

Fauna characteristics and ecological distribution of Carnivora and Artiodactyla in Niubeiliang National Nature Reserve, China

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Abstract Niubeiliang National Nature Reserve (NNR, 108°45'–109°04' E, 33°47'–33°56' N) is located on the eastern range of the Qinling Mountains in Shaanxi Province, China and spans the southern and northern slopes of Mt. Qinling. A transect survey and investigation were carried out in NNR to determine the fauna characteristics and ecological distribution of carnivora and artiodactyla from May 2003 to August 2004. The NNR has 18 mammals (carnivore and artiodactyl), two of which belong to the first class and seven to the second class of state key protected wildlife in China. The results of this study indicated that ungulates were abundant in the NNR, as all ungulates that were distributed within Mt. Qinling could be found within the reserve. However, only 45.5% of the carnivores distributed within Mt. Qinling were detected within the NNR. Among the mammals, there were 12 oriental species (66.7%), 1 palearctic species (5.5%) and 5 widely-distributed species (27.8%). The NNR is a crossing area of palearctic species and oriental species on the zoogeographical regions, and it is a transitional area from the oriental realm to the palearctic realm. The results of the analysis on the ecological distribution of carnivore and artiodactyl in the area showed that their elevation ranges had large differences. The species whose elevation ranges above 1 300 m, about 1 000 m, and in 450–700 m occupied one third respectively. The results also indicated that species richness for the mammals in the NNR peaked at a middle elevation (rising at first, then descending with the increase in elevation). Not only on the southern slope, but also on the northern slope of Mt. Qinling, the number of species distributed in the area at 1 800–2 200 m a.s.l. was the largest (more than 80%), while the number of species distributed in the area above 2 600 m a.s.l. was the smallest (about 50%). Elevation gradients of species

richness for the mammals in the NNR also embodied the mammal distributions among the vegetation types. The number of species distributed in the mixed coniferous and broadleaf deciduous forest at middle elevations was the largest, while the number of species distributed in the broadleaf deciduous forest at middle and low elevations, subalpine coniferous forest, subalpine shrubbery and meadow was relatively smaller.

Keywords mammal, fauna, ecological distribution, elevation gradients, species richness, Niubeiliang National Nature Reserve

1 Introduction

Mountain Qinling, belonging to the north of the west mountainous tableland subregion in the zoogeographical regions of China, is regarded as the boundary between the oriental realm and palearctic realm in eastern China (Zhang, 1999). The fauna characteristics of mammals there had both traits of the two realms (Chen et al., 1980; Wu and Li, 1982). Mt. Qinling is the crossing area of the oriental species and palearctic species, and has some obstructive effect on the dispersion and distribution of the species of the two realms. Therefore, it will be very significant to explore the formation and evolution of the fauna in Mt. Qinling through researching the fauna and distribution characteristics of mammals in this region. Many Chinese scholars have reported the features of mammal resource and fauna in whole or part area of Qinling (Chen et al., 1980; Wu and Li, 1982; Zheng, 1982; Zheng et al., 1982; Wu et al., 1986; Li et al., 1997; Ruan and Gong, 1999; Liu and Zhang, 2003). These works have established good foundation for the succeeding studies.

Many factors have effects on activities of wild animals. On the one hand, habitat fragmentation, loss or deterioration caused by human activities in the low elevation area of

Mt. Qinling has badly influenced animal survival. On the other hand, the function of wildlife nature reserve and the implementation of the “Natural Forest Protection Project” gradually restore and enlarge animal habitat in some regions especially the high elevation region. This not only makes for the survival and development of wild animals, but also provides the conditions for their movement and dispersion. Wild animals, especially wild large or medium mammals, are sensitive to habitat restoration. Habitat restoration will have effects on animal distribution, further resulting in the change of fauna composition in some region. Therefore, we analyze and discuss the fauna composition and ecological distribution of large and medium mammals after their habitats have been restored in Niubeiliang National Nature Reserve (for short “Niubeiliang Nature Reserve”) which spans the southern and northern slopes of Mt. Qinling. The research reports of Chen et al. (1980), Wu and Li (1982), and Zheng (1982) once referred to the resource and fauna characters of the mammals in the reserve and its circumference, and Ruan and Gong (1999) analyzed them completely. But, the information on the ecological distribution of mammals, which could be extracted from these research results, is very limited and loosed. The aim of this study is to clarify the effects of habitat restoration on animal movement, dispersion and ecological distribution to provide theoretical basis for the protection of species diversity in Mt. Qinling.

2 Study area and methods

2.1 Study area

The research was carried out in Niubeiliang Nature Reserve (NNR; 108°45′–109°04′ E, 33°47′–33°56′ N) lying in the eastern range of the Qinling Mountains in Shaanxi Province of China. It is a type of forest and wildlife nature reserve that gives priority to protect the golden takin (*Budorcas taxicolor bedfordi*) and its habitat. Mt. Qinling is the watershed of the Yangtse River system and the Yellow River system, the climate boundary of southern and northern China, and the transitional region of the north subtropical zone and warm temperate zone of China (Yang et al., 1994). Biodiversity in the Qinling has an important status, and many endemic wildlife species distribute there. It is a key region of biodiversity protection in a worldwide scale (Chen, 1993; Yang et al., 1994).

The NNR is located on the joint area of Ningshan county, Zhashui county and Changan district of Xi’an, and spans the southern and northern slopes of Mt. Qinling. The NNR is narrow and long in shape along the main ridge of Mt. Qinling. The reserve is 29 km long from east to west and 17.5 km wide from south to north. Its lowest elevation is 1 200 m. Niubeiliang (2 802.1 m a.s.l.) in the NNR is a peak of the eastern range of Qinling. Complex terrain results in a rich river system. The Xun river and Qianyou river feed the Han river of the Yangtse River system in the southern slope, while the

Shibianyu river and bangyu river feed the Wei river of the Yellow River system in the northern slope of Mt. Qinling. Climate there is half wet in a warm temperate zone. Temperature varies from 31.1°C to –21.6°C, with mean annual temperatures of 8°C–10°C. Annual precipitation is 850–950 mm. The no-frost period is 130 days.

The reserve was established in 1987 and consisted of forest land formerly belonging to four forestry companies. Its vegetation was once destroyed because of logging for many years. Setting up the reserve protected the animal habitat and gradually restore it. Vegetation in the NNR was characterized by vertical zonation, a broadleaf deciduous forest zone, a mixed coniferous and broadleaf deciduous forest zone and a sub-alpine coniferous zone occurred in turn from low to high elevation. The broadleaf deciduous forest zone (1 200–2 100 m a.s.l.) dominated by trees of *Quercus aliena* var. *acuteserrata*, *Q. liaotungensis*, *Q. glandulifera* var. *brevipetiloata*, *Populus davidiana* etc.; the mixed coniferous and broadleaf deciduous forest zone (2 100–2 500 m a.s.l.) dominated by trees of *Betula albo-sinensis*, *Betula albo-sinensis* var. *septentrionalis* and a spot of coniferous trees *Pinus tabulaeformis*, *P. armandii* etc.; the subalpine coniferous zone (2 500–2 800 m a.s.l.) dominated by trees of *Abies fargesii*, *Larix chinensis* and *P. armandii* etc. The bamboo *Fargesia spathacea* was preponderant in the understory in the southern slope, but less in the understory in the northern slope. *Larix chinensis* was only distributed in the area of high elevation, such as Guangtoushan and Niubeiliang. The subalpine shrub and meadow (2 300–2 802 m a.s.l.) was mixed in the coniferous forest in high elevation. The dominant species were *Potentilla arbuscula* var. *veitchii*, *P. arbuscula* var. *mandshurica*, *Rhododendron capitatum*, *Salix cupularis*, *Lonicera webbiana*, *Saussurea iodostegia*, *Carex* sp., *Cyperus* sp. and so on.

2.2 Methods

A transect survey and investigation were carried out in NNR to determine the fauna and ecological distribution of mammals (carnivore, artiodactyla and other large and medium-sized mammals). Seventeen line transects were set up in the study area. Each line crossed as many different habitat types as possible from low to high elevation. Total length of the line was more than 180 km. The line transects were wholly surveyed in each season from May 2003 to August 2004. The data from the observed animals and remained trace (including spoor, dejection, lying mark, food mark, hair, litter, cave, call, etc.) were recorded. Meanwhile, species, number grade and individual size of the animals were made certain according to features and density of their trace. Their locations and elevations were confirmed by GPS receiver. In addition, we used the method of visiting local residents to investigate the mammals that were difficult to find because of low number and density in the field. Visiting investigation was usually an important method to collect the data of large and medium mammals, and widely used in the investigation of animal fauna (Zhang, 2001; Chen, 2003). Our visiting objects were

the local forest protector, the staff in the local reserve station and the local villagers who usually pick and dig Chinese traditional medicine in the mountain. In total, more than 30 persons from the villages of Guanghuojie, Daping, Beigou, Laolin, Hongxing and Taihe were visited. We gave them priority to narrate the mammals they saw in the past, further confirmed their species through inquiring their shape features and offering some animal pictures for comparison.

The scientific names of mammals in this paper were given according to "A Complete Checklist of Mammal Species and Subspecies in China: a Taxonomic and Geographic Reference" (Wang, 2002). At the same time, their distribution pattern and fauna component were made certain according to "Zoogeography of China" (Zhang, 1999).

3 Results

3.1 Resource and fauna characteristics of mammals

Both carnivore and artiodactyl in the NNR had 18 species, belonging to 9 families and 2 orders (Table 1). Among these mammals, leopard cat *Prionailurus bengalensis* is the local key protected wildlife in Shaanxi province, 2 species (11.1%) including golden takin and leopard *Panthera pardus fusca* belong to the first class and seven species (38.9%) belong to the second class of state key protected wildlife in China. The latter seven species were the Asian wild dog *Cuon alpinus*, Asiatic black bear *Selenarctos thibetanus mupinensi*, yellow-throated marten *Martes flavigula flavigula*, Asiatic golden cat *Catopuma temmincki*, forest musk deer *Moschus berezovskii*, and Chinese goral *Naemorhedus caudatus griseus*, Serow *N. sumatraensis milneedwardsi*. Moreover, 2 species (11.1%) lack-toothed weasel *Mustela aistoodonnivalis* and Chinese muntjac *Muntiacus reevesi* are the endemic species of China, and 4 species (22.2%), including forest musk deer, tufted deer *Elaphodus cephalophus*, golden takin and Chinese goral, are the species mainly distributed in China.

Eighteen mammals in the NNR respectively belong to six kinds of distribution patterns, including ancient continent tropical-temperate pattern (1 species), palearctic pattern (3 species), monsoon pattern (2 species), Himalayas-Hengduan Mountain Range pattern (2 species), southern China pattern (3 species), and oriental pattern (7 species). The former 2 are the distribution of the palearctic realm, the latter 4 are the distribution pattern of the oriental realm (Tables 1, 2). Except for the roe deer being found only in the northern slope and lack-toothed weasel, Asiatic golden cat and tufted deer being found only in the southern slope among these mammals, others were found in both the southern and northern slopes of Mt. Qinling. The oriental pattern component had the most proportion (41.2% in the southern slope and 40.0% in the northern slope). But, from the southern slope to northern slope of Mt. Qinling, the proportion was decreasing for mammals in the oriental realm distribution pattern, and was increasing for mammals of the palearctic realm distribution

pattern (increased to 26.7% from 17.7%; Table 2). Moreover, among the 18 mammals, 12 species (66.7%) belong to the oriental realm, 1 specie (5.5%) to palearctic realm, and the other 5 mammals (27.8%) to widely-distributed species.

3.2 Status of ecological distribution of carnivore and artiodactyl

3.2.1 Distribution in different types of vegetation

Among the 18 species of carnivore and artiodactyl in the NNR, the mammals whose span of niche breadth covered all of the four vegetation types were 7 species, including Asiatic black bear, hog badger *Arctonyx collaris albogularis*, leopard, wild boar *Sus scrofa moupinensis*, roe deer *Capreolus capreolus*, golden takin and Chinese goral. Moreover, masked palm civet, tufted deer and Chinese muntjac were found only in the broadleaf deciduous forest, while lack-toothed weasel and forest musk deer were found only in the mixed coniferous and broadleaf deciduous forest; their niches were narrow (Table 1).

There were 14 mammals in the broadleaf deciduous forest, 15 mammals in the mixed coniferous and broadleaf deciduous forest, 10 mammals in the subalpine coniferous forest, and 7 mammals in the subalpine shrub and meadow among the four types of vegetation in the NNR.

Nine species including the hog badger, wild boar, tufted deer, Chinese muntjac, serow, yellow-throated marten, Siberian weasel *Mustela sibirica moupinensis*, masked palm civet *Paguma larvata reevesi* and leopard cat perennially lived in the broadleaf deciduous forest, while roe deer, Asiatic black bear, leopard, golden takin and Chinese goral seasonally lived here. In addition, the hog badger, wild boar, tufted deer, Chinese muntjac and serow were dominant species of this vegetation type.

Wild boar, golden takin, Chinese goral, serow, Asiatic black bear and leopard were dominant species in the mixed coniferous and broadleaf deciduous forest. Asian wild dog, lack-toothed weasel, Asiatic golden cat, forest musk deer and roe deer mainly inhabited in this vegetation type. Yellow-throated marten, Siberian weasel, hog badger and leopard cat also lived here.

Majority of the dominant species in the subalpine coniferous forest were large and medium ungulates, such as the golden takin and Chinese goral, and their natural enemy, the leopard. In summer, Asian wild dog, Asiatic black bear, Siberian weasel, hog badger, Asiatic golden cat, wild boar and roe deer often move about here. One roe deer was observed to move in the bamboo *Fargesia spathacea* and coniferous forest nearby 2 500 m a.s.l. in summer in 2004.

Only in summer and autumn could the Asiatic black bear, hog badger, leopard, wild boar, roe deer, golden takin and Chinese goral be found in the subalpine shrub and meadow. This type of vegetation was mainly the site where mammals transitorily fed and passed through. Chinese goral was observed 18 times to be resting or feeding there in the field.

Table 1 Fauna and habitats of Carnivora and Artiodactyla in Niubeiliang Nature Reserve

Names of mammal	DP	Fauna component	Protected status	Habitat	Investigated status		
					AO	Spoor	Visiting
Carnivora							
(a) Canidae							
1. <i>Cuon alpinus</i>	W	S _w	II	MCB/SC	—	√	√
(b) Ursidae							
2. <i>Selenarctos thibetanus mupinensis</i>	E	S _w	II	BD/MCB/SC/SM	√	√	—
(c) Mustelidae							
3. <i>Martes flavigula flavigula</i>	W	S _o		BD/MCB			√
4. <i>Mustela aistoodonnivalis</i> *	H	S _w	II	MCB			√
5. <i>M. sibirica moupinensis</i>	U	S _o		BD/MCB/SC	√		√
6. <i>Arctonyx collaris albogularis</i>	W	S _w		BD/MCB/SC/SM		√	
(d) Viverridae							
7. <i>Paguma larvata reevesi</i>	W	S _w	—	BD	—	√	√
(e) Felidae							
8. <i>Catopuma temmincki</i>	W	S _w	II	MCB/SC	—		√
9. <i>Prionailurus bengalensis</i>	W	S _o	Sx	BD/MCB			√
10. <i>Panthera pardus fusca</i>	O	S _o	I	BD/MCB/SC/SM		√	
Artiodactyla							
(f) Suidae							
11. <i>Sus scrofa moupinensis</i>	U	S _o	—	BD/MCB/SC/SM	√	√	—
(g) Moschidae							
12. <i>Moschus berezovskii</i> **	S	S _w	II	MCB	—	√	√
(h) Cervidae							
13. <i>Elaphodus cephalophus</i> **	S	S _w	—	BD		√	√
14. <i>Muntiacus reevesi</i> *	S	S _w		BD	√	√	√
15. <i>Capreolus capreolus</i>	U	S _u		BD/MCB/SC/SM	√	√	√
(i) Bovidae							
16. <i>Budorcas taxicolor bedfordi</i> **	H	S _w	I	BD/MCB/SC/SM	√	√	—
17. <i>Naemorhedus caudatus griseus</i> **	E	S _w	II	BD/MCB/SC/SM	√	√	
18. <i>N. sumatraensis milneedwardsi</i>	W	S _w	II	BD/MCB	√	√	

*: The endemic species of China

**: The species mainly distributed in China

DP: Distribution patterns

AO: Animal observed

U: Palearctic pattern

E: Monsoon pattern

H: Himalayas-Hengduan Mountain Range pattern

S: Southern China pattern

W: Oriental pattern

O: Ancient continent tropical-temperate pattern

S_u: Palearctic speciesS_w: Oriental speciesS_o: Widely-distributed species

I: First class state key protected wildlife in China

II: Second class state key protected wildlife in China

Sx: Local key protected wildlife in Shaanxi province (Min, 1991)

BD: Broadleaf deciduous forest

MCB: Mixed coniferous and broadleaf deciduous forest

SC: Subalpine coniferous forest

SM: Subalpine shrubbery and meadow

The feeding trace of wild boar and the dejecta of hog badger were often found there.

3.2.2 Vertical distribution

The ecological distribution of carnivore and artiodactyl in the NNR show that their elevation ranges have large differences (Figs. 1, 2). One-third of the mammals including Asiatic black bear, Siberian weasel, hog badger, wild boar, golden takin and Chinese goral, were distributed in the area from low to high mountain zones; their vertical elevation ranges were more than 1 300 m. The vertical elevation ranges of the Asian wild dog, leopard, yellow-throated marten, leopard cat, Chinese muntjac and serow were about 1 000 m. The former 2 species mainly distributed in the middle mountain zone and subalpine

zone, while the latter 4 species mainly in the middle and low mountain zone. The vertical elevation ranges of another third of the mammals were between 450–700 m. These animals included the lack-toothed weasel, masked palm civet, Asiatic golden cat, forest musk deer, tufted deer and roe deer. Masked palm civet and tufted deer were mainly distributed in the low mountain zone, while the lack-toothed weasel, forest musk deer and roe deer mainly in middle mountain zone, and Asiatic golden cat mainly in the subalpine zone.

4 Discussion

The mammal resource in the NNR, the eastern range (Zheng, 1982) and the whole area (Chen et al., 1980; Wu and Li,

Table 2 Comparison of distribution patterns for Carnivora and Artiodactyla in Niubeiliang Nature Reserve

Distribution pattern	SSQR		NSQR		WAR	
	Species	%	Species	%	Species	%
ACTT pattern	1	5.9	1	6.7	1	5.6
Palaearctic pattern	2	11.8	3	20.0	3	16.7
Monsoon pattern	2	11.8	2	13.3	2	11.1
HHMR pattern	2	11.8	1	6.7	2	11.1
Southern China pattern	3	17.6	2	13.3	3	16.7
Oriental pattern	7	41.2	6	40.0	7	38.9
Total	17	100	15	100	18	100

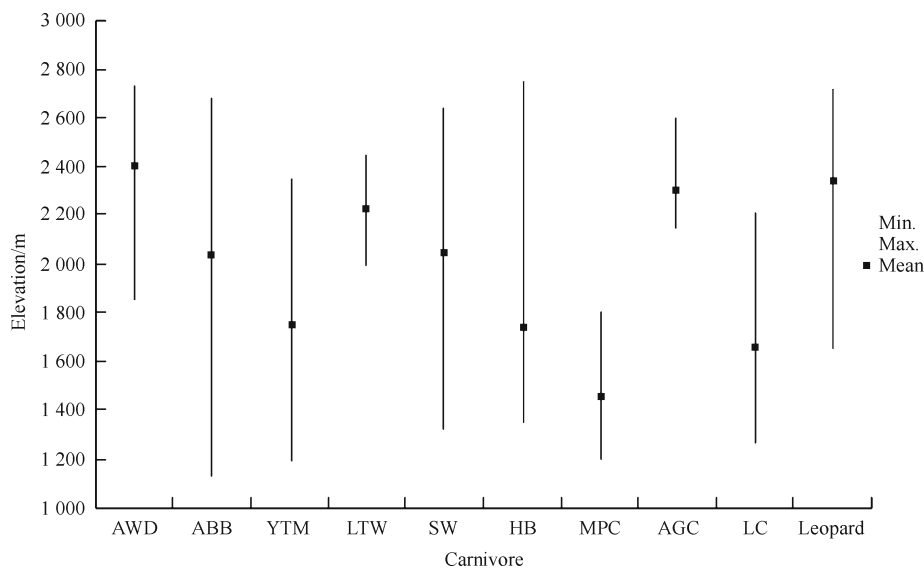
ACTT pattern: Ancient continent tropical-temperate pattern

HHMR pattern: Himalayas-Hengduan Mountain Range pattern

SSQR: Southern slope of the Mt. Qinling within the reserve

NSQR: Northern slope of the Mt. Qinling within the reserve

WAR: Whole area of the Niubeiliang Nature Reserve

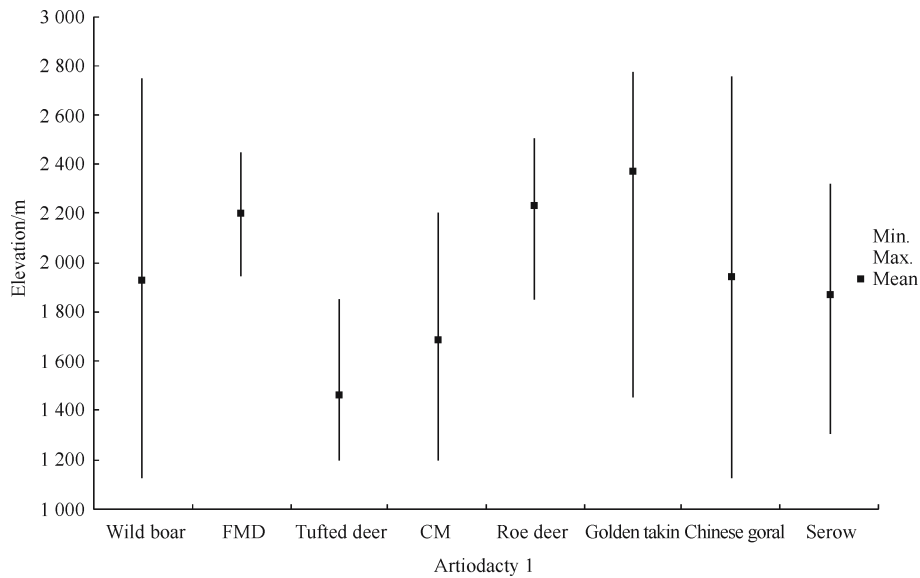


AWD: Asian wild dog; ABB: Asiatic black bear; YTM: Yellow-throated marten; LTW: Lack-toothed weasel; SW: Siberian weasel; HB: Hog badger; MPC: Masked palm civet; AGC: Asiatic golden cat; LC: Leopard cat

Fig. 1 Vertical changes of ecological distribution of carnivore

1982; Li et al., 1997; Wang, 2002; Liu and Zhang, 2003) of Mt. Qinling was compared and analyzed. The results show that the NNR had all species of ungulate, but was short of primates and some other species of carnivore, which were distributed in Mt. Qinling (Table 3). The giant panda *Ailuropoda melanoleuca*, golden monkey *Rhinopithecus roxellana qinlingensis*, great Indian civet *Viverra zibetha* and cloud leopard *Neofelis nebulosa* belong to the first class of state key protected wildlife in China and can be found in Mt. Qinling, while the Indian lesser civet *Viverricula indica* and otter *Lutra lutra* belong to the second class of state key protected wildlife in China and could be found in the eastern range of Mt. Qinling. However, these mammals were not found in the NNR. It was reported that the trace of a giant panda was once found in the reserve (Wu, 1986; Ruan and Gong, 1999), but it was not found again in the course of investigations in 1996 and recent years. The species of carnivore distributed in the NNR only amounted to 45.5% of that in the whole area of Mt. Qinling, and 58.8% of that in the eastern range of Mt. Qinling (Table 3).

Among the carnivore and artiodactyl in the NNR, the fauna component of the oriental realm was dominant, and the fauna component of the palaearctic realm was quite low. This together with their characters of distribution pattern indicate that the NNR in the eastern range of Mt. Qinling belongs to a crossing area of palaearctic species and oriental species, and is a transitional area from the oriental realm to the palaearctic realm on the zoogeographical regions. One or two scholars once arrived at similar conclusions through the analysis on the fauna component of mammals in Mt. Qinling (Chen et al., 1980; Wu and Li, 1982). The obstructive effect of the main ridge of Mt. Qinling on the dispersion and intercourse of large and medium mammals in the southern and northern slopes was not obvious on the zoogeography. Among the 18 species of carnivore and artiodactyl in the NNR, 14 species (77.8%) distribute in both the southern and northern slopes of Mt. Qinling. The Asiatic golden cat and tufted deer, belonging to the oriental species, are found in the northern slope of Mt. Qinling (Li et al., 1997). Another oriental species,



FMD: Forest musk deer; CM: Chinese muntjac
Fig. 2 Vertical changes of ecological distribution of artiodactyl

Table 3 Comparison of the mammal resource among Niubeiliang Nature Reserve, the eastern range and whole area of Mt. Qinling

Sorts	Family			Genus			Species				
	Q	EQ	NBL	Q	EQ	NBL	Q	EQ	NBL	NBL/Q	NBL/EQ
Primates	1	0	0	1	0	0	1	0	0	0	0
Carnivora	6	5	5	19	15	9	22	17	10	45.5%	58.8%
Artiodactyla	4	4	4	7	7	7	8	8	8	100%	100%
Sum	11	9	9	27	22	16	31	25	18	58.1%	72%

Q: Mt. Qinling; EQ: Eastern range of the Mt. Qinling; NBL: Niubeiliang Nature Reserve

lack-toothed weasel, is also distributed in the place round Luotuosu (the northern slope of Mt. Qinling) in Taibai Mountain (Gong Huisheng, unpublished data). One palearctic specie, the roe deer, is only seen in the northern slope of Mt. Qinling in the study area in the past, but we observed a roe deer to feed in the bamboo *Fargesia spathacea* near the main ridge of Mt. Qinling. In addition, someone hunted a roe deer in Foping National Nature Reserve lying in the southern slope of the middle range of Mt. Qinling. This indicates that roe deer can diffuse to the southern slope of Mt. Qinling.

The number of species of carnivore and artiodactyl in the NNR presents a rule change of rising at first and then decline with the rise in elevation (Table 4). It gradually increases below the area of 2 000–2 200 m a.s.l. with elevation ascent and gradually decreases above this area. There are 11 species (61.1%) in the area of less than 1 400 m a.s.l., 16 species (88.9%) in the area of 2 000–2 200 m a.s.l., and 8 species (44.4%) of mammals in the area over 2 600 m a.s.l. This kind of rule change is also very obvious in both the southern and northern slope of Mt. Qinling in the NNR. Not only on the southern slope, but also on the northern slope of the Mt. Qinling, the species of carnivore and artiodactyl is very rich in the area of 1 800–2 000 m and 2 000–2 200 m a.s.l.,

and its proportion is more than 80%. However, the number of the species in the area above 2 600 m a.s.l. is the smallest (about 50%).

This vertical change rule, where species richness for the mammals in the NNR rise at first and then decline with an increase in elevation, also embody the mammal distributions among the vegetation types. The species richness here is the number of species in the area of a certain elevation. Vegetation in the reserve is characterized by vertical zonation; a broadleaf deciduous forest zone (1 200–2 100 m a.s.l.) at middle and low elevations, a mixed coniferous and broadleaf deciduous forest zone (2 100–2 500 m a.s.l.) at middle elevations, a subalpine coniferous zone (2 500–2 800 m a.s.l.) and the subalpine shrub and meadow (2 300–2 802 m a.s.l.) being mixed in the coniferous forest at high elevation occurred in turn from low to high elevation. The research result even indicates that the number of species distributed in the mixed coniferous and broadleaf deciduous forest is the largest, while the number of species distributed in other vegetations is relatively smaller. Many studies indicate that the vertical change pattern of species richness with elevation ascent widely existed in non-flying mammals, especially in small mammals (Heaney, 2001; Md Nor, 2001; Rickart, 2001; Zhang, 2001).

Table 4 Elevation changes of the species of Carnivora and Artiodactyla in Niubeiliang Nature Reserve

Elevation /m	SSQR		NSQR		WAR	
	Species	%	Species	%	Species	%
> 2600	8	47.1	8	53.3	8	44.4
2400–2600	11	64.7	10	66.7	12	66.7
2200–2400	13	76.5	11	73.3	14	77.8
2000–2200	15	88.2	13	86.7	16	88.9
1800–2000	14	82.4	13	86.7	15	83.3
1600–1800	13	76.5	12	80.0	13	72.2
1400–1600	12	70.6	11	73.3	12	66.7
< 1400	10	58.8	10	66.7	11	61.1
Total	17	100	15	100	18	100

SSQR: Southern slope of the Mt. Qinling within the reserve; NSQR: Northern slope of the Mt. Qinling within the reserve;

WAR: Whole area of the Niubeiliang Nature Reserve

A series of hypotheses concerning the pattern have been discussed and tested by many authors, including climatic gradients, primary productivity, food resource diversity, and habitat diversity (Brown, 2001; Heaney, 2001; Lomolino, 2001; Md Nor, 2001; Rickart, 2001). We think that there is a close relationship between the distribution pattern of carnivore and artiodactyl and the factors of topography, vegetation, food resource and climate in the NNR. Since the area of high elevation is short of food resource, only in summer and autumn when food resource is relatively rich do ungulates of having a large body, strong motility and adaptability, such as the golden takin and Chinese goral, move to live there in order to avoid the hot weather and the disturbance from mosquitoes. As their predator, leopard and Asian wild dog also move there along with them.

Disturbance from human activities had negative effects on the distribution of mammals. For example, we could see little trace of the ungulates below the area of 2 000 m a.s.l. in Dadonggou outside the NNR now, whereas the golden takin could be found to move down the area of about 1 500 m a.s.l. in Dadonggou five years ago. The reason was the frequent disturbance of human activities caused by planting of mushroom on a large degree in this area in recent years. At the same time, we also found that habitat restoration in the NNR enlarged the movement range of animals continually. The habitat of large mammals within and around the NNR was badly destroyed because of deforestation in different degrees. But, the habitat in the protected area was restored continually and that made for enlarging of the distribution range of animals after the establishment of the NNR and the implementation of the natural forest protection project. In early spring this year, a large group of golden takin with over 30 individuals moved down to the area of about 1 500 a.s.l. in Xigouxia of the NNR. It is a powerful exemplification because a group of takin could not be found in this area before.

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