Front. Biol. China (2006) 1: 66–70
DOI 10.1007/s11515-005-0016-1

RESEARCH ARTICLE

Wang Nan, Jia Fei, Zheng Guangmei

Nest-site selection of the White Eared pheasant in southwestern Sichuan Province, China

© Higher Education Press and Springer-Verlag 2006

Abstract From April to July 2003 and 2004, we surveyed the nest-site selection of the White Eared pheasant (*Crossoptilon crossoptilon*) in the Zhujie Monastery and in the mountain facing it in Sichuan Province, China. In this paper, we studied the nest characteristics and the clutch size of the pheasant. Habitat sampling method was used to determine the variables that might affect the nest-site selection of the White Eared pheasant. Chi-square test was used to identify which habitat type was likely to be preferred by the bird. Independent-samples *t* test and Mann–Whitney *U* test were used to find which variables were important for the birds' nest-site selection. A total of 13 nests were found. Oak shrub was greatly preferred as nest sites (84.62%). Nests under a rock wall (7.69%) and a fallen tree (7.69%) were also found. The average clutch size of a White Eared pheasant is 7.33± 0.54 (range, 5–11; n=12). Laying period was between April 27 and May 21. In the Zhujie area, 1 nest was in the forest and 11 nests were in oak shrubs. The species preferred oak shrub as its nesting habitat (χ^2=8.333, df=1, P<0.05). The bird was more likely to place its nest in sites with a high coverage, i.e. 0.5, 1, and 2 m above the ground (independent-samples *t* test, P<0.05), and with a large shrub diameter (Mann–Whitney *U* test, P<0.05). The species are more likely to prefer sites with plant cover, shrub cover (independent-samples *t* test, P<0.05), and shrub height (Mann–Whitney *U* test, P<0.05) in a relatively small range.

Keywords White Eared pheasant, *Crossoptilon crossoptilon*, nest-site selection, clutch size, breeding

Translated from *Journal of Beijing Normal University (Natural Science)*, 2005, 41(2) (in Chinese)

Wang Nan, Jia Fei, Zheng Guangmei (✉)
Key Laboratory for Biodiversity Sciences and Ecological Engineering, Ministry of Education, College of Life Sciences, Beijing Normal University,
Beijing 100875, China
E-mail: zhenggm@bnu.edu.cn

Wang Nan
College of Natural Reserve, Beijing Forest University,
Beijing 100083, China

1 Introduction

Nest-site selection is very important for the survival and breeding of birds [1,2]. Nest success depends on predator, weather, quality of female, and the position of the nest [3–5]. Refuge provided by the environment of nests can influence the survival rate of birds, and the nest environment is characterized mainly by the vegetation around it [6,7]. Nest-site selection for one agnate bird is always similar, but the characteristics of the nest often vary with different habitat types, which can probably be attributed to the assumption that natural selection may alter the adaptive strategy of a species under different environmental pressures [8].

White Eared pheasant (*Crossoptilon crossoptilon*) is endemic in China and is mainly distributed in the west Sichuan Province, northwest Yunnan Province, east Qinghai Province, and east Tibet Autonomous Region [9]. The species are mainly found in mixed deciduous–conifer forest, subalpine conifer forest, subalpine shrub meadow, and the holly-leaf-like oak (*Quercus apuifolioides*) shrub and forest [10].

The White Eared pheasant nests on the ground [9]. Until now, no work has been conducted on the nest-site selection of the bird. To make clear why the species inhabit in many vegetation types and to obtain some fundamental information for the conservation of species, we studied the characteristics of the nest sites of the White Eared pheasant and identified the key variables affecting the nest-site selection of the bird.

2 Method

2.1 Study area

Our study was conducted in Daocheng County, Sichuan Province, Southwest China, from April to July 2003 and 2004. The study area consisted of two close sites, the area surrounding the Zhujie Monastery (100°10′E, 29°09′N) and the area near Suochong Village. Suochong village is located at the foot of the mountain facing the Zhujie Mon-

astery area. The Zhujie Monastery area is located on a south-facing slope with an elevation from 3,900 to 4,300 m and is dominated by hollyleaf-like oak (*Q. apuifolioides*) and meadows. Because logging activity has been strictly prohibited around the Zhujie Monastery for a long time, hollyleaf-like oak forests with elevated height and coverage are mainly scattered around the monastery. The forest is characterized by close canopy and sparse shrub. Outside the forest, logging is allowed. A large area of oak shrubs, characterized by a height of 2 m on average, is seen around the forest and is decorated by patches of meadow. Stream bands are dominated by the willow (*Salix sclerophylla*) and rhododendron (*Rhododendron* spp.) shrubs as well as hollyleaf-like oak. We classify habitat as oak forest, oak shrub, and wet shrub. The mountain near Suochong Village is a north-facing slope with an elevation from 3,900 to 4,300 m and dominated by Balfour spruce (*Picea likiangensis*), Chinese larch (*Larix potaninii*), and rhododendron (*Rhododendron* spp.).

2.2 Data collection

We searched nest sites during spring 2003 and 2004 by using random transect and by observing the behavior of males and females. Once nests were found, we measured some variables on nesting habitat and monitored the nests everyday. Thirteen nests were found during the study period. Three types of nest sites were found. They were located on a bush, under a rock wall, and under a fallen tree. We measured variables on habitat characteristics by using the methods provided by Lu and Zheng [11]. The nests were identified as the centers of the samples, and the samples were 10×10 m plots for trees and four 5×5 m plots in each 10×10 m plot for shrubs and herbs. In each sample, the following parameters were measured: altitude (measured with altimeter), degree of slope (measured with a compass), wood cover (%), wood height (m), wood diameter at breast height (cm), shrub cover (%), shrub height (m), herb cover (%), herb height (cm), plant cover (%), plant height (m), and coverage of the plant above the ground at heights of 0.5, 1, 2, 4, and above 4 m (%). Percent cover was estimated with an ocular tube. Height was measured using an altimeter (for trees) or a straight rod with a scale (for shrubs and grasses) from the ground to the top of the canopy. All the measures were carried out after hatching was finished. Two control samples of each nest were selected at sites 40 and 100 m away from the nest in random direction, respectively.

In each nest, we measured the diameter of shrub covering nest (cm), height of shrub covering nest (m), distance to the edge of shrub covering nest (m), up height (cm), nest diameter (cm), nest depth (cm), and pad thickness (cm). All of the nests we found were located beside a rock wall and a shrub root. We regarded the rock and the root as the back of the nest and measured the back cover, front cover, left cover, right cover, and up cover of each nest. When we estimated the surrounding coverage of each direction of the nest, we put a 20×29 cm white paper in the middle of the nests and observed the paper 1 m away from the nest. The percentage of covered area was determined as the coverage of each direction.

During the work, we found that shrub cover, shrub height, and plant cover varied little in nest sites. Hence, we compared the range of plant variables of nest sites and control sites to reflect the characteristics of nest-site selection.

2.3 Data analysis

The Chi-square test was used to determine the preferred habitat type. Independent-samples *t* test was used to identify the variables with significant difference between nest samples and control samples if the variables met assumptions of normality (one-sample Kolmogorov–Smirnov *Z* test, $P>0.05$), and the Mann–Whitney *U* test was used if not. In all statistical data, means are given as mean ± standard error (SE). We used SPSS for Windows (SPSS Inc., 1999) software to conduct all statistical analysis.

3 Results

3.1 Clutch size and hatching

We found a total of 13 nests, and 12 nests had been incubated. The clutch size was 7.33±0.54 (range, 5–11; $n=12$). Eight nests were hatched out between May 20 and June 15, 2004. The duration of incubation was 24–25 days [12–14]. Thus, in our study area, White Eared pheasants laid their eggs between April 27 and May 21. We found that six nests had hatched before 9:00, and two had been empty in the afternoon when we found them. Chicks followed their parents when they laft the nests. In May 20, we observed the whole process of 11 chicks' hatching from a nest. The female stayed near the nest to wait and warm the chicks. Its mate was guarding closely.

Table 1 Characteristics of the nests of the White Eared pheasant ($n=13$)

Variable	Minimum	Maximum	Mean ± SE
Diameter of shrub covering nest (m)	1.3	4.0	2.61±0.25
Height of shrub covering nest (m)	0.9	5.0	1.82±0.29
Distance to the edge of shrub covering nest(m)	60	176	75.92±10.06
Back cover (%)	70	100	96.92±2.37
Front cover (%)	20	90	63.08±6.83
Left cover (%)	1	100	58.54±8.57
Right cover (%)	20	90	55.00±6.93
Up cover (%)	40	100	82.31±5.05
Back cover (cm)	25	70	34.77±3.43
Nest diameter (cm)	26	34	28.31±0.68
Nest depth (cm)	3.5	10.0	5.50±0.43
Pad thickness (cm)	2	6	3.73±0.30

Table 2 Comparison of variables between nest sites and control sites

Variables	Nest site (n_1=13)	Control site (n_2=26)	Z^a	t^b
Altitude (m)	4,045.39±18.03	4,050.12±13.15	−0.164	
Slope degree (°)	23.08±3.08	18.96±2.28		1.056
Slope facing (°)	161.54±18.75	137.69±11.59	−1.019	
Plant cover (%)	51.54±4.51	36.73±5.49		1.759
Plant height (m)	2.17±0.24	2.02±0.23		0.411
Tree cover (%)	9.62±5.90	5.35±3.55	−0.888	
Tree height (m)	1.65±0.80	0.79±0.33	−0.888	
Tree diameter at breast height (cm)	2.69±1.35	1.00±0.47	−1.163	
Shrub cover (%)	45.77±5.12	30.88±5.46		1.741
Shrub height (m)	1.70±0.08	1.65±0.18		0.201
0.5 m Cover (%)	29.23±4.80	14.85±2.06		3.236**
1 m Cover (%)	31.15±3.68	17.00±2.61		3.132**
2 m Cover (%)	31.15±3.37	19.96±3.53		2.087*
4 m Cover (%)	9.23±3.53	12.92±4.40	−0.260	
Above 4 m cover (%)	4.62±3.83	3.77±3.08	−0.317	
Herb cover (%)	14.00±6.19	29.62±7.58	−0.844	
Herb height (cm)	6.77±1.63	4.96±1.12	−1.133	
Proportion of stone (%)	35.00±9.61	26.46±7.17	−0.448	
Distance to open area (m)	53.77±15.73	50.27±14.99		0.310
Density of shrub[c]	4.55±0.85	3.99±0.70		0.303
Diameter of shrub (m)[c]	3.85±0.68	2.79±0.55	−2.265*	

*P<0.05, **P<0.01
[a]Mann–Whitney U test; [b]independent-samples t test; [c]n_1=11, n_2=22

3.2 Characteristics of nest

We found a total of 12 nests in the Zhujie area. One (7.69%, n=13) was under a rock wall and covered by shrub. Eleven nests (84.62%, n=13) were in oak shrubs formed by logging and natural recovering. In the Suochong area, one nest was found under a fallen tree logged by the local people and covered by rhododendron shrub. All the nests we found were covered by shrub, rock wall, or fallen tree and were connected by passages outside. The nests have the shape of a shallow plate, and the materials were the sticks around the nest sites as well as some feathers. Some characteristics of the nest are shown in Table 1.

Table 3 Comparison of the ranges of variables between nest sites and control sites

Variable	Nest site (n_1=13)		Control site (n_2=26)		Z^a	t^b
	Range	Mean ± SE	Range	Mean ± SE		
Plant cover (%)	20–70	13.73±2.15	0–90	26.82±3.18		−2.747**
Plant height (m)	1.4–4.5	0.64±0.15	0–5	0.88±0.15	−0.673	
Tree cover (%)	0–70	14.03±4.29	0–80	12.79±2.60	−0.081	
Tree height (m)	0–9	2.29±0.45	0–5	1.80±0.09	−0.401	
Tree diameter at breast height (cm)	0–16	3.73±0.82	0–7	2.86±0.11	−0.613	
Shrub cover (%)	10–70	14.67±2.88	0–90	27.55±2.88		−2.820**
Shrub height (m)	1.2–2.3	0.18±0.06	0–3.5	0.68±0.12	−2.670**	
0.5 m Cover (%)	15–70	11.60±3.44	0–40	15.39±1.74		−1.100
1 m Cover (%)	15–60	10.06±2.25	0–50	16.96±1.83		−2.273*
2 m Cover (%)	10–50	9.50±1.96	0–60	18.26±2.03		−2.741**
4 m Cover (%)	0–40	9.17±2.33	0–80	15.30±3.25	−1.818	
Above 4 m cover (%)	0–50	7.51±3.16	0–80	7.09±2.74	−0.232	
Herb cover (%)	0–70	16.62±3.92	0–100	29.00±5.79	−0.904	
Herb height (cm)	0–18	4.60±0.94	0–25	4.59±0.74	−0.015	
Proportion of stone (%)	0–90	31.54±3.07	0–100	34.69±2.49	−0.603	
Distance to open area (m)	0–210	42.02±10.02	−31–254	59.10±9.24	−1.460	
Density of shrub[c]	1–10	2.13±0.51	0–11	2.72±0.41		−0.861
Diameter of shrub (m)[c]	2–10	1.48±0.49	0–10	2.33±0.33	−2.358*	

*P<0.05, **P<0.01
[a]Mann–Whitney U test; [b]independent-samples t test; [c]n_1=11, n_2=22

3.3 Characteristics of nest habitat

In the Zhujie area, the nests were found in two habitat types: wet shrubs and oak shrubs. The White Eared pheasant preferred the oak shrub as their nest habitats (χ^2=8.333, df=1, P<0.05). In the nest sites, covers of 0.5, 1, and 2 m above the ground and the diameter of shrub were significantly higher than those in control sites (Table 2). The results showed that the White Eared pheasant preferred the areas with high coverage under 2 m above the ground and those with large shrubs as nest site. Ranges of plant cover, shrub cover, shrub height, shrub diameter, and covers of 1 and 2 m above the ground were significantly lower in nest sites than in control sites (Table 3), suggesting that the White Eared pheasant preferred the sites with smaller ranges of the said variables.

4 Discussion

The White Eared pheasant is found in many habitat types [9]. Early studies conducted on the White Eared pheasant have collected 20 nests of the bird. Five (25%) of them were found in shrubs, three (15.0%) under a rock wall, nine (45.0%) from a leaning tree trunk, and three (15.0%) under a fallen tree [12–14]. In the Zhujie area, the wood canopy of the oak forest obstructs sunshine, which results in few shrubs growing in the forest and provides few optimal habitats for nesting. Around the forest, a large area of oak shrub provides many nesting habitats but few rock walls and leaning tree trunks exist. The nest in the Suochong area was under a fallen tree trunk logged by local people and covered by shrub. In our study, the number of the nests in shrubs is quite high, which can be attributed to the fact that the bird's nest-site selection varies with different habitat types. We suggest that moderate logging activity may provide some nest habitat for the White Eared pheasant, and the bird may adapt to human disturbances to some degree.

Many studies have emphasized that refuge provided by the habitat was important for the nest-site selection of pheasant species [8,11]. All the nest sites of the White Eared pheasant in early studies were located under covers provided by the nest habitat [12–14]. In our study, all the nests are covered by shrub. Five different directions of the nest show high coverage (Table 1). The coverage 0.5, 1, and 2 m above the ground is significantly higher in nest samples than in control ones, which suggests that the nest sites actually provide refuge for the bird's incubation.

When we determined which variables were important for habitat selection, we found that some key variables did not show significant differences between nest samples and control ones. The reason could possibly be attributed to the fact that we averaged the scattered data in the analysis. In our analysis, the range of plant feature is defined to reflect the ranges of variables. Analyzing it prevents us from eliminating some key variables in the analysis. Wood cover, shrub cover, and shrub height did not show significant differences between nest sites and control ones, but the ranges of the three variables are significantly different, which shows that they varied in smaller ranges in the nest sites and they were important variables affecting the nest-site selection of the White Eared pheasant as well. Dense shrub provides refuge for pheasants [8,11,15], but it also prevents the birds from finding prey and moving freely. Our study area has been logged and recovered in a large area for a long time and has been dominated by shrubs. Small shrubs are dense and can enshroud the bird well, but they also obstruct the birds' activities and their search for prey. In big shrubs and forest habitat, sparse plant appears under canopy. This vegetation characteristic provides few nest sites for the birds. The nest sites of the White Eared pheasant are not found in big shrubs, and the distance from the nests to the edges of the nest shrub is not too long (Table 1). Vegetation that is too dense and too sparse is not an ideal birds' nest site. Hence, a nest site whose variables such as plant height, shrub cover, and shrub height are in special ranges provides the birds refuge and makes them move freely.

Acknowledgements This study was supported by the National Sciences Foundation of China (no. 30330050) and the Chicago Zoological Society. Peter Garson provided constructive advice on the work and invaluable assistance through facilitating the support of the Chicago Zoological Society. We thank the Sichuan Province Forestry Bureau, the Daocheng County Forestry Bureau, and the Daocheng County Religion Bureau. They provided much help during our work.

References

1. Badyacv A. V., Nesting habitat and nesting success of Eastern Wild Turkeys in the Arkansas Ozark Highlands, Condor, 1994, 97: 221–232
2. Clark R. G. and Nudds T. D., Habitat patch size and duck nesting success: the crucial experiments have not been performed, Wildl. Soc. Bull., 1991, 19: 534–543
3. Batt B. D. J., Afton A. D., Anderson M. G., Ankney C. D., Johnson D. H., Kadlec J. A. and Krapu G. L. (eds) Ecology and Management of Breeding Waterfowl, Minneapolis: University of Minnesota Press, 1992
4. Flint P. L. and Grand J. B., Nesting success of Northern Pintails on the coastal Yukon Kuskokwim Delta, Alaska, Condor, 1996, 98: 54–60
5. Traylor J. J., Alisauskas R. T. and Kehoe F. P., Nesting ecology of White-winged Scoters (*Melanitta fusca deglandi*) at Redberry Lake, Saskatchewan, Auk, 2004, 121: 950
6. Martin T. E., Avian life history evolution in relation to nest sites, nest predation, and food, Ecol. Monogr., 1995, 65: 101–127
7. Clark R. G. and Shutler D., Avian habitat selection: pattern from process in nest-site use by ducks, Ecology, 1999, 80: 272–287
8. Nguyen L. P., Hamr J. and Parker G. H., Nest site characteristics of Eastern Wild Turkeys in Central Ontario, Northeast. Nat., 2004, 11: 255–260
9. Lu T. C., The Rare and Endangered Gamebirds in China, Fuzhou: Fujian Science and Technology Press, 1991 (in Chinese)
10. Gema J. C., Dong D. F. and Long W. X., A preliminary study on ecology of White Eared-pheasant, Chin. J. Zool., 1999, 34: 26–28 (in Chinese)

11. Lu X. and Zheng G. M., Reproduction ecology of Tibetan Eared Pheasant *Crossoptilon harmani* in scrub environment, with special reference to the effect of food, Ibis, 2003, 145: 657–666
12. Lu T. C., Breeding ecology Tibetan Eared Pheasant, Acta Zool. Sin., 1986, 32: 369–373 (in Chinese)
13. Gema J. C., Dong D. F. and Long W. X., A preliminary study on breeding ecology of Tibetan Eared Pheasant, Wildlife, 1995, 6: 8–12 (in Chinese)
14. Wu Y. and Peng J. T., Breeding ecology of the White Eared Pheasant (*Crossoptilon crossoptilon*) in western Sichuan, China, J. Yamashina Inst. Ornithol., 1996, 28: 98–102
15. Smith S. A., Stewart N. J. and Gates J. E., Home ranges, habitat selection and mortality of ring-necked pheasants (*Phasianus colchicus*) in North-central Maryland, Am. Midl. Nat., 1999, 141: 185–197