Shells Under Pressure

Use allele frequencies to investigate selection in shore snails

GEN.5.4 "Apply the Hardy-Weinberg formula to analyze changes in allelic frequencies due to natural selection in a population. Relate these changes to the environmental fitness of the phenotypes."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the evidence about which snails birds eat, circle the genotype counts in the table, and number the steps for finding the frequency of A.

When Birds Reach the Shore

1. On a rocky coast, shell thickness in a snail population depends on one gene with two alleles. Snails with AA or Aa have thick shells, while aa snails have thin shells. After shell-crushing birds arrive, field observations show that birds eat thin-shelled snails more often. Researchers sample newborn snails before the birds arrive and again several generations later.

GENOTYPES IN SAMPLES OF 1,000 NEWBORN SNAILS

Sample	AA	Aa	aa
Before birds arrive	360	480	160
Several generations later	490	420	90

2. Each newborn snail carries two alleles, so a sample of 1,000 snails contains 2,000 allele copies. To find the frequency of A, count two A copies per AA snail and one per Aa snail, then divide by 2,000. Count a in the same way. Call these frequencies p and q; $p + q = 1$.

3. For offspring produced by random mating, Hardy-Weinberg predicts genotype frequencies p^2 for AA, $2pq$ for Aa, and q^2 for aa if its conditions hold within that generation. The formula provides a comparison, not proof that selection is absent across generations. Connect any change in allele frequency to which shell type survives bird attacks and leaves more offspring.

2 ANSWER WITH EVIDENCE

Use the passage

1. Before the birds arrive, what are p and q? Show how you counted allele copies.

2. Several generations later, what are p and q? How much has the frequency of A changed?

3. Use q^2 to predict the fraction of thin-shelled newborns in each sample. How do your predictions compare with the table?

4. How can the newborn samples match Hardy-Weinberg predictions while bird predation favors a shell type between generations?

3 YOUR TURN

Your own words

In a different habitat, dark fur (D) is dominant over pale fur (d), and predators catch pale mice more often after fires darken the ground. Among 100 newborn mice, 25 are pale before the fires and 9 are pale several generations later; assuming Hardy-Weinberg proportions within each sample, calculate q and p at both times and explain which phenotype is favored.

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PART 1 · READ AND MARK

Underline the evidence about which snails birds eat, circle the genotype counts in the table, and number the steps for finding the frequency of A. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Before the birds arrive, what are p and q? Show how you counted allele copies.	**p = (2 × 360 + 480) ÷ 2,000 = 0.60; q = (2 × 160 + 480) ÷ 2,000 = 0.40.**
2	Several generations later, what are p and q? How much has the frequency of A changed?	**p = (2 × 490 + 420) ÷ 2,000 = 0.70; q = 0.30. The frequency of A increased by 0.10.**
3	Use q^2 to predict the fraction of thin-shelled newborns in each sample. How do your predictions compare with the table?	**Before birds arrive, $q^2 = 0.40^2 = 0.16$, or 160 of 1,000. Later, $q^2 = 0.30^2 = 0.09$, or 90 of 1,000. Both match the table.**
4	How can the newborn samples match Hardy-Weinberg predictions while bird predation favors a shell type between generations?	**Hardy-Weinberg proportions can describe newborns produced by random mating within each sampled generation. Between generations, birds eat more thin-shelled snails, so thick-shelled snails are more likely to survive and pass on A.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Pale mice are dd, so their frequency is q^2. Before the fires, $q^2 = 25/100 = 0.25$, giving $q = 0.50$ and $p = 0.50$. Later, $q^2 = 9/100 = 0.09$, giving $q = 0.30$ and $p = 0.70$. Dark fur is favored on the darkened ground because predators catch pale mice more often.

Accept equivalent allele-count calculations and fractions. A match to Hardy-Weinberg proportions within a newborn sample does not rule out selection between generations; the predation observations support the fitness explanation.