Lecture 12

See web site; Article 12
Reading from Futuyma, part of chap.
9, ‘Evolution’ (Sinauer)

Ecological Theater and Evolutionary Play

Ecology Now, Evolution Over Time
Ecology

Evolutionary Ecology

Evolution

Related Fields, Shared Questions

Evolution (population genetic sense)

Genetic change.

Measured as change in allele frequency over time.

Purpose of Hardy-Weinberg Law

To answer the following question: In a population with known allele frequencies at time t, what will the genotype frequencies be at generation t+1?

We will extend this to answer the evolutionary question: Given allele frequencies p and q at time t, what are the allele frequencies at time t+1? (Has there been evolution?)
A population contains 2 alleles, \(B_1\) and \(B_2\), for a flower color gene in mountain laurel. The \(B_1\) allele is dominant over the \(B_2\) allele, and \(B_1\) codes for a pigment producing a dark pink flower (\(B_1B_2\) is light pink). The genotype frequencies are \(F_{11}=.2\), \(F_{12}=.4\) and \(F_{22}=.4\) at the present time. Assume the Hardy-Weinberg Law holds.

1. What is the allele frequency, \(p\), in the current generation? (A) 0.2, (B) 0.3, (C) 0.4, (D) 0.5, (E) 0.6

2. What will the frequency of heterozygotes be in the next generation? (A) 0.04, (B) 0.24, (C) 0.36, (D) 0.48, (E) 0.64

3. What percent of the population will be dark pink in the next generation? (A) 0.24, (B) 0.48, (C) 0.64, (D) 0.86, (E) I don’t know how to calculate this…
Simplifying assumptions

1
2
3
4
5
6

Hardy-Weinberg Law

Matching socks in a drawer rule...

The Hardy-Weinberg Law
Evolution

► Evolution = ______________________________

► What does the Hardy-Weinberg Law predict about allele frequency change?

Finding Allele Freq. Change

H-W and Evolution

► At any one point in time:
Allele frequency change

Hardy Weinberg Review

- The H-W Law predicts genotype frequencies \((t+1)\) from allele frequencies \((t)\)
- Combined with the relationship between allele and genotype frequencies within generations, we can solve H-W problems.

<table>
<thead>
<tr>
<th>Allele Frequency</th>
<th>Genotype Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(p)</td>
<td>(F_{11})</td>
</tr>
<tr>
<td>(q)</td>
<td>(F_{22})</td>
</tr>
<tr>
<td>(2pq)</td>
<td>(F_{12})</td>
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</tbody>
</table>

Sample Problem - revisited

- A population contains 2 alleles, \(B_1\) and \(B_2\), for a flower color gene in mountain laurel. The \(B_1\) allele is dominant over the \(B_2\) allele, and codes for a pigment producing a dark pink flower (\(B_1B_1\) is light pink). The genotype frequencies are \(F_{11}=0.2\), \(F_{12}=0.4\) and \(F_{22}=0.4\) at the present time. Assume Hardy-Weinberg assumptions are met.
  - 1. What is the allele frequency, \(p\), in the current generation?
  - 2. What will the frequency of heterozygotes be in the next generation?
  - 3. What percent of the population will be dark pink in the next generation?
Clicker Problem – Hardy-Weinberg

The height of anthers in *Primula vulgaris* is controlled by gene A. Genotype AA or Aa produces a tall anther, while aa produces a short anther. A population is presently in Hardy-Weinberg equilibrium and the frequency of plants with short anthers is 36%.

1. What is the frequency (p) of the A allele in the population? (A) 0.36 (B) 0.40 (C) 0.60, (D) 0.64, (E) 1

Clicker Problem 2

The height of anthers in *Primula vulgaris* is controlled by gene A. Genotype AA or Aa produces a tall anther, while aa produces a short anther. A population is presently in Hardy-Weinberg equilibrium and the frequency of plants with short anthers is 36%.

2. What will the frequency of genotype Aa be in the next generation? (A) 0.16, (B) 0.24, (C) 0.36, (D) 0.48, (E) 0.72

Clicker Problem 3

The height of anthers in *Primula vulgaris* is controlled by gene A. Genotype AA or Aa produces a tall anther, while aa produces a short anther. A population is presently in Hardy-Weinberg equilibrium and the frequency of plants with short anthers is 36%.

3. What will the frequency of tall anthers be in the next generation? (A) 0.16, (B) 0.48, (C) 0.64, (D) 0.72 (E) 1
1. What is the frequency (p) of allele D in the population in the gene pool above?
   - (A) .6125
   - (B) .59375
   - (C) .52145
   - (D) .48625
   - (E) .40625

2. What is $F_1$?
   - (A) .4375
   - (B) .25
   - (C) .3125
   - (D) .40625
   - (E) cannot be calculated with the information given

3. Is this population already in Hardy-Weinberg equilibrium?
   - (A) Yes.
   - (B) No. At present there are too many heterozygotes and not enough homozygotes
   - (C) No. At present there are too few heterozygotes and too many homozygotes
   - (D) No. At present there are too many DD, but not enough Dd and dd
   - (E) No. At present there are too few DD, Dd, and dd
Yet another

If the Hardy-Weinberg assumptions are met for one generation, what change in allele frequency $p$ would be expected between $t$ and $t+1$?

(A) 0
(B) -.1260
(C) -.2225
(D) +.04665
(E) +.0625

Reiteration of Hardy-Weinberg conclusions

In large populations of a species with a simple life history, and no differential fitness of individuals carrying different genes:

- genotype frequencies will be $p^2, 2pq, q^2$
- these genotype frequencies will be reached after 1 generation of random mating
- populations will not evolve in terms of allele frequency

Hardy-Weinberg

* Is the fundamental theorem of population genetics
* Relaxing Hardy-Weinberg assumptions one at a time allows us to develop evolutionary models