

Biotope of Corsac Fox and Red Fox in Ikh Nart Nature Reserve

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Abstract

Corsac foxes (*Vulpes corsac*) and red foxes (*V. vulpes*) range widely across northern and central Asia, occupying a variety of arid biotopes. In Mongolia, both species live sympatrically throughout most of the country, but few details of their habitat associations exist. We examined the biotope of corsac and red foxes in Ikh Nart Nature Reserve in Dornogobi Aimag, Mongolia, which lies at the confluence of steppe and semi-desert vegetation zones. We evaluated the extent to which both species occur in these two zones and the habitats within them based on locations of scats ($n = 1,967$), opportunistic sightings ($n = 219$), and captures ($n = 35$) collected from August 2004 to August 2007. Corsac and red foxes occurred in both steppe and semi-desert zones and all habitat types in the reserve. However, corsacs occurred more frequently than expected in steppe zone and red foxes occurred more than expected in semi-desert zone. Corsac locations associated positively with steppe habitats, including grass, shrub, and semi-shrub plains, whereas red fox locations fell mainly in drier, more rugged semi-desert habitats, suggesting ecological separation exists between species. As corsac and red foxes appear to be declining in Mongolia, our results suggest that protection efforts in Ikh Nart should focus on steppe habitats for corsacs and semi-desert habitats for red foxes.

Key words: biotope, corsac fox, habitat, red fox, semi-desert, steppe, vegetation, *Vulpes*

Introduction

Corsac foxes and red foxes range widely across northern and central Asia (Heptner & Naumov, 1992; Macdonald & Reynolds, 2004; Poyarkov & Ovsyanikov, 2004). In Mongolia, both species occur sympatrically in many parts of the country and have been described as favoring open expanses of steppe and semi-desert environments (Allen, 1938; Ognev, 1962; Mallon, 1985; Heptner & Naumov, 1992). Descriptions of both species, however, have been based largely on anecdotal reports and hunting records, and few studies have examined their habitat associations or general ecology in Mongolia.

Corsac fox range extends across the steppe, semi-desert, and desert regions of Mongolia (Mallon, 1985; Poyarkov & Ovsyanikov, 2004). However, historic accounts of the species indicate that corsacs occupy mainly open grassland and shrubland steppe environments,

but also semi-deserts in some areas (Ognev, 1962; Heptner & Naumov, 1992). Red foxes, by comparison, purportedly range throughout the entire country, occupying all major vegetation zones from lowland desert regions to high alpine environments (Mallon, 1985; Macdonald & Reynolds, 2004). Although both species appear relatively common, declines in recent years from over-hunting led to both species being listed as IUCN 'near threatened' in Mongolia (Clark *et al.*, 2006).

Here, we describe the biotope of corsac foxes and red foxes in a nature reserve in central Mongolia that lies at the confluence of steppe and semi-desert vegetation zones. The unique biogeography of the region allowed us to examine the extent to which corsac and red foxes occur in both zones and the habitat types within them. Based on previous accounts, we expected corsacs to occur mainly in steppe areas and red foxes to occur equally across both vegetation zones.

Materials and Methods

Study area. We conducted the study in the Ikh Nart Nature Reserve (hereafter Ikh Nart), which is a small protected area located in the northwest region of Dornogobi Aimag (province), Mongolia (N 45.72°; E 108.65°) (Reading *et al.*, 2006). Established in 1996, the reserve protects approximately 666.2 km² and supports one of the largest populations of argali sheep (*Ovis ammon*) in Mongolia (Myagmarsuren, 2000; Reading *et al.*, 2005). Two soums (counties) overlap and jointly manage the reserve: Dalanjargal and Airag. Dalanjargal covers the northern 57% of the reserve and Airag covers the remaining southern region.

Ikh Nart lies at the border of two major vegetation zones in Mongolia, the steppe and semi-desert zones (Murzaev, 1948; Mallon, 1985), and is generally considered part of the ‘Gobi-steppe ecosystem’ (Reading *et al.*, 2006). The steppe zone is characterized by nearly level to gently rolling plains dominated by grasses, semi-shrubs, and shrubs. The semi-desert zone, by comparison, is more rugged, consisting of rocky outcrops and steep drainages, separated by shrublands and open forb-dominated plains. Seven distinct habitat types occur in the region, including 1) low-density shrub (shrubs at density ≤ 100 /ha constitute a majority of plant biomass), 2) high-density shrub (shrubs at density of >100 /ha constitute a majority of plant biomass), 3) semi-shrub (semi-shrubs constitute a majority of plant biomass), 4) forb-grass (forbs and short grasses constitute a majority of plant biomass), 5) tall vegetation (trees and grasses >1 m in mean height constitute greatest plant biomass), 6) dense rock (ground covered by solid rock, vegetation sparse), and 7) water bodies (ponds, pools, and springs with standing water) (Jackson *et al.*, in press). We conducted the study in a 232-km² section of the Dalanjargal part of Ikh Nart that included an area that borders the reserve to the west. We chose the study area because it lies at the distinct confluence of both vegetation zones (31% covered by steppe, 69% covered by semi-desert) and supports a sympatric population of corsac and red foxes (Reading *et al.*, 2006; Murdoch *et al.*, in press).

Biotope. We examined the biotope of corsac and red foxes by collecting locations of fox scats, sightings, and captures from August 2004 to August 2007 in the study area and comparing them between vegetation zones and habitat

types. We collected scats opportunistically while walking the study area regularly (once per week on average) and identified them to species based on descriptions in Heptner & Naumov (1992) and samples from captured animals. We recorded the locations of fox sightings opportunistically and those of animals captured in live-traps (Victor Softcatch 1 & 1.5, Woodstream Corporation, Lititz, Pennsylvania, USA; trapping effort equal in both vegetation zones) as part of a parallel radio-telemetry study.

We examined the associations of locations with vegetation zones. We tested whether locations of each species occurred more frequently than expected by chance in either the steppe or semi-desert zone. We also tested whether differences existed between species in terms of their associations. Differences were evaluated using chi-square tests with Yates’ correction for continuity (Sokal & Rohlf, 2000).

To gain finer-scale perspective, we also evaluated whether locations occurred preferentially in six habitats in the reserve (water bodies excluded). We calculated the availability of each habitat in the study area, determined the proportion of locations that fell in each type, and measured habitat preference as the ratio of locations in each type to availability; values greater than one indicated preference and values less than one indicated avoidance.

Results

We collected 955 corsac fox and 1,266 red fox locations. Corsac fox locations included 906 from scats, 32 from sightings, and 17 from captures (Table 1). Red fox locations included 1,061 from scats, 187 from sightings, and 18 from captures (Table 1). Corsac fox and red fox locations occurred in both vegetation zones (Table 1). However, corsac locations occurred more than expected in steppe zone than in semi-desert zone (72% of locations in steppe; $\chi^2 = 751.8$, *d.f.* = 1, $P < 0.001$; Fig. 1). By contrast, red fox locations occurred more than expected in semi-desert zone than steppe zone (88% of locations in semi-desert; $\chi^2 = 231.7$, *d.f.* = 1, $P < 0.001$; Fig. 1). Significant differences existed between species in terms of their association with vegetation zones with respect to scat locations ($\chi^2 = 723.7$, *d.f.* = 1, $P < 0.001$), sightings ($\chi^2 = 94.7$, *d.f.* = 1, $P < 0.001$), capture sites ($\chi^2 = 17.8$, *d.f.* = 1, $P < 0.001$), and

Table 1. Number of locations of corsac fox (*Vulpes corsac*) and red fox (*V. vulpes*) scats, sightings, and captures by vegetation zone recorded from August 2004 to August 2007 in northern Ikh Nart Nature Reserve, Dornogobi Aimag, Mongolia.

	Steppe zone	Semi-desert zone	Total
Corsac fox			
Scats	647	259	906
Sightings	26	6	32
Captures	15	2	17
Total	688	267	955
Red fox			
Scats	126	935	1,061
Sightings	14	173	187
Captures	2	16	18
Total	142	1,124	1,266

overall (*i.e.*, all locations combined; $\chi^2 = 927.1$, *d.f.* = 1, $P < 0.001$).

Corsac and red fox locations occurred in all habitat types in the study area (Table 2). Relative to availability, corsac fox locations associated positively with semi-shrub, tall vegetation, and high-density shrub habitat types and negatively with low-density shrub, forb-short grass, and dense rock types (Table 2). Red fox locations, by comparison, associated positively with tall vegetation, dense rock, and forb-short grass habitat types and negatively with semi-shrub, high-density shrub, and low-density shrub habitat types (Table 2).

Discussion

Corsac foxes and red foxes occur widely throughout northern Asia (Ognev, 1962; Mallon, 1985; Heptner & Naumov, 1992; Macdonald & Reynolds, 2004; Poyarkov & Ovsyanikov, 2004). In Mongolia, previous accounts noted that both species range sympatrically across most steppe and semi-desert biotopes of the country (Allen, 1938; Ognev, 1962; Mallon, 1985; Heptner & Naumov, 1992). In Ikh Nart Nature Reserve, our results support these assertions, finding that corsac

and red fox occur in both steppe and semi-desert vegetation zones and all major habitat types in the area. However, we found that some ecological separation exists between the species, with corsacs favoring steppe habitats and red foxes selecting drier, more rugged semi-desert terrain.

The biotope of corsac foxes in Ikh Nart is characterized mainly by open, level to gently rolling steppe plains. Vegetation in these areas consists largely of short grasses such as feathergrasses (*Stipa* spp.), turfy semi-shrubs like *Reaumuria* spp. and *Salsola* spp., and shrubs including the peashrub (*Caragana pygmaea*) that usually occurs in dense patches. Open steppe plains in Ikh Nart also contain shallow draws and drainages with sandy bottoms often lined by swaths of tall grasses, including needlegrass (*Achnatherum splendens*). Draws and drainages usually remain dry throughout the year, but may temporarily flood during periods of heavy rain in summer.

In Ikh Nart, the biotope of the corsac fox is generally consistent with previous descriptions of the species (Ognev, 1962; Sidorov & Botvinkin, 1987; Heptner & Naumov, 1992). In other parts of Mongolia, for example, historic accounts suggested that corsac foxes typically inhabit

Table 2. Habitat preference of corsac fox (*Vulpes corsac*) and red fox (*V. vulpes*) based on locations of scats, sightings, and capture sites in northern Ikh Nart Nature Reserve, Dornogobi Aimag, Mongolia from August 2004 to August 2007. Preference measured as the ratio of locations per habitat type to habitat availability (% of area); values greater than one indicate preference and values less than one indicate avoidance. Availability of habitat types in steppe followed by semi-desert vegetation zones given in parentheses.

Habitat type	Availability (%)	Percent of locations		Preference ratio	
		Corsac fox	Red fox	Corsac fox	Red fox
Low-density shrub	27.8 (3.1, 38.6)	11.0	14.8	0.40	0.53
High-density shrub	14.6 (42.6, 2.2)	25.3	7.0	1.73	0.48
Semi-shrub	11.2 (35.0, 0.6)	28.6	2.0	2.55	0.18
Forb-short grass	26.3 (5.2, 35.6)	11.2	33.5	0.43	1.27
Tall vegetation	5.6 (13.8, 2.0)	13.9	13.0	2.48	2.32
Dense rock	14.5 (0.1, 21.1)	9.9	29.7	0.68	2.05

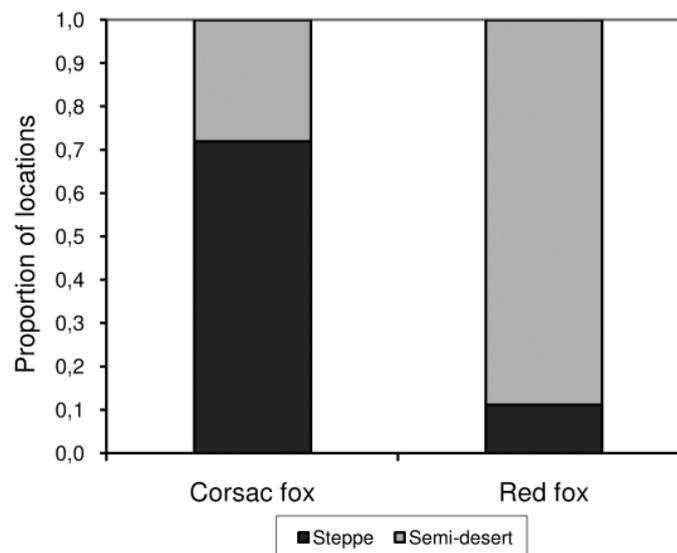


Figure 1. Proportion of corsac fox (*Vulpes corsac*) and red fox (*V. vulpes*) locations (scats, sightings, and trap sites) in steppe and semi-desert vegetation zones in northern Ikh Nart Nature Reserve, Dornogobi Aimag, Mongolia. Locations collected from August 2004 to August 2007.

slightly undulating dry steppes with small, shallow valleys covered by grasses and shrubs, and avoid mountainous relief with cliffs and rock slides (Heptner & Naumov, 1992). Other accounts also suggested that corsacs favor open grass and shrub steppe in the former Soviet Union (outside of Mongolia) (Ognev, 1962; Sidorov & Botvinkin, 1987; Heptner & Naumov, 1992). We did, however, record the presence of corsac foxes in semi-desert regions of Ikh Nart, suggesting that the species can exploit such habitats.

Red foxes, by comparison, ranged mainly in semi-desert habitats. In Ikh Nart, these areas are generally more rugged and consist of rocky outcrops and scree slopes; steep, sandy-bottom drainages where some of the only tree stands (Siberian elm: *Ulmus pumila*, willow: *Salix ledebouriana*) in the reserve occur; and flat, open forb-dominated (*Allium* spp.) expanses. We frequently recorded red foxes in drainages surrounded by rocky outcrops. Drainages contain most of the known freshwater springs that flow year-round in the study area. They also cross through different habitat types and may act as important habitat corridors for some species like tolai hare (*Lepus tolai*).

The red fox has the widest geographical distribution of any member of the order Carnivora, covering nearly 70 million km² (Macdonald & Reynolds, 2004). In northern and central Asia, the species occurs in a variety of biotopes, including both steppe and semi-desert areas, where the

species prefers open and semi-open expanses (Allen, 1938; Ognev, 1962; Heptner & Naumov, 1992; Schaller, 1998). In Mongolia, the red fox lives in all major vegetation zones, including alpine, taiga, forest-steppe, steppe, semi-desert, and desert zones (Mallon, 1985), and represents one of the widest ranging carnivores in the country. Based on previous accounts, we expected red foxes to occupy both steppe and semi-desert zones in relatively equal proportions. Although we recorded the species in both zones, the biotope of the red fox in Ikh Nart is characterized mainly by semi-desert habitats.

Biotope differences between corsac and red foxes may be attributed to several factors including the distribution of food resources. In Ikh Nart, corsac and red foxes share similar foods, including insects, small mammals, reptiles, birds, carrion, and plant material (fruits and seeds), but differ in the specific food items they eat throughout most of the year (Murdoch *et al.*, in prep.). As the availability of prey resources differs between habitats in the reserve, the distribution and abundance of key food items probably determines fox distribution to some extent. Similarly, water resources may affect distribution patterns. Corsac foxes are generally considered 'arid land' foxes and as such are probably able to obtain all of their water from food and do not require free standing water. Red foxes, by comparison, appear less arid-adapted and require free water, which might explain their greater affinity for semi-desert

habitats that contain some of the only sources of permanent water in the region. Water availability appears to be a limiting factor in the distribution of red foxes in North America (Cypher, 2003).

The distribution of other habitat resources may also explain biotope differences. Some steppe habitats, for example, support large marmot colonies (>100 burrows). Corsac foxes use marmot burrows regularly in Ikh Nart and other parts of their range for daytime shelter, as escape refuge from predators, and for whelping and pup rearing (Heptner & Naumov, 1992). Steppe habitats may provide better habitat for corsacs because of greater burrow availability. Rocky, semi-desert areas, by comparison, offer other landscape features that could provide other important habitat features, including greater topographic relief. Rocky areas are also hunted less by herders compared with steppe areas.

Competitive pressure may also partly explain differences in the biotopes of both fox species. Red foxes (ca. 4.5 kg) are larger than corsac foxes (ca. 2.5 kg) and reportedly kill and competitively exclude them in other steppe and semi-desert areas (Heptner & Naumov, 1992). In Kazakhstan, for example, accounts related a decrease in corsac fox numbers to the rapid growth of the red fox population (Heptner & Naumov, 1992). In Ikh Nart, other habitat use studies suggest that red foxes compete with corsacs and may exclude them from some semi-desert habitats (Murdoch *et al.*, in prep.). Other carnivores including wolf (*Canis lupus*), lynx (*Lynx lynx*), badger (*Meles meles*), Pallas' cat (*Otocolobus manul*), and marbled polecat (*Vormela peregusna*) also occur in the reserve (Murdoch *et al.*, in press) and reportedly compete to some extent with foxes in other regions (Heptner & Naumov, 1992). Wolves, in particular, have been reported to kill corsac and red foxes regularly in some areas and use similar food and habitat resources (Heptner & Naumov, 1992). In Ikh Nart, wolves range widely and their distribution probably represents an important factor that shapes the biotopes of both fox species.

Conservationists believe that corsac and red foxes are declining in Mongolia, mainly due to over-hunting and illegal poaching (Clark *et al.*, 2006; Wingard & Zahler, 2006). Although once considered ubiquitous, declines in recent years resulted in the listing of both species as IUCN 'near threatened' in the 2006 Mongolian Red List

of Mammals (Clark *et al.*, 2006). In Ikh Nart, fox hunting occurs regularly in winter, even though Mongolian law prohibits all forms of hunting in protected areas (Wingard & Odgerel, 2001). Populations appear to be declining in the reserve, despite recent efforts to limit illegal poaching, indicating that more aggressive management strategies will need to be developed, if protecting both species remains a priority of reserve administrators. Our results suggest that efforts to protect corsacs should focus largely on steppe habitats and those to protect red foxes should focus on semi-desert habitats.

Acknowledgements

We thank the Denver Zoological Foundation, Rufford Foundation, Trust for Mutual Understanding, and Earthwatch Institute supporting our project. We are also grateful to the Mongolian Academy of Sciences, Institute of Biology and the assistance of S. Amgalanbaatar, G. Otgonbayar, Dandarbaatar, B. Mandakh, D. Jackson, E. Tuguldur, D. Kenny, A. DeNicola and Earthwatch volunteers. We conducted the project under permit #3/451 from the Mongolian Academy of Sciences.

References

- Allen, G. M. 1938. *The Mammals of China and Mongolia*. Vol. XI, Part 1. American Museum of Natural History, New York.
- Clark, E. L., Munkhbat, J., Dulamtseren, S., Baillie, J. E. M., Batsaikhan, N., Samiya, R. & Stubbe, M. 2006. *Mongolian Red List of Mammals*. Regional Red List Series Vol. 1, Zoological Society of London, London.
- Cypher, B. L. 2003. Foxes (*Vulpes* species, *Urocyon* species, and *Alopex lagopus*). In: *Wild Mammals of North America Biology, Management, and Conservation*. (Ed. by G. A. Feldhamer, B. C. Thompson, and J. A. Chapman.). Johns Hopkins University Press, Baltimore, Maryland.
- Heptner, V. G. & Naumov, N. P. 1992. *Mammals of the Soviet Union*. E. J. Brill, New York.
- Macdonald, D. W. & Reynolds, J. C. 2004. Red fox *Vulpes vulpes*. In: *Canids: Foxes, Wolves, Jackals and Dogs. Status Survey and Conservation Action Plan*. (Ed. by C. Sillero-Zubiri & D. W. Macdonald), pp. 129-136.

- IUCN/SSC Canid Specialist Group, Gland, Switzerland.
- Mallon, D. P. 1985. The mammals of the Mongolian People's Republic. *Mammal Review* 15: 71-102.
- Murzaev, E. M. 1948. *The MPR: A Physio-geographical Description*. Academy of Sciences, Moscow, USSR. (in Russian)
- Myagmarsuren, D. 2000. *Special Protected Areas of Mongolia*. Mongolian Environmental Protection Agency and GTZ (German Technical Advisory Agency), Ulaanbaatar, Mongolia.
- Ognev, S. I. 1962. *Mammals of Eastern Europe and Northern Asia*. Vol. 2, Carnivora (Fissipedia). Israel Program for Scientific Translations, Jerusalem, Israel.
- Poyarkov, A. & Ovsyanikov, N. 2004. Corsac *Vulpes corsac*. In: *Canids: Foxes, Wolves, Jackals and Dogs. Status Survey and Conservation Action Plan*. (Ed. by C. Sillero-Zubiri & D.W. Macdonald), pp. 142-148. IUCN/SSC Canid Specialist Group, Gland, Switzerland.
- Reading, R., Kenny, D., Wingard, G., Mandakh, B. & Steinhauer-Burkart, B. 2006. *Ikh Nart Nature Reserve*. ECO Nature Edition, Ulaanbaatar, Mongolia.
- Reading, R. P., Amgalanbaatar, S., Wingard, G. J., Kenny, D. & Denicola, A. 2005. Ecology of Argali in Ikh Nartiin Chuluu, Dornogobi Aimag. *Erforschung Biologischer Ressourcen der Mongolei (Halle/Saale)* 9: 77-89.
- Schaller, G. B. 1998. *Wildlife of the Tibetan Steppe*. University of Chicago Press, Chicago, Illinois.
- Sidorov, G. N. & Botvinkin, A. D. 1987. The corsac fox (*Vulpes corsac*) in southern Siberia. *Zoologicheskii Zhurnal* 66: 914-927. (in Russian)
- Sokal, R. R. & Rohlf, F. J. 2000. *Biometry The Principles and Practice of Statistics in Biological Research*. Third edition. W.H. Freeman, New York.
- Wingard, J. R. & Odgerel, P. 2001. *Compendium of Environmental Law and Practice in Mongolia*. GTZ, Ulaanbaatar, Mongolia.
- Wingard, J. R. & Zahler, P. 2006. Silent steppe: the illegal wildlife trade crisis in Mongolia. *Mongolia Discussion Papers, East Asia and Pacific Environment and Social Development Department*. World Bank, Washington, D.C.

Хураангуй

Хярс (*Vulpes corsac*) ба шар үнэг (*V. vulpes*) нь Төв ба Хойд Азийн хуурайсаг биотопд өргөн тархсан зүйлүүд юм. Монгол орны газар нутгийн ихэнх хэсэгт эдгээр зүйлүүд симпатрик байдлаар тохиолдох боловч тэдгээрийн амьдрах орчны талаархи нарийвчилсан судалгааны мэдээ хомс байдаг. Бид хээр ба заримдаг цөлийн шинжийг хадгалсан, Дорноговь аймгийн нутагт байрлах Их Нартын Байгалийн Цогцолбор Газарт хярс ба үнэгний биотопын тархалт байршилтыг судлав. Энэ 2 зүйлийн хээр ба заримдаг цөлийн бүсэд тархсан байдал, амьдрах орчин зэргийг тэдгээрийн ялгадасны байрлал ($n = 1967$), бодит тохиолдоц ($n = 219$) ба барих ($n = 35$) аргаар 2004 оны 8-р сараас 2008 оны 8-р сарын хооронд судалж тодорхойлсон бөгөөд энэхүү 2 зүйл нь хээр болон заримдаг цөлийн бүсийн амьдралын бүх орчинд тохиолдож байв. Гэвч хярс нь хээрийн бүсэд илүү тохиолдоцтой байсан бол үнэг заримдаг цөлийн бүсэд илүү тохиолдож байв. Хярс нь өвслөг, сөөг ба сөөглөг ургамал бүхий хээрт тархсан байдаг бол үнэг нь харьцангуй хуурайсаг, заримдаг цөлд байрладаг ба энэ нь уг 2 зүйлийн хооронд экологийн буюу амьдрах орчны тусгаарлал буй болохыг илэрхийлж байна. Энэ 2 зүйлийн аль аль нь Монгол орны хэмжээнд ховордож байгаа бөгөөд бидний судалгаагаар Их Нартын Байгалийн Цогцолбор Газарт хярсныг хамгаалахын тулд хээрийн бүсийн амьдрах орчныг, үнэгийг хамгаалахын тулд заримдаг цөлийн амьдрах орчныг хамгаалах шаардлагатай болох нь тогтоогдов.

Received: 21 January 2008

Accepted: 18 March 2008