BSc / MSc Degree Examinations 2018-9

Department:
Biology

Title of Exam:
Genes and genomes in populations and evolution

Time Allowed:
1.5 hours

Allocation of Marks:
Marks will be allocated as indicated for each question.
Total marks available: 60

Instructions for Candidates:
Answer all questions.

Materials Supplied:
A calculator will be provided.

Do not write on this booklet before the exam begins
Do not turn over this page until instructed to do so by an invigilator
Question 1

a) In a diploid system where males and females form pair-bonds, there is some level of extra-pair paternity (mating outside of the bond). Males can have the strategy of either helping their son’s offspring or choosing not to help. Males who help suffer a cost of 0.2 offspring on average. The recipient of the help gets an increase of 2.5 offspring on average. Calculate whether males should help their son’s daughter, where extra-pair paternity is 50%. (5 marks)

b) In population A of a haplodiploid wasp species, females are singly mated, whereas in population B, females mate an average of 3 times. In this species, for every 1 offspring that a female can rear alone, a female helped by a daughter acting as a worker can rear 2.4. Using Hamilton’s rule, explain which population/s would be predicted to evolve helping behaviour by workers. (5 marks)
Question 2

The water mite *Neumania papillator* is a sit-and-wait predator that detects prey via vibrations. Male *N. papillator* water mites attract females by trembling their forelegs to create vibrations. Related mite species *Neumania distincta* is also a sit-and-wait predator, but males do not perform trembling.

a) How could we use these 2 species to test the hypothesis that males of *Neumania papillator* are exploiting a sensory bias? (2 marks)

b) A lab experiment compared the mating behaviour of starved and well-fed females of *Neumania papillator*. Which group of females would we predict to be more strongly attracted to trembling males, and why? (2 marks)

c) How does sexual selection for trembling behaviour conflict with natural selection for survival in *Neumania papillator* males? (1 mark)
Question 3

a) Describe the C-value paradox               (1 mark)

b) What features contribute to the large size of some eukaryote genomes?               (4 marks)

c) Describe how these factors have contributed to the evolution of eukaryotes.         (10 marks)
Question 4

a) Explain the assumption of molecular evolution that the McDonald-Kreitman test for non-neutral evolution explicitly tests.  

(2 marks)

b) Describe the data required to conduct McDonald-Kreitman tests.  

(3 marks)

c) Describe how one might use other genomic data to summarise polygenic adaptation.  

(3 marks)

d) If balancing selection were identified, which alternative a summary statistic(s) could be calculated that would provide support for this selection.  

(2 marks)
Question 5

a) What information can you attain from bacterial microbiomes by using 16S rRNA, metagenomics and transcriptomics sequencing? Which methods would you use to study community activity and why? (5 marks)

b) You are planning to start an experimental evolution experiment to study adaptation of the bacterium *Serratia marcescens* to 10% glucose media. You have decided on two treatments: one where the starting population is clonal containing one genotype and the other where the starting population is diverse containing five different genotypes. Briefly discuss how this manipulation would change the course of bacterial adaptation to the growth media. (5 marks)
Question 6

The figure below is from a comparative study performed on a large dataset of insect species’ traits collected from published literature, and shows a significant positive association between the two traits depicted.

Explain what was done to generate the above figure, why it was necessary, and what can be concluded from it. (5 marks)
Question 7

One potential explanation for the rise of birds is that they outcompeted pterosaurs which previously filled similar ecological niches. Explain how you could use a quantitative examination of the fossil record to test this potential explanation.

(5 marks)