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Review Scientific Paper

THE INFLUENCE OF ENVIRONMENTAL FACTORS ON THE CONSTITUTION OF DONKEYS

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Summary
The donkey, as one of the oldest domestic animals, is spread over all continents. There were no organized selection measures for centuries. The basic condition was that the donkey could walk for a long time and carry a load. Such requirements, as well as the ecological conditions in which they developed and live, caused donkeys, regardless of where they live, to have practically the same body constitution, which is reflected in the bony index. Regardless of the height of the withers, that is, the size of the body, the relative relationships of individual parts of the body are quite similar. The donkey has a strong body constitution.

Key words: donkey, ecological factors, bony index.

INTRODUCTION

The domestic donkey (*Equus asinus*) belongs to the group of the earliest domesticated animals. It originates from the African wild donkey (*Equus asinus africanus*) from northeastern Africa. There were three types of wild donkeys: Nubian, Somali and the Atlas mountain donkey. The African wild donkey from the Atlas mountain massif is reliably known to have disappeared (Urošević et al., 2022b). When it comes to the Nubian wild donkey, there is a justified suspicion that it has disappeared in the wild nature. It is assumed that the last specimen was seen in the wild nature in the 1930s.
The domestication process, most likely, began 8-11,000 years ago. This process slowly spread from North Africa to Southeast Asia and southern Europe (Trailović et al., 2021). Despite the fact that, on the basis of mitochondrial DNA research (Kimura et al., 2011), it is considered that the progenitor of the domestic donkey is exclusively the Nubian donkey, it seems that such research should be continued and deepened, since

certain phenotypic expressions of domestic donkeys do not fully support such a theory. Namely, the Nubian donkey does not have cross-striped lines, like a zebra, on its legs, while the Somali donkey does. In addition, the Nubian donkey has a "cross" on its back, while the Somali wild donkey does not. However, in practice, such division is not strict, since there are domestic donkeys without a "cross" but with transverse stripes on the legs or with both combinations. The Nubian wild donkey is about 122 cm tall at the withers, and the Somali wild donkey is about 140 cm (Urošević et al., 2022a). Ivanković et al. (2011) state the opinion that, most likely, these two subspecies of wild donkeys, Nubian (*Equus africanus africanus*) and Somali (*Equus africanus somaliensis*), mated with each other in the past. There is also an assumption that the Nubian wild donkey originates from the Somali wild donkey. This assumption cannot be completely rejected either.

It is believed that donkeys reached Europe from two directions. They came to the Balkans from Asia Minor. Adapting to the new climatic conditions in the Balkans, donkeys gradually spread to the west, to Italy. There, due to their characteristics, they became highly valued and loved. During the period of the expansion of the Roman Empire, the donkeys, along with the legionnaires, reached other regions and climatic conditions. Unlike this route or way of arriving in Europe, the second route was significantly shorter. They reached Spain through the Strait of Gibraltar, and from there the way to other countries was open to them.

The region where wild donkeys lived in nature is characterized by rather harsh living conditions. There was almost never enough food and water. Donkeys, although they are monogastric, have adapted and developed their stomach and entire digestive tract to be able to consume and use food that has significantly more cellulose than is the case with other monogastric animals, primarily horses.

Ecological conditions

Ecological conditions mean a set of ecological factors (Stanković, 1979). They represent a heterogeneous complex of the external environment, which constantly acts on all living beings. Zheleznova (2016) states that the term agrobiocenosis represents a set of all organisms that live in a certain area.

Impacts on animals occur as a result of the activities of living and non-living nature. The basic characteristic of such influences is continuity and complexity. Some environmental factors are not fixed but change in time and observed space, and often the effect of one factor is conditioned by the effect of another environmental factor. Such a complex system means that the independent action of one factor is impossible. The intensity of the influence of the complex of environmental factors is constantly changing, but it never stops. When one population is observed, primarily a micropopulation of an animal species, it is noticeable that the members of that part of the population have a relatively limited living space. That part of the living space is called an ecological niche. According to Stanković (1979), this term means the set of all ecological valences of one organic species. These are the limits that the

agrobiocenosis can bear, with tolerance, without harmful consequences, in the place it inhabits.

In order for a certain species to survive in certain conditions, it must be maximally adapted. The end of the adaptation process was preceded by a long modification process. The effects of modification, with the aim of adaptation, are different and visible. Furtunescu (1958) states that there are two basic groups of modification: morphological and physiological modification.

It is characteristic of morphological modifications that there are significant changes in the dimensions (size) and mass of the body. Then the changes provoke the changes in the conformation of the body. There are changes in the shape and size of the head, the shape of the body and the strength of the bones. Morphological modifications also include changes in the structure of the skeleton. Depending on where the animals live and how they perform their work, longer or shorter bones appear, that is, the animal's body is taller or shorter. The group of morphological modifications also includes a change in the color of the hair cover. There is a possibility that the pigment is absent (albinism). It is possible that there is no pigment in the hair, but only in the skin (leucism). With intense dark, black pigment, it is melanism, and if other colors are present, then it is flavism. Morphological-physiological changes in the musculature are also included in the complex of morphological modifications. Obvious examples are working animals (donkey) and fattening animals. These changes are evident, for example, in cattle selected for milk production and those for meat production.

Physiological modifications are necessary in order for a certain animal species to adapt to the existing living conditions. Donkeys are a typical example. These animals experienced significant physiological modifications in the type of food they consume, and in the amount of water they can lose, without consequences, from the body, as well as the way they compensate for lost water. Significant physiological modifications occurred in the genital apparatus and reproductive system. The mating season is so biologically organized that cubs are born at the time when there is the most food. It is not characteristic of donkeys that the mother gives birth to more cubs, unlike some other animals. This is a consequence of adapting to living conditions, which do not offer enough food for more cubs.

Acclimatization

Today, donkeys are spread on all continents, they are found in all areas and regions (except for areas of permafrost). This is a consequence of the successful acclimatization process of the donkeys. The process of acclimatization, i.e. its success, is expressed differently in different species, races, strains, and in addition, there are also racial differences (Nikolić and Simović, 1980). This leads to faster or slower acclimatization, which depends, first of all, on hereditary traits, body conformation, constitution and health status. Differences in climatic conditions and their impact on the organism are very important.

Donkeys come from warm, arid regions. Modification processes have enabled their survival in such regions. The question is often asked, how did the donkeys manage to acclimatize to such a wide range of climatic conditions.

When it comes to acclimatization, it is completely logical that the problems are much smaller and rarer if it is about similar regions from which the animals leave and to which they arrive. Acclimatization has the fewest problems if the animals are transported (moved) along an isothermal line. Acclimatization is easier if animals come from warmer and drier regions to wetter and less warm ones. This is exactly the situation with donkeys. They have acclimatized very well to the new conditions, which are drastically different from those where they were born.

The acclimatization process takes a long time, and permanent acclimatization can only be achieved after 3-4 generations (Nikolić and Simović, 1980).

Constitution

The term constitution was used in human medicine as early as the time of Hippocrates (approx. 460-380 BC). In contrast to humane medicine, constitution, in zootechnics, as a term appeared at the end of the 19th century (Zigo et al., 2016). This term means a set of characteristics that are hereditary and acquired, then it includes physiological characteristics as well as resistance to the influence of external environmental factors. The constitution includes all features (morphological, physiological, biochemical and functional characteristics) that influence and enable the vitality, endurance and productivity of an individual. Depending on the development of individuals, there are different types of constitution. Donkeys are characterized by a strong constitution.

The constitution is assessed in two ways (Creta et al., 1995):

- Somatoscopy: this is a quick way to assess the constitution, since the animal is visually observed and based on what is seen, conclusions are drawn and
- Somatometry: this is the most reliable way to assess and determine the constitution, since the morphological parameters are determined on the body of the observed animal.

Body mass index

Based on the obtained absolute values of individual morphometric parameters, it is not possible to make a comparison, that is, to draw a conclusion about certain relationships and determine the type of constitution. This is why indexes are used, and they represent the percentage ratio of one measure to another. Indices are calculated for those measures that best express certain relationships with their mutual relations, i.e. body proportions. They best reflect body composition (Panić, 1985).

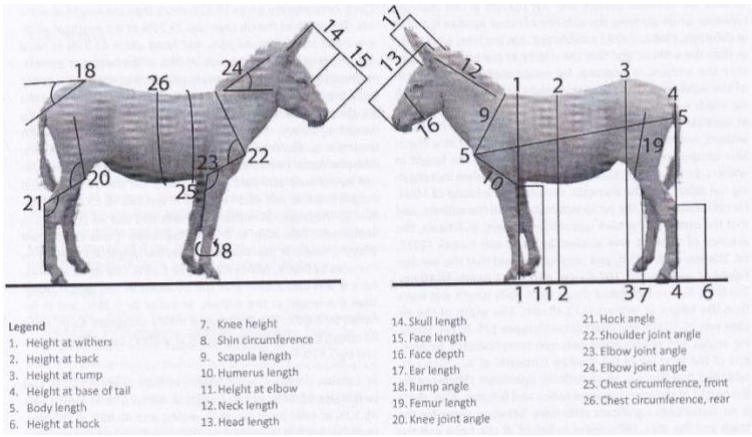

Figure 1 Determination of certain morphological parameters on the body of a donkey (Urosevic et al., 2019b)

Based on the obtained values of certain body indices, it is possible to make an assessment and draw a conclusion about the level of development and type of constitution of the observed animal.

For defining a certain type of constitution, the bony index is the most reliable. To calculate this index, it is necessary to determine the circumference of the shin and the height of the crest. The absolute value for the shin circumference is divided by the absolute value of the height of the withers and multiplied by 100.

When looking at the donkey phenotype (somatoscopy), they are quite a heterogeneous species. This applies primarily to the height of the ridge. There are donkeys whose withers do not even reach 90 cm, while on the other hand there are those whose withers are as high as 150 cm. If only the height of the crests is observed, they are, indeed, extremely different.

The donkey is a domestic animal that has not been subjected to any selection measures for centuries. Everything that was created was the result of natural selection, that is, adaptation to existing conditions and needs. The basic need was work. Regardless of the climatic conditions and geographical regions, the donkey was exclusively a working animal. Such a need shaped and conditioned the creation of a strong animal, which conditioned the creation of a strong constitution. Regardless of where they are, donkeys have a strong constitution and almost the same biostatic model of body structure. Such a biostatic model enables maximum production of biokinetic energy, which causes the biokinematic effect we call movement.

A strong constitution is reflected in the value of the bony index. Urosević et al. (2019b) in the population of the white baroque donkey in Austria determined an average circumference of the shin of 14.00 cm and an average height of the withers of 115.50 cm. The bony index was 12.12. When it comes to the girth of donkeys on the island of Rab (Croatia), Urošević et al. (2019a) found an average value of 13.30 cm for males

and 13.20 cm for females, and the average height of the withers was 100.80 cm for males and 95.40 cm for females. The ossity index of males was 13.90, and of females 13.83.

Back in 1938, Babić (1938), while determining the exterior characteristics of Neapolitan donkeys imported to Dalmatia (Croatia), determined that the height of the withers of the breeding stock was, on average, 128.80 cm, and the circumference of the shin was 16.30 cm on average. In that case, the bony index was 12.65.

On a fairly large sample of 147 stallions, 62 geldings and 240 donkeys, a total of 449 individuals, on the island of Mljet (Croatia), Essert (1959) determined that the overall average value of the tibia circumference was 12.20 cm and the height at the withers was 100.00 cm. Based on this, the average value of the bone index was 12.20.

Studying the land breeding of donkeys in Austria, Urošević et al. (2022a) determined that the circumference of the tibia is in the range of 12 to 16 cm with the height of the ridge from 99.60 to 140.60 cm. In this population, the ossification index did not differ much within the population. The differences in the height of the withers were 37.3%, and the differences in the bony index were 26.99%.

Ivanković et al. (2000) determined that the average value of the circumference of the shin in the Primorsko-Dinaric type of donkeys is 12.82 cm, and the height of the withers is 96.93 cm. Based on this, the bony index is 13.26. In the North Adriatic type of donkeys, these authors determined an average height of the withers of 115.28 cm and a circumference of the shin of 14.85 cm. In this case, the bony index is 12.88. In the case of the Istrian donkey, these authors determined an average height of the withers of 124.07 cm and the circumference of the tibia of 16.30 cm, which determines the bony index of 13.14.

In an impressive sample of 123 male donkeys and 200 female donkeys in the northwestern region of Ethiopia, Mustefa et al. (2020) determined that the circumference of the tibia ranges from 20.00 to 29.00 cm with a simultaneous ridge height of 79.00 to 119.00 cm. Based on these results, it follows that the bony index ranged from 24.37 to 25.32. It must be admitted that these values deviate quite a lot from numerous literature data on the bony index. It is obvious that the donkeys in the Benishangul Gumuz region have quite a strong skeleton.

Examining the morphological characteristics of amiata donkeys, Sargentini et al. (2018) found that the circumference of the tibia ranged from 16.30 to 17.60 cm in four groups of donkeys of this breed. Where the smallest girth value was registered, the mean value of the crest height was determined to be 123.20 cm, and with the largest shin circumference, the crest height was 130.70 cm. Based on these results, it follows that the ossification index was in the interval from 13.23 to 13.46.

CONCLUSION

Based on the data on the bone density index of donkeys in different climatic conditions, the conclusion is that all the results, except for those on donkeys in Ethiopia, are quite homogeneous. This is completely logical because regardless of body size, i.e. the

height of the withers, if donkeys perform the same or very similar work, it requires approximately the same body constitution, i.e. approximately the same bony index. This is the result of a selection that had the sole aim of selecting the most suitable individuals for long walks and carrying loads. Similar work requires the existence of a similar biostatic model of the donkey's body.

Conflict of interest statement: The authors declare that there is no conflict of interest.

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