



## Short Communication

# Autumn Time Budget and Diurnal Rhythm of Black-Necked Crane

Tong Zhang<sup>1,2</sup>, Feng Xu<sup>1,\*</sup>, Ming Ma<sup>1</sup> and Peng Ding<sup>3</sup>

<sup>1</sup>CAS Key Laboratory of Biogeography and Bioresources in Arid Land, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China

<sup>2</sup>Central South Forest Inventory and Planning Institute of State Forestry Administration, Changsha 410014, China

<sup>3</sup>Xinjiang Academy of Environmental Protection Science, Urumqi 830011, China

### ABSTRACT

In the autumn of 2011, both the time budget and diurnal rhythm of behavior of black-necked crane (*Grus nigricollis*) were studied at Altun Mountain National Nature Reserve, Xinjiang, China. The results showed that foraging was the main behavior of cranes in autumn, accounting for 69.07±1.64% of the diurnal time budget, followed by alert (19.38±0.87%), locomotion (5.97±0.49%), maintenance (2.88±0.60%) and other behavior (2.70±0.44%). In addition, we also compared the behaviors of black-necked cranes in different periods and places. The results indicate that the diurnal time budgets of cranes in autumn in breeding area are more like the wintering budget in wintering area than breeding season in breeding area. Cranes changed their diurnal time budget and behavior rhythm to adapt the environmental and social changes.

#### Article Information

Received 01 February 2018

Revised 02 April 2018

Accepted 11 April 2018

Available online 17 June 2020

#### Authors' Contributions

FX and MM conceived and designed the experiments. FX, TZ and PD performed the experiments. FX and TZ analyzed the data. FX, MM and TZ wrote the paper.

#### Key words

Black-necked crane, *Grus nigricollis*, Time budget, Rhythm of behavior, Altun Mountain National Nature Reserve.

The black-necked crane, *Grus nigricollis* is globally vulnerable specie and the only plateau crane in the world. Most of the cranes breed on the Qinghai-Tibetan Plateau including a small area of India, and it winters on the Yunnan-Guizhou Plateau of China, Bhutan, and Arunachal Pradesh in Northeast of India (Li and Li, 2005). With a world population estimated at about 11,000 (Li and Yang, 2003), the black-necked crane is listed as vulnerable in the IUCN's Red List (BirdLife International, 2017). Since their breeding and wintering areas are in remote areas, the biology of these cranes is little known (Qian *et al.*, 2009; Liu *et al.*, 2010). Some researchers have studied the migration routes (Lhendup and Webb, 2009; Qian *et al.*, 2009), habitat selection (Li, 1999; Wu *et al.*, 2009; Liu *et al.*, 2010; Kong *et al.*, 2011), diets (Li *et al.*, 1997), distribution and population size (Scott, 1993; Li and Yang, 2003; Ma *et al.*, 2011) of the black-necked cranes, but the diurnal time budget of the black-necked cranes got limited research (Li and Ma, 1992; Yang *et al.*, 2007). Some studies have reported the diurnal time budget of the black-necked cranes during the breeding season from March to August (Yang *et al.*, 2007) and during winter

from October to April (Li and Ma, 1992), but the diurnal time budget in autumn (September) when the cranes are accumulating and preparing to migration has seldom been studied.

Here in this paper, we studied the diurnal time budget of the black-necked cranes during the autumn in September to explore if there are some differences of the time budget among the autumn, breeding season, and winter. The results of this research will make us understand more about the behavior of the endemic species of black-necked cranes.

#### Materials and methods

This study was conducted in the Altun Mountain Nature Reserve (AMNR), Xinjiang, China. The AMNR is on the edges of Qinghai-Tibetan Plateau, located at the border among Xinjiang, Tibet, and Qinghai province (36°00'–37°49'N, 87°10'–91°18'E) with an area of 45,000 km<sup>2</sup> (Bleisch *et al.*, 2009). It is contiguous with the Changtang and Kekexili Nature Reserves in Tibet and Qinghai, respectively (Li *et al.*, 2006). The elevation of the AMNR ranges from 3,800 to 6,900 m and mountains with permanent snow above 5,500 m (Butler *et al.*, 1986; Bleisch *et al.*, 2009; Buzzard *et al.*, 2010). The climate of the area is continental, dry and cold. Average daily temperature was -21 to 2.4°C in the winter, and -3.4 to

\* Corresponding author: xufeng@ms.xjb.ac.cn  
0030-9923/2020/0001-0001 \$ 9.00/0  
Copyright 2020 Zoological Society of Pakistan

21°C in the summer (Buzzard *et al.*, 2010). Precipitation is rare and sparse and frequently falls as snow or sleet even in the summer (Achuff and Petocz, 1988; Buzzard *et al.*, 2010). Butler *et al.* (1986) and Achuff and Petocz (1988) provide detailed descriptions of the geography and vegetation of AMNR. AMNR is one of the biggest nature reserve in China and famous for its numerous abundant of ungulates such as wild yak *Bos mutus*, Tibetan antelope *Pantholops hodgsonii*, Tibetan wild ass *Equus kiang*, and Tibetan gazelle *Procapra picticaudata* (Butler *et al.*, 1986; Li *et al.*, 2006; Buzzard *et al.*, 2008, 2010). There are also a lot of other birds in AMNR, such as bar-headed goose *Anser indicus*, greylag goose *Anser anser*, northern pintail *Anas acuta* and brown-headed gull *Larus brunnicapillus*. AMNR is an important and also one of the most northern breeding site for black-necked cranes (Ma, 2011; Ma *et al.*, 2011).

Behavioral observation were conducted from September to October 2011. The basic social unit of cranes is the family group and several families may join together in groups. A family consists of two adult cranes with or without juvenile cranes. A flock of cranes consisted of two or more cranes occurring within at most 30 m from one another (Wang *et al.*, 2011). Behavior observation was conducted according to the group scan sampling method during the September 2011, and between 06:00 to 18:00 h. We randomly selected flocks using binoculars (Minox BV 10×42 BR) and observed their behavior using telescope (Carl Zeiss, Diascope 85, 20-60). Each observation session began when a flock of cranes were found and lasted until they disappeared or the group size changed. Observation sessions with fewer than six scans were discarded. The crane's activities were recorded by scanning crane flocks at 10 min intervals, and all of the observations were recorded by the same person. The behaviors were divided into 5 categories: foraging, alert, maintenance, locomotion, and others. Foraging refers to a crane excavating foods, swallowing, and drinking. Alert refers to a crane stretching the head upwards while standing or walking, scanning around. Maintenance refers to preening, stretching, shaking and bathing. Locomotion includes walking, running, leaping and flying. Other behavioral patterns include resting, calling and other behaviors not included above (Yang *et al.*, 2007; Wang *et al.*, 2011; Xu *et al.*, 2012). In total, we observed 68 behavioural sessions.

The data of the percentage of behavior were firstly arcsine square-root transformed and then tested for normality with the one-sample Kolmogorov-Smirnov test. Because all of the data showed a normal distribution, we used the one-way ANOVA combined with post-hoc tests to detect diurnal time budget of the difference kinds of behaviors of the black-necked crane. All of the significant

differences were indicated by  $P \leq 0.05$ , and all of the data were analyzed using the SPSS 16.0 statistical package.

### Results

During the autumn the black-necked cranes spent most of their time foraging (69.07±1.64%), followed by alert (19.38±0.87%), locomotion (5.97±0.49%), maintenance (2.88±0.60%) and other behavior (2.70±0.44%). One-way ANOVA showed that during the autumn, there were significant differences in the time spent on different kinds of behavior (One-way ANOVA:  $F=548.145$ ,  $P<0.001$ ).

Compared with the time budget of the black-necked crane during the breeding season and winter, the black-necked crane's time budget in autumn were more like the time budget in winter, and they spent more time on foraging and alert, but less time on locomotion and other activities than breeding season. There was little difference in maintenance (Table I).

**Table I.- Comparison of the time budgets of the black-necked crane among the breeding season, winter and the autumn.**

	Foraging	Alert	Maint.	Locomotion	Other activities
Breeding season <sup>a</sup>	45%	7%	9%	10%	29%
Wintering season <sup>b</sup>	71%	17%	7%	4%	1%
Autumn season	69%	19%	6%	3%	3%

a, Source: Yang *et al.* (2007); b, Source: Li and Ma (1992) without binomial values or sample sizes given.

The proportion of time spent on behavior varied during the daytime (Fig. 1). In the early morning before 7:00, the proportion of time spent on foraging was very low about 50%, and then the proportion increased to more than 70% and kept in high level. Only in 1300-1500 h, there was a period of relative low proportion of foraging behavior, but the proportion still more than 60%. Alert behavior reached its peak in the morning at 0600 h and in the afternoon at 1300 h, during other time there is no significant variation through the daytime. The proportion of time spent on other behaviors such as maintenance, locomotion, and other activity had no significant variation during the daytime.

### Discussion

During the autumn in September, black-necked cranes spent most of their time foraging, and followed by alert, maintenance, locomotion and other activities (Fig.

1). These results are consistent with researches on diurnal time budgets of wintering black-necked crane (Li and Ma, 1992) and wintering hooded cranes (*Grus monacha*) (Zhou et al., 2010). Both the black-necked crane and hooded cranes spent more than half of the time foraging (black-necked crane: 71%; hooded crane: 56.2%) (Yang et al., 2007; Zhou et al., 2010). These results could be expected in a pre-migration phase when birds are fattening up for the migration. The results also showed that alert was the second important behavior for black-necked crane during the autumn in September, and this result is consistent with the wintering black-necked crane and hooded cranes too. The reasons for the alert's increasing is that in winter when the cranes formed big groups, cranes spent more time on alert not only for predators and also for rivals. So the cranes need to allocate more time on alert.

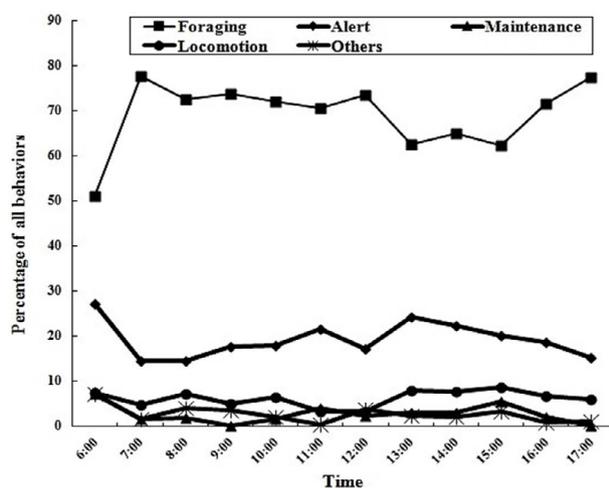


Fig. 1. Diurnal behavior rhythms of black-necked cranes in autumn (September) of 2011.

These diurnal time budget differences between breeding season and autumn reflected that the black-necked cranes altered their time budgets to adopt the environment. During the breeding season, the cranes lived with family commonly consisted by 2 adults, and during the autumn and winter, the cranes lived with big groups by several families live together. So, we think that the different diurnal time budget reflected the difference on living members. Another factor which causes the time budget difference is the breeding. During the breeding season, the cranes need to spend more time on breeding (28%), and thus they should the reduced the time spent on other behaviors such as foraging.

Compared with the behavior rhythm in breeding season, in autumn the black-necked crane's behavior was more consistent and showed the pattern of less variation

during the daytime. The behavior rhythm of the black-necked crane in breeding season has significant peak for foraging, alert, maintenance and resting behavior (Yang et al., 2007), but for the crane in autumn, only foraging and alert have a relative peak, other behavior didn't show much variations among the daytime. The reasons for this results maybe that in autumn, the food availability was not as good as in breeding season and the crane has to intake as much as food and energy for next migration. So the crane in autumn emerged to spend most of their time on foraging, and they don't have many choices as they are in breeding season.

### Conclusion

In this study we firstly reported the diurnal time budgets and behavior rhythm of the black-necked crane in autumn when they are accumulating and preparing for migration. The time budget of the crane during this period was almost the same as it is in winter, but different than the breeding season; and the behavior rhythm of the black-necked crane in autumn is also different with the breeding season. This result showed that after the breeding season from May to August, in autumn (September) the crane changed their diurnal time budget and behavior rhythm to adapt the environmental and social changes.

### Acknowledgements

We are grateful to the National Natural Science Foundation of China (31401986 and 31572292), and Management Bureau of Altun Mountain Natural Reservation for financing this research. And we thanks Zhang Huibin, Zhang Xiang, Li Weidong, Paul Buzzard, Xu Donghua, Liu Ming, Aishanjiang, Bao Gang, Li Huan and other staff from the nature reserve for providing logistical support during the fieldwork period.

### Statement of conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this article.

### References

- Achuff, P.L. and Petocz, R., 1988. *Preliminary resource inventory of the Arjin Mountain Nature Reserve, Xinjiang, People's Republic of China*. WWF, Gland, Switzerland.
- BirdLife International, 2017. *Grus nigricollis* (amended version of 2016 assessment). *The IUCN red list of threatened species 2017: e.T22692162A110659467*. Available at: <http://www.iucnredlist.org/details/22692162/0> (accessed 19 March 2018).
- Bleisch, W.V. and Buzzard, P.J., Zhang, H., Xu, D., Liu, Z., Li, W. and Wong, H., 2009. *Oryx*, **43**: 191.

- <https://doi.org/10.1017/S0030605308001506>
- Butler, J.P., Achuff, P. and Johnston, J., 1986. *Arjin Mountain Nature Reserve, Xinjiang, People's Republic of China*. IUCN/WWF, Gland, Switzerland.
- Buzzard, P.J., Bleisch, W.V., Xu, D. and Zhang, H., 2008. *J. Zool.*, **276**: 330-335. <https://doi.org/10.1111/j.1469-7998.2008.00493.x>
- Buzzard, P.J., Zhang, H.B., Xu, D.H. and Wong, H.M., 2010. *Oryx*, **44**: 577-580. <https://doi.org/10.1017/S0030605310000591>
- Kong, D.J., Yang, X.J., Liu, Q., Zhong, X.Y. and Yang, J.X., 2011. *Oryx*, **45**: 258-264. <https://doi.org/10.1017/S0030605310000888>
- Lhendup, P. and Webb, E.L., 2009. *Forktail*, **25**: 125-129.
- Li, F.S., 1999. *Chin. Biodiv.*, **7**: 257-262.
- Li, F.S. and Ma, J.Z., 1992. *Chin. Wildl.*, **14**: 36-41.
- Li, F.S., Nie, H. and Ye, C.H., 1997. *Zool. Res.*, **18**: 51-57.
- Li, F.S. and Yang, F., 2003. *Chin. J. Zool.*, **38**: 43-46.
- Li, Z.M. and Li, F.S., 2005. *Research on the black-necked crane*. Shanghai Scientific and Technological Education Publishing House, Shanghai, China.
- Li, Z.C., Yang, Q.S., Zhang, H.B., Liu, Z.H. and Yuan, G., 2006. *Sichuan J. Zool.*, **25**: 92-95.
- Liu, Q., Yang, J.X., Yang, X.J., Zhao, J.L. and Yu, H.Z., 2010. *J. Field Ornithol.*, **81**: 21-30. <https://doi.org/10.1111/j.1557-9263.2009.00257.x>
- Ma, M., 2011. *A checklist on the distribution of the birds in Xinjiang*. Science Press, Beijing.
- Ma, M., Li, W.D., Zhang, H.B., Zhang, X., Yuan, G.Y., Chen, Y., Yuan, L., Ding, P., Zhang, Y., Cheng, Y. and Sagen, G., 2011. *Chin. J. Zool.*, **46**: 64-68.
- Qian, F.W., Wu, H.Q., Gao, L.B., Zhang, H.G., Li, F.S., Zhong, X.Y., Yang, X.J. and Zheng, G.M., 2009. *J. Field Ornithol.*, **80**: 19-26. <https://doi.org/10.1111/j.1557-9263.2009.00201.x>
- Scott, D.A., 1993. *Bird Conserv. Int.*, **3**: 245-259. <https://doi.org/10.1017/S0959270900000939>
- Wang, Z., Li, Z.Q., Beauchamp, G. and Jiang, Z.G., 2011. *Biol. Conserv.*, **144**: 101-105. <https://doi.org/10.1016/j.biocon.2010.06.025>
- Wu, H.Q., Zha, K., Zhang, M. and Yang, X.J., 2009. *Bird Conserv. Int.*, **19**: 277-286. <https://doi.org/10.1017/S09592709090008168>
- Xu, F., Ma, M., Wu, Y.Q. and Yang, W.K., 2012. *Pakistan J. Zool.*, **44**: 389-392.
- Yang, R., Wu, H.Q., Yang, X.J., Jiang, W.G., Zuo, L. and Xiang, Z.R., 2007. *Waterbirds*, **30**: 80-85. [https://doi.org/10.1675/1524-4695\(2007\)030\[0080:DTB OTB\]2.0.CO;2](https://doi.org/10.1675/1524-4695(2007)030[0080:DTB OTB]2.0.CO;2)
- Zhou, B., Zhou, L.Z., Chen, J.Y., Cheng, Y.Q. and Xu, W.B., 2010. *Waterbirds*, **33**: 110-115. <https://doi.org/10.1675/063.033.0114>