Journal of Animal and Veterinary Advances 10 (1): 128-132, 2011
ISSN: 1680-5593

The Effect of Rearing Experience on the Behavior Patterns of Captive Male Alpine Musk Deer

Xiangwei Wang, Meng Tong and Xiuxiang Meng
College of Life and Environment Sciences, Minzu University of China, 100081 Beijing, China

Abstract: The effects of maternal and peer separation during infancy were studied on adult male alpine musk deer (*Moschus sifanicus*) at Xinglongshan Musk Deer Farm (XMDF) in Gansu province, China. The aim was to determine the effect of early experience on the behavior in adult deer. Doe Reared (DR) males remained with their mothers for a minimum of 3 months, prior to weaning which occurred annually in early October. Hand Reared (HR) males were removed from their parents before 3 weeks of age and reared in isolation, prior to weaning. Focal sampling was conducted on twenty two adult males (13 HR; 9 DR) to record the frequencies of 12 behavioral categories; resting, standing-alert, locomotion, ruminating, tail-pasting, urinating/defecating, environmental sniffing, self-directed behavior, ano-genital sniffing, affinitive interaction and agonistic interaction. The results showed that HR male musk deer demonstrate significantly more agonistic and less affinitive behavior when compared to DR males. This may be owing to the separation of HR deer from their peers and mother, in addition to proportionally greater contact with human caretakers. The results of this study have implication for musk deer farming.

Key words: Alpine musk deer (*Moschus sifanicus*), behavioral difference, rearing experience, in captivity, agonistic interaction, China

INTRODUCTION

The musk deer (*Moschus* sp.) well known for the secretion of musk by adult males are distributed throughout 13 countries in central Asia, including China, Mongolia and Bhutan (Yang *et al*., 2003). Alpine musk deer (*Moschus sifanicus*), an endemic species to the Tibetan Plateau of China have declined in numbers over the previous century as a result of habitat degradation and illegal poaching (Meng *et al*., 2006).

Alpine musk deer are currently listed as endangered in the Red Data Book of IUCN and are protected in China under the Wild Animal Protection Law as a category I key species. Xinglongshan Musk Deer Farm (XMDF), located at Xinglongshan National Nature Reserve, Gansu province was established in 1990 to conserve wild populations and sustainable harvest musk from adult males.

Despite initial high mortality rates and reduced quantity and longevity of musk production (Parry-Jones and Wu, 2001), captive deer farming techniques in China are constantly improving with approximatly 300 alpine musk deer currently housed at XMDF. Captivity is likely to effect many aspects of an animals life, encompassing both behaviour and physiological components. Such changes in behavior patterns are likely to impact both the long term survival and reproductive success of an individual (Zhang, 1979). Therefore, understanding this process is essential in developing appropriate breeding techniques for musk deer and improving musk production in males.

One aspect of captivity which has potential implications for adaptation is rearing experience being either naturally doe reared or in the case of orphaned fawns hand reared. As a result of maternal mortality, abandonment or inexperience, orphaned captive fawns are separated from conspecifics, prior to 3 weeks of age and bottle fed. During weaning which occurs annually in early October, both hand reared and naturally doe reared fawns are housed together in enclosures of up to five individuals.

Due to its endangered status, previous investigations on the musk deer are limited, particularly in the area of captive behavior changes. Hence, this study aims to provide preliminary investigations into the captive behavior of adult male musk deer, in relation to early

Corresponding Author: Xiuxiang Meng, College of Life and Environment Sciences, Minzu University of China, 100081 Beijing, China

Table 1: Behavioral ethogram for captive alpine musk deer

Behavior	Definition
Resting (RE)	Lying on the ground and in inactive and relaxed state
Standing-Alert (SA)	Still alert and gazing at stimuli or potential stimuli
Locomotion (LO)	Moving without any accompanying behaviors
Feeding-Drinking (FD)	Feeding or drinking
Ruminating (RU)	Expression of a series of behaviors, i.e., chewing, swallowing and regurgitating
Tail-Pasting (TP)	Rubbing its tail and scent-marking on a wall, doorframe or other surfaces
Urinating-Defecating (UD)	Full or partially exhibiting of a series of activities; including scratching the ground, urinating and pellet covering
Environmental Sniffing (ES)	Exploring the wall or ground with nose
Self-Directed behavior (SD)	Activities not associated with other animals; i.e., grooming, scratching
Ano-genital Sniffing (AS)	Sniffing or licking the ano-genital region of another animal
Affinitive Interaction (AI)	Direct physical contact between individuals without obvious aggression; i.e., mutual grooming, nursing and licking
Agonistic Interaction (CI)	Aggressive behavior, with or without direct body contact with another individual
Miscellaneous Behavior (MB)	Other behaviors

rearing experience. Results from this study will assist in developing appropriate management systems for captive musk deer to improve the welfare, survival and assist in species conservation.

MATERIALS AND METHODS

Experimental materials and procedures: This study was conducted at XMDF, Xinglongshan National Nature Reserve, Gansu province, China. Located at an elevation of 2000~2100 m, the reserve has a continental mountain climate with average high and low temperatures of 14°C (July) and 9°C (January), respectively. Rainfall occurs mainly in July, August and September with annual precipitation of 48~62.2 mm. During the study, 22 adult males, including 13 Hand Reared (HR) and 9 Doe Reared (DR) individuals were observed. Animals ranged in age from 2-6 years old and were housed in groups of up to five individuals in outdoor yards (100 m^2) to which six adjoining indoor cells (4 m^2) were attached.

Wire mesh separated enclosures, enabling visual, audial and olfactory contact between animals in adjoining enclosurrs but prevented physical contact. Animals were fed twice daily at dawn and dusk on a diet of fresh leaves (May-November) or dried leaves (December-April). Leaves of the preferred forage species, predominantly *Crataegus kansuensis* and *Acer tetramerum* were collected from Xinglongshan National Nature Reserve a habitat for wild musk deer.

The diet was supplemented with artificial feed containing approximately 40% corn, 25% wheat and 25% bean which was mixed onsite. Seasonal vegetables were also provided opportunistically and water was provided *ad libitum*. Animals were identified with a plastic ear tag number.

Behavioral ethogram: An ethogram for behavioral sampling was developed on the basis of published musk deer studies (Sheng and Ohtaishi, 1993; Zhang, 1979; Green, 1987) and preliminary observations at XMDF (Table 1).

Statistical analysis: At XMDF, mating season is defined between November and February, whilst non-mating season occurs from August and October with fawning in June and July (Meng *et al*., 2003). Due to lighting restrictions, behavioral observations were recorded during daylight hours with the assistance of binoculars (10×42) to confirm individual ear tag numbers. A focal animal was selected randomly within each enclosure and its behaviors recorded continuously for 5 min. Observations were conducted by a single researcher, 10 times each day over a 6 week period with 280 observation hours in total.

Average monthly frequency and standard error was calculated for each behavior on an individual basis. Miscellaneous Behavior (MB) and behavioral samples whose total recording time was <5 min were excluded from the analysis. The Mann-Whitney U test was used to test the potential differences between HR and DR male musk deer. Statistic analysis was conducted with SPSS11.0 software (SPSS Inc., Chicago, Illinois), using two tailed probability with a significance level of $p = 0.05$.

RESULTS

Behavioral comparisons during non-mating season: The behavioral patterns of male musk deer during non-mating season were shown in Fig. 1. HR males expressed significantly more agonistic interaction (CI, 0.06±0.02) than DR males (CI, 0.02±0.01, $p<0.05$). HR males expressed higher frequency of resting, standing-gazing, locomotion, feeding-drinking and ruminating than DR males however, this was not significantly different.

Behavior comparison during mating season: The behavioral patterns of male musk deer during the mating season were showed in Fig. 2. DR males expressed

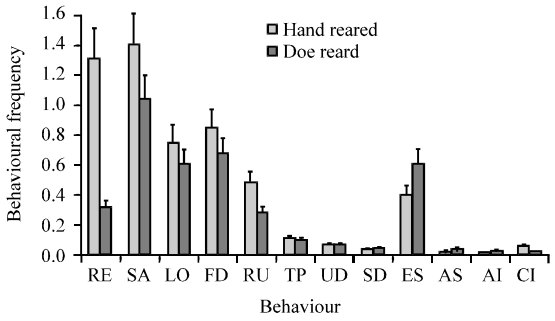

Fig. 1: Behavioral frequency of hand-reared and doe-reared male musk deer during non-mating season

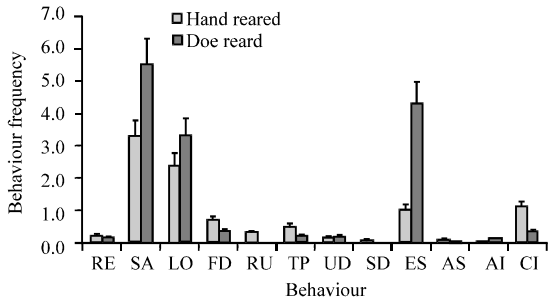

Fig. 2: Behavioral frequency of hand-reared and doe-reared male musk deer during mating season

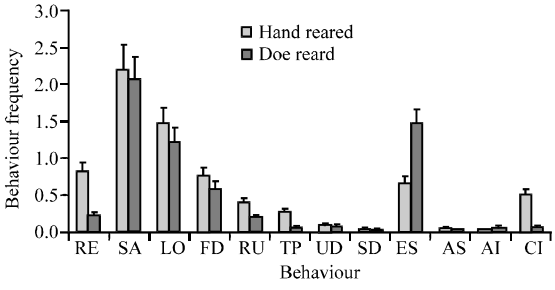

Fig. 3: The behavioral patterns of hand-reared and doe-reared male musk deer

significantly more affinitive interaction (0.04±0.02) than HR males (AI, 0.02±0.01, $p<0.01$). General trends indicated the frequency of tail-pasting (0.49±0.21) and ano-genital sniffing (0.07±0.05) by HR males was higher than DR males (TP, 0.20±0.08; AS, 0.02±0.01) but lower frequency of environmental sniffing (4.33±2.40) however, these differences were not statistically significant.

Seasonal behavior frequency of hand-reared and doe-reared males: Pooling seasonal data, behaviour comparisons of male HR and DR musk deer is sbehavioral frequency is shown in Fig. 3. Compared to DR musk deer (CI, 0.08±0.05; AI, 0.03±0.02), HR musk deer shown more frequent agonistic interaction (0.51±0.19) and less frequent affinitive interaction (0.02±0.01) however, only the former behavioralwas significantly different ($p<0.05$). All other behaviour were not significantly different.

DISCUSSION

Animal behavior patterns are shaped by a combination of genetic and environmental factors (Raussi *et al*., 2003). For captive animals, the environment is likely to have a large impact of behavioral patterns, specifically during development (Hakansson *et al*., 2007). As such early rearing experience may contribute to variations in behavior patterns exhibited in the adult. This study indicated that rearing conditions; either hand or doe rearing, influenced the social behavior patterns of captive adult male musk deer. Hand reared individuals were generally more aggressive than doe reared males and recorded higher frequency of agonistic behavior and lower frequency of affinitive behaviors. As the genetic origin and captive management systems under which the deer were housed was identical such behavior patterns, specifically those related to social behavior interactions are likely to be related to the different weaning pattern and related experiences in early life.

Weaning is a crucial period in an animal's life; in which a young animal simultaneously loses both its most important source of food and its maternal connection (Weary and Chua, 2000). In musk deer farming, weaning of captive fawn is a gradual process commencing 3 months after birth (Zhang, 1979; Du and Sheng, 1998). In the current study, weaning occurs in October, prior to which doe reared males are housed with their mothers. In contrast, fawns orphaned as a result of maternal death, neglect and fawn abandonment are separated from their mother and other conspecifics at very early stage and hand reared by humans.

In social animals, Raussi *et al.* (2003) found that captive calves which maintained social contact through pair housing arrangements had lower stress level than those separated from conspecifics. Whilst wild musk deer typically lead solitary lives, captive individuals under-take social interactions with neighboring individuals via activities such as territory and border marking (Green, 1987; Zhang, 1979).

Similarly, doe reared fawns in captivity are provided with extensive maternal interaction through the lactation phase in which suckling, grooming and ano-genital licking behaviors occur between the lactating female and the fawn (Du and Sheng, 1998). In contrast limited social interaction is available for hand reared fawns which are isolated from both maternal and conspecific interactions from an early age. For animals in captivity, behaviour

patterns, specifically social behaviors are strongly influenced by the social environment (Hakansson *et al*., 2007). At XMDF, pregnant females are housed and give birth in common enclosures with up to five individuals. As such, newborn fawns face extensive interactions not only with their mothers but other fawns and adult musk deer, during early development. The opportunity to engage in social behaviors is essential in captive newborn animals as it stimulates behavioral variability and enhances the ability to cope with environmental and social changes (Spruijt *et al*., 2005).

Aside from conspecific social isolation, hand reared captive musk deer are also exposed to frequent human interactions. Such close contact with humans can modify an animals behavior, especially social behaviors (Nogueria *et al*., 2004; Hakansson *et al*., 2007). During animal farming, the newborn animal may bond with humans through an imprinting process in which the younger the animal, the more complete the bond. In cows and calves for example bond can begin as little as 5 min after birth, whilst separation within the first 24 h after birth can reduce bonding between the cow and calf (Weary and Chua, 2000; Flower and Weary, 2003).

For an orphan animal, its imprints to a human will have a bond with that person as powerful as the attachment between a newborn and its mother therefore, the ability to interace on a social level is greatly improved when the calf is allowed to spend more time with the cow (Hudson and Mullord, 1977). In this study hand reared individuals have extensive social interaction with humans through the process of bottle feeding and physical contact. Conversely human contact with doe reared individuals is limited to daily husbandry tasks, totaling <10 min per day.

Throughout, musk deer farms, Zhang (1979) observed doe reared musk deer to show greater flight response to caretaker whereas hand-reared males were more disposed to the handling conditions and more docile when the caretakers was present (Zhang, 1979). Raussi *et al.* (2003) also noted that higher social contact with humans increased an animals' likelihood of approaching humans but could not compensate for social interactions with conspecifics. Similarly behavioral differences have been observed between hand reared and maternal reared individuals in a range of species including chimpanzees (*Pan troglodytes*) and sloth bears (*Ursus ursinus*) (Martin, 2005; Forthman and Bakeman, 1992).

CONCLUSION

In the study, the social environment under which captive musk deer develops is an important factor shaping the behavior of the adult. Hand reared musk deer were more aggressive than the doe reared musk deer due to limited social contact with conspecifics and intensive human exposure. To improve the survival rate, productivity and the overall welfare of captive musk deer, musk deer farms should attach more importance to conspecific stimulation, providing orphan newborns with social interactions through visual and physical contact with other individuals. Further studies into the degree of social stress amongst doe and hand reared individuals would also assist in providing recommendations to improve the welfare of captive musk deer.

ACKNOWLEDGEMENTS

This research was supported by Nature Science Foundation of China (30970374, 30770286, 30811120554), Program for New Century Excellent Talents in University (NCET-08-0596) and National Key Technology R and D Program in the 11th 5 year Plan of China (2008BADB0B06). We are especially grateful to Ms. Genevieve C. Perkins who helped to correct the English.

REFERENCES

Du, W. and H. Sheng, 1998. Time budget and behavior of forest musk deer during lactation. Acta Theriologica Sinica, 18: 21-26.

Flower, F.C. and D.M. Weary, 2003. The effects of early separation on the dairy cow and calf. Anim. Welfare, 12: 339-348.

Forthman, D.L. and L. Bakeman, 1992. Environmental and social influences on enclosure use and activity patterns of captive sloth bears (*Ursus ursinus*). Zoo Biol., 11: 405-415.

Green, M.J.B., 1987. Scent-marking in the Himalayan musk deer (*Moschus chrysogaster*). J. Zool., 1: 721-737.

Hakansson, J., C. Bratt and P. Jensen, 2007. Behavioral differences between two captive populations of red jungle fowl (*Gallus gallus*) with different genetic background, raised under identical conditions. Applied Anim. Behav. Sci., 102: 24-38.

Hudson, S.J. and M.M. Mullord, 1977. Investigations of maternal bonding in dairy cattle. Applied Anim. Ethol., 3: 271-276.

Martin, J.E., 2005. The effects of rearing conditions on grooming and play behavior in captive chimpanzees. Anim. Welfare, 14: 125-133.

Meng, X., C. Zhou, J. Hu, C. Li and Z. Meng *et al*., 2006. The musk deer farming in China. Anim. Sci., 82: 1-6.

Meng, X., Q. Yang, L. Xia, Z. Feng, Y. Jiang and P. Wang, 2003. The temporal estrous patterns of female alpine musk deer in captivity. Applied Anim. Behav. Sci., 82: 75-85.

Nogueria, S.S.C., L.G. Bernardi and S.L.G. Nogueira-Filho, 2004. A note on comparative enclosure facility usage by wild and captive-born capybaras (*Hydrochoerus hydrochaeris*). Applied Anim. Behav. Sci., 89: 139-143.

Parry-Jones, R. and J.Y. Wu, 2001. Musk Deer Farming as a Conservation Tool in China. TRAFFIC, East Asia, Hong Kong, pp: 34.

Raussi, S., B.J. Lensink, A. Boissy, M. Pykonen and I. Veissier, 2003. The effect of contact with conspecifics and humans on calves behavior and stress response. Anim. Welfare, 12: 191-203.

Sheng, H. and N. Ohtaishi, 1993. The Status of Deer in China. In: Deer of China: Biology and Management, Ohtaishi, N. and H.I. Sheng (Eds.). Elsevier Science Publishers, Amsterdam, Netherlands.

Spruijt, B.M., J.V. Leeuwen and C.M. Vinke, 2005. Juvenile farmed mink (*Mustela vison*) with additional access to swimming water play more frequently than animals housed with a cylinder and platform, but without swimming water. Anim. Welfare, 14: 53-60.

Weary, D.M. and B. Chua, 2000. Effects of early separation on the dairy cow and calf: 1. Separation at 6 h, 1 day and 4 days after birth. Applied Anim. Behav. Sci., 69: 177-188.

Yang, Q.S., X.X. Meng, Z.J. Feng and L. Xia, 2003. Conservation status and causes of decline of musk deer (*Moschus* spp.) in China. Biol. Conserv., 109: 333-342.

Zhang, B., 1979. The Taming and Raising of Musk Deer. Agriculture Press of China, Beijing, China.