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Preliminary Study on Time Budget and Foraging Strategy of Wintering Oriental White Stork at Poyang Lake, Jiangxi Province, China

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Abstract - The time budgets, behavior rhythms, foraging habitats and food preferences of oriental white stork *Ciconia boyciana* were studied from December 2013 to March 2014 with instantaneous scan sampling and focus animal sampling methods at Poyang Lake, Jiangxi province, China. The results showed that the main behavior of oriental white stork were resting (40.07±3.21%) and foraging (35.44±2.42%), followed by moving (13.46±1.01%) and preening (9.05±0.62%). The patterns of time budgets were similar in early and later wintering periods. Daily minimum temperature showed a significant linear relationship with foraging and resting. Foraging was significantly positively correlated with daily minimum temperature, and resting was significantly negatively correlated with daily minimum temperature, which indicated that minimum temperature was the key factor affecting stork behavior in winter. Foraging behavior peaked at 7:00–7:59 and 16:00–16:59 hours and resting peaked at 11:00–11:59 hour. Oriental white stork foraging habitats varied in different months and gradually shifted from shallow water to grassland. Their average moving rate was 17.86±0.61 steps/min, pecking rate was 8.31±0.25, and pecking success rate was 1.03±0.04 pecks/min. In shallow water, average pecking rate was significantly positively correlated with moving rate and pecking success rate. In mudflats and grasslands, moving rate was significantly negatively correlated with pecking success rate. We argued that oriental white stork use different foraging methods and prey capture techniques in different habitats, possibly because food resources in mudflats and grasslands differ from those in shallow water. The oriental white stork mainly preyed on fish in shallow water, and it handled large-sized fishes (>15 cm) for 201.07±35.31 sec (n=23), and small-sized fishes (<15 cm) for 85.22 ± 20.86 sec (n=14).

Key words: Oriental white stork, *Ciconia boyciana*, time budget, foraging strategy.

INTRODUCTION

Activity rhythms and time budgets are directly related to metabolism for animals, and this is an important part of the study of behavioral ecology (Halle and Stenaeth, 2000). Multiple factors such as the variations in habitats or different periods can promote differences in the behaviors of wintering bird, and so the consequences on their energy demands will change according to these different conditions (Fort *et al*., 2013). Therefore, it is necessary to study wintering behavior rhythms and time budgets to gain an understanding of the behavioral characteristics and adaptive strategies of birds (Yi *et al*., 2010). Foraging is a dominant behavior of wintering birds (Whitehorne, 2010). Understanding the foraging strategies of wintering birds is a central question in their behavioral ecology (Sommerfeld *et al*., 2013). Further, exploring the factors influencing the foraging strategies of wintering birds is also a priority (Goss-Custard, 2003).

The oriental white stork, *Ciconia boyciana*, is a large-sized water bird. It is an endemic species to East Asian and is classified as endangered species by IUCN (IUCN, 2014). It is listed in the first category of the nationally protected wild species in China. The population is current estimated as less than 3000 globally (Birdlife International, 2013). It breeds around the Heilongjiang and Ussuri rivers in China and the Northeast part of Russia. It has a wide-ranging wintering area, including long stretches along the south of Yangtze River, and occasionally as far as Hong Kong (Murata *et al*., 2004; Ma *et al*., 2006). However, the Poyang Lake in Jiangxi province provides the main wintering habitat for the species across world (Shao *et al*., 2014). There are many studies about the distribution

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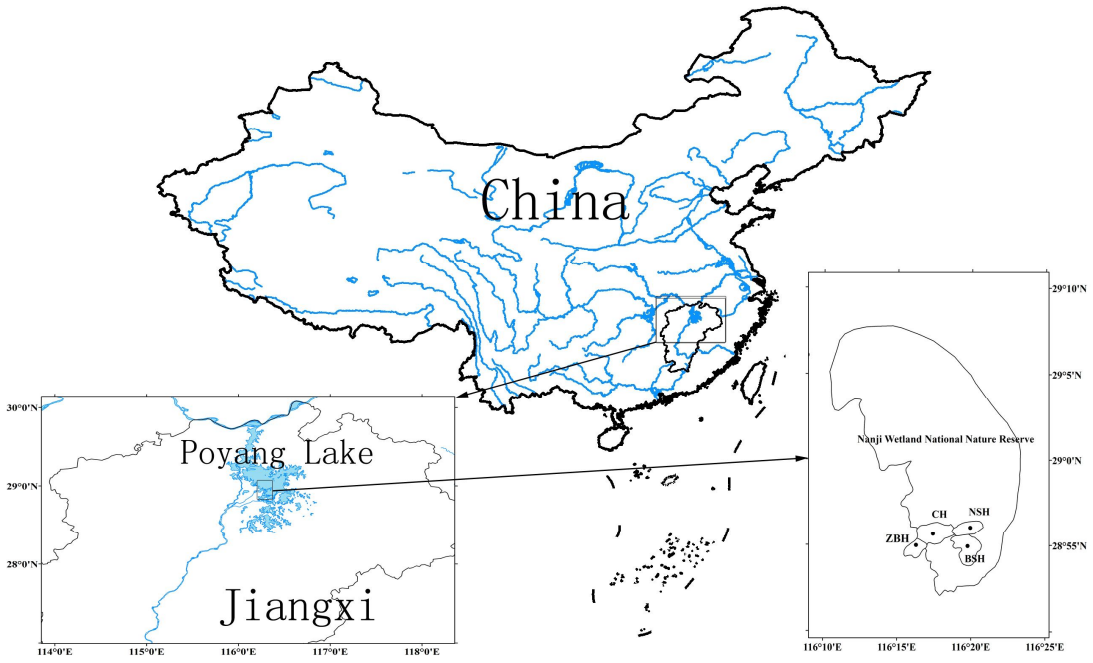


Fig.1. Distribution of surveyed areas in Nanjishan National Nature Reserve of Poyang Lake, Jiangxi Province, China.

and population size (Shao *et al*., 2014), migration routes (Shimazaki *et al*., 2004), and the observation of the captivity stork (Tian *et al*., 2005; Ma *et al*., 2006). However, little is known about the wintering behavior ecology of the species. We studied the wintering behavior time budget and foraging strategies of the oriental white stork in Jiangxi Province, China. The objectives of this study were to 1) provide preliminary information on wintering behavior of this endangered species; 2) identify the factors that influence the wintering behavior; and 3) discuss different foraging strategies used by oriental white stork in different habitats and periods.

STUDY AREA AND METHODS

Study area

Poyang Lake is the biggest freshwater lake in China. It occupies the middle and lower reaches of the Yangtze River in Jiangxi Province and the elevation of the lake is about 16 m (Liu *et al*., 2006). Our study area was Nanjishan National Nature Reserve and is located in the delta of the front edge of Poyang Lake (116°10′24″- 116°23′50″, 28°52′21″- 29°06′46″). The area of the whole nature reserve is 333 km^2. It has a humid subtropical climate with an annual average temperature of 16.6-17.7°C. The average annual precipitation is 1450-1550 mm (Shao *et al*., 2012). The wetland vegetation in Poyang Lake is dominated by *Cares* spp., *Phragmites australis*, *Potamogeton* spp. and *Polygonum* spp. (Liu *et al*., 2006). The lakes surveyed in this study included ChangHu (CH), NanshenHu (NSH), BaishaHU (BSH), ZhanbeiHu (ZBH), shown in Figure 1. The distance between roads and lakes was relatively short in CH, NSH and ZBH lakes. Other water birds coexisting with oriental white storks included white spoonbills *Platalea leucorodia*, common crane *Grus grus*, white crane *Grus leucogeranus*, grey heron *Ardea cinerea*, spotted redshank *Tringa erythropus*, and great crested grebe *Podiceps cristatus*.

Methods

Instantaneous scan sampling was conducted to observe the wintering behaviors of the oriental white stork with Swarovski monocular telescope (20×60) and Nikon binocular telescope (×8). The oriental white stork winters in Poyang Lake for a very short time, often migrating to our study area in

late November and departing by early March. Because of the small population size, difficultly of observation and scattered distribution of the species, only 23 days from December 2013 to March 2014 were selected to observe behaviors. Activities of each individual were recorded every 5 min from 07:00 to 17:30. Focus animal sampling was conducted to observe their foraging behavior for a total of 892 min. Pecking rate and moving rate were recorded with a monocular telescope and a stopwatch within 1-min. (Altmann, 1974). To avoid sampling error, we omitted samples if birds flew out of the recorder's sight. The temperature, humidity and foraging habitat parameters of the study site were recorded during the sampling period with data from the China Meteorological Administration website.

Definitions

Through observations and comparisons to published literature, activities were classified as foraging, moving, resting, preening, vigilance and others (Tian *et al*., 2005; Ma *et al*., 2006) (Table I). Wintering periods were divided into three categories: early (December), middle (January to early February), and later (late February to early March). We defined three foraging parameters when oriental white storks were handling or searching for food, and if the storks did not forage for long enough during our observation, we rejected the sample. The foraging parameters were moving rate (the total number of moving steps when the stork was searching or handling food within a 1-min period), average pecking rate (the total number of pecking within a 1-min period), and pecking success rate (the number of successful pecking and ingestion within a 1-min period) (Maccarone and Brzorad, 2002; Papakostas *et al*., 2005). The foraging habitats of oriental white storks were divided into three types: shallow water (water depth is about 1/3–1/2 of the bird's leg length), mudflat, and grassland (Table II). When the storks were close enough, we identified the species of fish consumed according to their characteristics (including sizes, colors and shapes) using a monocular telescope. The length of the fish was estimated using the bill of birds (210-253 mm, Zhao, 2001) as a scale and classified into two levels: 15 cm and >15 cm.

Table I.- Wintering behaviors and definitions of the wintering oriental white stork.

Wintering behaviors	Behavior definitions
Foraging	Time spent foraging by walking and pecking, including placing the head below the surface to look for food
Moving	Time spent moving, including aerial chases and walking,
Resting	Time spent stationary, including standing and relaxing
Preening	Time spent dipping, preening and spreading wings
Vigilance	Time spent in stay alert, including looking around and warning
Others	Time spent social actions, including playing, fighting and vocalizing

Table II.- Foraging habitat definitions of wintering oriental white stork.

Foraging habitat	Foraging habitat definitions
Shallow water	The area connecting the shallow lakeshore and deep basin, that the depth there is about 1/3-1/2 of the leg length for oriental white stork
Mudflat	Swamp and wetland area along the lakeshore, that very few plants grow
Grassland	The grassland not far from the lake, that a large of plants is growing there such as *Miscanthus Sacchariflorus* and *Artemisia Selengensis*

Statistical analysis

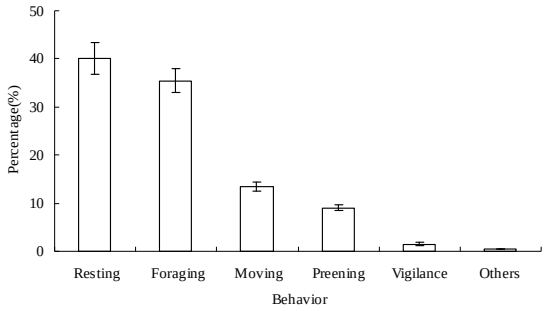
A Kolmogorov-Smirnov test was used to examine if the values of time budget in percentage fitted the normal distribution. Because all behavior values were normally distributed, one-way ANOVA was used for analysis. A Spearman correlation test was used to examine the correlation between various behaviors and foraging parameters in different habitats. A Pearson test was used to examine if the main behaviors (foraging, resting, preening and moving) were correlated with climate factors, and regression analysis was used to analyze the linear relation between behaviors and climate factors if their correlation was significant. In this paper, values presented as means ± SE, and p-values < 0.05 are considered significant. The process of

statistical analysis was handled through Excel 2013 and SPSS 19.0.

RESULTS

Time budget

From a total of 161 h of behavioral observation, we recorded 13499 instances of behavior and 520 instances of foraging. The main behaviors of oriental white stork were resting and foraging, accounting for 40.07±3.21% and 35.44±2.42%, respectively, followed by moving 13.46±1.01% and preening 9.05±0.62% (Fig.2A).



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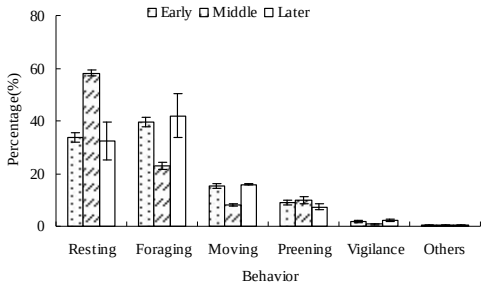

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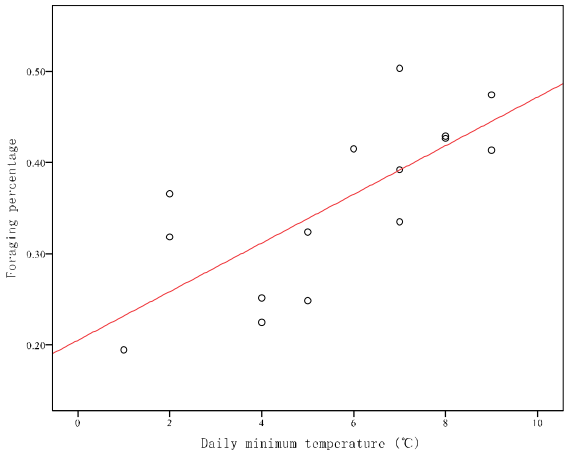
Fig. 2. Time budget of wintering oriental white stork. A, the whole winter; B, the different periods.

Time budgets showed no significant difference between early and later periods (P=0.05) (Fig. 2B). However, time spent foraging ($F_{2,11}$=36.172, P=0.001), resting ($F_{2,11}$=63.908, P=0.001) and moving ($F_{2,11}$=31.709, P=0.001) showed extremely significant difference between the early and middle periods. Further, time spent moving showed extremely significant difference ($F_{1,4}$=31.709, P=0.001), time spent resting showed significant difference ($F_{1,4}$=11.781, P=0.05) between middle and later periods.

Main behaviors and climatic factors

Foraging was significantly positively correlated with daily minimum temperature (R=0.737, df =15, P=0.002) and further analysis showed a significant relationship between the two variables in a simple linear regression model (F=15.432, P=0.01) (Fig. 3A). Resting was significantly negatively correlated with daily minimum temperature (R=-0.548, df=15, P=0.035) and further analysis showed a significant relationship in a simple linear regression model. Preening and moving were not correlated with the climate factors (F=5.570, P=0.05) (Fig. 3B).



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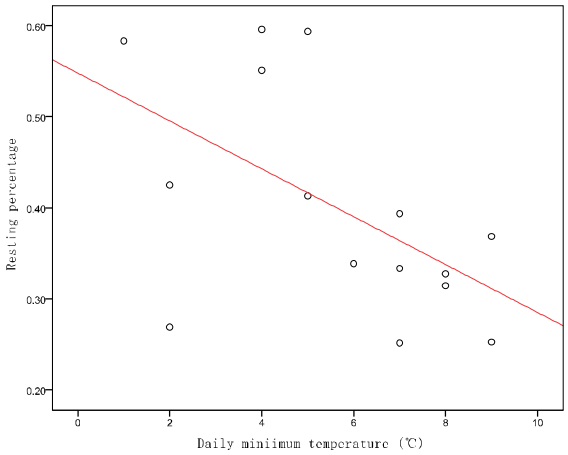

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Fig. 3. Correlation between daily minimum temperature and the behaviors of oriental white stork (a: foraging; b: resting).

Behavior rhythm

Behavior rhythm was analyzed for a total of 15 days. The time spent foraging reached the first peak at 7:00–7:59 (account for 41.82±3.70 %) and a second peak at 16:00–16:59 (account for 39.74±4.52 %). Less time was spent foraging from 10:00 to 15:59, with the lowest occurring at 11:00–11:59 (account for 28.18±2.95 %). Resting peaked at 11:00–11:59 (account for 47.04±4.11 %) and was lowest at 7:00–7:59 (account for 28.27±4.16 %). Moving rhythm and foraging rhythm showed consistency, with moving reaching the first peak at 7:00–7:59 (accounting for 11.60 ± 1.64%) and the second peak at 17:00 (accounting for 17.29 ± 2.15%). Time spent preening reached a peak at 11:00–11:59 (accounting for 11.60±1.64%) and also increased from 13:00 to 14:59.

Foraging strategy

The foraging habitats of the oriental white stork varied in different months. In December, 51.69% of the storks foraged in shallow water and 37.20% in mudflats. However, foraging gradually shifted from shallow water to grasslands, and all storks foraged in grasslands by March (Fig. 4).

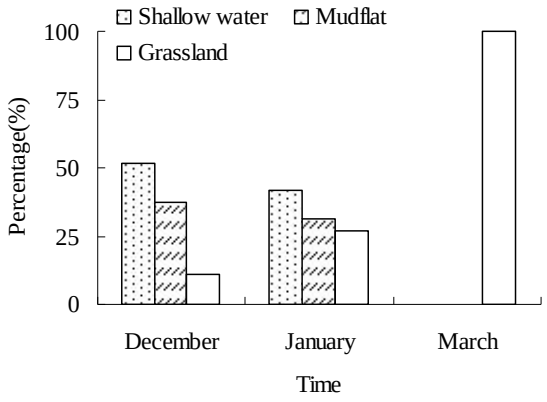

Fig. 4. Time variation of the foraging sites for wintering oriental white stork.

Moving rate was 17.86±0.61 steps/min (n=505). Average pecking rate and pecking success rate were 8.31±0.25 and 1.03±0.04 pecks/min (n=520), respectively (Fig.5). In shallow water, average pecking rate was significantly positively correlated with moving rate (R=0.328, d*f* =189, *P*=0.000), and was positively correlated with pecking success rate (R=0.161, d*f* =209, *P*=0.023). In mudflats and grasslands, moving rate was significantly negatively correlated with pecking success rate grassland: R= -0.249, d*f* = 152, *P* = 0.002; mudflat: R=-0.185, d*f*=152, *P* = 0.023).

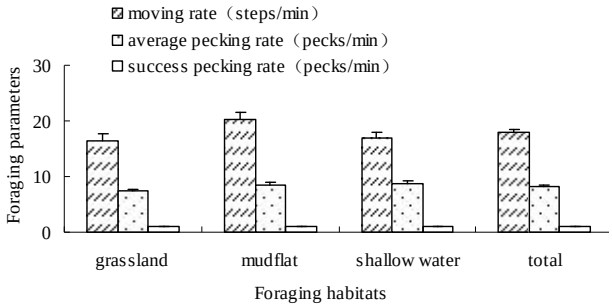

Fig.5. The comparison of the foraging parameters for wintering oriental white stork in different foraging sites

The oriental white stork mainly preyed on fish in shallow water. The fishes that were preyed on by the storks included yellow catfish *Pelteobagrus fulvidraco*, crucian carp *Carassius auratus*, grass carp *Ctenopharyngodon idella*, loach *Misgurnus anguillicaudatus*. The stork handled large-sized fishes (>15 cm) for 201.07±35.31 sec (n=23), and small-sized fishes (<15 cm) for 85.22±20.86 sec (n = 14).

DISCUSSION

Time budget and behavior rhythm

Time and energy spent in various activities can influence the survival condition of birds. Time budgets can be adapted to differing environments and is also the response to the factors that influence the activities as well (Yang and Yang, 1996). The results showed that the main behaviors of the oriental white stork were resting, foraging and moving, which was similar to sympatric wintering large wading birds such as the black stork *Ciconia nigra* (Feng, 2008), little egret *Egretta garzetta* and great egret *Casmerodius albus* (Zhang *et al*., 2008). Foraging and resting are behaviors that result in energy accumulation and were the main behaviors

Table III.- Daily behavioral rhythms for wintering oriental white stork.

Time	Mean frequency of percentage various behaviors (Mean±SE)					
	Moving	Preening	Foraging	Resting	Vigilance	Others
7:00-7:59	19.53±1.79	6.82±1.31	41.82±3.70	28.27±4.16	3.09±0.93	0.46±0.32
8:00-8:59	12.88±0.97	9.46±2.17	38.48±5.59	35.65±5.36	2.24±0.59	0.29±0.15
9:00-9:59	11.15±1.41	10.69±1.58	36.98±7.71	39.24±4.38	1.58±0.62	0.36±0.20
10:00-10:59	12.19±1.49	9.59±1.15	37.81±3.71	38.57±4.32	1.60±0.92	0.25±0.16
11:00-11:59	11.30±2.01	11.60±1.64	28.18±2.95	47.04±4.11	1.19±0.38	0.69±0.26
12:00-12:59	13.82±1.88	8.11±0.92	33.87±3.97	41.59±4.97	1.54±0.45	1.06±0.38
13:00-13:59	14.86±2.26	11.44±2.10	29.80±3.56	41.24±4.92	2.13±0.93	0.53±0.25
14:00-14:59	11.44±1.40	11.43±2.34	33.00±3.84	41.81±3.82	2.13±0.76	0.19±0.15
15:00-15:59	13.80±2.09	7.44±1.18	34.33±4.08	43.01±4.53	1.18±0.34	0.24±0.19
16:00-16:59	14.76±1.59	7.23±1.52	39.74±4.52	36.94±4.76	1.27±0.36	0.06±0.06
17:00-	17.29±2.15	6.49±1.30	31.74±4.20	42.45±4.44	0.80±0.40	1.23±0.60

(75.51%) observed during the study. Oriental white storks in captivity spent 59.25% of the time resting, and only 6.41% of the time foraging and 5.14% of the time moving (Ma *et al*., 2006). The difference in time budgets between wild and captive storks is due to food abundance. Captive storks can spend less time foraging because they have an artificial food supply.

Oriental white storks, black storks *Ciconia nigra* (Feng, 2008), little egrets *Egretta garzetta* and great egret *Casmerodius albus* (Zhang *et al*., 2008) dedicate more time to standing and resting (around 44–58%) than foraging (around 19–36%). Hooded cranes (Jing *et al*., 2001) and common crane *Grus grus* (Li *et al*., 2008), however, spend more time foraging than other behaviors and also have a higher proportion of vigilance behavior. The intensity and pattern of vigilance can be influenced by various factors, with predation risk and human disturbance being the main external factors (Che and Li, 2014). In southern China, there are typically no predators in lakes that prey on large-sized water birds (Zhao, 2001). Oriental white storks and black storks are large carnivores with strong beaks and an aggressive nature (Zhao, 2001), so they do not need to spend as much time in vigilance. Similarly, egrets can spend a lot of time in trees where it is much safer than on the ground, and so also have lower vigilance Cranes, however, are restricted to grassland, farmland and lake, which are easily reached by humans and other terrestrial mammals (Zhang *et al*., 2008b), so they must spend more time conducting vigilant behaviors.

The behavior of birds can be influenced by climatic factors, and birds generate corresponding adaptive changes in the specific range (Beauchamp, 2006; Whitehorne, 2010). During this investigation, there was a significant linear relationship between daily minimum temperature and the behaviors of foraging and resting (Fig. 3). When the daily minimum temperature increased, the percentage of foraging increased while the percentage of resting decreased, which is similar to studies conducted on captive storks (Ma *et al.*, 2006). However, we found that there was no relationship between daily maximum temperature and the other main behaviors, indicating that minimum temperature was the key factor affecting stork behavior in winter.

Because of the oriental white stork's physiological activity and various factors in its environment, behavioral rhythms varied during the day. Similar to what has been found in many wintering birds, foraging behavior peaked in the early morning and dusk (Boxall and Lein, 1986), perhaps to compensate for the long period of overnight fasting. Resting peaked both at noon and dusk, which has similarly been found in wintering common cranes and crested ibis (Li *et al*., 2008; Shi, 2010).

Foraging strategy

The foraging habitats of oriental white storks gradually shifted from shallow water to grass over the winter period. While the optimum habitat was shallow water, storks shifted to other habitats such as grasslands possibly because of low water levels, food shortages and increased human disturbance

(Wang *et al*., 2010). Indeed, water level and food resources (especially fish) were drastically reduced by fishing activity in the late winter. For future studies on the oriental white stork, we will test whether the shift from water to grassland habitats is related to food shortage.

In shallow water, the average pecking rate was positively correlated with the moving rate and pecking success rate, which is similar to results found in the Squacco heron *Ardeola ralloides* (Papakostas *et al.*, 2005). This is probably because wading birds are able to catch more prey items (fishes) when they are moving. In contrast, moving rate was negatively correlated with the pecking success rate in mudflats and grasslands. It is clear that oriental white stork use different foraging methods and prey capture techniques in different habitats, possibly because food resources in mudflats and grasslands differ from those in shallow water. Further, it is possible that the anti-predator strategy of preys (fish) in shallow water is moving and hiding, which would cause the stork to move more in these habitats. In mudflats and grasslands, however, prey may rely on hiding, so storks may risk losing prey if they move too fast. We will be testing this assumption in future studies.

Oriental white storks mainly preyed on yellow catfish and crucian carp at Poyang Lake. This diet was similar to that of storks at Shengjinhu, Anhui Province. However, at Yancheng National Reserve, Jiangsu Province, storks preyed on tigerfish *Hydrocynus vittatus*, mudskipper *Periophthalmus cantonensis* (Wang and Yang, 1995) mainly because of different prey communities between the two different habitats. This result indicates that the diet of oriental white storks is relatively wide.

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REFERENCES

ALTMANN, J., 1974. Observational study of behavior: sampling methods. *Behaviour*, 49: 227-267.

BEAUCHAMP, G., 2006. Spatial, temporal and weather factors influencing the foraging behavior of migrating semipalmated sandpipers. *Waterbirds*, **29**: 221-225.

BIRDLIFE INTERNATIONAL, 2008. *Ciconia boyciana*. In: IUCN 2014 *IUCN red list of threatened species*.

BOXALL, P. C. AND LEIN, M. R., 1986. Time budgets and activity of wintering snowy owls. *J. Field Ornithol.*, **60**: 20-29.

CHE, Y. AND LI, Z. Q., 2014. Vigilance behavior of animals: Overview and perspective. *Sichuan J. Zool.*, **33**: 144-150.

FENG, L., 2008. *Wintering ecology of* Ciconia nigra *at Napahai*. Southeast Forestry University.

FORT, J., STEEN, H., STRØM, H., TREMBLAY, Y., GRØNNINGSÆTER, E., PETTEX, E. AND GRÉMILLET, D., 2013. Energetic consequences of contrasting winter migratory strategies in a sympatric Arctic seabird duet. *J. Avian Biol.*, **44**: 255-262.

GOSS-CUSTARD, J. D., 2003. Fitness, demographic rates and managing the coast for wader populations. *Bull. -wader Study Group*, **100**: 183-191.

HALLE, S. AND STENAETH, N. C., 2000. *Activity patterns in small mammals: An ecological approach.* Springer-Verlag, New York.

JING, K., TANG, S., CHEN, J. AND MA, Z. J., 2001. Wintering ecology of the hooded crane in the eastern tideland of Chongming Island [J]. *Chinese J. Zool.*, **37**: 29-34.

LI, X. Y., YANG, Y., YANG, S. J., JIANG, W. G. AND PENG, G. H., 2008. Preliminary observation on the wintering behavior of Eurasian crane in Lashihai lake, Yunnan. *Chinese J. Zool.*, **43**: 65-70.

LIU, X. Z., FAN, S. B. AND HU, B. H., 2006. *Integrated scientific survey of Najishan Wetland Nature Reserve, Jiangxi Province*. China Forestry Publishing, Beijing.

MA, X. F., TIAN, X. H., HE, X. B., CHEN, H. AND GUO, N., 2006. Over wintering behavior of oriental white stork in captivity. *Chinese J. Wildl.*, **27**: 36-39.

MACCARONE, A. D. AND BRZORAD, J. N., 2002. Foraging patterns of breeding egrets at coastal and interior locations. *Waterbirds*, **25**: 1-7.

MURATA, K., SATOU, M., MATSUSHIMA, K., SATAKE, S. AND YAMAMOTO, Y., 2004. Retrospective estimation of genetic diversity of an extinct oriental white stork (*Ciconia boyciana*) population in Japan using mounted specimens and implications for reintroduction programs. *Conserv. Genet.*, **5**: 553-560.

PAPAKOSTAS, G., KAZANTZIDIS, S., GOUTNER, V. AND CHARALAMBIDOU, I., 2005. Factors affecting the foraging behavior of the squacco heron. *Waterbirds*, **28**: 28-34.

SHAO, M, Q., ZENG, B. B., HOUNSOME, T., CHEN, L. X., YOU, C. Y., WANG, H. B. AND DAI, N. H., 2012. Winter ecology and conservation threats of scaly-sided

merganser *Mergus squamatus* in Poyang Lake watershed, China. *Pakistan J. Zool.*, **44**: 503-510.

SHAO, M. Q., JIANG, J. H., GUO, HONG AND ZENG, B. B., 2014. Abundance, distribution and diversity variations of wintering water birds in Poyang Lake, Jiangxi Province, China. *Pakistan J. Zool.*, **46**: 451-462.

SHI, L., 2010. *Study on the reintroduction population daily behavior and protection strategy of the crested ibis at Nishan, Shanxi Province*. Shanxi Normal University.

SHIMAZAKI, H., TAMURA, M., DARMAN, Y., ANDRONOV, V., PARILOV, M. P., NAGENDRAN, M. AND HIGUCHI, H., 2004. Network analysis of potential migration routes for oriental white storks (*Ciconia boyciana*). *Ecol. Res.*, **19**: 683-698.

SOMMERFELD, J., KATO, A., ROPERT-COUDERT, Y., GARTHE, S. AND HINDELL, M. A., 2013. The individual counts: within sex differences in foraging strategies are as important as sex‐specific differences in masked boobies *Sula dactylatra*. *J. Avian Biol.*, **44**: 531-540.

TIAN, X. H., WANG, J. R. AND ZHANG, B. L., 2005. Time budget of captive oriental white storks in breeding season. *Chinese J. Zool.*, **40**: 35-40.

WANG, Q. S. AND YANG, Z. F., 1995. Current study on oriental white stork. *J. Anhui Univ. Nature Since Edition*, **1**:82-97.

WANG, Y.S., RUAN, L.Z., HUANG, P., LUO, H.X. AND CHEN, S.P., 2010. Habitat selection and protection of *Ciconia boyciana* during over wintering stage in Poyang Lake. *J. Anhui Agric.*, **38**:7376-7378.

WHITEHORNE, I., 2010. Wintering behavior, physiology and site fidelity in a partial migrant, the American dipper (*Cinclus mexicanus*). *Waterbirds*, **33**: 461-470.

YANG, X. J. AND YANG, L., 1996. The observation of time budgets of captive green peafowl (*Pavo muticus*). *Acta Zool. Sin.*, **42**: 106-111.

YI, G. D., YANG, Z. J., LIU, Y., ZUO, B., ZHAO, J. AND HAO, X. L., 2010. Behavioral time budget and daily rhythms for wintering Mergus squamatus. *Acta Ecol. Sin.*, **30**: 2228-2234.

ZHANG, G. G., LIANG, W. AND CHU, G. Z., 2008. Comparative studies on wintering behavior of three egrets. *Chinese J. Wildl.*, **42**: 125-130.

ZHANG, W., LIU, N. AND LIU, X. G., 2008b. Habitat utilization of common crane (*Grus grus*) during winter in Lashi Lake, Yunnan Province. *Sichuan J. Zool.*, **27**: 356-362.

ZHAO, Z. J., 2001. *Chinese birds* (volume 1). Jilin Science Press, Changchun.

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