Selection and its types

The term **selection** (= selection) in population genetics characterizes a situation that does not meet the limiting conditions for deriving the basic model (i.e. the average fertility of individuals is the same, independent of their genotype , so there is no selection).

- It is among the classical evolutionary mechanisms of Darwinism; there is always a **reduction in the number of offspring .**
- To measure the intensity of selection, we use the a**verage number of offspring** from a parent of a certain genotype; relative number is used, not absolute, where this relative value can be based on a ratio, for example, to the average number of offspring of all phenotypes or on a ratio to the number of offspring of the most fertile phenotype .
- From this we can derive: (i = max) i.e. the average number of offspring of genotype i / the average number of offspring of the most fertile genotype, where wi = absolute average number of offspring of genotype $w < i = \frac{w_i'}{w}$ it:
- **Relative reproductive capacity** (also adaptive value) of a given genotype = w_i'.
- **Election coefficient** , which characterizes the intensity of selection: $s = 1 - w_i$.

Selection against homozygotes

The starting population is in *Castle–Hardy–Weinberg equilibrium* .

When selection of intensity s i against recessive homozygotes aa (i = aa) begins, it will:

- *frequency before selection* : for (for , for ,);$aa = q^2$ (pro $AA = p^2$, pro $Aa = 2pq$, $\sum = 1$);
- *selection intensity* s_i: pro aa = s (pro AA = 0, pro Aa = 0);
- *relative reproductive capacity*w_i : pro aa = 1 − s (pro AA = 1, pro Aa = 1);
- *freequency after selection* $aa = q^2(1-s)$ (pro $AA = p^2$, pro $Aa = 2pq$, $\sum = 1 - q^2 s$).

We calculate the gene frequency in the generation after selection as: q´ = $\frac{q(1-qs)}{1-q^2 s}$.

- The size of the change is characterized by the **selection difference** (difference): Δq = q´ − q = $-\frac{pq^2 s}{1-q^2 s}$.
- **Δq** allows us to find out whether the investigated polymorphism is stable or transient, or how fast selection-induced changes take place.

In the case of **stable polymorphism** , Δq = 0; this happens when the numerator of the fraction in the equation is 0, which can happen when:

1. p = 0, i.e. the population consists only of homozygotes aa;
2. $q^2 = 0$ (q = 0), the population consists only of AA homozygotes;
3. s = 0, the considered selection does not occur;

- These three conditions = the so-called **trivial (general, basic) conditions.**
- Under non-trivial conditions, gene frequencies change (allele a decreases).
- The magnitude of this decline is directly proportional to the intensity of selection and the square of the gene frequency.
- If the gene frequency is high at the beginning, its decrease is greater.
- At smaller values of q, the decline slows down (biologically explainable by the fact that at low values of q, most a alleles in the genotype are heterozygotes, against which the given type of selection does not act).
- The dynamics of these gene frequency changes for the values of the selection coefficient have a sinusoidal character in various ways in the graph (dependency on time measured in generations).

Selection against both types of homozygotes

The so-called heterozygote preference (also referred to as super dominance or heterosis) (and i) leads to an equilibrium state where . ($s_{Aa} = 0$ a $s_{AA} > 0$ i $s_{aa} > 0$) $q_{rovn.} = \frac{s_{AA}}{s_{aa} + s_{AA}}$.

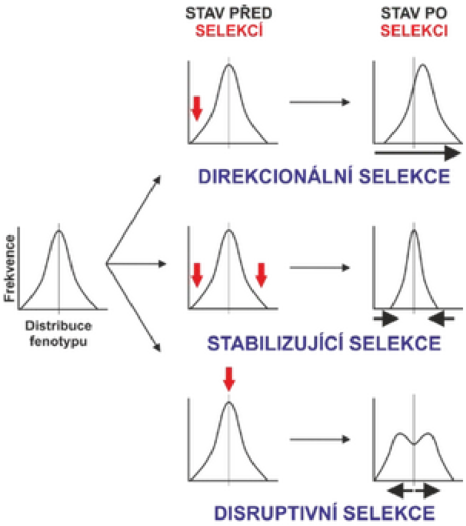
Thus, equilibrium values of paq depend only on selection coefficients, not on allele frequencies.

- E.g. hemoglobinopathies in the homozygous constitution cause anaemia .
- A selection factor that affects dominant homozygotes is malaria infection , to which heterozygotes are partially resistant.

- An extreme case is a **balanced lethal system** , where and the population then consists only of heterozygotes (e.g. the T locus in the mouse, which is involved in the development caudal part of the body) $s_{AA} = s_{aa} = 1$ a
- **Some dominant (T) and recessive (t) alleles have a lethal** effect in the homozygous constitution , usually due to severe disturbances during ontogeny ; whereas the mechanism of damage is different for dominant and recessive homozygotes, heterozygous individuals are viable.

Selection against heterozygotes

- E.g. fetal erythroblastosis .
- Except for the situation where p = q = 0.5, equilibrium can only be reached under trivial conditions.
- Since the non-trivial equilibrium p = q = 0.5 is easily violated, practically always under this type of selection there is a situation where the gene frequency of the allele with a higher frequency increases.



Basic types of selection

Types of selection

1. ***Normalizing selection***

   is applied in maintaining the current state of the population by excluding deviations from the norm; eg hereditary diseases.

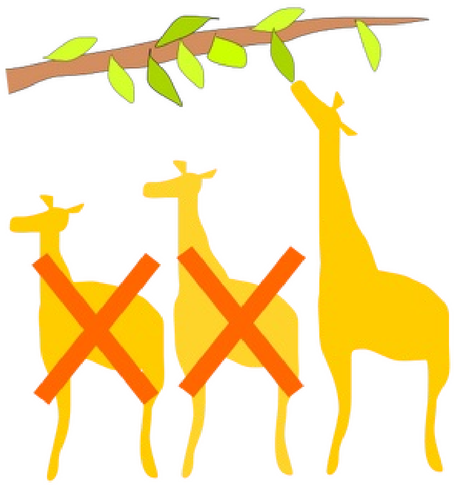
2. ***Balancing selection***

   maintains a certain degree of polymorphism in the population; e.g. heterozygote preference (sickle cell disease).

3. ***Directional selection***

   is applied especially when the external conditions change, its action selects the best adapted phenotype.

- This is a typical effect of natural selection in the sense of classical Darwinism.
- E.g. industrial melanism of some insects.


Selection

Fisher's fundamental theorem of natural selection is: "The rate of rise in (relative) fertility of any organism at any time is equal to the genetic variance of (relative) fertility at that time". Better: "The greater the genetic variability that can be acted upon by selection toward higher fitness, the greater the progress in fitness." or "The rate of change of a trait depends exclusively on the additive genetic variance in the fitness of that trait." (1930)

Links

Related articles

- Population polymorphisms
- Hardy-Weinberg equilibrium

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