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The regions of conservation importance for grouse, partridges and pheasants in China

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Introduction

China is a large country, occupying 9,600,000 km^2. It lies between longitudes 73°40′E and 135° 05′E, a distance of some 5,200 km. Mountainous in the west and flat in the east, the land surface of China slopes downward from west to east in a three-step staircase and can be divided into moist, semi-moist, semi-arid and arid regions from the east coast to the inland north-west respectively. From north to south, China covers frigid, temperate, subtropical and tropical zones. All of this variation in geographical and climate conditions combine to give it a high diversity of fauna and flora.

The country is rich in Galliformes. Sixty-one species of two families (Tetraonidae and Phasianidae) are found in the country (Cheng 1994), which is about 22% of the 277 Galliformes species of the world (Sibley and Monroe 1990). In recent decades, as a result of big changes in the environments and the increasing human activities, the ranges of Chinese Galliformes have decreased and the population densities have declined (Zheng and Zhang 1993). The status of the country's Galliformes was assessed in the mid 1990s as part of two global reviews: through the compilation of IUCN/World Pheasant Association (WPA) action plans for pheasants (McGowan and Garson 1995) and partridges (McGowan *et al*., 1995), and through the revision of BirdLife International's list of threatened bird species (Collar *et al*. 1994). Both assessments considered that a high proportion of the world's threatened Galliformes occurred in China.

A major obstacle to investigating patterns in the distribution of species is the difficulty of obtaining information of localities from which species have been recorded. Because of the importance of China in the conservation of the world's pheasants in particular, the IUCN/WPA Pheasant Specialist Group considered that the establishment of a database holding records of all localities from which Chinese Galliformes have been recorded was one of the highest global priorities for these birds (McGowan and Garson 1995). The establishment of this WPA database (Ding 1996) provides the opportunity to investigate patterns of distribution and identify important areas for Galliformes in China.

Since the establishment of the Site Records Database for Chinese Galliformes, distribution data for Chinese partridges and pheasants are available and easily manageable. This means that regions of high species richness can be identified and used to make conservation action more effective. Here, we investigate the species richness in different areas (or regions) throughout the country. We combined Galliformes locality data with the zoogeographical regions (Zhang 1984) and the physicogeographical regions of China (Huang 1989), to calculate species richness in each subregion and physicogeographical province. We then used a conservation index to rank areas of conservation importance.

Methods

Locality data

Locality data are held in the Site Records Database for Chinese Galliformes, which contained 3,172 records. Geographical coordinates for sites were obtained from standard gazetteers and lists presented in some of the locality sources. The vast majority of coordinates were believed accurate to within 10′ of the collection or observation sites. Localities that were not accurate to within 1° were not used.

Zoogeographical regions and physicogeographical provinces of China

China's varied natural conditions give it a wealth of animals and plants. Zoogeographically, China occupies sizeable portions of two major fauna realms, Palearctic Realm and Oriental Realm. Based on the land-vertebrate fauna and geographical characters, Zhang (1984) suggested that the country could be split

Table 1. The zoogeographical regions of China (from Zhang 1984)

Realm	Region	Subregion	Subregion code
Palearctic	North-east	Northern Daxing'anling mountains	142
		Shongliao plain	133
		Changbai and Xiaoxing'anling mountains	134
		Sanjiang plain	135
	North China	Huangtu plateau	131
		Huanghuai plateau	132
	Mongolia-Xingjiang	Altay mountains	141
		Ili and Hasake desert	211
		Tarim and Alashan desert	212
		Eastern Inner Mongolia grassland	213
	Qinghai-Tibet	Qiangtang plateau and Kunlun mountains	221
		Southern and eastern mountains of Qinghai and Xizang	222
Oriental	South-west	Southern slope of Himalayas	111
		Hengduan mountains	121
		Eastern Yunnan and western Guizhou plateau	122
	Mid-China	Sichuan basin	124
		Qinling, Bashan and Hubei mountains	125
		Middle–low reaches of Yangzi river	126
	South China	Southern Yunnan mountains	112
		Hills and plains of Guangdong and Fujian	113
		Hainan island	114
		Taiwan island	115
		South China mountains	123

Table 2. Physiogeographical regionalization of China (from Huang Bingwei 1989)

Thermal belts	Moisture regions	Physiogeographical provinces	Province code
I. Cold temperate	A. Humid	IA1. Northern Da Hinggan mountains	0111
II. Middle temperate	A. Humid	IIA1. Sanjiang plain	0211
		IIA2. Mountains of eastern North-east China	0212
		IIA3. Piedmont Plain of eastern north-east China	0213
	B. Subhumid	IIB1. Central Songhuajiang-Liaohe plain	0221
		IIB2. Middle Da Hinggan mountains	0222
		IIB3. Piedmont plain and hills of Sanhe	0223
	C. Semiarid	IIC1. South-western Songhuajiang-Liaohe plain	0241
		IIC2. Southern Da Hinggan mountains	0242
		IIC3. Eastern Nei-Mongol high plain	0243
	D. Arid	IID1. Western Nei-Mongol high plain	0251
		IID2. Area of Lanzhou and eastern Hexi (Gansu corridor)	0252
		IID3. Junggar basin	0253
		IID4. Altay mountains, Tacheng basin and Ertix valley	0254
		IID5. Ili basin	0255
III. Warm temperate	A. Humid	IIIA1. Hills and mountains of Liaodong and eastern Shandong	0311
	B. Subhumid	IIIB1. Hills and mountains of central Shandong	0321
		IIIB2. North China plain	0322
		IIIB3. Mountains and hills of north China	0323
		IIIB4. Plains of southern Shaanxi and Weihe valley	0324
	C. Semiarid	IIIC1. Loess highlands of central Shanxi and northern Shaanxi	0341
	D. Arid	IIID1. Tarim basin and Turpan basin	0351
IV. Northern subtropical	A. Humid	IVA1. Huanan and middle-low reaches of Changjiang river	0411
		IVA2. Hanzhong basin	0412
V. Middle subtropical	A. Humid	VA1. Hills and mountains of Nanling mountains	0511
		VA2. Guizhou plateau	0512
		VA3. Sichuan basin	0513
		VA4. Yunnan plateau	0514
		VA5. Southern slope of eastern Himalayas	0515

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Table 2. *Continued.*

Thermal belts	Moisture regions	Physiogeographical provinces	Province code
VI. Southern subtropical	A. Humid	VIA1. Central and northern Taiwan	0611
		VIA2. Hills and plains of Guangdong, Guangxi and Fujian	0612
		VIA3. Mountains and hills of Yunnan between Wenshan and Tengchong	0613
VII. Peripheral tropical	A. Humid	VIIA1. Lowlands of southern Taiwan	0711
		VIIA2. Central and northern Hainan and Leizhou peninsula	0712
		VIIA3. Valleys of southernmost Yunnan	0712
VIII. Middle tropical	A. Humid	VIIIA1. Southern Hainan and South China Sea islands	0811
HO. Plateau polar	D. Arid	HOD1. Kunlun mountains	1051
HI. Plateau subpolar	B. Subhumid	HIB1. Aba-Nagqu area	1121
	C. Semiarid	HIC1. Southern Qinghai and Qiangtang plateau	1141
HII. Plateau temperate	AB. Humid and subhumid	HIIAB1. High mountains and gorges of western Sichuan and eastern Xizang	1231
	C. Semiarid	HIIC1. Plateau and mountains of eastern Qinghai	1241
		HIIC2. Mountains of southern Xizang	1242
	D. Arid	HIID1. Qaiham basin	1251
		HIID2. Ngari mountains	1252

From Huang Bingwei (1989).

into a series of zoogeographical regions and subregions. This classification consisted of two realms, seven regions and 24 subregions (Table 1). Subsequently, Huang (1989) proposed a geophysical classification based on thermal conditions, moisture regimes and variation in landform. Forty-five geophysical provinces were recognized (Table 2). Since there are no site records collected from the islands of South China Sea, this area (subregion code: 123, province code: 811) was omitted from the analysis.

Identification of areas of high species richness

The computer software package ''China Ecological Information System (EIS)'' was used to overlap the localities of Chinese partridges and pheasants on the zoogeographical subregions and physicogeographical provinces. The species richness in each subregion and province was then calculated and sorted to identify the areas of high richness.

Conservation index

In order to highlight the importance of endemic and threatened species, we proposed an index that would give added weight to these species, so that sub-

Table 3. The categories of species richness (SPR) and hotspot value (HSV)

Category	Zoogeographical subregions		Physiogeographical provinces	
	SPR	HSV	SPR	HSV
I	⩾20	⩾35	⩾15	⩾30
II	⩾10	⩾20	⩾10	⩾20
III	<10	<20	<10	<20

regions and provinces rich in such species (''hotspots'') would be revealed. We treated the Snow Partridge *Lerwa lerwa*, Tibetan Partridge *Perdix hodgsoniae*, Bamboo Partridge *Bambusicola fytchii* and Temminck's Tragopan *Tragopan temminckii* as near-endemic species since most of their ranges are believed to be within China. We used the threat categories assigned in *Birds to Watch 2*, as this provides the global list of threatened birds for IUCN, The World Conservation Union.

The conservation index was calculated according to the formula:

$$HSV = (SPR \times 1) + (Ed \times 1) + (C \times 4) + (E \times 3) + (V \times 2) + (Nt \times 1)$$

where HSV is hotspot value; SPR is species richness; Ed is number of Endemic species; C is number of Critical species; E is number of Endangered species; V is number of Vulnerable species; and Nt is number of Near-threatened species.

We then sorted the zoogeographical subregions and the physicogeographical provinces by their ''hotspot'' values and identified the hotspots (important regions) of highest conservation importance for Chinese partridges and pheasants. We used the thresholds to sort the areas into three categories of importance as shown in Table 3.

Results

Species richness and hotspot value

The species richness and the hotspot value of each zoogeographical subregion and physicogeographical province are illustrated in Figures 1 and 2. These two regression equations are closely related:
For the zoogeographical subregions:

$$HSV = 2.03277 \times SPR \ (r = 0.97896,\ n = 23,\ P < 0.0001)$$

For the physicogeographical provinces:

$$HSV' = 1.98143 \times SPR' \ (r = 0.98502,\ n = 39,\ P < 0.0001)$$

The linear regressions are illustrated in Figures 3 and 4.

Areas of high species richness and hotspots for conservation

The zoogeographical subregions that had the highest species richness (20 or more species) and hotspot values (HSV of 35 or more) were identified (Figure 5). These were:

1. Hengduan Mountains

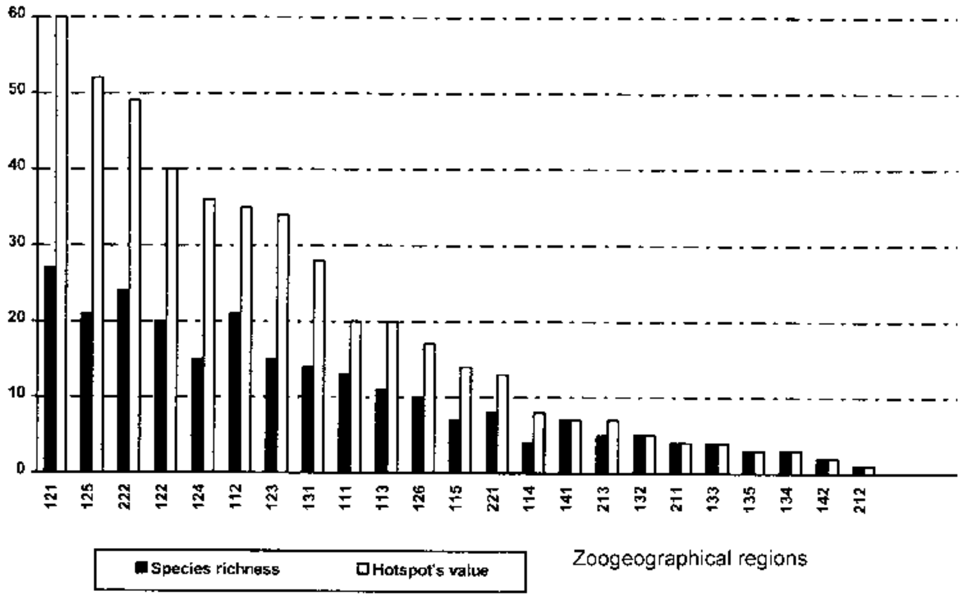

Figure 1. The species richness and hotspot value of each zoogeographical subregion.

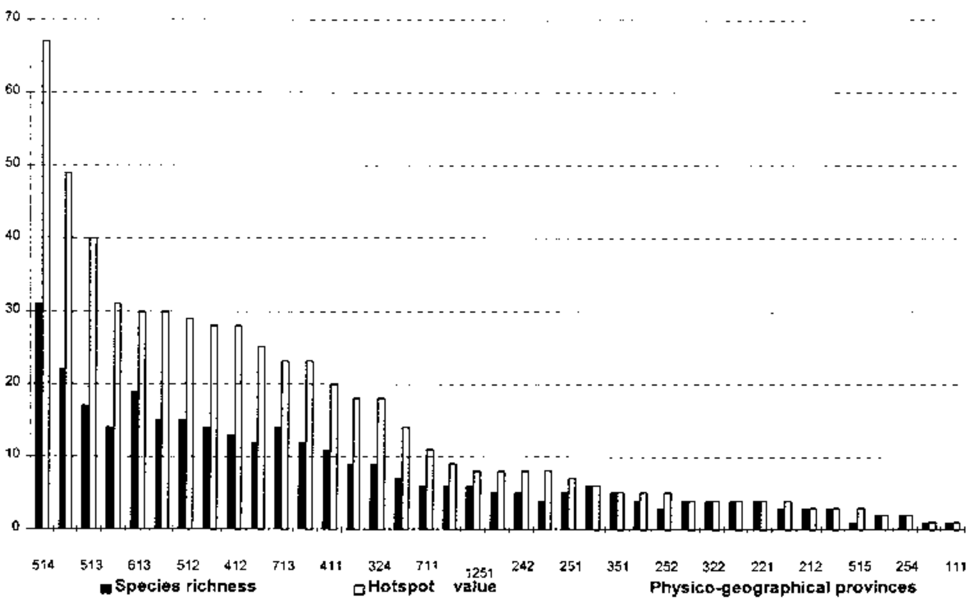

Figure 2. The species richness and hotspot value of each physicogeographical province.

2. Mountains of Qinling, Bashan and Hubei
3. Southern and eastern mountains of Qinghai-Tibet Plateau
4. Eastern Yunnan and western Guizhou plateau
5. Sichuan Basin

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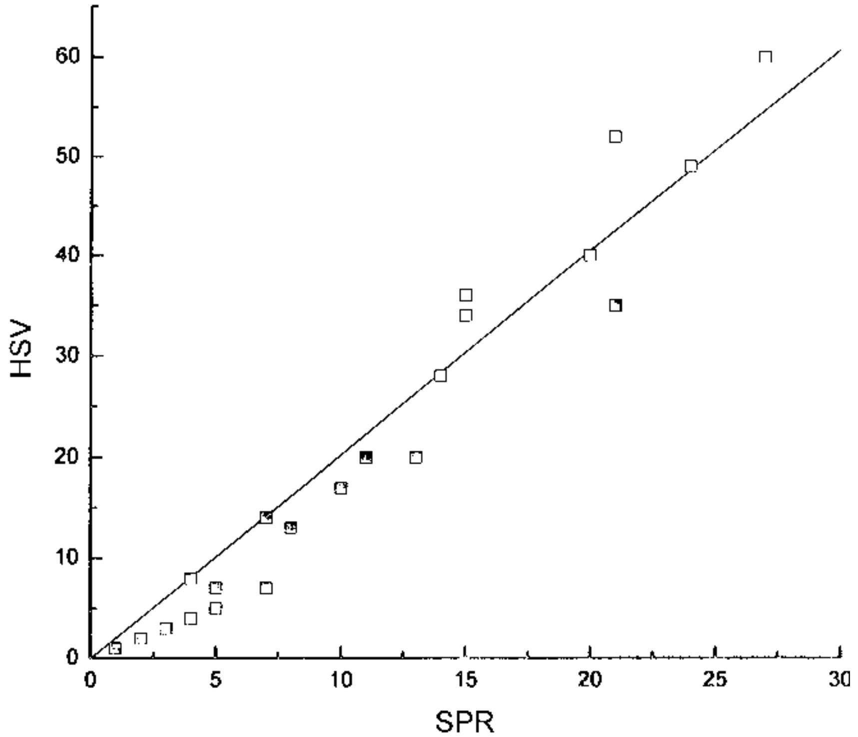

Figure 3. Linear regression of hotspot value (HSV) versus species richness (SPR) based on zoogeographical subregions.

6. Southern Yunnan Mountains.

The geophysical provinces that had the highest species richness (15 or more species) and hotspot value (HSV of 30 or more) were (see Figure 6):

1. Yunnan Plateau
2. High mountains and gorges of western Sichuan and eastern Xizang
3. Sichuan Basin
4. Mountains and hills of Yunnan between Weishan and Tengchong
5. Mountains of southern Xizang
6. Guizhou Plateau.

The subregions and the provinces that fall into the second and third categories are also illustrated in Figures 5 and 6. Those in the second category we call secondary conservation areas.

Discussion

Zoogeographical regions and physicogeographical provinces of China

The zoogeographical and physicogeographical classifications broadly overlap in China. Both of these zonations were used in this study to explore differences

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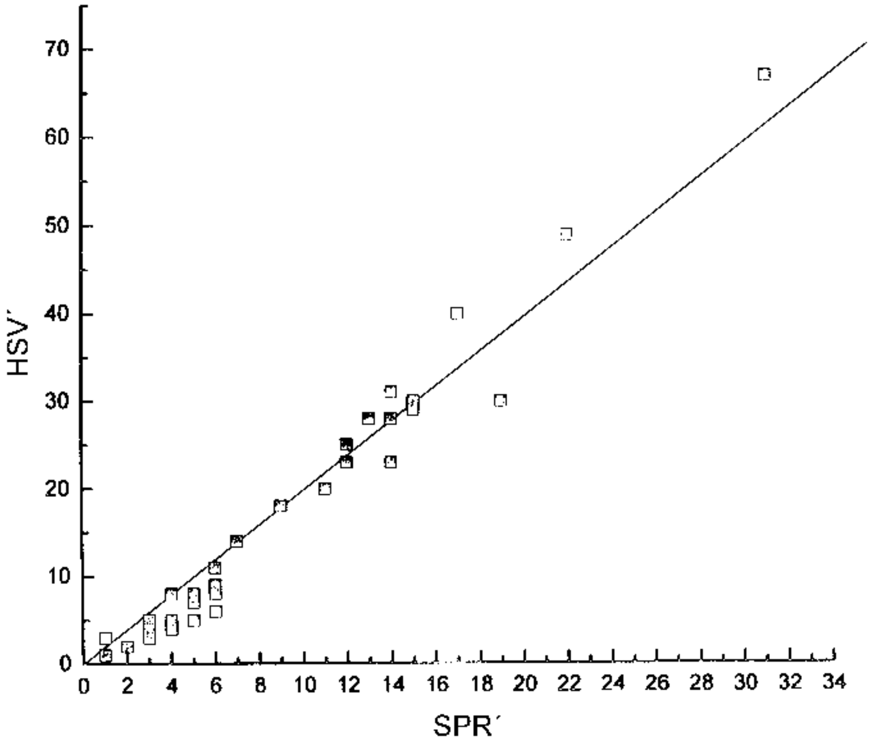

Figure 4. Linear regression of hotspot value versus species richness based on physicogeographical provinces.

between them in identifying the regions of conservation importance for Chinese pheasants and partridges.

Comparing the ''hotspots'' identified using zoogeographical regions (Figure 5) with those derived from physicogeographical provinces (Figure 6), there is considerable overlap. South-west and central China are the most important areas in both classifications and the more northerly areas, especially those to the east and west, contain fewer species and correspondingly fewer endemics and threatened species.

One interesting area of divergence between the two classifications is the northern part of Hengduan mountains and the mountains of Qinling and Dabashan. Using the zoogeographical classification, this emerges as a hotspot (Figure 5), but not when the physicogeographical map is used (Figure 6). In this area there are several threatened species of pheasants and partridges (*Tetraophasis obscurus, Alectoris magna, Lophophorus lhuysii, Crossoptilon crossoptilon, C. auritum* and *Syrmaticus reevesii*) and it has a hotpot value of more than 35. This may mean that zoogeographical regions are more suitable for identifying the regions of conservation importance for Chinese pheasants and partridges than the physicogeographical provinces. Currently, the zoogeographical classification is used mainly by faunal researchers whereas the latter is usually used in studies of agriculture and climate.

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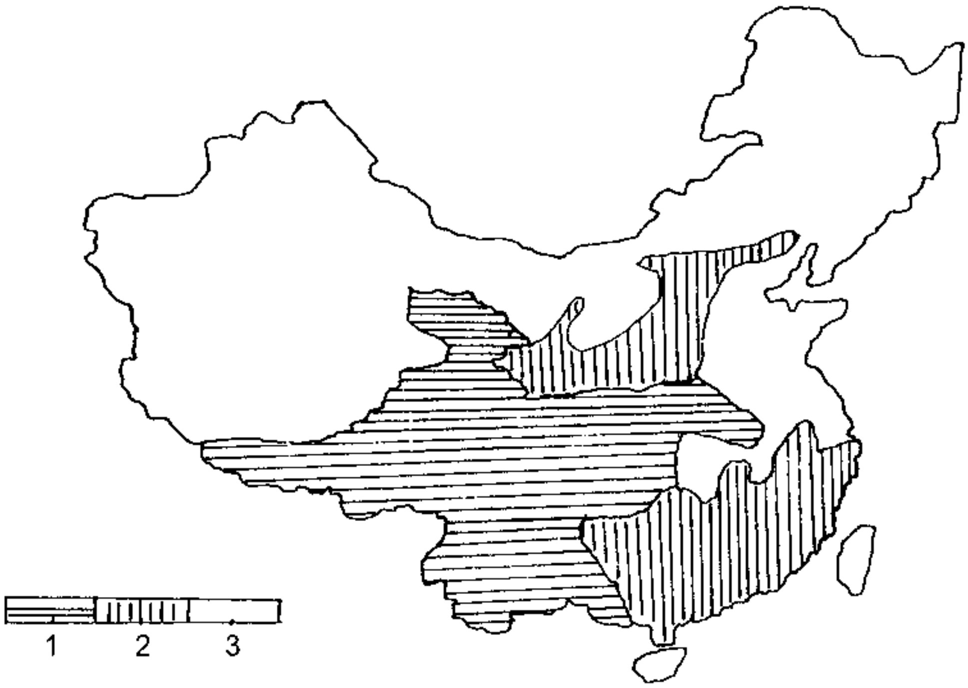

Figure 5. The hotspots for conservation of Chinese partridges and pheasants based on zoogeographical subregions of mainland China. 1, hotspots for conservation; 2, areas of secondary importance for conservation; 3, less rich areas.

The relations of HSV and SPR

It is clear that the conservation of endemic or threatened species is much more of a challenge than the conservation of common species. Consequently, species richness alone is not sufficient to identify regions of high conservation importance. The conservation index (HSV) was derived to reflect this concern. According to formula (1), HSV is related to SPR. The regions with more species will have a higher HSV. However, the region with higher HSV does not mean it has more species. Figures 1 and 2 show that HSV is a little more sensitive than SPR in identifying key areas. The coefficients could be investigated to make HSV more sensitive to conservation importance.

Regions of conservation importance

The overlap of important areas based on both zoogeographical and physicalgeographical classifications is striking, and are especially concentrated on the eastern and southern slopes of Qinghai-Tibet plateau, Sichuan, southwest Yunnan and western Guizhou plateau.

The Himalayas, Hengduan mountains and Qinling mountains are recognized as the boundary between the Palearctic Realm and the Oriental Realm (Zhang 1979). Most of the hotspots are located around and south of the boundary, one reason being that most Chinese pheasants and partridges occur in mountain

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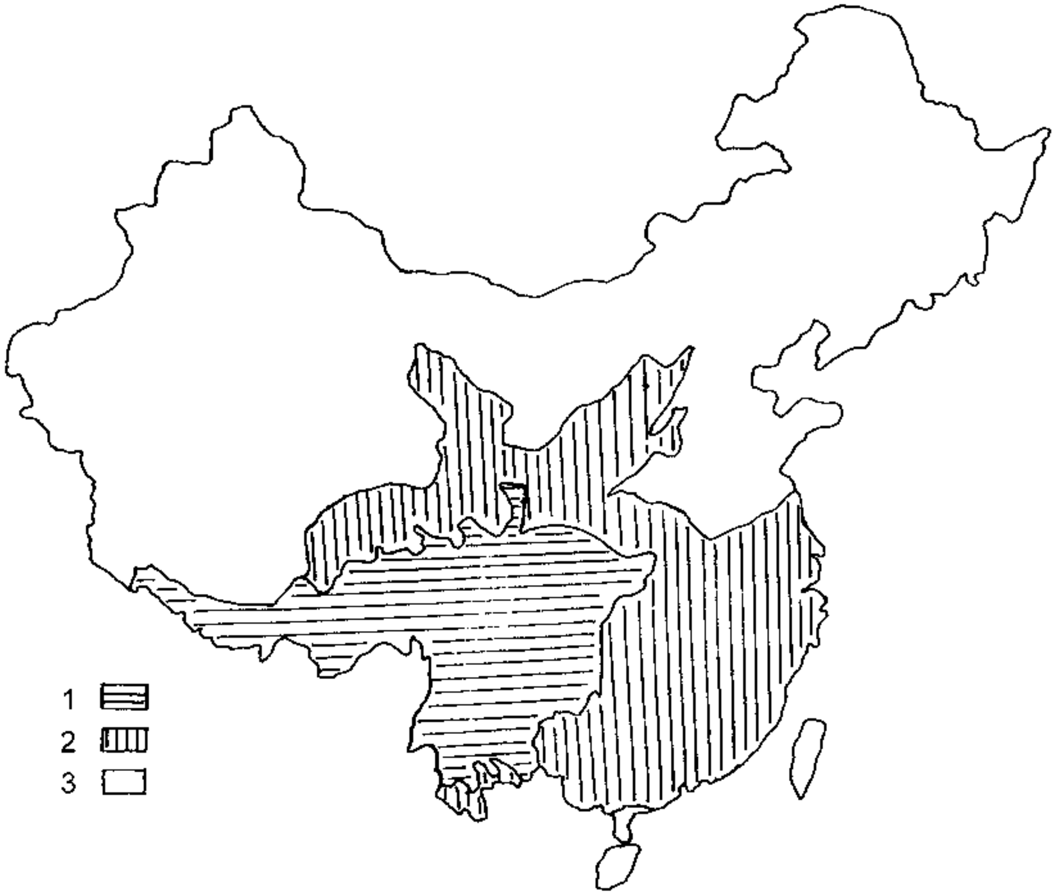

Figure 6. The hotspots for conservation of Chinese partridges and pheasants based on physicogeographical provinces of mainland China. 1, hotspots for conservation; 2, areas of secondary importance for conservation; 3, less rich areas.

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areas. This boundary consists of the three main mountain ranges in the country and is home to many species of pheasants and partridges.

The eastern margin of Qinghai-Tibet plateau and the region connected with Hengduan mountains was not much affected by glaciers, thus forming a shelter for some relicts, such as Giant Panda *Ailuropoda melanoleuca* and Chinese Hazel Grouse *Bonasa sewerzowi* (Cheng *et.al*. 1981). In other words, the forests in this area were preserved and provided available habitats for the local Galliformes.

This subregion has the most varied fauna in China. It is not only a centre of ancient species, but also an area to which more recent species have spread (Zhang 1979). Conservation actions in this region would make a substantial contribution towards ensuring the survival of China's more threatened and unique species of pheasants and partridges.

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