

## *Vulpes corsac* (Carnivora: Canidae)

HOWARD O. CLARK, JR., JAMES D. MURDOCH, DARREN P. NEWMAN, AND CLAUDIO SILLERO-ZUBIRI

H. T. Harvey & Associates, 7815 North Palm Avenue, Suite 310, Fresno, CA 93711, USA; hclark@harveyecology.com (HOC, DPN)

Wildlife Conservation Research Unit, University of Oxford, Tubney House, Abingdon Road, Tubney, Abingdon OX13 5QL, United Kingdom (JDM, CSZ)

**Abstract:** *Vulpes corsac* (Linnaeus, 1768) is a canid commonly called the corsac fox or steppe fox. It is distributed throughout nearly all of the central Asian republics of Turkmenistan, Uzbekistan, and Kazakhstan and its range extends into portions of Afghanistan, Iran, Tajikistan, Kyrgyzstan, Russia, Mongolia, and China. It is adapted to arid conditions and can forego food and water for extended periods of time. Cortex and medulla features of its fur allow it to endure cold, harsh winter conditions but it is not adapted for walking on snow. It typically inhabits grassland steppes, semideserts, and deserts and will frequent agricultural lands and plowed fields in some areas. It is an opportunistic forager and hunter that is considered a species of Least Concern from a conservation standpoint. DOI: 10.1644/832.1.

**Key words:** arid, Asia, canid, carnivore, corsac fox, foxes, fur bearer, sand fox, steppe fox, steppes

Published 27 May 2009 by the American Society of Mammalogists  
Synonymy completed 20 June 2008

[www.mammalogy.org](http://www.mammalogy.org)



### *Vulpes corsac* (Linnaeus, 1768) Corsac Fox

*Canis corsac* Linnaeus, 1768:223. Type locality “in campis magi deserti ab Jaco fluvio versus Irtim,” USSR northern Kazakhstan, steppes between Ural and Irtysh rivers, now in Kazakhstan; further specified as “near Petropavlovsk” for *Vulpes corsac corsac* by Ognev (1935:634).

*Vulpes nigra* Kastschenko, 1912:393. Preoccupied by *Canis vulpes nigra* Borkhausen, 1797.

*Vulpes corsac corsac* Ognev, 1935:634. Incorrect subsequent spelling of *Canis corsac* Linnaeus, 1768.

*Vulpes corsac skorodumovi* Dorogostaiski, 1935:47. Type locality “южного Забайкалья,” southern Transbaikalia; synonym of *V. corsac* (Wozencraft 2005:584).

CONTEXT AND CONTENT. Order Carnivora, suborder Caniformia, family Canidae. *Vulpes corsac* has 3 subspecies (Wozencraft 2005):

*V. c. corsac* (Linnaeus, 1768:223). See above.

*V. c. kalmykorum* Ognev, 1935:634. Type locality “Калмыцко-приуральская степь” = Steppe Kalmytsko-priuralskaja [Kalmuck steppes near the Ural]; further specified as “steppes at the right bank of Lower Volga River” by Heptner et al. (1967:273).

*V. c. turkmenicus* Ognev, 1935:635. Type locality “Туркменские и таджикские пустыни и полупустыни”

= Turkmen [Turkmenian] and Tadjik [Tadzhik] deserts and semideserts; restricted to “the region of Murghab and Tedjen rivers and planes at eastern Kopet Dagh foothills (east of Ashghabad)” by Heptner et al. (1967:273).

NOMENCLATORIAL NOTES. Vernacular names for *Vulpes corsac* include steppe fox, sand fox, korsak or korsak fox,



**Fig. 1.**—Adult *Vulpes corsac*, Xinjiang Province of the People’s Republic of China. Photograph by X. Eichaker, used with permission.

korsac fox, korssuk fox, tartar fox, and steppenfuchs. *Vulpes* is Latin for fox. The specific epithet *corsac* is from the Russian *corsack* and Turkic *karsak* meaning steppe fox (Room 2002). Based on morphometrics, Bliznyuk (1994) recognized 2 subspecies, *V. c. corsac* and *V. c. turkmenicus*; previously 3 or 4 subspecies were recognized (Heptner et al. 1967).

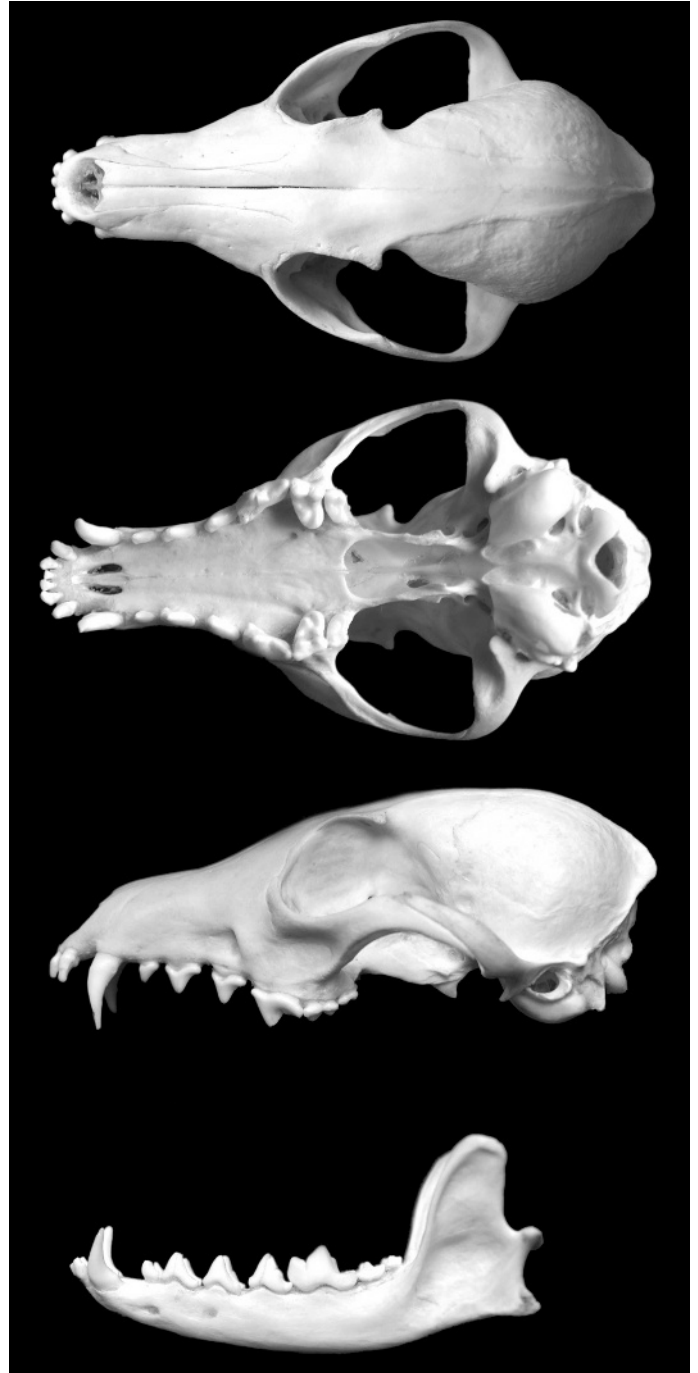
### DIAGNOSIS

*Vulpes corsac* (Fig. 1) differs in body size from congeners with which it is sympatric in parts of its range. *V. corsac* may reach the body mass of the smallest *V. vulpes*, but generally *V. corsac* is much smaller (*V. vulpes* body mass = 3–14 kg—Larivière and Pasitschniak-Arts 1996); *V. corsac* also is slightly smaller than *V. ferrilata* (*V. ferrilata* = 4–6 kg—Cai 1989) but twice as large as *V. cana* (*V. cana* = 1 kg—Geffen 1994). *V. corsac* has a dark, often black-tipped, tail and light yellow forelegs that distinguish it from *V. vulpes*, which has a white-tipped tail and dark brown or black forelegs (Poyarkov and Ovsyanikov 2004a). *V. corsac* lacks the blotchy black, brownish gray, and white pelage and dark markings under the eye that typify *V. cana*, and the dark stripes on both sides of the neck and white-tipped tail of *V. ferrilata* (Geffen 1994). *V. corsac* is distinguished from *V. bengalensis* by the pelage on the ears: ears of *V. corsac* are banded brown on their front side and ochre-gray or reddish brown on their backs, whereas the backs of the ears of *V. bengalensis* are light sandy-gray in color (Poyarkov and Ovsyanikov 2004a). *V. corsac* differs from *V. rueppellii*, which has lighter tan, agouti pelage, a dark patch between the nose and eyes, a longer tail with dark guard hairs and a white tip, backs of broad ears and head of light gray color, and legs without black markings (Larivière and Seddon 2001).

Total length of skull of *V. corsac* (Fig. 2) is less than that of *V. vulpes* (*V. vulpes* = 140–150 mm—Larivière and Pasitschniak-Arts 1996). *V. corsac* has a less-developed and lower sagittal crest, a more gradually tapering rostrum, and smaller, flatter auditory bullae than does *V. vulpes* (Sheldon 1992).

### GENERAL CHARACTERS

Pelage on the head of *Vulpes corsac* is generally grayish ochre or brown, and darker on the forehead with a white or pale yellowish tint around mouth, throat, and lower neck. Ears are banded brown on their fronts and are ochre-gray or reddish brown on their backs. Ventrally, pelage on the torso is slightly yellowish and the abdominal region is never black (Novikov 1956). Forelegs are light yellow anteriorly and rusty yellow laterally. Hind legs are paler than forelegs, but similarly colored. Winter pelage is dense, silky and soft, of a straw-gray with ochre color and a middorsal brown line, and the guard hair tips are a silvery white (Poyarkov and Ovsyanikov 2004a).



**Fig. 2.**—Dorsal, ventral, and lateral views of skull and lateral view of mandible of an adult (>1 year of age) *Vulpes corsac* of unknown sex collected in Ikh Nartiin Chuluu Nature Reserve, Dalanjargal soum, Dornogobi aimag (45.723°N, 108.645°E) by J. Murdoch. Maximum length of skull is 116 mm; maximum width is 67 mm. Skull deposited in the mammal collection, Natural History Museum of Mongolia, Ulaanbaatar, Mongolia. Photograph by L. Distelhorst and J. Murdoch, National University of Mongolia, used with permission.

The tail is covered with dense fluffy hairs of dark ochre or gray-brown. Dorsally, the tail is black with a dark spot about 6–7 cm from the base in the region of the supracaudal gland. Ventrally, tail pelage varies from ash-gray to brownish or slightly rusty (Poyarkov and Ovsyanikov 2004a). Males and females are similarly colored (Heptner et al. 1998).

Body measurements from multiple sets of data (ranges; mm) of 10 female and 31 male *V. corsac*, respectively, are: total length, 450–500, 450–650 (Ognev 1935; Poyarkov and Ovsyanikov 2004a); height at the shoulder, 300–350 (sexes combined—Allen 1938; Heptner et al. 1998); length of tail, 250–300, 190–350 (Novikov 1956; Poyarkov and Ovsyanikov 2004a); length of ear, 60–75, 50–75 (Poyarkov and Ovsyanikov 2004a); body mass (kg), 1.9–2.6, 1.6–3.2 (Poyarkov and Ovsyanikov 2004a).

Selected cranial measurements (ranges; mm) for 6 individuals (sexes combined) are: overall length of skull, 103–111; condylobasal length, 98–118; basilar length, 96–113; width of zygomatic, 57–71; maximum width of braincase, 49–50; length of nasals, 36–42; length of rostrum, 46–52; height in region of osseous bullae, 39–46; length of upper toothrow, 48–55 (Allen 1938; Heptner et al. 1998; Ognev 1931). Teeth are small and weakly developed; the upper 1st molar is much reduced in size compared to that of other foxes (Sheldon 1992).

## DISTRIBUTION

*Vulpes corsac* is distributed over nearly all of the central Asian republics of Turkmenistan, Uzbekistan, and Kazakhstan (Fig. 3). Its range extends southward into north-central Afghanistan, northeast Iran, western Tajikistan, and northern Kyrgyzstan. Northern limits to its distribution are in Russia, specifically Caucasia and the Samara region, including Tatarstan, in southern portions of western Siberia, and in southern Transbaikalia, and northern Mongolia, and China. In China, the distribution of *V. corsac* extends into Manchuria, Inner Mongolia (between Argun and Big Khingan), Mongolia, Dzungaria, and Kashgaria (Heptner et al. 1998; Mallon 1985; Sidorov and Botvinkin 1987). The western limit of its distribution includes the Voronezh region of Russia (Poyarkov and Ovsyanikov 2004a).

## FOSSIL RECORD

During the early Pleistocene, an ancestral species *Vulpes praecorsac* occurred in Austria and Hungary (Poyarkov and Ovsyanikov 2004a). The oldest record of *V. corsac* is from the middle Pleistocene of China (Kurtén 1968). By the late Pleistocene, *V. corsac* occurred from Switzerland to northern China and in the Urals, Russia (Kosintsev 2007). Specimens of *V. corsac* have been reported from the Middle Palaeolithic Prolo姆 II cave, Crimean Peninsula, Ukraine (Enloe et al. 2000; Stepanchuk 1993). A few records in the Ukraine show

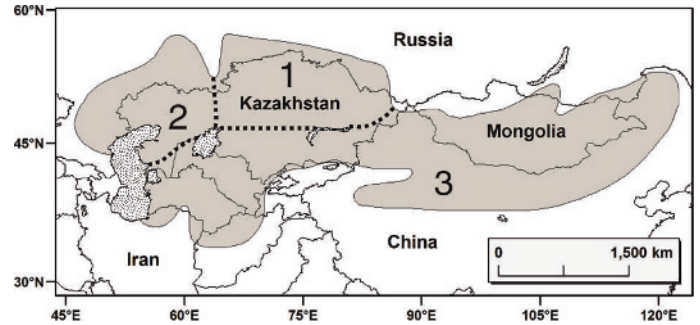


Fig. 3.—Geographic distribution of the *Vulpes corsac*. The dashed lines define the distribution boundary between 1, *V. c. corsac*, 2, *V. c. kalmykorum*, and 3, *V. c. turkmenicus*. Map adapted from Poyarkov and Ovsyanikov (2004a) and Heptner et al. (1998).

that *V. corsac* occurred in the Crimean in the Pleni-Glacial (75,000–15,000 BC) and the Late-Glacial period (15,000–9,500 BC—Sommer and Benecke 2005). Subfossil remains have been found in the Sub-Boreal (3,000–1,000 BC) in the Crimean and the Sub-Boreal to the Sub-Atlantic (0–1,500 BC) in the Denez River basin, northern Black Sea region (Sommer and Benecke 2005).

## FORM AND FUNCTION

*Vulpes corsac* is adapted to arid conditions and can forego food and water for extended periods of time (Poyarkov and Ovsyanikov 2004a). In desert steppe regions, *V. corsac* is often attracted to water pools by prey, from which it is able to obtain sufficient water (Poyarkov and Ovsyanikov 2004a).

The fur of *V. corsac* allows it to endure cold weather and harsh winter conditions that are characteristic of many parts of its range. Maximum diameter of the multiple pores of the cortex and medulla of hairs does not exceed 2.0  $\mu\text{m}$  in *V. corsac*, but varies seasonally. This characteristic enhances the thermal insulation capacity of their pelage, as it does in cold-adapted *V. ferrilata* and *V. lagopus* (Chernova 2003). *V. corsac* molts in spring and fall, completely replacing winter pelage in spring (Heptner et al. 1998).

*Vulpes corsac* is not adapted for walking on snow. Specific weight pressure is high despite its small body mass: 68–80  $\text{g}/\text{cm}^2$ . *V. vulpes* in similar snowy regions has a specific weight pressure of 27–30  $\text{g}/\text{cm}^2$  (Heptner et al. 1998).

*Vulpes corsac* has well-developed visual, olfactory, and auditory senses (Heptner et al. 1998; Nowak 1999). Measurements of the cornea of *V. corsac* (means;  $\mu\text{m}$ ) are within the ranges typical of other carnivores (Merindano et al. 2002): maximum diameter of the central cornea of *V. corsac* = 820, the thickness of the central corneal epithelium = 46, and of the Descemet's membrane = 9. Bowman's layer is absent, as in all carnivores (Merindano et al. 2002).

The tip of the upper canine reaches the lower edge of the mandibular bone, and apex of lower canine extends beyond

the edge of the alveolus of the upper canine when the jaws are closed. There can be either 2 or 3 lower molars and the characteristic reduction in size of m2 is variable among individuals. Dental formula is  $i\ 3/3, c\ 1/1, p\ 4/4, m\ 2/2-3$ , total 40–42 (Heptner et al. 1998; Poyarkov and Ovsyanikov 2004a).

*Vulpes corsac* has a well-developed hepatoid, supracaudal scent gland at base of the tail. It is surrounded by and penetrated by erector pili muscles, contraction of which extrudes a lipoprotein secretion onto the skin surface. The glandular layer of the scent gland exhibits large secretory cisterns (Shabadash and Zelikina 2004). Secretions can produce pungent odors (Shabadash and Zelikina 2002) but they are less strong than those of most *Vulpes* (Nowak 1999). *V. corsac* also possesses anal, digital, and cheek glands (Macdonald 1985).

The relative masses of cervical:thoracic:lumbar vertebrae in *V. corsac* are 1.26:1:1.48. An analysis of the functional significance of spinal column mass ratios by Heráñ (1996) suggests that *V. corsac* has the most compact neck compared to the other 10 canids analyzed (other foxes analyzed include *V. vulpes*, *V. zerda*, and *Otocyon megalotis*).

## ONTOGENY AND REPRODUCTION

Mating takes place from January to March throughout most of the range of *Vulpes corsac*. Estrus generally occurs in January or February (Novikov 1956) and gestation is 52–60 days (Kadyrbaev and Sludskii 1981; Novikov 1956). Earliest births are in mid-March, but most occur in April (Poyarkov and Ovsyanikov 2004a). There is 1 litter per year (Ognev 1931) with 5 or 6 young (range = 2–10;  $n = 100$ —Heptner et al. 1998; Novikov 1956). Disease, predation, and ants are causes of juvenile mortality within the den (Heptner et al. 1998). Fertility of *V. corsac* may increase with increased food availability, because larger litters are often associated with periods of food abundance (Heptner et al. 1998).

Newborn of *V. corsac* weigh 60–65 g, are 130–140 mm long, and are covered with light brown, fluffy pelage (Poyarkov and Ovsyanikov 2004a). Their tail, unlike that of adults, is monocolored and general coloration of fur becomes more yellow with age (Heptner et al. 1998). Young are born blind and with closed auditory meatuses. Eyes open at 14–16 days of age. At 28 days, pups are able to eat meat (Poyarkov and Ovsyanikov 2004a). Juveniles emerge from dens in mid-May. Young grow rapidly, reach adult size in 4 months, and become sexually mature in 9 months (Poyarkov and Ovsyanikov 2004a). Adults can live up to 9 years (Sidorov and Botvinkin 1987).

## ECOLOGY

*Vulpes corsac* typically inhabits grassland steppes, semideserts, and deserts in south-central Asia. It frequents

agricultural lands and plowed fields in some areas and typically avoids mountains, dense brush, woodlands, and dense grasslands (Heptner et al. 1998). *V. corsac* avoids snow depths that exceed 150 mm, preferring highly compressed or shallow snow often tamped by migratory herds of ungulates (Poyarkov and Ovsyanikov 2004a).

*Vulpes corsac* is an opportunistic forager and hunter. Prey species vary throughout the range of the species, but a majority of the diet consists of small and medium-sized vertebrates and insects. Narrow-skulled voles (*Microtus gregalis*) and steppe voles (*Lagurus lagurus*) are taken by *V. corsac* in the northern part of its range, and in other regions, it consumes gerbils (*Meriones* and *Rhombomys opimus*—Rogovin et al. 2004), jerboas (*Allactaga* and *Dipus*), hamsters (*Cricetulus* and *Phodopus*), voles (*Alticola*, *Lasiopodomys*, and *Microtus*), and long-tailed ground squirrels (*Spermophilus undulatus*—Rícanokova et al. 2006). Pika (*Ochotona*) and larger prey such as hares (*Lepus*) and marmots (*Marmota*) are taken opportunistically (Heptner et al. 1998).

When prey is scarce, particularly during winter, *V. corsac* will scavenge remains of wolf (*Canis lupus*) kills and carcasses of wild and domestic ungulates (e.g., *Bos*). *V. corsac* has been identified as the principle terrestrial predator of the Macqueen's bustard (*Chlamydotis macqueenii*) in parts of China (Combreau et al. 2002; Yang et al. 2003). Trash and refuse also are consumed where *V. corsac* lives near humans. Occasionally, it also eats small amounts of vegetation (Heptner et al. 1998); however, consumption of fruit appears to be an important source of energy and nutrition, the most commonly consumed species being *Allium polyrhizum*, *Asparagus gobicus*, and *Tribulus terrestris* (Murdoch et al. 2009).

Early accounts suggest that *V. corsac* in the northern parts of its distribution migrates southward when winter approaches (Allen 1938). Distances traversed during migration events range from 50 to 600 km (Heptner et al. 1998). *V. corsac* also has been reported to move from forest-steppes to arid steppe environments and semideserts in response to low rodent availability due to heavy snow cover (Heptner et al. 1998). Depth of snow cover is a factor that limits movement of *V. corsac* in some areas (Borovik 2002). In other parts of its range, *V. corsac* may follow migrating herds of ungulates such as steppe saiga (*Saiga tatarica*) and gazelle (*Gazella subgutturosa* and *Procapra gutturosa*—Heptner et al. 1998). Herds compact the snow, facilitating rodent excavation and food access for *V. corsac* (Heptner et al. 1998). *V. corsac* may also move toward areas of rodent population irruptions, particularly those of Brandt's voles (*Lasiopodomys brandtii*—Heptner et al. 1998).

Wolves, red foxes, and feral dogs (*C. l. familiaris*) kill *V. corsac* (Heptner et al. 1998). Predation by wolves is greatest during times of high snowfall (Heptner et al. 1998). During the summer, *V. vulpes* displaces *V. corsac* from burrows and kills the young (Heptner et al. 1998). *V. corsac* also is prey of the golden eagle (*Aquila chrysaetos*), imperial eagle (*A.*

*heliaca*—Katzner et al. 2006), tawny eagle (*A. rapax*), upland buzzard (*Buteo hemilasius*), eagle owl (*Bubo bubo*), and snowy owl (*Nyctea scandiaca*—Heptner et al. 1998). *V. corsac* remains also have been found at cinereus vulture (*Aegypius monachus*) roosts (Heptner et al. 1998).

Several species potentially compete with *V. corsac*. These include wolves and red foxes, particularly during winter when food is scarce (Heptner et al. 1998), Eurasian badger (*Meles meles*), mountain weasel (*Mustela altaica*), ermine (*M. erminea*), steppe polecat (*M. eversmannii*), least weasel (*M. nivalis*), Siberian weasel (*M. sibirica*), Pallas's cat (*Felis manul*), and marbled polecat (*Vormela peregusna*—Heptner et al. 1998). Avian competitors include saker falcon (*Falco cherrug*), pallid harrier (*Circus macrourus*), northern harrier (*C. cyaneus*), steppe eagle (*Aquila nipalensis*), rough-legged hawk (*Buteo lagopus*), long-legged buzzard (*B. rufinus*), and upland buzzard (Heptner et al. 1998). Mortality due to starvation increases within populations of *V. corsac* during long winter storms and blizzards (Heptner et al. 1998).

*Vulpes corsac* hosts the parasitic nematodes *Trichinella pseudospiralis* (Pozio et al. 1992) and *T. nativa* (Pozio 2000, 2001), and helminthes *Echinococcus multilocularis* and *E. sibiricensis* (the causative agent of alveolar *Echinococcus*—Tang et al. 2004), *Macracanthorhynchus catulinus*, *Mesocestoides lineatus*, and *Isopoda buriatica* (Poyarkov and Ovsyanikov 2004a). In northern Kazakhstan, Irtysh Territory, the prevalence of *Trichinella nativa* infection in *V. corsac* is attributed to the use of fox carcasses as fox bait and the improper disposal of carcass remains, practices that expose other foxes to infection (Murrella and Pozio 2000). *V. corsac* is a natural reservoir of the parasitic protozoan *Leishmania donovani* (the causative agent of visceral leishmaniasis—El-naïem et al. 2001) and is the intermediate host of the protozoan *Sarcocystis corsaci* (Levine 1986). When fed flesh infected with *Sarcocystis citellivulpes* under laboratory conditions, *V. corsac* began to excrete sporocysts 7–8 days later (Pak et al. 1979). *V. corsac* also carries rabies (Kuzmin et al. 2004), can be infected with canine distemper (Heptner et al. 1998), suffers canine epilepsy (Lohi et al. 2005), and can have cystic goiters (Hilgendorf and Paulicki 1869).

*Vulpes corsac* also hosts numerous ectoparasites, including the fleas *Amphalius runatus*, *Amphipsylla vinogradovi*, *Archaeopsylla sinensis*, *Ceratophyllus calcarifer*, *C. tesquorum sungaris*, *C. tristinus*, *Chaetopsylla homoeus*, *C. korobkovi*, *Ctenocephalides canis*, *Ctenophyllus hirticrus*, *Ctenophthalmus breviatus*, *Frontopsylla elata luculenta*, *F. wagneri*, *Neopsylla bidentatiformes*, *N. pleskei orientalis*, *Ophthalmopsylla praefecta*, *Oropsylla silantiewi*, *Paraceras flabellum*, *Pectinocentrus pavlovskii*, *Pulex irritans*, and *Rhadinopsylla dahurica* (Gottschalk et al. 2003) and ticks (species not determined—Heptner et al. 1998). The number of fleas on host foxes varies throughout the year and is highest in early fall (Poyarkov and Ovsyanikov 2004a).

## BEHAVIOR

The family group is the basic social unit in *Vulpes corsac*. Rutting begins in January or February and is often accompanied by barking (Heptner et al. 1998). Several males run behind a female in estrus and fights often occur between the males. Monogamy is established when the female chooses a male (Novikov 1956). Pairs usually breed in a den. Female *V. corsac* live with the pups in the den until they are 2 months old. Males participate in raising and feeding young but stay in another den or just outside the natal den (Asa and Valdespino 1998). Two females and 2 litters may occur in a single den; helper foxes may assist a parental pair (Heptner et al. 1998). When young are weaned and approach maturity, the female may stay with the male in another den while young stay in the natal den. Females change dens and move young 2 or 3 times as dens become infested with parasites (Heptner et al. 1998). Juveniles and adults also change dens often. Most juveniles disperse during late summer and autumn, but some remain philopatric (Heptner et al. 1998).

*Vulpes corsac* often remains in dens during severe blizzards and frost. Several individuals may gather in a single den, further indication of a level of sociality (Sludskiy and Lazarev 1966).

During favorable years in optimal habitats, home range for a breeding pair can be as small as 1 km<sup>2</sup> (Heptner et al. 1998). However, low-quality habitat with low food abundance tends to result in larger home-range sizes, 35–40 km<sup>2</sup> (Heptner et al. 1998). Territory sizes are variable. In the Zelenograd area, Soviet Union, they are 1.9–3.7 km<sup>2</sup> (Poyarkov and Ovsyanikov 2004a) and one of us (JDM) has recorded territory sizes of 3.5–11.4 km<sup>2</sup> in central Mongolia.

Scent marking with urine and feces frequently occurs near natal dens and is presumed to be important for maintaining territories and other intraspecific communication (Heptner et al. 1998). However, scent-marking behavior (Clark 2007) remains largely unknown in the species.

The most common vocalization in *V. corsac* is barking (Tembrock 1976). Distinctly different barks are produced during hunting (Ognev 1931), courtship, territorial defense, and as threats (Heptner et al. 1998). Close-distance vocalizations such as alarm calls and greetings are high-tone rhythmic sounds described as peeps, chirps, and yelps (Heptner et al. 1998). Vocalizations for different situations are summarized by Heptner et al. (1998) and Ognev (1931).

*Vulpes corsac* typically hunts alone during summer, although the foraging behavior of the species remains largely unstudied (Heptner et al. 1998). Small hunting packs have been observed (Heptner et al. 1998), many of which may have been social or family groups (Nowak 1999). Activity is primarily nocturnal but typically continues until the early morning. Diurnal activity becomes common during times when young need to be fed and when food is scarce, as in the winter (Heptner et al. 1998).

Denning information presented herein is from Heptner et al. (1998). *V. corsac* uses dens for protection from extreme temperatures and for escape from predators. Dens often are modified burrows of marmots (*Marmota bobak*), sousliks (*Spermophilus*), and great gerbils (*R. opimus*), and more rarely are abandoned dens of red foxes and badgers. Dens excavated by *V. corsac* are often shallow (<1 m deep) and have 1–4 entrances. *V. corsac* is a poor burrower, and cannot excavate hard ground. Dens are usually constructed in open plains and on gentle slopes and are  $\leq 1,000$  m from a water source and  $\geq 1,000$  m from human disturbance (Kun et al. 2006; Zhang et al. 2002). Natal dens often have 2 or more entrances (up to 23) that lead to a large central chamber used for whelping. Feces often accumulate around den entrances but latrine use also has been reported. When dens are not available, *V. corsac* will hide in any depression, ravine, canyon, or rocky area during the day (Ognev 1931).

### GENETICS

Parsimony analyses of phylogenetic information establish that *Vulpes corsac* and *V. ferrilata* are more closely related to each other than to members of a 2nd closely interrelated group that includes *V. bengalensis*, *V. chama*, and *V. pallida* (Bininda-Emonds et al. 1999). *V. bengalensis* was previously regarded as a subspecies of *V. corsac* (Sheldon 1992). Analyses of 3 genes (cytochrome *b*, *COI*, and *COII*) and 188 morphological, developmental, behavioral, and cytogenetic characters revealed that *V. corsac* and *V. ferrilata* are closely related and belong to the Holarctic clade of foxes (*V. lagopus*, *V. macrotis*, *V. velox*, and *V. vulpes*—Zrzavý and Řičánková 2004). A phylogenetic tree based on the combined analyses of 6 nuclear loci (3,816 base pairs) and a mitochondrial tree based on the combined analysis of cytochrome *b*, *COI*, and *COII* (2,001 base pairs) groups *V. corsac*, *V. lagopus*, *V. macrotis*, *V. vulpes*, and *V. zerda* as sister taxa (Bardeleben et al. 2005). Graphodatsky et al. (2008) confirmed that the karyotypes of *V. corsac* and *V. vulpes* may have evolved through centric and tandem fusions of ancestral chromosomes but with different branch combinations. Diploid number (2n) for *V. corsac* is 36 and the fundamental chromosome number (FN) is 72 (Aristov and Baryshnikov 2001).

### CONSERVATION

*Vulpes corsac* is a valuable fur-bearing species and has been harvested by humans since the Bronze Age for subsistence and commercial purposes (Poyarkov and Ovsyanikov 2004a). The harvest of pelts of *V. corsac* has contributed to declining populations in many parts of its range (Reading et al. 1998). Pelts are intensively traded in Russia, Mongolia, China, and other areas in the northern parts of its range

(Reading et al. 1998). *V. corsac* is traditionally hunted with trained domestic dogs, saker falcons, and golden eagles (Poyarkov and Ovsyanikov 2004a) but also is hunted with snares set at burrow entrances, leghold traps, and guns. Plowing of virgin land also has led to the disappearance of *V. corsac* from some areas (Heptner et al. 1998). The International Union for the Conservation of Nature and Natural Resources (World Conservation Union) lists *V. corsac* as “Least Concern” (Poyarkov and Ovsyanikov 2004b). The Convention on International Trade in Endangered Species of Wild Fauna and Flora does not have a listing for *V. corsac* (United Nations Environment Programme–World Conservation Monitoring Centre 2007). Borovik (2002) argues that, at least for the Ukraine, *V. corsac* should be included in the *Red Book* and provided with conservation arrangements.

### REMARKS

*Vulpes corsac* reportedly tames well (Heptner et al. 1998) and in the 17th century these foxes were popular pets in the former USSR (Alderton 1994). When the North American swift fox (*Vulpes velox*) was 1st described by Say (1823:486), *V. corsac* was mentioned as a comparative species: “The ridge of the nose is somewhat paler, and a more brownish dilated line passes from the eye to near the nostrils (as in the *C. corsac* [sic]).”

The Greek researcher and storyteller Herodotus of Halicarnassus (5th century BCE) wrote an account of “gold-bearing ants” said to be “nearly the size of a dog. They dig their tunnels in the ground and 3 times a day they bring up gold sand and nuggets and pile them in huge heaps.” These “ants” are now thought to have been corsac foxes (cited in Rudwick 1997:213).

### ACKNOWLEDGMENTS

We thank C. Wozencraft, I. Llanes, F. Vang, S. Hagen, and M. Neary for their assistance with the account. We also thank N. Javzmaa, scientific unit head of the Natural History Museum of Mongolia, and T. Munkhzul of the Mongolian Academy of Sciences for their assistance and X. Eichaker for providing the photograph used as Fig. 1.

### LITERATURE CITED

- ALDERTON, D. 1994. Foxes, wolves and wild dogs of the world. Blandford, London, United Kingdom.
- ALLEN, G. M. 1938. The mammals of China and Mongolia. Natural history of central Asia. American Museum of Natural History, New York.
- ARISTOV, A. A., AND G. F. BARYSHNIKOV. 2001. The mammals of Russia and adjacent territories: carnivores and pinnipeds. Zoological Institute of the Russian Academy of Sciences 169:1–560.
- ASA, C. S., AND C. VALDESPINO. 1998. Canid reproductive biology: an integration of proximate mechanisms and ultimate causes. *American Zoologist* 38:251–259.

- BARDELEBEN, C., R. L. MOORE, AND R. K. WAYNE. 2005. A molecular phylogeny of the Canidae based on six nuclear loci. *Molecular Phylogenetics and Evolution* 37:815–831.
- BININDA-EMONDS, O. R. P., J. L. GITTLEMAN, AND A. PURVIS. 1999. Building large trees by combining phylogenetic information: a complete phylogeny of the extant Carnivora (Mammalia). *Biological Reviews* 74:143–175.
- BLIZNYUK, A. I. 1994. On *Vulpes corsac* L., 1768 variability. *Byullet' Moskovskogo Obshchestva Ispytatelei Prirody Otdel Biologicheskii* 99:8–13.
- BORKHAUSEN, M. B. 1797. *Deutsche Fauna, oder Kurgefasste Naturgeschichte der Thiere Deutschlands. I. Säugthiere und Vogel. Varrentrapp und Wenner, Frankfurt am Mayn, Germany.*
- BOROVIK, E. N. 2002. *Vulpes corsac* (Carnivora, Canidae) in Ukraine. *Vestnik Zoologii* 36:95–96.
- CAI, G. Q. 1989. Carnivora. Pp. 593–625 in *Academia Sinica, North West Plateau Institute of Biology: Qinghai economic and zoological annual* (D. H. Li, ed.). Quinghai People's Publishing, Xining, China.
- CHERNOVA, O. F. 2003. Architectonic and diagnostic significance of hair cortex and medulla. *Biology Bulletin* 30:53–62.
- CLARK, H. O., JR. 2007. Marking of novel objects by kit fox. *California Fish and Game* 93:103–106.
- COMBREAUX, O., ET AL. 2002. Breeding success in a houbara bustard *Chlamydotis [undulata] macqueenii* population on the eastern fringe of the Jungar Basin, People's Republic of China. *Ibis* 144: 45–56.
- DOROGOSTAISKI, V. C. 1935. Novyi podvid korsaka iz Yuzhnogo Zabaikal'ya of (*Vulpes corsak skorodumovi* n. subsp.) [A new subspecies of the corsak fox from southern Transbaikalia (*Vulpes corsak skorodumovi* n. subsp.)]. *Izvestiya Irkutskogo Gosudarstvennogo Protivochumnogo Instituta Sibiri i Dal'ne-Vostochnogo Kraya* 1:47–54 (dated 1934 but published in 1935).
- ELNAIEM, D. A., ET AL. 2001. The Egyptian mongoose, *Herpestes ichneumon*, is a possible reservoir host of visceral leishmaniasis in eastern Sudan. *Parasitology* 122:531–536.
- ENLOE, J. G., F. DAVID, AND G. BARYSHNIKOV. 2000. Hyenas and hunters: zooarchaeological investigations at Prolom II Cave, Crimea. *International Journal of Osteoarchaeology* 10:310–324.
- GEFFEN, E. 1994. *Vulpes cana*. *Mammalian Species* 462:1–4.
- GOTTSCHALK, C., J. THIELEBEIN, AND T. SPRECKE. 2003. Comments on the flea infestation of a corsac fox, *Vulpes corsac* (Linnaeus, 1768), at the Zoological Garden of Halle. *Zoologische Garten* 73: 416–421.
- GRAPHODATSKY, A. S., ET AL. 2008. Phylogenomics of the dog and fox family (Canidae, Carnivora) revealed by chromosome painting. *Chromosome Research* 16:129–143.
- HEPTNER, V. G., N. P. NAUMOV, P. B. YURGENSON, A. A. SLUDSKIY, A. F. CHIRKOVA, AND A. G. BANNIKOV. 1967. *Mlekopitayushchie Sovetskogo Souza* [Mammals of Soviet Union]. Vol. 2(1) Sea cows and carnivores. *Vyshaya Shkola, Moscow, Russia* (in Russian).
- HEPTNER, V. G., N. P. NAUMOV, P. B. YURGENSON, A. A. SLUDSKII, A. F. CHIRKOVA, AND A. G. BANNIKOV. 1998. *Mammals of the Soviet Union. Vol. II, part 1a. Sirenia and Carnivora (sea cows; wolves and bears).* *Vyshaya Shkola Publishers, Moscow, Russia.*
- HERÁŇ, I. 1996. Interspecific difference in proportions of the praesacral spine in Canidae (Mammalia: Carnivora). *Acta Societatis Zoologicae Bohemicae* 60:31–36.
- HILGENDORF, F., AND A. PAULICKI. 1869. *Struma cystica bei einem Korsak (Canis corsac).* *Virchows Archiv* 48:529.
- KADYRBAEV, C. K., AND A. A. SLUDSKII. 1981. *Corsac fox.* Pp. 104–132 in *Mammals of Kazakhstan* (E. V. Gvozdev and E. I. Strautman, eds.). *Nauka Kazahskoy SSR, Alma-Ata, Russia.*
- KASTSCHENKO, N. F. 1912. *Novye issledovaniya po mammologii Zabaikal'ya* (New studies on the mammalogy of Transbaikalia). *Ezhgodnik Zoologicheskogo Muzeya* 17:393–394.
- KATZNER, T. E., E. A. BRAGIN, S. T. KNICK, AND A. T. SMITH. 2006. Spatial structure in the diet of imperial eagles *Aquila heliaca* in Kazakhstan. *Journal of Avian Biology* 37:594–600.
- KOSINTSEV, P. 2007. Late Pleistocene large mammal faunas from the Urals. *Quaternary International* 160:112–120.
- KUN, J., L. ZHI-DONG, AND G. ZHONG-XIN. 2006. Spring habitat selection of dens by *Vulpes corsac* in Hulunbeir grassland. *Scientia Silvae Sinicae* 42:126–128.
- KURTÉN, B. 1968. *Pleistocene mammals of Europe.* Aldine Publishing Co., Chicago, Illinois.
- KUZMIN, I. V., ET AL. 2004. Molecular epidemiology of terrestrial rabies in the former Soviet Union. *Journal of Wildlife Diseases* 40: 617–631.
- LARIVIÈRE, S., AND M. PASITSCHNIK-ARTS. 1996. *Vulpes vulpes.* *Mammalian Species* 537:1–11.
- LARIVIÈRE, S., AND P. J. SEDDON. 2001. *Vulpes rueppelli.* *Mammalian Species* 678:1–5.
- LEVINE, N. D. 1986. The taxonomy of *Sarcocystis* (Protozoa, Apicomplexa) species. *Journal of Parasitology* 72:372–382.
- LINNAEUS, C. 1768. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis synonymis, locis. Regum animale. Class I, Mammalia.* 12th ed. Laurentii Salvii, Stockholm, Sweden 1:1–824.
- LOHI, H., ET AL. 2005. Expanded repeat in canine epilepsy. *Science* 307:81.
- MACDONALD, D. W. 1985. The carnivores: order Carnivora. Pp. 619–722 in *Social odours of mammals* (R. E. Brown and D. W. Macdonald, eds.). Clarendon Press, Oxford, United Kingdom.
- MALLON, D. P. 1985. The mammals of the Mongolian People's Republic. *Mammal Review* 15:71–102.
- MERINDANO, M. D., J. COSTA, M. CANALS, J. M. POTAU, AND D. RUANO. 2002. A comparative study of Bowman's layer in some mammals: relationships with other constituent corneal structures. *European Journal of Anatomy* 6:133–139.
- MURDOCH, J. D., S. BUYANDELGER, AND B. L. CYPHER. 2009. Patterns of seed occurrence in corsac and red fox diets in Mongolia. *Journal of Arid Environments* 73:381–384.
- MURRELLA, K. D., AND E. POZIO. 2000. Trichinellosis: the zoonosis that won't go quietly. *International Journal for Parasitology* 30: 1339–1349.
- NOVIKOV, G. A. 1956. Carnivorous mammals of the fauna of the USSR. *Zoological Institute of the Academy of Sciences of the USSR* 62: 66–69 Israel Program for Scientific Translations, Jerusalem, Israel.
- NOWAK, R. M. 1999. *Walker's mammals of the world.* 6th ed. Johns Hopkins University Press, Baltimore, Maryland.
- OGNEV, S. I. 1931. *Mammals of eastern Europe and northern Asia. Carnivora (Fissipedia).* Vol. II. Israel Program for Scientific Translations, Jerusalem, Israel.
- OGNEV, S. I. 1935. *Mammals of U.S.S.R. and adjacent countries. Carnivora (Fissipedia and Pinnipedia).* Vol. III. Israel Program for Scientific Translations, Jerusalem, Israel.
- PAK, S. M., V. V. PERMINOVA, AND N. V. ESHTOKINA. 1979. *Sarcocystis citellivulpes* n. sp. from *Citellus fulvus*. *Protozoologiya* 4:111–114.
- POYARKOV, A., AND N. OVSYANIKOV. 2004a. *Vulpes corsac.* Pp. 142–148. in *Canids: foxes, wolves, jackals and dogs. Status survey and conservation action plan* (C. Sillero-Zubiri, M. Hoffmann, and D. W. Macdonald, eds.). *International Union for Conservation of Nature and Natural Resources/Species Survival Commission Canid Specialist Group, Gland, Switzerland.*
- POYARKOV, A., AND N. OVSYANIKOV. 2004b. *Vulpes corsac.* In: *IUCN 2007. 2007 IUCN Red list of threatened species.* www.iucnredlist.org, accessed 26 October 2007.
- POZIO, E. 2000. Factors affecting the flow among domestic, synanthropic and sylvatic cycles of *Trichinella*. *Veterinary Parasitology* 93:241–262.
- POZIO, E. 2001. New patterns of *Trichinella* infection. *Veterinary Parasitology* 98:133–148.
- POZIO, E., B. SHAIKOV, G. LA ROSA, AND D. L. OBENDORF. 1992. Allozymic and biological characters of *Trichinella pseudospiralis* isolates from free-ranging animals. *Journal of Parasitology* 78: 1087–1090.
- READING, R. P., H. MIX, B. LHAGVASUREN, AND N. TSEVEENMYADAG. 1998. The commercial harvest of wildlife in Dornod Aimag, Mongolia. *Journal of Wildlife Management* 62:59–71.
- RICANKOVA, V., Z. FRIC, J. CHLACHULA, P. STASTNA, A. FALTYNKOVA, AND F. ZEMEK. 2006. Habitat requirements of the long-tailed ground squirrel (*Spermophilus undulatus*) in the southern Altai. *Journal of Zoology (London)* 270:1–8.

- ROGOVIN, K., J. A. RANDALL, I. KOLOSOVA, AND M. MOSHKIN. 2004. Predation on a social desert rodent, *Rhombomys opimus*: effect of group size, composition, and location. *Journal of Mammalogy* 85: 723–730.
- ROOM, A. 2002. *Cassell's dictionary of word histories*. Sterling Publishing Company, Inc., New York.
- RUDWICK, M. J. S. 1997. Georges Cuvier, fossil bones, and geological catastrophes: new translations and interpretations of the primary texts. University of Chicago Press, Chicago, Illinois.
- SAY, T. 1823. Account of an expedition from Pittsburg to the Rocky Mountains, performed in the years 1819 and '20, by order of the Hon. J. C. Calhoun, Secretary of War (E. James, comp.). Vol. 2. Carey and Lea, Philadelphia, Pennsylvania.
- SHABADASH, S. A., AND T. I. ZELIKINA. 2002. Detection of hepatoid glands and distinctive features of the hepatoid acinus. *Biology Bulletin* 29:559–567.
- SHABADASH, S. A., AND T. I. ZELIKINA. 2004. The tail gland of canids. *Biology Bulletin* 31:367–376.
- SHELDON, J. W. 1992. *Wild dogs. The natural history of the nondomestic Canidae*. Blackburn Press, Caldwell, New Jersey.
- SIDOROV, G. N., AND A. D. BOTVINKIN. 1987. Corsac fox (*Vulpes corsac*) in southern Siberia. *Zoologicheskyy Zhurnal* 66:914–927.
- SLUDSKYI, A. A., AND A. A. LAZAREV. 1966. Corsac fox: its ecology and hunting. *Hunting mammals of Kazakhstan*. Kaynar, Alma-Ata, Russia.
- SOMMER, R., AND N. BENECKE. 2005. Late-Pleistocene and early Holocene history of the canid fauna of Europe (Canidae). *Mammalian Biology* 70:227–241.
- STEPANCHUK, V. N. 1993. Prolom II, a Middle Palaeolithic cave site in the eastern Crimea with nonutilitarian bone artifacts. *Proceedings of the Prehistoric Society* 59:17–37.
- TANG, C. T., ET AL. 2004. Study on the ecological distribution of alveolar *Echinococcus* in Hulunbeier Pasture of Inner Mongolia, China. *Parasitology* 128:187–194.
- TEMBROCK, G. 1976. Canid vocalizations. *Behavioural Processes* 1: 57–75.
- [UNEP-WCMC] UNITED NATIONS ENVIRONMENT PROGRAMME–WORLD CONSERVATION MONITORING CENTRE. 2007. UNEP-WCMC species database: CITES-listed species. <http://www.unep-wcmc.org/>, accessed 1 February 2008.
- WOZENCRAFT, W. C. 2005. Order Carnivora. Pp. 532–628 in *Mammal species of the world: a taxonomic and geographic reference* (D. E. Wilson and D. M. Reeder, eds.). 3rd ed. Johns Hopkins University Press, Baltimore, Maryland.
- YANG, W. K., J. F. QIAO, O. COMBREAU, X. Y. GAO, AND W. Q. ZHONG. 2003. Breeding habitat selection by the houbara bustard *Chlamydotis [undulata] macqueenii* in Mori, Xinjiang, China. *Zoological Studies* 42:470–475.
- ZHANG, M., Z. GAO, S. GONG, W. WANG, AND Y. ZHANG. 2002. The selection of dens in spring of the corsac fox (*Vulpes corsac*) in the prairie of eastern Inner Mongolia. *Acta Theriologica Sinica* 22: 284–291.
- ZRZAVÝ, J., AND V. ŘICÁNKOVÁ. 2004. Phylogeny of Recent Canidae (Mammalia, Carnivora): relative reliability and utility of morphological and molecular datasets. *Zoologica Scripta* 33:311–333.

Associate editors of this account were RON GETTINGER, KRISTOFER M. HELGEN, BETTY MCGUIRE, and PAMELA R. OWEN. ALFRED L. GARDNER reviewed the synonymy. Editors were MEREDITH J. HAMILTON and VIRGINIA HAYSSSEN.