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Seasonal Changes in Habitat Use of Blue-Eared Pheasant, *Crossoptilon auritum*

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Abstract.- From 2007 to 2009, a study on the seasonal changes in the ranging area of blue-eared pheasant (*Crossoptilon auritum*) and its affecting factors was conducted in the Gahai-zecha National Nature Reserve, Gansu Province, China. The foraging-site samples and random-plot samples were selected by line transects crossing the study area. Fifteen factors related to the changes of vegetation factors, terrain factors, and food factors, etc were measured in each site. The main result of this study indicated there are significant difference on seasonal habitat change in altitude, slope degree, position on slope, cover of tree and grasses between breeding season and non-breeding season. Our results suggested that vegetation features and food resources were the most important habitat factors influencing habitat selection of blue-eared pheasants. High quality vegetation features with adequate camouflaged foraging-sites and fewer human disturbances in the breeding stage is important to ensure the maximum reproduction and survival of birds. However, in the non-breeding stage, due to lack of abundant food, blue-eared pheasants in winter always have larger habitat territories such as different types of forest or a larger range of altitudes to find more food resources.

Key words: Blue eared pheasant, golden pheasant, lady Amherst pheasant, brown eared pheasant.

INTRODUCTION

Birds can select the most suitable habitat for themselves from a variety of available habitat types in a phenomenon known as habitat selection (Partridge, 1978). Habitat quality directly affects the birds' geographic distribution, population density, breeding success rate, survival rate of adult birds, etc. (Cody, 1985). Therefore, habitat research has become an important aspect of the ecology in birds (Zhang and Zheng, 1999) and it may provide the most effective protective measures for biodiversity. For endangered birds, the study of relationship between their habitat preference and habitat structure is helpful to predict their suitable habitat, assess their habitat quality and further improve their habitat conditions for the conservation and management of their populations (Morris, 2003). Habitat selection by birds at different spatial scales is a very complex process resulting from the combined effects of multilevel ecological environmental factors (Yang *et al*., 2000). Thus, in pheasant research, it is necessary to study the relationship between birds and their habitats to understand how species adapt to their environment (Cody, 1985; Johnsgard, 1999; Graves, 2002; Xu *et al*., 2010).

The blue-eared pheasant (*Crossoptilon auritum*) belongs to the family Phasianidae, Order Galliformes. It is a rare and endemic species to China distributed only in the east and northeast Qinghai Province, northwest and south Gansu Province, northwest Sichuan Province, and west Ningxia Autonomous Region (Lu *et al*., 1998). The four species of eared pheasants (*Crossoptilon spp*.) are usually found in forest habitats (Johnsgard, 1999), but the blue-eared pheasant also occurs in relatively sparse shrub vegetation typical of sub-alpine shrub meadows (Li *et al*., 1985). Previously, studies of blue-eared pheasant mainly focused on the breeding biology and growth (Zheng and Liao, 1983), nest-site selection (Wu and Liu, 2011) and behavior (Li *et al*., 1985; Sun *et al*., 2005; Wu and Liu, 2010) of this species have been carried out in northwest China. However, spatial changes of habitat selection by seasonal scales have not been systematically studied. More detailed knowledge of seasonal habitat preferences are crucial to proper conservation of this species. Therefore, the aims of this study were to measure

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habitat characteristics in breeding and non-breeding seasons of blue-eared pheasant, and to identify what key variables influence habitat selection.

MATERIALS AND METHODS

Study area

This study was conducted in southern Gansu Province, northwest China during the 2007-2009. The study area locates in the Gahai-zecha National Nature Reserve (102°05′ - 102°47′E, 33°58′ - 34°32′N). In Zecha forest, logging activity has been strictly prohibited here for ten years. Two main habitat types dominate the nature reserve: cold-temperate coniferous forest characterized by spruce (*Picea asperata*) and fir (*Abies* spp.), and mountain-temperate coniferous forests with Qilian Juniper (*Sabina przewalskii*) distributed on sunny and partly sunny slopes. The local forest is characterized by closed canopy with an elevation from 3,000 to 3,500 m. Closed-canopy areas are interspersed with gaps containing shrubs and meadows. In study area, there are some farmlands on the foot of a mountain which can provide the deciduous grain as potential food source for blue-eared pheasant (Liu and Ma, 1997).

Data collection

We conducted a quantitative survey on the habitat selection of blue-eared pheasants in breeding season (from early April to mid-June) and non-breeding season (from early November to late December). The line transects traversing the entire study areas were used to record the foraging sites of birds in different habitats from 08:00 to 18:00. The length of line transects ranged from 3–5 km and the width was around 50 m for each side. It was difficult to find blue-eared pheasants due to their scattered populations particularly in the breeding season. Therefore, findings of fresh feeding traces and feces allowed us to quantify feeding habitat selection of this pheasants. In field, we recognized the flock which foraged under natural conditions.

For all appearance sites, 15 parameters of habitat variables of blue-eared pheasants were recorded in 10m×10m tracking plots. Once a foraging site was located, this site was used as the center of a 10×10 m sample plot. Each 10×10 m plot was divided into four 2×2 m plots which located in four angle of foraging-site sample, and five 1×1 m plots which located in quarter cater-corner and centre of foraging-site sample. In the entire study period, total 24 summer habitat (breeding stage) and 27 winter habitats (non-breeding stage) were investigated.

In 10×10 m samples, the following parameters were measured: altitude (measured by GPS), slope degree (measured by declinometer), slope aspect (measured with GPS, east = 1, southeast = 2, south = 3,…..northeast = 8), position on slope (divided into low, mid-low, medium, mid-high, high valuing from 1 to 5, respectively), diameter of tree (cm), height of tree (m), cover of tree (%), distance to path (divided into five different intervals from the spot as 0–100, 101–200, 201–300, 301–400 and over 401 m, valuing from 1 to 5, respectively), distance to water (m) (measured by tape measure). In 2×2 m plots, we measured height of shrub (m), cover of shrub (%), and species richness (all species of shrub and grasses). In 1×1 m plots, we measured density of grasses, height of grasses (cm), and cover of grasses (%). In those parameters, percent cover was estimated; tree height was measured with an altimeter from the ground to the top of the canopy; shrub and grass height was measured with a scale ruler. Control samples for each foraging site were selected at sites 100 m away from the spot in random directions.

Data analysis

To examine the significance of differences between variables, Independent- samples t test was used to identify the variables with significant difference between foraging-site samples and control samples if the variables met assumptions of normality (Kolmogorov–Smirnov Z test, $P>0.05$), and the Mann–Whitney U test was used if not. Correlation between significant variables was estimated with Spearman's rank correlation coefficient. Stepwise-forward discriminate function analysis (DFA) was employed to determine which variables had major influences on habitat selection. All results are shown as mean ± SD. We used SPSS 17.0 for Windows software to conduct all statistical analysis.

RESULTS

Summer habitat

Throughout the breeding stage, the appearance sites of blue-eared pheasants ranged from altitudes of 3,050 to 3,327 m and slope degrees from 25° to 70° (Table I). In terms of the position on slopes, the utilization rate was higher on medium, mid-high and high positions on slopes than low and mid-low ones. Of these parameters, there were significant differences of habitat use of this pheasants in slope degree (P<0.01) and slope position between breeding sites and control sites (Table I).

Utilization rate of blue-eared pheasants in the forest habitat with larger diameters at the breast height of trees, taller trees and grasses, thicker grasses, more species richness, larger cover of tree and shrub and grasses, was higher than in those control sites (Table I). Among these parameters, there were significant differences of habitat use by blue-eared pheasants in cover of grasses (P < 0.05) and in species richness (P < 0.01). In term of distance to path, there was significant differences of habitat use between appearance sites and control sites (P < 0.01) suggesting this pheasant avoid of med- or max disturbance in egg laying and brood period. While there were no significant differences of habitat use in distance to water between appearance sites and control sites (P > 0.05).

In breeding stage, after extraction by these principal components in both appearance sites and control site, the results show that there were heavy loads for position on slope, species richness, height of tree, height of grasses, slope aspect, slope degree. Principal component analysis (PCA) indicated that 89.29% of accumulated variance among all the 15 habitat factors was attributed to the first six principal components (PCs). The varimax rotated factor matrix shows significance for each PC. blue-eared pheasants preferred these forests with higher tree and grasses, higher position on slope, higher species richness, and steeper slope. Thus, we could summarize the first six PCs into the following four categories of habitat factors: vegetation, terrain, and shelter conditions.

Winter habitat

Throughout the non-breeding season, the average slope degree was around 28.53° of habitat use of blue-eared pheasants, and in the control site, it was around 34.13°. Whereas there were no significant differences of habitat use in slope degree between breeding stage and non-breeding stage (P > 0.05). In terms of the position on slopes, the utilization rate was higher on low and mid-low positions on slopes than mid-high and high positions. While, there were no significant differences of habitat use of this pheasants in position on slope between non-breeding sites and control ones. Similarly, there were no significant differences in altitude, slope aspect, distance to path, and distance to water between non-breeding sites and control sites (P > 0.05) (Table II).

With regard to the vegetation factors, except for diameter of tree, height of tree, and cover of tree, utilization rate in height of shrub, cover of shrub, density of grasses, height of grasses, cover of grasses, species richness by blue-eared pheasants in the shrub-grasses mixed habitat were higher than in those control sites. In nine variables of vegetation factors, there were significant differences of habitat use in cover of tree, height of shrub, cover of shrub, density of grasses, cover of grasses, species richness, (P<0.01, respectively). Throughout the whole non-breeding stage, blue-eared pheasants preferred those areas close to water with closed distance to path. Whereas there were no significant differences in distance to water and to path between appearance sites and control site (P>0.05, respectively).

In non-breeding stage, after extraction by these principal components in both appearance sites and control site, the results show that there were heavy loads for density of grasses, position on slope, height and cover of tree, species richness, distance to water, height of shrub, and diameter of tree. Principal component analysis (PCA) indicated that 86.07% of accumulated variance among all the 15 habitat factors was attributed to the first seven principal components (PCs). blue-eared pheasants preferred these forests with more grasses, lower position on slope, lower tree, more species richness, closely distance to water, higher shrub, and thinner tree diameter. Thus, we could summarize the first seven PCs into the following four categories of habitat factors: vegetation, terrain, and food conditions.

Table I.- The variables comparisons between summer habitat and control site of the blue-eared pheasant during breeding stage.

Variables	Summer habitat (*n* =24)	Control site(*n*= 24)	*Z* value	*t* value
Altitude (m)	3194.78 ± 69.92	3166.75 ± 57.68		1.278
Slope degree (°)	43.36 ± 13.95	30.75 ± 10.04		3.070**
Slope aspect	4.57 ± 3.18	4.75 ± 2.53		-0.175
Position on slope	3.50 ± 1.09	2.80 ± 0.83		2.121*
Diameter of tree (cm)	18.62 ± 10.66	13.63 ± 6.13		1.730
Height of tree (m)	11.05 ± 5.29	9.58 ± 5.49		0.781
Cover of tree (%)	39.29 ± 25.71	32.65 ± 23.19		0.785
Height of shrub (m)	1.52 ± 0.44	3.16 ± 8.69		-0.704
Cover of shrub (%)	34.86 ± 25.30	29.45 ± 18.35		0.723
Density of grasses (/m^2)	61.18±77.94	27.35 ± 31.06		1.541
Height of grasses (cm)	11.30 ± 6.35	8.14 ± 4.16		1.635
Cover of grasses (%)	55.36 ± 30.29	34.70 ± 15.72		2.341*
Species richness	9.50 ± 1.91	6.69 ± 1.87	-3.490**	
Distance to path (m)	2.36 ± 0.49	3.35 ±0 .93	-3.406**	
Distance to water (m)	187.50 ± 152.22	133.25 ± 74.91		1.379

* Correlation significant at the 0.05 level (2-tailed); ** Correlation significant at the 0.01 level (2-tailed)

Table II.- The variables comparisons between winter habitat and control site of the blue-eared pheasant during non-breeding stage.

Variables	Winter habitat (*n* =27)	Control site(*n*= 27)	*Z* value	*t* value
Altitude (m)	3121.06 ± 65.66	3148.61 ± 68.27		-1.282
Slope degree (°)	28.53 ± 11.42	34.13 ± 11.54		-1.523
Slope aspect	4.12 ± 1.54	4.09 ± 2.25		0.051
Position on slope	2.59 ± 0.94	3.04 ± 0.98		-1.481
Diameter of tree (cm)	12.97 ± 8.71	17.09 ± 6.02		-1.772
Height of tree (m)	8.64 ± 7.38	10.31 ± 4.42		-0.832
Cover of tree (%)	15.88 ± 12.65	29.91 ± 14.90	-2.814**	
Height of shrub (m)	1.64 ± 1.75	1.15 ± 1.24	-3.429**	
Cover of shrub (%)	45.59 ± 12.48	34.46 ± 7.76	-2.829**	
Density of grasses (/m^2)	37.68 ± 18.55	20.12 ± 19.68	-3.367**	
Height of grasses (cm)	8.35 ± 3.51	7.70 ± 5.55	-1.193	
Cover of grasses (%)	27.35 ± 7.53	20.77 ± 12.72	-2.607**	
Species richness	8.25 ± 1.97	5.69 ± 1.67	-3.657**	
Distance to path (m)	2.76 ± 0.83	3.26 ± 0.92		-1.761
Distance to water (m)	142.06 ± 123.81	176.52 ± 118.91		-0.891

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

The seasonal changes

In term of vegetation factors, cover of tree, cover of grasses in breeding stage were significantly higher than those in non-breeding stage (compare Tables I, II). The results showed that the blue-eared pheasant preferred the areas with higher cover of tree and grasses ($P<0.01$, respectively). In breeding stage, blue-eared pheasants preferred those areas closed distance to path. Whereas, there were no significant differences in distance to water in both breeding stage and non-breeding stage. With regard to the terrain factors, there were significant differences of habitat use in altitude, slope degree and position on slope between breeding stage and non-breeding stage, suggesting that the blue-eared pheasants regarded the higher and steeper slope as foraging sites in breeding stage.

DISCUSSION

In breeding stage, blue-eared pheasant prefer the habitats on steeper slope (average 43.36±13.95) to foraging, which similar to golden pheasant (*Chrysolophus pictus*) with the slope degree ranged 30° to 50° (Shao, 1998). The results suggested the disturbance by potherb collecting and herding in local forest has affected the scope availability of this pheasant, which can be verified by the variables differences of distance to path between breeding habitat and control site of this pheasant ($P<0.01$). The present study also revealed that breeding blue-eared pheasants preferred mid-high and high positions on slopes with more species richness and higher cover of grasses (Table I) because in those areas, more types of plant and higher cover of grasses can provide not only the seeds and roots of grasses for their foraging but also a good place for different kinds of insects, which are the major food resources of their fledglings. Usually, the development of grasses and grasslands correlates with species richness and abundance of invertebrates (Tscharntke and Greiler, 1995; Morris and Thompson, 1998). In the habitat with rich and abundant grasses, the fledglings of the ring-necked pheasant always have a lower mortality (Riley *et al*., 1998). From an evolutionary perspective, this strategy of habitat selection of the breeding blue-eared pheasant may be a behavioral and ecological adaptation to avoid predators and maximize their fitness, and an optimal ecological tactic to obtain a high survival rate of their population and maintain a stable population size (Sun, 2002).

By comparison, habitat use by blue-eared pheasant has significant differences between breeding stage and non-breeding stage at the cover of tree and cover of grasses (Tables I, II). As a typical terrestrial forest species, the blue-eared pheasant in life history can be found in almost all types of forests including coniferous forest, coniferous-deciduous mixed forest, deciduous forest, and even shrubs (Zheng and Liao, 1983; Li *et al*., 1985; Li *et al*., 1988). However, in the breeding stage, *Crossoptilon auritum* likely regard the conifer and broad-leaf mixed forest as main activities terrain and avoid open field activity, which similar to Lady Amherst pheasant (*Chrysolophus amherstiae*) (Kang and Zheng, 2007), golden pheasant (Liang *et al*., 2003) and brown-eared pheasant (Zhang *et al*., 2003). Whereas in non-breeding stage, for field flocks of blue-eared pheasants, the principal foraging method of the birds consisted of digging up plant roots which makes it difficult for the birds in higher cover of tree and grass to dig food on the freezing ground with weaken solar radiation in coniferous forest. Therefore, blue-eared pheasants flocks preferred these habitats with scattered trees and grasses in non-breeding stage.

To conclude, there are significant difference on seasonal habitat change in altitude, slope degree, position on slope, cover of tree and grasses between breeding season and non-breeding season. Our results suggested that vegetation features and food resources were the most important habitat factors influencing habitat selection of blue-eared pheasants. High quality vegetation features with adequate camouflaged foraging-sites and fewer human disturbances in the breeding stage is important to ensure the maximum reproduction and survival of birds. However, in the non-breeding stage, due to lack of abundant food, blue-eared pheasants in winter always have larger habitat territories such as different types of forest or a larger range of altitudes (*i.e.*, moving from a top-hill to foothill even farmland) to find more food resources. Therefore, some measures were recommended to conserve this pheasant, including strengthening the conservation of existing suitable habitat, reducing man-made interference, and optimizing landscape configuration, which would be beneficial in promoting habitat conservation of this pheasant more effectively.

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