Classification of natural selection

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This part of the encyclopedia will introduce the criteria for natural selection classification and the differences between different categories of selection. The classification of natural selection can be based on numerous factors. For a certain selection process, the criteria mainly include these sides: its impact on the target properties, its effect on the population’s gene pool, the time period when it functions, the target of the selection, and the natural resources that selection targets compete for (Wikipedia, 2023). In the following parts, this essay will focus on the several types classified by impact on the properties and introduce what’s unique about each type.

Since trait is the more professional name for inheritable properties or characteristics, it will be used in the following paragraphs instead. According to the impact selection has on the target trait, it can be divided into three different types: balancing selection, stabilizing selection and disruptive selection. Generally speaking, balancing selection functions to hold the frequency of a trait at a stable stage, while directional selection often leads to a significant change of certain figures in the population. The disruptive selection is the least common kind, yet has the greatest effect on a population in multiple directions, and sometimes can even indicate the emergence of new species.

Balancing selection is the selective process that causes multiple alleles to maintain at a stable frequency in the gene pool of a population. Allele, also known as allelomorph, generally refers to a pair of genes located at the same position on a pair of chromosomes that control relative traits. This type of selection mainly occurs when the target heterozygotes for the alleles have a greater advantage than the homozygotes, which is called “heterozygote advantage”. One classic example of this is the sickle-cell (S) and normal alleles at the β-hemoglobin locus of the human body. While the heterozygotes turn out to have the greatest resistance to malaria, it becomes the dominant genotype where malaria is the major threat to living (Phillip, 2007). Through this kind of selection, the genetic frequencies formed will be larger than those formed by genetic drift alone. Also, the genetic diversity will be well conserved since most of the genotypes are preserved.

Generally, two methods can be used to detect potential balancing selection. One is to evaluate the association between fitness for particular genotypes with environmental factors. “Fitness” here refers to the advantage in survival under certain circumstances, and by detecting this can the trend of gene frequency changes be revealed. Another popular method is to count the numbers of alleles that stay higher than mutation rate frequencies, which would tell if evidence for natural selection exists (Phillip, 2007).

By contrast of balancing selection, directional selection is a “negative natural selection”, which means it could result in an extreme increase on frequencies of certain genes. It usually occurs when the living environment changes, including rapid climate change and immigration to new areas. Under these circumstances, the environmental favor for an extreme phenotype over other phenotypes, and thus the allele frequency gradually shifts in the direction of that phenotype. In the process of directional selection, the advantage of different genotypes in survival and reproduction has a significant difference, and consequently the frequency of most advantageous allele increases steadily with time. The increases don’t depend on whether the gene is dominant or recessive, but if the allele is recessive, it will eventually become fixed.

To detect this kind of selection, some chemical methods, like using protein. In proteins, amino acids that seldom occur at specific places in a group of related species are possibly “victims” of the past selection, while those that appear frequently may have been favored by selection. By analyzing these differences in frequency, the distinct roles each amino acid plays in the population’s adaptation to the environment can be inferred. A fitness profile is then created to show the relative fitness of each amino acid at a particular place. In an evolution model, the fitness profile could indicate the probability of arising mutations during the process of evolution through mutation and selection, thus intuitively presenting the selective pressure of different periods (Louis et al., 2022).

Disruptive selection, also known as diversifying selection, is one of the most essential selection types which often indicates the outcome of new species. Disruptive selection refers to the changes of genetic frequencies in a population where extreme characteristics are more favored than intermediate ones. In this situation, more individuals tend to transform towards either this polar of trait or the other, and thus the population is gradually divided into two distinct groups. This is thought to be leading to the form of new species in the same area, which is also known as the “sympatric speciation”.

The cause for disruptive selection varies, and so is its outcome, which does not always result in speciation. The most typical cause comes from the lack of natural resources, which leaves little choice for the population. Take the famous Darwin’s finches on the Galápagos archipelago for an example: on the islands, since the main food in each area is strongly limited, their physical traits in food access differ, especially the beaks with unique sizes and shapes. These features suit well with their functions of collecting and taking in different food, including seed,insects and even small animals. These differences arise from the unique diets of finches, resulting in thirteen different species in total with similar appearance and mutual ancestors (Peter, 2005).

It needs to be noticed that although the disruptive selection may sound amazing, the outcome of it is not always inspiring. The sympatric speciation is not the only way of speciation, and results other than sympatric speciation is often unpredictable. At present, our understanding concerning the full spectrum of possible adaptive responses to disruptive selection and how to assess their relative possibilities is still limited. And all of the potential responses have shown common characteristics that some increase in the diversity of phenotype will occur as a tendency to reduce the impact of disruptive selection. Since the different reactions under the long-term influence of disruptive selection remains unclear, it is important to identify the potential responses under different circumstances before determining whether this form of selection is “disruptive” or not (Claus et al., 2006).

Above is the introduction for the classification of natural selection. In the following part, a further step will be taken to show the inner genetic mechanism of natural selection.

References

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