Hardy Weinberg Equilibrium Worksheet
BIOL 01104 Fall 2019, Dr. Spielman

Scenario 1

Wing coloration in the scarlet tiger moth is governed by a single gene with two alleles, A and a, where each genotype has the given phenotype.

- Genotype **AA** individuals have white spots.
- Genotype **Aa** have intermediate-colored spots.
- Genotype **aa** have no spots at all.

This phenotype-genotype relationship provides an example of a *phenotypic incomplete dominance*, under *balancing* natural selection. Researchers studying a population of these moths found the following numbers of individuals for each phenotype (genotype): white-spotted (AA) = 1470, intermediate spots (Aa) = 140, and no spots (aa) = 10. $N = 1620$

1. Calculate the values for *p* (frequency of allele "A") and *q* (frequency of allele "a") . Confirm you are correct by checking that *p+q=1*.

$p: \frac{1470 + 140/2}{1620} = 0.95$

$q: \frac{140/2 + 10}{1620} = 0.05$

AA Aa aa

2. Calculate the ***expected NUMBER*** of individuals for each genotype using the formula $p^2 + 2pq + q^2$. (Hint: this formula will give you the expected <u>frequencies</u> of genotypes. You must multiply by the total number of individuals to get the <u>expected number</u>.)

$p^2 \times N = 0.95^2 \times 1620 = 1462.05$

$2pq \times N = 2 * 0.95 \times 0.05 \times 1620 = 153.9$ → means, for example ..... if population is in HWE (no evolution!), there would be ~154 Aa individuals in a population of 1620.

$q^2 \times N = 0.05^2 \times 1620 = 4.05$

3. Use the expected and observed **numbers** (not frequencies!) of individuals to calculate X^2 .

$X^2 = \sum \frac{(O-E)^2}{E}$ ← add up all genotypes

AA: $\frac{(1470 - 1462.05)^2}{1462.05} = 0.043$

Aa: $+ \frac{(140 - 153.9)^2}{153.9} = 1.26$

aa: $+ \frac{(10 - 4.05)^2}{4.05} = 8.74$

$= 10.04$

4. Determine your p-value from your X^2 calculation. Is there evidence that the population is evolving, or is it more likely under Hardy Weinberg Equilibrium?

Since $\chi^2 = 10.04$, $P < 0.05$

Evidence that population is evolving and NOT in HWE.

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Scenario 2

You are studying an elusive population of blast-ended skrewts, who show heritable variation in their attack phenotypes - some preferentially shoot fire at and some preferentially sting their prey. You have further determined that this trait is controlled by a single gene, F/f (for fire!), such that:

- Genotype **FF and Ff** individuals shoot fire.
- Genotype **ff** individuals sting.

With a brave crew of research volunteers, you journey into the Forbidden Forest and take a small sample (very carefully!) from their tails to determine their genotypes. In the end, you found 250 skrewts with the following genotypes: 119 FF, 107 Ff, and 24 ff. $N = 250$

1. Calculate the values for *p* (frequency of allele "F") and *q* (frequency of allele "f") . Confirm you are correct by checking that $p+q=1$.

$$p = \frac{119 + 107/2}{250} = 0.69$$

$$q = \frac{107/2 + 24}{250} = 0.31$$

2. Calculate the expected NUMBER of individuals for each genotype using the formula $p^2 + 2pq + q^2$.

$$p^2 \times N = 0.69^2 \times 250 = 119.025$$

$$2pq \times N = 2 \times 0.69 \times 0.31 \times 250 = 106.75$$

$$q^2 \times N = 0.31^2 \times 250 = 24.025$$

3. Use the expected and observed numbers of individuals to calculate X^2. $\frac{\Sigma(O-E)^2}{E}$

FF

$$\frac{(119-119.025)^2}{119.025} + \frac{(107-106.75)^2}{106.75} + \frac{(24-24.025)^2}{24.025} =$$

$$\sim 5 \times 10^{-5}$$

4. Determine your p-value from your X^2 calculation. Is there evidence that the population is evolving, or is it more likely under Hardy Weinberg Equilibrium?

$P > 0.05$

No evidence that the population is evolving.

Probably in HWE.