In the year 2374, humans finally developed the technology necessary for time travels. You are a scientist interested in the population genetics of extinct animals. Taking advantage of this technological advance, you decide to go to the past 8 million years to conduct a field work in Venezuela to study a population of *Phoberomys pattersoni*, the world’s largest extinct rodent weighing approximately 700 kg (1500 lb) and looking vaguely like a giant guinea pig. The coat color of this rodent varies between tan (dominant) and brown (recessive). Assume the population is in Hardy-Weinberg equilibrium. You observed 336 tan *Phoberomys* and 64 brown *Phoberomys* during your study.

a) What is the frequency of the homozygous recessive genotype?

There are 336 + 64 = 400 animals in the population. 64 are homozygous recessive (brown)

Frequency of homozygous recessive = \(q^2 = \frac{64}{400} = 0.16\)

b) What is the allelic frequency of the dominant (tan) allele in the population?

Since \(q^2 = 0.16\), take the square root to get \(q = 0.4\)

Remember that \(p + q = 1\) (formula for allele frequencies)

Frequency of the dominant allele \(p = 0.6\)

c) Of the animals you observed, how many were heterozygous?

Frequency of heterozygote genotypes = \(2pq\)

\[2pq = (2)(0.6)(0.4) = 0.48\]

Multiply the frequency by the total population size to get the number of animals: \((0.48)(400) = 192\)

You make another trip to Venezuela and this time you observe 650 animals.

d) How many of the 650 animals would you expect to be tan, assuming the population is still in Hardy-Weinberg equilibrium?

If the population is still in H-W equilibrium, then the allele frequencies would be the same: \(p = 0.6\), \(q = 0.4\)

The tan phenotype is produced by 2 genotypes, homozygous dominant and heterozygous

Frequency of these genotypes is \(p^2\) and \(2pq\)

\[p^2 = (0.6)^2 = 0.36\] and \[2pq = (2)(0.6)(0.4) = 0.48\]

Multiple each of these frequencies by the total population size \((0.36)(650) = 234\), and \((0.48)(650) = 312\). Then, \(234 + 312 = 546\) tan

e) How many of these tan animals are homozygous for the dominant allele?

We calculated this in the previous problem:

\[p^2 = (0.6)^2 = 0.36\], and then we multiply the genotypic frequency by the total population:

\[(0.36)(650) = 234\]

f) How many of these 650 animals would you expect to be brown, assuming the population is still in Hardy-Weinberg equilibrium?

Brown animals are homozygous recessive Frequency of brown is \(q^2 = (0.4)^2 = 0.16\)

Multiply the frequency by the total population size \((0.16)(650) = 104\)
g) As you observe the animals, you count 200 brown *Phoberomys* and 450 tan. Conduct a chi-square test to determine if your observations are significantly different from what you expect.

<table>
<thead>
<tr>
<th></th>
<th>Observed</th>
<th>Expected</th>
<th>(O-E)^2</th>
<th>(O-E)^2/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tan</td>
<td>450</td>
<td>546</td>
<td>9216</td>
<td>16.88</td>
</tr>
<tr>
<td>Brown</td>
<td>200</td>
<td>104</td>
<td>9216</td>
<td>88.62</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>105.5</strong></td>
</tr>
</tbody>
</table>

The calculated $X^2$ is 105.5  
There are 2 phenotypes (brown and tan), so there is 1 degree of freedom ($2 - 1 = 1$)  
The theoretical $X^2$ for 1 degree of freedom is 3.841, which is much smaller than our calculated one. Therefore, we reject the null hypothesis that the population of 650 is in H-W equilibrium. Our observations are significantly different from our expectation, assuming H-W equilibrium.

h) What does your result in #7 mean in terms of the genetic composition of this population of *Phoberomys*?  
The chi-square test tells us that this population is not in H-W equilibrium with the population that we first observed. This means that evolution has been occurring – at least one of the assumptions of H-W equilibrium is not being met. Perhaps natural selection is occurring, or perhaps there has been some gene flow. We don’t know how the H-W equilibrium has been violated, but we do know that the genetic composition of this population is different from that of the original population of 400.