Module Code: BIO00012H

Examination Candidate Number: __________

Desk Number: __________

BSc Degree Examinations 2018-9

Department: BIOLOGY

Title of Exam: Ecological genetics

Time Allowed: 2 hours

Marking Scheme: Total marks available for this paper: 100
Section A: Short Answer / Problem / Experimental Design questions (50 marks)
Section B: Essay question (marked out of 100, weighted 50 marks)

Instructions:
Section A: Answer all questions in the spaces provided on the examination paper
Section B: Answer either question A or B. Write your answer in the green answer booklet provided and attach it to the back of the question paper using the cable tie provided.

Materials Supplied:
Green Answer Booklet

For marker use only
Office 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

Question 1.
The Alpine Rock-Cress *Arabis alpina* is a short-lived alpine perennial that is found at altitudes between 800 m and 3,100 m in the French Alps, which is an unusually wide altitudinal range. Within this altitudinal range many genetically differentiated populations exist. The plants reproduce mostly by selfing.

a) Explain which two processes might allow *A. alpina* to persist across such a wide range of environmental conditions. (3 marks)

The figure below shows the results of an experiment where seeds from six different populations (denoted by different colours) were sown in two experimental gardens (Vercors and Lautaret). The original populations were located at different altitudes, and are arranged from origins at low altitude (dark red) to high altitude (dark blue) in the figure legend. Increasing altitude correlates with lower average temperatures and shorter growing seasons.

The following parameters were measured:

**Morphotype**: ranging from 0 = not compact, to 2 = compact; **Survival**; **Total Fruit Length** (TFL): the combined length of all fruit on a plant (mm); **Reproductive Height** (H. repro.) in mm.

The Vercors experimental garden is at lower altitude and has a higher average temperature than the Lautaret garden.
b) Describe the main results of the experiment, focusing on a comparison of the populations at the two experimental locations.  

(6 marks)
c) Considering the experimental result, discuss how the two processes that you identified in (a) contribute to the persistence of *A. alpina* at different altitudes.  

(5 marks)

d) How might the predicted rise in average temperatures affect the two high elevation populations GAL and PIC?  

(2 marks)

**Question 2.**

a) Explain how the genetic diversity of a host population that is coevolving with a parasite is likely to change compared to a host population that is evolving resistance to a genetically uniform parasite.  

(3 marks)
b) Discuss whether you would expect to see any differences in mating behaviour between the populations in (a) after fifteen generations of selection, and if so describe what kind of mating behaviour might evolve. (4 marks)
Question 3.

In 2014, the population structure of black bear populations along the lower Mississippi valley was examined by genotyping 265 bears from seven populations (LARB, UARB, TRC, TRB, MISS WRB and MINN) using 23 microsatellite loci. The map below shows the locations of these seven populations. On the map, purple populations were present prior to 2000, and red populations were established after 2000. During the 1960s, black bears were translocated from the MINN population to the UARB and TRB populations.
The figure above shows the results of analysing the microsatellite genotypes of the sampled black bears using the program STRUCTURE in which individuals were assigned to genetic clusters (K). The analysis was carried out using a range of values of K, of which K= 5 was found to be the most probable.

a) What source populations have contributed to the two newly established populations? Discuss this in the context of the locations of these populations.

(5 marks)

b) Evaluate what impact the translocations from MINN have had on the population genetic structure in the other six populations.

(5 marks)
Question 4.

Fifty two thinhorn sheep (Ovis dalli) from North America were genotyped at 10,000 genome-wide SNPs.

Figure A) Phylogenetic tree of the 52 thinhorn sheep. * indicate nodes with 100% bootstrap support. Red/yellow/green branches colours correspond to colours of sampling locations on the map.

Figure B) Map of northwest North America showing the sampling locations of the sheep. The grey shaded area represents the extent of ice cover during the last ice age, and the white shading represents ice-free areas.

Figure C) Results of analysing the genotypes of the sampled sheep using the program STRUCTURE in which individuals were assigned to genetic clusters (K = 2).
Using the genetic data and ice cover information, what can you infer about the number and locations of possible ice-free refugia for thinhorn sheep, and postglacial colonisation routes out of these refugia. (8 marks)
Question 5.

As plants are stationary, migration or gene flow happens via seed dispersal (nuclear and organelle genes) and pollination (nuclear genes). Discuss how different types of seed dispersal (small mammals, birds and wind) and types of pollination (self, insect and wind) might be expected to affect patterns of isolation by distance detected using nuclear and chloroplast markers. (9 marks)
SECTION B: Essay question

Answer one question in the green answer booklet provided.

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

Mark total for this section: 50

EITHER

A) Discuss problems that might arise when conservation decisions are taken at the species level without taking lower levels of population structure into account.

OR

B) Discuss whether or not hybridisation between species is an issue of conservation importance.