

Mate preference and sexual selection in giant panda, *Ailuropoda melanoleuca* in captivity

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A b s t r a c t. Giant panda is difficult to breed in captivity due to low oestrus and mating rate, high cub mortality and diseases. Thus, how to improve the mating success of giant pandas in captivity is an important conservation issue. After observation on eleven female and three male giant pandas from Beijing Zoo, Lanzhou Zoo, Chengdu Zoo and Giant Panda Breeding Center during their mating season in 2000–2001, we found that mate preference and sexual selection plays an important role in the mating success in giant panda. Both male and female pandas actively chose their mates. Successful copulations only occurred in those males and females that both showed high frequencies of courting behavior to opposite sex. Of those cases that only male or female showed one-sided high or low frequency of courting behaviour in the keeper-arranged panda pairs in random order, no copulation was observed. Only three out of twenty-four paired pandas successfully copulated. All three copulated female pandas in this study bore cubs. The results show that both male and female giant pandas have to be interested in each other in order to mate, but panda managers and researchers in China historically believed that females play no role in mate choice and that males are the choosy sex. This indicated that mating choice was one of the important factors resulted in unsuccessful copulation and failure of reproduction. We recommend that attention be paid to the mate preference and sexual selection in giant panda when breeding pandas in pens are paired for reproduction in the future.

Key words: natural mating, courting frequency

Introduction

Sexual selection has been a major focus of evolutionary biology since Darwin noted that mate preference and sexual selection conferred an immediate advantage to preferred individuals. Sexual selection depends on differential patterns of mate preference and choice. Parker (1983) distinguishes three types of mate choice: (1) both sexes are nondiscrimination in their choice of mates; (2) one sex is passive and non-discriminating, but the other sex engages in active choice; and (3) both sexes are discriminating and engage in active choice. Active mate preference and sexual selection has been inferred from the observation that individuals visit several prospective mates but choose only one (or a subset) of them and rejecting the remainder (Gibson & Langen 1996). Most work reported that animals in wide taxonomic range, including insects (Moore 1989), crustaceans (Backwell & Passmore 1996), fish (Warner 1995), frogs (Ryan 1985), birds (Gibson 1996, Fiske & Kålås 1995, Rintamäki 1995) and mammals (Bers et al. 1994) are engaged in a process of active choice while searching for mates (Parker 1983).

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It is difficult to breed the giant panda in captivity due to their low reproduction rate, high cub mortality rate and diseases (H u 1988, P e n g et al. 2001a, P e n g et al. 2001b, P e n g et al. 2006, P e n g et al. 2007). So, how to improve the mating success of giant pandas in captivity, especially of male pandas, is an important conservation problem. In fact, giant pandas communicate information about their status of estrus and emotion to each other by olfactory, auditory, visual and touch signs during the breeding season (S c h a l l e r 1993, H u 1988). H u (1990b) observed that one estrous female was actively courting one male but ignored the other males. He thought that not only mate competition but also mate preference and sexual selection occurred in giant pandas. It's essential to understand sexual selection of pandas. The pairing of the male and female pandas in pens during breeding season should be arranged in zoo. However, the practice is never assessed even though the panda in pens has low mating success. So, we studied the courting behavior and mating success of the arranged pairing in giant pandas from Beijing Zoo, Lanzhou Zoo, Chengdu Zoo and Chengdu Giant Panda Breeding Center during their mating season in 2000–2001.

Material and Methods

We observed the courting frequencies of eleven adult females and three adult males. All observed giant pandas were healthy and 10 of 14 had mated naturally in a previous breeding season (Table 1). In order to increase the genetic variability of giant pandas in captivity to avoid inbreeding, two adult female pandas (Stud# 403 and 421) from Beijing Zoo and one female panda (Stud# 407) from Lanzhou Zoo were transported to Chengdu Zoo, and two adult male pandas (Stud#369 and 345) from Beijing Zoo transported to Chengdu at the end of February in 2000 and 2001, respectively. Male and female panda, when they both were observed to present courting or rutting behavior during their mating season, were paired by the keepers according to studbook, origin and birth location to avoid inbreeding. Twenty-four groups were paired in the study, which were identified as *a, b, ..., w, x* (Fig. 1). We recorded all courting behaviors of each pair of pandas from 8:00 to 11:00 from March 1st to April 30th in 2000 and 2001. Further, the courting frequencies (times per 10min) of eleven adult females and three adult males were calculated.

Courting behavior in the study was described as one or all of the following behaviors: (1) a panda approached a sexual partner forwardly, and presented estrous or rutting behaviors, such as shaking head, urinating/defecating, rubbing anogenital and so on; (2) he or she was bleating “Mie, Mie”, stared at the partner, sniffed the urine, faeces and the scent mark left by the partner; (3) or a panda tried to scratch the partner in order to attract his or her attention.

A female was paired with a male if she firstly showed no aggression sign towards the male partner, then she might raise her hindquarters, erected her tail and showed the anogenital region to the male as him courted her, she finally accepted his mounting. At the same time, the male mounted the female, inserted his penis into the female and thrust, both pandas bleated during the copulation, the female vocalized quavering moans as the male ejaculated. If the male's penis entered the female panda's vagina and later heard the high chirp cries of the female, then we recorded the mating as a successful copulation. If the panda were paired and they started to bite and to attack each other, or the male or female showed less courting to each other, they seldom approached each other in the pen and never copulated, the keeper finally had to separate the two pandas. Then, we recorded the pairing as a failed copulation.

Table 1. Reproductive records of the giant panda used in this study.

Name	Stud #	Sex	Birth date (MM/DD/YY)	Origin	Location	Reproduction history before the study
Le Le	320	Female	9/8/1986	Captive born	Beijing Zoo	Gave birth to 7 cubs (3 twins) by natural mating and artificial insemination.
Ying Ying	369	Male	8/15/1991	Captive born	Beijing Zoo	Had a record of natural copulation last year.
You You	345	Male	6/23/1988	Captive born	Beijing Zoo	Has oestrus every year after the sex maturation, but never successfully copulated with a female. His semen is artificially collected every year.
Ji Ni	403	Female	11/4/1993	Captive born	Beijing Zoo	Had her first oestrus last year, naturally mated but not pregnant. Had her second oestrus this year.
Niu Niu	421	Female	9/5/1995	Captive born	Beijing Zoo	Had her first oestrus last year, naturally mated but not pregnant. Had her second oestrus this year.
Qing Qing	278	Female	9/9/1984	Captive born	Chengdu Zoo	Gave birth to 8 cubs (2 twins) by natural mating or artificial insemination.
Ha Lan	287	Male	8/1984	Wild born	Chengdu Zoo	Fathered 7 cubs (3 twins) by natural mating or artificial insemination with his semen.
Cheng Cheng	297	Female	9/24/1985	Captive born	Chengdu Breeding Center	Gave birth to 5 cubs (1 twins) by natural mating or artificial insemination.
Bing Bing	314	Female	8/6/1986	Captive born	Chengdu Breeding Center	Gave birth to 8 cubs (2 twins) by natural mating or artificial insemination.
Li Li	387	Female	9/3/1992	Captive born	Chengdu Breeding Center	Did not have oestrus due to poor health. However, Li Li had her first oestrus this year.
Er Yatou	401	Female	9/19/1993	Captive born	Chengdu Zoo	Gave birth to 1 twins by natural mating and artificial insemination last year.
Mei Mei	408	Female	8/31/1994	Captive born	Chengdu Breeding Center	Gave birth to 1 twins by natural mating and artificial insemination last year.
Jiao Zi	425	Female	8/21/1995	Captive born	Chengdu Breeding Center	Had her first oestrus this year.
Shu Lan	407	Female	8/31/1994	Captive born	Lanzhou Zoo	Had her first oestrus this year.

We recorded the mating success or failure during their copulation and also recorded the copulation duration. Subsequently, we monitored whether the female pandas became pregnant and gave birth. We used the Mann-Whitney U tests to check the difference between the occurrences (times) of courting behaviors of the male and the female panda for each paired group separately. Kruskal-Wallis H tests were used to check the difference in courting frequencies (times per 10 min) between the groups over all paired experiments.

Results

A significant difference of courting frequency was found between males towards females and females towards males ($P < 0.05$; Fig. 1). We discovered three types of outcomes: First, the male and female panda showed different frequency of courting behavior, when the male actively approached and courted to the female, but the female ignored him and rejected to copulate, or when the female actively approached and courted to the male but the male reject to mount the female. Second, both male and female showed low but equal frequency of courting behaviors, they evaded each other and the paired panda did not copulate. Third, both male and female showed high frequencies of courting behaviors and the paired panda had a successful copulation. So the rate of successful copulation was 12.5%. Because all of the three paired-groups that successfully copulated became pregnant and bore cubs, the parturition rate is 100%.

From Fig. 1 we could clearly see that the courting frequencies of both male and female in group *a*, *b* and *k* were significantly higher than that of other groups. This indicated that both males and females in group *a*, *b* and *k* were interested to each other, and only they could mate favourably and successfully. However, the males and females in other groups were uninterested to each other, or one exhibited one-sided love but the other one evaded, then they would fail to copulate.

Discussion

Giant pandas primarily live solitarily and territorially during non-breeding season in the field. Males and females seldom contact each other (H u et al. 1985, H u 1990a, H u 1990b). Only during breeding season, the giant panda start to search for mates frequently. Males may gather and compete for mate. Once five males chased and mated with a female in turn in the Wolong natural reserve, W a n g (1987) thought that female pandas play passive role in copulation. G a o & P u (1994) also supposed the male giant pandas do not choose mates during breeding season. They thought that mating success highly depends on the number of healthy, sexually matured males in a population. However, in this study, we found out that male and female giant pandas have diverse behavior. If only the male panda showed high courting behavior to a female panda but the female panda had no or little response to the male's courting, then they would not copulate, or vice versa. Giant pandas are choosy in selecting their sexual partners, either male or female pandas refuse to mate with a sexually matured partner who he or she is not interested in courting. Only those males and females who showed high frequencies of courting behavior to each other mated had a successful copulation. Coordination between mates is essential for a successful mating (K l e i m a n 1983).

Generally, the female pandas reproduce every 1.5–2.5 years after sexual maturity in the field, then they only produce 6–8 litters throughout their lifetime (H u 1988, H u 1990a).

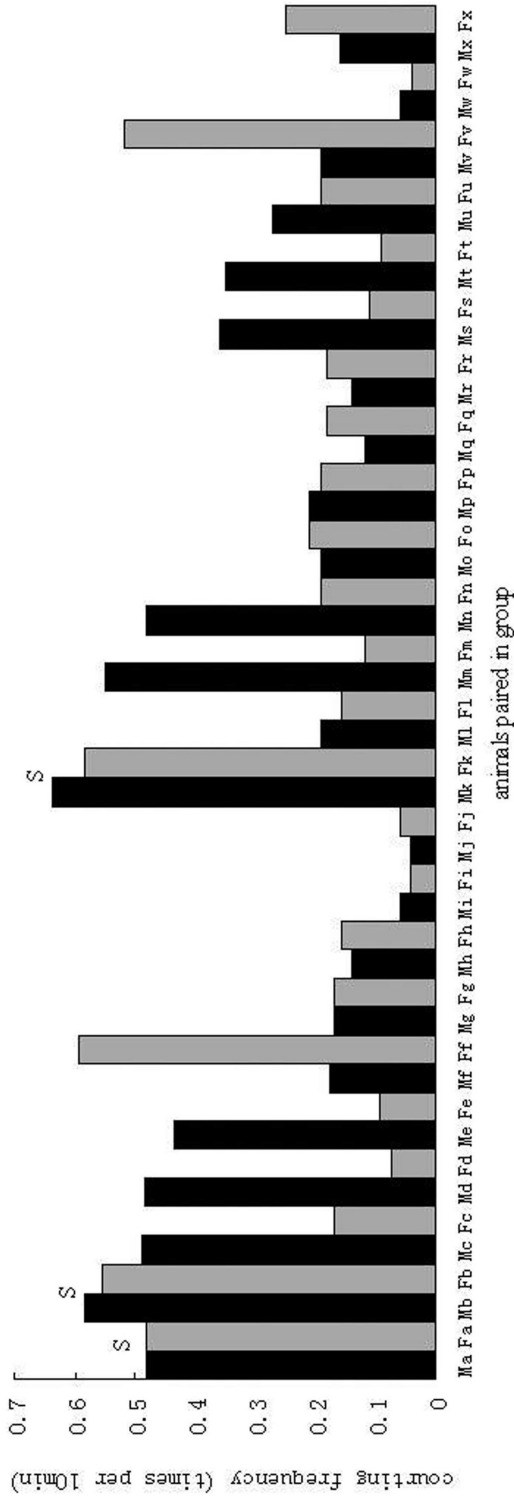


Fig. 1. Actively courting frequencies of male or female giant pandas during their mating season (times per 10min). Ma (left dark column), the actively courting frequencies of male tended towards female in Group a. Fa (right grey column), the actively courting frequencies of female tended towards male in Group a, respectively. The same as in other groups b, c, ..., w, x, S, the male and female successfully copulated by natural mating and parturition.

Mate preference and sexual selection and competition might redound to natural selection of giant panda. Obviously, both partners will try to strictly choose their mate that possesses the best characteristics for survival and successful reproduction during the breeding season, and let the offspring possess advantageous genetic characteristics of their parents, which maximize fitness and finally enhance their population survival.

When both sexes choose their mates, low quality (less desirable) individuals should be less frequently selected (Gibson & Langen 1996). Because numbered pandas bred in captivity, they had a limited number of mates to be chosen. Most pandas rejected to copulate with the mates they disliked. In our study, only three out of twenty-four paired pandas successfully copulated, the success rate was 12.5%. This indicated that mate preference and sexual selection was one of the important factors for unsuccessful copulation and failure of reproduction. We should pay attention to the mate preference and sexual selection in giant panda when we pair breeding pandas in pens in the future. Moreover, only three mated female pandas in this study bore cubs, and all other failed.

In our study, we only studied 24 groups of paired pandas because of limited available animals, and even the number of males was far less than that of females. So, it is necessary to make more male pandas become founders, because the shortage of reproductive males will increase the inbreeding probability and decrease the population genetic diversity in captivity. However, captive pandas were separated into tens of very small populations in the world, even some zoos only have one or two pandas. Furthermore, all captive pandas seldom have the chances to meet together and reproduce. More than eighty percent of pandas in captivity have never reproduced before they died (Peng et al. 2001a, Peng et al. 2001b, Peng et al. 2006, Peng et al. 2007). So, we advise that all reproductive pandas in captive should be gathered together to let them have chances to choose their mates during breeding season. To ensure successful breeding every time is necessary for the numbered pandas in captivity.

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