

SELECTION

Natural selection is the nonrandom process by which biologic traits become more or less common in a population as a function of differential reproduction of their bearers. It is a key mechanism of evolution.

The genetic variation within a population of organisms may cause some individuals to survive and reproduce more successfully than others. Factors which affect reproductive success are also important, an issue which Charles Darwin developed in his ideas on sexual selection.

Natural selection acts on the phenotype, or the observable characteristics of an organism, but the genetic (heritable) basis of any phenotype which gives a reproductive advantage will become more common in a population (see allele frequency). Over time, this process can result in adaptations that specialize populations for particular ecological niches and may eventually result in the emergence of new species. In other words, natural selection is an important process (though not the only process) by which evolution takes place within a population of organisms. As opposed to artificial selection, in which humans favor specific traits, in natural selection the environment acts as a sieve through which only certain variations can pass.

Natural selection is one of the cornerstones of modern biology. The term was introduced by Darwin in his influential 1859 book *On the Origin of Species*,^[1] in which natural selection was described as analogous to artificial selection, a process by which animals and plants with traits considered desirable by human breeders are systematically favored for reproduction. The concept of natural selection was originally developed in the absence of a valid theory of heredity; at the time of Darwin's writing, nothing was known of modern genetics. The union of traditional Darwinian evolution with subsequent discoveries in classical and molecular genetics is termed

the modern evolutionary synthesis. Natural selection remains the primary explanation for adaptive evolution.

General principles

Typica and *carbonaria* morphs resting on the same tree. The light-colored *typica* (below the bark's scar) is hard to see on this pollution-free tree, camouflaging it from predators such as Great Tits.

Natural variation occurs among the individuals of any population of organisms. Many of these differences do not affect survival (such as differences in eye color in humans), but some differences may improve the chances of survival of a particular individual. A rabbit that runs faster than others may be more likely to escape from predators, and algae that are more efficient at extracting energy from sunlight will grow faster. Something that increases an animal's survival will often also include its reproductive rate; however, sometimes there is a trade-off between survival and current reproduction. Ultimately, what matters is total lifetime reproduction of the animal.

If the traits that give these individuals a reproductive advantage are also heritable, that is, passed from parent to child, then there will be a slightly higher proportion of fast rabbits or efficient algae in the next generation. This is known as *differential reproduction*. Even if the reproductive advantage is very slight, over many generations any heritable advantage will become dominant in the population. In this way the natural environment of an organism "selects" for traits that confer a reproductive advantage, causing gradual changes or evolution of life. This effect was first described and named by Charles Darwin.

The concept of natural selection predates the understanding of genetics, the mechanism of heredity for all known life forms. In modern terms, selection acts on an organism's phenotype, or observable characteristics, but it is the organism's genetic make-up or genotype that is inherited. The phenotype is the result of the genotype and the environment in which the organism lives (Genotype-phenotype distinction).

This is the link between natural selection and genetics, as described in the modern evolutionary synthesis. Although a complete theory of evolution also requires an account of how genetic variation arises in the first place (such as by mutation and sexual reproduction) and includes other evolutionary mechanisms (such as genetic drift and gene flow), natural selection appears to be the most important mechanism for creating complex adaptations in nature.

Types of selection

Natural selection can act on any heritable phenotypic trait, and selective pressure can be produced by any aspect of the environment, including sexual selection and competition with members of the same or other species. However, this does not imply that natural selection is always directional and results in adaptive evolution; natural selection often results in the maintenance of the status quo by eliminating less fit variants.

The unit of selection can be the individual or it can be another level within the hierarchy of biological organization, such as genes, cells, and kin groups. There is still debate about whether natural selection acts at the level of groups or species to produce adaptations that benefit a larger, non-kin group. Likewise, there is debate as to whether selection at the molecular level prior to gene mutations and fertilization of the zygote should be ascribed to conventional natural selection because traditionally natural

selection is an environmental and exterior force that acts upon a phenotype typically after birth. Some science journalists distinguish natural selection from gene selection by informally referencing selection of mutations as "pre-selection." http://en.wikipedia.org/wiki/Natural_selection

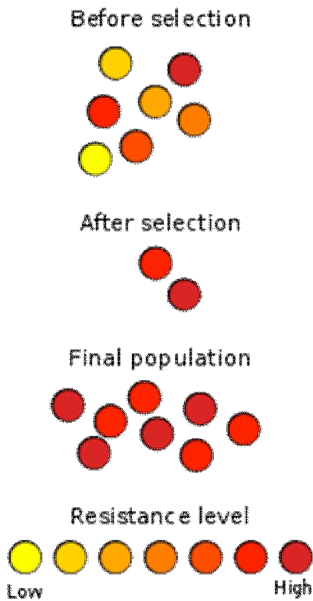
Selection at a different level such as the gene can result in an increase in fitness for that gene, while at the same time reducing the fitness of the individuals carrying that gene, in a process called intragenomic conflict. Overall, the combined effect of all selection pressures at various levels determines the overall fitness of an individual, and hence the outcome of natural selection.

The life cycle of a sexually reproducing organism. Various components of natural selection are indicated for each life stage.

Natural selection occurs at every life stage of an individual. An individual organism must survive until adulthood before it can reproduce, and selection of those that reach this stage is called *viability selection*. In many species, adults must compete with each other for mates via sexual selection, and success in this competition determines who will parent the next generation. When individuals can reproduce more than once, a longer survival in the reproductive phase increases the number of offspring, called *survival selection*.

The fecundity of both females and males (for example, giant sperm in certain species of *Drosophila*) can be limited via "fecundity selection". The viability of produced gametes can differ, while intragenomic conflicts such as meiotic drive between the haploid gametes can result in gametic or "genic selection". Finally, the union of some combinations of eggs and sperm might be more compatible than others; this is termed *compatibility selection*.

Examples of natural selection



Resistance to antibiotics is increased through the survival of individuals which are immune to the effects of the antibiotic, whose offspring then inherit the resistance, creating a new population of resistant bacteria.

A well-known example of natural selection in action is the development of antibiotic resistance in microorganisms. Since the discovery of penicillin in 1928 by Alexander Fleming, antibiotics have been used to fight bacterial diseases. Natural populations of bacteria contain, among their vast numbers of individual members, considerable variation in their genetic material, primarily as the result of mutations. When exposed to antibiotics, most bacteria die quickly, but some may have mutations that make them slightly less susceptible. If the exposure to antibiotics is short, these individuals will survive the treatment. This selective elimination of maladapted individuals from a population is natural selection.

These surviving bacteria will then reproduce again, producing the next generation. Due to the elimination of the maladapted individuals in the past generation, this population contains more bacteria that have some resistance against the antibiotic. At the same time, new mutations

occur, contributing new genetic variation to the existing genetic variation. Spontaneous mutations are very rare, and advantageous mutations are even rarer. However, populations of bacteria are large enough that a few individuals will have beneficial mutations. If a new mutation reduces their susceptibility to an antibiotic, these individuals are more likely to survive when next confronted with that antibiotic.

Given enough time, and repeated exposure to the antibiotic, a population of antibiotic-resistant bacteria will emerge. This new changed population of antibiotic-resistant bacteria is optimally adapted to the context it evolved in. At the same time, it is not necessarily optimally adapted any more to the old antibiotic free environment. The end result of natural selection is two populations that are both optimally adapted to their specific environment, while both perform substandard in the other environment.

The widespread use and misuse of antibiotics has resulted in increased microbial resistance to antibiotics in clinical use, to the point that the methicillin-resistant *Staphylococcus aureus* (MRSA) has been described as a "superbug" because of the threat it poses to health and its relative invulnerability to existing drugs.http://en.wikipedia.org/wiki/Natural_selection Response strategies typically include the use of different, stronger antibiotics; however, new strains of MRSA have recently emerged that are resistant even to these drugs.¹

This is an example of what is known as an evolutionary arms race, in which bacteria continue to develop strains that are less susceptible to antibiotics, while medical researchers continue to develop new antibiotics that can kill them. A similar situation occurs with pesticide resistance in plants and insects. Arms races are not necessarily induced by man; a well-documented example involves the spread of a gene in the butterfly *Hypolimnas bolina* suppressing male-killing

activity by Wolbachia bacteria parasites on the island of Samoa, where the spread of the gene is known to have occurred over a period of just five years

Evolution by means of natural selection

A prerequisite for natural selection to result in adaptive evolution, novel traits and speciation, is the presence of heritable genetic variation that results in fitness differences. Genetic variation is the result of mutations, recombinations and alterations in the karyotype (the number, shape, size and internal arrangement of the chromosomes). Any of these changes might have an effect that is highly advantageous or highly disadvantageous, but large effects are very rare. In the past, most changes in the genetic material were considered neutral or close to neutral because they occurred in noncoding DNA or resulted in a synonymous substitution. However, recent research suggests that many mutations in non-coding DNA do have slight deleterious effects.http://en.wikipedia.org/wiki/Natural_selection Although both mutation rates and average fitness effects of mutations are dependent on the organism, estimates from data in humans have found that a majority of mutations are slightly deleterious.http://en.wikipedia.org/wiki/Natural_selection



The exuberant tail of the peacock is thought to be the result of sexual selection by females. This peacock is an albino; selection against albinos in nature is intense because they are easily spotted by predators or are unsuccessful in competition for mates.

By the definition of fitness, individuals with greater fitness are more likely to contribute offspring to the next generation, while individuals with lesser fitness are more likely to die early or fail to reproduce. As a result, alleles which on average result in greater fitness become more abundant in the next generation, while alleles which generally reduce fitness become rarer. If the selection forces remain the same for many generations, beneficial alleles become more and more abundant, until they dominate the population, while alleles with a lesser fitness disappear. In every generation, new mutations and re-combinations arise spontaneously, producing a new spectrum of phenotypes. Therefore, each new generation will be enriched by the increasing abundance of alleles that contribute to those traits that were favored by selection, enhancing these traits over successive generations.

Established traits are not immutable; traits that have high fitness in one environmental context may be much less fit if environmental conditions change. In the absence of natural selection to preserve such a trait, it will become more variable and deteriorate over time, possibly resulting in a vestigial manifestation of the trait, also called evolutionary baggage. In many circumstances, the apparently vestigial structure may retain a limited functionality, or may be co-opted for other advantageous traits in a phenomenon known as preadaptation. A famous example of a vestigial structure, the eye of the blind mole rat, is believed to retain function in photoperiod perception.http://en.wikipedia.org/wiki/Natural_selection

Speciation

Speciation requires selective mating, which result in a reduced gene flow. Selective mating can be the result of 1. Geographic isolation, 2. Behavioral isolation, or 3. Temporal isolation. For example, a change in the physical environment (geographic isolation by an extrinsic barrier) would follow number 1, a change in camouflage for number 2 or a shift in mating times (i.e., one species of deer shifts location and therefore changes its "rut") for number 3.

Over time, these subgroups might diverge radically to become different species, either because of differences in selection pressures on the different subgroups, or because different mutations arise spontaneously in the different populations, or because of founder effects – some potentially beneficial alleles may, by chance, be present in only one or other of two subgroups when they first become separated. A lesser-known mechanism of speciation occurs via hybridization, well-documented in plants and occasionally observed in species-rich groups of animals such as cichlid fishes. http://en.wikipedia.org/wiki/Natural_selection Such mechanisms of rapid speciation can reflect a mechanism of evolutionary change known as punctuated equilibrium, which suggests that evolutionary change and particularly speciation typically happens quickly after interrupting long periods of stasis.

Genetic changes within groups result in increasing incompatibility between the genomes of the two subgroups, thus reducing gene flow between the groups. Gene flow will effectively cease when the distinctive mutations characterizing each subgroup become fixed. As few as two mutations can result in speciation: if each mutation has a neutral or positive effect on fitness when they occur separately, but a negative effect when they occur together, then fixation of these genes in the respective subgroups will lead to two

reproductively isolated populations. According to the biological species concept, these will be two different species.

Historical development



The modern theory of natural selection derives from the work of Charles Darwin in the nineteenth century.

Pre-Darwinian theories

Several ancient philosophers expressed the idea that nature produces a huge variety of creatures, apparently randomly, and that only those creatures survive that manage to provide for themselves and reproduce successfully; well-known examples include Empedocles and his intellectual successor, Lucretius, http://en.wikipedia.org/wiki/Natural_selection while related ideas were later refined by Aristotle. The struggle for existence was later described by Al-Jahiz, who argued that environmental factors influence animals to develop new characteristics to ensure survival

Abu Rayhan Biruni described the idea of artificial selection and argued that nature works in much the same way. Such classical arguments were reintroduced in the 18th century by Pierre Louis Maupertuis and others, including Charles Darwin's grandfather Erasmus Darwin. While these forerunners had an influence on Darwinism, they later had little influence on the trajectory of evolutionary thought after Charles Darwin.

Until the early 19th century, the prevailing view in Western societies was that differences between individuals of a species were uninteresting departures from their Platonic idealism (or typus) of created kinds. However, the theory of uniformitarianism in geology promoted the idea that simple, weak forces could act continuously over long periods of time to produce radical changes in the Earth's landscape. The success of this theory raised awareness of the vast scale of geological time and made plausible the idea that tiny, virtually imperceptible changes in successive generations could produce consequences on the scale of differences between species.

Early 19th century evolutionists such as Jean Baptiste Lamarck suggested the inheritance of acquired characteristics as a mechanism for evolutionary change; adaptive traits acquired by an organism during its lifetime could be inherited by that organism's progeny, eventually causing transmutation of species. This theory has come to be known as Lamarckism and was an influence on the anti-genetic ideas of the Stalinist Soviet biologist Trofim Lysenko.http://en.wikipedia.org/wiki/Natural_selection

Darwin's theory

In 1859, Charles Darwin set out his theory of evolution by natural selection as an explanation for adaptation and speciation. He defined natural selection as the "principle by which each slight variation [of a trait], if useful, is

preserved".http://en.wikipedia.org/wiki/Natural_selection The concept was simple but powerful: individuals best adapted to their environments are more likely to survive and reproduce. As long as there is some variation between them, there will be an inevitable selection of individuals with the most advantageous variations. If the variations are inherited, then differential reproductive success will lead to a progressive evolution of particular populations of a species, and populations that evolve to be sufficiently different eventually become different species.

Darwin's ideas were inspired by the observations that he had made on the *Beagle voyage*, and by the work of a political economist, the Reverend Thomas Malthus, who in *An Essay on the Principle of Population*, noted that population (if unchecked) increases exponentially whereas the food supply grows only arithmetically; thus inevitable limitations of resources would have demographic implications, leading to a "struggle for existence".http://en.wikipedia.org/wiki/Natural_selection When Darwin read Malthus in 1838 he was already primed by his work as a naturalist to appreciate the "struggle for existence" in nature and it struck him that as population outgrew resources, "favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species."

Here is Darwin's own summary of the idea, which can be found in the fourth chapter of the *Origin*:

If during the long course of ages and under varying conditions of life, organic beings vary at all in the several parts of their organization, and I think this cannot be disputed; if there be, owing to the high geometrical powers of increase of each species, at some age, season, or year, a severe struggle for life, and this certainly cannot be disputed; then, considering the infinite complexity of the relations of all organic beings to each other and to their conditions of existence, causing an infinite diversity in structure,

constitution, and habits, to be advantageous to them, I think it would be a most extraordinary fact if no variation ever had occurred useful to each being's own welfare, in the same way as so many variations have occurred useful to man. But if variations useful to any organic being do occur, assuredly individuals thus characterized will have the best chance of being preserved in the struggle for life; and from the strong principle of inheritance they will tend to produce offspring similarly characterized. This principle of preservation, I have called, for the sake of brevity, Natural Selection.

Once he had his theory "by which to work", Darwin was meticulous about gathering and refining evidence as his "prime hobby" before making his idea public. He was in the process of writing his "big book" to present his researches when the naturalist Alfred Russel Wallace independently conceived of the principle and described it in an essay he sent to Darwin to forward to Charles Lyell. Lyell and Joseph Dalton Hooker decided (without Wallace's knowledge) to present his essay together with unpublished writings which Darwin had sent to fellow naturalists, and *On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection* was read to the Linnean Society announcing co-discovery of the principle in July 1858. Darwin published a detailed account of his evidence and conclusions in *On the Origin of Species* in 1859. In the 3rd edition of 1861 Darwin acknowledged that others — notably William Charles Wells in 1813, and Patrick Matthew in 1831 — had proposed similar ideas, but had neither developed them nor presented them in notable scientific publications.

Darwin thought of natural selection by analogy to how farmers select crops or livestock for breeding, which he called "artificial selection"; in his early manuscripts he referred to a 'Nature' which would do the selection. At the time, other mechanisms of evolution such as evolution by genetic drift were not yet explicitly formulated, and Darwin believed that selection was likely

only part of the story. For Darwin and his contemporaries, natural selection was essentially synonymous with evolution by natural selection. After the publication of *On the Origin of Species*, educated people generally accepted that evolution had occurred in some form. However, natural selection remained controversial as a mechanism, partly because it was perceived to be too weak to explain the range of observed characteristics of living organisms, and partly because even supporters of evolution balked at its "unguided" and non-progressive nature,http://en.wikipedia.org/wiki/Natural_selection a response that has been characterized as the single most significant impediment to the idea's acceptance.http://en.wikipedia.org/wiki/Natural_selection

However, some thinkers enthusiastically embraced natural selection; after reading Darwin, Herbert Spencer introduced the term *survival of the fittest*, which became a popular summary of the theory.http://en.wikipedia.org/wiki/Natural_selection The fifth edition of *On the Origin of Species* published in 1869 included Spencer's phrase as an alternative to natural selection, with credit given: "But the expression often used by Mr. Herbert Spencer, of the Survival of the Fittest, is more accurate, and is sometimes equally convenient." Although the phrase is still often used by non-biologists, modern biologists avoid it because it is tautological if "fittest" is read to mean "functionally superior" and is applied to individuals rather than considered as an averaged quantity over populations.http://en.wikipedia.org/wiki/Natural_selection

Modern evolutionary synthesis

Natural selection relies crucially on the idea of heredity, but it was developed long before the basic concepts of genetics. Although the Austrian monk Gregor Mendel, the father of modern genetics, was a contemporary of Darwin's, his work would lie in

obscurity until the early 20th century. Only after the integration of Darwin's theory of evolution with a complex statistical appreciation of Gregor Mendel's 're-discovered' laws of inheritance did natural selection become generally accepted by scientists.

Methods of Selection

The choice of a selection method will determine the effectiveness of reaching a given goal in breeding. Plant Breeding is the conscious human effort needed to improve and develop new varieties of crop in order to satisfy the demands for human food and animal feed.

Objectives

- (i) To discuss the genetic concepts that may help breeders to choose appropriate breeding strategies for different situations.
- (ii) To discuss the different forms of plant material available and their possible uses in breeding programmes.
- (iii) To describe and compare different selection plans for developing useful cultivars

A breeder strategy is a breeding program set up to improve certain characteristics in a crop plant. It is very important to analyse specific crop problems in depth before starting a breeding programme in order to minimize the risk of wrong choices and unexpected results.

Characteristics of a breeding strategy such a breeding strategy should:

- (1) Make an impact on the agricultural development of a region e.g increase yield, insect/disease resistance.
- (2) Make economic, social and environmental impact on the people e.g better mechanization and commercialization of a crop, better growing conditions, smaller and cheap input and labour.

- (3) Have realistic objective - not abstract.
- (4) Be handled by a team of well-trained personnel

Selection and genetic variation

A portion of all genetic variation is functionally neutral in that it produces no phenotypic effect or significant difference in fitness; the hypothesis that this variation accounts for a large fraction of observed genetic diversity is known as the neutral theory of molecular evolution and was originated by Motoo Kimura. When genetic variation does not result in differences in fitness, selection cannot *directly* affect the frequency of such variation. As a result, the genetic variation at those sites will be higher than at sites where variation does influence fitness. However, after a period with no new mutation, the genetic variation at these sites will be eliminated due to genetic drift.

Mutation selection balance

Natural selection results in the reduction of genetic variation through the elimination of maladapted individuals and consequently of the mutations that caused the maladaptation. At the same time, new mutations occur, resulting in a mutation-selection balance. The exact outcome of the two processes depends both on the rate at which new mutations occur and on the strength of the natural selection, which is a function of how unfavorable the mutation proves to be. Consequently, changes in the mutation rate or the selection pressure will result in a different mutation-selection balance.

Genetic linkage

Genetic linkage occurs when the loci of two alleles are *linked*, or in close proximity to each other on the chromosome. During the formation of gametes, recombination of the genetic material results in reshuffling of the alleles. However, the chance that such a reshuffle occurs between two alleles depends on the distance between those alleles; the closer the alleles are to each other, the less likely it is that such a reshuffle will occur. Consequently, when selection targets one allele, this automatically results in selection of the other allele as well; through this mechanism, selection can have a strong influence on patterns of variation in the genome.

Selective sweeps occur when an allele becomes more common in a population as a result of positive selection. As the prevalence of one allele increases, linked alleles can also become more common, whether they are neutral or even slightly deleterious. This is called genetic hitchhiking. A strong selective sweep results in a region of the genome where the positively selected haplotype (the allele and its neighbours) are essentially the only ones that exist in the population.

Whether a selective sweep has occurred or not can be investigated by measuring linkage disequilibrium, or whether a given haplotype is overrepresented in the population. Normally, genetic recombination results in a reshuffling of the different alleles within a haplotype, and none of the haplotypes will dominate the population. However, during a selective sweep, selection for a specific allele will also result in selection of neighbouring alleles. Therefore, the presence of a block of strong linkage disequilibrium might indicate that there has been a 'recent' selective sweep near the center of the block, and this can be used to identify sites recently under selection.

Background selection is the opposite of a selective sweep. If a specific site experiences strong and persistent purifying selection, linked variation will tend to be weeded out along with it, producing a region in the genome of low overall variability. Because background selection is a result of deleterious new mutations, which can occur randomly in any haplotype, it does not produce clear blocks of linkage disequilibrium, although with low recombination it can still lead to slightly negative linkage disequilibrium overall.

Factors affecting Selection Methods

(a) *Reproductive system of the plant*

Self pollinating (autogamous) Vs Crossers (allogamous). Autogamous plants cannot be easily outcrossed to other plants due to functional or morphological barriers which have to be overcome by artificial techniques e.g emasculation. However, hybrids can be produced in certain self pollinating crops e.g. wheat, tomato, tobacco, cotton. Autogamous plants are homozygous.

It is easy to cross most allogamous plants by hand or by exposing female plant to desired pollen due to their heterozygosity nature e.g maize.

(b) *Heterosis*

Heterosis has been used in the development of hybrid maize as high production costs are easily compensated for by higher yields in hybrids.

(c) *Cytogenetic structure*

The ploidy level of a crop can influence the expression of a particular character of that crop e.g

- *Tetraploidy*:- four (4) sets of genome is used to increase dry matter yield in forage crops.

- *Allopolyploidy*: Multiples of different set of genomes is useful for creating new crop species such as triticale (wheat x rye)
- It is also used to transfer genes from the wild to cultivated crop genotypes manifestations of Heterosis.
 - (a) Increased size and productiveness
 - (b) Earlier maturity than either parents
 - (c) Greater resistance to disease, insect and environmental factors
 - (e) Increase number of leaves, nodes in the F₁

(d) *Qualitative Vs. Quantitative Traits*

Qualitative traits show simple Mendelian inheritance, controlled by one or 2 genes. Phenotypes in the F₂ have close resemblance with the parents. They are easily measured e.g flower, shape, specific resistance. Quantitative traits are continuous in their phenotypic expression and segregants in the F₂ are diverse cannot be grouped into distinct classes e.g response to light, temperature and water etc which are morpho/physiological; grain yield, total dry matter, protein and oil content, general disease resistance such traits are agronomic and have a complex inheritance and are controlled by many (major genes) with environment segregant in the F₂ diversified. These traits are improved by Recurrent Selection which leads to small but steady genetic gain to the trait in each selection cycle. Therefore, selection is faster when dealing with qualitative traits because unfavourable alleles are easily eliminated.

(e) *Gene action*

There are 3 possible genotypes in the F_n when a pair of gene is in a single locus involved Heterozygote (Hh) and the two homozygous (HH and hh)

Additive gene action: absence of DOMINANCE in case of single locus i.e $\sigma^2_A = 100\%$ $\sigma^2_G = 0\%$. There can be additive gene action. HH and hh similar can be substituted or dominance gene action all HH or Hh

HH Hh and hh are genotypes

A d -a genotypic values (Falconer, 1981)

H is favourable allele (it adds to trait value)

h is unfavourable allele (it subtracts from

a is additive effect

d is Dominance effect

Where gene action is additive d = 0

Alleles at a given locus act in an additive manner: $\sigma^2_A = 66.62\%$

Where there is dominance gene₂ actions $\sigma^2_G = 33.33\%$

d is the different from zero and σ^2_G large α sig GCA is warrant of additive gene action. The more the deviation from zero, the more important the dominant gene action will be.

Therefore, the breeding procedure chosen for a crop genotype will depend on the prevalence of gene action e.g additive gene action will be effective in accumulating favourable alleles in breeding materials especially in self-pollinating crops e.g Additive models accounted for almost

the whole genetic variability in soyabeans which is autogamous with additive effects, unfavourable alleles can be eliminated at Hh & hh state.

Whole genetic variability in soyabeans which is autogamous hybrid varieties will show the highest performance. Dominance gene action is employed in hybrid seed production. This the most appropriate selection methods will be those that take advantage of heterosis and general & specific combining abilities. Recessive unfavourable alleles can be eliminated if they manifest at homozygous (hh) state. Therefore, selfing which increases homozygosity (9hh) alternated with crossing that recovers heterozygosity is the ideal breeding strategy under this condition.

(f) Heritability

Phenotype = Genotype + environment

$$h^2 = \frac{\sigma_A^2}{\sigma_P^2}$$

Where

$$S^2_P = S^2_G + \sigma^2_{G \times E} + \sigma^2_E$$

e rxe

$$\sigma^2_A = \text{genetic variance}$$

$$\sigma^2_{G \times E} = \text{genetic x environmental variance}$$

$$\sigma^2_E = \text{environmental variance} = \text{experimental error}$$

$$e = \text{number of environment}$$

r = number of replication

From the above, it means that only the additive part of the variance is transmitted to the offspring.

h^2 will improve if we can reduce the environmental error and the genetic x environment component of the phenotypic variance i.e

- increase the number of replications (r)
- increase the number of sites (e) in a selection experiment to reduce σ^2_E

Note

Replication is possible only if selection units are families (not if individual plants) or unless individual plants are clonally propagated.

Thus

Heritability of a trait (h^2) can be improved only if selection is made on a family basis.

Improved genetic gain.

(g) Conventional Vs Special Methods

- Selection, testing, crossing, selfing, polyploidy, mutation breeding are all conventional methods.
- Tissue culture, genetic engineering, (genetic marker) methods are special methods.

A combination of both methods is the most likely avenue for future plant breeding. The choice depends on availability of time, facilities & expertise (trained & experienced personnel)

