BIOLOGY B242: EVOLUTIONARY AND ECOLOGICAL GENETICS

EXAM 2003

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 of the whole paper.

SECTION A (Carries 1/3 of the marks). Essay. Answer ONE of questions 1-3.

1. "From an evolutionary perspective, mutations of individually small effect are far more important than relatively rare 'macromutations' of large effect." Review the evidence for this statement.

2. What is a species? Discuss the various ideas and their importance.

3. Game theory was originally used to resolve debates in the discipline of economics. Provide a comprehensive guide to the application of game theory in evolutionary biology to aid our understanding of animal conflicts.

SECTION B (Carries 1/3 of the marks). Short answers.
Answer TWO of questions 4-8.

4. Explain, using an illustrative example, how to distinguish between 'single gene' and 'many gene' explanations of the genetic basis of quantitative traits.

5. Summarise the advantages, but also the limitations, of the use of artificial selection in evolutionary biology.

6. Discuss whether sexual selection can explain human sexual dimorphism. Are there likely to be any differences between animal and human sexual selection?

7. Briefly describe the theory of inbreeding and genetic drift. Discuss two important uses of the theory that we can apply to the world's problems.

8. Explain why Darwin's 'provisional theory of pangenesis' is an inadequate mechanism of heredity.

PLEASE TURN OVER FOR SECTION C!!

SECTION C. (Carries 1/3 of the marks). Attempt ALL parts.

9. Samples from a polymorphic population of the scarlet tiger moth *Panaxia dominula* were taken, and the following genotype data were obtained for the colour pattern gene affecting the 'medionigra' phenotype:

Year	'typical' phenotypes A_1A_1	'medionigra' phenotypes A_1A_2	A_2A_2	Total in sample
1955	308	7	0	315
1956	1231	76	1	1308

a) What are the allele frequencies for 1955 and 1956?

Using data and allele frequencies for **1956 ONLY ...**

b) What are the expected genotypic frequencies for 1956 assuming Hardy-Weinberg Equilibrium?

c) Perform a chi-square test on observed and expected values for 1956. What is the overall value of the chi-square?

Table of chi-square values

Degrees of freedom	Value of *P* 0.99	0.9	0.5	0.1	0.05	0.01	0.001
1	0.00	0.02	0.46	2.71	3.84	6.63	10.83
2	0.02	0.21	1.39	4.61	5.99	9.21	13.82

d) Look up the chi-square value from (c) in the table of chi-square given above. How probable is it that the observed results would occur under the null hypothesis of Hardy-Weinberg Equilibrium?

Using the data from **BOTH 1955 AND 1956 ...**

e) Find the numbers of A_1 and A_2 alleles sampled in each year, and then perform a 2 x 2 chi-square homogeneity (i.e. contingency table) test of the null hypothesis of no allele frequency change between 1955 and 1956. What is the overall value of chi-square for this test?

f) Look up the value of chi-square found in (e). What is the *P* value?

g) Is there any evidence for a significant change in allele frequency?

h) The moths have one generation per year. What is the value of the change in allele frequency, Δp per generation, between the two years?

i) Give two causes that might explain this Δp. Which is most likely? Why?

The 'medionigra' phenotypes are largely dominant (though heterozygotes are detectable). Therefore selection acts mainly against A_1A_1. The change in allele frequency under selection **AGAINST** common recessive alleles (when the fitness of A_1A_1 is $1-s$) is approximately $\Delta p \approx -\frac{sq}{1-s}$ (q is the frequency of A_2 in 1955).

j) What selection coefficient, *s*, could explain the observed Δp?

END OF PAPER