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HARDY WEINBERG Law

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EVOLUTION

Hardy Weinberg law

The theory describing the genetypic equilibrium based on stable gene frequencies and random mating is known as the Hardy-weinberg law. This is the foundation the arum of population genetics. Its main contribution to evolutionary thought lies in demonstrating that genetic differences in a randomly breeding population end to remain constent unless acted on by external forces.

Historical View → Following the publication of "on the origin of species" Darwin proposed that natural selection operated on small continuous hereditary variations while galton and others maintain that variations were sharp & discontinous. The controversy resolved when researches showed that several genes, each with small effect can influence the expression of a single phenotype trait that has a large effect. By 1930 it was clear that evolution is population phenomenon that we can represent as a charge in gene-frequencies in a population because of the action of various natural forces such as selection and genetic drift and this changes can lead to different among races, species and higher taxa. Gene frequencies and the gene pool are two major attributes of a population. Population can be defined as a group of potentially inbreeding organisms. gene frequency is the ratio of the different alles of a gene in a population without regards to their homozygosity or hetrozygosity. A gene pool consist of all alleles in the gametes of a population and there fore represents all the genes aviable for the next generation.

Hardy – Weinberg – Principle :

The conversion of allele (gene) and allele frequencies in large populations under conditions of random mating and in the absence of evolutionary forces, such as selection, migration and genetic drift, which act to change allele frequencies.

At first in 1908 both Hardy in England and Weinberg in Germany disproved the argument against normal Mendelian segregation in population. They demonstrated that gene frequencies do not depend on dominance or recessiveness but remain essentially unchanged from one generation to the next under certain conditions.

The following tables outlines major assumptions and steps in the Hardy – Weinberg – Principle.

Assumptions	Steps
(1) Parents represent a random sample of the gene frequencies in the population	
(2) genes segregate normally into gametes (Heterozygotes) for any gene pair produce their two kinds of gametes in equal frequencies.	A. Provide gene frequencies in gametes.
(3) Parents are equally fertile (gametes are produced according to the frequencies of the parents)	
(4) Gametes are equally fertile (all have an equal chance of becoming a zygote).	B. Provides gene frequencies in gametes.
(5) The population is very large (all the possible kinds of zygotes will be formed in frequencies determined by the gametic frequencies.	C. Provides gene frequency in the gamete that form the zygote.

(6) Mating between gametes is random (not determined by any preferences associated with specific genotypes.

(7) Gene frequencies are the same in both ♂ and ♀ parents.

D. Provides genotype frequencies in the zygote

↓

(8) All genotypes have equal reproductive ability

E. Provides genotype frequencies in adult progeny produced by zygotes.

↓

F. Repeat of steps A B C D E etc.

Populations of Gene Frequencies :—

Gene frequencies are simply the proportion of the different alleles of a gene in a population. To get these proportions, we count the total no. of organisms with various genotypes in the population and estimate the relative frequencies of the alleles involved. Of course except for gametes and occasional mutation, the genetic components of all cell in a multicellular organism are the same. We may therefore adopt the convention that a haploid organism has only one gene of any one locus, a diploid has two, a triploid three and so on.

Examples ⟶ Human's who can and cannot taste the phenylthio carbamide, resides in a single gene difference between the alleles T and t. Since the allele for tasting T, is dominant over t, two genotypes (Homozygous TT & Heterozygous Tt) represents tasters and the non-tasters are tt. A population of 200 Individuals composed of 90 TT, 60 Tt and 50 tt. We therefore have a total of 400 alleles at this locous.

TABLE – I

Technique for obtaining gene frequencies for a diploid population of 200 individual.

(a) using numerical gene counts (there are 400 genes in 200 diploid individuals)

$T = 180\ (\text{in } TT) + 60\ (\text{in } Tt) = \frac{240}{400} = 0.60$

$t = 100\ (\text{in } tt) + 60\ (\text{in } Tt)\ \frac{160}{400} = 0.40$

Total ⟶ 1.00

(b) using genotype frequencies :—

$T = .45\ TT + \frac{1}{2}(30\ Tt) = .45 + .15 = .60$

$t = .25\ tt + \frac{1}{2}(30\ \text{in}\ Tt) = .25 + 1.5 = .40$

Total ⟶ 1.00

Note ⟶ these individuals are of the following types ⟶

90 TT + 60 Tt + 50 tt = 200 (individuals)

.45 TT + .30 Tt + .25 tt = 1.00 (genotypes)

CONSERVATION of gene frequencies :—

The Principle Hardy Weinberg discovered may be simply illustrated using the testing example mentioned above.

Let us, for instance, place on a island a group of children in the ratio just given :— 4.5 TT / .30 tt / .25 tt,

where gene frequencies are there fore – .60 T and .40.

Let us also assume that the no. of individuals in this newly formed population is large and that tasting or non-tasting has no effect on survival (viability), fertility or attraction between the sexes.

As these children mature they will choose their mates at random from those of the opposite sex regardless of their tasting abilities. We can then predict mating between any two genotypes solely on the basis of the genotype frequencies in the population. The following tables shows nine different types of mating can occurs, of which three mating are reciprocals of other.

e.g. – Tt × tt = tt × TT)

TABLE II

Gene frequencies produced by random mating among individuals in a population having the frequencies given in Table I

TT = 4.5 Tt = 30 tt = 2.5

TT = .45	2025	.1350	.1125
♀ Tt = .30	13504	.0900	.0750
tt = .25	.1125	.750	.0625

✱ PARENTS

Mating of genotypes	Box no. from above	mating frequencies TT	Of spring Tt tt
TT x TT	(1)	= .2025	0.2025
TT x Tt	(2)+(4)	= .2700	.1350 . 1350
TT x tt	(3) + (7)	= .2250	.2250
Tt x Tt	(5)	= 0.0900	.0025 .0450 .0225
Tt x tt	(6) + (8)	= .1500	0.0750 . 0750
tt x tt	(9)	= .0625	.0625
Total	=	1.0000	4800/3600 = .4800

= .1600

Gene Frequencies among Off Spring :—

T = .36 TT + 1/2 (.48 Tt) = .45 + .15 = .60

.25 + 15 = .40

Total = 1.00

Note that the random mating has altered the frequencies of genotypes, the gene frequencies among the off spring have not changed equilibrium.

Bionomical expansion :—

$(p + q)^2 \; p^2 + 2pv + v^2$

with any given pandu and random mating between genotypes, one generation of a population in which generations donot over laps enough to establish equilibrium for the frequencies of gene and genotypes, once established, the equilibrium will persists untill the gene frequencies are changed

Multinomial Expansion :—

If three are only three posible alleles of a locous A_1, A_2, A_3, with respective frequencies p, q and r so that the total 1. The Trinomical expansion of $(p + q + r)^2$ determines the genotype equilibrium frequencies.

Independently Assorting Genes :—

If there are two or more pairs of independently ossorting genes, there are many more possible genotype and the more gene pairs the longer it will take to achive over all genotype equilbrium.

Linked Genes :—

In the case of linkage the higher the frequency of recombination between linked genes the shorter the time needed to reach equilibrium.

When genes are linked on the X-chromosome, gene frequencies of equilibrium will be equal in both sexes, but this may take a no. of generations if frequencies between the two sexes differentially.

NATURAL POPULATION →:

We can determine genotype frequencies quite easily if no allele is dominant and such observations generaly show that equilibrium has been achived.

If on of the two alleles is dominant, we can get gene frequencies by assuming Handy - Weinberg equilibrium and using the frequencies of homozygous recessive individuals as q^2 in the genotype equlibrium formula. When we do this for various recessive conditions present in low frequencies the frequency of heterozygous (carrier) is surprisingly high.

CONCLUSIONS:-

Most sudies indicates that gene pools are quite stable and generally remain at equilibrium unless selection or some other conditions interfere.

Inbreeding do not affect gene frequencies but does increase homozygosity, allowing relatively rare recessive alleles to be expresed. If these alleles are harmful inbreeding depression may result.