BIOLOGY B242: EVOLUTIONARY AND ECOLOGICAL GENETICS

EXAM 2001

Answer ONE question from section A, TWO questions from section B, and ALL OF section C (overleaf). Each section carries 1/3 of the marks on the paper.

SECTION A. Answer ONE of questions 1-3.

1. Why is heritability useful and how do we estimate it? Discuss some examples of its application in evolution.

2. Write an essay on recent theories and evidence from natural populations that address the problem of sympatric speciation.

3. Why has sex evolved?

SECTION B. Answer TWO of questions 4-8.

4. "When animals interact, they play games". Discuss and justify.

5. How does Darwin's theory rely on Mendel's mechanism?

6. Describe the key features of "balancer chromosomes", and explain their usefulness in the study of mutation.

7. Why, in the animals, do males tend to be more elaborately ornamented than females?

8. What use is the "Hardy-Weinberg equilibrium" in modern evolutionary genetics?

Remember to answer Section C overleaf!

TURN OVER

SECTION C. Attempt ALL parts of question 9.

9. Cystic fibrosis (CF) is a single-locus recessive genetic disease of humans. The gene is on chromosome 7, and affected individuals in Scotland occur at a frequency of 1 in 1,984 newborns: it is one of the commonest serious genetic diseases among Europeans. Affected individuals rarely survive to reproduce.

    a) Assuming random mating with respect to this gene, what is the frequency of mutant CF alleles in the Scottish population?

    b) Assuming random mating, what is the frequency of carriers (i.e. heterozygotes for the mutant allele?

    c) The equilibrium gene frequency q^* expected if there is a balance between mutation at rate μ and selection pressure t for a deleterious recessive gene is: $q^* = \sqrt{(\mu/t)}$ [HINT: the fitness of the CF homozygote is assumed to be $(1-t)$ in this model]. Assuming the allele frequency in Scotland is at equilibrium under mutation-selection balance, what is the value of μ? Is this value of μ plausible?

    d) Part (c) gives an explanation of the frequency of CF in terms of mutation rate alone. Give explanations for the high frequency of CF in terms of each of the following possible alternative scenarios:

        i. genetic drift alone;
        ii. heterozygote advantage alone [HINT: the equilibrium gene frequency under heterozygote advantage is expected to be $p^* = t/(s+t)$];
        iii. inbreeding alone [HINT: under inbreeding, $Het = 2pq(1-F)$];

    Which do you think might be the most likely? Give your reasoning.

END OF PAPER