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Different Effects of Month of Conception and Birth on Gestation Length in Mares

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Abstract: Equine prenatal development is subjected to a great variety of effects. The aim of the study was to compare the effects of the month of conception and month of birth on gestation length in mares. Data from 321 pregnancies were used. The conception occurred between February and August. Mares that conceived early in the year had a longer gestation than mares that conceived later in the breeding season ($p<0.001$). Foals were born between January and July. The gestation period increased in mares that foaled from January to April ($p<0.001$) and then decreased in later months. Mares carrying male fetuses had a longer gestation ($p<0.05$) than those carrying female fetuses. Mare age, stud farm and year of foal birth had no significant influence on gestation length. In conclusion, the data suggest that the effects of the month of conception and month of foaling on gestation length are the reverse in the first third of the year.

Key words: Gestation length, horse, conception, parturition, foal sex

INTRODUCTION

Accurate prediction of parturition is an important aspect in managing equine pregnancy and parturition, especially in high-risk mares. However, the variation in clinical signs of imminent parturition makes the prediction of foaling particularly difficult. In addition, equine fetal maturity and readiness for birth are difficult to determine based on the gestational age because of marked variability in gestation length (Valera *et al*., 2006). The inability to accurately predict the timing of parturition incurs extra labor and veterinary costs and higher risks to both mare and foal. Preparations for impending parturition would be more efficient if further information on the expected date of parturition was available. Any findings that may be used to help determine the exact time of foaling are, therefore of considerable interest to horse breeders (Morel *et al*., 2002).

The average length of pregnancy in mares ranges from 333 days (Meliani *et al*., 2011) to 344 days (Morel *et al*., 2002) but there is tremendous variation among mares. Extremes of gestation ranging from 305 to >400 days have been reported with viable foals being born (Hintz *et al*., 1979; Card and Hillman, 1993). Prenatal development from conception to birth is affected by many intrinsic and extrinsic factors including the month of conception, sex of the foal, year of breeding, age of the mare and breed (Satue *et al*., 2011). The effect of the month of conception on gestation length has been reported in several studies (Hintz *et al*., 1992; Marteniuk *et al*., 1998; Perez *et al*., 2003; Cilek, 2009; Meliani *et al*., 2011). In all of these investigations, mares that conceived early in the year had a longer gestation than mares that mated at the end of the breeding season. On the other hand, the effect of the month of foaling on gestation length was investigated only by Morel *et al*. (2002). Mares that foaled in January had shorter gestation than mares that foaled in April. To the knowledge no study has simultaneously analyzed the effects of the month of conception and month of foaling on gestation length in mares.

The main objective of this study was to compare the effects of the month of conception, month of foaling and their interaction on gestation length in mares. Simultaneously, researchers examined the influences of foal sex, mare age, stud farm and year of foal birth on gestation length.

MATERIALS AND METHODS

Animals: The records for 321 Czech Warmblood mare pregnancies all of which were conceived and foaled on four horse stud farms within the Moravian area of the Czech Republic at latitude of 50 degrees North were studied. All mares were kept under a natural photoperiod. The pregnancies selected were all pregnancies that produced a single live foal during 2004 to 2011. The length of gestation was determined as the time between ovulation and the date of foaling. Daily ultrasound examinations of ovaries were performed to determine the

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moment of ovulation in estrous mares. Mating was carried out on the basis of ultrasound scanning evidence regarding the imminence of ovulation (Morel *et al*., 2002). The age of the mares ranged from 3-21 years, with only a few of the oldest age. Therefore, the age of the mare was treated on an annual basis except for the oldest mares where one category was allocated for mares 18 years and older.

Statistical analysis: Statistical evaluation of the data was performed using the SAS Software (SAS Institute Inc., Cary, NC, USA). Data for the length of gestation, measured from ovulation to foaling were evaluated using the mixed model procedure. The model included the fixed effects of the month of conception, month of foaling, foal sex, mare age, stud farm, year of foal birth and their two-way interactions. In the model, the mare was used as the random variable. The χ^2-test was used to analyze the ratio of colt to filly foals. All data were reported as the mean±SEM and results were considered significant at $p<0.05$.

RESULTS AND DISCUSSION

The mean gestation length for 321 mares was 339.2±0.63 days with a range of 305-392 days. The coefficient of variation was 3.34%. All pregnancies resulted in viable foals. There was no significant difference in the percentage of colt and filly foals born, 48.6% (156) colts, 51.4% (165) fillies.

There were no significant effects of the age of the mare (Table 1), stud farm (Table 2) and year of foal birth (Table 3) on gestation length as well as two-way interactions throughout all the factors examined in the present study. As these factors did not have a significant effect they were excluded from the statistical model. The only factors that had a significant effect on gestation length were the month of conception, month of foaling and foal sex.

The effect of the month of conception on gestation length is shown in Fig. 1. Mares conceived between February (5 mares) and August (14 mares) with the majority in May (93 mares). The length of gestation decreased as the months of conception progressed ($p<0.001$), reaching the highest value when conception occurred in February (345.8±7.64 days) and the lowest when conception occurred in August (333.2±2.61 days).

The effect of the month of birth on gestation length is presented in Fig. 2. Foals were born between January (5 foals) and July (14 foals) with the majority in May (98 foals). Significant differences in gestation length between foaling months were observed. The shortest gestation was found at the beginning of the year, January (330.0±4.47 days). Thereafter, the length of gestation increased as foaling months progressed ($p<0.001$), reaching a peak in April (342.2±1.08 days) and in later months it decreased.

Table 1: The mean (±SEM) gestation length (days) in mares of the different age (years)

Mare age	n	Gestation length
3	23	334.8±1.23
4	13	340.2±2.81
5	10	331.6±2.25
6	28	339.1±1.91
7	16	339.5±2.38
8	27	336.7±2.36
9	23	340.1±2.18
10	25	339.5±1.74
11	19	342.4±2.08
12	22	337.2±2.54
13	26	338.7±2.57
14	20	336.6±2.59
15	27	342.6±3.05
16	12	340.0±3.56
17	11	336.5±3.27
18	7	348.9±3.23
19	7	351.7±5.48
20	4	341.8±3.71
21	1	340.0±0.00

Table 2: The mean (±SEM) gestation length (days) in mares on different stud farms

Stud farm	n	Gestation length
1	57	340.3±1.65
2	135	339.1±0.91
3	87	338.0±1.26
4	42	340.3±1.80

Table 3: The mean (±SEM) gestation length (days) in mares in different years of foaling

Year of foaling	n	Gestation length
2004	27	339.1±1.93
2005	29	338.9±2.30
2006	35	339.0±1.81
2007	46	339.2±1.41
2008	40	339.8±1.84
2009	43	337.5±1.71
2010	57	340.3±1.65
2011	44	339.2±1.88

The effect of the sex of the foal on gestation length is given in Fig. 3. The average gestation was longer ($p<0.05$) in mares carrying male fetuses (340.2±0.97 days) than when carrying female fetuses (338.5±0.88 days).

Month of conception: The length of gestation shortened as conception months progressed. Mares that conceived early in the year had a considerably longer gestation than mares that conceived later in the breeding season. The average gestation was >12 days longer in mares that conceived in February at the beginning of the breeding

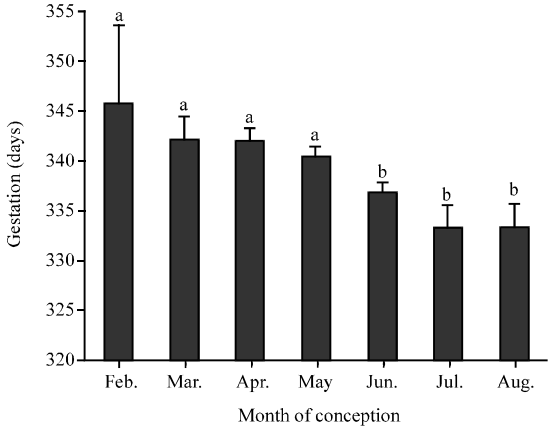

Fig. 1: The mean (SEM) gestation length in mares that conceived in different months of the year (February (n = 5), March (n = 27), April (n = 79), May (n = 93), June (n = 77) and July (n = 26), August (n = 14), means with different superscripts differ at p<0.001

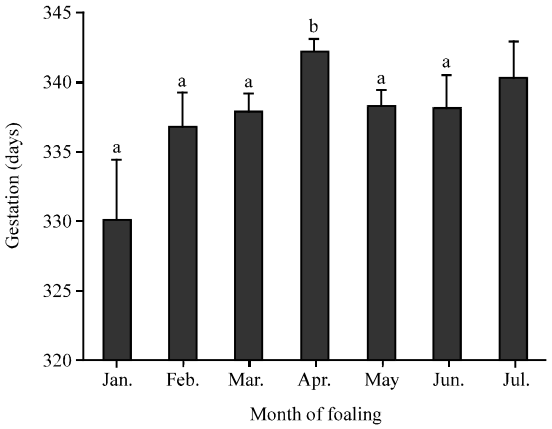

Fig. 2: The mean (SEM) gestation length in mares that foaled in different months of the year (January (n = 5), February (n = 19), March (n = 68), April (n = 89), May (n = 98) June (n = 28) and July (n = 14), means with different superscripts differ at p<0.001

season than at the end of the season in August. That represents a decrease of about 2.1 days per month. This phenomenon was also reported in other studies (Hintz *et al*., 1992; Marteniuk *et al*., 1998; Perez *et al*., 2003; Meliani *et al*., 2011). Based on these findings, a longer gestation resulting from earlier breeding was most likely related to extrinsic factors associated with the timing of breeding.

Mares are seasonal long day breeders and in the Northern Hemisphere their natural breeding season begins in April (Ginther, 1992). This is triggered mainly by

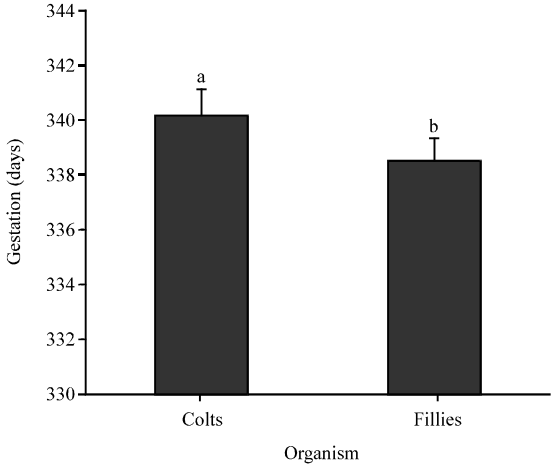

Fig. 3: The mean (SEM) gestation length in mares that carried male (n = 156) and female (n = 165) fetuses, means with different superscripts differ at p<0.05

an increase in the photoperiod (Palmer and Guillaume, 1992). Some equine farms prefer that births occur at the beginning of the year (Satue *et al*., 2011) which can be achieved by breeding mares before the natural breeding season. The application of supplemental lighting treatments during the season with a shorter photoperiod stimulates ovarian follicular activity since, the long photoperiod advances the date of the first ovulation after the Winter anestrus (Scraba and Ginther, 1985). The longer gestation in mares conceived at the beginning of the year indicates that some unknown mechanism attempts to bring mares back into the natural foaling season (early spring) when environmental conditions are favorable for the survival of the offspring.

Month of foaling: Differences in gestation length between foaling months are evident in mares. The shortest gestation was found when foals were born in January. The longest gestation was seen when foals were born in April and in later months it decreased. The average gestation was >12 days longer in mares that foaled in April than in January. A significant increase in the length of gestation in mares that foaled from January to April was also reported by Morel *et al*. (2002). Thus, the effects of the month of conception and month of foaling on gestation length are the reverse from January to April. Moreover, the lack of a significant interaction suggests that the effects of the month of conception and month of foaling on gestation length are independent. On average, equine gestation lasts 340 days. Therefore, mares conceive and give birth practically in the same season of the year. Taken together, researchers assume that

environmental factors may have different effects on the prenatal development in connection with the time of conception and foaling.

The climate, in particular the photoperiod and ambient temperature are thought to affect the timing of foaling (Morel *et al*., 2002). Mares usually give birth during the spring season to assure the best conditions for the survival of foals. Consistent with this, the majority of mares foaled in April and May. Similarly, a shorter gestation in mares that foaled later than in April is in agreement with the tendency to ensure that foals are born at an appropriate time of the year. The fact that the long photoperiod reduces gestation length is supported by the finding that pregnant mares subjected to 16 h of daily light from the beginning of December, advanced the date of parturition in relation to mares exposed to natural light (Hodge *et al*., 1982). On the other hand, the reason why gestation length gradually increased in mares that foaled from January to April is unclear.

Foal sex: A higher proportion of colts than fillies were born in the study of Morel *et al*. (2002). A similar but not significant tendency was found in the present study. It is accepted that colt foals are carried longer in the uterus than fillies (Marteniuk *et al*., 1998; Morel *et al*., 2002; Valera *et al*., 2006; Cilek, 2009). Similarly in the study, the development of males from conception to delivery was longer than the development of females. The reason why male offspring have longer gestation than female offspring is still unclear. It is hypothesized that the difference is due to different endocrine functions of male and female fetuses interacting differently with the endocrine control of parturition (Jainudeen and Hafez, 2000).

Mare age: The effect of the age of mares on gestation length was not significant. Similarly, other studies failed to detect differences in gestation length when comparing mares of different ages (Morel *et al*., 2002; Winter *et al*., 2007). On the other hand, the age of the mare has been considered an important factor determining gestation length in several studies (Valera *et al*., 2006; Cilek, 2009; Meliani *et al*., 2011). The different distribution of mares with and without the age-related degenerative changes in the endometrium in different age groups could be one of the reasons for these differences. The deleterious effect of age on the formation of the microcotyledons was provided by Wilsher and Allen (2003) who showed that the surface density of the microcotyledons (surface area per unit volume) is signicantly reduced as the mares become older. Age-related degenerative changes in the mare's endometrium which result in fibrous deposition in the endometrial stroma reduce the ability of the endometrium to interdigitate closely and extensively with the allantochorion after day 40 of gestation also cause nutritional deprivation owing to the reduced total area of contact between the fetal and maternal epithelial layers at the placental interface (Wilsher and Allen, 2012).

Stud farm: The length of gestation may vary among different stud farms (Satue *et al*., 2011). However, there were no significant differences among farms in the study. The same finding was reported by Morel *et al*. (2002). This may be explained by similar environmental conditions and management regimes on farms. The equine breeds that reside in regions of similar latitudes have a similar gestation length and are affected by similar factors (Satue *et al*., 2011).

Year of foal birth: No significant differences in gestation length between the years were evident in the present study. Similar results were reported by Morel *et al*. (2002). However, in some studies (Valera *et al*., 2006; Cilek, 2009) gestation length was affected by the year. Valera e*t al*. (2006) stated that dry years or those with more extreme temperatures were years when gestation was longer than its expected duration. The main reason could be the influence of the nutritional quality of feedstuffs (Satue *et al*., 2011).

CONCLUSION

Mares that conceived early in the year had a longer gestation than mares that conceived later in the breeding season. One of the reasons may be that some unknown mechanism attempts to bring mares back into the natural foaling season. On the contrary, mares that foaled at the beginning of the year had a shorter gestation than mares that foaled in April. Thus, the effects of the month of conception and month of foaling on gestation length are the reverse from January to April. Moreover, their effects on gestation length are independent as shown by the lack of a significant interaction between them. These findings indicate that it is necessary to analyze the effects of the time of conception and foaling together for a more precise prediction of gestation length. Further studies are needed to clarify why the gestation period increased in mares that foaled from January to April.

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