

7. Genetic variation in wild and domesticated populations (conservation genetics)

Hello. In this lecture, we will focus on the importance of genetic variability in populations of wild and domesticated animals, the conservation and management of genetic diversity, which is the field of conservation genetics. The lecture is part of module 2, Conservation and sustainable utilization of animal genetic resources. The creation of this presentation was supported by the ERASMUS+ KA2 grant as part of the project ISAGREED, Innovation of content and structure of study programs in the management of animal genetic and food resources using digitization.

Currently, the analyses of complete genomes at the population level are becoming increasingly possible in many species. Adaptations and harmful variability in populations are being discovered, and the connection between genetic variability and phenotypic variability is being explored. New technologies for data collection and the use of genomic knowledge for the protection of biological diversity are being developed. There is an expected impact of genomic approaches on conservation efforts in the next decade.

Topics include: Application of conservation genomics to endangered species; Detection of adaptations in populations; Use of eDNA (environmental DNA) approaches; Linking genotypes with phenotypes for conservation purposes; Detection and understanding of the effects of harmful variability; or Translation of research into conservation efforts.

Genetic diversity is the fundamental source of biodiversity, which is defined as "any measure that quantifies the extent of genetic variability within a population" or "the actual composition of variability of organisms and species on Earth." Genetic diversity represents "the range and sum of genetic variability within or among populations," where the term diversity, which simply means a state of exhibiting differences, distinctions, or diversity, has gained an extended meaning that represents the sum of variability.

The International Union for Conservation of Nature (IUCN) publishes a list of endangered animals and plants every two years. The basic categories are Vulnerable (up to 10% probability of extinction in 100 years), Endangered (up to 20% probability of extinction in 20 years or 5 generations), and Critically Endangered (with a 50% probability of extinction in 10 years or 3 generations).

IUCN publishes a list known as the Red List, which was established in 1964 as a source of information for possible conservation interventions. It is considered an indicator of the health of global biodiversity. Currently, it lists more than 41,000 species that are threatened with extinction (28% of all evaluated species). In the case of mammals, 27% are threatened, and for birds, it is 13%.

The image shows the different levels of threat within the categories. Aside from categories that are not evaluated or have unusable or missing data, there is a category for evaluated species, which expresses the risk of extinction - ranging from least concern to extinct. In addition to species that are globally extinct, there are those that are extinct in the wild and regionally extinct. Species for which conservation approaches can be applied and population rescue attempts can be made are classified as vulnerable, endangered, or critically endangered.

Here we see selected species that are highly endangered. As we can see, their status is recorded here. Whether their population is constantly decreasing, as in the case of the banteng, wild yak, gaur, African wild ass, or bearded pig, or whether it is stabilized, as with the American bison and Asian wild ass. Or their population size is increasing, as is the case with the European bison or Przewalski's horse.

Under the United Nations, the Food and Agriculture Organization, known as FAO, is included. It organizes the Domestic Animal Diversity Information System, also known as DAD-IS. Here, various information can be obtained, such as the situation of endangered animal breeds either globally or in specific regions or countries. When looking at the overall situation, there are 1,871 populations of domesticated species and breeds at risk of endangerment on the planet. These are often local breeds. In the Czech Republic, 4 breeds are not endangered, while 23 breeds are endangered.

In Poland, 17 breeds are not endangered, while 100 breeds are endangered. And in Slovakia, 2 breeds are not endangered, while 16 breeds are endangered. The so-called SDG indicator, which assesses this degree of endangerment, is quite similar among these mentioned countries, ranging from 85% to 89%.

Genetic variability in wild and domesticated populations is significant for their ability to adapt to a changing environment. It applies to both wild and domesticated populations, with domesticated populations generally having lower levels of diversity. Genetic variability in wild and domesticated populations is an important topic in biology. Domestication is a process in which humans have modified the characteristics of wild organisms for use in agriculture, industry, or society. Domestication and the intensity of selection have led to a reduction in genetic diversity in domesticated populations compared to their wild counterparts.

Geneticists have identified low genetic variability as a problem in many species of wild and captive populations, including cheetahs, California foxes (*Urocyon littoralis*), American black bears (*Ursus americanus*), Asian lions from Gir Forest (*Panthera leo*), southern koalas (*Phascolarctus cinereus*), European bison (*Bison bonasus*), and others.

This information can be used for various applications in the field of conservation and management, including determining population units, maintaining maximum genetic diversity in captive or wild populations, and predicting adaptive responses to environmental changes.

Recent research indicates a high interest of scientists in functional genetic variability. Unprecedented rates of extinction require the efficient utilization of genetics, which could help preserve biological diversity. Several recent studies based on genomics and simulations argue that the field of conservation biology focuses too much on preserving the genetic variability of the entire genome and should instead concentrate on managing a subset of functional genetic variability, which is assumed to influence fitness. According to a study from 2020, high genetic variability is associated with a high level of adaptability to environmental changes.

However, focusing conservation efforts on likely functional genetic variability will only be feasible occasionally, often misleading and counterproductive if prioritized over the genetic variability of the entire genome. Given the increasing pace of habitat loss and other environmental changes, failure to recognize the harmful effects of lost genetic variability of the entire genome on the long-term viability of populations will only deepen the biodiversity crisis.

An increasingly significant problem is the sustainability of wild and domesticated animal populations. Genetic diversity refers to the range of different inherited traits within a species. Genetics helps us understand and reduce the risk of population and species extinction. It is important to preserve genetic diversity and the health of populations in the wild to maintain healthy ecosystems. The loss of biological diversity is a global problem, and human population growth has a significant impact on this loss.

However, if we continue to encroach on natural animal habitats, even the best conservation genetics approaches will not prevent species extinction.

And thank you for your attention.