

Difference of Early Experience of Foals According to Dominance Ranks of Their Mothers in the Jeju Pony (*Equus caballus*)

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In order to determine whether foals of more dominant mothers were harassed less by mares than those of lower-ranked mothers, harassment of foals was studied in a herd of Jeju ponies (*Equus caballus*) consisting of 73 mares, their 53 foals, and one stallion. Mares harassed the foals on 71 occasions between March to September, 1998. The frequency of harassment tended to decrease as foals aged, but the relationship was not significant ($P = 0.079$). Foals were harassed when sleeping ($n = 14$), grazing ($n = 19$), moving ($n = 8$), approaching a mare in the vicinity ($n = 13$), or play-fighting with the foal of the harassing mare ($n = 17$). Mares harassed foals of younger, more subordinate mares than those of older, more dominant mares ($P < 0.001$). We conclude that early social experience of foals is associated with the dominance rank of its mother.

In social animals, reproductive success increases with rank in dominance hierarchies (Clutton-Brock, 1988). Factors known to affect dominance status in vertebrates include body size (Haley et al., 1994), age (Pusey and Packer, 1997; Aujard and Perret, 1998), and genetic factors (e.g. Moss et al., 1982; Kikkawa et al., 1986).

A parents dominance rank is a good predictor of an offsprings dominance (Dewsbury, 1990). In ungulates, the ranks of offspring are often positively correlated to the rank of their mothers (Cassinello, 1995; Guilhem et al., 2000). In horses, dominance ranks of foals are strongly correlated with those of their mothers (Haupt and Wolski, 1980; Arba and Crowell-Davis, 1994; Weeks et al., 2000).

Several possible mechanisms have been proposed to explain the association between dominance of parents and offspring. One hypothesis is that the social experience of the offspring is dependent on the dominance rank of its mother. In various species (domestic fowl: Ratner, 1961; white-crowned sparrow: Parsons and Baptista, 1980; pumpkin-seed sunfish: Beacham, 1987; and green swordtail: Beaugrand et al., 1996), the prior experience of winning results in an increase in the probability of winning in later encounters. In horses, Weeks et al., (2000) found that foals of more dominant mothers were more aggressive toward other foals, and these early experiences were associated with a higher post-weaning, dominance rank.

In a related paper (Rho et al., in review), we demonstrated that a foals early social experience will be influenced by the dominance rank of its mother. When foals were play-fighting with peers, the frequency that mothers intervened was associated with the mothers dominance rank. Another early social experience that might influence future social rank is the degree to which a foal is harassed by mares in the herd. Here we demonstrate that foals of high-ranked mothers receive less harassment from mares than foals of low-ranked mothers.

Materials and Methods

Study site and subjects

The study was conducted on a herd on Jeju Island (33°25'50"N, 126°36'E), Korea. The Institute for Live-stock Promotion first established the herd in 1986 with 64 mares and 1 stallion. The number of mares ranged from 45 to 73 between the establishment of the herd and 1998, the year of this study. In addition, the herd consisted of the foals and a single stallion, which was exchanged for a new stallion each year. More details about the care of the herd may be found in Rho and Choe (2002).

From March to October, 1998 during this study, the herd consisted of 73 mares and 53 foals born in either the spring or summer. The mares ranging from 1 to 11 years old were born on the farm, but 14 mares older than 11 years were born elsewhere and transferred to establish the herd. For the latter group of mares, age was

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estimated based on the degree of tooth wear when the mares were introduced (Ensminger, 1969). Mare age ranged from 17 to 25 years in this latter group. Here we use dominance rank and mare age interchangeably because Rho et al. (in press) found that dominance ranks in Jeju ponies are linear and increase with mare age.

Data collection

Ponies were individually recognized by distinctive markings on their backs and other body characteristics such as general body shape, coat color, etc. Observations were made in daylight (between 07:00 and 19:00 hours) using the focal animal continuous sampling method (*sensu* Altmann 1974). The daily observation was divided into four 3-hour periods: 07:00-10:00, 10:00-13:00, 13:00-16:00, and 16:00-19:00 hours. We tried to conduct observations in different time periods on different days to avoid observing the horses more or less in the same periods.

Undisturbed foals were usually observed with the naked eye from about 25-30 m. We collected data for this study when the foals were 4, 7, 14, 30, 60, 90, and 120-day old. We tried to conduct observations of the foals from 4- or 7-day old to 120-day, as they aged. We collected data for 51 hours on 26 4-day old foals, 92 hours on 38 7-day old foals, 83 hours on 49 14-day old, 126 hours on 48 30-day old, 102 hours on 38 60-day old, 112 hours on 37 90-day old, and 92 hours on 33 120-day old foals.

We recorded the number of times that a mare threatened to bite, bit and kicked the focal foal. We also recorded the behavior of the foal when harassed (including when resting, grazing, moving, approaching the mare, or play-fighting with another foal.)

Results

We accumulated 658 hours of observation in 1998 on 53

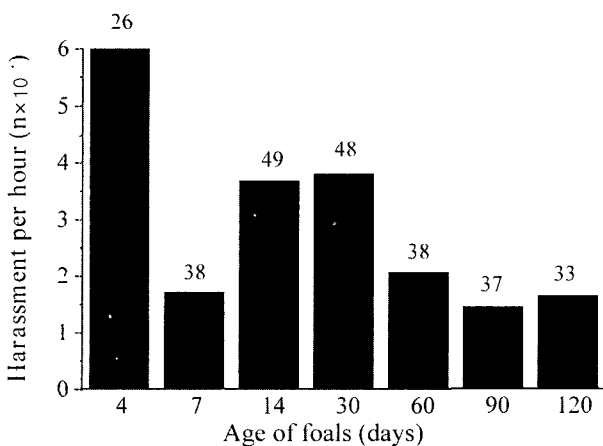


Fig. 1. The frequency of harassment per hour relative to age of the foals. The number in each age class indicates the sample size.

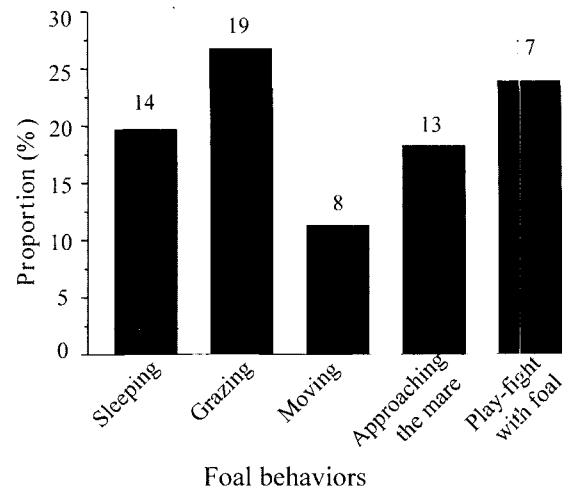


Fig. 2. The proportion of times that foals were harassed by mares relative to the foal behaviors. Sample sizes are given above the vertical bars.

foals. Mares harassed foals 71 times during the observation period. In two hour observation period, the probability that a 4-day old foal was harassed was 0.31. This probability decreased to 0.13 at 7-day old but increased again to 0.36 at 14- and 30-day old. At 60 days and later, the probability of being harassed decreased to 0.16 or less. The frequency of harassment per hour tended to decrease as foals became older, but the relationship was not significant (Pearson correlation, $r = -0.7, P = 0.079$, Fig. 1).

Two levels of harassment were apparent; threat displays to bite or overt bites, which represented an escalated level of harassment. Bites were frequent and slightly more common (54.9%, $n = 39$) than threats to bite (45.1%, $n = 32$). When threatened, the foals tried to avoid the aggressor, but if kicked or bitten they would usually run further way.

The foals were harassed most commonly when grazing ($n = 19$ events, Fig. 2) or play-fighting with other foals of the same age and the mother of the opposing foal intervened ($n = 17$ events, Fig. 3). They were also



Fig. 3. Play-fighting between foals of the same age.

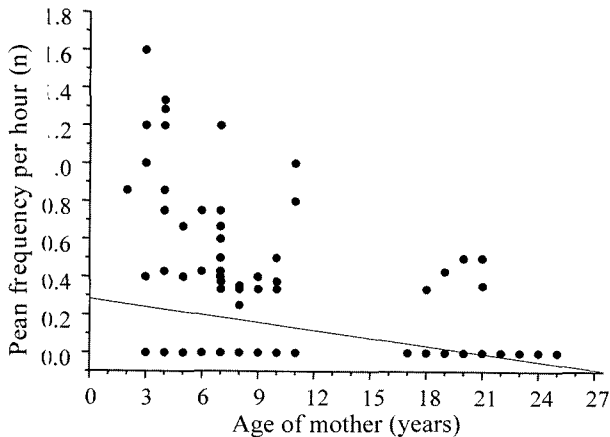


Fig. 4. The level of harassment given to the mares foals relative to their ages.

commonly harassed when they were asleep ($n = 14$ events), indicating that the foals need not incite the mare to be harassed. They were also harassed when approaching a mare that then turned on them ($n = 13$ events) or when on the move ($n = 8$ events).

There was a significant negative correlation between the frequency of mare harassment of foals and the age of the foals mothers (Fig. 4, Spearman's coefficient $r = -.297$, $n = 71$, $P < 0.0001$). The foals produced by younger mares were harassed more often than the foals produced by older mares.

Discussion

In our study, the frequency of harassment per hour peaked when the foals were 4-day old and again at 14- and 30-day old. It was apparent that there was a sharp drop in harassment from this second peak as the foals aged. However, the relationship between foal age and harassment was not significant, probably due to a drop in harassment at 7 days old when the foals mother closely guarded her offspring.

Maternal care during the early life of a Jeju pony was high and decreased as the foals became older (Rho et al., Unpublished data). In other horses as well, mothers spend the majority of their time near their foals for a number of days following parturition. Crowell-Davis (1986) reported that Welsh pony mares and foals spent at least 50% of the observed time within 5 m of each other through week 24. In addition, mothers approach their foals frequently to care for them (Weeks et al., 2000). When mares approached or moved near a foal, the foals mother did not prevent the harassment in all cases, but did their best to care for their foals.

Harassment could have a number of direct costs for the foals. For example, kicks and bites can lead to infection and mortality. For horses, most of the mortality was within the first week of life, and a principal cause of

mortality is harassment by mares (Duncan, 1992). In Jeju ponies, harassment did not result in mortality, but harassed foals may become less active socially or less vigorous in competition between peers compared to less harassed foals.

Harassment might also have a number of indirect costs. For example, loss of social activities, vigor in competition, or dominance status may result from frequent harassment. In addition, loss of time spent grazing and increased time being vigilant to prevent harassment may ultimately affect the health of the foals.

Clearly, the levels of mare harassment of foals vary with the dominance status of the mother of the foal. In our study, the foals of subordinate mares were harassed more frequently than those of dominant mares. In a related study, foals of younger, more subordinate mothers were harassed when play-fighting with another foal more than foals of older, more dominant mares (Rho et al., in review). In addition, Tyler (1972) found that foals of dominant mares were not threatened by subordinate mares. Foals produced by mares lower in rank were also harassed more than foals produced by mares higher in rank during nursing bouts (Rutberg and Greenberg, 1990).

Because the foals typically form harems with peers or mares with which they have associated (Waring, 2003), they may delay formation of their harem because of frequent harassment. In a related study in Jeju ponies, foals began to socially affiliate with young mares and peers when 14 days old (Rho and Choe in prep.). Therefore, foals that were harassed more frequently at an earlier age may develop more slowly and affiliate less with young mares and peers. As a result, harassed male foals may delay formation of harems.

It can be difficult to detect a maternal effect when mammalian mothers influence the development of the social relationships of their progeny because there are so many ways in which such effects could be mediated (Bernardo, 1996). Maternal intervention or the presence of the mother near their offspring is one proximate mechanism whereby juvenile spotted hyenas (Holekamp and Smale, 1993a,b), Belding's ground squirrels (Holmes and Mateo, 1998), and vervet monkeys (review in Chapais, 1992) establish dominance rank over their peers. Level of the harassment is not the sole index used in creating the dominance hierarchy of foals, but in this study, the level of harassment of foals was associated with dominance ranks of their mothers. We suggest that early experience of foals at young age play a critical role in the social relationships of the foals, and consequently, on the inheritance of the dominance ranks of their mothers.

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