

**REPRODUCTIVE PARAMETERS OF THOROUGHBRED MARES IN CROATIA****Korabi N, Baban Mirjana, Antunović B, Pavičić Ž, Ostović M, Tadić D,  
Jakšić D, Prvanović Babić Nikica****Summary**

For the purpose of gaining better cognition on Thoroughbred breeding in Croatia, reproductive parameters of 87 Thoroughbred mares were analyzed. An average age of the first covering and foaling were 5.9 and 6.6 years, respectively. The average gestation length was 341.1 days and the most frequent foaling period (20.2% of foalings) was recorded between 336 to 340 days of gestation. Prolonged gestation period ( $p < 0.05$ ) was determined in colts. The gestation length was the longest in January (344.4 days) and the shortest in July (324.0 days). Between the gestation length and the age of the mare no significant correlation was found. There was a trend of foaling rate decreasing in mares older than 11 years. The highest number of successively registered foalings with 10 live born foals was observed on 2 individual samples. The greatest number of foalings occurred in April (30.9%), whilst there was no foaling in October. The genders were 50.6% male and 49.4% female foals. The incidence of abortions was 7.3%. Although indicators point to the breeding strategy heading towards the right direction, by educating the owners and with frequent veterinary supervision, especially for twin reduction, the reproductive performance could be enhanced.

Key words: Croatia, mares, reproductive parameters, Thoroughbred.

**Introduction**

The beginning of the Thoroughbreds dates back from the end of the 16<sup>th</sup> century, when the first Arabian horses captured in Crusades arrived to Europe. At first the breed had great performance value, whilst today it is almost exclusively a racing breed used for gallop races.

Thoroughbred horses are introduced into training and sports activities as the two-year-olds and compete for many years (Hartley Edwards, 2008). During this time they are constantly exposed to physical strain, stress, medical products and special feeding programs, all above mentioned factors leading to deviation of certain reproductive parameters (Taveira and Mota, 2007). Fertility of Thoroughbred mares is low. Cunningham (1991) states that there is a little over 50 foals foaled *per* 100 Thoroughbred mares on a global level. A slightly larger percentage at about 67% was noted within the Thoroughbred population in Ireland. On contrary, recent studies published on complete Thoroughbred flatrace population in the United Kingdom have shown that with proper reproductive management approximately 80% of mares produce a vital alive foal (Allen *et al.*, 2007).

The reproductive parameters of the Thoroughbred mares in Croatia horse breeding are poorly investigated, although equine reproduction research has been continuously performed for many decades. The members of the "Croatian Thoroughbred Breeders Association" in 1998 had in total 51 mares and fillies intended for breeding. Only 37 of them were covered and 27 conceived (73%), delivering 22 vital foals (Sukalić *et al.*, 2000). However, considering the European trends in horse breeding and to gain a better perspective and the possibility of greater prosperity at an international level, it is pertinent to obtain as many knowledge as possible regarding the breeding of sports horses in Croatia, including their reproductive performance as integral part of horse breeding strategy.

The aim of the present study was to analyse the reproductive parameters of Thoroughbred mares in Croatia.

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## Material and Methods

A data for this study was obtained, from the Central Registry of Equidae of the Republic of Croatia at the Croatian Center for Horse Breeding - State Stud Farms Đakovo and Lipik. The analysis of reproduction parameters included 87 Thoroughbred broodmares registered in the Central Registry in year 2010. The mares were aged 6 to 25 years (Table 1), reproductively effective in period between ages 4 to 21, with altogether 314 foalings of alive foals (Figure 2). Since a high percentage of broodmares are imported mares which were reproductively fully mature at the time of import, the analysis of the age of the first covering ( $n=31$ ) and the age of the first foaling ( $n=38$ ) was only conducted on mares which have had their first covering and foaling registered in the Croatia. Considering that the actual period of ovulation (insemination) is not possible to determine without the use of an ultrasound, the gestational length was calculated from the date of the last covering of the stallion till the date of foaling, and the analysis was performed, according to the availability of information, on the total of 267 foalings (Tables 2-3, Figure 1). In the statistical processing of the data and demonstration of the results, the following programs were used: SPSS Statistics 17.0 (2008), Statistica 7.0 (Stat Soft, Inc. 1984-2004) and Tesio Power 5.0 (Syntax Software, 2002).

Table 1. – OVERVIEW OF THE NUMBER OF MARES IN THE STUDY ACCORDING TO THEIR AGE

Mare (n)	Age of mare (years)
1	6
5	7
5	8
8	9
11	10
9	11
7	12
3	13
5	14
3	15
8	16
6	17
2	18
1	19
4	20
1	21
4	22
3	23
0	24
1	25

Table 2. – OVERVIEW OF THE GESTATION LENGTH AND NUMBER OF FOALINGS ACCORDING TO MONTHS

Month of foaling	Foaling (n)	Gestation length (days) Mean±SD
January	5	344.4±10.1
February	23	341.8±14.5
March	63	342.4±11
April	89	341.7±9.2
May	59	340.6±11.1
June	14	339.6±7.5
July	2	324.0±7.1
August	8	335.8±8.8
September	3	332.7±12.4
October	0	-
November	1	333.0±0.0
December	0	-

Table 3. – THE TREND OF GESTATION LENGTH IN MARES IN RELATION TO AGE DURING FOALING

Foaling (pregnancy) (n)	Age of pregnant mare (years)	Gestation length (days) Mean±SD
2	4	341.5±0.7
20	5	340.1±11.7
21	6	341.0±8.1
19	7	337.1±12.8
34	8	340.5±12.1
30	9	336.9±7.5
27	10	343.7±11.6
30	11	343.7±11.6
18	12	340.9±9.7
14	13	345.7±10.3
11	14	342.6±9.0
8	15	342.0±8.4
10	16	345.5±7.9
6	17	337.3±10.0
8	18	341.1±10.9
3	19	336.3±2.5
4	20	339.3±13.7
2	21	355.5±14.8

Figure 1. – PROPORTION OF AN AVERAGE GESTATION LENGTH REGARDING INTERVALS

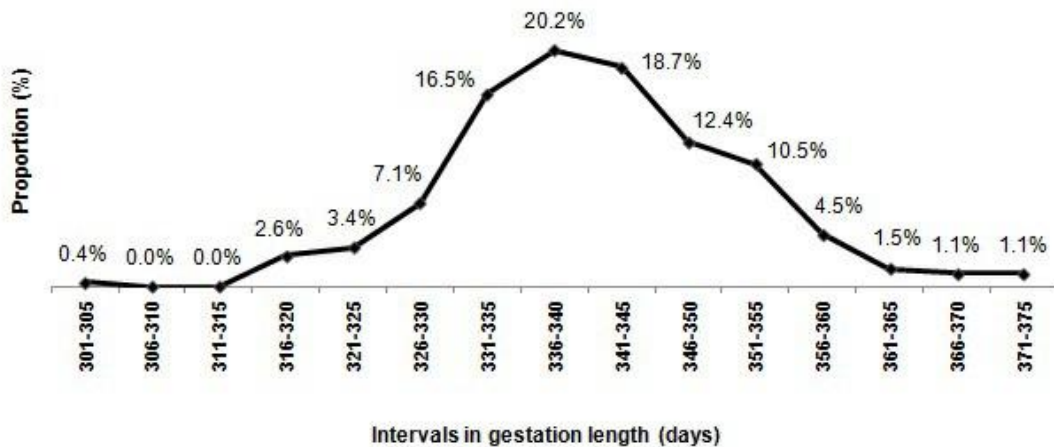
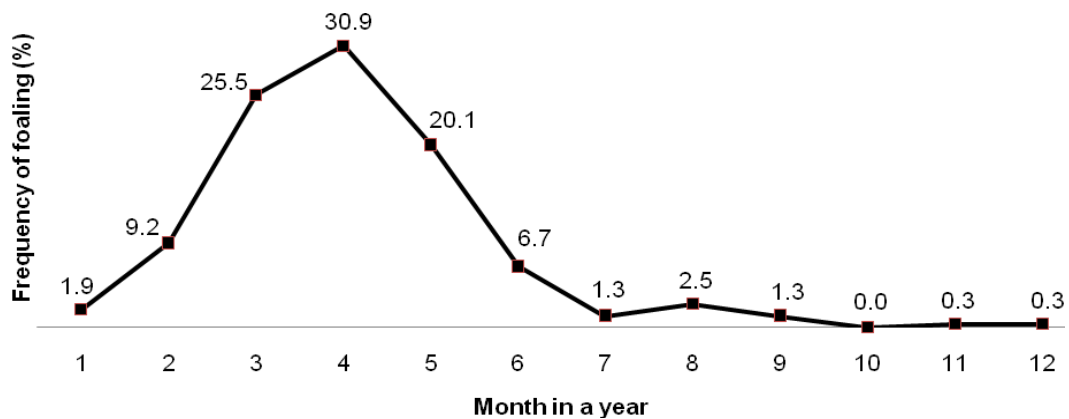


Figure 2. – OVERVIEW OF THE FREQUENCY OF FOALING ACCORDING TO MONTHS



## Results

*The first covering and foaling.* The average age in which a mare was first covered was  $5.9 \pm 1.7$  years, while the first foaling was recorded at the average age of  $6.6 \pm 1.8$  years.

*The gestation length.* The average gestation length was  $341.1 \pm 10.7$  days, and the most frequent foaling period, with up to 20.2% of foalings, was recorded from 336 to 340 days of gestation (Figure 1). Comparing the average gestation length in relation to gender statistically significant difference ( $p < 0.05$ ) between male ( $342.9 \pm 11.0$  days) and female foals ( $338.9 \pm 9.9$  days) was determined. With regard to month of foaling the longest gestation length on an average was recorded in January ( $344.4 \pm 10.1$  days) and the shortest in July ( $324.0 \pm 7.1$  days) (Table 2). Between the gestational length and the age of the mare (Table 3) no significant correlation was found.

*Foaling.* There was a considerable decreasing in foaling rate in mares older than 11 years (Table 3). The highest number of successively registered foalings was 10 live born foals and was recorded on 2 individual samples. The greatest number of foalings was recorded in April (30.9%), whereas no foaling was recorded in October. According to trimesters, the highest number of foalings (57.7%) occurred from April to June, and the smallest from October to December (0.6%) (Figure 2).

*The proportion of genders.* The proportion of genders in the overall registered progeny of Thoroughbred mares ( $n=314$ ) was 50.6% of male and 49.4% of female foals. Analyzing only a sample of purebred Thoroughbred foals born in Croatia ( $n=212$ ), the ratio of genders does not differ significantly, and it is 50.2% of colts and 49.8% of fillies.

*Abortion.* In the Thoroughbred Registry of the Republic of Croatia there are 21 registered cases of abortion (7.3%). The maximum number of registered abortions *per* mare is 2 abortions, and it was recorded in 4 mares. The average duration of an aborted pregnancy in a mare was  $227.9 \pm 69.3$  days. Analysis according to the number of aborted fetuses indicates that in 50% of the cases the mares aborted twins, and in 50% of these cases the twins were of a different gender.

## Discussion

The average age of the first covering as well as the first foaling of Thoroughbred mares in the present study was mostly the consequence of introducing young female horses into sports activities before introducing them into breeding, i.e. testing their performances as an important segment for breeding assessment. If compared to the present study Taveira and Mota (2007) found a lower average age at first covering (4.9 years) and foaling (6.0 years), while Hevia *et al.* (1994) recorded higher average age of the first foaling (6.9 years) in the Thoroughbred mares. Nevertheless, studies on other breeds point to a different strategy in breeding, since the average age of the first foaling in Traditional Arabian mares was 5 years (Rastija *et al.*, 1992), in coldblood breed Croatian Posavac was 3.8 years (Čačić *et al.*, 2002a), in Lipizzan horses was 4 years (Čačić *et al.*, 2002b), and 3.6 years (Žanić *et al.*, 2009).

In comparison to the average gestation length in mares, which ranges between 320 and 335 days (with shorter gestation period in pony breeds) (Davies Morel, 1993), in this study 27% of the foals were foaled during that interval (Figure 1). Comparing studies concerning the same breed, the obtained average gestation length was shorter in relation to the results obtained by Davies Morel *et al.* (2002) (344.1 days) and longer than the study of Romić (1976) (329.8 days) and Hevia *et al.* (1994) (337.2 days). In relation to other breeds, the results of this study point out a shorter gestation length in comparison to the Fjord pony (342.2 days), Dutch Coldblood (343.3 days) (Bos and van der Mey, 1980), Icelandic horse (350.0 days) (Dýrmundsson, 1994), and Trotters (343.3 days) (Marteniuk *et al.*, 1998), and prolonged in relation to the Shetland pony (337.2 days), Friesian horse (337.7 days) (Bos and van der Mey, 1980), Lipizzan (329.9 days) (Baban, 1996), Nonius breed (332.4 days) (Hura *et al.*, 1997), Carthusian breed (339.0 days)

(Pérez *et al.*, 2003), Andalusian breed (336.8 days) and Arabian Purebred (340.3 days) (Valera *et al.*, 2006). The average gestation length of Thoroughbred mares in this study was the most similar to the Haflinger breed study (Bos and van der Mey, 1980), where the average determined gestation length was 341.3 days.

Numerous studies of gestation duration in relation to foal gender emphasise prolonged gestation in male foals (Bos and van der Mey, 1980; Stipić, 1980; Hevia *et al.*, 1994; Hura *et al.*, 1997; Marteniuk *et al.*, 1998; Davies Morel *et al.*, 2002; Čačić *et al.*, 2002b; Pérez *et al.*, 2003; Taveira and Mota, 2007). The same result was confirmed in this study as well. The reason is considered unknown, however it has been often attributed to diverse endocrine functions in male and female fetuses whose interaction with the endocrine control of the partus is different (Jainudeen and Hafez, 2000).

Howell and Rollins (1951) in the study on a population of Arabian horses concluded that the gestation length is greatly influenced by the foaling season, and that the pregnancies were in average 10.4 days prolonged in the period from December to May in comparison to the ones from June to November. That thesis is also supported in our study. Considering the relations between gestation length and month of foaling in the same breed, the results of this study (Table 2) are similar to the ones obtained by Rophia *et al.* (1969), whereas Davies Morel *et al.* (2002) determined the shortest gestation length in January, and the longest in April. In the study of Howell and Rollins (1951), the results of comparing mares in different physical condition pointed to the fact that the quality of feeding is also of great influence on the gestation length, i.e. a group of well fed mares carried a fetus approximately 4 days shorter than the ones fed on the level of their basic needs. Seeing how the influence of the foaling season and feeding is mutually independent, it is considered that another factor connected to the foaling season and feeding is responsible for the variability of the gestation length. They concluded that the influence of seasonal variability of day length and its influence on the endocrine system of the mare is in question, what had been proved in other studies (Bos and van der Mey, 1980; Davies Morel *et al.*, 2002; Pérez *et al.*, 2003). In this study above mentioned facts related to the season of foaling were also confirmed (Figure 2).

Obtained study results had shown a decreasing trend of foaling rate in mares older than 11 years (Table 3), that is similar to results published by Brück *et al.* (1993). The range of the mares' age at the time of foaling in the present study was in a wide range. If the extremely long mean gestation length of mares at 21 years of age (n=2) are excluded from the overview, it is visible that a somewhat shorter gestation length is determined with younger and older mares (Table 3). However, between the gestation length and the age of the mare no significant correlation was found. Bos and van der Mey (1980) noted that mares which had their first foals in three years of age carry the foal longer than the older ones. On contrary, Davies Morel *et al.* (2002) haven't established a statistical correlation with the age of the dam, what is in accordance with our study, but stated that in their study Flade and Feredich (1963) and Geissler (1941) established that older mares carried the foal longer in relation to younger mares, which is explained by the decreased blood flow and consequently nutrition through the uterus and the placenta in older mares which consequently lengthens the pregnancy interval. Recent studies introducing modern techniques such as immunohistochemistry and Doppler had proved these assumptions. Interference of endometrial surface density, endometrial glands activity and circulatory blood flow in uterus with intensity and dynamics of foetal development influenced pregnancy length combined with parity (Heidler *et al.*, 2004; Lefranc and Allen, 2007; Prvanović *et al.*, 2008).

The proportion of genders in this study is, as expected, consistent with natural laws of gender proportion. A similar proportion of 50.9% male and 49.1% female foals were also noted by Baban (1996) in the Lipizzan breed.

The incidence of abortions in the present study was within expected limits (McKinnon and Voss, 1993). However, abortion incidence caused by twins was two times higher than previously

reported (50% versus 20-30% according to Samper *et al.*, 2007) and this could be attributed to lack of professional reproductive control of the mares with respect to poor breeding management.

### Conclusion

It is concluded that the Thoroughbred is a specific breed in regards to physical growth and development of the horse combined with introduction to professional training, which reflects on reproduction parameters. However, it needs to be taken into consideration the fact that the Thoroughbred population in Croatia is small, and consequently this study included a small number of mares. Although indicators point to the breeding strategy heading towards the right direction, by educating the owners and with frequent veterinary supervision, especially for twin reduction, the reproductive performance could be enhanced.

### REFERENCES

1. Allen WR, Brown L, Wright M, Wilsher S, 2007, Reproductive efficiency of Flatrace and National Hunt Thoroughbred mares and stallions in England, *Equine Vet J*, 39, 438-45.
2. Baban M, 1996, Genetic analysis of morphological and reproductional traits in population of Lipizzan horses, Master Thesis, Faculty of Agriculture, University of Zagreb, Zagreb, Croatia.
3. Bos H, van der Mey GJW, 1980, Length of gestation periods of horses and ponies belonging to different breeds, *Livest Prod Sci*, 7, 181-7.
4. Brück I, Anderson GA, Hyland JH, 1993, Reproductive performance of Thoroughbred mares on six commercial stud farms, *Aust Vet J*, 70, 299-303.
5. Cunningham P, 1991, The Genetics of Thoroughbred Horses, *Sci Am*, 264, 92-8.
6. Čačić M, Caput P, Ivanković A, 2002a, Reproduction characteristics of Posavina mares, *Stočarstvo*, 56, 163-74.
7. Čačić M, Caput P, Ivanković A, 2002b, Comparison of reproduction characteristics of pure blood Lipizzaner mares and Lipizzaner mares of deficient origin, *Stočarstvo*, 56, 91-103.
8. Davies Morel MCG, 1993, *Equine Reproductive Physiology, Breeding and Stud Management*, UK: Farming Press Books.
9. Davies Morel MCG, Newcombe JR, Holland SJ, 2002, Factors affecting gestation length in the Thoroughbred mare, *Anim Reprod Sci*, 74, 175-85.
10. Dýrmundsson ÓR, 1994, Reproduction of Icelandic horses with special reference to seasonal sexual activity, *Icel Agr Sci*, 8, 51-7.
11. Flade JE, Frederich W, 1963, Contribution to the problem of gestation length in the horse and factors relating to it, *Arch Tierz*, 6, 505-20.
12. Geissler H, 1941, Duration of pregnancy in the horse, Dissertation, Faculty of veterinary medicine, University of Hanover, Hanover, Germany.
13. Hartley Edwards E, 2008, *The Encyclopedia of the Horse*, New York: Dorling Kindersley Book.
14. Heidler B, Aurich JE, Pohl W, Aurich C, 2004, Body weight of mares and foals, estrous cycles and plasma glucose concentration in lactating and non-lactating Lipizzaner mares, *Theriogenology*, 61, 883-93.
15. Hevia ML, Quiles AJ, Fuentes F, Gonzalo C, 1994, Reproductive performance of thoroughbred horses in Spain, *J Equine Vet Sci*, 14, 89-92.
16. Howell CE, Rollins WC, 1951, Environmental sources of variation in the gestation length of the horse, *J Anim Sci*, 10, 789-96.
17. Hura V, Hajurka J, Kacmárik JJ, Csicsai G, Valocky I, 1997, The effect of some factors on gestation length in nonius breed mares in Slovakia, UVL, 04101 Kosice, Komenského 73, Slovak Republic.
18. Jainudeen MR, Hafez ESE, 2000, Gestation, prenatal physiology and parturition, In: Hafez ESE, Hafez B, editors, *Reproduction in farm animals*, 7th ed, Maryland, USA: Lippincott Williams & Wilkins, 140-55.

19. Lefranc AC, Allen WR, 2007, Influence of breed and oestrus cycle on endometrial gland surface density in the mare, *Equine Vet J*, 39, 506-10.
20. Marteniuk JV, Carleton CL, Lloyd JW, Shea ME, 1998, Association of sex of fetus, sire, month of conception, or year of foaling with duration of gestation in Standardbred mares, *J Am Vet Med Assoc*, 212, 1743-5.
21. McKinnon AO, Voss JL, 1993, *Equine Reproduction*, USA: Williams & Wilkins.
22. Pérez CC, Rodríguez I, Mota J, Dorado J, Hidalgo M, Felipe M et al., 2003, Gestation length in Carthusian Spanishbred mares, *Livest Prod Sci*, 82, 181-7.
23. Prvanović N, Cergolj M, Čačić M, Gašpar A, Horvat S, Grizelj J et al., 2008, Influence of breed, parity and age on reproductive efficiency and conception rate of mares, *Proceedings of the 4th Croatian Veterinary Congress*, 5-8 November, Šibenik, Croatia, 239-45.
24. Rastija T, Baban M, Barišić A, 1992, Reproduction traits and body measurements in Arabian horses, *Znan prak poljop tehnol*, 22, 117-20.
25. Romić S, 1976, Thoroughbred horse, *Veterinaria Sarajevo*, 25, 127-36.
26. Rophia RT, Mathews RG, Butterfield RM, Moss FP, McFadden WJ, 1969, The duration of pregnancy in Thoroughbred mares, *Vet Rec*, 84, 552-5.
27. Samper JC, Pycck JF, McKinnon AO, 2007, *Current Therapy in Equine Reproduction*, USA: Saunders, Elsevier.
28. Stipić L, 1980, Results of research on morphological and some production traits in Zobnatica english halfblood horse, *Dissertation*, Faculty of Agriculture, University of Osijek, Osijek, Croatia.
29. Sukalić M, Makek Z, Sukalić T, Nushol Z, 2000, Fertility of English Thoroughbred mares in Croatia, *Stočarstvo*, 54, 81-9.
30. Taveira RZ, Mota MDS, 2007, Genetic and quantitative evaluation of breeding traits in thoroughbred mares, *REDVET*, 8, 1-11.
31. Valera M, Blesa F, Dos Santos R, Molina A, 2006, Genetic study of gestation length in andalusian and arabian mares, *Anim Reprod Sci*, 95, 75-96.
32. Žanić N, Baban M, Antunović Z, Mijić P, Čačić M, Antunović B et al., 2009, Reproduction traits of Lipizzan mares in Lipizzan State Stud Farm Đakovo, *Proceedings of the 44th Croatian and 4th International Symposium of Agriculture*, 16-20 February, Opatija, Croatia, 762-6.

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