

Genetic structure of the Lipizzan horse breed in Hungary through the mare families

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SUMMARY

Modern animal husbandry has drastically changed the genetic structure of some domestic species. The varieties, genotypes that we think we do not need at the moment can only be saved from extinction with the help of gene conservation. Traditional Hungarian horse breeds have a long history (more than 200 years) and a demonstrably different genetic structure from other horse breeds in Europe and the rest of the world. Consequently, their enormous genetic value is undoubted. The subject of our research was to study the structure of the mare families found in the population of the Lipizzan horse breed and the genetic structure of the Hungarian population. Out of the total 61 mare families in the world, 35 are present in Hungary. There are 11 Hungarian, 12 families of Fogaras, 7 original, 4 Croatian and 1 Slovenian mare families in the Hungarian population. The proportion of mare families in Hungary and Fogaras is almost the same. The proportion of Croatian and Slovenian families is negligible. In terms of their number, they are not significant in Hungary. For this reason they have little effect on the Hungarian Lipizzan population. Except one of the original mare families are in the same situation as the Croatian and Slovenian families. The Presciana / Bradamanta mare family is the most populous of all families due to their long stay in Hungary. The proportion of families is unbalanced. Seven mare families accounting for 56.36% of the total population. Given the basic requirements of gene conservation work, this condition is far from optimal.

Keywords: Lipizzan, mare families, gene conservation

INTRODUCTION

Since the onset of domestication of species, man has, involuntarily and consciously, exploited the factors that shape the genetic structure of different populations, thereby reducing the genetic variability of different species and breeds. Traditional Hungarian horse breeds have roughly 200 years breeding history, but due to the changed peculiarities of horse breeding, their number has become smaller and smaller. As they are part of the cultural heritage of the Hungarians, they have now become protected. During their breeding, the rules of gene protection is given a special role, in order to get to know their diversity, the analysis of their origin has started for each variety.

Breeding according to the rules of gene conservation would presuppose an accurate knowledge of mare families, but in general, this knowledge also belongs to the Hungarian cultural heritage. The fact of globalization it is also inevitable in horse breeding. This is also felt in Hungary with regard to the Lipizzan breed. The series of outstanding international successes of the breed in driving sport has aroused interest in it and it would be superfluous to deny it, a special situation for the population has been created by the Lipizzan horses available at better prices from abroad.

The importance of mare families in horse breeding

The identity of the varieties is to be found in different origins, different historical backgrounds, different looks and different performances (Mihók, 2000). In horse breeding, great emphasis has been placed on pedigree since the second half of the 18th century (Druml, 2013). In the case of varieties that often have nearly the same appearance, it is the origin

that determines the identity of the variety (Mihók, 2008).

In the case of Hungarian horse breeds, we use two common breeding methods within purebred breeding, line breeding and inbreeding from families (Anker, 1998). Inbreeding from families means the further breeding of the offspring of the most valuable females. Inbreeding from family's procedure should focus on mares and their offspring of outstanding genetic value (Anker, 1998; Horn, 1976). In the case of closed pedigree breeds with a small population size, mare families are already of great value. It is the responsibility of breeders to pay special attention to their maintenance (Pataki, 1997). In addition to the identity of the breeds, mare families also contribute to the balanced inheritance, so faster genetic progress can be expected (Mihók, 2008). It has long been known that the quality of a horse population is better reflected by mares than by stallions. Excellent mares are able to determine successful breeding for a long time (Mihók, 2000).

We find countless examples of the hereditary power of mare families, in the form of performance (Hecker, 2016; Mihók and Ernst, 2015). This fact can be proved by the phenomenon of mitochondrial inheritance. The germ cell consists of a nucleus and a cytoplasm. Mitochondria in the cytoplasm contain genes that an individual can pass on to their offspring during reproduction. This transfer of information takes place only in the case of females, since males are only able to pass on hereditary material stored in the nucleus to their offspring. Cytoplasmic inheritance increases the genetic value of mares and supports the cause of protection of mares. It follows that stallions are responsible for maximum the half of the traits of the

offspring and the mares for minimum the half of the traits of the offspring (Mihók, 2008).

Mare families of the Lipizzan breed

Like many other breeds, in the case of the Lipizzan horse, the principle of breeding organization is implemented along stallion lines and mare families. The maintenance of these practices is necessary to protect the complete genetic material of the variety. The genetic structure and regenerative capacity of the breed can be characterized by the number of live mare families and the balance within the population. In addition, genetic advancement can only be achieved through reasonable breeding activity based on these intra-breed systematization units (Mihók and Ernst, 2015).

The mare families of the Lipizzan breed can be divided into 5 groups according to their origin:

- original mare families
- Hungarian mare families
- Croatian mare families
- families of Fogaras
- Slovenian mare family (Druml, 2013).

The breed has 17 original, 17 Hungarian, 14 families of Fogaras and 15 Croatian and 1 Slovenian, with a total of 64 mares (Hop, 2013a).

Original families

The history of the original mares of the breed dates back to the 18th century. There are 17 families in this group. Five of these families are from Lipica, three of which were founded by mares of the “old karst breeds” (Sardinia, Spadiglia, Argentina) and two from arabic genetic backgrounds (Gidrane, Theodorosta). Although the mare named Theodorosta founded a mare family in Lipica, it was arguably a mare from Bukovina. Eight families come from the former imperial, royal stud in the Kladrub (Africa, Almerina, Presciana, Englanderia, Europa, Deflorata, Capriola, Rava). Of these, the mare named Rava, Almerina, and Africa also founded a mare family in the Kladrub breed. The Deflorata mare family was founded by a mare in Fredericksborg. The origins of two mare families can be traced back to the imperial, royal court in Kopcsány (Famosa, Fistula). The mare named Famosa also founded a mare family in the kladrub breed. There are two more mares of Radautz mares (Mercurio, Djebrin), whose founding mares were born in Radautz (60 Freies Gestüt) and Bábolna (100 Generale Junior) (Druml, 2013; Hop, 2013b).

Hungarian mare families

Due to the special historical situation, mare families with a long breeding history have been established in all offspring states, including Hungary, which are not directly related to the maternal founders, but undoubtedly belong to the breed (Druml, 2013). Derived from the pedigree data, 17 mare families are called of Hungarian origin. The founders of these are the mares of Mezőhegyes, Bábolna, Moldavia, Holstein, Lipica, Pusztaszer and Bukovina. 7 of them in Mezőhegyes (542 Hungarian mare, 759 Moldavian

mare, 2064 Neapolitano Lepkés, 2070 Madar VI, Anemone, 461 Bukovinian mare, 555 Generale XXII), one in Bábolna (2038 Neapolitano Juci), one in Lipica (501 Karst Párta), two in Tata in the stud of the Count of Esterházy (2052 Neapolitano Szerena, 81 Maestoso Sostenuta), a mare founded in Mozsgo in the stud of the Count of Biedermann (Toplica-Siglavý) and four in the stud of the Count of Pallavicini in Pusztaszer (Druml, 2013; Hop, 2013b; Tóth and Várady, 1980).

Mare families of Fogaras

The number of recognized mare families in Fogaras is currently 14, but there are also 4 mare families whose origins probably go back to the founding mare of another mare family in Dagaras, but so far this has not been documented. The Fogarasi Stud is undoubtedly located in Romania today, but it is well known that the history of mare families of Romanian origin known in the international literature can be traced back to the pre-Trianon period. In June 1874, 94 Lipizzan horses moved from Mezőhegyes to Fogaras. Between 1874 and 1912, the herd of the latter consisted mainly of horses from Mezőhegyes, Moldova, Alsó-Szombatfalva and Fogaras (Meissner, 1929).

In terms of the origin of seven mare families, it belongs to the Mezőhegyes families (60 Lipitzer Races, 461 original Moldavian mare, 410 Turtsy, 519 original Hungarian mare, 54 Romanito, 296 Conversano XII-3, 759 original Moldavian mare). Five mare families can be traced from Fogaras (48 Favory X-4, 5 Favory XV-8, 14 Tulipan-14, 84 Tulipan-4, 36 Neapolitano-1), which at that time operated as a branch stud in Mezőhegyes. Two of these families also have two possible founding mares (mare family 6 and 7). Two families go back to mares from Alsó-Szombatfalva (49 Hidas, 22 Maestoso Basovica) (Druml, 2013; Hop, 2013b).

Croatian mare families

The number of Croatian mare families is 15, which can be divided into 5 groups according to their origin. The first group includes mare families that can be traced back to the Vukovar stud of the Counts of Eltzs’ (Rendes, Hamad-Flora [111 Hamad, goes back to a mare from Bábolna], Eljen-Odaliska, Miss Wood, Fruska. The second group consists of mare families traced back to the stud farm of Count Jankovic in Terezovac and Cabuna. (Terezovac: Ercel, Czirka, 502 Mozsgo Perla, Cabuna: Traviata, Margit, Manczi). The third group includes only one mare family called Mima. The origin of this family goes back to the stud of Count Tüköry, in Daruvár. Three mare families from the Dakovo stud, but it is said that these mare families from Lipica stud, but no supporting documents are available. So far, this has not been substantiated with documents, so we record them as a separate mare family (Druml, 2013; Hop, 2013b).

Slovenian mare family

The Rebecca/Thais family from Croatian breeding (Vrbik, an Arabian private stud in Croatia) of Arabic origin, which will be used only in the II. It was

integrated into the breeding of the Lipizzan breed in Lipica after the Second World War and is now recognized as a Slovenian mare family (Druml, 2013; Hop, 2013b).

Gene conservation in Hungarian horse breeding

Modern animal husbandry has radically changed the genetic structure of some domestic species. The varieties, genotypes that we think we do not need at the moment can only be saved from extinction with the help of gene conservation (Bodó, 2011; Mihók, 2008). The protection of gene reserves in domestic populations was one of the first in Hungary. Today, this process must be always seen as the duty of every state (Bodó, 2008). Our traditional Hungarian horse breeds have a long history (up to 200 years) and have a demonstrably different genetic structure from other horse breeds in Europe and the rest of the world. As a result, they undoubtedly represent enormous genetic value (Bartók, 2000; Bodó, 2011; Mihók, 2008). Population genetic research of different detail has been carried out in all domestic horse breeds called native, however, the work done in this field cannot be considered satisfactory for most breeds (Bodó, 2011).

MATERIALS AND METHODS

The subject of our research was the study of the genetic structure of the Hungarian population of Lipizzan horses. In the course of our work, the entire Hungarian Lipizzan mare population was studied.

The processing of the Hungarian mare families is described in the Hungarian Lipizzan Studbook I. (Agricultural Certification Institute, 1988), a Hungarian Lipizzan Studbook II. (Hungarian Lipizzaner Breeders Association, 1990), a Hungarian Lipizzan Studbook III. (Hungarian Lipizzaner Breeders Association, 2008), and the Hungarian Lipizzan Studbook IV. (Hungarian Lipizzaner Breeders Association, 2013). This study was supplemented by the old pedigrees kept in Bábolna, Fogaras and Szilvásvárad, owned by the State Stud Farm, Szilvásvárad. (Lipizzan Stud of Fogaras Studbook 3., 1882–1896; Lipizzan Stud of Fogaras Studbook 4., 1889–1905; Lipizzan Stud of Fogaras Studbook 5., 1885–1913; Lipizzan Stud of Bábolna and Szilvásvárad, 1950–1975).

Volume I of the Stutenprotokoll in Mezőhegyes between 1785 and 1880 was used, which helped us with a number of useful and non-negligible information.

The mare families in Fogaras were processed partly on the basis of the notes of János Romfeld (the manager of the romanian organization).

Study of Čačić, 2005; Čačić, 2010; Keresteš, 2008; Mandić and Rastija, 1997 helped us to process the Croatian mare families.

Regarding the original mare families, in addition to the literature listed above, Thomas Druml's notes helped us, too.

In addition, during the research we used the pedigree data found in the Hungarian Lipizzan

Breeders Association and the database of the National Association of Hungarian Horse Breeders.

As the first step of our work, we build the mare families in the Hungarian population. When making the family trees, we traced the origin of the mares currently living in the association register back to the founding mare on the maternal branch. As a second step, a pedigrological analysis of the Hungarian population was carried out, which gave us a real picture of the genetic composition of the Hungarian Lipizzan population. I create the branch drawings and process the data using the Microsoft Office 365 program.

RESULTS AND DISCUSSION

Number of mare families in the Hungarian population compared to the total number of mare families

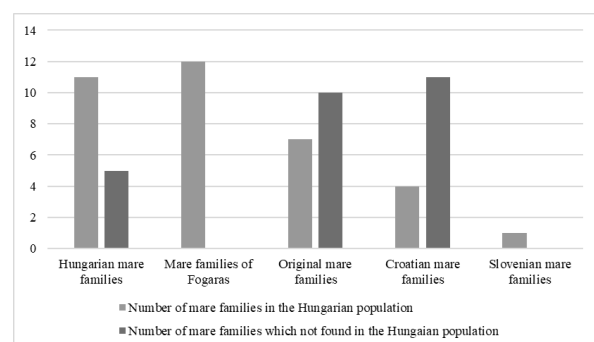
of the 61 mare families in the world, there are currently 35 mare families in the country. Surprisingly, all of the mare families from Fogaras are represented in the Hungarian population.

It is a matter of concern that one third of Hungarian families do not have a living individual in our country. They are all alive, of which 3 are present in Sweden, 1 in Bosnia-Herzegovina and 1 in Bosnia-Herzegovina and Croatia.

The majority of the original, Croatian and Slovenian mare families have a small number of individuals in the Hungarian pedigree register, their presence does not significantly affect the domestic breeding.

The ratio of the mare families that make up the population to the total mare families present in the world is illustrated in *Figure 1*.

Figure 1: The number of mare families in the world and Hungary



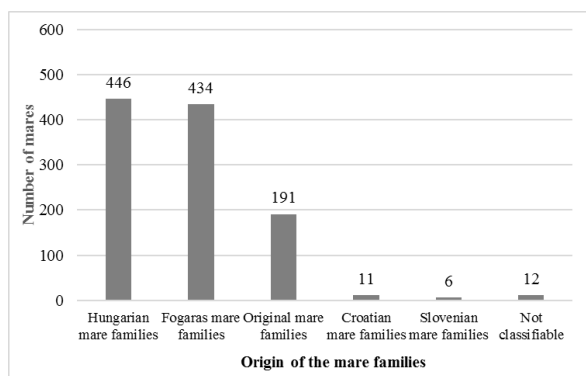
Characterization of the structure of the mare families that make up the population of The Hungarian population consists of 11 Hungarian, 15 families from Fogaras (3 of them registered in "B" studbook), 6 original, 5 Croatian and 1 Slovenian mare family. *Figure 3* shows the percentage distribution.

The proportion of Hungarian and the families of Fogaras is almost the same, both around 40%. The original mare families represent 17.09% of the population. The proportions of Croatian and Slovenian families are 1.27% and 0.55%.

The surprisingly high proportion of mare families in Fogaras is due to imports from Romania in recent decades.

Figure 2 and 3 illustrate the numbers and percentage distributions of mare families of different origins.

Figure 2: Number of individuals of mares by origin

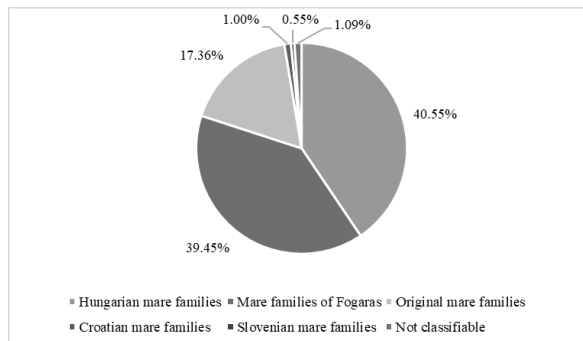


Out of the 38 mare families, there are 16 mare families in the Hungarian population with less than 1.0%. These include 2 Hungarians, 5 from Fogaras, the only Slovenian, 4 Croatian, and 6 original mare families.

There are 6 Hungarian and 9 mare families of Fogaras in the population between 1.01 and 5.0%.

Among them, 3 Hungarian and 3 families of Fogaras with a value between 5.01 and 10% are included.

Figure 3: Percentage of mares by origin



The original mare family, Presciana, has the highest number of individuals (172 mares) and, consequently over 10%. This represents 15.64% of the total mare population.

It can be stated that there is a significant difference between the mare families in terms of their number. Only 7 mare families make up 56.36% of the mare population. Considering the principles of gene conservation work, this condition cannot be considered favorable.

The number of mares in the population is shown in Figure 4, and their percentage distribution is shown in Figure 5.

Figure 4: Number of the mares in mare families in Hungary

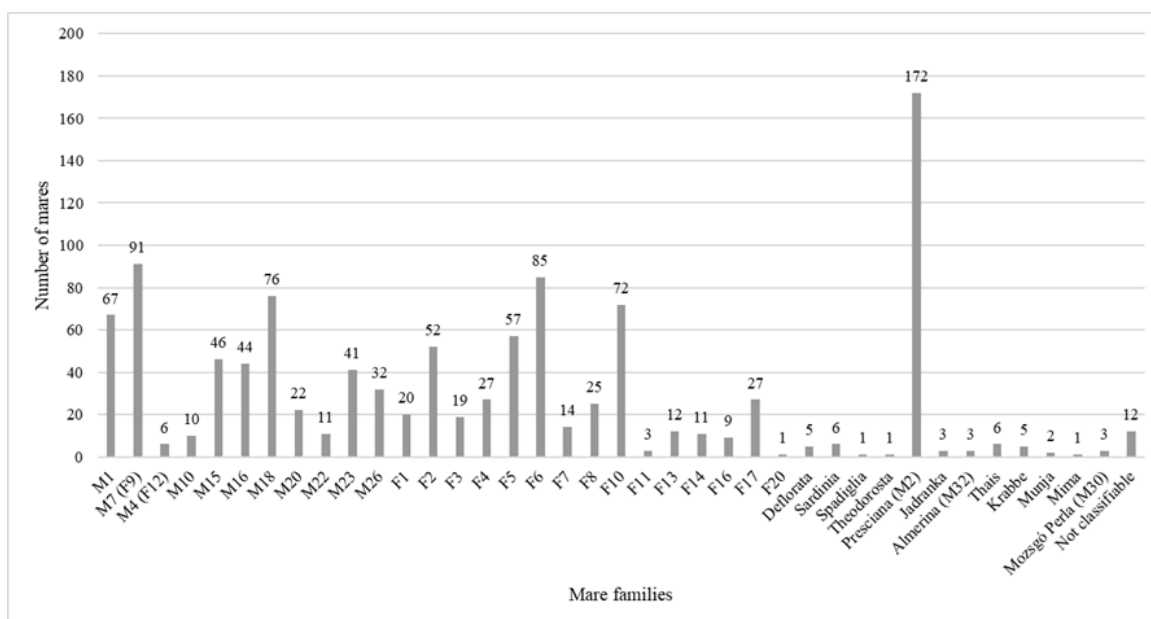
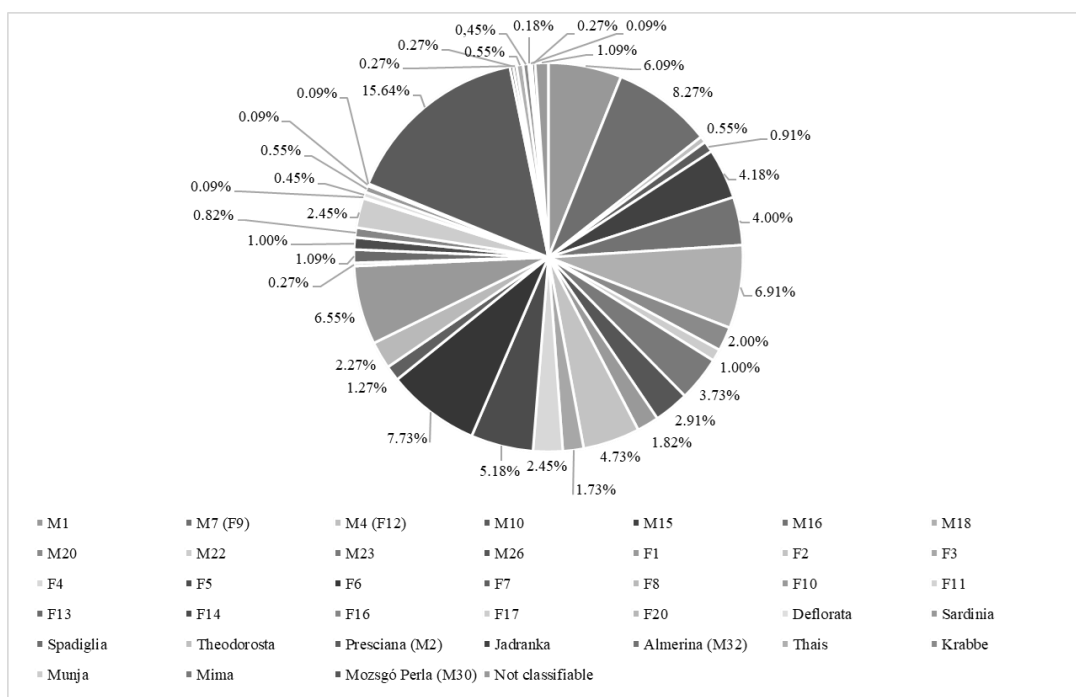


Figure 5: Percentage of mare families found in Hungary



The distribution of mare families may be unfavorable, yet the majority of families have a sufficient number of individuals (1–5% of the population = 11–55 mares) for long-term, safe maintenance. In the case of smaller number mares, efforts should be made to increase their numbers in order to make the balance of genetic diversity more favorable. Spacious mare families create the opportunity for greater selection pressure, thereby improving quality.

Hungarian mare families

The Hungarian population contains representatives of 11 Hungarian mare families with 446 mares.

As a result, the situation of the mare families is satisfactory, they are bred with 6 individuals in the 4th mare family with the least number of individuals. Three families have between 10 and 30 families and six families have between 30 and 80 individuals. Most of the 91 individuals, the mare family number 7, represent 20.4% of the Hungarian mare families.

Figure 6 and 7 illustrate the numbers and percentages of Hungarian mare families.

Mare families of Fogaras

There are 15 mare families of Fogaras in the Hungarian pedigree register (12 which in the “A” register), with a total of 434 mares contributing to the Hungarian population.

The Hungarian population includes the all mare families of Fogaras.

The situation for families is reassuring, with the exception of families 11th, 16th and 20th. In Except of this families the each other has minimum 10 mares.

Figure 8 and 9 illustrate the numbers and percentage distribution of mare families of Fogaras.

Figure 6: Individual numbers of Hungarian mare families

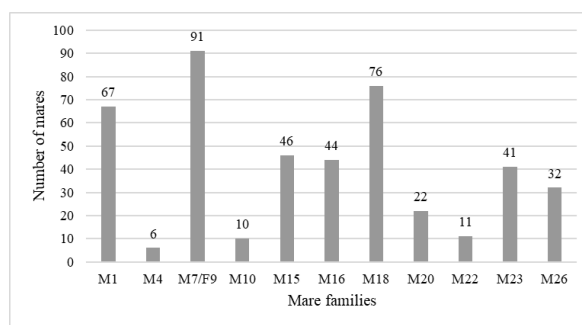


Figure 7: Percentage of Hungarian mare families

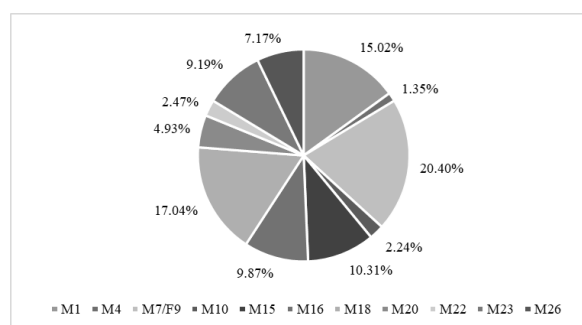


Figure 8: Number of individuals the mare families of Fogaras

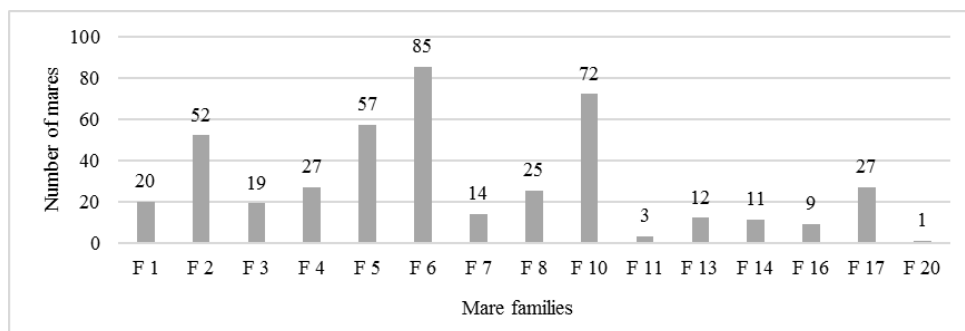


Figure 9: Percentage the mare families of Fogaras

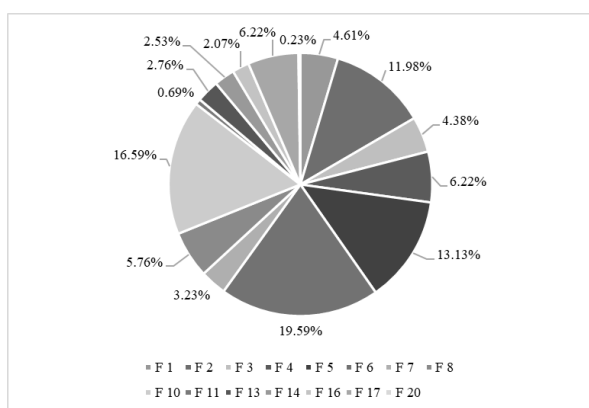
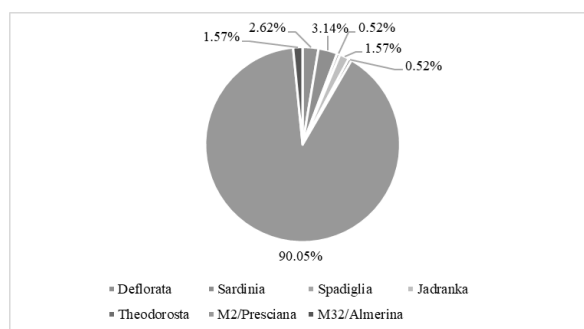


Figure 11: Percentage of original mare families

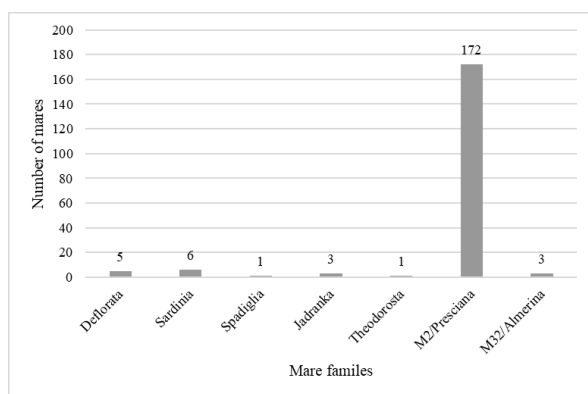


Original mare families

Representatives of 6 original mare families (191 mares) can be found in the Hungarian Lipizzan breed. Two families has only one mare, two family has 3 mares, one has 5 mares, another one family has 6 mares. The Presciana/Bradamanta mare family with 172 mares is the largest family in the Hungarian population.

The numbers and percentages of the original mare families are illustrated in Figure 10 and 11.

Figure 10: Individual numbers of original mare families

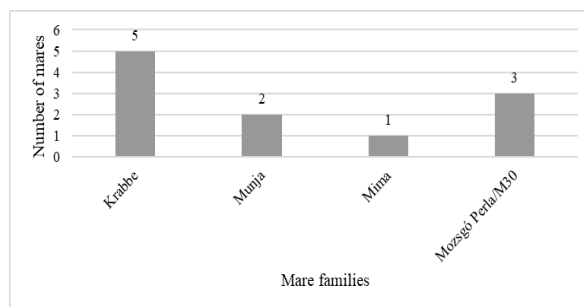


Croatian mare families

The Hungarian breeding organization registers only 11 mares out of 4 Croatian mare families. There are only 5 breeding animals from the most populous family, so these have a small effect on the genetic structure of the lipizzan breed in Hungary.

Figure 12 and 13 illustrate the numbers and percentages of Croatian mare families.

Figure 12: Individual numbers of Croatian mare families

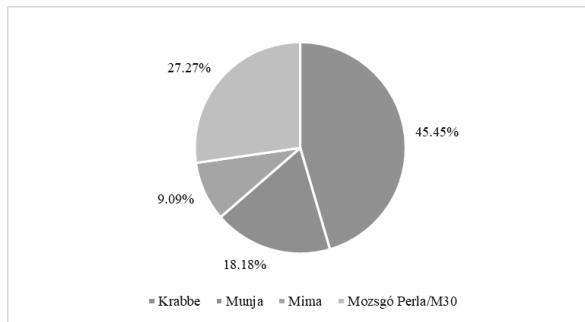


Slovenian mare family

The only Slovenian mare family is the Thais which has 6 mares registered.

Due to the small number of mares of this family, do not have a significant impact on the Hungarian population.

Figure 13: Percentage of Croatian mare families



CONCLUSIONS

In this study 35 out of a total of 61 mare families in the world were found in Hungary.

It is a matter of concern that there is no live mare from 5 Hungarian mare families in Hungarian breeding. Due to their cultural-historical value for the future, it is recommended to import the domestic breeding organization and pedigree of the breed into individuals belonging to these mare families and to maintain them, taking into account gene conservation tasks and reasonable breeding work.

In order to maintain the identity of the breed, in addition to the current population size, it is also recommended to start and maintain long-term domestic breeding program of all original mare families. In the first generations, this is likely to lead to a temporary change in the type over a few generations, but it can be eliminated by consistent breeding, using stallions belonging to the type typical of the Hungarian population.

Based on our investigations, the population consists of 11 Hungarian, 12 from Fogaras, 7 originals, 4 Croatian and 1 Slovenian mare families.

A significant part of the Hungarian and mare families from Fogaras have enough mares to keep them safe for a long time. In the case of families with a small number of individuals (<1% = 11 individuals), efforts should be made to maintain genetic diversity as much as possible and to increase their number. In the case of

large families (>5% = 55 individuals), efforts should be made to improve the quality due to the higher selection pressure, even by excluding individuals of poor quality from breeding.

The proportions of Croatian and Slovenian families are negligible, at 1.00% and 0.55%. In terms of their total proportion and the number of horses per mare families, they are not significant in Hungary either, thus they have a small impact on the Hungarian population.

The original mare families represent 17.36% of the Hungarian population. With the exception of one, they are in the same situation as Croatian and Slovenian families. Due to the long-term breeding of the Presciana/Bradamanta mare family in Hungary, it is the most populous of all families (172 mares).

The proportion of individual families is unbalanced, with only 7 mare families accounting for 56.36% of the total population. Considering the basic requirements of gene conservation, this condition cannot be considered optimal. In the future, we need to strike a balance in staff numbers.

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