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Behavioural Alterations in Domestication Process: Comparative Studies Between Wild, Captive and Inbred Red-Crowned Cranes (*Grus japonensis*)

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Abstract: The Red-crowned crane (*Grus japonensis*) is one of the largest birds in East Asia which is among the rarest and endangered cranes in the world. In order to enhance population management and further conservation of Red-crowned cranes, researchers compared behavioural changes from wild population to captive population. Meanwhile, researchers also compared the artificial inbred population with the natural normal populations. In this research, five main behavioural patterns of Red-crowned cranes include resting, moving, preening, feeding and alerting were identified by all occurrence sampling and instantaneous scanning sampling methods with 5-10 min intervals. The referred wild and captive populations were concluded from the previous publications and the artificial inbred populations were observed in Hangzhou Wildlife Park (China) during August and September, 2009. As a result, researchers found the difference ($p>0.05$) between wild and captive populations is not significant. However, preening in captive population is higher than in wild population. The wild population spent more time for resting compared to captive population yet feeding is the most time-spent behaviours for both populations. Furthermore, behavioural patterns between normal and inbred populations are found significantly different ($p<0.05$). Alerting and resting behaviours are significantly higher in the normal population than in inbred population. Moreover, moving is the dominant behaviour of inbred population but feeding is taken the most time by normal population.

Key words: Red-crowned cranes (*Grus japonensis*), behavioural patterns, artificial selection, wild, captive, inbred population

INTRODUCTION

Animal domestication probably began thousands years ago coming along with human demands. Through efficient means of artificial selection, animals are domesticated with clear uses. From wild to captive, from captive to artificial breeding, the processes of behavioural alterations are extremely interesting to scientific community as well as the public. The Red-crowned crane (*Grus japonensis*) a large crane is the second rarest crane in the world. Up to date, a small number of populations with 1700-2000 individuals are living in the East Asia which was listed on the IUCN red list of threatened species in 1994 (Bird Life International, 2009). This migratory bird ranges from Russian Siberia to North Korea and Southern China and adapts to the wetland environments (Higuchi *et al*., 1998). Its behavioural studies started from early 1990's, most of those were focused on time budgets and activity rhythms (Wu *et al*., 2002; Zhou *et al*., 2002; Tian *et al*., 2005, 2006; Lu and Cheng, 2006; Li *et al*., 2007), reproduction behaviour (Wu *et al*., 2002; Qiu *et al*., 2002; Zou *et al*., 2003a), feeding behaviours (Zou *et al*., 2003a, 2007a, b), habitat selections (Ding and Zhou, 1982; Lu and Zhou, 1990; Ma *et al*., 1999). Wildlife domesticalization is one of the most useful strategies to sustain species. As one of the endangered cranes, this approach shows applicable access to maintain diversity of crane. However in advance, it is important to understand its physiology and behaviour of the targeted wildlife. Comparative studies regarding reproductive behaviour of semi-wild and wild populations of Red-crowned crane behaviour showed that all behavioural styles were similar and no significant differences. Yet, the fluctuation of reproduction behaviour

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is much severe in semi-captive population than wild population (Ji *et al*., 2008). Zou *et al*. (2007a) reported that semi-domestic population had the same behavioural patterns as wild populations but the feeding behaviour was different due to the availability of food resources. Wang *et al*. (2010) compared semi-captive and wild populations of Red-crowned crane which indicated that semi-captive population had a lower requirement of nest-site selection. Despite many studies have been performed on comparing of crane behaviours, there is still a large gap of information that has not been illustrated. In this study, researchers aim to demonstrate behavioural differences between captive and wild populations of Red-crowned cranes. Meanwhile, researchers will compare the behavioural differences between normal and inbred populations of Red-crowned cranes. Finally, researchers will depict a clear view of how the domestication process from wild to most human selected inbred populations can alter cranes' behaviours. This study will also contribute to other wildlife rearing management and conservation.

MATERIALS AND METHODS

Studying location and animals: This research was conducted at Hangzhou Wildlife Park (119°59 E, 30°09 N), Fuyang county, Hangzhou city, Zhejiang province, China. The average temperature in this region is 16.2°C annually with average temperatures of 28.6 and 3.8°C in Summer and Winter, respectively. The average rainfall is 1435 mm $year^{-1}$. During the time of this research, the average temperature range was from 36.3-42.4°C. A small inbred population from two nests of Red-crowned Cranes (N = 6) were observed in this study. They were kept in a grass-bamboo-made enclosure with an area of 100 m^2 in a roof-netted captivity during the night and open grassland with an area of 2000 m^2 was used for daytime activities. In the middle of the grassland, there is a 20 m^2 pond with 15-30 cm in depth. They were fed twice a day with dry fodder, chicken eggs and fresh vegetables in the morning around 10:00 and with living loaches in the afternoon around 15:00. All animals are in good health and the experimental protocol met the regulation of animal care and uses (Law of Wildlife Protection, China in 1988 and Regulations for the Administration of Affairs Concerning Experimental Animals, China in 1988) and also received approval from the Veterinary Committee of Wildlife Park.

Methods and processing: During observations, observers always hide in front of the enclosure kept a distance of 100-200 m and telescope monitoring was assisted to check the behavioural patterns. The observation persisted 4 weeks from 9:00 am to 5:00 pm during August and September in 2009. The behavioural patterns were identified by all occurrence sampling and instantaneous scanning sampling methods with 5-10 min intervals. The observation items recorded in this study mainly included resting, feeding, moving and alerting. Resting was defined as standing or lying quiescently on the ground or in the water without moving and feeding. Feeding was defined as initiative eating either in the ground or in the shallow lakes. Moving was defined as walking or pacing in or out of the water without any other relevant target actions including the reproduction actions. Alerting is primarily meant watching around and making sounds or behavioural alarms to the population. The wild population means natural population in the original habitats. Captive population is kept in the captivities with naturally mating selection. Artificial inbred population are the offspring (F3 generation) bred domestically by human selection normally accompanying with physiological and morphological faults. Moreover, their F1 (grand-parents) and F2 (parents) are both captive inbred populations. Normal population includes captive and wild populations excluding inbred population.

Statistics analysis: Data analysis is based on the software SPSS Statistics 18 and Microsoft Office Excel 2003. The total efficient data were 2835 sampling observations. Behavioural data was calculated by temporal percentage of defined behaviours (resting, feeding, moving and preening and alerting behaviors) in defined observing time. The ratio (full ratio is equal to 1) of activity meant the occurring frequency of defined behaviour. The one-way ANOVA test was used to compare the mean percentages of behavioural patterns between captive and wild populations and between normal and inbred populations. Chi-square statistics was adopted for the significant test of paired-behavioural patterns between captive and wild populations and between normal and inbred populations. Significant level was set as 0.05. The data was represented as mean±SE.

RESULTS AND DISCUSSION

Animal behaviours are susceptible to different human selection forces under evolution. Hereinto, domestication is an evolutionary process which may cause various behavioural variances. Price (1984) summarized domestication closely connects to adaptation in a captive environment and it is often achieved by genetic changes over generations as well as by environment-induced changes in development that recur in each generation. Such domestication enforces animals which are rearing in the captivity are greatly stressed by artificial selection.

After a long-term adaptation and evolution, they changed their lifestyles and genetic basis according to human demands.

Comparisons of behavioural patterns between captive and wild populations: In Fig. 1, the ratio of each behavioural pattern of captive population is not significantly different from the wild population ($F = 0.050$, $df = 1$, $p>0.05$). Feeding behaviour is the dominant behaviour for both captive (34.58±3.48%) and wild population (37.34±9.26%). Preening behaviour is much less in wild population (2.55±1.48%) comparing to captive population (13.05±3.30%). Alerting is slightly higher in wild population (15.22±1.66%) than captive population (14.21±1.58%). Captive population takes less time for resting (21.64±8.97%) than wild population (34.46±10.01%) (Table 1).

The free-living wild populations normally spend more time for food searching while food provision for the captive population is always controlled within defined time and places. Food provisioning and human control over the breeding process have reduced competition for important resources and thus have permitted selection for the retention of juvenile characteristics (Price, 1984). The results also support that wild population has a higher rate of feeding behaviour than captive population which might threatened by unpredictable environments and other potential risks (Anholt and Werner, 1995). Alerting behaviour of wild population should be higher than captive population which also meet the results (Zhang *et al*., 2007; Tian *et al*., 2006; Li *et al*., 2007; Cui and Li, 2005; Zou *et al*., 2003a, 2002). Interestingly, preening behaviour is higher in the captive population than wild population. Birds remove dust, dirt and parasites from their feathers and adjust their feather in the optimum position while preening (Delius, 1988; Martin-Platero *et al*., 2006; Lewis *et al*., 2007; Tripet and Heinz, 1999). Most birds will preen several times a day to keep themselves healthy. It is probably that captivity or cage is a closed environment in which the hygienic condition is not as better as natural habitats. Birds have no free rights to select their habitats, instead of adapting themselves into it. Resting behaviour is less in the captivity than in the wild. This resting strategy may be related to the energy-based socio-economic principle (Bryant, 1997). Fernie *et al*. (2000) compared behaviours between free-ranging and captive American which shows captive kestrels are more active than controls. It is important to understand that the better resting could turn out the more feeding. Domestication has influenced the quantitative animal movements rather than qualitative nature of the behavioural response. Price (1984) concluded the postulated loss of certain behavior patterns under domestication is a heightening of response thresholds above normal levels of stimulation. Within the process of domestication, responsiveness is reduced to changes in the animal environment.

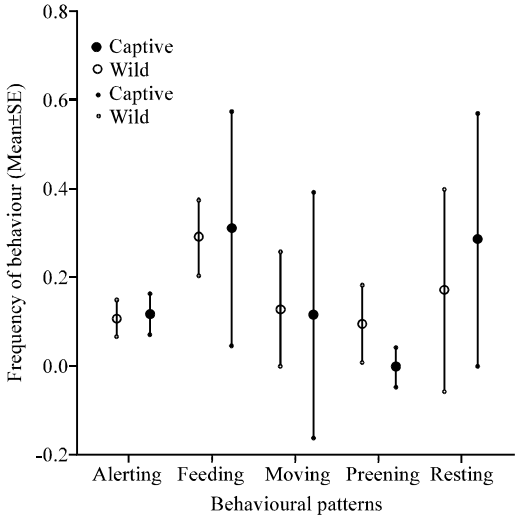

Fig. 1: Frequencies of behavioural patterns between wild and captive crane populations

Comparisons of behavioural patterns between normal and inbred populations: Comparing wild population with captive population, the differences between normal and inbred populations are much fluctuated (Fig. 2). Behavioural patterns are significantly different between normal and inbred populations ($F = 32.876$, $df = 4$, $p<0.05$). Alerting (Chi-square = 37.351, $df = 23$, $p<0.05$) and resting

Table 1: Available dataset of behavioural time budgets of domestic and wild populations

Population	Resting (%)	Moving (%)	Preening (%)	Feeding (%)	Alerting (%)	Origins
Domestic	4.36	33.15	21.17	28.31	13.01	Zhang *et al*. (2007)
	7.40	12.30	14.72	46.65	18.92	Zhang *et al*. (2007)
	18.43	21.50	11.40	32.03	16.64	Tian *et al*. (2006)
	23.30	12.33	16.47	37.73	10.13	Tian *et al*. (2006)
	54.73	3.27	1.47	28.19	12.34	Li *et al*. (2007)
Wild	27.83	12.17	6.88	65.09	10.79	Cui and Li (2005)
	52.12	3.48	1.04	27.77	15.59	Zou *et al*. (2003b)
	48.77	3.27	0.34	27.36	18.84	Zou *et al*. (2003a)
	9.13	44.11	1.95	29.14	15.67	Zhou *et al*. (2002)

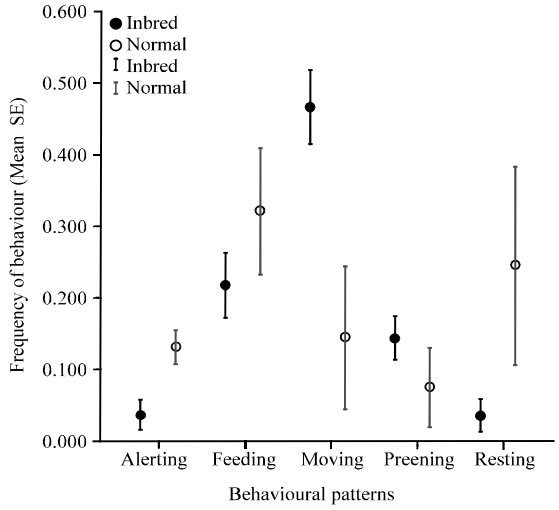

Fig. 2: Frequencies of behavioural patterns between normal and inbred crane populations

(Chi-square = 32.876, df = 20, $p<0.05$) behaviours are significantly different between normal and inbred populations. Normal population uses 28% of time to take rest but rest time of inbred population is much lower with only (3.69%). Alerting has a higher ratio in normal population (14.72%) than inbreeding one (4.23%). Moving is the dominant behaviour of inbred population (51.47%) which is much higher than normal population (16.14%). Inbreeders (15.95%) prefer preening twice than normal population (7.8%). Feeding behaviours of both populations are relatively high but normal population (35.95%) is much willing to eat than the inbred populations (24.66%).

Inbreeding may be unavoidable to relative small, closed, captive populations (Fuller and Thompson, 1960). Basically, natural selective pressures are much reduced in captive population. Inbreeding should typically cause a reduction of genotypic variability and fitness. Species faces inbreeding depression can seriously lead to extinction (Brook *et al*., 2002). In this study, inbred birds are the third generation of captive inbred population. Their parents and grand-parents should have adapted to the captivities since a long-term of rearing. Inbreeding is always accompanied with body flaws, genetic vulnerabilities and behavioural abnormalities (Brook *et al*., 2002). The studies confirm that inbreeding may affect behavioural patterns quantitatively (Margulis and Altmann, 1997). Moving behaviour of inbred population is greatly higher than natural population which is firstly published. Alerting behaviour of inbred population is much lower than natural population which should be in relation with long-term domestication. High rate of alerting behaviour also can further infer an abnormal development of nervous system. Low rate of preening behaviour in inbred population can be similarly explained as the captive population. In general, inbred population is very much different from captive and wild population. Despite those inbred birds belonged to captive population, there is still large difference from normal captive population. Researchers demonstrate quantitative behavioural alterations from wild population to captive and inbred population are reduced by the processing of domestication. Again, domestication is one of the good reasons for species decline and genetic loss. Therefore, abnormal behaviours from inbred population should be given special attention which could promote better wildlife conservation and management.

CONCLUSION

In this research, researchers compared behavioural changes according to the process of domestication. The results show no significant differences are found between wild and captive populations. In general, preening behaviour of captive population is higher than wild population; the wild population spends more time for resting compared to captive population; feeding is the most time-spent behaviours for both wild and captive populations. However, about normal population and inbreeding population, alerting and resting behaviours are significantly more in the former rather than latter. Moving is the dominant behaviour of inbreeding population and feeding was taken the most time of normal population. In general, inbreeding is confirmed to be able to affect behavioural patterns.

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