3rd lecture

Factors Affecting Gene Frequency

Lecturer: Kamaran Mustafa Taha

M.Sc. Animal Molecular Genetics , 2015

Subject: Animal Breeding, 3rd stage

Agricultural Engineering Sciences - Animal Resources Dept.

E. mail: kamaran.taha@su.edu.krd

Factors affecting gene frequency:

Gene frequencies tend to remain constant from generation to generation when disturbing factors are not present.

These factors disturb the natural equilibrium of **gene frequencies.**

These factors are called **evolutionary factors**

1. Mutation:

A mutation is a **spontaneous** **(NOT INDUCED)??** change in the gene frequency that takes place in a population and occurs at a low rate, random, natural.

The definition from the animal breeder view:

- Most cases of the mutations are recessive (lethal).
- It is according to the existence of modifier genes.

$$A \underset{v}{\overset{u}{\rightleftharpoons}} A'$$

Suppose the gene A could mutate to A' by **u** rate, and the gene A' could mutant to A by **v** rate.

The number of genes mutating from A to A' are equals to the number of genes operating in the opposite side.

$$pu = qv$$
$$p+q = 1$$
$$(1-q)u = qv$$
$$u-qu = qv$$
$$u = qv + qu$$
$$u = q\,(v+u)$$
$$q = u \,/\, (v+u)$$

Example (1): Calculate q_A in H.W. equilibrium in case of:

$u = 1 \times 10^{-5}$ $v = 1 \times 10^{-6}$

$q = u / (v+u) = 1 \times 10^{-5}/(1 \times 10^{-6} + 1 \times 10^{-5})$

= 0.00001 / (0.000001 + 0.00001) = 0.00001/0.000011 = 0.9

PA' = 1 - 0.9 = 0.1

(what does 1×10^{-6} mean??)

it means that a mutation for a particular gene will occur once every million cells per generation, or once in every million base pairs of DNA per generation.

2. <u>Migration:</u>

the movement of individuals from one population to another.

It is considered to be a major force in changing G.F. of a population. Suppose we have a large diversity in G.F. between two population:

q1= mqm + (1-m)qo

= mqm + qo-mqo

= m(qm- qo) + qo

q1: is g.f. of the Immigration population

qo: is g.f. of the Native population.

m: is the portion of the Migrated animals,

1-m: is the portion of the Native animal.

The more (q1 - qo) the more important migration force will be.

Δq = q1 - qo

= m(qm-qo) + qo - qo = m(qm-qo)

Δq = m(qm - qo) : change in g.f. rate.

q1 = mqm + (1-m)qo : g.f. in the population after migration.

Example 1: A group of breeding animals were imported from U.K. which was ¼ of the flock there. By random mating with our native animals, what was the **G.F**. of the immigrant animals, if you know that **G.F**. before immigration was 0.4 and was 0.5 after it.

$q1 = mqm + (1\text{-}m)qo$

$0.5 = ¼\ qm + (3/4)o.4$

$¼\ qm = 0.5 - 0.3 = 0.2$

$qm = 0.2 \text{ X } 4 = 0.8$

q1: is g.f. of the Immigration population
qo: is g.f. of the Native population.
m: is the portion of the Migrated animals,
1-m: is the portion of the Native animal.

Example 2: Suppose we have 10 animals from a population in the random mating with g.f = 0.8 and then they added to another group containing 90 animals with g.f. = 0.6. What will be the gene frequency if they matted randomly?

$\Delta q = m(qm - qo)$

$\Delta q = 0.1(0.8 - 0.6)$

$\Delta = 0.1 \text{ X } 0.2$

$= 0.02$

$q1= mqm + (1 -m)qo$

$= (0.1)(0.8) + (0.9)(0.6)$

$= 0.08 + 0.54 = 0.62$

$\Delta q= q1\text{-}qo = 0.62\text{-}0.6 = 0.02$

3. Selection:

It is the most important effective in changing gene frequency due to the fact that individuals differ in viability and fertility

therefore, they contribute different numbers of offspring to the next generation.

In this way, selection causes a change of gene frequency and consequently also of genotype frequency.

Selection was done usually by choosing the best individuals in the flock to be parents of the next generation depending on their phenotype

pedigree or progeny or by using selection index where selection was for more than one trait.

For example: if we have a X population with genotype array:

AA	Aa	aa
(1) 0.25	(2)0.5	(1)0.25

and when we select parents in a ratio of 3:2:1 for AA, Aa and aa respectively,
that mean we select the individuals with allele A and against the recessive allele a.
This called ***selection intensity (s)***, and sometimes called coefficient of selection
defined as the strength of the selection,
which is the proportionate reduction in the gametic contribution of a particular genotype compared with a standard genotype usually the most favored.
Selection was studied as a factor affecting gene frequency according to the degree of dominance:

Example

Genotype	BB	Bb	bb
performance	2.5	2.5	2.0
Frequency	720	960	320

$$pB = \frac{2\times720+920}{2\times2000} = 0.60$$

qb= 1- 0.60 = 0.40

Genotype	BB	Bb	bb
Frequency	720	960	~~320~~

$$pB = \frac{2\times720+960}{2(720+960)} = 0.70$$

qb= 1- 0.70 = 0.30

	B (0.7)	b (0.3)
B (0.7)	BB 0.49	Bb 0.21
b (0.3)	Bb 0.21	bb 0.09

Genotype	BB	Bb	bb
Frequency	0.49	0.42	0.09

4. Genetic or random drift:

The random changes (by a chance) of gene frequency are called random drift.

Depends on the size of the population, the smaller the population the bigger the effect of chance.

In any group of individuals differential fertility and fecundity will lead to variation in family size.

Types of random drift:

- Bottle neck effect
- Founder effect

Example: Suppose that $q_A = 0.8$ in a population under H.W. equilibrium. What will be the mutation rate from A to A' if the opposite mutation rate from A' to A is 3×10^{-6}.

Example: Suppose we have two populations A and B with G.F. 0.25 and 0.30 respectively. The ratio of imported animals from A to B will be 1/5. What will be the gene frequency in the new population?

Example: Suppose we have 500 animals from population in the random mating with G.F(0.4)and they added to next population 100 animal with q (0.6) calculate (G .F) after migration and change of (G.F)?