UNIVERSITY OF YORK
BSc Stage 3 Degree Examinations 2017-18

Department:
BIOLOGY

Title of Exam:
Ecological Genetics

Time allowed: 2 hours
Total marks available for this paper: 100

Section A: Short Answer (50 marks)
Answer all questions in this section in the spaces provided on the examination paper.

Section B: Essay question (marked out of 100, weighted 50 marks)
Answer either question A or question B
Write your answer on the separate paper provided and attach it to the back of the question paper using the treasury tag provided.

Instructions:
The marks available for each question are indicated on the paper
A calculator will be provided

For marker use only:

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SECTION A: Short Answer / Problem / Experimental Design questions
Answer all questions in the spaces provided.
Mark total for this section: 50

1. A reciprocal transplant experiment has been conducted with *Arabidopsis thaliana* from an Italian and a Swedish site, where seeds or seedlings were transplanted every year for five years. Figure 2A shows the number of fruit produced per planted seed or seedling across several experimental years. Closed circles represent the Italian genotypes while the open circles represent the Swedish genotypes. The asterisks indicate a significant difference at the site in that year. Figure 2B shows the survival of the Italian genotypes at the Swedish site depending on the minimum soil temperature in the winter of the experimental year.

![Figure 2A](image1)

![Figure 2B](image2)
a) Discuss whether there is evidence for local adaptation in these populations. (3 marks)

b) Compare the overall suitability of the two transplant sites and discuss the role of winter temperatures in determining this. (7 marks)

c) Discuss the processes that may have led to the two populations displaying a different degree of phenotypic plasticity. (4 marks)
2. A large road, the Interstate Highway 10 (I10), runs through the habitat of Western diamondback rattlesnakes in Arizona. Rattlesnake individuals were sampled from three populations I10E, I10W and CT. Figure 3A is a map of the area showing the locations of sampled individuals from these populations; I10W (orange squares), I10E (green circles) and CT (green triangles).

![Figure 3A](image1)

The rattlesnake samples were also genotyped using 30 microsatellite markers. These genotypes were used in the program STRUCTURE to find the most likely number of genetic groups among the sampled individuals. Figure 3B below shows the probability that each individual belongs to each of three groups (red, yellow and green).

![Figure 3B](image2)
a) Explain why the genetic evidence presented in Figure 3B is not sufficient to show that the highway itself poses a significant barrier to gene flow between rattlesnake populations. (4 marks)

b) What other analyses or experiments would you need to carry out to determine whether or not the highway itself poses a significant barrier to gene flow between rattlesnake populations? (4 marks)

c) How could the results in Figure 3B be depicted in a more informative manner, and why would this be an improvement? (3 marks)
3. The Black-browed Tit (*Aegithalos bonvaloti*) and Sooty Tit (*A. fuliginosus*) are thought to be two closely-related species that occur in East Asia. *A. bonvaloti* inhabits high altitude habitats (1500-4400 m), whereas *A. fuliginosus* inhabits relatively lower altitudes (1000 to 2600 m). In Figure 4A the solid and dashed lines indicate the distribution ranges of *A. bonvaloti* and *A. fuliginosus* respectively. The overlapping region represents a contact zone in their distributions. The circles and triangles indicate the sampling localities of *A. bonvaloti* and *A. fuliginosus* respectively. All the samples were genotyped at a large number of SNPs which were then used to construct a phylogenetic tree (Figure 4B).
a) What is the evidence for hybridisation between *A. bonvaloti* and *A. fuliginosus*? (4 marks)

b) Explain how the ABBA-BABA test could be carried out in this system to test for hybridization between the two taxa. (5 marks)
c) Discuss whether or not these two taxa should be considered to be separate species.  
   (3 marks)

4. Define adaptive introgression and explain why it is so much more common among bacteria compared to eukaryotes?  
   (5 marks)
5. a) Explain how the transmission mode of a pathogen will affect the evolution of the interaction with its host. (4 marks)

b) Briefly outline an experiment to test the prediction in (a). (4 marks)
SECTION B: Essay question

Answer one question on the separate paper provided

Remember to write your candidate number at the top of the page and indicate whether you have answered question A or B

Mark total for this section: 50

EITHER

A) Discuss how the Pleistocene Ice Ages might have contributed to current phylogeographic patterns.

OR

B) Discuss how spatial variation might affect coevolutionary dynamics.