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四川唐家河羚牛、鬣羚、斑羚春冬季生境选择比较研究

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摘要：1998 年 3 月～1999 年 2 月，在四川省青川县唐家河自然保护区，运用逐步判别分析的方法，对羚牛、鬣羚、斑羚春冬季对生境的利用进行了对比研究。研究结果表明：虽然它们在生境选择上有部分重叠，但是其对生境的利用方式均有显著的差异。在春季，羚牛主要利用海拔较高、食物丰富度高、灌木较大、离灌木较远的生境；鬣羚和斑羚主要利用海拔较低、食物丰富度中等、灌木较小、离灌木较近的生境。在冬季，羚牛主要利用坡度适中、海拔适中、乔木较大、乔木较稀、离乔木较远的生境；鬣羚主要利用坡度较陡、海拔较高、乔木较小、乔木较稀、离乔木适中的生境；斑羚主要利用坡度较缓、海拔较低、乔木较小、乔木较密、离乔木较近的生境。

关键词：羚牛；鬣羚；斑羚；春冬季生境选择；四川唐家河

A comparison in spring and winter habitat selection of Takin, Swtow and Groal in Tangjiahe, Sichuan

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Abstract: Takin (*Budorcas taxicolor*) is listed in the Category I of State Key Protected Wildlife List, Serow (*Capricornis sumatraensis*) and Goral (*Naemorhedus goral*) are listed in the Category Ⅱ of the List. They distribute in the same mountain ranges in the Minshan Range, Qionglai Range, Xiangling Range and Liangshan Range. They leave their own fresh mark in the habital, such as footprints, excrement and urine. The more they utilize the habitat, the more the fresh traces are kept behind. Therefore the fresh mark may be considered as an indirect parameter to the habitat analysis of Takin, Serow and Goral. A survey was done in Tangjiahe Natural Reserve, Qingchuan County of Sichuan Province from March 1998 to February 1999, and lots of sampling lines were randomly set up in the habitat of Takin, Serow and Goral. The sampling lines were 10km in length and 20m in width, with a space distance more than 1500m. 13 strips of the sampling lines with a total length about more than 567km were randomly set up in spring, while 12 strips of the sampling lines with a total length about more than 360km were randomly set up in winter. Meanwhile, one 1m×1m square sample, two 2m×10m rectangle sample and one 20m×20m square sample were set up according to the fresh trace of Takin, Serow and Goral. Moreover, four 1m×1m food sample were set up in the center of every one forth of the 20m×20m square sample. Canopy, slope, slope position, shope direction, elevation, vegetation type, water source, human destruction and animal disturbance were

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野外工作期间曾得到四川省林业厅、唐家河自然保护区的大力支持，王育在整理材料和处理数据过程中提供了帮助，郭延蜀副教授、余志伟教授、邓其祥教授给予热情指导，在此一并致谢。

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noted in the 20m × 20m square sample. Tree size, tree distance, shrub size and shrub distance were measured in the 10m×10m square sample. Tree density and strub density were measured in the two 2m× 10m rectangle sample. Food abundance was measured in the every 1m×1m square sample. At last, the data of habitat variables was calculated and analyzed to distinguish the differences between spring and winter habitat selection of Takin, Serow and Goral.

In spring, it was find out that the main difference among the habitat selection of Takin, Serow and Goral were vegetation type, slope position, and canopy and water source by comparing the distribution frequency of habitat variables of the character type. Takin mainly selected the habitat with temperate mixed forest, middle and up slope position and canopy less that 40%. Serow and Goral resided in the habitat with broad-leaf forest or temperate mixed forest, but Goral more liked to select up slope position and the distance less than 500m from water source. As a result, we found that there were no obvious differences in the habitat selection between Serow and Goral, and there were notable differences in the habital selection between Takin, Serow and Goral by analyzing the habitat variables of the data type. Serow and Goral mainly selected the habitat close to shrub and with low elevation, moderate food abundance, small shrub. In contrast, Takin mainly selected the habitat far from shrub and with high elevation, excellent food abundance, large shrub.

In winter, the results revealed that the main difference among the habitat selection of Takin, Serow and Foral was water source by comparing the distributing frequency of habitat variables of the character type. Takin and Serow mainly selected the habitat with water source within 500m. Goral was not strict to the habitat with water source. The results also showed that there were obvious differences in the habitat selection between Takin, Serow and Goral by analyzing the habitat variables of the data type. Takin mainly selected the habitat with moderate slope and elevation, large and sparse tree and far distance from tree. Serow had a preference for the habitat with steep slope, high elevation, small and sparse tree, moderate distance from tree. However, Goral preferred the habitat with gentle slope, low elevation, small and dense tree, near distance from tree.

Takin, Serow and Goral that scatter in the same mountain ranges of Tangjiahe Natural Reserve, have the same habit of transference with the change of seasons, looking for the food at the morning and dusk, and eating all kinds of young branches and leaves of shrub and tree, which overlap partly in niches. However, in spring, Takin mostly live in the temperate mixed forest with high elevation and canopy less than 40%, Serow mainly selected broad-leaf forest or temperate mixed forest with low elevation, and Goral prefer broad-leaf forest or temperate mixed forest with the water source within 500m. The tree types reflect synthetically the character of buildup of food, temperature, light, landform and physiognomy. Consequently, it meets the habitat need of animals mostly. At the same time, Takin, Serow and Goral select different food abundance, shrub size and the distance from shrub. Serow and Goral mainly select the habitat with moderate food abundance, small shrub and short distance from shrub, on the contrary, Takin prefer the habitat with excellent food abundance, large shrub and fare distance from shrub, which is related to their body size and space-use mode. Takin would like to inhabit together, and their body size is larger than Serow's and Goral's, so if they look for food in the habitat with excellent food abundance, largc shrub and far distance from shrub, they would get more income at thje same time. In contrast, Serow and Goral would like to inhabit singly, and their body size is smaller than Takin's, so if they look for food in the habitat with moderate food abundance, small shrub and short distance from shrub, they would get more income at the same time. In winter, it is obivious that the main differences in the habitat selection among Takin, Serow and Goral are slope, elevation, tree size, tree density and tree distance. Takin mainly selected broad-leaf

forest with moderate slope, and Serow has a preference for the habitat with steep slope. However, Goral preferred to select the habitat with gentle slope. Takin's body size is large. So if they look for food in the habitat with dense tree, they would spend much more time and prower than in the habitat with sparse tree, therefore they often look for food in the habitat with large and sparse tree and far distance from tree. Goral's body size is small, tree density doesn't have serious influence on their action, so they often look for food in the habitat with small and dense tree and short distance from tree. Serow's body size is in the middle of Takin's and Goral's, so they often look for food in the habitat with small and sparse tree, moderate distance from tree. In addition, competition for the habitat among Takin, Serow and Goral results in the separation of niche, which finally weakens the competition between them. Takin distributes in the mountain ranges in the Mashang-Shuichiping-Maoxiangba Range, Jiazhihao-wenxianhe-ningnui Range, Sheqiaohe-yianzhiyan-Nuotuoling-Baishilang Range, Tangjiahe-Dachaotang-Xiaowanhe Range. Serow exists in the mountain ranges in the Tangjiahe-Dawanhe-Xiaowanhe Range, while Goral mainly lives in the mountain ranges in the Tangjiahe-Dawanhe-Xiaowanhe Range, Maoxiangba Range.

Though Takin, Serow and Goral overlap partly in time rhythm, season rhythm and resource niche, they notably differ from each other in the space niche, mode of habitat to get most generalized fit degree during the long-term evolution process. As a result, they can adapt to each other and coexist. This supported the competitive exclusion principle that two species with identical niches can not coexist.

Key words: *Budorcas taxicolor*; *Capricornis sumatraensis*; *Naemorhedus goral*; spring and winter habiat selection; Tangjiahe Sichuan

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羚牛(*Budorcas taxicolor*)为我国Ⅰ级保护动物,鬣羚(*Capricornis sumatraensis*)、斑羚(*Naemorhedus goral*)为我国Ⅱ级保护动物,国际自然与自然资源保护联盟(IUCN)将它们列为“世界物种红色名录易危级”,濒危野生动植物物种国际贸易公约(CITES)将羚牛列在附录II,鬣羚、斑羚列在附录I中,以加强对其保护和严格控制国际间的交换与贸易。

羚牛、鬣羚、斑羚同域分布在邛崃山、岷山、相岭、凉山等山系[1~9],目前面临着同样的环境压力,如森林过度采伐、生境不断丧失、种群不断被分割以及偷猎等问题[2,5,8,9],故从1998年3月至1999年2月在四川省青川县唐家河自然保护区,对其春冬季生境选择进行对比研究,从理论上探讨它们春冬季对生境利用的差异,这对更好地制定这3种珍稀动物保护管理计划具有重要的理论和现实意义。

1 研究地点概况

唐家河自然保护区地处岷山山系,龙门山西北侧,摩天岭南麓,其北麓毗连甘肃白水江自然保护区,东经104°36′~104°52′,北纬32°30′~32°41′之间,总面积400km²。该保护区是羚牛、鬣羚、斑羚的集中分布区,是研究它们生境选择差异的理想基地。保护区由于受到地貌及其所制约的生物气侯垂直差异的影响,由低海拔至高海拔分别出现如下植被带:

海拔1600m以下为山地常绿阔叶林,优势种有较能耐寒的种类,如曼青冈(*Cyclobabanopsis oxyodon*)、青冈(*C. glauca*)、川桂(*Cinnamomum wilsonii*)、黑壳楠(*Lindora megaphylla*)、白楠(*Phoebe neurantha*)和小果润楠(*Machilus microcarpa*)等。

海拔1600~2100m为常绿与落叶阔叶混交林带,其常绿成分主要有青冈、曼青冈、包石栎(*Lithocarpus cleistocarpus*)与红豆杉(*Taxus chinensis*)等。落叶树种较多,主要有灯台树(*Cornus controversa*)、青榨槭(*Acer davidii*)、木姜子(*Litsea* sp.)、稠李(*Prunus* sp.)、漆树(*Toxicodendron vernicifluum*)与椴树(*Tilia chinensi*)等。

海拔2100~2600m为针阔叶混交林带,主要由麦吊杉(*Picea brachytyla*)、铁杉(*Tsuga chinensis*)与华山松(*Pinus armandi*)、红桦(*Betulaalbo-sinensis*)、糙皮桦(*B. utilis*)、水青树(*Tetracentron sinense*)、太白杨

(*Populus purdomii*)与槭树(*Acer* sp.)等组成。

海拔 2400～3600m 为亚高山针叶林带，除下缘有小块麦吊杉林外，大都为岷江冷杉林(*Abies faxoniana*)。

海拔 3600m 以上是高山灌丛与草甸，主要在西缘大草坪一带，故此植被带不甚发育。

2　研究方法

羚牛、鬣羚、斑羚在栖息的生境内要留下足迹和粪便等新鲜活动痕迹，对栖息的生境利用时间越长，在生境内留下的粪便和足迹等新鲜活动痕迹就越多。因而可用足迹与粪便堆数等新鲜活动痕迹作为间接指标来判断羚牛、鬣羚、斑羚对生境的利用情况。作者于 1998 年 3 月至 1999 年 2 月，进行野外观测，在羚牛、鬣羚、斑羚的主要生境中随机设置若干条调查样线(＞10km)，样线间距＞1500m，样线宽度为 20m。在春季，随机设置样线 13 条，总长大于 567 km。在冬季，随机设置样线 12 条，总长大于 360 km。在样线中以羚牛、鬣羚、斑羚的新鲜活动痕迹为中心，设置以下 3 个独立样方，即 1 个 1m×1m 正方形样方，2 个 2m×10m 长方形样方，1 个 20m×20m 正方形样方。在 20m×20m 正方形样方每 1/4 的小样方(10m×10m)中央，设置 1m×1m 食物样方，数据采集分 3 个不同层次，即乔木层，灌木层，地表层。参照常弘等[11]和张明海等[12]的测定方法，并根据它们对生境选择的实际情况，各生境变量的测定方法如下：

在 20m×20m 正方形样方中，记录每个样方的郁闭度、坡度、坡向、坡位、海拔、植被型、水源、人为干扰、动物干扰度等生态因子，其中郁闭度共分为 5 级，即＜20%、20%～40%、40%～60%、60%～80%和 80%以上，坡位共分 3 级，即坡上位(山岗和坡上部)、坡中位(山腰或坡中部)、坡下位(山谷和坡下部)，水源共分 2 级，即＜500m＞500m，人为干扰共分 2 级，即＜1000m＞1000m。在每个 10m×10m 正方形样方中，测定乔木大小、乔木距离、灌木大小、灌木距离。从 2 个 2m×10m 长方形样方中，测定乔木密度、灌木密度。在每个 1m×1m 小样方中，测定食物丰富度。

对于文字型生态因子，如植被型和坡位等 5 个生境变量，通过计算各类数据所占的百分比，找出羚牛、鬣羚、斑羚生境选择的主要差异特征。

对于数字型生态因子，如坡度和海拔等 11 个生境变量，采用多元统计分析中的逐步判别分析[13](DFA)判别羚牛、鬣羚、斑羚春冬季生境选择的分离。

3　研究结果

3.1　羚牛、鬣羚、斑羚春季生境选择比较研究

3.1.1　羚牛、鬣羚、斑羚春季生境选择中文字型生态因子的分布频次比较　从表 1 中可以看出，在春季，羚牛、鬣羚、斑羚春季生境选择的分离主要表现在植被型、坡位、郁闭度、水源 4 个生态因子上。羚牛主要利用针阔混交林、中上坡位、郁闭度小于 40%的生境；鬣羚主要利用阔叶林、针阔混交林的生境；斑羚主要利用阔叶林、针阔混交林、上坡位、离水源的距离小于 500m 的生境(表 3)。而 3 种动物都利用人为干扰大于 1000m 的生境。

3.1.2　羚牛、鬣羚、斑羚春季生境选择中数字型生态因子的判别分析　对羚牛、鬣羚、斑羚春季生境选择中 11 个数字型生态因子的判别分析表明，鬣羚、斑羚春季对生境的利用没有显著的差异($F_{0.05,4,64}=2.1675<F_{0.05,4,64}=2.525$)，鬣羚、羚牛春季对生境的利用有极显著的差异($F_{0.01,4,64}=8.2919>F_{0.01,4,64}=3.649$)，斑羚、羚牛春季对生境的利用也有极显著的差异($F_{0.01,4,64}=5.5451>F_{0.01,4,64}=3.649$)。从函数与变量间相关系数(见表 2)来看，海拔、食物丰富度、灌木大小、灌木距离对判别函数的贡献最大，这说明鬣羚、斑羚与羚牛春季对生境的选择分离主要表现在这四个生态因子上。鬣羚、斑羚主要利用海拔较低、食物丰富度中等、灌木较小、离灌木较近的生境；而羚牛主要利用海拔较高、食物丰富度高、灌木较大、离灌木较远的生境(见表 3)。

3.2　羚牛、鬣羚、斑羚冬季生境选择比较研究

3.2.1　羚牛、鬣羚、斑羚冬季生境选择中文字型生态因子的分布频次比较　从表 1 中可以看出，在冬季，羚牛、鬣羚、斑羚对生境选择的分离主要表现在水源一个生态因子上。羚牛、鬣羚主要利用水源小于 500m 的生境；斑羚对水源的要求不是十分严格(见表 3)。

表 1 羚牛、鬣羚、斑羚春冬季生境选择中各生态因子的分布频次

Table 1 Distribution frequency of ecological factors in spring and winter habitat selection of Takin, Serow, Goral

生境变量 Habitat variables	项目 Item	春季 Spring						冬季 Winter					
		羚牛 Takin		鬣羚 Serow		斑羚 Goral		羚牛 Takin		鬣羚 Serow		斑羚 Goral	
		F	P	F	P	F	P	F	P	F	P	F	P
植被型 Vegetation type	阔叶林	4	12	8	44	5	26	34	100	34	100	22	100
	针阔混交林	23	70	8	45	14	74	0	0	0	0	0	0
	针叶林	4	12	2	11	0	0	0	0	0	0	0	0
	高山灌丛草甸	2	6	0	0	0	0	0	0	0	0	0	0
坡位 Slope position	上坡位	17	52	8	45	14	74	3	9	0	0	0	0
	中坡位	13	39	4	22	2	11	6	18	16	47	5	23
	下坡位	3	9	6	33	3	15	25	73	18	53	16	72
郁闭度 Canopy	<20%	20	61	4	33	5	26	19	56	15	44	13	59
	20%~40%	7	21	7	39	9	47	15	44	19	56	8	36
	40%~60%	4	12	4	33	4	21	0	0	0	0	0	0
	60%~80%	2	6	3	17	1	5	0	0	0	0	0	0
人为干扰 Human disturbance	>1000m	32	97	18	100	19	100	34	100	34	100	22	100
	<1000m	1	3	0	0	0	0	0	0	0	0	0	0
水源 Water source	>500m	19	58	8	45	5	26	9	26	10	29	13	59
	<500m	14	42	10	55	14	74	25	74	24	71	9	41

*:F:频次 Frequency; P:百分率(%)Percentage

3.2.2 羚牛、鬣羚、斑羚冬季生境选择中数字型生态因子的判别分析 对羚牛、鬣羚、斑羚冬季生境选择中 11 个数字型生态因子的判别分析表明,鬣羚、斑羚冬季对生境的利用有极显著的差异($F_{0.01,5,83}=3.2500>F_{0.01,5,83}=3.1470$),鬣羚、羚牛冬季对生境的利用有极显著的差异($F_{0.01,5,83}=9.8899>F_{0.01,5,83}=3.1470$),斑羚、羚牛冬季对生境的利用也有极显著的差异($F_{0.01,5,83}=9.9626>F_{0.01,5,83}=3.1470$)。从函数与变量间相关系数(见表 2)来看,坡度、海拔、乔木大小、乔木密度、乔木距离对判别函数的贡献最大,说明羚牛、鬣羚、斑羚冬季对生境的选择分离主要表现在这五个生态因子上。羚牛主要利用坡度适中、海拔适中、乔木较大、乔木较稀、离乔木较远的生境;鬣羚主要利用坡度较陡、海拔较高、乔木较小、乔木较稀、离乔木适中的生境;斑羚主要利用坡度较缓、海拔较低、乔木较小、乔木较密、离乔木较近的生境(见表 3)。

4 讨论

竞争排斥原理认为:生态上相同的两个物种不能在同一地区内共存,如果生活在同一地区内,由于剧烈竞争,它们之间必然出现栖息地、食性、活动时间或其它特征上的生态位分化[17,18]。羚牛、鬣羚、斑羚,它们同域分布在唐家河自然保护区,均具有季节迁移的习性,均在晨昏采食,均以各种灌木和乔木的幼枝和嫩叶为食[1~3,6,9~11,15,16],在生态位上出现部分重叠。但在春季,羚牛主要生活在海拔相对较高、郁闭度小于 40%的针阔混交林中、鬣羚主要选择海拔相对较低的阔叶林或针阔混交林,斑羚则喜好离水源距离小于 500m 的阔叶林或针阔混交林。林型综合反映了动物的食物组成、温度、光、地形和地貌等因子的特征,最大程度上满足了动物对生境的选择的需求。同时,这三种动物对食物丰富度、灌木大小、灌木距离的选择也不相同。羚牛选择高食物丰富度、灌木较大、离灌木较远的生境。鬣羚、斑羚则喜好中等食物丰富度、灌木较小、离灌木较近的生境。这可能与它们的体型大小、空间利用方式有关。羚牛体型大、喜群栖,在高食物丰富度、灌木较大、离灌木较远的生境中采食,单位时间内获得的净收益就大。鬣羚、斑羚的体型稍小、一般为独栖,在中等食物丰富度、灌木较小、离灌木较近的生境中采食,也能获得最大的净收益。在冬季,3 种动物对生境选择的分离主要表现在坡度、海拔、乔木大小、乔木密度、乔木距离等生态因子上。羚牛喜欢在坡度适中的阔叶林中活动。鬣羚喜好在坡度较陡的山坡中活动。斑羚则与鬣羚相反,喜好在坡度较缓的山坡中活动。羚牛体型大,若在过密的树林中觅食,穿行这样的树林将耗费较多的时间和能量,因此,常在乔木较大、

表 2　羚牛、鬣羚、斑羚春冬季生态因子逐步判别分析

Table 2　Discrimination functional analysis of habitat variables of Takin, Serow, Goral in spring and winter

生境变量 Habitat variables	函数与变量间相关系数 Correlation between discriminating variables and canonical functions					
	春季 Spring			冬季 Winter		
	羚牛 Takin	鬣羚 Serow	斑羚 Goral	羚牛 Takin	鬣羚 Serow	斑羚 Goral
坡度 Slope	0	0	0	1.7835	3.5821	5.2132
坡向 Slope position	0	0	0	0	0	0
海拔 Elevation	2.5312	3.3605	7.5275	5.6442	3.6775	4.4635
食物丰富度 Food abundance	5.3688	7.9594	5.7573	0	0	0
动物干扰度 Animal disturbance	0	0	0	0	0	0
乔木大小 Tree size	0	0	0	12.6404	10.3125	6.5309
乔木密度 Tree density	0	0	0	16.8509	13.5313	16.1128
乔木距离 Tree distance	0	0	0	15.6638	10.9692	20.0063
灌木大小 Shrub size	0.5527	2.5482	3.4798	0	0	0
灌木密度 Shrub density	0	0	0	0	0	0
灌木距离 Shrub distance	8.4465	6.2474	2.5671	0	0	0

表 3　羚牛、鬣羚、斑羚春冬季生境选择比较

Table 3　Comparison of habitat variables by Takin, Serow, Goral in spring and winter

生境变量 Habitat variables	春季 Spring			冬季 Winter		
	羚牛 Takin	鬣羚 Serow	斑羚 Goral	羚牛 Takin	鬣羚 Serow	斑羚 Goral
植被型 Vegetation type	针阔混交林	阔叶林或针阔混交林	阔叶林或针阔混交林	阔叶林	阔叶林	阔叶林
坡位 Slope position	中上坡位	不严格	上坡位	中下坡位	中下坡位	中下坡位
郁闭度 Canopy	小于 40%	不严格	小于 60%	小于 40%	小于 40%	小于 40%
水源 Water source	不严格	不严格	小于 500m	小于 500m	小于 500m	不严格
坡度 Slope				适中	较陡	较缓
海拔 Elevation	较高	较低	较低	适中	较高	较低
食物丰富度 Food abundance	高	中等	中等			
乔木大小 Tree size				较大	适中	较小
乔木密度 Tree density				较稀	较稀	较密
乔木距离 Tree distance				较远	适中	较近
灌木大小 Shrub size	较大	较小	较小			
灌木距离 Shrub distance	较远	较近	较近			

乔木较稀、离乔木较远的生境中觅食。斑羚体型较小,树林的密度对它的影响不大,它们常在乔木较小、乔木较密、离乔木较近的生境中活动。鬣羚体型介于两者之间,选择乔木大小适中、离乔木适中的生境栖息。另外,这三种动物种间竞争的结果,还导致它们空间生态位的分离。羚牛主要分布于麻山-水池坪-毛香坝山区、加字号-文县河-羚牛山区、石桥河-燕子岩-骆驼岭-白石狼山区、唐家河-大草堂-小湾河山区[7];鬣羚主要分布于唐家河-大湾河-小湾河山区;斑羚主要分布于唐家河-大湾河-小湾河山区、毛香坝山区。从而避免了空间竞争和过分拥挤,使种间竞争降至最低点。

可见,羚牛、鬣羚、斑羚这三种同域分布的有蹄类动物,虽然在时间节律、季节节律、资源生态位上有部分重叠,但在长期的进化过程中,它们为了获得最大的广义适合度,在空间生态位、生境的利用方式上明显不同,从而达到相互适应、长期共存。这符合竞争排斥原理。

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