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Research Note

Winter Microhabitat Separation between Giant and Red Pandas in *Bashania faberi* Bamboo Forest in Fengtongzhai Nature Reserve

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Abstract

*We studied microhabitat use of the giant panda (*Ailuropoda melanoleuca*) and the red panda (*Ailurus fulgens*) from November 2002 to March 2003 at Fengtongzhai Nature Reserve, Baoxing County of Sichuan Province, China, where the 2 species are sympatric. The means of discriminant scores between the 2 species differed, suggesting each had a distinct microhabitat selection pattern, consistent with 1-way ANOVA and Kruskal-Wallis tests. We found that 6 of 19 microhabitat variables differed significantly between these species. Four variables were associated with preferences of the giant panda and 2 from preferences of the red panda. We suggest that environmental factors (slope, fallen log, etc.) other than food availability were primarily responsible for microhabitat separation between the 2 pandas. We hypothesize that the pattern of microhabitat separation did not result from ecological or evolutionary adjustment to reduce interspecific competition but from differences in physiological and ecological requirements. With abundant food resources, slope appeared to be a more important microhabitat feature to the giant panda than any single food factor. The presence of fallen logs and tree stumps was similarly an important microhabitat feature selected by red pandas.* (JOURNAL OF WILDLIFE MANAGEMENT 70(1):231–235; 2006)

Key words

environmental factor, giant panda, interspecific competition, microhabitat separation, red panda.

The giant panda and the red panda are respectively classified as Category I and II protected species in China, and both are CITES Appendix I species. The 2 species face similar environmental pressures and threats to genetic diversity stemming from habitat loss and fragmentation, poaching, and inbreeding depression (Wei et al. 1999*a*). The 2 pandas are sympatric in the Minshan, Qionglai, Liangshan, Bigger Xiangling, and Lesser Xiangling Mountains in western Sichuan, China (Wei et al. 1999*a*,*b*, 2000).

Sympatry and diet overlap between both pandas (Wei et al. 1999*a*,*b*) raise the interesting question of whether they compete, or if not, how they avoid competition? Previous research suggested that microhabitat use differed for the 2 species (Wei et al. 1999*a*, 2000, Zhang et al. 2002). These studies, however, failed to determine whether these different preferences were by one or both species. For example, divergent slope use led to earlier conclusions that red pandas prefer steeper slopes, and giant pandas gentler slopes (Wei et al. 1999*a*, 2000, Zhang et al. 2002). This conclusion may be premature. It is plausible that differential slope use reflects preference of only 1 species, whereas the other species may have no preference at all. Our research was designed to further explore observed patterns of microhabitat separation.

Partitioning of habitats is one of the most common forms of sympatric-species separation, and habitat-use strategies are often cited as the means by which sympatric species avoid competition (Dueser and Shugart 1979, Marsh and Harris 2000, Sébastien et al. 2003). Although divergent habitat-use strategies may reflect evolutionary mechanisms to reduce interspecific competition (Dueser and Shugart 1979, Jane 2002), they may also merely reflect different physiological or ecological requirements (Wendy and Chris 2001). We also attempted to address the likelihood of interspecific competition between these 2 species and identify possible mechanisms that may reduce competition.

Study Area

Our fieldwork was conducted from November 2002 to March 2003 at Fengtongzhai Nature Reserve (102°48′–103°00′E, 30°19′–30°47′N), Baoxing County of Sichuan Province, China. This reserve covers about 390 km^2 of rugged ridges and narrow valleys at elevations of 1,000–4,896 m. Our field research base was located in the core region of the reserve (102°53'27.5"E, 30°37'02.9"N), an area of nearly 20 km^2. Mean annual temperature, humidity and rainfall are 5.9–7.2C, 79–83% and 730–1,300 mm, respectively. The highest mean daily temperature occurs in July, ranging from 15.1 to 16.3C, and the lowest in January, ranging from −4.0–2.7C (from Baoxing Weather Station, unpublished data).

As altitude increases, vegetation transitions from subtropical evergreen deciduous forest to coniferous forest, then to shrub and grasslands at the highest elevations. Two bamboo species, *Yushania brevipaniculata* and *Bashania faberi*, are dominant in our study area; the former occurs at elevations of 1,500–2,600 m, and the latter at elevations of 2,400–3,300 m. Some parameters

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(old shoot proportion, bamboo density, canopy, etc.) vary greatly among different bamboo species and seasons, and both pandas spend most of their time in *B. faberi* bamboo forest. We focused our fieldwork in this bamboo forest during winter.

Methods

Both pandas live in mountainous terrain covered by dense forests, making direct observations difficult. Previous research indicated that feces deposition was an effective indicator of microhabitat utilization for these species (Reid and Hu 1991, Wei et al. 2000, Zhang et al. 2002), so we used this method to index microhabitat use.

We compared microhabitat plots used by both pandas, and control plots reflecting the environment at large, to investigate microhabitat use patterns. All microhabitat plots were centered on fresh fecal deposits randomly found in the field. The mean distance among microhabitat plots was commonly above 100 m. Sampling followed Wei et al. (2000). To establish control plots, we randomly located points on the ridges in our study area, which were equally distant from each other, and established 8 transects from these points. Transects were oriented downwards, and control plots were identified and established at about every 80-m loss in elevation. Control plots were sampled similarly to microhabitat plots. We measured 19 variables, including vegetation, tree, brush, bamboo and forest-floor characteristics (Table 1). We sampled 150 plots (50 for each panda species, and 50 for control plots).

We used 1-way analysis of variance (ANOVA) and Kruskal-Wallis tests to compare means of variables among different plot groups. We only retained for further analysis those variables with similar results using both tests, in order to provide a conservative basis for detecting microhabitat use and separation between the 2 pandas. We also used discriminant function analysis (DFA) to assess relative importance of each variable. We used discriminant scores from the DFA for each plot as input data for a subsequent one-way ANOVA. We estimated the correlation among pairs of variables using the pairwise Pearson correlation coefficient (Lu et al. 1997; Sébastien et al. 2003). The significance level of all analyses was set at 0.05.

Results

The ANOVA and Kruskal-Wallis tests gave similar results, excepting shrub density and size (Table 2). Eight of 19 variables differed significantly ($P < 0.05$). Thus, we omitted shrub density and size from further analyses.

Six variables (slope, bamboo height, tree size, fallen log density, fallen log dispersion, tree stump density) differed significantly between the 2 panda plot types (Table 3). Giant panda plots were on gentler slopes than control plots, whereas red panda plots did not differ from control plots relative to slope (Table 3). Similarly, giant panda plots indicated preference for taller bamboo, thicker trees, and greater fallen log dispersion, whereas red panda plots did not. By contrast, red panda plots suggested preferences for microhabitats containing higher densities of fallen logs and tree stumps, whereas giant panda plots did not (Table 3).

Between giant and red panda plots, fallen-log density and slope had significantly larger absolute values of discriminant coefficients than for the other variables (Table 4), indicating that microhabitat separation between the 2 pandas mainly resulted from these 2 variables (Wilk's $\lambda = 0.38$, $P = 0.001$; 86.8% of observations classified correctly). Similarly, slope was mainly responsible for the separation between giant panda and control-plot groups, and fallen log density, canopy and tree stump density were mainly responsible for that between the red panda and control plot groups (Table 4).

Table 1. Description of 19 variables used in this research.

Variables	Description
Vegetation type	Six categories: mixed evergreen and deciduous broadleaf forest, mixed coniferous and broadleaf forest, coniferous forest, shrub, grassland, and naked land
Slope	From 0° to 90°, using every 10-degree interval as a category
Slope aspect	Aspect of each 400-m^2 plot, defined as 4 categories: eastern slope (45–135°), southern slope (135–225°), western slope (225–315°) and northern slope (315°–45°)
Canopy	Canopy of overstory in each 400-m^2 plot, divided into 4 categories: <25%, 25–50%, 50–75%, and >75%.
Bamboo density (culms/m^2)	Average number of culms in 5 1.0-m^2 bamboo plots.
Bamboo height (cm)	Average height of culms in 5 1.0-m^2 bamboo plots (5 culms are measured randomly at each plot).
Old shoot proportion (%)	Average proportion of old shoots in 5 1.0-m^2 bamboo plots
Tree density	Average number of trees in 2 20-m^2 rectangular transects
Tree size (cm)	Average diameter at breast height (DBH) of the nearest trees from the center in each 100-m^2 square plot
Tree dispersion (m)	Average distance to the nearest tree from the center in each 100-m^2 square plot
Shrub density	Average number of shrubs in 2 20-m^2 rectangular transects
Shrub size (cm)	Average DBH of the nearest shrub apart from the center in each 100-m^2 square plot
Shrub dispersion (m)	Average distance to the nearest shrub from the center in each 100-m^2 square plot
Tree stump density	Average number of tree stumps (>15 cm in diameter) in each 100-m^2 square plot
Tree stump size (cm)	Average diameter of the nearest tree stumps (>15 cm in diameter) from the center in each 100-m^2 square plot
Tree stump dispersion (m)	Average distance to the nearest tree stumps (>15 cm in diameter) from the center in each 100-m^2 square plot
Fallen log density	Average number of fallen logs (>15 cm in diameter) in each 100-m^2 square plot
Fallen log size	Average diameter of the nearest fallen logs (>15 cm in diameter) from the center in each 100-m^2 square plot
Fallen log dispersion	Average distance to the nearest fallen logs (>15 cm in diameter) from the center in each 100-m^2 square plot

Table 2. Means, *SD*, ANOVA, and Kruskal-Wallis tests for each variable among different plot groups.

Variables	Giant panda Mean (SD)	Red panda Mean (SD)	Control plots Mean (SD)	ANOVA *F* (*P*)	Kruskal-Wallis tests χ^2 (*P*)
Vegetation type	2.14(0.88)	2.10(0.93)	2.39(0.92)	1.38(0.23)	2.99(0.23)
Slope	2.34(1.04)	3.64(1.37)	4.14(1.60)	23.44(0.00)	37.86(0.00)
Slope aspect	1.74(0.73)	1.64(0.59)	1.70(0.81)	0.18(0.84)	0.25(0.88)
Canopy	1.98(0.89)	1.84(0.79)	2.26(1.05)	2.73(0.07)	4.06(0.13)
Bamboo density	74.69(21.02)	68.08(29.23)	56.30(41.49)	4.31(0.02)	6.74(0.03)
Bamboo height	96.65(18.58)	84.90(19.27)	75.89(25.45)	11.61(0.00)	18.77(0.00)
Old shoot proportion	14.97(6.20)	12.81(6.84)	8.80(4.81)	13.56(0.00)	28.06(0.00)
Tree density	0.52(0.57)	0.57(0.48)	0.49(0.54)	0.30(0.75)	1.49(0.48)
Shrub density	1.37(1.00)	1.69(1.27)	2.19(2.13)	3.56(0.03)	3.09(0.21)
Tree size	48.33(16.65)	40.49(12.80)	37.85(14.80)	6.39(0.00)	11.91(0.00)
Tree dispersion	6.28(2.15)	6.38(1.76)	6.46(1.85)	0.11 (0.89)	0.011(0.10)
Shrub size	11.08(6.84)	9.97(4.66)	8.38(7.61)	2.18(0.12)	12.40(0.00)
Shrub dispersion	4.42(1.54)	4.19(1.34)	4.44(1.81)	0.39(0.68)	0.41(0.82)
Fallen log density	1.13(0.63)	1.87(0.94)	1.33(0.79)	11.58(0.00)	17.97(0.00)
Fallen log size	26.49(11.10)	25.38(9.56)	27.51(9.86)	0.55(0.58)	0.75(0.69)
Fallen log dispersion	6.18(1.71)	4.90(1.97)	5.31(2.10)	5.68(0.00)	11.33(0.00)
Tree stump density	0.30(0.30)	0.54(0.44)	0.38(0.36)	5.47(0.01)	10.13(0.01)
Tree stump size	46.99(29.87)	40.01(37.89)	41.10(22.19)	0.52(0.59)	4.44(0.11)
Tree stump dispersion	7.26(2.59)	6.02(3.00)	6.65(2.95)	1.74(0.18)	3.60(0.17)

Discussion

Preferred habitats should contain resources that are essential for individual survival and reproduction. For sympatric species, environmental heterogeneity can reduce competition to promote their coexistence (Stephanie 2004). Among 19 variables evaluated in this study, 6 differed significantly between the 2 panda plots, indicating microhabitat separation between the 2 panda species. However, the nature of these differences varied with species. Differences for 4 variables resulted only from apparent preferences by giant pandas, whereas the red panda showed no preference for these same features. For the other 2 variables, red panda plots suggested preference, but giant panda plot data provided no evidence of selection for these features. Previous research has demonstrated that microhabitat variables differed between habitats selected by the 2 pandas; however, explanations for those were speculative because no control plots were available to characterize available habitat features (Wei et al. 2000*a*, Zhang et al. 2002). Without control plots, we cannot conclude that either species had any microhabitat preferences, only that they were found in different microhabitats. Our control plots allowed us to infer which microhabitat variables were important to each species.

Previous studies confirmed that daily energy intake for giant pandas is marginally more than daily energy expenditure (Hu et al. 1985, Wei et al. 1997), suggesting energy conservation should be an important feature of the daily ecology of this species. Restricting movements to gentler slopes has been widely hypothesized to be a means of energy saving by giant pandas (Hu et al. 1985, Reid and Hu 1991, Wei et al. 1996, 2000, Hu 2001). Alternatively, because giant pandas mainly feed on old shoots in winter (Hu et al. 1985), they may prefer gentler slopes for easier access to old shoots, which are more common at sites with less slope ($r = -0.26$, $p = 0.001$). Bamboo leaves are the main winter food resource for red pandas (Wei et al. 1999*c*, 2000). Because of their small body size, red pandas may utilize fallen logs and tree stumps to gain access to bamboo leaves.

Interestingly, although both pandas mainly feed on the same bamboo species in our study area, differences in microhabitats selected were apparent, and these differences appeared to be

Table 3. One-way ANOVA for the 8 variables with significant differences in Table 2 ($\bar{x}_1$ represents means of variables for giant panda group, $\bar{x}_2$ represents that for red panda group and $\bar{x}_3$ represents that for the control group).

Variables	$\bar{x}_1 - \bar{x}_2$	ANOVA *F*	ANOVA *P*	$\bar{x}_1 - \bar{x}_3$	ANOVA *F*	ANOVA *P*	$\bar{x}_2 - \bar{x}_3$	ANOVA *F*	ANOVA *P*
Slope	−1.30	28.61	0.00	−1.80	44.29	0.00	−0.50	2.82	0.10
Bamboo density	6.61	1.68	0.20	18.39	7.81	0.01	11.78	2.69	0.10
Old shoot proportion	2.16	2.74	0.10	6.17	30.89	0.00	4.01	11.49	0.00
Bamboo height	11.75	9.63	0.00	20.76	21.07	0.00	9.01	3.86	0.05
Tree size	7.84	6.55	0.01	10.48	10.52	0.00	2.64	0.86	0.34
Tree stump density	−0.24	10.23	0.00	−0.08	1.47	0.23	0.16	4.00	0.05
Fallen log density	−0.74	21.39	0.00	−0.20	1.96	0.16	0.54	9.74	0.00
Fallen log dispersion	1.28	12.02	0.00	0.87	5.14	0.03	−0.41	1.01	0.32

Table 4. Discriminant coefficients between every 2 group plots.

Variables	Discriminant coefficients		
	Giant panda-red panda	Giant panda-control	Red panda-control
Vegetation type	−0.30	−0.62	0.10
Slope	0.59	0.99	−0.02
Slope aspect	−0.14	−0.22	−0.17
Canopy	0.17	0.37	−0.67
Bamboo density	0.04	−0.43	0.16
Bamboo height	0.19	0.46	0.14
Old shoot proportion	−0.22	−0.65	0.43
Tree density	−0.07	0.42	0.44
Tree size	−0.18	−0.14	0.03
Tree dispersion	−0.34	0.38	−0.11
Shrub dispersion	−0.35	−0.16	−0.21
Tree stump density	0.41	0.38	0.57
Tree stump size	0.31	0.05	0.21
Tree stump dispersion	−0.02	0.09	0.05
Fallen log density	0.86	0.35	0.69
Fallen log size	0.17	0.22	0.00
Fallen log dispersion	−0.34	−0.24	−0.23

driven by environmental factors indirectly related to food. We inferred that intense food competition between red and giant pandas likely does not occur currently because selection for different microhabitat features, such as slope and fallen logs, allows the 2 species to feed on similar food resources, but at different locations. In some communities, habitat preferences among co-occurring species are likely to have evolved independently and do not depend on interactions between them to maintain the competitive reduction mechanism (Wendy and Chris 2001). We hypothesize that current distinct microhabitat utilization patterns of the 2 panda species did not result from interspecific competition but from differences in physiological and ecological requirements. Other researchers have inferred that food resource was not a limiting factor influencing coexistence of both pandas, and that competition was minimal (Hu 2001, Wei et al. 1999*a*, 2000).

Management Implications

More than 40 reserves have been established for the giant panda in China. As an indicator species, conserving giant panda habitat is widely considered to be a means of conserving species with similar habitat affinities. Based on our findings, different habitat management strategies should be taken respectively for the 2 pandas. The giant panda prefers sites with gentle slope, but human cultivation, deforestation, and road construction commonly occur in these sites. Therefore, specific efforts should be made to conserve such areas. Because red pandas select sites with fallen logs and tree stumps, these features should not be removed from red panda habitat.

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