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Male-free environment prevents pregnancy disruption in domestic horse mares mated away of home

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ABSTRACT

In a previous study (Bartoš et al., 2011) we have reported on the effects of the male social environment on the maintenance or disruption of pregnancy in domestic mares mated away from home. In this follow-up study we compare the effects of returning to a home environment including a male (or males) to which the returning mare had, or was denied, access or did not have access, with that of returning to a home environment containing only other females. As in the previous study, we used data collected from private horse owners in the Czech Republic. The probability of disruption of pregnancy was lowest when the mare was sharing an enclosure only with other mares. Incidence of pregnancy failure was highest when the mare was in one enclosure, while the male or males stayed in an adjacent enclosure and intermediate where females returned to a home enclosure and shared it with the home male(s). In addition, the probability of pregnancy disruption decreased with increasing number of foals delivered in the mare's previous reproductive history.

1. Introduction

Principles of behavioural ecology and sociobiology can lead to insight into farm animal behaviour. However, these principles have been applied to domestic animals rarely (e.g., Fraser et al., 1995; Bartošová et al., 2011; Polák et al., 2015). In previous studies (Bartoš et al., 2011, 2015), we have suggested that the common practice of transporting the mare for mating and then bringing her back to an environment with males, stallions or geldings, which did not sire the foetus, may be a major cause of an unusually high incidence of foetal loss in domestic horses recorded by various authors (Bain, 1969; Platt, 1973; Lucas et al., 1991; Rambags et al., 2003; Vanderwall, 2008). Mares returned from away-of-home mating into a vicinity of a male who was not the father of her foetus ('non-sire male') were more likely to terminate their pregnancy to save energy and avoid the possibility of future loss of their progeny to infanticide by a non-sire male(s) (Hrdy, 1979). Pregnancy disruption in the mare was seven times lower if the returning mare was housed within the same enclosure as the non-sire male(s) than when the non-sire male(s) were present in her vicinity but denied physical contact. (The same effect has been recently shown also in domestic dogs, Bartoš et al., 2016.) Repeated sexual activity with a non-sire stallion or gelding observed shortly after the pregnant mare joined the group including a male or males led to conclusion that in this situation a mare may manipulate the male's paternity assessment by promiscuous mating as a counterstrategy against the danger of potential infanticide. If the mare has no chance to do that she may block or terminate pregnancy (Bartoš et al., 2011).

Since we published these results, one additional questions has arisen. In the previous study we did not consider the outcome if the pregnant mare was brought back to home farm containing mares only. From our previous work we predicted no pregnancy block in away-mated mares returned home but to an environment containing only other mares. In this study we tested the hypothesis that an incidence of a pregnancy disruption induced by a pregnant mare will be higher in a situation when a pregnant mare is in potential danger of the male's infanticide, compared to the situation when a pregnant mare is not in such a danger and/or can manipulate the male's paternity assessment by promiscuous mating.

2. Material and methods

The data were obtained from a questionnaire on reproduction of individual mares distributed via internet to private horse owners in the Czech Republic. In the present study we used all the away-mated females from the previous study - 45 records of the original data (Bartoš et al., 2011), extended them with additional 31 new records from

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pregnant mares mated away from away of home sharing then their home environment with one or more stallions and/or geldings ("home males"), and 34 records including situations with mares mated away and brought home to environment surrounded only by female herd mates. All mares involved were positive in pregnancy testing carried out after mating. In total this provided 110 records of 75 different mares aged from 3 to 20 years, giving birth between 0–13 foals, and bred between years 1984–2011. They belonged to 21 breeds and came from 37 individual breeders.

2.1. Statistics

The data were analysed with the aid of SAS (version 9.4) using a Generalized Linear Mixed Models (GLMM, PROC GLIMMIX for binary distribution). Link function was logit and distribution of error terms was binomial in the GLMM. The fitted model included mare's identity as a random effect to account for the use of repeated measures on the same individuals. We focused exclusively on pregnant mares that had been transported for mating to another facility, or artificially inseminated mostly in the home environment. We checked if they were returned back to (or stayed in when inseminated) home environment either containing at least one stallion and/or gelding or containing no males but only other mares. We constructed the models by entering first 'social environment' in which the mare was staying after coming home from mating (with three levels: male or males sharing the enclosure, male or males present outside the enclosure, only mares present in pregnant mare's environment) expected to have an effect on the mare's probability to disrupt pregnancy and then checking the model with addition of the factors which could also affect the result (Table 1). Any factors which did not add to significance ($P > 0.05$) were dropped from the model and will not be mentioned any further. We tested interaction terms.

To compare whether the probability of a certain event was the same for two groups, we computed the odds ratio (Stokes et al., 2012). An odds ratio greater than one implies that the event is more likely to occur in the first group, whilst an odds ratio less than one implies that the event is more likely to occur in the second group. All performed statistical tests were two-tailed.

3. Results

The social environment to which the mare was reintroduced after coming home from mating had a significant effect on likelihood of pregnancy failure when it was the only term that entered the GLMM ($F_{(2,32)} = 3.92$, $P = 0.03$, proportion of cases in Fig. 1). The probability of pregnancy disruption was significantly higher when the mare was in one enclosure, while the male or males stayed in adjacent enclosure in comparison to when the mare was sharing enclosure with home stallion and/or geldings (Odds ratio = 4.51, $P = 0.04$) or when the mare was sharing enclosure only with mares (Odds ratio = 13.90. $P = 0.01$). Although the probability of pregnancy disruption appeared to be lowest when the mare was sharing her enclosure only with other mares, the difference between this and the rate of pregnancy disruption which occurred when the mare was sharing (and able to interact physically with) with male(s) was not statistically significant (Odds ratio = 3.06. $P = 0.21$).

When other factors were allowed to enter into the models only one other significant factor was found, the number of foals the mare had delivered in the past ($F_{(1,31)} = 8.74$, $P = 0.006$, Fig. 2). When taken in this combination with reproductive history, the influence of social environment weakened ($F_{(2,31)} = 3.14$, $P = 0.05$). With an increase in the number of foals delivered in her previous reproductive history the probability for the mare to disrupt pregnancy decreased.

4. Discussion

The extended data showed results wholly consistent with the previous study (Bartoš et al., 2011), in that even in analysis of the extended dataset, mares returned home who could see, but had no physical access to home males in an adjacent enclosure showed disruption of pregnancy at a higher frequency than those returned to an enclosure where they had physical access to home males. In agreement with our prediction, the proportion of pregnancies which were blocked or disrupted was lowest when away-mated mares returned home to an environment containing only other mares. Perhaps surprisingly, the frequency of pregnancy disruption in this category did not however, differ significantly from the situation when away-mated mares were sharing enclosure with home males and could manipulate the male's paternity assessment.

Taken together with the observation that the effect of social environment on pregnancy disruption was the same after artificial insemination, as with natural matings away from home (Bartoš et al., 2015), strongly supports the original idea (Bartoš et al., 2011), that the primary factor modifying reproduction is a counterstrategy to the danger of potential infanticide (Hrdy, 1979). In effect, whatever the method of insemination, once a mare is hormonally 'aware' of pregnancy, if she subsequently has no opportunity to mate with the home male (and thus confuse him about possible paternity), she will show

Table 1
Questionnaire on reproduction of the mares involved and conditions under which the mares were living during the analysed pregnancy. (Countable variables are presented as (mean ± standard deviation.).

Characteristic	Range or categories
Year of her birth	1986–2004
Age	6.70 ± 4.70
Breed	Different breeds of horses[a]
Number of foals she had delivered	2.90 ± 2.84
Number of failing pregnancies before the analysed one	0.80 ± 1.31
Transported elsewhere for mating/insemination	Yes/No
Method of breeding	Mating/Artificial insemination
Number of horses kept within the facility regardless of the housing system	14.16 ± 10.89
Number of adult mares kept within the facility regardless of the housing system	10.56 ± 8.68
Number of adult home stallions and/or geldings kept within the facility regardless of the housing system	3.63 ± 3.55
Social environment[b]	Male or males sharing the enclosure/male or males present outside the enclosure/only mares present in pregnant mare's environment
If the mare was tested for pregnancy before returning home	Yes/No

[a] Akhal-Teke, American quarter horse, Arabian, Austrian warm-blooded horse, Belgian draft horse, Czech saddle ponies, Czech warm-blooded horse, English Thoroughbred, Friesian, Furioso, Haflinger, Hanoverian, Hutsul horse, Lipizzaner, Kladruby horse, P.R.E., Saxon, Silesian cold-blooded horse, Welsh cob, Welsh pony, cross-breeds.

[b] Detailed description where the other animals were kept was available. This included: in an adjacent box, in a distant box, within the same enclosure as the mare or in the adjacent enclosure. Since this did not appear significant, the details are omitted in the table.