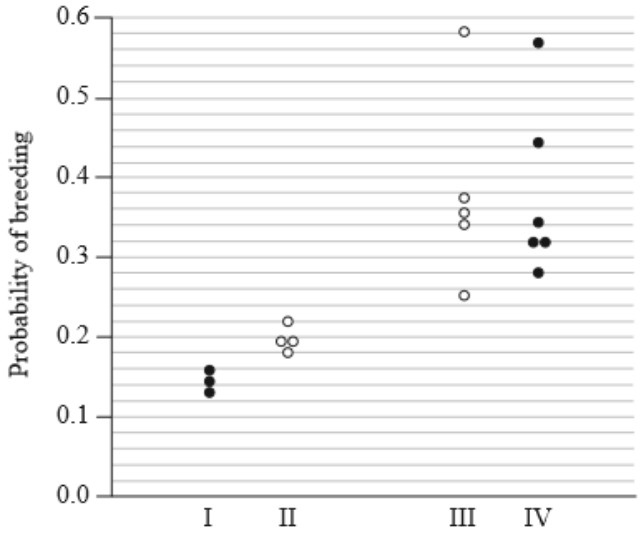
a. Adaptive radiation was very poorly answered.

b. Quite a few candidates got the two definitions right, but not the discussion part.

Populations of threespine sticklebacks (*Gasterosteus sp.*), a fish living in small freshwater lakes in British Columbia, Canada, are derived from the marine threespine stickleback (*Gasterosteus aculeatus*). In order to investigate the process of speciation in these populations, three small lakes were studied. Each lake contained two varieties of stickleback: a large, bottom-dwelling variety that fed on invertebrates near the shore and a small, plankton-eating variety that lived in the open water. The probability of breeding between pairs of individuals was measured under laboratory conditions in the following breeding combinations:

I different varieties (small × large) from the same lake
II different varieties from different lakes
III same variety (small × small) and (large × large) from different lakes
IV same variety from the same lake.

The data are summarized below.



From H. D. Rundle et al. (2000) Science, 287, pp. 306–308. Reprinted with permission from AAAS.

a. Identify the highest and lowest probabilities of breeding for individuals of the same variety from different lakes. [1]

Highest probability: .....

Lowest probability: .....

b. Identify the breeding combination that results in the lowest probability of breeding. [1]

c. Analyse the probability of breeding between individuals from the same lake. [2]

d. Scientists concluded that speciation is taking place in these populations. Discuss the evidence for speciation provided by the data. [3]

Markscheme

a. *Highest probability:* 0.58 *(Allow answers from 0.57–0.59)*

Lowest probability: 0.25 *(Allow answers from 0.24–0.26)*

Both required for the mark.

b. different varieties from same lake / I

c. individuals are more likely to breed if they are the same variety / individuals of different varieties have a low probability of breeding;

the probability of breeding between individuals of the same variety shows a large range of values / narrow range if of different variety;

the probability of breeding between any two individuals is always less than 0.6/correct numerical value;

d. data provides (strong) evidence for reproductive isolation between the varieties in each lake;

different sizes/feeding habits/habitat (shore versus open water) seem to contribute (strongly) to low breeding probability;

this could lead to speciation/formation of separate species in each lake;

same varieties from different lakes do not show strong reproductive isolation/ geographical isolation is a weak factor in speciation / no evidence of allopatric speciation;

sympatric speciation seems to be taking place because different varieties from the same lake have a low probability of breeding;

Examiners report

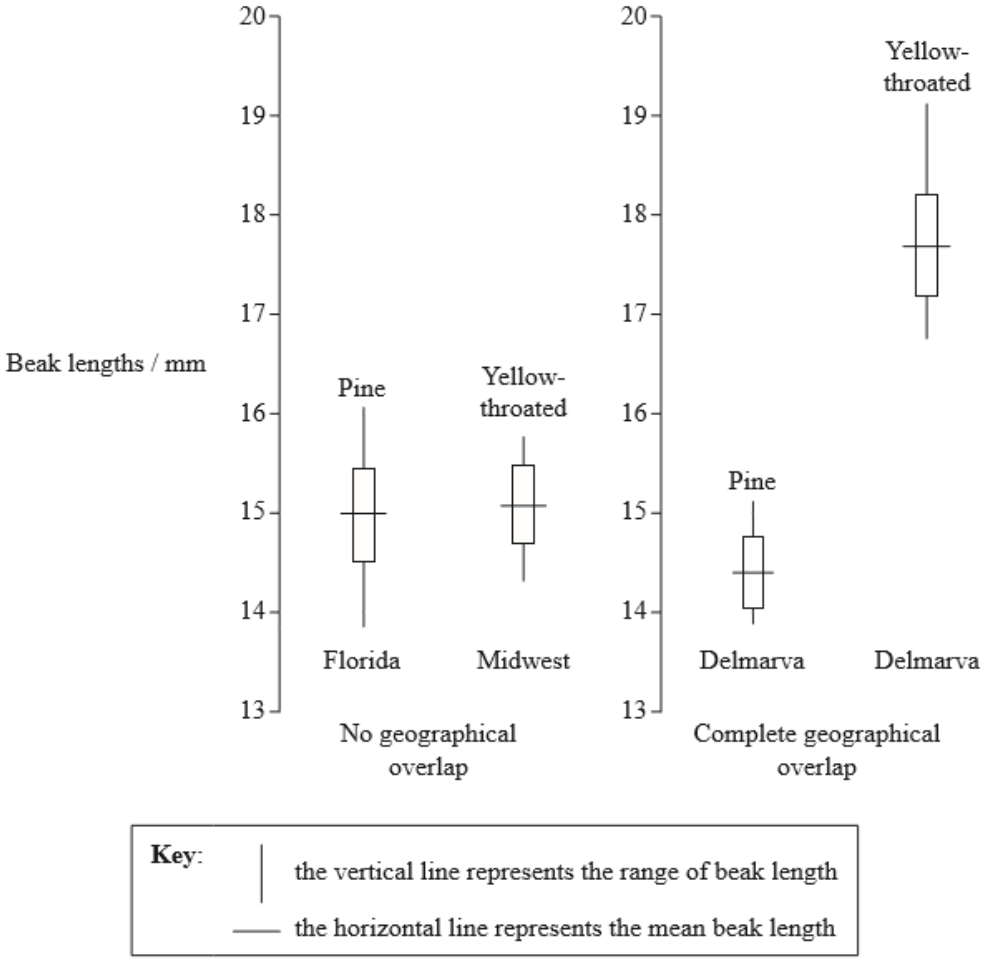
a. Most candidates answered this correctly.

b. The majority of candidates identified the correct breeding combination.

c. A good proportion of candidates gained two marks, showing their ability to correctly analyse the data given.

d. This was a good discriminator as it allowed the better students to connect the data with their knowledge of speciation, although very few mentioned allopatric speciation, and few gained all three marks. Many weaker candidates appear to have little understanding of the process of speciation however, and answers were often difficult to interpret.

Competition between genetically similar species of birds may lead to changes of one or more characteristics. One characteristic that results from this kind of selection is differences in the beaks. Researchers studied the beak lengths of two species of warblers. The graphs below show the beak lengths of Pine Warblers (*Dendroica pinus*) and Yellow-throated Warblers (*Dendroica dominica*) from three geographically isolated areas in the USA.



R. Ficken *et al.* (1968) *Evolution*, 27, pp. 307–314. Republished with the permission of Wiley-Blackwell.

a (i). Identify the species with the shortest mean beak length. [1]

a (ii). Determine the difference in the mean beak length of the two populations of Yellow-throated Warblers in Midwest and Delmarva. [1]

a (iii). Compare the range of variation in beak length of the Yellow-throated Warblers in Midwest to the beak length of the Yellow-throated Warblers in Delmarva. [1]

b. Suggest an advantage for the longer beaks of Yellow-throated Warblers in Delmarva. [1]

Markscheme

a (i). Pine Warblers/*Dendroica pinus* (of Delmarva)

a (ii). 2.6mm (*accept answers in the range of 2.5 mm to 2.7 mm*)

a (iii). Yellow-throated Warblers have a bigger range / greater variation (of beak length) in Delmarva than in Midwest (*accept numerical values*)

Accept converse.

b. allows them to eat other foods / changes feeding behaviour;

reduces competition with Pine Warblers;

Examiners report

a (i) Candidates had little trouble with the data presented in this option and D1 was well answered.

a (ii) Candidates had little trouble with the data presented in this option and D1 was well answered.

a (iii) Candidates had little trouble with the data presented in this option and D1 was well answered, though D1 (iii) presented problems for students who did not engage with the command term “compare”.

b. Candidates had little trouble with the data presented in this option and D1 was well answered.