Study of Hardy Weinberg law of Genetic Equilibrium, Salient Features and Significance of Hardy-Weinberg Law

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Abstract : The Hardy-Weinberg equilibrium is a principle stating that the genetic variation in a population will remain constant from one generation to the next in the absence of disturbing factors. When mating is random in a large population with no disruptive circumstances, the law predicts that both genotype and allele frequencies will remain constant because they are in equilibrium.

The Hardy-Weinberg equilibrium can be disturbed by a number of forces, including mutations, natural selection, nonrandom mating, genetic drift, and gene flow. For instance, mutations disrupt the equilibrium of allele frequencies by introducing new alleles into a population. Similarly, natural selection and nonrandom mating disrupt the Hardy-Weinberg equilibrium because they result in changes in gene frequencies. This occurs because certain alleles help or harm the reproductive success of the organisms that carry them. Another factor that can upset this equilibrium is genetic drift, which occurs when allele frequencies grow higher or lower by chance and typically takes place in small populations. Gene flow, which occurs when breeding between two populations transfers new alleles into a population, can also alter the Hardy-Weinberg equilibrium.

Because all of these disruptive forces commonly occur in nature, the Hardy-Weinberg equilibrium rarely applies in reality. Therefore, the Hardy-Weinberg equilibrium describes an idealized state, and genetic variations in nature can be measured as changes from this equilibrium state.

Key Words : Hardy-Weinberg Equilibrium, Genes, Alleles, Frequencies.

Hardy-Weinberg law depends on the following kinds of genetic equilibrium for its full attainment.

1. The population is infinitely large and mate at random.
2. No selection is operative.
3. No mutation is operative in alleles.
4. The-population is closed, i.e., no immigration or emigration occurs.
5. Meiosis is normal so that chance is the only factor operative in gametogenesis.

The law describes a theoretical situation in which a population is undergoing no evolu-tionary change. It explains that if evolutionary forces are absent; the population is large; its individuals have random mating, each parent produces roughly equal number of gametes and the gametes produced by the mating parents combine at random and the gene frequency remains constant; then the genetic equilibrium of the genes in question is maintained and the variability present in the population is preserved.

Calculations of The genotype frequencies :

The genotype frequencies are calculated using the square expansion of the allele frequencies. To illustrate this concept, assume that at some locus, A, you have two alleles, call them A1, and A2. Assume that the frequency of allele A1 is p and the frequency of allele A2 is q. We can write this as:

f(A1) = p f(A2) = q

Under Hardy-Weinberg conditions, the expected genotypic proportions in the population are

(p + q)2

The square expansion of allele frequencies when there are two alleles is p2 + 2pq + q2 meaning that: f(A1A1) = p2, f(A1A2) = 2pq, and f(A2A2) = q2

If there were a third allele, call it A3, and it was present at frequency r, then the expected genotypic proportions would be (p + q + r)2. In other words, the expected genotypic frequencies would be: f(A1A1) = p2, f(A2A2) = q2, f(A3A3) = r2 , f(A1A2) = 2pq, f(A1A3) = 2pr, and f(A2A3) = 2qr.

Salient Features of Hardy-Weinberg law:

1. The gene and genotype frequencies of each gene or allele in a population remain at an equilib-rium generation after generation.
2. In a population, the mating is a completely random phenomenon.
3. The equilibrium in the gene and genotype frequencies occurs only in large sized populations. In a small population gene frequencies may be unpredictable.
4. All the genotypes in a population reproduce equally successfully.
5. Particular alleles will neither be differentially added to nor differentially subtracted from a population.

Significance of Hardy-Weinberg Law:

The law is important primarily because it describes the situation in which there is no evolution, and thus it provides a theoretical baseline for measuring evolutionary change. The equilibrium tendency serves to conserve gains which have been made in the past and also to avoid too rapid changes; in other words, giving a genetic stability to the population.

The Hardy-Weinberg equation describes conditions that are not found in natural population. The function of the Hardy-Weinberg principle, and its equation, is as an experimental control— a prediction of what the allelic and genotypic frequencies should be if nothing acts to alter the gene pool. Thus, if q is known to be 0.40 then q2 in the next generation should be 0.16.

If instead it is 0.02, then we known that a change has occurred in the gene pool, the magnitude of that change, and that it was caused by: mutations, genetic drift, gene flow, assertive mating, or natural selection. We can then design experiments to test which of the five agents of change contributed most to the change in allelic and genotypic frequencies.

Importance of Hardy–Weinberg Proportions

Given the many assumptions needed to derive the Hardy–Weinberg Law, it may come as a surprise to learn that it plays a central role in the theory of population genetics. It does so for two reasons. First, it provides a way to estimate allele frequencies for a trait in which heterozygotes are indistinguishable from one of the homozygotes, provided we are willing to assume that all of the assumptions apply to the population in which we are interested. Second, it tells us what will happen in a population in the absence of any evolutionary forces. As the philosopher Elliott

Sober has pointed out, it plays a role in population genetic theory similar to the role that the first and second laws of motion play in Newtonian mechanics.

The first and second laws of motion tell us that an object at rest will tend to remain at rest and an object in motion will tend to remain in motion (in a straight line at a constant speed) unless acted on by outside forces. They are 'zero-force laws' that tell us what to expect when no forces are operating on an object. Moreover, they allow us to judge the magnitude and direction of any forces operating on an object by the acceleration to which it is subject.

The Hardy–Weinberg law is population genetics' zero-force law. It tells us what a population will look like if neither genetic drift nor any evolutionary forces affect it. If all of the assumptions of Hardy–Weinberg apply, then the population must have genotypes in Hardy–Weinberg proportions. Moreover, a single generation in which those assumptions apply is sufficient to put genotypes into those proportions, and neither the allele frequency nor the genotype frequencies will change so long as they continue to apply. If genotypes are not in Hardy–Weinberg proportions, then one or more of the assumptions must have been violated in this population, and the direction in which genotypes depart from Hardy–Weinberg proportions is often a clue to the cause of the departure. If, for example, fewer heterozygotes are observed than expected, some form of inbreeding is a likely cause.

It is important to remember, however, which inferences can be made with the Hardy–Weinberg law and which cannot:

1.If the assumptions apply, genotypes will be in Hardy–Weinberg proportions.

2.If genotypes are not in Hardy–Weinberg proportions, one or more of the assumptions has been violated.

Conclusion :

The Hardy-Weinberg Law offers a model that is often used as a starting point for studying the population genetics of diploid organisms that meets the basic assumptions of large population size, random-mating, and no migration, mutation, or selection. It is tempting to conclude that if genotypes are in Hardy–Weinberg proportions, all the assumptions apply. But this conclusion is not justified. Suppose, for example, genotypes differ in their ability to survive, but all the other assumptions apply. Then genotypes will be found in Hardy–Weinberg proportions among newly formed zygotes, but they will not be found in Hardy–Weinberg proportions in adults.

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