2. Evolution of important livestock species

Hello. In this lecture, we will focus on the evolution of important species of livestock animals and animals in general. The lecture is part of Module 2, Conservation and Sustainable Use of Animal Genetic Resources. The creation of this presentation was supported by the ERASMUS+ KA2 grant as part of the ISAGREED project, Innovation of Content and Structure of Study Programs in the Field of Animal Genetic and Food Resources Management Using Digitization.

The first living organisms appeared on Earth 4 billion years ago. The first photosynthesis occurred 3.2 billion years ago. Eukaryotes then appeared 2.3 billion years ago. These were still single-celled organisms. The first multicellular life forms are dated back to around 1.5 billion years ago. It was only about 600 million years ago that the first animals emerged. The presence of vertebrates, which gradually transitioned to land, such as amphibians, dates back 390 million years. The first forms of mammals evolved 250 million years ago and the first hominids appeared 2 million years ago.

In the bottom left, we see the oldest imprint of one of the first animals, a ribbed creature called Dickinsonia, which existed 558 million years ago. The oldest preserved fish imprint is 518 million years old and it had a pair of large protruding eyes and small paired nasal capsules.

The development of life on the planet was influenced by major global catastrophes - resulting in either cooling or warming. The most significant of these was the Permian-Triassic extinction event (which caused the extinction of 95% of life), marking the end of the Paleozoic era and enabling the development of life in the Mesozoic era, leading to the rise of reptiles in forms that eventually led to dinosaurs, mammals, and birds. However, the dominant group during this time were the dinosaurs. The global catastrophe 65 million years ago ended the reign of dinosaurs and also marked the end of the Mesozoic era. This was the time of a great radiation of mammal and bird forms during the Tertiary period.

The evolution of mammals and birds is associated with the evolution of reptiles as they share a common origin. Recently, the first dinosauriform reptiles (early dinosaurs) from the Middle Triassic period (240 million years ago) were discovered in present-day South America.

The first forms of reptiles with mammal traits date back to the end of the Permian period (250 million years ago). Birds diverged from the dinosaur line only in the middle of the Triassic period (approximately 230 million years ago).

The ancestors of mammals are cynodont therapsids (Cynodontia, Therapsida, Synapsida), reptiles that were one of the dominant groups of terrestrial vertebrates during the Triassic period. Cynodonts exhibited a mosaic of "old reptilian" and "new mammalian" characteristics to varying degrees.

The ancestor of mammals can be traced back to the late Permian period among therapsid reptiles. During evolution, a variety of evolutionary lineages emerged, with some showing primitive mammalian characteristics. The transition from a reptilian to a mammalian form occurred gradually, with different traits appearing in a mosaic pattern among different species of therapsids. The oldest mammals appeared over 200 million years ago. The second adaptive radiation of mammals occurred at the end of the Cretaceous period (after the extinction of

dinosaurs). This led to the extensive mammalian community in the Paleocene (65 to 55 million years ago), dominated by archaic primates, insectivores, ungulates, and marsupials. However, most of these forms became extinct.

Every modern mammal, from monotremes to blue whales, can be traced back to a common ancestor that lived approximately 180 million years ago. Scientists used highly quality genome sequences from 32 living species, representing 23 out of 26 known orders of mammals, including humans and chimpanzees, wombats and rabbits, rodents, domestic cattle, rhinoceroses, bats, and pangolins. The genomes of chickens and Chinese alligators were also included in the analysis as comparative groups. The ancestor of mammals had 19 autosomal chromosomes ($2n = 38$) + 2 sex chromosomes. Nine complete chromosomes or their fragments, with gene order identical to that of modern bird chromosomes (320 million years ago - conserved synteny), were identified in the ancestor of mammals.

During the Eocene (55 to 37 million years ago) and the Oligocene (37 to 2.5 million years ago), all groups of archaic mammals were replaced by new groups such as even-toed ungulates, odd-toed ungulates, and carnivores. During this time, some continents became isolated (Australia and South America), leading to slightly different developments in mammals. In Antarctica, mammals became extinct due to climate change. Australia became isolated first, resulting in the persistence of the oldest and most widespread types of mammals - marsupials. Similarly, in South America, alongside ancient marsupials, diverse forms of herbivores and unique types of ungulates also evolved. In the late Tertiary, further evolutionary radiation occurred, leading to advanced specialized mammals. This is the final stage of mammalian evolution in the Tertiary and Quaternary periods. Horses with three toes evolved into horses with a single hoof, old forms of deer disappeared, and new forms emerged. Even-toed ungulates reached their peak. Modern carnivores emerged, but overly specialized saber-toothed cats became extinct. Primitive dogs branched into wolves and foxes. The species diversity was much more extensive than it is today.

One study using genomic time trees confirms the difference in the rate of evolution during the Cretaceous period and the Paleogene period, when a major diversification of mammals occurred mainly after the large extinction event 66 million years ago.

Radiation of birds. Modern birds achieved their enormous diversity during an evolutionary path lasting over 150 million years, which began with their divergence from theropod dinosaurs, continued with the gradual and partial acquisition of a flight-adaptive body plan, and included two points of diversification: the first in the Mesozoic era, when the fully formed small feathered winged dinosaur emerged, and the second when surviving species gained the opportunity to thrive after the extinction event at the end of the Cretaceous.

The evolution of ungulates, as a highly diverse group of herbivores, began with early ungulates (141-65 million years ago), which had small bodies, primitive teeth, and claws. True ungulates only appeared at the beginning of the Paleocene, gradually evolving alongside extinctions before 37-22 million years ago, leading to even-toed ungulates.

Molecular analyses using SINE sequences have revealed specific sequences for mammals, even-toed ungulates, and ruminants.

Among the economically most significant ruminants are cattle. The development of cattle began in the middle Oligocene (25 million years ago), with the center of origin being the tropics and subtropics of Central Asia. Direct ancestors appeared 5-2 million years ago in Eurasia, and only

in the Pleistocene did they reach North America (reaching South America with the help of humans). Preserved finds of bison, cattle, and buffalo date back to sediments from older interglacial periods with suitable climates.

The genus Bos is one of the most utilized by humans. The domestic cattle (Bos primigenius) is descended from the aurochs, which is now extinct, and has been domesticated in two forms, Bos primigenius taurus and Bos primigenius indicus. Gaurs (Bos gaurus) exist in many subspecies, as well as one domesticated form called gayal. There is also one domesticated form of banteng (Bos banteng). In the high-altitude conditions of Asia, another form, yak (Bos mutus grunniensis), was domesticated.

The second large group of animals successfully domesticated was a species from the Suidae family, the wild boar (Sus scrofa), which inhabits all of Eurasia and Africa in many subspecies. Other closely related species have not been domesticated.

When the number of chromosomes was studied, it was found that the genus Sus had a predominant number of 38 chromosomes. In Sus scrofa, due to chromosomal mutations, variants of 36 and 37 chromosomes also appear in addition to the basic number of 38 chromosomes, as a result of mutations called translocation (the fusion of the 16th and 17th chromosome, or the 15th and 17th chromosome).

The genus Sus originates from the islands of Southeast Asia (6-5.3 million years ago), from where it gradually spread to the Middle East, North Africa, and Europe. According to morphological and molecular genetic data, species of the genus Sus cluster into 3 evolutionary groups. Wild boar, Sus scrofa, belongs to one of these groups.

The species Sus scrofa originated in Southeast Asia sometime 3-4 million years ago and spread throughout almost the entire Eurasia within 1 million years. Wild pigs were also found in the northern part of Sumatra, this population separated from the Eurasian pig about 1.5-2 million years ago. European and Asian wild pigs diverged about 1 million years ago based on the description of very different low-frequency alleles at millions of genomic loci, and over a million loci that are fixed for alternative alleles.

The two main domestication centers for pigs are the Middle East and Southeast Asia, similar to cattle. However, due to the extensive distribution of the species, more domestication centers have gradually been identified.

The following table describes the times of domestication initiation and the main domestication areas for the most significant domesticated animal species. The oldest species to be domesticated is the dog, and the youngest species is the duck.

And thank you for your attention.