J.B.S. Haldane and the Evolution of the Hardy-Weinberg Model

Read this article and answer the following questions.

1. What does this case show about the following aspects of doing biology?
    a. Different uses of models

    b. The assumptions made by models

    c. How models change over time

2. Dominant ≠ Frequent! Explain why high fitness is not the same as dominance. How does understanding this distinction allow you to answer the question posed to Punnett after his lecture?

3. One of the characteristics of the Hardy-Weinberg model is that its predictions hold even when its assumptions are not completely met. Explain 2 ways in which the Hardy-Weinberg model is helpful even though the assumptions mean virtually no real population exists that would meet it.

4. Haldane made a model of evolution in (1) the case where selection operated against a dominant allele as well as in (2) the case of selection against the homozygous recessive allele. In which case would you expect evolution to proceed more rapidly? Why?

5. The initial population in the eye-color example in the text was already in Hardy-Weinberg equilibrium. Hardy's original *Science* paper began with a population made up exclusively of homozygous individuals; thus, his population was not in equilibrium. Calculate the allele frequency and the genotype frequencies of the next generation for a population consisting of 30 homozygous brown-eyed individuals and 70 homozygous blue-eyed individuals. How do these frequencies compare with the eye-color example in the text? If a population is disturbed from Hardy-Weinberg equilibrium, how long does it take to return to equilibrium genotype frequencies?

6. Revisit the example from the text where $w = 0.20$ for the less successful form (remember w always equals 1.0 for the most successful form). Realize that this is an example of very intense natural selection, as the most fit genotype is producing five times as many offspring as the less fit genotype. If $w = 0.20$, then $s = 1 - 0.20 = 0.80$. Let's begin with an intermediate frequency of the recessive allele of $q = 0.60$ and see how the allele frequency changes from one generation to the next. The change in the frequency of of the recessive allele, $\Delta q = -spq^2/(1 - sq^2)$, =

$-0.80(0.40)(0.60)^2/(1 - 0.80(0.60))^2 = -0.1152/(1 - 0.288) = -0.1618$. Thus q for the next generation is 0.60 - 0.1618 = 0.4382. This dramatic decrease in the frequency of the recessive allele occurs because the fitness of the homozygous individual is so low.

Intuitively, do you think evolutionary change will be most rapid at high, intermediate (as in our example), or low frequencies of the recessive allele? Haldane was particularly interested in how fast evolutionary change should occur under different conditions. Help him solve this problem, and test your intuition by using his formula to determine if Δq is greatest at high, intermediate, or low frequencies of the recessive allele.

7. Reflect on this article. Did you find it interesting? Did it help your understanding of Hardy-Weinberg or of the scientific process? Would you recommend this article to other students?
