山階鳥学誌 (J. Yamashina Inst. Ornithol.), **46**: 41−54, 2014

Report（報　告）

The Breeding Ecology of the White-naped Crane *Grus vipio* in Muraviovka Park, Southeast Russia

Tamaki Kitagawa[1]

Abstract. The White-naped Crane *Grus vipio* is one of the most threatened species within the Family Gruidae. To address the paucity of information on the biology of this species, a study of its breeding ecology was conducted in Muraviovka Park, southeast Russia in 2011−12. It was discovered that the egg-laying period at this site extended over a 25 day period, and that both parents participated in incubation and exchanged incubation duties on average 7.3 times per day. The incubation period lasted 33−35 days and hatching success per nest was at least 56.3%. Only the female brooded the chicks. To assess time budget, recorded behaviors were divided into 11 different categories. Differences were seen in the time allocation of each parent towards different behaviors and these differences sometimes varied in relation to the incubation period versus the chick-care period. The adaptive significance of these behavioral shifts and the differences in the roles of each parent in terms of chick survival are a topic for future investigation.

Key words: Muraviovka Park, Nest, Russia, Time budget, White-naped Crane *Grus vivio*.

キーワード： ムラヴィオフカ公園，巣，ロシア，行動配分，マナヅル *Grus vivio*.

Introduction

The White-naped Crane *Grus vipio* is one of the most threatened species within the Family Gruidae. At Izumi, Kyushu, Japan, this species winters in large flocks together with the Hooded Crane *Grus monacha*. The breeding grounds of *Grus vipio* are mostly located in northeast Mongolia, northeast China, and southeast Russia (Johnsguard 1983, Meine & Archibald 1996, BirdLife International 2001). Telemetry studies have shown that several White-naped Cranes have migrated to Izumi from breeding sites in southeast Russia: two individuals from Khingansky National Park in 1992 and 1993, and one from Muraviovka Park in 1993 (Higuchi *et al.* 2004). Studies of the foraging activities of these cranes at their wintering sites, as well as several detailed accounts of breeding habits, such as reproductive performance and mating behavior, have been published (Zhu 1986, Ohsako 1987, Su *et al.* 1991, Yuan & Li 1991, Tseveenmyadag & Goroshko 2001, Bradter *et al.* 2005, Lee *et al*. 2007). However, with the exception of a study by Bradter *et al.* (2007), little information is available on the behavioral time budget of the White-naped Crane during the breeding season.

Received 24 March 2014.

[1] Chiba Reimei High School, Yachimata Ho-625, Yachimata, Chiba 289−1115, Japan.
E-mail: tamaki.kitagawa@pure.ocn.ne.jp

This report describes a study of the breeding ecology of the White-naped Crane in Muraviovka Park, southeast Russia, and includes nest locations and features, descriptions of breeding habits, and the behavioral time budget of this species during its breeding season.

Methods

Muraviovka Park, which is located in the Amur region of southeast Russia, is an important breeding area for the White-naped Crane and the Red-crowned Crane *Grus japonensis* (Fig. 1). The park also serves as an important stopover in the spring and fall migrations of several different crane species, including the White-naped Crane, Red-crowned Crane, Hooded Crane, Common Crane *Grus grus*, Demoiselle Crane *Anthropoides virgo*, and Siberian Crane *Grus leucogeranus* (Nosatchenko & Smirenski 2007). Muraviovka Park was founded in 1996 to preserve these breeding areas and stopover sites, and to provide a location for the environmental education of young people by a private nongovernmental organization (Smirenski 1999, Smirenski & Smirenski 2009). The park covers approximately 6,000 ha, and comprises the following vegetation types: marshes dominated by reeds *Phragmites communis* or sedges *Carex* sp.; marshes intermingled with sedges and sites dotted with alder *Alnus* spp.; scattered groves dominated by white and black birches *Betula* spp.; and abandoned farmlands dominated by wormwood *Artemisia absinthium*. Wheat, barley, soybean and grass are cultivated at several sites, particularly those surrounding the marshland (Fig. 2).

I conducted a preliminary study on the White-naped Crane from March 15 to November 11, 2011, and studied their reproductive performance and time budget from April 4 to July 5, 2012. I used a binocular telescope (×10) and a high-magnification telescope (×25–50) to observe the cranes. The locations of nests in 2012 were mapped using a GPS.

Full daytime observations on a focal pair of White-naped Cranes were conducted 17

Fig. 1. Location of the study area, Muraviovka Park.

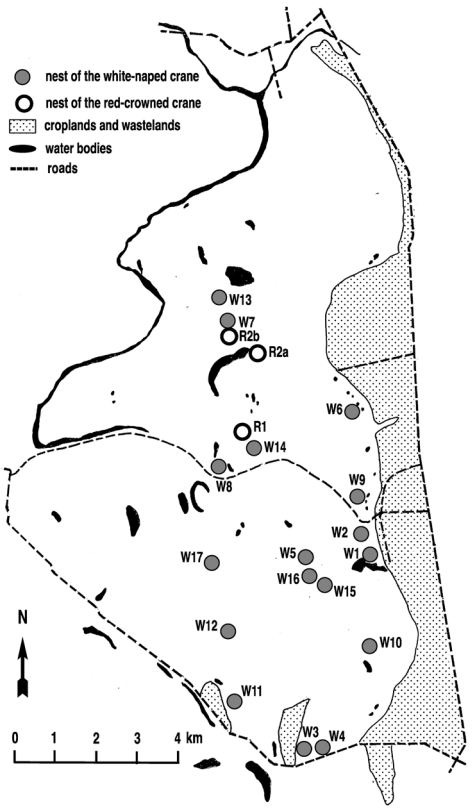

Fig. 2. Distribution of crane nests in Muraviovka Park: R2a, the nest for the first clutch; R2b, the second nest for the replacement clutch.

times in 2012. To assess the time budget, I noted the behavior of one or both members of the focal pair at 30-sec intervals. Additionally, I recorded unison calls uttered by both the focal pair and their neighbors during the 13 of the 17 full daytime observation days, whenever the weather conditions were good enough to record the sounds of the call. Sexing of the adults was based on the body size (males are larger than females) or by the body posture during the unison call (when uttering the unison call, only the males strongly raise their wings while letting the primaries drop; Archibald 1976, Johnsgard 1983). Pair members were identified individually from the patterns of dark bristly hair-like feathers on the cheek and forehead (Johnsgard 1983), and patterns of white and gray neck feathers.

I divided the observation period into two segments: before the day when the second egg hatched was considered the incubation period (from April 19 to May 23), and after this day was considered the chick-care period (from May 24 to June 30). The total number of full daytime observation hours in each period was 126.9 h and 124.2 h, respectively.

I recorded 175 types of individual behaviors and integrated them into nine categories: food intake behavior, locomotion, comfort behavior, resting and sleeping, alerting or vigi-

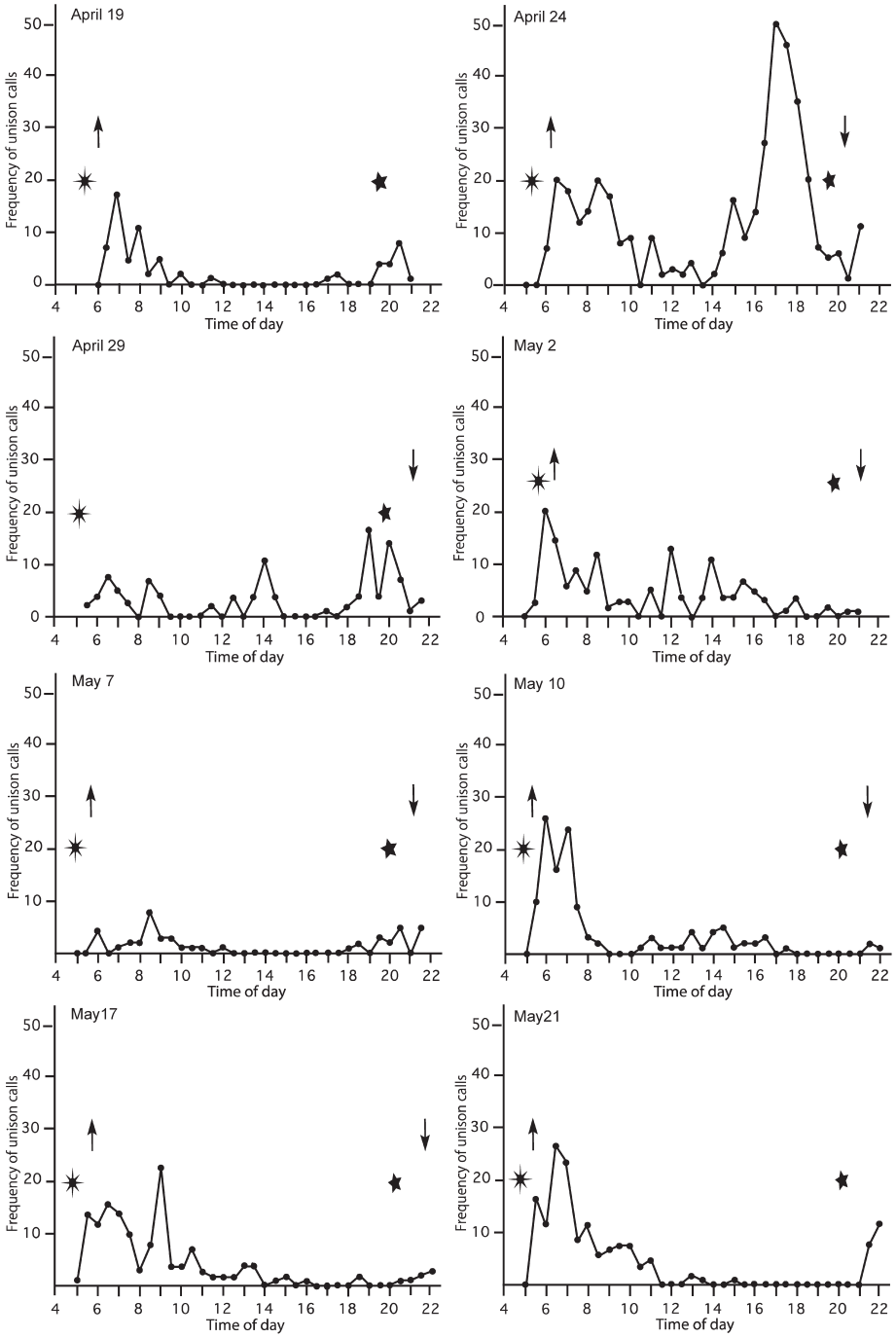
April 19
April 24
April 29
May 2
May 7
May 10
May17
May21
Frequency of unison calls
Time of day
0
10
20
30
40
50
4
6
8
10
12
14
16
18
20
22

Fig. 3.

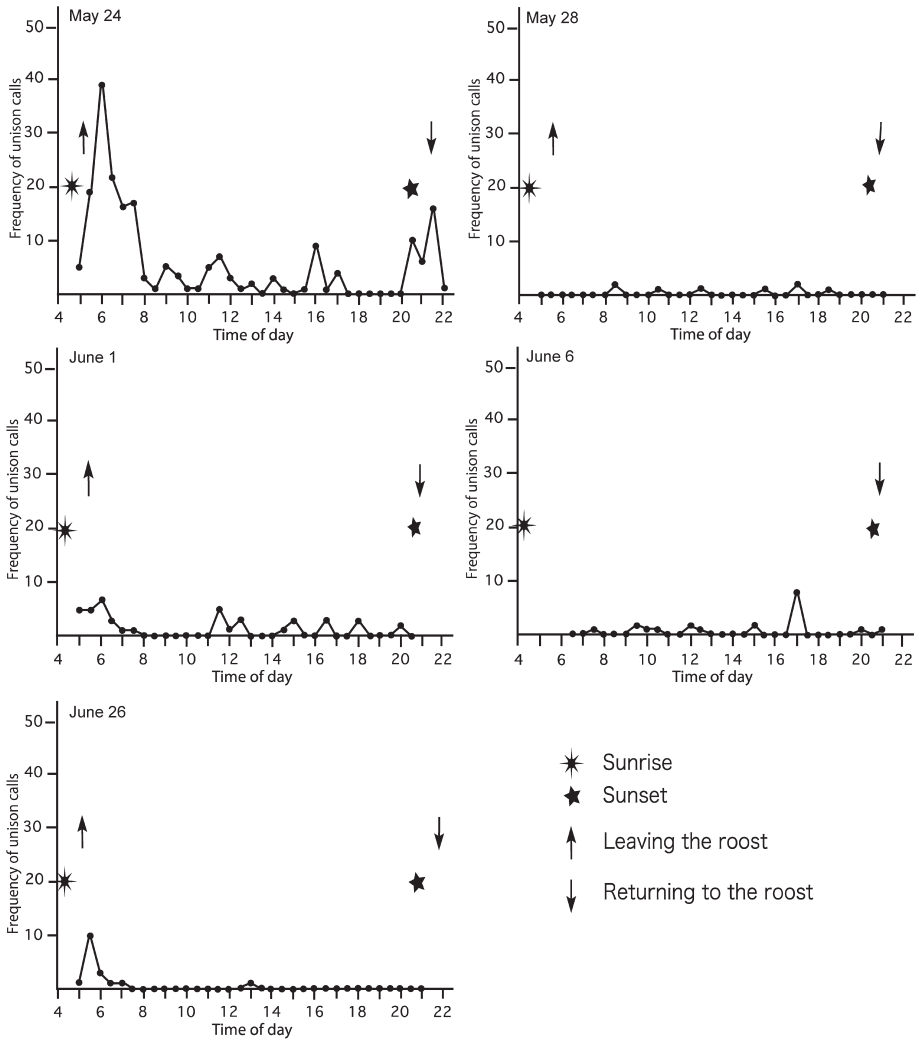

Fig. 3. Continued.
Daily shift of the frequency of unison calls. The time of leaving roosts was not recorded on April 29 and on June 6, and that of returning to roosts was not recorded on April 19 and May 21.

lance, territorial behavior, social behavior between pair members, parental care (divided into incubation and chick-caring behavior), and nest building (indicating nest-mending behavior during the incubation period and construction of roosting-nests during the chick-care period). Off-territory indicates that the focal birds flew out of the breeding territory, only within which the occupants performed chasing invaders, and not visible, which indicates that the birds were hidden from view within the territory, were also included as time budget categories. The frequency of not-visible observations increased gradually over the study period (cf. Table 2) ow-

ing to emergent vegetation making it difficult to follow each individual continuously, particularly from late June onward.

I examined whether the time budget spent on each behavior category was sex-dependent during each period using a *G*-test. The allocation to each behavior category by the male and the female between the incubation and chick-care periods was also examined using a *G*-test. If a significant difference was detected, adjusted residuals (henceforth, *ar*) were used to determine the type of behavior category that affected the difference. When calculating the mean time per incubation bout, the incubation time before the first incubation exchange in the morning and after the last incubation exchange in the evening was excluded, because it was unclear whether any incubation exchanges were performed during the night.

Results

Brief description of reproductive sequence

In 2011, the White-naped Cranes arrived at Muraviovka Park on March 31. Although the cranes were not individually marked, it was assumed that nearly the same four sites were used as breeding territories for two years in a row: W3, W4, W9, and W14 (Fig. 2). From April to June, 2012, many non-breeding pairs and families gathered in flocks and remained at several sites within the breeding area. During the daytime, these cranes often left the sites for nearby or remote croplands, but they returned to roost within the area in the evening.

In 2012, the first egg laying was confirmed on April 18 in nest W1, and the last was confirmed on May 13 in nest W16 (Fig. 2). Incubation activities were performed by both parents. In 2012, the chick from the first egg in nest W1 hatched on May 21 after 33 days of incubation, whereas the chick from the first egg in nest W2 hatched on May 30 after 35 days of incubation. The second chick in nest W1 hatched on May 23, two days after the first egg. Both parents fed the chicks, but only the female performed brooding behaviors. According to the observations from one family in 2011, chicks acquired flight ability approximately 85 days after hatching. The parents of the family made their own roosting sites within the breeding territory. Each day, the family left their roost in the early morning and returned in the late evening (Fig. 3). During the early chick-care period, the female brooded the chicks at the roost and the male rested or slept in a standing posture at night. During the later chick-care period, all family members roosted in a standing posture at the roost.

In 2011, many post-breeding families of the White-naped Cranes arrived at the park from other areas from late June and remained there to mid-October. These cranes roosted and foraged in marshes, and often flew to the surrounding croplands and more remote locations during the daytime. All White-naped Cranes had left the park by October 18, 2011.

Locations of nests

The locations of 17 nests of the White-naped Cranes and three nests of the Red-crowned Cranes are shown in Figure 2. The features of each nest of the White-naped Cranes are presented in Table 1. Nest W17 was assumed to be unused, and the location of nest W16 could not be determined. The mean diameter of 16 nests, except nest W16, was 107.8 cm × 100.2 cm (n＝16), the mean water depth was 37.2 cm, except nests W15 and W16 (n＝15;

Table 1. Nests and their features of the White-naped Crane. NR: Not recorded.

Nests	Longer axis (cm)	Shorter axis (cm)	Water depth (cm)	Height above water (cm)	Egg shells within the nest	Nest materials	Vegetation surrounding nest
W1	113	97	27	27	Few	Sedges	Sedges
W2	125	125	30	25	None	Sedges, sedge roots	Sedges
W3	97	70	44	18	Many	Reeds, sedge roots	Sedges surrounded semi-circularly with reeds
W4	106	106	36	13	Many	Reeds, sedge roots	Small pond surrounded with reeds, interspersed with irises
W5	127	112	23	13	None	Reeds, sedge roots	Sedges and reeds
W6	107	107	30	9	Many	Reeds, sedges	Small pond surrounded with reeds
W7	115	110	25	14	Many	Sedges, sedge roots	Sedges
W8	120	120	64	15	None	Reeds, sedges	Small pond surrounded with sedges and reeds
W9	90	75	27	15	Few	Sedges, sedge roots	Sedges
W10	68	62	19	12	Few	Sedges, sedge roots	Sedges
W11	106	106	53	12	None	Sedges, sedge roots cattails	Small pond surrounded with sedges
W12	123	115	62	12	None	Reeds, sedges, sedge roots, cattails	Small pond surrounded with sedges and reeds
W13	105	97	35	13	None	Sedges, sedge roots	Sedges
W14	124	117	28	14	Few	Sedges	Sedges
W15	98	94	NR	NR	None	Sedges, sedge roots	Sedges
W16	NR	NR	NR	NR	NR	NR	NR
W17	100	90	55	33	None	Reeds, sedges	Sedges and reeds
Max	127	125	64	33			
Min	68	62	19	9			
Mean	107.8	100.2	37.2	16.3			

max 64 cm; min 19 cm), and the mean height above water was 16.3 cm (n＝15; max 33 cm; min 9 cm). Of 16 nests, six were constructed of sedges and sedge roots; three were constructed of reeds and sedge roots; three were constructed of reeds and sedges; two were constructed of only sedges; one was constructed of sedges, sedge roots, and cattails *Typha* sp.; and one was constructed of reeds, sedges, sedge roots and cattails.

Of 16 nests, eight were situated in the sedge vegetation, two in sedge and reed vegetation, one in sedge vegetation surrounded with reed vegetation, and five in small ponds (two of five nests were surrounded with sedge and reed vegetation, two were surrounded with reed vegetation, and one was surrounded with sedge vegetation).

At two sites, the breeding territories of the White-naped Cranes and the Red-crowned Cranes overlapped almost entirely: W14 and R1, as well as W7 and R2b (Fig. 2). The distances between these nests were 420 m and 53 m, respectively. Territorial conflict was rarely observed between them.

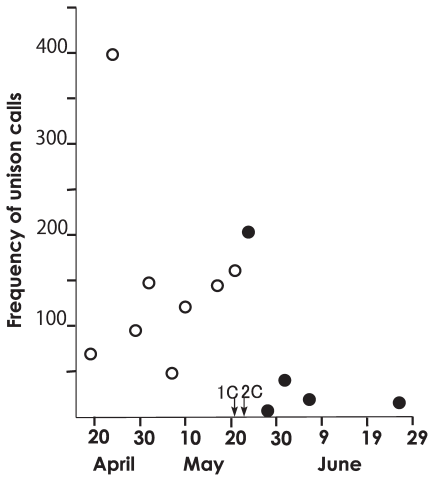

Fig. 4. Total frequency of unison calls uttered by the focal and neighbouring pairs. ○, records before the second chick hatched; ●, records after the second chick hatched; 1C and 2C, hatching dates of the first and the second chick, respectively.

Incubation and hatching success

The mean frequency of the incubation exchange was 7.3 times per day (range 3–9, cf. Fig. 5). The mean time per egg incubation bout for the male was 107.8±31.6 SE min, whereas that for the female was 130.0±19.8 SE min ($n_1=7$, $n_2=7$; Mann-Whitney's *U*-test, $z=-1.342$, $P=0.1797$). On the morning of May 21, 2012, when the first egg hatched at nest W1, the female of the pair removed one piece of the eggshell from the nest, and she subsequently consumed small eggshell pieces in the nest on several occasions. In the case of the Red-crowned Crane, if the chicks succeeded in hatching, pieces of the eggshells usually remained in and around the nests (Masatomi 1972). As shown in Table 1, pieces of eggshells were detected in only eight out of 15 nests, except unused nest W17. The eggs in most of the nests that did not contain eggshells may have been preyed upon by predators such as the Asian badger *Meles meles*, the raccoon dog *Nyctereutes procyonoides*, or the red fox *Vulpes vulpes*, all of which inhabited the breeding area of the cranes (Smirensky unpublished data). Although eggshells were not detected in nest W2, only one of the two eggs was confirmed to have hatched. Furthermore, the eggs in nest W16 were believed to have been predated, because it was observed that chicks did not hatch and parents ceased incubation activities. Therefore, hatching success per nest was estimated at a minimum of 56.3% (successful nests 9, unsuccessful nests 7; Table 1).

Frequency of unison calls

A unison call uttered by a pair often provoked the same response in neighboring pairs, resulting in the propagation of the call among many pairs throughout the habitat. The call appears to function as a territorial advertisement or defense, as well as for the maintenance of pair bonds (Masatomi & Kitagawa 1975). Therefore, the frequency of unison calls reflects a

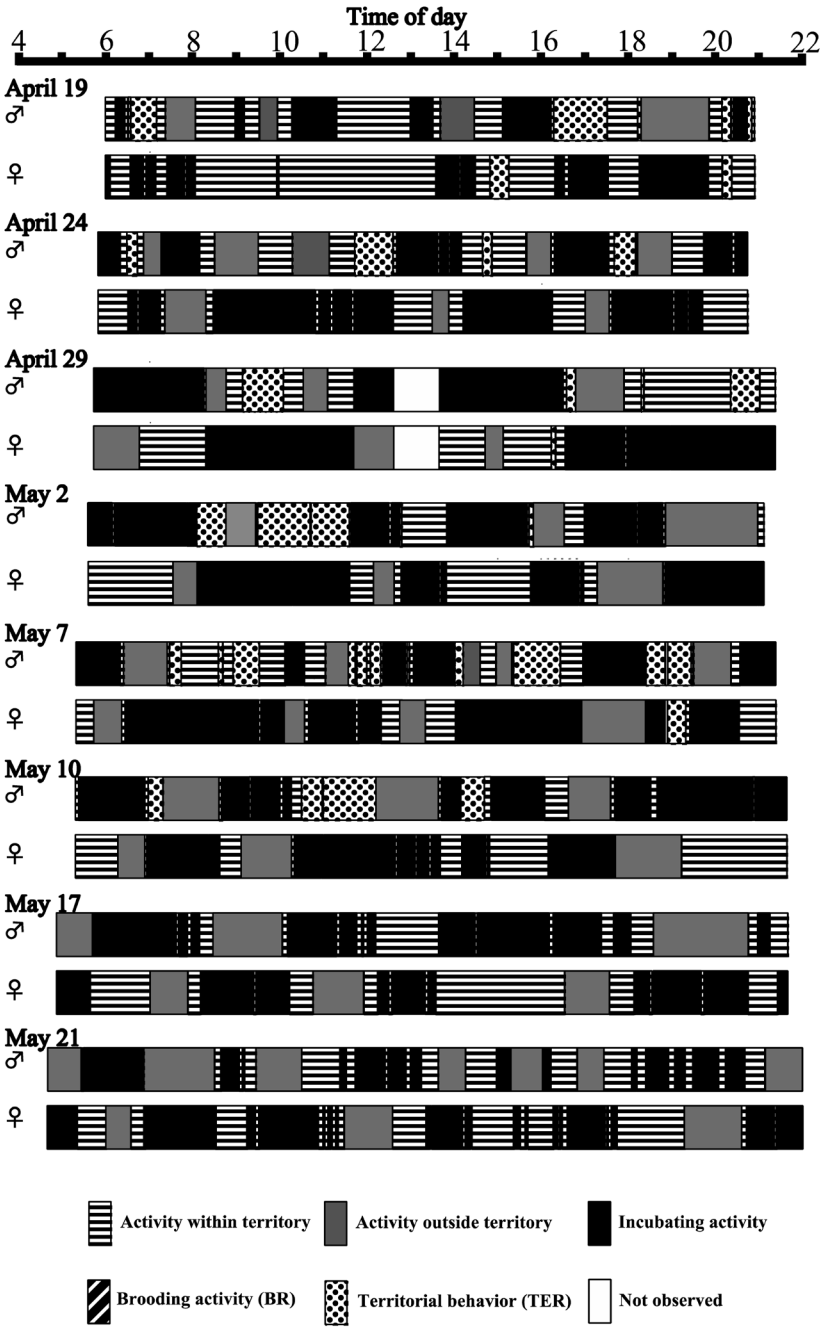
Time of day
4
6
8
10
12
14
16
18
20
22
April 19
♂
♀
April 24
♂
♀
April 29
♂
♀
May 2
♂
♀
May 7
♂
♀
May 10
♂
♀
May 17
♂
♀
May 21
♂
♀
Activity within territory
Activity outside territory
Incubating activity
Brooding activity (BR)
Territorial behavior (TER)
Not observed

Fig. 5.

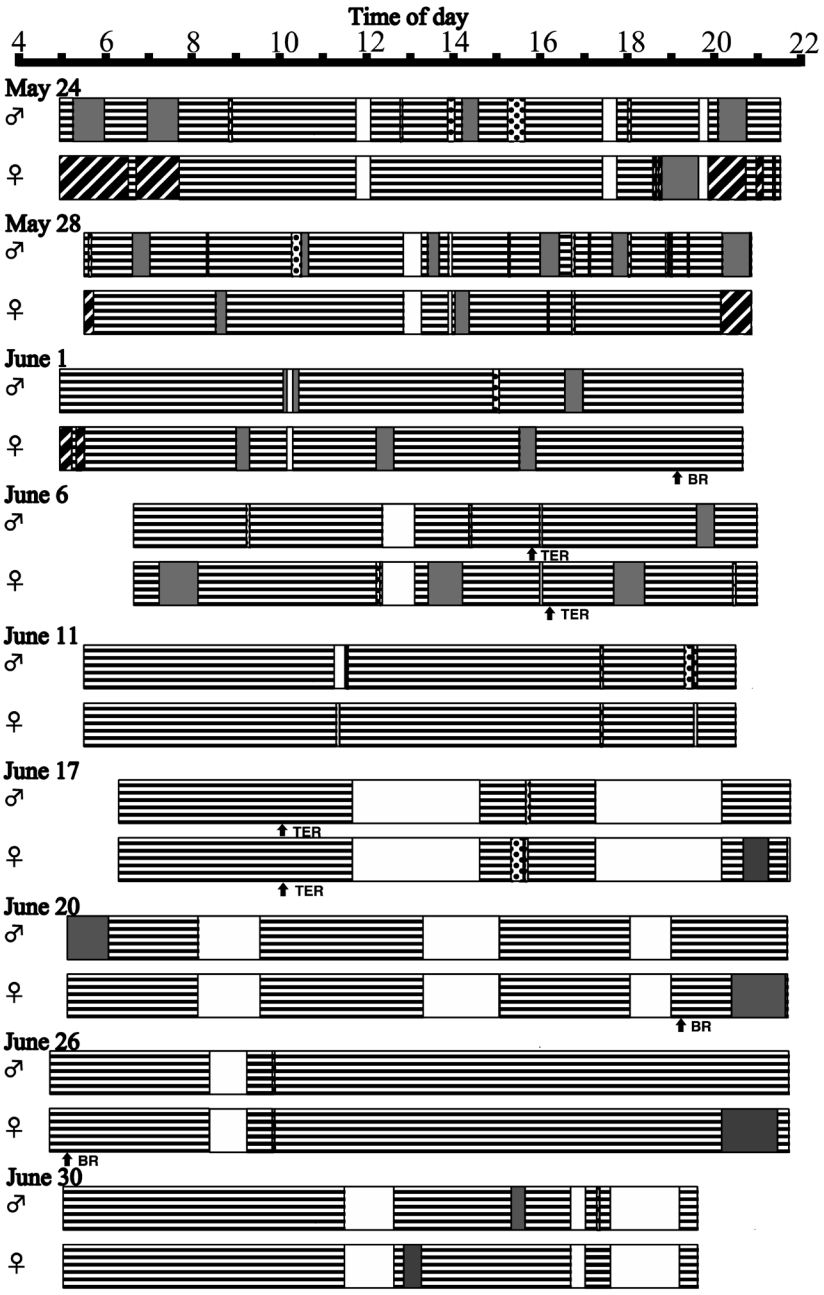

Fig. 5. Continued.
Diurnal activities of the focal pair in nest W1 within and outside of the breeding territory. Duration of incubation and brooding, and territorial behaviors is also shown. TER, territorial behavior; BR, brooding behavior.

Table 2. Time budget of the focal pair in nest W1. Incubation period was defined as the day when the second chick hatched and the preceding days. In the incubation and chick-care periods, the pair was observed during eight days (126.9 h) and nine days (124.2 h), respectively.

Behavior	Incubation period		Chick-care period	
	Male	Female	Male	Female
Food intake behavior	688	1,154	7,227	6,189
Locomotion	469	409	407	295
Comfort behavior	500	1,520	293	417
Resting and Sleeping	361	174	144	13
Alerting	1,407	1,453	1,761	2,314
Territorial behavior	1,799	149	238	95
Social behavior between pair members	107	83	81	70
Parental care	6,253	7,576	590	1,298
(Incubation)	(6,219)	(7,501)	(0)	(0)
(Chick-caring behavior)	(34)	(75)	(590)	(1,298)
Nest building	43	40	13	13
Off-territory	3,320	2,283	867	886
Not visible	295	401	3,285	3,316

daily shift in the intensity of territorial behaviors. The frequencies of unison calls uttered by the focal and neighboring pairs are shown in Figure 3, in which "leaving the roost" indicates the time when at least one of the focal family members left the roost in the morning, and "returning to the roost" indicates the time when every member of the focal family arrived at the roost in the evening. A bimodal rhythm in unison calls, peaking in the morning and in the evening, was evident on five of eight observation days before the second egg hatched: April 19, 24; May 7, 17, and 21. Furthermore, the frequency of unison calls decreased after the second chick hatched, except on May 24 (Fig. 4).

Time budget

The time budget spent on each behavior category by the focal pair is shown in Table 2. The time budget spent on chick-caring behavior during the incubation period given in Table 2 indicates the behaviors directed only toward the first-hatched chick before the hatching of the second egg. The time budget spent on nest building during the chick-care period given in Table 2 indicates that both parents built the roosting-nest at the roosting site. The time budget spent on off-territory is also shown in Figure 5.

During the incubation and chick-care periods, there were significant differences between the male and the female in the time budget spent on each behavior category (during the incubation period, $G=2{,}726.646$, $df=11$, $P<0.0001$; and during the chick-care period, $G=660.069$, $df=10$, $P<0.0001$).

During the incubation period, the male allocated more time for locomotion ($ar=2.055$), resting and sleeping ($ar=8.157$), territorial behavior ($ar=38.639$) and off-territory ($ar=15.335$) than did the female. The female allocated more for food intake behavior ($ar=11.201$), comfort behavior ($ar=23.486$), incubation ($ar=14.759$) and chick-caring behavior ($ar=3.934$) than did the male.

During the chick-care period, the male allocated more time for food intake behavior

(ar＝12.084), locomotion (ar＝4.278), resting and sleeping (ar＝10.483) and territorial behavior (ar＝7.880) than did the female. The female allocated more time for comfort behavior (ar＝4.710), alerting (ar＝9.323) and parental care (ar＝16.836) than did the male.

Furthermore, pair members showed significant differences in their respective time budgets spent on each behavior category between the incubation and chick-care periods (male, G＝17,788.969, df＝10, P＜0.0001; and female, G＝13,028.426, df＝10, P＜0.0001).

The male allocated more time for comfort behavior (ar＝7.132), resting and sleeping (ar＝9.486), territorial behavior (ar＝35.299), parental care (ar＝76.819), nest building (ar＝3.929) and off-territory (ar＝40.077) during the incubation period than during the chick-care period, and allocated more time for food intake behavior (ar＝86.749) and alerting (ar＝7.312) during chick-care period than during the incubation period.

In comparison, the female allocated more time for locomotion (ar＝4.049), comfort behavior (ar＝25.402), resting and sleeping (ar＝11.658), territorial behavior (ar＝3.296), parental care (ar＝78.090), nest building (ar＝3.631) and off-territory (ar＝25.572) during the incubation period than during the chick-care period., and allocated more time for food intake behavior (ar＝68.660) and alerting (ar＝15.729) during the chick-care period than during the incubation period.

The adaptive significance of these behavioral shifts and the differences in the roles of each parent in terms of chick survival are a topic for future study.

Acknowledgements

I express my gratitude to Dr. Smirensky, S. M., Muraviovka Park, Dr. Smirenski, E. M. and Dr. Archibald, G. W., International Crane Foundation, for their valuable suggestions and extensive support during the study. I also express my sincere gratitude to Dr. Asai, S., Yamashina Institute for Ornithology, for helpful advice on the manuscript. I am also grateful to Mrs. Yakovenko, S. M., Muraviovka Park and members of “Friends of Muraviovka Park” for helping facilitate my stay at the park. This study was partially financed by the Grant of Takehiko Yamashina.

References

Archibald, G. W. 1976. *The Unison Call of Cranes as a Useful Taxonomic Tool*. Ph.D. dissertation, Cornell University, New York.

BirdLife international 2001. *Threatened Birds of Asia: The BirdLife International Red Data Book.* BirdLife International, Cambridge.

Bradter, U., Gombobaatar, S., Uuganbayar, C., Grazia, T. E. & Exo, K. M. 2005. Reproductive performance and nest-site selection of White-naped Cranes *Grus vipio* in the Ulz river valley, north-eastern Mongolia. Bird Conservation International **15**: 313–326.

Bradter U., Gombobaatar, S., Uuganbayar, C., Grazia, T. E. & Exo, K. M. 2007. Time budgets and habitat use of White-naped Cranes *Grus vipio* in the Ulz river valley, northeastern Mongolia during the breeding season. Bird Conservation International **17**: 259–271.

Higuchi, H., Pierre, J. P., Krever, V., Andronov, V., Fujita, G., Ozaki, K., Goroshko, O., Ueta, M., Smirensky, S. & Mita, N. 2004. Using a remote technology in conservation: satellite tracking white-naped cranes in Russia and Asia. Conservation Biology **18**: 136–147.

Johnsgard, P. A. 1983. *Cranes of the World*. University of Nebraska, Lincoln.

Lee, S. D., Jablonski, P. G. & Higuchi, H. 2007. Winter foraging of threatened cranes in the demilitarized zone of Korea: Behavioral evidence for the conservation importance of unplowed rice fields. Biological Conservation **138**: 286−289.

Masatomi, H. 1972. Ecological studies on the Japanese crane *Grus japonensis* III. Journal of Senshu University, Hokkaido **3**: 153−161. (in Japanese)

Masatomi, H & Kitagawa, T. 1975. Bionomics and sociology of Tancho or the Japanese Crane, *Grus japonensis*, II. Ethogram. Journal of the Faculty of Science, Hokkaido University **19**: 834−878.

Meine, C. D. & Archibald, G. W. 1996. *The Cranes: Status Survey and Conservation Action Plan*. IUCN, Gland and Cambridge.

Nosatchenko, G. V. & Smirenski, S. M. 2007. The structure and distribution of crane roosting sites in Muraviovka Park for sustainable land use. Eurasian Journal of Forest Researech **10**: 139−143.

Ohsako, Y. 1987. Effects of artificial feeding on cranes wintering in Izumi and Akune, Kyushu, Japan. In *Proceedings of the 1983 International Crane Workshop* (eds. G. W. Archibald & R. F. Pasquier), pp. 89−98. International Crane Foundation, Baraboo.

Smirenski, S. M. 1999. Crane protection, environmental education, and sustainable development in rural areas of the Russian Far East. In *Proceedings of the Third European Crane Workshop 1996 and Actual papers* (eds. H. Prange, G. Nowald & W. Mewes), pp. 323−327. Halle-Wittenberg, Germany.

Smirenski, S. M. & Smirenski, E. M. 2009. Protection status of the Red-crowned Crane in the Amur region of Russia: practical measures to offset the threats. In *Proceedings of the Workshop*, "*Establishment of a Feasible International Project for Protection of the Tancho* Grus japonensis *in 2009*" (eds. K. Koga, D. Hu, K. Momose, K. Lee, E. Ilyashenko & Y. S. Momose), pp. 21−31. Tancho Protection Group, Kushiro.

Su, L., Xu, J. & Zhou, D. 1991. Breeding habits of White-naped Cranes at Zhalong Nature Reserve, China. In *Proceedings of the 1987 International Crane Workshop* (ed. J. Harris), pp. 51−57. International Crane Foundation, Baraboo.

Tseveenmyadag, N. & Goroshko, O. 2001. Some results of studies on reproduction and autumn migration of rare cranes in eastern Mongolia. Ecosystem of Eastern Mongolia: 56−63. (in Mongolian).

Yuan, T. & Li, P. 1991. Observations on mating behavior of White-naped Cranes in the wild. In *Proceedings of the 1987 International Crane Workshop* (ed. J. Harris), pp. 63−65. International Crane Foundation, Baraboo.

Zhu, C. 1986. On the mating behavior of white-naped crane. In *Crane Research and Conservation in China* (ed. Y. Ma), pp. 178−183. Heilongijang Education Press, Harbin.

ロシア，ムラヴィオフカ公園におけるマナヅルの繁殖生態

マナヅル*Grus vipio*は，ツル科の中でも，最も絶滅の危ぶまれる種の一つであるが，その生態については，あまり知られていない。私は2011–12年にロシア南東部に位置するムラヴィオフカ公園においてマナヅルの繁殖生態の調査を行った。公園での産卵期間は4月18日よりはじまり25日間に及んだ。抱卵は雄雌が行い，1日あたり平均7.3回の抱卵交代が行われた。抱卵期間は33–35日で，孵化成功率は少なくとも56.3％と推定された。抱雛は雌のみが行った。観察した行動を11のカテゴリーに分けてまとめて，行動配分を調べた。雄雌間の各行動カテゴリーの時間配分には抱卵期，育雛期それぞれに有意差が見られた。抱卵期と育雛期の間の雄雌それぞれの行動配分にも有意差がみられた。こうした行動配分の違いと雛の生残性に関わる雄雌の行動の役割の違いの適応的意義については今後の研究課題としたい。

北川珠樹：千葉黎明高等学校，〒289–1115 千葉県八街市八街ほ625.
E-mail: tamaki.kitagawa@pure.ocn.ne.jp