

North Africa and the Middle East (Ethiopian)

7.1 Blanford's fox

Vulpes cana Blanford, 1877

Vulnerable – VU: C1 (2004)

E. Geffen, R. Hefner and P. Wright

Other names

Arabic: tha'leb sakhari; **English:** royal fox, hoary fox, king fox, Afghan fox; **French:** renard royale; **German:** Afghanfuchs; **Hebrew:** shual tzukim.

Taxonomy

Vulpes canus Blanford, 1877. J. Asiat. Soc. Bengal, 2: 315. Type locality: "Gwadar, Baluchistan" [Pakistan].

A cladistic analysis of mtDNA restriction-fragment and restriction-site data, and 402 base pairs of cytochrome b sequence in fox-like canids, revealed that Blanford's fox and the co-existing desert species, the fennec fox (*Vulpes zerda*), were consistently associated as sister taxa (Geffen *et al.* 1992e). Furthermore, these two taxa formed a monophyletic clade distinct from the other fox-like canids, and thereby defined a taxonomic grouping that previously has not been recognised. However, based on restriction-site data, the sequence divergence between the fennec fox and Blanford's fox is 8.7%, indicating an ancient divergence as much as 3–4 million years ago. This divergence is coincident with the appearance of desert regions in the Middle East and northern Africa (Wickens 1984).

Chromosome number not known.

Description

Blanford's fox is a small fox (c. 1kg) with a long and very bushy tail (Table 7.1.1.). Sexual dimorphism is minimal, males having significantly longer bodies and front legs, but these differences are on a scale of 3–6%. The head is orange buff in colour, especially in the winter coat. The face is slender with a distinctive dark band extending from the upper part of the sharply pointed muzzle to the internal angle of the eyes. The iris is almost as dark as the pupil (Geffen 1994). The ears are pale brown on both sides with long white hairs along the antero-medial border (Harrison and Bates 1991; Geffen *et al.* 1992d; Geffen 1994). The body is brownish-grey, fading to pale yellow on the belly. The winter coat is soft and woolly with a dense, black under wool. Its dorsal region is sprinkled with white-tipped hair. The summer coat is less dense, the fur is paler, and the white-tipped hairs are less apparent. Specimens from the eastern part of the distribution may be predominantly grey. A distinctive mid-dorsal black band extends from the

nape of the neck caudally, becoming a mid-dorsal crest throughout the length of the tail. The tail is similar in colour to the body. A distinctive dorsal black spot (violet gland) is present at the base of the tail, which usually has a black tip, although in some individuals the tip is white (4% in Israel and 26% in U.A.E.). The dark mid-dorsal band, which is a distinctive feature of the Israeli specimens, is less evident in specimens from Oman, although the black tail markings are equally developed (Harrison and Bates 1989). Also, specimens collected in Israel were lighter and had shorter bodies and ears than those collected in the United Arab Emirates (Smith *et al.* 2003). The fore feet and hind feet are dorsally pale yellowish-white, while posteriorly they are dark grey. Unlike the other fox species in the Arabian deserts, the blackish pads of the feet and digits are hairless and the claws are cat-like, curved, sharp, and semi-retractile (Geffen *et al.* 1992d; Geffen 1994). The baculum of Blanford's fox is similar in size to that of Rüppell's fox (*V. rueppellii*) (41mm), but it is broader and has an expanded bulbous tip (Harrison and Bates 1991).

The skull of Blanford's fox is intermediate in size (mean of greatest length is 94mm) between fennec fox and Rüppell's fox. The rostrum is slender, and the nasal bones are long and thin. The postorbital processes are well developed and are not deeply concave dorsally. The braincase is relatively narrow and weakly ridged. The

Table 7.1.1. Body measurements for Blanford's fox.

	Ein Gedi and Eilat, Israel (Geffen <i>et al.</i> 1992d).	United Arab Emirates (Smith <i>et al.</i> 2003).
HB male	427mm (385–470) n=19	744mm (700–800) n=8
HB female	411mm (385–450) n=17	711mm (657–762) n=11
T male	324mm (260–355) n=19	328mm (307–350) n=8
T female	317mm (290–340) n=17	322mm (300–350) n=11
HF male	92mm (80–100) n=19	98mm (91–105) n=8
HF female	93mm (82–110) n=17	93mm (85–100) n=11
E male	80mm (72–85) n=19	86mm (80–95) n=8
E female	78mm (74–87) n=17	86mm (82–91) n=11
WT male	1.0kg (0.8–1.3) n=19	1.2kg (0.9–1.4) n=9
WT female	1.0kg (0.8–1.5) n=17	1.3kg (1.0–1.5) n=6



Blanford's fox, Israel.

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palatines are narrow, and the mesopterygoid space also is long and thin. The tympanic bullae are relatively smaller than those of Rüppell's fox, and the coronoid process of the mandible is relatively more convex (Harrison and Bates 1991). The dental formula is 3/3-1/1-4/4-2/3=42.

Subspecies Monotypic (Mendelssohn *et al.* 1987).

Similar species Red fox (*Vulpes vulpes*), fennec fox (*V. zerda*) and Rüppell's fox (*V. rueppellii*). The tail of the Blanford's fox is bushy and longer (mean=323mm), relative to length of body (mean=426mm), than in the other Arabian desert foxes (6.8%, 9.8%, and 22.5% longer than that of Rüppell's fox, red fox, and fennec fox, respectively (Mendelssohn *et al.* 1987; Geffen *et al.* 1992d). The length

of the hind foot, relative to body length, is significantly shorter in Blanford's fox (1.8%, 0.8%, and 3.2% shorter than that of Rüppell's, red, and fennec fox, respectively). The relative ear length is intermediate (2.0% longer than in red fox and 2.6% and 5.4% shorter than in Rüppell's and fennec fox, respectively; Harrison and Bates 1991; Geffen *et al.* 1992d).

Current distribution

Present in arid mountainous regions of the Middle East eastwards to Afghanistan (Figure 7.1.1). The Blanford's fox was first described from south-western Asia in 1877, and specimens were collected from Afghanistan, Pakistan, Iran and Turkistan (=Kazakhstan) (Novikov 1962; Bobrinskii *et al.* 1965; Lay 1967; Hassinger 1973; Roberts

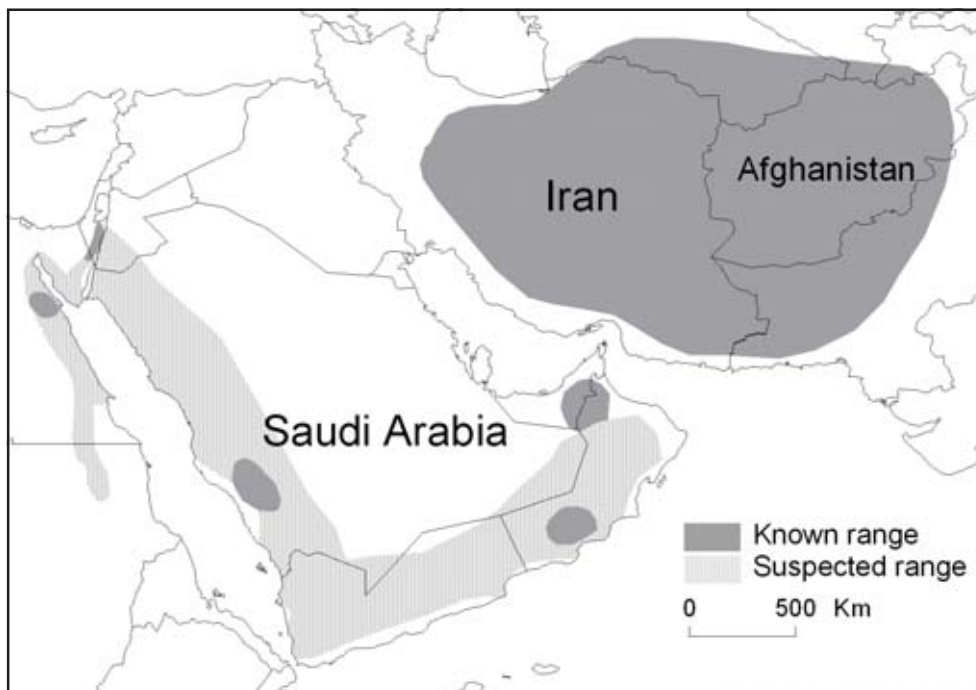


Figure 7.1.1. Current distribution of Blanford's fox.

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1977). In 1981, the species was discovered in Israel (Ilany 1983), and since then throughout the Middle East (Harrison and Bates 1989; Al Khalil 1993; Stuart and Stuart 1995; Amr *et al.* 1996; Amr 2000) and recently in Egypt (Peters and Rödel 1994).

Range countries Afghanistan, Egypt, Eritrea (?), Iran, Israel, Jordan, Kazakhstan, Oman, Pakistan, Saudi Arabia, Sudan (?), United Arab Emirates, Yemen (?) (Al Khalil 1993; Geffen *et al.* 1993; Peters and Rödel 1994).

Relative abundance

Fairly common in south-eastern Israel; in Israel, density estimates of 2.0/km² in Ein Gedi and 0.5/km² in Eilat have been recorded. Abundance in other countries is unknown.

Estimated populations/relative abundance and population trends

Table 7.1.1. Status of Blanford's foxes in Israel (C=common, S=stable).

Region	Population/abundance	Trend
Israel, Ein Gedi	C	S
Israel, Eilat	C	S

Habitat

Blanford's fox is confined to mountainous regions (Lay 1967; Roberts 1977). Hassinger (1973) concluded that Blanford's foxes are generally found below an altitude of 2,000m in dry montane biotopes. All the records collected on the Persian Plateau are from foothills and mountains in the vicinity of lower plains and basins (Hassinger 1973; Roberts 1977). In that region, the habitat of Blanford's fox comprises the slopes of rocky mountains with stony plains and patches of cultivation (Lay 1967; Roberts 1977). This species appears to avoid higher mountain ranges as well as lower, warmer valleys (Roberts 1977).

In the Middle East, Blanford's foxes are confined to mountainous desert ranges and inhabit steep, rocky slopes, canyons, and cliffs (Mendelssohn *et al.* 1987; Harrison and Bates 1989). In Israel, Blanford's fox is distributed along the western side of the Rift Valley, and, in the central Negev, specimens were collected in creeks that drain into the Rift Valley (Geffen *et al.* 1993). Apparently, Blanford's fox can occur on various rock formations as long as its other requirements are met. The distribution of Blanford's fox in the Arabian Desert is not limited by access to water (Geffen *et al.* 1992a). In Israel, Blanford's foxes inhabit the driest and hottest regions. The densest population is found in the Judaeen Desert at elevations of 100–350m below sea level. This is in contrast to Roberts' (1977) remark that the species avoids low, warm valleys in Pakistan.

Geffen *et al.* (1992c) found that dry creek bed was the most frequently visited habitat in all home ranges in Israel. Home ranges at Ein Gedi (in km²), comprised an

average (\pm SD) of $63.4 \pm 3.2\%$ gravel scree, $3.6 \pm 2.6\%$ boulder scree, $28.4 \pm 4.0\%$ dry creek bed, and $4.5 \pm 3.5\%$ stream and spring. Average time (\pm SD) spent by foxes at Ein Gedi in gravel scree was 148.8 ± 109.8 min/night, 46.0 ± 63.8 min/night in boulder scree, 359.9 ± 141.9 min/night in dry creek bed, and 13.0 ± 27.9 min/night near a water source (Geffen *et al.* 1992c). Dry creek bed provided abundant prey for the foxes and only sparse cover for their terrestrial predators. Creek bed patches were used in proportion to their size. Both the available area of creek bed in each range and the area of creek bed patches that was used by the foxes were independent of home range size. However, variance in home range size was explained by the mean distance between the main denning area and the most frequently used patches of creek bed (Geffen *et al.* 1992c; and see Social and reproductive behaviour).

Food and foraging behaviour

Food In Israel, Blanford's foxes are primarily insectivorous and frugivorous (Ilany 1983; Geffen *et al.* 1992b). Invertebrates are the major food with beetles, grasshoppers, ants, and termites eaten most often (Geffen *et al.* 1992b). Plant foods consisted mainly of the fruits of two caperbush species, *Capparis cartilaginea* and *C. spinosa*. Fruits and plant material of *Phoenix dactylifera*, *Ochradenus baccatus*, *Fagonia mollis*, and various species of Gramineae were also eaten. Remains of vertebrates were present in c.10% of faecal samples analysed (Geffen *et al.* 1992b). The diet differed significantly between two sites examined in Israel, but seasonal and individual differences in diet were not detected (Geffen *et al.* 1992b). Blanford's foxes in Pakistan are largely frugivorous feeding on Russian olives (*Elaeagnus hortensis*), melons, and grapes (Roberts 1977).

Foraging Blanford's foxes are almost always solitary foragers (92% of 463 observations; Geffen *et al.* 1992b), only occasionally foraging in pairs. Mated pairs, which shared home ranges, differed significantly in the time of arrival at fruitful food patches and in the pattern of use of their home range (Geffen and Macdonald 1993). Three types of foraging behaviour were observed: 1) unhurried movements back and forth between rocky patches in a small area (0.01–0.03km²), accompanied by sniffing and looking under large stones and occasionally digging a shallow scrape; 2) standing near a bush for a few seconds, alert with ears erect, prior to circling the bush or pouncing upon prey within, and then walking to another bush to repeat the sequence (on four occasions members of a pair were observed using this type of foraging behaviour simultaneously around the same bushes); and 3) short, fast sprint after small terrestrial or low-flying prey (Geffen *et al.* 1992b). Food caching is rare or absent in the Blanford's fox, contrary to other fox species. Food offered to foxes was either consumed on the spot or carried away and eaten (Geffen *et al.* 1992b).

Blanford's foxes are strictly nocturnal, likely an anti-predator response to diurnal raptors (Geffen and Macdonald 1993). The onset of activity is governed largely by light conditions, and closely follows sunset. Foxes were active *c.* 8–9 h/night, independent of duration of darkness. Average distance (\pm SD) travelled per night was 9.3 ± 2.7 km, and size of nightly home range averaged 1.1 ± 0.7 km² (Geffen and Macdonald 1992). Significant seasonal or sexual differences in duration of activity, nightly distance travelled, or nightly home range, were not detected (Geffen *et al.* 1992c). Climatic conditions at night in the desert appeared to have little direct effect on the activity of Blanford's foxes, except when conditions were extreme (Geffen and Macdonald 1993).

Damage to livestock or game Not known. May prey on free-ranging chickens.

Adaptations

Most canids are cursorial terrestrial carnivores adapted for long-distance travel over horizontal ground. Blanford's fox and the Arctic fox (*Alopex lagopus*) are the only canids known regularly to climb cliffs, and the gray fox (*Urocyon cinereoargenteus*) is the only species that routinely climbs trees. Compared with other small canids, the Blanford's fox has a relatively long, bushy tail. Large tails are typical of tree-dwelling carnivores such as stone martens (*Martens foina*) and ringtails (*Bassariscus astutus*). Jumping is usually an integral part of the locomotor pattern in fast-moving arboreal mammals and the large tail is probably an important counter-balance during jumps and may function like a parachute. Mendelssohn *et al.* (1987) described the jumping ability of Blanford's fox as astonishing; captive individuals bounced from one wall to another or jumped to the highest ledges (2–3 m) in their cage with remarkable ease and as part of their normal movements. Their small feet and naked pads provide sure footing even on the narrow ledges of a vertical wall. In the field, these foxes were observed climbing vertical, crumbling cliffs by a series of jumps up the vertical sections. Their sharp, curved claws doubtless enhance traction on the more difficult vertical ascents.

Daily energy expenditure of free-ranging Blanford's foxes near the Dead Sea was 0.63–0.65 kJ/g/day, with no significant seasonal difference (Geffen *et al.* 1992a). Mean rate of water intake was significantly higher in summer (0.11 ml/g/day) than in winter (0.08 ml/g/day). They concluded that foxes maintained water and energy balances on a diet of invertebrates and fruits without drinking. Furthermore, this study suggested that Blanford's foxes foraged more for water than for energy, because metabolic needs are met before water requirements when feeding on invertebrates. Blanford's foxes in Israel consume more fruit during the hot summer, which compensates for deficiencies in body water (Geffen *et al.* 1992a, b).

Social behaviour

Data from 11 radio-tracked Blanford's foxes studied over two years in Israel indicated that they were organised as strictly monogamous pairs in territories of *c.* 1.6 km² that overlapped minimally (Geffen and Macdonald 1992; Geffen *et al.* 1992c). Locations and configurations of home ranges were stable during that study. A shift in location of home range was observed only once following the death of a pair member. Three of five territories contained one, non-breeding, yearling female during the mating season, but there was no evidence of polygyny (Geffen and Macdonald 1992).

Reproduction and denning behaviour

Blanford's foxes live in monogamous pairs (Geffen and Macdonald 1992). Females are monoestrus and come into heat during January and February (in Israel). Gestation period is *c.* 50–60 days, and litter size is 1–3 pups. Females have 2–6 active teats, and the lactation period is 30–45 days. Neonates are born with soft, black fur. Based on repeated measures of body mass of three young born in captivity, a neonate body mass of 29 g has been estimated (Mendelssohn *et al.* 1987; Geffen 1994). The body mass of a subadult is reached in *c.* 3–4 months (700–900 g). At about two months of age, the young start to forage, accompanied by one of the parents, and at three months of age they start to forage alone. Juveniles have similar markings as the adult, but their coat is darker and more greyish. Sexual maturity is reached at 10–12 months of age (Geffen 1994).

Young are entirely dependent upon their mother's milk for food and water until they begin to forage for themselves. Adult Blanford's foxes have never been observed to carry food to the young and only one den was found with remains of prey at the entrance (Geffen and Macdonald 1992). Observations of Blanford's foxes suggest that food is not regurgitated to the young, as in other small canids. Geffen and Macdonald (1992) have no indication that the male provides food either to the female or to the cubs, although they observed males grooming and accompanying 2–4-month-old juveniles. Therefore, it appears that the direct contribution to survival of the young by any individual other than the mother is probably minimal. Offspring often remain within their natal home range until autumn (October–November).

Dens used by Blanford's foxes in Israel were usually on a mountain slope and consisted of large rock and boulder piles or scree. Blanford's foxes appeared to use only available natural cavities and never dug burrows. Dens were used both for rearing young during spring and for daytime resting throughout the year. During winter and spring, both members of a pair frequently occupied the same den, or adjacent dens at the same site, while during summer and autumn they often denned in separate locations. Frequent changes in location of den from day to

day were more common in summer and autumn (Geffen and Macdonald 1992).

Competition

Blanford's foxes have been observed to flee from a red fox. However, occasionally, individuals will stand at a safe distance and bark at larger potential predators (e.g., leopards and humans).

Mortality and pathogens

Natural sources of mortality In Israel, old age or rabies were the primary causes of death (Geffen 1994). Only a single known case of predation was recorded, where the suspect was thought to be a red fox.

Persecution Not known. There is a single poisoning record of three Blanford's foxes and two red foxes from U.A.E. However, we anticipate that poisoning is a rare cause of mortality in this species.

Hunting and trapping for fur Records by CITES showed that no furs were exported during 1983 and 1985 to 1986. In 1980 and 1982, seven were exported, and in 1981 c. 30 skins were exported from Afghanistan. In 1984, 519 Blanford's fox skins were reportedly exported, mostly from Canada, which is well beyond the distribution of this species (Ginsberg and Macdonald 1990). There is no hunting of this species in Israel.

Road kills A single record from Saudi Arabia. None reported elsewhere.

Pathogens and parasites Blanford's foxes appear to be susceptible to rabies. During 1988 to 1989, 11 dead Blanford's foxes were found in two populations in Israel, and two fresh carcasses tested positive for rabies. Individuals that are in poor body condition often have many ticks.

Longevity The lifespan of Blanford's foxes in the wild was estimated at 4–5 years. In captivity, individuals reached six years of age. Old individuals showed severe tooth wear, absence of some incisors and canines, and poor body condition.

Historical perspective

None.

Conservation status

Threats The threat from habitat loss in Israel is limited as most of the area where this species occurs is designated as protected. Political developments may change the status of the northern Judean Desert. Human development along the Dead Sea coasts may also pose a considerable threat to existing habitat. Similar concerns exist for the populations in the U.A.E.

Commercial use At present, the trade in Blanford's fox fur is negligible and confined to Afghanistan. See Mortality and pathogens.

Occurrence in protected areas

- *Israel*: Ein Gedi Nature Reserve, Judean Desert Nature Reserve, Maktesh Ramon Nature Reserve, Eilat Mountain Nature Reserve;
- *Jordan*: Dana Nature Reserve;
- *Oman*: Jebel Samhan Sanctuary, Dhofar.

Protection status CITES – Appendix II (2000)

Current legal protection Fully protected in Israel, with no hunting, trapping or trading permitted. Holding in captivity requires a special permit from the Nature Reserves Authority of Israel. There is a ban on hunting in Jordan and Oman. However, there is no legal protection in Egypt, Saudi Arabia, U.A.E., Iran, Afghanistan or Pakistan.

Conservation measures taken None.

Occurrence in captivity

In Israel, the species is kept in captivity at the Hai Bar Breeding Centre (near Eilat). In previous years, there was a pair at the Tel Aviv University Zoo. Captive individuals are also kept at the Breeding Centre for Endangered Arabian Wildlife, Sharjah, U.A.E. Foxes have been successfully bred at all the above facilities.

Current or planned research projects

Research on the life history and diseases in Blanford's foxes is currently being conducted in U.A.E., and extensive surveys are being carried out in Saudi Arabia, Oman and U.A.E. (M. Smith, K.J. Budd and C. Gross, Breeding Centre for Endangered Arabian Wildlife, Sharjah, United Arab Emirates).

Gaps in knowledge

The information on the biology of Blanford's foxes is mostly from the southern part of Israel. Nothing is known on the behaviour and ecology of the species in the eastern part of its distribution. Interactions with other predators and the susceptibility to diseases are poorly understood.

Core literature

Geffen 1994; Geffen *et al.* 1992a,b,c,d,e, 1993; Geffen and Macdonald 1992, 1993; Harrison and Bates 1989, 1991; Mendelsohn *et al.* 1987.

Reviewers: Yoram Yom-Tov, Gustav Peters, Chris Stuart and Tilde Stuart. **Editors:** Michael Hoffmann, Claudio Sillero-Zubiri.

7.2 Pale fox

Vulpes pallida (Cretzschmar, 1827)

Data Deficient (2004).

C. Sillero-Zubiri

Other names

Arabic: tsaaleb; **English:** pallid fox, African sand fox; **French:** renard pâle; **German:** blassfuchs; **Spanish:** zorro pálido.

Taxonomy

Canis pallidus Cretzschmar, 1827. In Rüppell, Atlas Reise Nordl. Afr., Zool., Säugeth. (dated 1826), pp. 33, pl. 11. Type locality: “Kordofan” [Sudan].

Thomas (1918) associated *Vulpes pallida* with Rüppell’s fox (*V. rueppellii*) and the fennec fox (*V. zerda*). Clutton-Brock *et al.* (1976) support this grouping and suggest that these desert foxes are also closely related to the Indian fox (*V. bengalensis*) and the Cape fox (*V. chama*).

Chromosome number not known.

Description

A small, very pale fox with longish legs and large ears (Table 7.2.1). Pale face, elongated muzzle with relatively long whiskers, and a black eye-ring. Large ears, white inside and rufous-brown on the outer surface. Body creamy-white to sandy fawn, relatively thin coat, back sometimes flecked with black or rufous, with darker mid-dorsal line. Flanks paler than dorsal pelage, merging into white or buffy-white undersides, and legs rufous. Long, bushy tail, reddish brown with conspicuous black tip and a dark patch above tail gland. Females have three pairs of mammae. The skull is small with a relatively short maxillary region, and well-developed upper molars in relation to relatively weak carnassial teeth (Clutton-Brock *et al.* 1976). Bullae of the pale fox are slightly larger and the nasals appreciably longer than in Rüppell’s fox (Rosevear 1974). Dental formula is 3/3-1/1-4/4-2/3=42.

Table 7.2.1. Combined body measurements for the pale fox from across the range (Dorst and Dandelot 1970; Rosevear 1974; Happold 1987).

HB	380–550mm
T	230–290mm
HF	100mm
E	65–72mm
WT	2.0–3.6kg

Subspecies Five races have been described, four of which are listed here (following Coetzee 1977). According to Rosevear (1974), variation may be clinal.

- *V. p. pallida* (Sudan, from Kordofan to Dongola)
- *V. p. edwardsi* (Mali, Senegal)
- *V. p. harterti* (northern Nigeria northwards to Air in Niger, and westwards to Burkina Faso)
- *V. p. oertzeni* (Nigeria, northern Cameroon and Chad to Libya in the north and Darfur province of Sudan in the south).

Similar species Red fox (*Vulpes vulpes*): larger, with shorter legs and ears. Rüppell’s fox (*V. rueppellii*): ears larger; longer tail without black tip (usually white); carnassials 1–3mm longer. Fennec fox (*V. zerda*): ears much larger and thicker, longer coat.

Current distribution

The pale fox is distributed in the semi-arid Sahelian region of Africa bordering the Sahara, from Mauritania and Senegal through Nigeria, Cameroon and Chad to the Red Sea (Figure 7.2.1). Southern limit of geographical range extends into northern Guinean savannah zones.

Range countries Algeria(?), Burkina Faso, Cameroon, Central African Republic (?), Chad, Eritrea, Ethiopia, Gambia, Libya, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia (?), Sudan (Lavauden 1926; Rosevear 1974;



Figure 7.2.1. Current distribution of the pale fox.

Pale fox, age and sex unknown.



Happold 1987; Yalden *et al.* 1980, 1996; Granjon *et al.* 1995; Grubb *et al.* 1998).

Relative abundance

Widespread and present throughout range but in most parts locally rare. It is one of the least known canid species.

Estimated populations/relative abundance and population trends There is no detailed information on its abundance or status.

Habitat

Typically inhabiting very dry sandy and stony sub-Saharan desert and semi-desert areas, but extending to some extent southwards into moister Guinean savannahs. Therefore, they have a very extensive distribution within an unstable and fluctuating ecological band lying between true desert and the Guinean savannahs. May occur near human habitation and cultivated fields where food is more readily available than in natural habitats (Rosevear 1974).

Food and foraging behaviour

Food Well-developed molars suggest pale foxes are essentially herbivorous, eating mainly berries, wild fruit such as melons, and vegetable matter. They also feed on small rodents, ground-nesting birds, small reptiles and invertebrates (Dorst and Dandelot 1970; Kingdon 1997).

Foraging behaviour Unknown.

Damage to livestock or game: Unlikely, although they are known to kill domestic birds (Rosevear 1974).

Adaptations

Pale foxes tolerate heat well. They can survive lengthy hot, dry seasons, presumably on fruits and the residual moisture of their prey, although they are unable to bear completely waterless conditions (Kingdon 1997).

Social behaviour

Little is known of their habits, but they are gregarious and have been observed in pairs and small family parties (Dorst and Dandelot 1970; Rosevear 1974; Coetzee 1977). In captivity, a group of one female and two males got along amicably (Bueler 1973). They are active from dusk till dawn, resting during the day in extensive burrows, occupied by several individuals (Coetzee 1977).

Reproduction and denning behaviour

Pale foxes dig extensive burrows, 2–3m deep and up to 15m in length, with inner chambers lined with dry vegetation, often under sandy tracks or in the neighbourhood of villages (Haltenorth and Diller 1980). Gestation is likely to be in the region of 7–8 weeks. A captive female gave birth to a litter of four in June (Bueler 1973). Gestation period

in captivity is 51–53 days. Three to six young are born; weaning takes six to eight weeks.

Competition

Unknown.

Mortality and pathogens

Unknown, but probably susceptible to predation by other desert carnivores and aerial predators and pathogens like rabies and canine distemper. Anderson (1902) mentioned skulls of the species found in the nest of a kite near Khartoum.

Longevity A captive animal lived to three years (Rosevear 1974), but it is likely that they live to at least twice this age.

Historical perspective

No information available.

Conservation status

Threats Unknown, although occasional persecution by chicken raiders may take place.

Commercial use None.

Occurrence in protected areas Likely to occur in a number of protected areas throughout the species' range, but no reliable information available.

Protection status CITES – not listed.

Current legal protection No information available.

Conservation measures taken No information available, although it is unlikely that any proactive measures have been taken by any of the range countries.

Occurrence in captivity

There are no pale foxes in captivity in collections reporting to ISIS or the International Zoo Year Book. There have been no breeding records for the last decade.

Current or planned research projects

None known.

Gaps in knowledge

This is one of the least known canid species, and studies on distribution, status, basic biology and ecological requirements are needed.

Core literature

Coetzee 1977; Dorst and Dandelot 1970; Happold 1987; Kingdon 1997; Rosevear 1974.

Reviewers: Joshua R. Ginsberg, Chris Stuart and Tilde Stuart. **Editor:** Michael Hoffmann.

7.3 Rüppell's fox *Vulpes rueppellii* (Schinz, 1825) Data Deficient (2004)

F. Cuzin and D.M. Lenain

Other names

Arabic: tsaaleb (name in use for all foxes), tsaaleb Sahir (Saudi Arabia), taaleb (Maghreb); **English:** Rüppell's fox, sand fox, Rüppell's sand fox; **French:** renard famélique, renard de Rüppell; **Hebrew:** shual holot, shual Negev; **Indigenous names:** Berber: abarhourh (Tachelhaït), akanouch (Zenet), aalboun (Tamazight) (name in use for all foxes); Tuareg: tazbat mallet, achorri, ehadjeh, avarran; Tubu: tourkou fidji tchou ouma (means literally jackal with white tail tip).

Taxonomy

Canis rüppellii Schinz, 1825. In G. Cuvier, Das Thierreich, 4: 508. Type locality: "Vatherland Dongola" [Sudan].

Originally included in *Canis*, but subsequently included in the genus *Vulpes*. The specific name has been misspelt in various ways (e.g., *V. rüppelli*: Ellerman and Morrison-Scott 1951). It is most commonly cited as *V. rueppelli* (Coetzee 1977; Corbet and Hill 1980), but the correct spelling of the name is *V. rueppellii*, as used by Wozencraft (1993). The specific name *rueppellii* is the genitive form of "rueppellius", the Latinisation of Rueppell's name (P. Grubb pers. comm.).

Chromosome number: 2n=40 (Ewer 1973).

Description

One of the smaller *Vulpes* species, Rüppell's fox is slighter in build than the red fox (*V. vulpes*), and has smaller limbs (Table 7.3.1). The ears are long and large in relation to the head, rather similar to the fennec fox (*V. zerda*), but this species lacks darker markings on the back of the ears. Coat colour is variable. The head is beige to a pale sand colour. The ears and face are usually pale, with most

animals having black whisker patches running up to the eye, although this too is variable. The colour on the back varies from pale sandy to greyish and even sometimes reddish, with a more or less silvery sheen due to black speckling being present. Flanks and the underbody are usually paler. The legs are beige to a fawn colour, and plantar and digital pads are almost completely covered by hairs. The black speckling from the back culminates in a dense black patch at the base of the tail, which is full and bushy and usually tipped white (a useful diagnostic feature). The fur is very fine and soft with two coats, a thicker darker coat for winter and a lighter colour coat for summer. Females have three pairs of mammae.

Rosevear (1974) remarked that the skull is like a smaller version of the side-striped jackal (*Canis adustus*), but without such well-developed occipital crests. The braincase is rounded, the postorbital processes are blunt and narrow, the zygomatic arches are strong, and the bullae are relatively large (though not so expanded as in fennec fox). The dental formula is 3/3-1/1-4/4-2/3=42.

Rüppell's fox captured from Rhub Al Khali, age and sex not noted. Dubai, United Arab Emirates, 1998.



Chris and Tilde Stuart

Table 7.3.1. Body measurements for the Rüppell's fox.

	Mahazat as-Sayd Protected Area, Saudi Arabia (Lenain 2000)	Israel (H. Hefner and E. Geffen unpubl.)	Egypt (Osborn and Helmy 1980)
HB male	462.3mm (400–520) n=35	474mm (430–550) n=9	466.0mm (419–519) n=28
HB female	434.7mm (345–487) n=15	450mm (420–480) n=1	419.4mm (411–559) n=16
T male	307.0mm (251–361) n=35	295mm (260–330) n=9	340.9mm (290–387) n=28
T female	275.0mm (230–332) n=15	268mm (220–300) n=5	320.7mm (273–363) n=16
HF male	111.8mm (100–127) n=35		126.8mm (115–138) n=29
HF female	104.7mm (96–115) n=15		121.5mm (110–131) n=16
E male	92.8mm (80–106) n=35	98mm (80–110) n=9	98.4mm (89–110) n=27
E female	86.4mm (75–93) n=15	90mm (80–100) n=5	96.4mm (88–110) n=16
WT male	1.62kg (1.10–2.30) n=179	1.638kg (1000–1800) n=9	1.79kg (1.4–2.3) n=13
WT female	1.48kg (1.10–1.80) n=93	1.470kg (1250–1700) n=5	1.67kg (1.4–1.8) n=6

Subspecies Many subspecies have been described (e.g., Allen 1939; Coetzee 1977), but the variability of specimens seems high (Hüfnagl 1972; Rosevear 1974). The following races seem to be the most valid:

- *V. r. rueppellii* (Egypt and Sudan)
- *V. r. caesia* (north-west Africa and Western Sahara)
- *V. r. cyrenaica* (including *V. r. cufrana*?) (Libya, south-western Egypt, extreme north-western Sudan)
- *V. r. somaliae* (Eritrea and Somalia)
- *V. r. sabaia* (Middle East and Arabic Peninsula)
- *V. r. zarudnyi* (Baluchistan)

Similar species The species may be confused with the red fox (*Vulpes vulpes*), which has darker markings to the back of the ears, especially by European observers who may be unfamiliar with the sleekness, pallor and long ears of local red foxes (Osborne 1992). Their small size may lead to confusion with the fennec fox (*V. zerda*), but the latter has a darker tail tip. The pale fox (*V. pallida*) has a relatively shorter, black-tipped tail, smaller ears, and smaller carnassials (Rosevear 1974).

Current distribution

Widespread in arid biotopes of desert and semi-desert regions of North Africa (north of 17°N) from Morocco and Mauritania to Egypt and Somalia, the northern limit of which is the northern fringes of the Sahara Desert (Figure 7.3.1). Also present in arid regions across the Arabian Peninsula eastwards to Pakistan (68°E) and north-west to Israel and Jordan. Suspected historical expansion of distribution area is likely due to desertification, compensated by competition with the red fox due to new human settlements. It seems to avoid the extreme arid regions in the middle of the Sahara, and the Arabian Empty Quarter, being more abundant on the fringes, in mountain massifs and near oases.

Range countries Afghanistan, Algeria, Chad, Djibouti, Egypt, Eritrea, Ethiopia, Iran, Iraq, Israel, Jordan, Libya,

Mali (?), Mauritania, Morocco (including Western Sahara), Niger, Oman, Pakistan, Palestine (?), Qatar (?), Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, Yemen. (Valverde 1957; Ingersoll 1968; Hüfnagl 1972; Rosevear 1974; Osborn and Helmy 1980; Gasperetti *et al.* 1985; Aulagnier and Thévenot 1986; De Smet 1988; Le Berre 1990; Harrison and Bates 1991; Kowalski and Rzebik-Kowalska 1991; Dragesco-Joffé 1993; Cuzin 1996; Lenain 2000).

Relative abundance

Although widespread throughout the Arabian Peninsula, the species is limited by the large desert areas (Harrison and Bates 1991) and is mainly confined to the arid and steppe regions. In southern Morocco, Rüppell's foxes seem to be rare and the population trend is unknown.

The density of Rüppell's fox is usually low, but seems higher in areas where food is more freely available, such as near human settlements (Valverde 1957; K. De Smet pers. comm). In a large, fenced, protected area of 2,244km² in Saudi Arabia, densities are 0.68/km² (Lenain 2000). Lower population estimates outside the fenced reserve indicate that the species may be very vulnerable in the over-grazed, human-influenced landscape of central Arabia. In the reserve, the population is stable, but there is a need to document long-term population dynamics (Lenain 2000).

Estimated populations/relative abundance and population trends There is no detailed information on its abundance or status.

Habitat

Their typical habitat includes sand and stone deserts. In Saudi Arabia, they have been found in open and stony habitat often with sparse vegetation cover, including a few herb and grass species (*Fagonia indica*, *Indigofera spinosa*, *Tribulus* spp., *Stipagrostis* spp. and *Panicum turgidum*). Taller vegetation, such as grasses and trees, was usually

Figure 7.3.1. Current distribution of Rüppell's fox.



sparse. Annual rainfall averaged 100mm per year with a maximum of 240mm per year (Lenain 2000).

On the northern fringe of the Sahara, Rüppell's fox may be found in areas with up to 150mm annual rainfall. In Morocco (including Western Sahara), the general habitat presents sparse to very sparse vegetation cover, dominated by small brushes (*Hammada scoparia*, *Panicum turgidum*, *Fagonia* spp.) mostly concentrated in wadis (with *Acacia* spp., *Argania spinosa*, *Balanites aegyptiaca*, *Maerua crassifolia* and *Capparis decidua* trees). In Niger (Dragesco-Joffé 1993) and Morocco (F. Cuzin pers. obs.), this species avoids large sand dune areas, where the fennec fox is the only other reported canid species; however, in Algeria, they also occur in large ergs (De Smet 1988).

The Rüppell's fox also lives in coastal areas, with extremely sparse vegetation and without any trees. They are able to survive in areas without any available water, as in central Saudi Arabia (Mahazat as-Sayd protected area) on the fringes of the Arabian Empty Quarter, in Algeria (De Smet 1988) and in Western Sahara, where observations do not show any relationship with distance to the nearest available water (F. Cuzin unpubl.).

Food and foraging behaviour

Food Rüppell's foxes are generalist predators. Their diet includes a high invertebrate content, as well as rodents, lizards, snakes, birds, and wild fruits (Valverde 1957; Osborn and Helmy 1980; Lindsay and Macdonald 1986; Kowalski 1988; Kingdon 1997). Lenain (2000) found that small mammals are an important component of their diet and that in the absence of small mammals, they will turn to beetles (Coleoptera). Scats also contained the remains of desert locusts (*Schistocera gregaria*), which were found in large numbers during some study periods (Olfermann 1996; Lenain 2000), suggesting that they may be very opportunistic.

Foraging behaviour Little is known except that they are solitary foragers (Olfermann 1996) and usually scavenge at camps and permanent human settlements (Valverde 1957; Harrison and Bates 1991; K. De Smet pers. comm; F. Cuzin pers. obs.). The species is mainly crepuscular/nocturnal, but active animals have been seen during the daytime in winter in the Western Sahara (F. Cuzin pers. obs.) and in Tunisia (K. De Smet pers. comm). Lenain (2000) recorded that departure from the den site usually took place in the hour following sunset. This was followed by alternating periods of activity and inactivity throughout the night, the latter usually taking place in the early hours of the morning. Foxes usually re-entered the den site before sunrise, remaining in the den throughout the day.

Damage to livestock or game Local breeders have reported that Rüppell's foxes prey on chickens, lambs and young goats in Saudi Arabia (Lenain 2000), Egypt (Osborn

and Helmy 1980), Niger (Dragesco-Joffé 1993) and in Algeria Hoggar (K. De Smet pers. comm).

Adaptations

Their ability to survive in a hyper-arid environment, where the opportunity to drink would be extremely rare, appears to be facilitated by various ecological, behavioural and physiological adaptations (though not to the extent seen in the fennec fox); even a captive specimen never drank (Petter 1952). The diet, which includes plant material, fruits and roots (Rosevear 1974; Lenain 2000), likely provides much of their moisture requirements, and behavioural (e.g., nocturnal activity patterns) and morphological adaptations (e.g., coat colour, hair on feet, large ears) help in thermoregulation. The role of physiological mechanisms (e.g., urinary concentrating ability) has yet to be established. They are reportedly able to squirt the noxious contents of their anal glands at potential aggressors (Kingdon 1997).

Social behaviour

Little is known, but reports indicate that the species may be gregarious, having been sighted in groups of 3–15 (I. Linn pers. comm.). These may represent extended family groups. Grouping may be incidental, a result of close aggregation of dens in the few areas where denning sites are available.

In Oman, Lindsay and Macdonald (1986) found that home ranges were very expansive covering some 69km², and social units were spatially separate. In Mahazat as-Sayd, Olfermann (1996) found a mean annual home range of 16.3km², while Lenain (2000) gives a figure of 10.2km². Olfermann (1996) found that males had significantly larger seasonal home ranges than females. Adults were usually organised as monogamous pairs.

Reproduction and denning behaviour

In Saudi Arabia, studies show that mating takes place from December to February (Olfermann 1996; Lenain 2000), which usually coincides with the first rains after the harsh summer period. Tracks of two adult animals obviously engaged in a courtship display were found in southern Morocco in November, a few days after heavy rainfall (F. Cuzin pers. obs.). Captures of young cubs have been made in early March in Saudi Arabia (Lenain 2000) and in March in Western Sahara (Valverde 1957). Petter (1952) recorded very young animals in the area of Beni Abbès (Algeria) in May, and peaks of captures of young cubs in Saudi Arabia were made from July to August following the dependency period (Lenain 2000). Gestation lasts 7–8 weeks (Olfermann 1996) and litter size is 2–3 in the Mahazat as-Sayd protected area in Saudi Arabia (Olfermann 1996). Young cubs remain dependent on their parents for an undefined period, after which they venture out from the den site area. Both sexes reach sexual maturity at around 9–10 months (Olfermann 1996).

Dens are commonly located under slabs of rock or dug at the base of trees or bushes (Lindsay and Macdonald 1986; Harrison and Bates 1991; Kingdon 1997). In areas with few shelters (like in southern Western Sahara), the species may use very exposed dens, often in the middle of plains (some of these burrows are dug by honey badgers, *Mellivora capensis*). In such areas, any disturbance induces the flight of the animal (F. Cuzin pers. obs.), and, in Niger, Dragesco-Joffé (1993) states that they often prefer to flee from their den in case of danger. This behaviour is very common for the Arabian red fox too.

In Oman, Lindsay and Macdonald (1986) found that study animals changed den sites frequently, likely as an anti-predator strategy or perhaps due to resource availability in other areas of a home range. Lenain (2000) recorded an instance where a shift occurred due to cooling: a male Rüppell's fox used a shallow scrape in a sabkha-type substrate (packed silt), with a maximum depth of 700mm. This type of substrate offers effective cooling, and midday temperatures may be 12–15°C lower inside the den than outside. This type of shallow scrape was recorded throughout the study area, although its cooling facility varied depending on the substrate.

Competition

In Saudi Arabia, Israel and Morocco, the red fox is present in the fringes of the desert, particularly those colonised by man. Rüppell's foxes may only be able to compete in the harshest desert areas, where the red fox is not able to survive, or in protected areas where red fox control is taking place (Yom-Tov and Mendelssohn 1988). The settlement of new areas represents an opportunity for the red fox to increase its range, at the expense of Rüppell's fox. In the Aïr, Niger, Dragesco-Joffé (1993) suggests that the density of Rüppell's fox is higher in areas where other carnivores, such as golden jackal (*Canis aureus*), caracal (*Caracal caracal*), sand cat (*Felis margarita*), striped hyaena (*Hyaena hyaena*) and fennec fox are absent.

Mortality and pathogens

Natural sources of mortality The fragments of the jaws of a young fox were found in pellets of an owl (*Bubo ascalaphus*) near Idjil (Mauritania) by Heim de Balsac and Heim de Balsac (1954), while Olfermann (1996) recorded predation by steppe eagles (*Aquila nipalensis*) and owls (*Bubo ascalaphus*) in Arabia. Lenain and Ostrowski (1998) recorded the death of a Rüppell's fox in a cage trap as a result of a honey badger attack. However, the honey badger is unlikely to be a predator of Rüppell's foxes and this was probably an opportunistic attack.

Persecution Poisoned baits are used indiscriminately to control predators in Saudi Arabia (Gasperetti *et al.* 1985), Niger (Dragesco-Joffé 1993) and Morocco (Cuzin 1996). Individuals are accidentally killed by jaw-traps used against

jackals (Dragesco-Joffé 1993). They are occasionally killed for food by nomads (Ginsberg and Macdonald 1990; F. Cuzin pers. obs.).

Hunting and trapping for fur Rüppell's fox furs have been found on sale (D. Lenain pers. obs.).

Road kills No road kills were recorded in Morocco (F. Cuzin pers. comm) or in Algeria and Tunisia (K. De Smet pers. comm) or Saudi Arabia (D. Lenain pers. obs.).

Pathogens and parasites Susceptibility to disease is poorly known. However, Lenain (2000) reported seroprevalence to canine distemper virus, canine parvovirus and canine rotavirus. Rabies does affect this species (S. Ostrowski pers. comm.), and they may be infested by ticks (e.g., *Rhipicephalus sanguineus*) and by various species of fleas (Olferman 1996; Lenain 2000).

Longevity Ostrowski (1999) estimated an age of 87.5–88.5 months for a male tagged in 1992 in the wild in Saudi Arabia; the maximum confirmed age in the wild is seven years, but it could be higher (Olfermann 1996). Haltenorth and Diller (1980) give longevity as 6.5 years in captivity.

Historical perspective

None.

Conservation status

Threats Habitat loss, fragmentation and degradation, direct and indirect persecution by hunting, and indiscriminate use of poisons, appear to represent the main threats in Morocco. In Israel, the species is on the verge of extinction due to competitive exclusion by red foxes that are expanding their range following human settlements in the Negev Desert (Yom-Tov and Mendelssohn 1988).

Commercial use Rarely hunted for food or for sale of furs.

Occurrence in protected areas

- *Algeria*: Ahaggar and Tasili n'Ajjer National Parks;
- *Egypt*: Gebel Elba Conservation Area;
- *Israel*: Maktesh Ramon National Park, Tznifim Nature Reserve;
- *Jordan*: Al-Shaumari Wildlife Reserve;
- *Libya*: Nefhusa National Park, Zellaf Nature Reserve;
- *Mauritania*: Banc d'Arguin National Park;
- *Niger*: Aïr and Tenere National Reserve;
- *Oman*: Jiddat al Harasis;
- *Saudi Arabia*: Mahazat as-Sayd, Harrat al' Harrah, Hawat bani Tamim, Uruq Bani Ma'arid, Majami Al Hadb, Saja / Umm ar Rimth;
- *Tunisia*: Sidi Toui National Park.

Protection status CITES – not listed.

The species is classed as Lower Risk: Near Threatened in Morocco (including Western Sahara) (Cuzin 1996).

Current legal protection In Saudi Arabia, there is currently no effective legislation for the protection of native carnivores (P. Seddon pers. comm.). It is not illegal to shoot, poison or trap mammalian carnivores. Hunting laws (Decree No. 457 and Decrees M/22, No.128) restrict such activities within the National Commission for Wildlife and Conservation Development protected areas network. Some of the areas encompass and protect carnivore populations, although none to date have been established with the protection of Rüppell's foxes listed as the main objective.

In Israel, the species is fully protected by law, and no hunting, trapping or trading is allowed. In Morocco, according to the annual hunting decree, Rüppell's foxes and red foxes may be hunted during the whole year, as they are considered as pests. There is no information for other countries.

Conservation measures taken None known.

Occurrence in captivity

Rüppell's foxes are held in captivity. According to the International Zoo Yearbook (1992), only two cases of successful breeding occurred in zoos (Nikolaev, Ukraine and Tel Aviv, Israel). Attempts to breed Rüppell's foxes have not been very successful (Ginsberg and Macdonald 1990), although they have been successfully bred in the Hai Bar Breeding Centre, Eilat, Israel (E. Geffen pers. comm.). According to ISIS data, 2 males, 4 females and 1 unsexed animal are kept in zoos, without any recent reproduction noted. One female is kept in Rabat Zoo, Morocco.

Current or planned research projects

J.B. Williams (Ohio State University, Columbus, USA) and D.M. Lenain and S. Ostrowski (National Wildlife Research Center, Taif, Saudi Arabia) are investigating metabolic response and water turnover of Rüppell's foxes in an arid environment in Saudi Arabia.

S. Ostrowski and D.M. Lenain (National Wildlife Research Centre, Taif, Saudi Arabia) and M. van Vuren (University of Pretoria, South Africa) are undertaking research into seroprevalence of canine diseases in the Rüppell's fox population at Mahazat as-Sayd, Saudi Arabia.

R. Hefner and E. Geffen (Tel Aviv University, Israel) are studying habitat use of Rüppell's foxes in Israel.

Gaps in knowledge

The status and ecology of North African populations remains largely unknown. Monitoring of populations in

well-established protected areas throughout the species' range is encouraged. There is scope for detailed study of competition between Rüppell's and red foxes.

Core literature

Lenain 2000; Lindsay and Macdonald 1986; Kowalski 1988; Olfermann 1996.

Reviewers: Eli Geffen, Stephane Ostrowski, Koenraad J.M. De Smet. **Editors:** Michael Hoffmann, Claudio Sillero-Zubiri.

7.4 Fennec fox

Vulpes zerda (Zimmermann, 1780)
Data Deficient (2004)

C.S. Asa, C. Valdespino and F. Cuzin

Other names

Arabic: Fenek: rhorchi, gorchi, arhorchi, aqorchi (Maghreb); **English:** fennec; **French:** fennec; **German:** fenek, wüstenfuchs; **Spanish:** fenec; **Indigenous names:** Tuareg: akori, akorhal, eresker, ahuneski.

Taxonomy

Canis zerda Zimmermann, 1780. Geogr. Gesch. Mensch. Vierf. Thiere 2: 247. Type locality: "Es bewohnt die Soara und andere Theile von Nordafrika hinter des Atlas, der Ritter Bruce behautet, man Fände es auch in tripolitanischen." [Sahara].

Placed in the genus *Fennecus* by Stains (1975), Coetzee (1977) and Nowak (1999). Wozencraft (1993) included *Fennecus* in the genus *Vulpes*, an arrangement in agreement with many other authorities (e.g., Clutton-Brock *et al.* 1976; Geffen *et al.* 1992e) and followed here. Note that two previously described races, *saarensis* Skjöldebrand, 1777 and *zaarensis* Gray, 1843 are synonyms.

Chromosome number: 2n=64 (Ewer 1973).

Description

The fennec fox is the smallest canid, with extremely large ears that give it the greatest ear to body ratio in the family (Table 7.4.1). The muzzle and legs are slender and delicate. Pelage is typically sandy or cream-coloured, although it may have a light fawn, red or grey cast; underparts are paler. The large ears are darker on the back and white or nearly so inside; ear edges are white. Eyes are large and dark, with dark streaks extending from the inner eye down and outward to either side of the muzzle. Upper parts of limbs reportedly coloured reddish-sand in individuals from North Africa, whereas those from further south are nearly white in these areas. The coat is very thick and long; dense fur on the feet extends to cover the pads. The tail is also well furred with a darker tip and a slightly darker spot

Table 7.4.1. Body measurements for the fennec fox.

	Saint Louis Zoo, St. Louis, MO, USA	West Africa, Sudan, and northern Africa (Rosevear 1974) (gender not reported)	Egypt (Osborn and Helmy 1980) (gender not reported)
HB male	392mm (390–395) n=2	362mm (333–395) n=9	368mm (337–387) n=46
HB female	382mm (345–395) n=5		
T male	232mm (225–240) n=2	169mm (125–187) n=9	206mm (186–230) n=46
T female	241mm (230–250) n=5		
HF male	105mm (100–110) n=2	93mm (90–98) n=9	103mm (93–111) n=46
HF female	98mm (92–100) n=5		
E male	100mm (100) n=1	91mm (86–97) n=9	96mm (88–104) n=46
E female	93mm (90–95) n=5		
WT male	1.5kg (1.3–1.7) n=2		1.1kg (0.8–1.15) n=9
WT female	1.4kg (1.0–1.9) n=5		



Six year-old female fennec fox.
St Louis Zoo, Missouri, USA,
2001.

Chuck Dresner

covering the caudal gland. Females have three pairs of mammae. It has a vulpine skull, but with very large tympanic bullae (Clutton-Brock *et al.* 1976). The canines are small and narrow. The dental formula is 3/3-1/1-4/4-2/3=42.

Subspecies Monotypic (Coetzee 1977).

Similar species Rüppell's fox (*Vulpes rueppellii*): larger; upper parts silvery grey. Pale fox (*V. pallida*): larger; upper parts pale sandy fawn suffused with black hairs (Dorst and Dandelot 1970).

Current distribution

Widespread in the sandy deserts and semi-deserts of northern Africa to northern Sinai (Figure 7.4.1) (Saleh and Basuony 1998).

Historical distribution Morocco, Algeria, Tunisia, Libya, and Egypt south to the Sudan.

Current distribution They are common throughout the Sahara (Harrison and Bates 1991) and may occur to north Sahelian areas in the south to 14°N (Dragesco-Joffé 1993; Granjon *et al.* 1995). References to fennec fox sightings in the United Arab Emirates were based on an animal in the Al Ain zoo (Al-Robbæ 1982), which was, in fact, a Rüppell's fox (Gasperetti *et al.* 1985). Thesiger (1949) reported fennec fox tracks in the region of Abu Dhabi but whether the tracks were accurately identified is uncertain. The only documented regression concerns northern Moroccan Sahara, where the fennec foxes disappeared during the 1960s from four localities, which were restricted sandy areas close to permanent human settlements (F. Cuzin pers. obs.).

Range countries Algeria, Chad, Egypt, Libya, Mali, Mauritania, Morocco (including Western Sahara), Niger, Sudan, and Tunisia (Hufnagl 1972; De Smet 1988; Bel Hadj Kacem *et al.* 1994; Granjon *et al.* 1995; Poilecot 1996; Saleh and Basuony 1998).

Relative abundance

Current statistics are not available, but the population is assumed to be adequate based on the observations that the fennec fox is still commonly trapped and sold commercially in northern Africa. In southern Morocco, fennec foxes were commonly seen in all sandy areas away from permanent human settlements (F. Cuzin pers. obs.).

Estimated populations/relative abundance and population trends There is no detailed information on its abundance or status.

Habitat

Fennec foxes subsist in arid desert environments, preferring this substrate for burrowing. Stable sand dunes are believed to be ideal habitat (Dorst and Dandelot 1970; Coetzee 1977), although they also live in very sparsely vegetated sand dunes near the Atlantic coast (F. Cuzin pers. obs.). Annual rainfall is less than 100mm per year on the northern fringe of the fennec fox's distribution. On the southern fringe, it may be found up to the Sahelian areas that receive as much as 300mm rainfall per year. In the Sahara, sparse vegetation is usually dominated by *Aristida* spp., and *Ephedra alata* in large sand dunes. In small sand dunes, it is dominated by *Panicum turgidum*, *Zygophyllum* spp., and sometimes by trees like *Acacia* spp. and *Capparis decidua* (F. Cuzin pers. obs.). The fennec fox is claimed to be the only carnivore of the Sahara living completely away from water sources (Dekeyser and Derivot 1959, in Noll-Banholzer 1979).

Food and foraging behaviour

Food Fennec foxes are omnivorous and are reported to consume insects, small rodents (e.g., *Jaculus jaculus*, *Gerbillus* spp. and *Meriones* spp.), lizards (e.g., *Acanthodactylus* spp.), geckos (e.g., *Stenodactylus* spp.), skinks (e.g., *Scincus albifasciatus*), eggs, small birds (e.g., larks and sandgrouse), various fruits and some tubers (Dragesco-Joffé 1993; F. Cuzin pers. obs.). Captive fennec foxes have also been reported to capture and kill an adult rabbit (Gauthier-Pilters 1962).

Foraging behaviour Fennec foxes hunt alone (Coetzee 1977), probably because solitary hunting of small prey is more efficient. They have not been seen using the “mouse jump” hunting strategy typical of most fox species (Ewer 1973), but reportedly dig to find insects and small vertebrates. However, like other foxes, they do cache food by burying. Fennec foxes are very opportunistic and commonly visit temporary human settlements during the night in search of food (Dragesco-Joffé 1993; F. Cuzin pers. obs.).

Damage to livestock or game In Niger, some individuals have been reported raiding poultry coops (Dragesco-Joffé 1993).

Adaptations

The fennec fox is well adapted to desert living. They are primarily nocturnal, although crepuscular activity is also reported (Gauthier-Pilters 1967). In southern Morocco, animals were commonly active in winter until around mid-morning (F. Cuzin pers. obs.). The pale, dense fur presumably serves to protect against cold nights, whereas the well-furred feet facilitate walking on hot, sandy substrates. The exceptionally large ears likely help in heat dissipation, but may also aid in locating insects and small



Figure 6.3.1. Current distribution of the fennec fox.

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vertebrates (Ewer 1973). Nocturnal activity patterns, the use of burrows during the day, and the moisture content of their prey probably contribute to their ability to go without drinking water (Schmidt-Nielsen 1964; Dragesco-Joffé 1993; F. Cuzin pers. obs.). In addition, their kidneys filter extremely high concentrations of urea with little water loss (Gasperetti *et al.* 1985).

Social behaviour

Fennec foxes are thought to be moderately social, but this evidence is based mainly on captive animals. The basic social unit is believed to be a mated pair and their offspring, and, like some other canids, the young of the previous year may remain in the family even when a new litter is born (Gauthier-Pilters 1967). Play behaviour is common, even among adults, although males show more aggression and urine-marking around the time of oestrus. Captive fennec foxes engage in high levels of affiliative behaviour, and typically rest in contact with each other. In captivity, fennec foxes often bury faeces by pushing loose substrate with their noses or hind feet (Gauthier-Pilters 1962).

Reproduction and denning behaviour

First mating is reported at nine months (Bekoff *et al.* 1981) to one year (Gauthier-Pilters 1967). In the wild, fennec foxes mate in January and February and give birth in March and April (Gauthier-Pilters 1967). In captivity, births can occur year round, but most litters are born between March and July (Bauman 2002). Data from captivity are more extensive than those from the wild, but, because captive animals are maintained in a broad range of environmental conditions, inter-oestrous intervals vary considerably. Individual differences are also likely to contribute to this variability. Fennec foxes most commonly give birth once annually, but more than one litter per year is possible under some conditions (Koenig 1970; Valdespino *et al.* 2002).

The fennec fox monoestrous cycle is characterised by a pro-oestrous phase of about six days and a one- to two-day oestrus (Gauthier-Pilters 1967; Koenig 1970; Valdespino *et al.* 2002). There is no sanguineous discharge in association with oestrus or pro-oestrus. In non-fertile cycles, ovulation is followed by an approximately 50-day di-oestrous period, also called pseudopregnancy because it is equivalent in hormonal pattern and duration to gestation (Asa and Valdespino 1998; Valdespino 2000). Most remarkable is the exceptionally long copulatory tie of as long as 2 hrs 45 min (Valdespino 2000; Valdespino *et al.* 2002). The male becomes very aggressive and protective of the female after mating, and he provisions her during pregnancy and lactation (Sowards 1981).

Gestation is 50–52 days (Petter 1957; Volf 1957; Saint Giron 1962; Koenig 1970); however, Gangloff (1972) reported 62- and 63-day gestations for two fennec foxes at the Strasbourg Zoo. Litter size ranges from 1–4 (Petter

1957; Gauthier-Pilters 1967; Koenig 1970; Gangloff 1972; Bauman 2002), and weaning takes place at 61–70 days (Koenig 1970).

Dens are always dug in sand, in open areas or places sheltered by plants such as *Aristida pungens*, and *Calligonum comosum* (Dragesco-Joffé 1993; F. Cuzin pers. obs.). Dens may be huge and labyrinthine, especially in the most compacted soils, covering up to 120m², with as many as 15 different entrances (Dragesco-Joffé 1993). Bueler (1973) reports that dens may be close together or even interconnected. In soft sand, dens are usually small and simple, with just one entrance and one tunnel leading to a chamber (Dragesco-Joffé 1993; Cuzin 1996).

Competition

The fennec fox is partly sympatric with, and thus may face competition from, Rüppell's fox (Lindsay and Macdonald 1986), although direct observations have not been made. In southern Morocco, encounters between these species are rare, as Rüppell's fox rarely goes into large sandy areas (F. Cuzin pers. obs.). At its southern limit, the fennec fox is sympatric with the pale fox (Dragesco-Joffé 1993).

Mortality and pathogens

Natural sources of mortality In the wild, jackals, striped hyaenas (*Hyaena hyaena*) and domestic dogs are reported to prey on fennec foxes (Gauthier-Pilters 1967), though this is anecdotal and possibly questionable. The capture of fennec foxes is likely very difficult, as they are fast and able to change direction very quickly. Nomads consider them very difficult to capture, even for the saluki, a local greyhound-like dog (Monteil 1951; Dragesco-Joffé 1993). However, the eagle owl may prey on young fennec foxes (Dragesco-Joffé 1993). There is significant mortality of neonates in captivity, generally attributed to the sensitivity of the parents to disturbance (Petter 1957; Volf 1957; Gangloff 1972).

Persecution Young foxes are captured in their burrow by humans for photographic exhibition, to be sold to tourists (F. Cuzin pers. obs.), or to locals to be raised for meat (Schmidt-Nielsen 1964). In southern Morocco, however, fennec fox meat is not eaten because it is considered foul smelling (F. Cuzin pers. obs.).

Hunting and trapping for fur Fennec foxes are commonly trapped for sale to the pet trade and for fur by the indigenous people of northern Africa.

Road kills Because roads are rare in large sandy areas, only one mortality has been recorded in southern Morocco (F. Cuzin pers. obs.).

Pathogens and parasite Fennec foxes are presumed to be susceptible to pathogens and parasites that affect

domestic dogs. There is some evidence that modified-live canine distemper vaccine may induce canine distemper in fennec foxes (Montali *et al.* 1994), but the newer sub-unit vaccines should not (R. Junge pers. comm.).

Longevity Lifespan in the wild is unknown. In captivity, the recorded maximum longevity is 14 years for males and 13 years for females (Bauman 2002).

Historical perspective

None.

Conservation status

Threats The primary threat appears to be trapping for commercial use. In sandy areas commonly visited by tourists, the fennec fox is well known, but because it is otherwise difficult to see, it is trapped for exhibition or sale to tourists (F. Cuzin pers. obs.). Though restricted to marginal areas, new permanent human settlements such as those in southern Morocco have resulted in the disappearance of fennec foxes in these areas (F. Cuzin pers. obs.).

Commercial use See Mortality and pathogens.

Occurrence in protected areas

- *Algeria*: Ahaggar and Tasili n’Ajjjer National Parks;
- *Egypt*: Bir El Abd Conservation Area;
- *Libya*: Nefhusa National Park, Zellaf Nature Reserve;
- *Mauritania*: Banc d’Arguin and Diawling National Parks;
- *Niger*: Aïr and Tenere National Reserve;
- *Tunisia*: Sidi Toui National Park.

Protection status CITES – Appendix II (2000)

Listed as Lower Risk: Least Concern (Cuzin 1996) in Morocco, which probably reflects their threat status across their range.

Current legal protection Legally protected in Morocco (including Western Sahara).

Conservation measures taken No specific measures taken.

Occurrence in captivity

Historically, the North American Regional Studbook (Bauman 2002) lists some 839 individuals that have been held in the North American region between 1900 and 2001. At the end of 2001, there were 131 individuals in 51 institutions. The Australian Regional Studbook lists 81 historically, with only 12 in the captive population at present. Although fennec foxes occur in European zoos, there is no studbook or management plan. Fennec foxes are also kept as pets and bred privately, but these records are not available.

Current or planned research projects

None known.

Gaps in knowledge

While studies of captive animals have gone some way towards improving our knowledge of this enigmatic species (particularly as regards reproduction), much remains unknown of their basic ecology and behaviour in the wild. Work on captive populations is encouraged, but an in-depth study of the species, with particular emphasis on habitat use and population dynamics in the wild, is overdue.

Core literature

Bauman 2002; Gangloff 1972; Gautier-Pilters 1962, 1967; Petter 1957; Valdespino 2000; Valdespino *et al.* 2002.

Reviewer: Karen L. Bauman. **Editors:** Michael Hoffmann, Claudio Sillero-Zubiri.

South Asia – South of the Himalaya (Oriental)

8.1 Dhole

Cuon alpinus (Pallas, 1811)

Endangered – EN: C2a(i) (2004)

L.S. Durbin, A.Venkataraman, S. Hedges
and W. Duckworth

Other names

English: Asiatic wild dog, Indian wild dog, red dog; **French:** chien sauvage d'Asie, cuon d'Asie; **German:** der alpenwolf, rotwolf; **Spanish:** perro salvaje Asiatico; **Indigenous names:** Assamese: kuang-kukur, rang kukur; Bahasa Indonesia: adjag or ajag, anjing hutan; Bahasa Malaysia: srigala, Bengali: ban-kutta, ban-kukur; Bhutanese: phara, phou; Burmese: tan-kwe; Buryat: zurbi; Chinese: tsai-lang; Gujarati: kutra; Gurkhali: ban-kukur; Hindi: adivi-kuta, son-kuta, sona-kuta, rasa-kuta, jungli kuta; Javanese: asu alas; Kachin: kyi-kwa-lam; Kashmiri: jungli-kuta, ram-hun, ban-kuta, bhansa; Kazakh: chue; Kirgizian: chue, nyar; Kannada: kadu nai, korku, bun-seeta; Khmer: chikai prey [wild dog]; Ladakh: farra; Lao: ma nai [big dog]; Tibetan: farra; Manipuri: huithou; Lepcha: sa-tun; Malayalam/Tamil: chen nai; Marathi: kolsun; Mongolian: dshergul; Nepali: bwaso; Oriya: balia kukura; Russian: krasnyi volk [red wolf], dikaya sobaka [wild dog], chikalka; Telugu: resu kukka; Thai: maa nay; Telegu: resu kukka; Tungus: dzergil; Vietnamese: cho soi lua.

Taxonomy

Canis alpinus Pallas, 1811:34. Type locality: near Udskoi Ostrog, Uda R., Amur region, former USSR.

The genus *Cuon* is post-Pleistocene in origin, and related more closely to the extant jackals than to wolves (Thenius 1954). Simpson (1945) placed the dhole in the subfamily Simocyoninae of the family Canidae, together with the African wild dog (*Lycaon pictus*) and the bush dog (*Speothos venaticus*) of South America on the basis of shared anatomical features, most notably the reduction

of the role of the crushing post-carnassial molars. Many have questioned Simpson's classification arguing that similarities in dentition are due to convergent evolution because of a highly predatory diet (Thenius 1954).

Clutton-Brock *et al.* (1976) provided further support for Thenius's view by analysing morphological, ecological and behavioural characteristics across 39 canid species. Their study found that *Cuon* was more similar to *Canis*, *Dusicyon* and even *Alopex*, than to *Speothos* or *Lycaon*. However, *Cuon* resembled *Speothos* and *Lycaon* only when skull and dental characters were considered. According to Kleiman (1972) and Lorenz (1975), *Cuon*, *Lycaon* and *Speothos* appear more closely related to other canid genera than to each other. Further evidence of the taxonomic distinctiveness between *Speothos*, *Cuon* and *Lycaon* comes from analysis of sequences from mitochondrial genes (Wayne *et al.* 1997); both *Lycaon* and *Cuon* were classified as *Canis*-like canids and *Speothos* within a clade with another South American canid, the maned wolf (*Chrysocyon brachyurus*).

Chromosome number: 2n=78 (Aristov and Baryshnikov 2001).

Description

Dholes are large canids (typically 12–20kg) (Table 8.1.1), usually having a reddish or brown coat and a darker, bushy tail (sometimes with a white tip). Sexual dimorphism is not very distinct with no quantitative anatomical differences known. The ears are triangular with rounded tips (about half the length of the face). The pinnae are usually whitish-fawn on the inside and reddish-brown on the outside. The muzzle is brown, relatively short, and slightly convex in profile. The nose is black and the eyes slightly hooded with amber irises. The dorsal and lateral pelage is red to brown and the foreneck, chest and undersides are often whitish or light ginger coloured. In the south and south-west of the dhole's range, the fur is shorter and rusty-red coloured. In the north and north-

Table 8.1.1. Body measurements for the dhole.

	Cohen (1978)	Phu Khieo Wildlife Sanctuary, Thailand (L. Grassman unpubl.).	Kanha, India (L. Durbin unpubl.).
HB	880–1,130mm	male: 970mm (880–1,050) n=3	1,355mm n=1
T	410–500mm	male: 340mm (320–360) n=3	421mm n=1
WT male	15–20kg	16.0kg (15.0–17.0) n=3	15.5kg, n=1
WT female	10–13kg		



Two-year-old male dhole.
Bandipur National Park,
Karnataka State, India, 1996.

Krupakar Senani

east, the fur is longer, brownish-red or yellowish-brown. The legs are notably shorter in some alpine regions and the coat is a yellowish-grey colour in Himalayan regions. In Thailand, the coat is more uniform brown lacking the lighter throat and chest. The coat is occasionally grizzled (Duckworth *et al.* 1998). The toes are red, brown and/or white; the hairless fore-toe pads (on all feet) are joined at the base (near the main pad) unlike most domestic dogs. Dentition is unique within the Canidae having one fewer lower molar tooth (3/3-1/1-4/4-2/2), with the heel of the lower carnassial M_1 crested and with a single cusp (all other canids within the range of *Cuon* have two cusps). There are usually six or seven pairs of mammae, rather than the five pairs typical for *Canis* (Burton 1940).

Subspecies Mivart (1890) distinguished two species of *Cuon*, the southern dhole (*C. javanicus*) and the northern dhole (*C. alpinus*), on the bases of body size and the second upper and lower molars. Ellerman and Morrison-Scott (1951), however, recognised 10 subspecies, later revised to nine (Ellerman and Morrison-Scott 1966) or 11, according to Ginsberg and Macdonald (1990), which are given below. The validity of many of these forms is doubtful.

- *C. a. alpinus* (east of eastern Sayans, East Russia). Thick tawny red coat greyish neck and ochre muzzle.
- *C. a. lepturus* (south of Yangze River, China). Uniform red coat with thick underfur.
- *C. a. dukhunensis* (south of the Ganges, India). Reddish coat, short hair on the paws and black whiskers.
- *C. a. adjustus* (North Myanmar and north-east India). Reddish brown coat.
- *C. a. primaevus* (Himalayan Nepal, Sikkim and Bhutan). Longer redder coat than *C. a. dukhunensis*, long hair on paws.

- *C. a. laniger* (Kashmir and southern Tibet). Full, yellowish-grey coat, tail not black but same colour as body.
- *C. a. hesperius* (East Russia and China). Long yellow-tinted coat, white underside and pale whiskers.
- *C. a. fumosus* (West Szechuan, China and Mongolia). Luxuriant yellowish-red coat, dark back and grey neck.
- *C. a. infuscus* (South Myanmar, Malaysia, Thailand, Laos, Cambodia and Vietnam). Relatively uniform brown coat.
- *C. a. sumatrensis* (Sumatra, Indonesia). Short red coat and dark whiskers.
- *C. a. javanicus* (Java, Indonesia). Short, bright red coat.

Similar species Dingo (*Canis lupus dingo*): Tail less bushy and when held upright often bends forward towards the head; penis more visible from side and ears pointed; proportionally longer jaw relative to head length.

Golden jackal (*Canis aureus*): Notably smaller (*c.* 2/3 size of dhole), with proportionally shorter tail to body; coat yellowish-brown and always grizzled; face thin and ears pointed; distinctive fast trotting gait.

Grey wolf (*Canis lupus*): Notably larger; distinctive greyish coat; ears pointed; penis more visible from side; proportionally longer jaw relative to head length.

Distribution

Historical distribution Most of South, East, and South-east Asia. Extending from the Tian-Shan and Altai mountains and the Maritime Province of the former USSR southwards through Mongolia, Korea, China, Tibet, Nepal, India, and south-eastwards into Myanmar and Indochina (Cambodia, Vietnam, and Laos), Thailand, the Malaysian peninsula, and the Indonesian islands of Sumatra and Java.

Current distribution

Central and eastern Asia: There have been no confirmed, recent reports of dholes from Russia, Mongolia, Kazakhstan, Kyrgyzstan (where they were found formerly in the Tian-Shan area), or Tajikistan (where they were found formerly in the eastern Pamir area) (A. Poyarkov and N. Ovsyanikov *in litt.* D. Miquelle pers. comm.). There is a recent report of a dhole that was captured in Jiangxi district, south China (C. Bellamy pers. comm.). Dholes were once present in parts of western China in the Tian-Shan Range, but the species' current status in this area is unclear. The species is still found in Tibet today, particularly in areas bordering the Ladakh region of India (R. Wangchuk pers. comm.), and the Tibet Forestry Bureau has reported that dholes are still "common" in parts of south-east Tibet (S. Chan, *in litt.*). Dholes occurred in northern Korea (Won Chang Man and Smith 1999) and a few small populations may still exist. There have been no records from Pakistan, but the species occurred on the alpine steppes of Ladakh, Kashmir, and India (Johnsingh 1985) that extend into the region termed Pakistan-occupied Kashmir by India.

India: Dholes are still found throughout much of India south of the river Ganges, and especially in the Central Indian Highlands and the Western and Eastern Ghats of the southern states. They are also found throughout north-east India, in the states of Arunachal Pradesh, Assam,

Meghalaya, and West Bengal (A. Venkataraman, A.J.T. Johnsingh and L. Durbin pers. comm.). In the Himalaya and north-western India, the status of dholes seems more precarious with a much more fragmented distribution. Dholes reportedly still occur in the Ladakh area of Kashmir, which is contiguous with the Tibetan highlands in China (R. Wangchuk pers. comm.).

Nepal Formerly recorded in the Terai region of the Indo-gangetic plain, including the Royal Chitawan National Park in Nepal, but there have been few recent reports. There is an unconfirmed report of dholes in Dhorpatan Hunting Reserve in the late 1990s (R.C. Kandel pers. comm.).

Bhutan: There have been recent press reports that dholes have recovered from a government-initiated mass poisoning campaign in the 1970s, and there have apparently been numerous recent incidents of dholes killing livestock in the lower Kheng region. Two recent, independent, eye-witness reports identify dholes in six protected areas in Bhutan (S. Wangchuk pers. comm.; T. Wangchuk pers. comm.). In some regions, dhole predation on wild boar (*Sus scrofa*) may be viewed in a positive light by local people (T. Wangchuk pers. comm.).

Bangladesh: Dholes were thought to occur in the forested tracts of the Chittagong and Sylhet Districts (Johnsingh 1985). It is not certain whether any remain in Bangladesh.

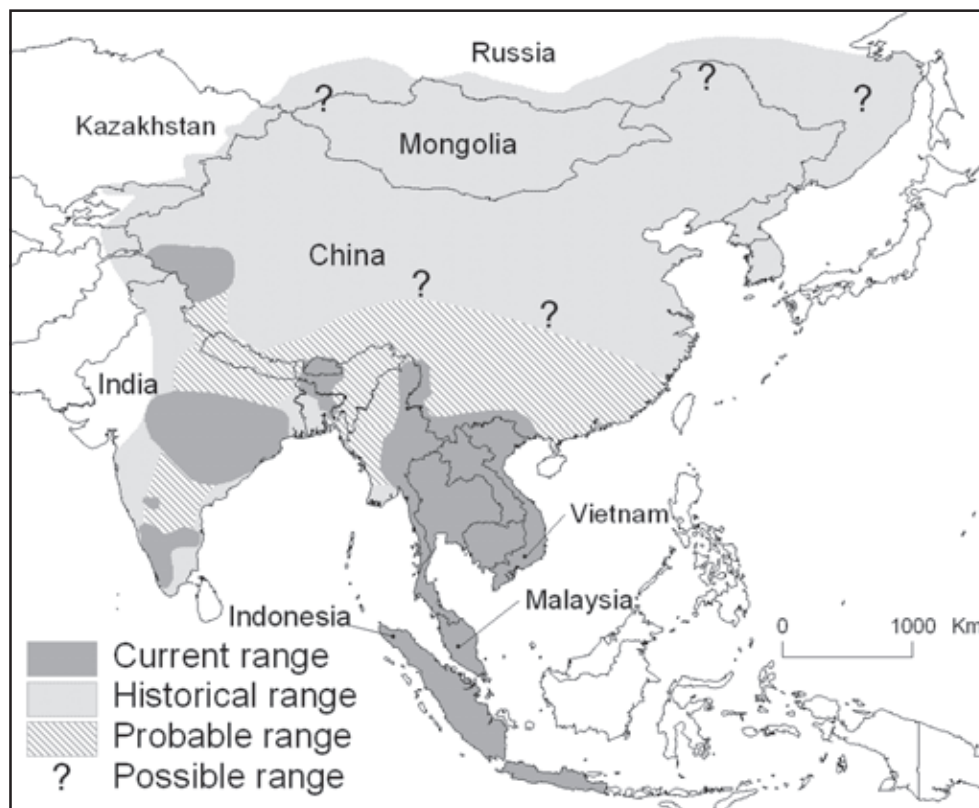


Figure 8.1.1. Current distribution of the dhole.

Myanmar: In Myanmar, dholes were recorded by camera trapping at 11 of 15 survey areas scattered across the country, only four of which were protected. Dholes and/or leopards have apparently replaced tigers as the top predator in these areas (Myanmar Forest Department 2003).

Indochina (Laos, Cambodia, Vietnam) and Thailand: Dholes probably ranged over all or almost all of Laos, Cambodia, Vietnam, and Thailand, although reliable site-specific information is scarce. Present distribution is highly fragmented, and large parts, particularly of Vietnam and Thailand are without any regular occurrence of dholes, although they persist in a number of protected areas (Duckworth *et al.* 1999; Waltson 2001; M. Baltzer and R. Shore *in litt.*; A. Lynam pers. comm.).

Indonesia and Malaysia: Their historical range probably included all or most of the Malaysian peninsula and the Indonesian islands of Sumatra and Java, but reliable information is scarce. Current distribution is poorly known but is thought to be highly fragmented. On the Malaysian peninsula, dholes are known to occur in four sites in northern and central areas of the peninsula (from recent camera-trap surveys; J.B. Abdul pers. comm.). On Java, dholes appear to be most common in the protected areas at the eastern and western ends of the island. On Sumatra, very little is known, but dholes are known to occur in major protected areas in the southern, central, and northern parts of the island (e.g., from camera trapping; D. Martyr pers. comm.).

Range countries Bangladesh (?), Bhutan, Cambodia, China (including Tibet), India, Indonesia (Sumatra and Java), Kazakhstan (Ex?), Kyrgyzstan (Ex?), North Korea (?), South Korea (?), Laos, Malaysian peninsula, Mongolia (?), Myanmar, Nepal (?), Pakistan (?), Russia (?), Tajikistan (Ex?), Thailand, and Vietnam (Johnsingh 1985; Sosnovskii 1967; A. Poyarkov and N. Ovsyanikov *in litt.*; D. Miquelle pers. comm.).

Relative abundance

The only information on dhole abundance comes from a few protected areas in southern and central India. These estimates have not been obtained through systematic sample-based survey methods, but are based on estimates of the number of packs within the protected areas (derived using known home range areas and knowledge of mean pack sizes).

Estimated populations/relative abundance and population trends Reported densities of dholes in protected areas include: Bandipur Project Tiger Reserve (Karnataka, southern India), 0.13 dholes/km² (A. Venkataraman and V. Narendra Babu unpubl.); Mudumalai Sanctuary (Tamil Nadu, southern India), 0.095 dholes/km² (A. Venkataraman

and V. Narendra Babu unpubl.); Pench National Park (Madhya Pradesh, central India), 0.3 dholes/km² (B.B. Acharya and A.J.T. Johnsingh unpubl.).

In the Mudumalai Sanctuary, dhole numbers have been monitored for the last 13 years, and there are indications that overall numbers are stable though substantial annual variations do occur. However, in parts of the adjoining Bandipur National Park, a significant decline in numbers has been observed in the years 2002 to 2003 (A. Venkataraman, pers. obs.). The reason for this decline is unknown. A.J.T. Johnsingh (pers. comm.) noted a decline of dholes during the 1970s in the Mundanthurai Plateau area of the Kalakad-Mundanthurai Project Tiger Reserve in southern India. There has been a recent increase in the number of dhole packs seen.

In general dholes are thought to be abundant in protected areas in southern and central India, including Bandipur and Nagarhole National Parks (Karnataka), Periyar Project Tiger Reserve (Kerala), Kanha National Park (Madhya Pradesh), and Melghat and Tadoba Project Tiger Reserves (Maharashtra). Abundance is relatively lower in West Bengal, Assam and Arunachal Pradesh. In the rest of north-east India (Nagaland, Mizoram), dholes are currently extinct or close to extinction.

No remotely comparable information on density is available for any part of Southeast Asia, and there are no empirical data on trends in this region.

Habitat

The dhole is found in a wide variety of vegetation types, including: primary, secondary and degraded forms of tropical dry and moist deciduous forest; evergreen and semi-evergreen forests; dry thorn forests; grassland–scrub–forest mosaics; and alpine steppe (above 3,000m a.s.l.). They are not recorded from desert regions.

In India, tropical dry and moist deciduous forest may represent optimal habitats, based on the regions thought to hold the largest dhole populations. Ungulate biomass, particularly that of cervid species, is highest in these vegetation types when compared to others in the same region (A. Venkataraman and V. Narendra Babu unpubl.). In India, tropical dry and moist deciduous forests are subject to seasonal monsoon climates.

Important factors that may influence habitat selection include the availability of medium to large ungulate prey species, water, the presence of other large carnivore species, human population levels, and suitability of breeding sites (proximity to water, presence of suitable boulder structures, and sufficient prey).

Food and foraging behaviour

Food The main prey of dholes varies throughout their range. Beetles, rodents, and birds have all been recorded among dhole prey items (e.g., Adams 1949; Davidar 1975); and dholes also occasionally consume grass and other

plants like most other carnivores (A.J.T. Johnsingh pers. comm.). However, dholes hunt mainly vertebrate prey, with a preference for medium to large ungulates. Studies of prey selection by sympatric carnivores in Nagarahole, in southern India, showed that dholes prefer medium-sized prey between 31kg and 175kg in weight (Karanth and Sunquist 1995, 2000). The average weight of prey killed by dholes was 43kg in Nagarahole. In Bandipur, prey weighing less than 50kg were most preferred (Johnsingh 1992). In Mudumalai Sanctuary, India, Venkataraman *et al.* (1995) reported the occurrence of prey remains in scats for two packs: chital remains comprised 70% and 41%, sambar (*Cervus unicolor*) 22% and 23%, cattle 4% and 15%, and lagomorphs 3% and 20%, for the two packs, respectively. In parts of Russia, the main prey species were reported to be reindeer (*Rangifer rangifer*), wild sheep (*Ovis* spp.), and wild goats (*Capra* spp.) (Sosnovski 1967). In Alas Purwo National Park in East Java, Indonesia, banteng (*Bos javanicus*) were frequently eaten by dholes during a study in the mid- to late-1990s (Hedges and Tyson 1996). Elsewhere on Java, dholes seem to take Javan rusa (*Cervus timorensis*) and red muntjac (*Muntiacus muntjac*) in preference to banteng (Hedges and Tyson 1996). In Khao Yai, Thailand, prey occurrence in scats comprised: sambar, 63%; red muntjac, 18%; East Asian porcupine (*Hystrix brachyura*), 5%; insects, 3%; birds, 3%; reptiles, 3% and vegetation, 5% (S. Austin unpubl.).

In Kanha National Park, India, dholes have been seen to return to scavenge on prey remains several days after the prey was killed (L. Durbin pers. obs.). Dholes were also occasionally observed to eat carrion (elephant (*Elephas maximus*) and gaur (*Bos gaurus*) carcasses), in Mudumalai Sanctuary (A. Venkataraman and R. Arumugam unpubl.) and have been seen feeding on a red muntjac carcass originally killed by a python in Thailand (Nettelbeck 1995). It has, however, been suggested that such scavenging only occurs during periods of prey scarcity, particularly during the dry season.

Dholes will occasionally eat vegetation and invertebrate prey. Grass is ingested, but may serve an anti-helminthic function rather than a nutritional one (L. Durbin unpubl.). Prater (1971) also writes “*In the South Indian hill ranges dholes are said to feed greedily on the fallen fruits of bael and black wood trees*”. Cohen (1977) found vegetable matter in only 25% of scats; Johnsingh (1983) found grass to be a major component in only 7% of scats.

Foraging behaviour Dholes are communal hunters, occasionally forming packs of over 30 animals (Fox 1984), but are more often found in hunting groups of fewer than 10 animals. Depending on prey availability, dholes may also hunt alone or in pairs, taking smaller prey such as infant deer or hares (Cohen 1977; Venkataraman *et al.* 1995). The dhole is primarily a crepuscular forager but can hunt at any time of the day or night (Johnsingh 1982; L.

Durbin, S. Hedges, and M. Tyson pers. obs.). In central India, dholes rarely run their prey to exhaustion and most chases extend for less than a few hundred metres (L. Durbin pers. obs.). This is generally the case when dholes hunt deer and banteng in East Java, but occasionally dholes chase banteng until the latter appear exhausted (S. Hedges and M. Tyson pers. obs.). During hunts, some dholes may lie in ambush while others drive prey towards them. Dholes often drive deer into water, where they surround them and swim out to capture them. It is common for certain individuals to take particular roles in the hunt, such as leading the chase or taking the first grab at the prey. Pack members communicate their whereabouts with whistles and yelps, and cooperate in bringing down and killing the prey. They eat quickly (e.g., up to 1kg per dog in 4 minutes; Johnsingh 1983), with relatively little aggression, except when dealing with small prey. Usually one or more dholes take turns as sentinel (who possibly look out for leopards and tigers that could prey on dholes or appropriate their kills or humans who scavenge kills in some areas) when feeding on large prey (L. Durbin, pers. obs.). Dholes hunt successfully both in open meadows and in denser forest. They prefer to kill their own prey, but sometimes steal the kills of other species, or scavenge from old kills.

Damage to livestock or game Dholes generally prefer to kill wild prey species and ignore domestic livestock (Venkataraman *et al.* 1995; L. Durbin pers. obs.). Sometimes they resort to stock predation (e.g., domestic cattle or goats) when their natural prey is diminished (Venkataraman *et al.* 1995; L. Durbin, S. Hedges and M. Tyson pers. obs.). Dholes sometimes prey on threatened species; for example, it was feared that the banteng population of Alas Purwo National Park in Java was being driven to local extinction by dhole predation (Hedges and Tyson 1996). It was the dholes that finally “disappeared” when banteng numbers reached a level that, apparently, could no longer sustain them. Possibly, these dholes turned to cattle predation and suffered retributive human persecution (S. Hedges and M. Tyson unpubl.). In Kanha, central India, dholes prey on a rare, endemic subspecies of swamp deer (*Cervus duvauceli branderi*). The two species seem to coexist, as chital, which constitute the dholes’ principal prey, are numerous in Kanha (L. Durbin pers. obs.).

Adaptations

The presence of only a single crested cusp (two in other canids) on the lower carnassial M_1 may enhance the sheering capacity of the teeth and hence the speed at which prey can be consumed. This may improve the dholes’ ability to compete with kleptoparasites.

Dholes have the capacity to hold large quantities of meat in their stomachs (c. 3kg). Like African wild dogs, they can also regurgitate small quantities at will, thus allowing the transportation of food to pack-mates and

neonates. This is an adaptation to communal breeding, providing food for the pups, the mother, and other adult helpers that remain at the den.

Social behaviour

Dholes usually live in packs of 5–10 individuals, but groups of as many as 18 (Alas Purwo, Java, Indonesia; Hedges and Tyson 1996), 24 (Kanha, India; L. Durbin unpubl.), and 25 (Mudumalai Sanctuary, India; Venkataraman *et al.* 1995) have been recorded on a regular basis. These group sizes included juvenile animals. Group size and composition may vary under different environmental conditions, but most of the current data are from India. Packs studied by Johnsingh (1983), Venkataraman *et al.* (1995), and L. Durbin (unpubl.), contained significantly more males than females, perhaps a reflection of female-biased dispersal (Venkataraman 1998).

Pack members regularly play together, engaging in mock-fights, rolling, and allo-grooming. Social rank is established by pushing and holding, but rarely by aggressive biting (M. Boer pers. comm., L. Durbin unpubl.). Groups have a strong hierarchical structure, with a dominant male and female who are the main, or sole, breeders.

Pack members over-mark each other's faeces and urine, producing latrines throughout the group's range. Latrines may serve intra-group communicative functions (e.g., relaying information about hierarchical or sexual status) as well as territorial ones. The ranges (or at least core areas) of neighbouring packs are often quite separate (Johnsingh 1982; Venkataraman *et al.* 1995; L. Durbin unpubl.), though interactions between groups can be either friendly or hostile.

In Bandipur, India, Johnsingh (1983) reports a home range size of 40 km² and Venkataraman *et al.* (1995) found ranges of 54 and 83 km² in Mudumalai. Durbin *et al.* (pers. comm.) radio-tracked an adult male within a breeding pack (12 adults; 12 pups) in Kanha, India, and during the three month tracking period, when adults were tending pups at den sites, the pack used a range of 55 km². In a more recent study in Thailand, three adult male dholes were captured, radio-collared, and tracked for one to ten months in Phu Khieo Wildlife Sanctuary, Thailand, between March 2000 and June 2002. A total of 101 radio-locations were recorded for two animals and used to calculate home range sizes. The overall home range sizes of two of the males were 12.0 km² and 49.5 km² respectively, while the third male could not be tracked after radio-collaring. The dholes did not utilise the habitat within their ranges in a uniform manner; instead, open forest/grassland was used proportionately more than closed forest (L. Grassman *in litt.*).

Dholes have a broad and unusual vocal repertoire that includes whines, mews, and squeaks (Fox 1984). Growls, growl-barks, chattering calls, and screams are used as alarms to alert other pack-mates to danger (Johnsingh 1982). This large range of alarm calls may have evolved to

alert pack-mates to danger from humans or other predators (e.g. leopard, tiger). Such calls could also act as a threat to intimidate adversaries. A repetitive whistle-like contact call may allow dispersed pack members to identify one another and to re-group (Durbin 1998). Maintaining group cohesion in this way is likely to be highly adaptive in areas with other large predators. Whistle calls travel well at ground level due to their frequency and structure and allow easy location of the source (L. Durbin unpubl.).

Reproduction and denning behaviour

Dholes give birth once a year and have a gestation period of about nine weeks (Sosnovskii 1967). Mating occurs between November and April (dry season) in India, with a peak during December and January (Davidar 1973; L. Durbin pers. obs; but see Venkataraman 1998; Johnsingh 1982). In East Java, dholes are thought to mate mainly during January and May (i.e., end of the wet season) (S. Hedges and M. Tyson pers. obs.). Females exhibit seasonal polyoestrus with a cycle of 4–6 weeks (M. Boer pers. comm.). The dominant pair engages in vigorous play and marking, culminating in a copulatory tie (Davidar 1973; Paulraj *et al.* 1992). It is usually only the dominant female that breeds, but exceptions have been noted. Johnsingh (1979) has observed lone females breeding outside the group, with limited or no success in rearing their litters. By contrast, three females have been seen suckling within a single group (Davidar 1974). Whether this represents plural breeding or "wet nursing" is uncertain. Subordinate males sometimes show sexual interest in the alpha female and may contribute to the paternity of the litter (Venkataraman 1998; M. Boer pers. comm.).

Litter sizes vary dramatically, even within the same pack in different years (e.g., up to 8, and 5–10, for two packs in Mudumalai; Venkataraman *et al.* 1995). The largest litter size recorded is 12, with only one lactating female in the group (Kanha, India; L. Durbin *et al.* unpubl.).

In captivity, newborn pups can weigh 200–350 g, although by the age of 10 days their body weight can double, and they have a total body length of about 340 mm (Sosnovskii 1967). Pups suckle from the mother until they are about three weeks old, when they start to receive regurgitated meat from other pack members. Pups are weaned by about 6–7 weeks (L. Durbin *et al.* unpubl.), although, in captivity, weaning has been recorded at 8–9 weeks (M. Boer pers. comm.). In their early weeks, the pups are quarrelsome, but with age they become more vigilant and less aggressive, noticeably so by around eight weeks (L. Durbin *et al.* unpubl.). All adults take part in guarding, feeding, grooming, and playing with the pups. By about three months, the pups accompany the adults during hunts (Johnsingh 1982); however, the pack may not be fully mobile until about eight months (Venkataraman 1998). Dholes reach adult size by about 15 months. Venkataraman (1998) states that female dholes breed for

the first time at three years. This is probably due to behavioural, as well as physiological, constraints. In captivity, dholes of both sexes can reproduce at two years of age (M. Boeer pers. comm.).

Den types range from earthen burrows to rocky caverns. Johnsingh (1982) and Fox (1984) provide more information on dhole den sites.

Competition

A number of instances have been recorded where dholes were killed and eaten by tigers and leopards (Venkataraman 1995). However, Venkataraman (1995) reported that injuries or deaths as a result of interactions between dholes and leopards or tigers were rare. Interactions are usually limited to intimidation and harassment, presumably to reduce competition resulting from use of common hunting grounds. In Nagarhole National Park, southern India, Karanth and Sunquist (1992) found dhole hairs in leopard scats, evidence that dholes are occasionally eaten by leopards. However, the effect of intra-guild competition on dhole densities is unknown.

In some areas humans scavenge dhole kill; for example, Kurumba tribes of the Nilgiris in southern India (Venkataraman 1999), and among at least one Mon Khmer speaking tribal group in Laos (Chamberlain 2003).

Mortality and pathogens

Natural sources of mortality Most observed injuries to dholes are probably inflicted by prey animals, but dholes have been wounded and killed by leopards and tigers (e.g., Connell 1944; Venkataraman 1998).

Persecution Dholes are persecuted throughout their range. In India, bounties were paid for carcasses until the Wildlife Act of 1972, when dholes were given legal protection. Perhaps the most common reason for persecution is the fear of stock predation. Methods of persecution include poisoning of carcasses, snaring, shooting, and clubbing of animals at den sites. In India, farmers can be compensated if there is proof that their stock has been killed by wild animals outside core protected areas. Despite this, stock predation is a common reason for dhole persecution by local people in India, e.g., Arunachal Pradesh (N. Babu pers. comm.). In India, British colonial hunters also shot and poisoned dholes because they saw them as a threat to the wild ungulate populations. Today, human persecution still occurs, but levels vary regionally depending on the enforcement of wildlife laws, levels of stock predation, and cultural beliefs. Across Laos, Cambodia, and Vietnam, levels of hunting are very high, sufficient to reduce almost all species of mammal larger than a hare to very low densities, except in the largest wildernesses, and to cause widespread local extinction of most species of large carnivores and ungulates. There is little if any evidence of dholes being specifically

hunted anywhere in these three countries, but because many hunting techniques are essentially non-selective (e.g., snaring), dholes are affected. Any dholes moving out of wilderness areas into human-settled areas are at risk of being killed, either as a result of indiscriminate snaring or as presumed stock predators.

Hunting and trapping for fur Not thought to be a significant mortality factor at present. Skins have been reported as curios (Duckworth *et al.* 1999). In the countries of the former USSR, dholes were not hunted for fur to any great extent because they occurred at too low densities (A. Poyarkov and N. Ovsyanikov *in litt.*). However, in the mid-19th century, dhole pelts were valuable in Ussuryisk Krai, and at the beginning of the 20th century, in Manchzhuriya, prices for dhole pelts were high (Geptner *et al.* 1967).

Road kills In India, many roads cut through dhole habitat and injuries and death by traffic are possibly significant causes of dhole mortality.

Pathogens and parasites When dholes are in contact with other species, especially other canids, they are at risk of contracting and transmitting infectious diseases. Dholes may occasionally present human health risks. Their faeces contain infectious pathogens such as *Toxocara canis*. Dholes have also been known to suffer from rabies (Morris 1942), canine distemper (Davidar 1975; M. Boeer pers. comm.), mange (Morris 1937; L. Durbin pers. obs.), trypanosomiasis (S.K. Ray pers. comm.), canine parvovirus (seroprevalences found in Chennai and Hopenhagen zoos, M. Boeer pers. comm.), and endoparasites such as cestodes and roundworms. In the 1940s, a rabies epidemic in the Billigirirangan Hills, India, resulted in villagers being bitten by rabid dholes and subsequently dying (Morris 1942).

Longevity Dholes can live to at least 16 years in captivity (Sosnovskii 1967), but this is uncommon in the wild. Venkataraman (1998) found that older dholes often “disappeared” from packs when 7–8 years old.

Historical perspective

No information.

Conservation Status

Threats

Depletion of the dhole's prey base. Across almost all of Cambodia, Laos, and Vietnam, as well as within protected areas, ungulates occur at levels well below natural. All species of ungulate except muntjacs (*Muntiacus* spp.), pigs (*Sus* spp.) and in some areas southern serow (*Naemorhedus sumatraensis*) are ecologically or fully extinct across extensive parts of the region. Only a few of the largest wildernesses support nearly intact species assemblages and even in these, the larger species (*Bos* spp., *Cervus* spp., hog

deer *Axis porcinus*) are very rare. This situation will likely hinder any possibility of recovery by the region's dhole populations, even if the other issues could be addressed. While not as depressed as in Indochina, prey levels in Indonesia also exist at levels much below carrying capacity (because of illegal hunting and habitat degradation). In protected areas in southern and central India, where dhole numbers are stable, prey densities are high. In north-east India, prey densities are very low in protected areas with dholes.

Habitat loss and transformation. Currently, extensive areas of natural or semi-natural vegetation remain in Laos and Cambodia, some areas encompassing many hundreds of square kilometres of potential dhole habitat. However, habitat conversion and fragmentation are proceeding apace. In Vietnam, very few natural areas of over 50km² remain. Habitat loss and fragmentation is a major threat to protected areas in Indonesia, particularly those on Sumatra. Habitat loss and degradation are also serious threats to dholes in South Asia, and the disappearance of dholes from many of the forested tracts in India has been attributed in large part to loss of habitat.

Persecution by cattle graziers through poisoning, shooting, trapping, and killing of pups at dens. This certainly occurs in Indochina, although it is unclear how often. In Indonesia, too, it is a threat but again its significance is unknown. In India, such persecution can play a serious role in limiting local populations. Dholes living outside or on the edge of core protected areas are particularly vulnerable to human kleptoparasitism, snaring (non-selective) and direct persecution. For example, during a radio-tracking study in 2000, in the buffer zone of Kanha Tiger Reserve, central India, at least 16 out of 24 dholes in one pack died from a sudden strychnine poisoning (L. Durbin pers. obs). In southern India, such persecution is moderate to low, and often occurs indirectly when cattle graziers and others inadvertently go close to dhole dens and disturb adults and pups, disrupting breeding and rearing (A. Venkataraman pers. obs.). "By-catch" in snares and other traps is probably a significant threat to dholes across Indochina at least.

Competition with other species including feral domestic dogs for prey species. Apparently, free-living dogs have been seen and/or camera trapped in many parts of Indochina, but there is no evidence for existence of large populations. Undoubtedly, the main competitor for prey species in Indochina is people. There is no evidence that feral dogs are significant competitors with dholes in Indonesia. In many parts of their range, dholes are sympatric with tigers and leopards and so the potential for significant interspecific competition for prey exists, especially if the prey populations are reduced as a result of hunting by people.

Disease and pathogens. Particularly those transmitted by feral and/or domestic dogs, e.g., mange, canine distemper, parvovirus and rabies. The significance of

disease is unclear in Indochina, but diseases are a significant threat in South Asia, and probably in parts of Indonesia.

Commercial use There is no widespread exploitation for fur or other purposes, though medicinal use should be investigated in China.

Occurrence in protected areas

- **Bhutan:** Reliable reports of dholes in Thrumshingla National Park, Royal Manas National Park, Jigme Dorji National Park, Jigme Singye Wangchuck National Park, Bumdeling Wildlife Sanctuary, Toorsa Strict Nature Reserve, and Phiposs Wildlife Sanctuary (CSG Dhole Database 2003; Sanjay pers. comm., T. Wangchuk pers. comm.).
- **Cambodia:** Reliable reports of dholes in The Trapeang Thom and Russei Thom areas of Preah Vihear Province; Virachey NP in Ratanakiri Province; the Koh Nhek area of Mondulakiri Province; Lomphat WS in Ratanakiri Province; Kulen Promtep WS in Preah Vihear Province; the Chhep area in Preah Vihear Province; Phnom Samkos WS in Pursat Province; and in the Central Cardamoms (Prek Tatai area) in Koh Kong Province. The last two listed are unconfirmed, since they are based on footprints only (Long *et al.* 2000). The other reports are primarily from the camera-trap surveys conducted by the Wildlife Conservation Society's Cambodia Program and WWF Cambodia.
- **China:** Reliable reports of dholes from two protected areas in the 1990s (Taohongling NR and Li Shan NR) and unconfirmed reports from at least five other sites (CSG Dhole Database 2003). There is also a report of a dhole trapped near Poyang Lake Nature Reserve in Jiangxi province, South China, and currently being held in captivity (C. Bellamy pers. comm.).
- **India:** Reliable reports of dholes from at least 38 protected areas in India (15 in southern India, 11 in central India, 6 in western India, and 6 in northern India; CSG Dhole Database 2003).
- **Indonesia:** Dholes are known to occur, or to have occurred recently (in the 1990s) on Java: Alas Purwo National Park, Baluran National Park, and Ujung Kulon National Park. There are unconfirmed reports from at least six other protected areas on the island. Sumatra: dholes are known to have occurred recently (in the 1990s), in Bukit Barisan Selatan National Park, Kerinci-Seblat National Park, and Gunung Leuser National Park. Outside of these areas information is sparse (CSG Dhole Database 2003). In Way Kambas National Park, Sumatra, dholes were previously listed; however, a three-year camera trapping study failed to record any dholes (R. Tilson pers. comm.).
- **Laos:** Dholes have been recorded from eight declared or proposed national protected areas and there are unconfirmed reports from another 11 areas. Four of the

five existing or proposed protected areas without records or reports are those least well surveyed. The fifth, Xe Bang-Nouan, was surveyed with a very rigorous approach to village-interview derived data and species were only listed as reported where a dated, site-located, claim was discussed in detail with the original observer. The species may well have occurred into the 1990s in all declared or proposed national protected areas in Laos. There is no more recent information from most areas (CSG Dhole Database 2003).

- *Malaysian peninsula*: Dholes were photographed recently (using camera traps; e.g., J.B. Abdul, pers. comm.) in the following protected areas, Taman Negara (national park), Cameron Highlands Wildlife Sanctuary, Ulu Lepar Forest Reserve, and Krau Wildlife Reserve (CSG Dhole Database 2003).
- *Myanmar*: There are recent reliable records from eight areas in Myanmar, including the Alaungdaw Kathapa National Park, Mamanyaing Reserve Forest, and the Southern Rakhine Yoma Elephant Range.
- *Thailand*: There are confirmed reports of dholes in three protected areas from 1999 or 2000 (Khao Yai NP, Phu Khieo WS, Thapraya NP) and unconfirmed reports from seven other sites (CSG Dhole Database 2003).
- *Vietnam*: Dholes were thought to occur in Vu Quang NR, Pu Mat NR, Ngoc Linh (Quang Nam) NR, and Phong Nha NR in the 1990s, there were unconfirmed reports from 18 other sites (CSG Dhole Database 2003).

Protection status CITES – Appendix II (2003)

Current legal protection In Cambodia, the current wildlife decrees give the dhole protection from all hunting. A new forestry law is under preparation, and a proposal to list the species as a fully protected species is under discussion. In India, the dhole is protected under Schedule 2 of the Wildlife Act of 1972 (permission is required to kill any individual unless in self defence or if an individual is a man killer). The creation of Project Tiger Reserves in India has provided some protection for populations of the *C. a. dukhunensis* subspecies (A.J.T. Johnsingh pers. comm., L. Durbin pers. obs.). In the Russian Federation, dholes received the status of “protected animal” in 1974 (A. Poyarkov and N. Ovsyanikov *in litt.*); however, the poisoning of grey wolves may inadvertently affect any remnant dhole populations (V. Puzanskii pers. comm.). In Vietnam, the dhole is protected by Decree 18/HDBT (17/01/1992) and the amendment Decree 48/2002/ND-DP (22/04/2002) under category IIB, which limits extraction and utilisation. However, the levels of extraction or utilisation are not quantified (B. Long *in litt.* 2003).

Conservation measures taken None specifically focused on dholes have been reported for most range

states. In India, Project Tiger could potentially maintain dhole prey bases in areas where tigers and dholes coexist. There do not appear to be any specific measures for dhole conservation in Indochina, although the declaration of relatively large protected area networks in Cambodia, Laos, and Vietnam will, when these areas become functional realities on the ground, form a suitable conservation system for the species in at least Cambodia and Laos.

Occurrence in captivity

There are at least 110 dholes in captivity, and the sex ratio is approximately even. Except for some captive populations in India heterozygosity appears to be good, but there is little chance of breeding the putative subspecies as animals from diverse geographical origins have been widely interbred (M. Boer pers. comm.). Dholes are known to breed in Beijing, Winnipeg, Dresden, Novosibirsk, Chennai (Madras), Hodenhagen, Safari Park Beekse Bergen, Magdeburg, and Howletts (M. Boer pers. comm.). To our knowledge there have been no attempts to reintroduce the species, and at present there is no evidence that this would be justified.

Current or planned research projects

L. Durbin, B.B. Acharya, A.J. Durbin, and A.J.T. Johnsingh (Centre for Ecology and Hydrology, UK and Wildlife Institute of India) undertook an ecological study of dholes in Kanha Tiger Reserve, central India, between May 1998 and March 2000. Radio-telemetry data were restricted to a three-month period for a male in a large breeding pack.

L.I. Grassman (Texas A and M University, USA) carried out a ten-month radio-telemetry study of a pack-living male dhole in Phu Khieo Wildlife Sanctuary, Thailand, between March 2000 and June 2002.

S. Hedges and M.J. Tyson (Wildlife Conservation Society, Indonesia) studied the impact of predation by dholes, leopards, and human poachers on the ungulate prey base in Baluran and Alas Purwo National Parks in East Java, Indonesia, from September 1991 to January 1999. There are plans to begin a radio-telemetry study of dholes in East Java.

M. Boer (Hodenhagen Safari Park, Germany) is involved in studies of reproductive biology and behaviour of a pack of dholes in a large enclosure at Hodenhagen Safari Park, from 1995 to present.

C. Sommer (Philipps-University of Marburg, Germany) is carrying out a comparative study of dhole, African wild dog, and grey wolf in captivity, with special emphasis on dominance hierarchy, communication, individual distances, and mating behaviour.

A. Iyengar, S. Hedges, A. Venkataraman, V. Narendra Babu, and P.A. Morin (Laboratory of Conservation Genetics, Max Planck Institute for Evolutionary

Anthropology, Germany, the Indian Institute of Science, and the Wildlife Conservation Society) are studying the conservation genetics of dholes.

A. Venkataraman and V. Narendra Babu (Asian Nature Conservation Foundation, Bangalore, India) are currently undertaking a conservation assessment of dholes in southern and central India.

A.J.T. Johnsingh, K. Sankar, and B. B. Acharya (Wildlife Institute of India) are conducting a radio-telemetry study of dholes in Pench, central India.

Gaps in knowledge

Data on distribution, status, relative abundance and population trends in Southeast Asia, and data on relative abundance and population trends in India, are essential. Furthermore, the possible existence of remnant populations of dholes in central and north-east Asia (i.e., Korea, China, Mongolia, Russia, Kazakhstan, Kyrgyzstan and Tajikistan) needs to be investigated. Additional research on threats emerges as an immediate area requiring additional research, particularly regarding the role of disease in dhole population dynamics, the significance of road kills and the ability of dhole to persist on small prey items (e.g., lagomorphs, rats and mice) in areas where populations of large (or indeed of all) ungulates have been reduced to negligible levels.

Core literature

Burton 1940; Cohen 1978; Davidar 1975; Durbin 1998; Fox 1984; Johnsingh 1982, 1985; Venkataraman 1995, 1998; Venkataraman and Johnsingh 2004; Venkataraman *et al.* 1995.

Reviewers: Arati Iyengar, A.J.T. Johnsingh. **Editors:** Claudio Sillero-Zubiri, Michael Hoffmann.

8.2 Indian fox *Vulpes bengalensis* (Shaw, 1800) Least Concern (2004)

A.J.T. Johnsingh and Y.V. Jhala

Other names

English: Bengal fox; **Indigenous names:** Hindi: lomri (India); Tamil: kulla naree (India); Telugu: gunta nakka (India); Kanada: kanka nari, sanna nari (India); Marathi: kokri (India); Nepali: phiamro (Nepal); Gujarati and Kutchi: lokdi (India).

Taxonomy

Canis bengalensis Shaw, 1800. Gen. Zool. Syst. Nat. Hist., 1(2), Mammalia, p. 330. Type locality: “Bengal” [India, c. 22°00'N, 86°00'E].

Chromosome number not known.

Description

Medium-sized fox with typical vulpine appearance, though smaller than any of the subspecies of the red fox *V. vulpes* (Table 8.2.1). The species' ears are proportional, with darker brown hair on the back. The nose and lips are black, and the eyes have dark tear marks. The muzzle is pointed with tan to black hair around the upper part and near the eyes. The pelage is grey, varying between yellowish grey to silver grey, and lacking the rusty red hair that is typical of the red fox. The dorsal region is darker, while the underside is a paler cream to dirty white. The winter coat can be quite luxuriant. The limbs are slender with some rufous on them, and the tail is more than half the body length. The tip of the tail is black. The tail is carried trailing during normal travel, it is kept horizontal when the fox is running, and it is raised to almost vertical when the fox makes sudden turns. Females have three pairs of mammae. The dental formula is 3/3-1/1-4/4-2/3=42.

Subspecies Monotypic.

Table 8.2.1. Body measurements for the Indian fox from Bombay Natural History Society museum specimens (Y. Jhala unpubl.).

HB male	500mm (390–575) n=6
HB female	472mm (460–480) n=3
T male	289mm (247–320) n=5
T female	276mm (245–312) n=3
HF male	118mm (110–125) n=5
HF female	114mm (112–116) n=3
E male	71mm (68–73) n=4
E female	75mm (72–79) n=3
WT male	2.7–3.2kg
WT female	>1.8kg

Adult Indian fox, sex unknown. Ahmednagar, Maharashtra, India, 2002.



Hira Punjabi

Similar species Desert fox (*Vulpes vulpes pusilla*) sympatric in western Indian and Pakistan, larger and taller at the shoulders, and with white-tipped tail.

Current distribution

The Indian fox is endemic to the Indian subcontinent (Figure 8.2.1). It ranges from the foothills of the Himalaya in Nepal to the southern tip of the Indian peninsula. In the northern part of the Indian subcontinent, the species' range extends from Sindh province of Pakistan to north Bengal in India.

Range countries India, Nepal, and Pakistan (Prater 1971; Roberts 1977; Shrestha 1997).

Relative abundance

Nowhere in its range is the Indian fox abundant. Densities seem to track rodent abundance in the Bhal area of Gujarat (Y.V. Jhala unpubl.), which fluctuates widely between years in the species' prime habitat (arid and semi-arid zones of India) (Prakash 1975; Tripathi *et al.* 1992). Occurrence of the Indian fox in Langtan National Park and Shey Wildlife Reserve in Nepal was reported by Shrestha (1997); however, this has not been confirmed and is considered unlikely.

Estimated populations/relative abundance and population trends Densities of breeding pairs range from 0.15–0.1/km² during periods of peak rodent abundance (1995 to 1996) to 0.01/km² during periods of low rodent abundance (1999 to 2000) (Y.V. Jhala unpubl.). In more diverse and stable prey systems (e.g., the Kutch), fox densities are more constant (0.04–0.06/km² over the past five years) (Y.V. Jhala unpubl.). Fox densities also range from 1.62/km² in protected grassland plots (Rollapadu

Wildlife Sanctuary, Andhra Pradesh) to 0.37/km² in unprotected areas; in this area populations declined five-fold due to an epidemic in 1995 (Manakadan and Rahmani 2000). Due to loss of short grassland-scrub habitat to intensive agriculture, industry and development projects the Indian fox population is on the decline. However, there is no available estimate on the rate of these declines.

Habitat

The Indian fox prefers semi-arid, flat to undulating terrain, scrub and grassland habitats where it is easy to hunt and dig dens. It avoids dense forests, steep terrain, tall grasslands, and true deserts. The species is relatively abundant in the biogeographic zones 3, 4, and 6 of India, in which rainfall is low, and the vegetation is typically scrub, thorn or dry deciduous forests, or short grasslands (Rodgers *et al.* 2000). In the Indian peninsula, the species is restricted to the plains and open scrub forest.

Food and foraging behaviour

Food Indian foxes are omnivorous, opportunistic feeders and generally consume any food that they can handle. Their diet consists mainly of insects (e.g., crickets, winged termites, grasshoppers, ants, beetle grubs, spiders), small rodents, including soft-furred field rats (*Millardiameltada*), field mice (*Mus booduga*), and Indian gerbils (*Tatera indica*), and birds and their eggs, including Indian mynah (*Acridotheres tristis*), ashy-crowned finch lark (*Eremopterix grisea*) and grey partridge (*Francolinus ponticerianus*). Other prey species include ground lizards, rat snakes (*Ptyas mucuosus*), hedgehogs (*Paraechinus nudiventris*), and hares (*Lepus nigricollis*) (Johnsingh 1978; Rahmani 1989; Manakadan and Rahmani 2000). Shepherds have also seen Indian foxes eating the freshly voided pellets of sheep (Johnsingh 1978). Amongst vegetable matter, the Indian fox has been reported to feed on fruits of ber (*Ziziphus* spp.), neem (*Azadirachta indica*), mango (*Mangifera indica*), jambu (*Syzigium cumini*), banyan (*Ficus bengalensis*), melons, fruits and the shoots and pods of *Cicer arietum* (Mivart 1890; Prater 1971; Mitchell 1977; Roberts 1977; Johnsingh 1978; Manakadan and Rahmani 2000). The scats of pups are almost exclusively composed of rodent hair (Johnsingh 1978; Manakadan and Rahmani 2000).

Foraging behaviour In most parts of its range Indian foxes are crepuscular and nocturnal. Therefore, individuals usually wait for darkness before starting their evening hunt. However, if the temperature is mild, as on rainy days, they may also hunt at mid-day. While the basic social unit consists of a breeding pair, foraging is normally done singly (Johnsingh 1978).

Damage to livestock and game There have been no reports of the Indian fox raiding poultry or attacking sheep.

Figure 8.2.1. Current distribution of the Indian fox.



Adaptations

The Indian fox, being a specialist of hot, arid, short grass-scrub habitats, has large external ears for an animal of its size (probably an adaptation for thermoregulation).

Social behaviour

The basic social unit of the Indian fox is the breeding pair, formed through pair bonds that may last for several years. Larger aggregations may exist when grown pups remain in the natal group for longer than normal (Johnsingh 1978). Other observations suggest that the Indian fox may be more social at times. Johnsingh (1978) reported observing two lactating females suckling pups in a single den during one year. Four adult-sized foxes were also observed resting together on two occasions and once emerging from a single den in Rollapadu (Manakadan and Rahmani 2000).

The common vocalisation of the Indian fox is a chattering cry that seems to have a major role in maintaining territoriality and may also be used as an alarm call. Besides this, foxes also growl, whimper, whine and make a sound which could be called a growl-bark (Johnsingh 1978). Scent marking by scats and urine may serve as a “book keeper” (Henry 1977) to indicate if an area has been hunted recently.

Reproduction and denning behaviour

The Indian fox breeds from December to January in Bhal and Kutch (Y.V. Jhala unpubl.). During the breeding season, the male vocalises intensively, sometimes through the night but mostly during the early part of the night and morning. The gestation period of Indian foxes is 50–53 days (Jerdon 1984; Sheldon 1992), with parturition occurring between January and March (Acharjyo and Misra 1976; Johnsingh 1978). Litter size is 2–4 (Roberts 1977; Sheldon 1992), and averaged 2.7 in the Bhal area (Y.V. Jhala unpubl.). Responsibility for post-natal care of the pups is shared by both sexes. Both parents bring food to the pups and guard the den. The presence of helpers has not been observed in the species (Y.V. Jhala unpubl.). Rarely is the den left unguarded in the first two months after the pups are born since the parents take turns foraging. Post-natal care lasts approximately 4–5 months, after which young disperse, usually at the onset of the monsoon in north-western India, when food is plentiful (June/July) (Y.V. Jhala unpubl.).

Den use by the Indian fox is primarily restricted to the pup-rearing period (Johnsingh 1978; Manakadan and Rahmani 2000). Dens are excavated in open habitat, never in dense vegetation (Manakadan and Rahmani 2000). Indian foxes will usually excavate their own dens but occasionally they will appropriate and enlarge gerbil holes (Manakadan and Rahmani 2000). The species exhibits great site fidelity with sites being reused by breeding pairs year after year (Johnsingh 1978; Y.V. Jhala pers. obs.).

Dens consist of a mosaic of tunnels in various stages of excavation leading to a small chamber about 0.5–1.0m below the surface where the pups are born. The number of holes in a den complex is usually between two and seven (although as many as 43 have been recorded) (Manakadan and Rahmani 2000). The holes and tunnels of a well-used den site in the Bhal area of Gujarat covered an area 10 x 8m (Y.V. Jhala unpubl.). Pups are rarely moved between dens during the denning period (Manakadan and Rahmani 2000; Y.V. Jhala pers. obs.), although, once pups become more mobile, Indian foxes may use any of the numerous dens excavated within the territory of the parents (Manakadan and Rahmani 2000).

Competition

Grey wolves (*Canis lupus pallipes*) have been observed to appropriate fox holes and enlarge them to make their dens in the Bhal and Kutch areas (Jhala 1991). Wolves and jackals (*C. aureus*) were both recorded to appropriate fox holes in Rollapadu (Manakadan and Rahmani 2000). On one occasion wolf pups and fox pups shared the same den site in Velavadar National Park (Y.V. Jhala unpubl.).

Mortality and pathogens

Natural sources of mortality Wolves and feral dogs do predate on the Indian fox, but such events are not a threat to the population.

Persecution In the study area of Tamil Nadu, humans are a major mortality factor for the fox, especially nomadic tribals, *Nari kuravas*, and their dogs. Occasionally, the tribals visit the area where they use their ability to mimic fox calls to easily net and kill foxes for flesh, teeth, claws and skin. They also use handmade, animal fat-covered, country bombs to kill foxes (Johnsingh 1978). In Rollapadu, the fox is hunted by certain castes of people using smoke, nets and dogs at dens (Manakadan and Rahmani 2000). Further mortality is caused by the local ‘hunters’ who do not hesitate to shoot or attempt to kill foxes with their dogs. In Tamil Nadu people often block fox dens with stones (Johnsingh 1978). In Gujarat and Rajasthan, a major stronghold for the species, humans rarely persecute foxes, though the *waghri* and *koli* tribes kill and eat foxes occasionally.

Hunting and trapping for fur There is no organised fur trade, since the pelt is of poor quality. Illegal hunting of hare (*Lepus nigricollis*) by the use of dogs sometimes results in the killing of the Indian fox. In such cases the pelt is taken and kept due to local beliefs that the pelt brings good luck (A.J.T. Johnsingh pers. comm.).

Road kills Indian foxes are often killed by fast moving traffic and the development of major highways, in the semi-arid tracts, are likely to become barriers to dispersal.

Pathogens and parasites The Indian fox is susceptible to infectious diseases. There has been no local authenticated report of the Indian fox suffering from or transmitting rabies. In Rollapadu Wildlife Sanctuary, a disease epidemic which could have been caused by either rabies or distemper resulted in a five-fold variation in population density within a period of three years (Manakadan and Rahmani 2000). Mass mortality in certain years has also been observed in the Bhal and Kutch areas of Gujarat and in Rollapadu (Y.V. Jhala pers. obs., Manakadan and Rahmani 2000). The cause of this mortality was not ascertained, but it may have been caused by distemper that was prevalent amongst dogs, wolves and jackals in the Bhal area during that time (Y.V. Jhala unpubl.).

Longevity In captivity, the Indian fox lives 6–8 years (Y.V. Jhala pers. obs.).

Historical perspective

The Indian fox features in several animal short stories of the ancient Jataka texts and the Panchatantra. The fox is depicted as a clever and sometimes cunning creature in these tales.

Conservation status

Threats Although the Indian fox is widespread, it occurs at low densities throughout its range, and populations can undergo major fluctuations due to prey availability. It is also quite sensitive to human modifications of its habitat. With expanding human populations and continued development of grasslands and “wastelands” for agricultural and industrial uses, the habitat of the Indian fox is continuously being depleted. The combination of above factors along with disease and/or natural mortality could potentially cause local extinctions. In certain states like Gujarat, Maharashtra, and Rajasthan the Indian fox habitat is widespread with minimal threats while in other states like Karnataka and Tamil Nadu the specialised habitats of the Indian fox are limited and on the decrease. In such areas the survival of the Indian fox is under serious threat.

Commercial use There are no known commercial uses for the Indian fox, although there is limited localised trade for skin, tail, teeth and claws (for medicinal and charm purposes). There is no trade or potential for trade of the Indian fox.

Occurrence in protected areas

- *India*: the Indian fox occurs in a number of protected areas in Rajasthan (16), Gujarat (9), Maharashtra (5), Madhya Pradesh (17), Andhra Pradesh (10) and over 25 protected areas in other states;
- *Nepal*: it is reported to occur in Royal Bardia National Park, Royal Chitwan National Park, Royal Shukla Phanta Wildlife Reserve and in Kosi Tappu Wildlife Reserve (Majupuri and Kumar 1998).

Protection status CITES – not listed.

Current legal protection The Indian Wildlife Protection Act (1972 as amended up to 1991) prohibits hunting of all wildlife and lists the Indian fox in Schedule II. It is not on any special category for protection in the wildlife legislation of Nepal.

Conservation measures taken There have been no conservation efforts targeted specifically for the species.

Occurrence in captivity

The Indian fox is held in captivity in several zoos in India, where the species breeds well. In 2001, there were 15 males, 14 females, and 11 unsexed individuals in several zoos (Central Zoo Authority pers. comm.).

Current or planned research projects

Y.V. Jhala (Wildlife Institute of India) is studying the food habits distribution and densities of the Indian fox in the Bhal and Kutch areas of Gujarat, India.

Gaps in knowledge

A status survey is needed to identify areas throughout the species' range that have large, relatively secure fox populations. In some of these areas, an in-depth, long-term study is needed on population dynamics of the Indian fox. This would help elucidate the fox's relationship with prey population cycles and disease outbreaks. Research is also needed on ranging patterns, territoriality, and behaviour of this poorly studied species.

Core literature

Johnsingh 1978; Manakadan and Rahmani 2000.

Reviewers: Asad Rahmani, Ullas Karanth. **Editors:** Deborah Randall, Michael Hoffmann, Claudio Sillero-Zubiri.

Australia and Oceania (Australasian)

9.1 Dingo

Canis lupus dingo (Meyer, 1793)

Vulnerable – VU: A2e (2004)

L.K. Corbett

Other names

French: dingo; **German:** dingo; **Indonesian:** tengger dog; **Japanese:** akita, hokkaido, shikoku, kai, shiba, kishu; **Korean:** jindo, jingo; **Thai:** maa; **Indigenous names:** Australian Aborigine: warrigal, tingo, joogoong, mirigung, noggum, boolomo, papa-inura, wantibirri, maliki, kal, dwer-da, kurpany; Melanesia: koli, kuli; Micronesia: kiti, kiri, komoa; New Guinea: New Guinea singing dog, singer, waia, sfa, katatope, kurr ona, agl koghma, yan-kararop; New Zealand: kirri, kuri, pero, ghooree; Philippines: aso; Polynesian: kuri, ilio, kurio, maile, uli, ooree.

Taxonomy

Canis antarticus Kerr, 1792. Animal Kingdom, vol.i, p.136. Type locality: Port Jackson, New South Wales [Australia].

The nomenclature is based on Honacki *et al.* (1982) as well as usage in recent dingo publications and major Australian institutions, including the Australian Museum and CSIRO. Furthermore, recent research clearly indicates the long antiquity of the dingo and the evolutionary line of the wolf-dingo-domestic dog (Corbett 2004).

Europeans did not discover the dingo in Australia until the 17th century and taxonomists originally thought the dingo was a feral domestic dog (hence one of the earlier names *Canis familiaris dingo*). Many early zoologists and anatomists assumed that Aborigines introduced the dingo into Australia in Pleistocene times, and this led to much confusion about the dingo's nomenclature and relationships for about 200 years. It is only since recent investigations have shown that the dingo is a primitive dog transported to Australia by Asian seafarers about 4,000 years ago (Corbett 1985) that the taxonomy is better understood.

Today, the wild population comprises dingoes, feral dogs and hybrids of the two. The names *C. f. dingo* for the dingo proportion of the wild dog population and *C. f. familiaris* for both wild-living and commensal domestic dogs have had the greatest use in scientific literature over the past 50 years. Corbett (1995) concludes that wild-living dogs in Australia are subspecies of the grey wolf (*C. lupus*), that is *C. l. dingo* and *C. l. familiaris*, and these designations are currently being investigated (W.D.C. Ride pers. comm.).

Chromosome number: 2n=78 (Hsu and Benirschke 1967–1976).

The relatively extended isolation of a dingo-like dog population in Papua New Guinea – initially described as the New Guinea singing dog (*Canis hallstromi*) (Troughton 1957; Schultz 1969) – and subsequent adaptations to the mountainous habitat it occupies (Ortolani 1990; Brisbin *et al.* 1994; Bino 1996; Koler-Matznick *et al.* 2000), strongly suggests that it could be designated an “evolutionarily significant unit” (Crandall *et al.* 2000) within dingoes (Bininda-Emonds 2002).

Further research based on valid morphological and molecular comparisons is required to elucidate the taxonomic status of dingo-like dog populations in Papua New Guinea, Asia, Africa and North America. There is, however, mounting evidence that recent and extant populations are now hybrid. For example, the morphology of all New Guinea singing dog skulls examined to date, including the holotype and paratype, matches that of hybrid dingoes (L. Corbett unpubl.). Further research is also required to confirm whether or not the ‘Carolina dog’ (Brisbin and Risch 1997) and ‘basenji’ (Coe 1997), in North America and Africa, respectively, have descended from pure dingoes.

The following definitions of dingoes and other wild, dingo-like dogs are based on Fleming *et al.* (2001):

- *Dingoes*: Native dogs originating in Asia. Dingoes were present in Australasia and Oceania before European settlement. Pure dingoes are populations or individuals that have not hybridised with domestic dogs or hybrids.
- *Domestic dogs*: Dog breeds (other than dingoes) selectively bred by humans, initially from wolves and/or dingoes that usually live in association with humans. Introduced to Australia and other range countries by Europeans.
- *Hybrids*: Dogs resulting from crossbreeding of a dingo and a domestic dog and the descendants of crossbred progeny. Some hybrids are phenotypically indistinguishable from pure dingoes (e.g., hybrid populations in south-eastern Australia – see Daniels and Corbett 2003).
- *Wild dogs*: All wild-living dogs (including dingoes and hybrids).
- *Feral dogs*: Wild-living domestic dogs.
- *Free-roaming dogs*: Dogs that are ‘owned’ by humans but not restrained so they are free to travel away from their owner’s residence and breed.
- *Commensal dogs*: Wild dogs (including dingoes and free-roaming domestic dogs) living in close association with, but independent of humans.

Description

Dingoes are dog-like with a fairly broad head and tapered muzzle, erect ears about half the head length, legs about half the head-body length and without dewclaws, hind feet about a third of the leg length, short body hair and a fairly bushy tail that does not extend beyond the hocks. In order of frequency of occurrence, the adult pelage colours are ginger (red to sandy), black with tan areas (cheeks, muzzle, ears, legs), all white, and all black. Most individuals have small white markings on the chest, feet/legs and tail tip, and some have white belly markings and/or a black muzzle. In ginger animals, there is a faint but distinctive shoulder

stripe. All other colorations indicate hybridisation with domestic dogs (Daniels and Corbett 2003). Males are universally larger and heavier than females of the same age (Table 9.1.1). Dingoes from northern and north-western Australia are larger than dingoes in central and southern regions; all Australian dingoes are larger and heavier than those in Asia (Corbett 1985, 1995; see body measurements). Relative to similar-sized domestic dogs, dingoes have longer muzzles, larger bullae, larger carnassial teeth, longer canine teeth, and flatter crania with larger nuchal crests (Newsome *et al.* 1980). Dental formula is $3-1/1-4/4-2/3=42$.

Table 9.1.1. Body measurements for the wild and commensal dingo and the New Guinea singing dog. All Australian and Thailand measurements were of adults with ginger pelts and females that were not obviously pregnant (Corbett 1985, 1995). Australian measurements are means of samples from northern (Kakadu National Park) and central (Alice Springs) regions, and Thai measurements are from north-eastern (Tharee) and North Thailand (Chieng Mai) (Corbett 1985, 1988a). All New Guinea measurements were of captive specimens one year of age or older (J. Koler-Matznick unpubl.). Wild specimens may weigh less.

	Australia (wild dingoes)	Thailand (wild and commensal dingoes)	New Guinea (New Guinea singing dogs)
HB male	914mm (835–1,110) n=50	824mm (750–917) n=20	849mm (780–910) n=10
HB female	883mm (813–1,010) n=38	755mm (703–810) n=16	802mm (710–889) n=9
T male	324mm (280–370) n=50	264mm (210–301) n=20	252mm (220–280) n=10
T female	311mm (247–350) n=38	239mm (200–270) n=16	235mm (230–250) n=9
HF male	190mm (176–220) n=51	166mm (149–190) n=21	156mm (140–168) n=10
HF female	180mm (165–195) n=38	152mm (143–165) n=16	148mm (140–168) n=9
E male	103mm (95–110) n=50	85mm (76–99) n=21	95mm (70–110) n=10
E female	98mm (87–107) n=38	79mm (71–87) n=16	90mm (65–105) n=9
WT male	15kg (12–22) n=51	12kg (7–17) n=21	12.2kg (9.3–14.4) n=9
WT female	13kg (11–17) n=38	10kg (8–14) n=16	11.2kg (8.6–13.2) n=7



Yearling male dingo.
Strathmore Station, Gulf of
Carpentaria, Australia, 1997.

Lee Allen

Subspecies Based on skull morphology, size, coat colour and reproduction, regionally distinct populations of dingoes appear to exist between Australia and Thailand (Corbett 1985, 1995) but not within Australia (Corbett 2001). There may, therefore, be a case for subspecific names for dingo populations in Thailand and Australia.

Similar species Grey wolves (*Canis lupus*), are generally larger, more slender and with relatively longer legs than dingoes. Dingo-like dogs and hybrids are usually distinguished from pure dingoes by coat colours other than ginger, black-and-tan, all black and all white.

Distribution

Historical distribution Based on fossil (Olsen and Olsen 1977), molecular (Vilà *et al.* 1997; Corbett 2004) and anthropological evidence (Corbett 1995), the early primitive dingoes formerly had a cosmopolitan distribution (Corbett 1995). The primitive dingoes were associated with nomadic, human hunter-gatherer societies and later with sedentary agricultural population centres where the primitive dingoes were tamed and subsequently transported around the world. Austronesian-speaking people transported the dingo from mainland Asia to

Australia and other islands in Southeast Asia and the Pacific between 1,000 and 5,000 years ago (Corbett 1985).

Current distribution Pure dingoes have been demonstrated to occur only as remnant populations in central and northern Australia and throughout Thailand. However, based on external phenotypic characters, they may also occur in Burma, Cambodia, China, India, Indonesia, Laos, Malaysia, Papua New Guinea, Philippines and Vietnam.

Range countries Australia, Burma, Cambodia, China, India, Indonesia, Laos, Malaysia, Papua New Guinea, Philippines, Thailand, Vietnam (De Vis 1911; Troughton 1957; Menzel and Menzel 1960; Schultz 1969; Fernando 1977; Medway 1977; Corbett 1985, 1988a, 1995; Koler-Matznick *et al.* 2000).

Relative abundance

Estimating dingo abundance is difficult because the external phenotypic characters of many hybrids are indistinguishable from pure dingoes. For example, populations of 'wild dogs' in the south-eastern highlands of Australia have been fairly abundant over the past 50 years. However, the proportion of pure dingoes, as based on skull morphometrics, has declined from about 49% in



Figure 9.1.1. Current distribution of the dingo.

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the 1960s (Newsome and Corbett 1985) to about 17% in the 1980s (Jones 1990) and the pure form may now be locally extinct (Corbett 2001). Such quantitative data is not available for countries other than Australia, Thailand and Papua New Guinea so that the following qualitative estimates of abundance refer to pure dingo and/or hybrid populations as based on general body form, pelage colour and breeding pattern.

In Australia, pure dingoes are common in northern, north-western and central regions, rare in southern and north-eastern regions, and probably extinct in the south-eastern and south-western regions. The density of wild dogs (dingoes and hybrids) varies between 0.03 and 0.3 per km² according to habitat and prey availability (Fleming *et al.* 2001). Dingoes are rare in New Guinea and possibly extinct as there have been no confirmed sightings for about 30 years (Newsome 1971; Brisbin *et al.* 1994; Bino 1996; Koler-Matznick *et al.* 2000). Dingoes are common in Sulawesi but their abundance elsewhere in Indonesia is unknown. They are common throughout the northern and central regions of Thailand, but less so in the southern regions; considered rare in the Philippines and probably extinct on many islands. Present in Malaysia, Vietnam, Cambodia, Laos, China, Burma and India, but abundance unknown. Dingoes are probably extinct in the wild in Korea, Japan and Oceania, although several local dog breeds share dingo-like characteristics.

Estimated populations/relative abundance and population trends Dingoes were formerly widespread throughout the world (Corbett 1995) and although populations of wild dogs remain abundant in Australia and other countries, the proportion of pure dingoes is

declining through hybridisation with domestic dogs (Table 9.1.2). The data in the following table refers to estimated populations of pure dingoes and/or hybrid populations as based on general body form, pelage colour and breeding pattern.

The ecological and behavioural information in the following sections is largely based on wild-living dingoes in Australia and Thailand.

Habitat

Dingoes occupy all habitats, including tropical alpine moorlands above 3,800m a.s.l. in Papua New Guinea (Troughton 1957; Newsome 1971), forested snow-clad peaks in temperate eastern Australia, arid hot deserts in central Australia, and tropical wetlands and forests of northern Australia (Corbett 1995). The absence of dingoes in many grassland habitats of Australia is due to persecution by humans (Fleming *et al.* 2001).

Food and foraging behaviour

Food Most of the dietary information comes from studies conducted in Australia, where dingoes eat a diverse range of prey types and over 170 species have been identified ranging from insects to buffalo (Corbett 1995). However, in a particular region they usually specialise on the most available (common) vertebrate prey. The main prey in Australia are magpie geese (*Anseranas semipalmata*), rodents (*Rattus colletti*) and agile wallabies (*Macropus agilis*) in the northern tropical wetlands (Corbett 1989); rabbits (*Oryctolagus cuniculus*), rodents (*Rattus villosissimus*, *Mus musculus*), lizards (*Ctenophorus nuchalis*) and red kangaroos (*Macropus rufus*) in arid central Australia (Corbett and Newsome 1987; Corbett 1995); euros (*Macropus robustus*) and red kangaroos in arid north-western habitats (Thomson 1992); rabbits in the south-western deserts (Marsack and Campbell 1990); and wallabies (*Wallabia bicolor*, *Macropus rufogriseus*), possums (*Trichosurus vulpecula*, *Pseudocheirus peregrinus*) and wombats (*Vombatus ursinus*) in the east and south-eastern highlands (Newsome *et al.* 1983; Robertshaw and Harden 1985; Corbett 1995). In recent years, rabbit populations throughout Australia have greatly declined due to rabbit calicivirus disease, and dingo diet in former rabbit-infested regions is likely to change (Fleming *et al.* 2001).

In Asia, dingoes live commensally with humans in most regions and their main food items are rice, fruit and other table scraps provided by people or scavenged (Corbett 1995). In rural areas of Thailand and Sulawesi, dingoes have been observed hunting insects, rats and lizards along roadsides, rice paddies and in forests (Corbett 1985, 1988a). In the Papua New Guinea highlands, Newsome (1971) reported rodents in canid scats. Bino (1996) noted that wild dogs commonly eat cuscus (*Phalanger* spp.) and scavenge harpy eagle kills and human-trapped animals.

Table 9.1.2. The status of dingoes in various range countries (Population: A=abundant, C=common, U=unknown, Ex=extinct, ?=current presence not confirmed; Trend: D=decreasing).

Country	Population/abundance	Trend
Australia	C	D
north/north-west	A	D
central	A	D
south-west	U	D
north-east	C	D
south-east	Ex?	D
Burma	U	D
Cambodia	U	D
China	U	D
India	?	D
Indonesia	U	D
Laos	U	D
Malaysia	U	D
New Guinea	Ex?	D
Philippines	Ex?	D
Thailand	C	D
Vietnam	U	D

Foraging behaviour Dingoes change their group size and hunting strategy in order to maximise hunting success. For example, packs have greater success than solitary dingoes in hunting kangaroos (Thomson 1992) and vice versa when hunting rabbits. Dingoes also scavenge and steal prey from other predators (Corbett 1995).

Damage to livestock or game In Australia, dingoes (and hybrids) kill livestock, particularly sheep, cattle and goats, and can threaten the economic viability of properties in some areas (Fleming *et al.* 2001). Many attacks occur when native prey is scarce (e.g., during droughts or as a result of human disturbance to habitats). However, there is evidence of seasonal peaks in predation on livestock, possibly related to the seasonal breeding activity of dingoes, as well as the timing of lambing, calving and control activity (Fleming *et al.* 2001).

Adaptations

During droughts in Australia, dingo packs fragment and the likelihood of death is high for all pack members, irrespective of social status. During good seasons, population recruitment is also low due to infanticide where the alpha female kills the pups of subordinate females (Corbett 1988b). This behaviour is believed to be an adaptation to the capricious Australian environment that has demanded a common reproductive selection strategy: the more pups born, the greater the chance that some will survive adverse periods. Since most breeding dingoes are closely related, at least some of the alpha's genes will survive to the next generation if all pregnancies go to term and if some of the smaller pack units survive the drought (Corbett 1995).

Other adaptations to drought are the dingoes' ability to survive on free and metabolic water from prey in waterless regions in winter (Green 1973), and female's regurgitating water to weaned pups confined to den sites in summer (Corbett 1995).

Social behaviour

Throughout most of their range in Australia and Asia, dingoes are usually seen alone but most individuals belong to socially integrated groups whose members meet every few days or coalesce during the breeding season to mate and rear pups. At such times, scent marking and howling is most pronounced and there are frequent skirmishes with adjacent groups (Corbett 1995).

In remote areas of Australia, where dingoes and their prey are least disturbed by humans, discrete and stable packs of 3–12 dingoes occupy territories throughout the year. The home ranges of individual pack members overlap considerably but neighbouring pack territories do not (Thomson 1992; Corbett 1995). Packs have distinct male and female hierarchies where rank order is largely determined and maintained by aggression, especially in

male ranks. The dominant pair may be the only successful breeders but other pack members assist in rearing the pups including coaching the pups in hunting (Corbett 1988b, 1995).

Territory size varies with prey resources and terrain but is not correlated with pack size. For individuals, home range size also varies with age (Thomson 1992). The largest recorded home ranges (90–300km²) occur in the deserts of south-western Australia (Thomson and Marsack 1992). Home ranges recorded elsewhere are 45–113km² in north-western Australia (Thomson and Marsack 1992), 25–67km² for arid central Australia (Corbett 1995; L. Best pers. comm.), mean 39km² for tropical northern Australia (Corbett 1995) and 10–27km² for forested mountains in eastern Australia (Harden 1985; McIlroy *et al.* 1986). Most dingoes remain in their natal area and mean distances travelled per day average less than 20km. Some dingoes disperse, especially young males, and the longest recorded distance for a tagged dingo is about 250km (Thomson and Marsack 1992; Corbett 1995).

Dingoes frequently howl but rarely bark as domestic dogs do. There are three basic howls (moans, bark-howls and snuffs) with at least 10 variations (Corbett 1995). Dingoes howl over large distances to locate other dingoes for the purposes of attracting pack members and repelling intruders. Dingoes howl with distinct pitches in a chorus howl and as the number of animals howling in a group increases, so do the variation in pitches (Ortolani 1990); this suggests that dingoes can estimate the size of an unseen pack. The frequency of howling varies and is influenced by breeding, dispersal and social stability of packs (Thomson 1992; Corbett 1995). The New Guinea singing dog has a distinctive shriek-like howl that is characterised by a very sharp rise in pitch at the start and ends at a very high frequency (Ortolani 1990).

Dingoes also communicate with pack members and rival packs by defecating and urinating on grass tussocks and other conspicuous objects at shared sites such as waters, trails and hunting grounds. Males scent-mark more than females and both sexes perform more in the breeding season (Corbett 1995). Dingoes also scent-rub whereby an animal rolls on its neck, shoulders or back on a 'smell' that is usually associated with food or the scent markings of conspecifics (Thomson 1992; Corbett 1995).

Reproduction and denning behaviour

Dingoes breed once each year. Litters are usually whelped in winter (May to July) although in tropical habitats breeding can occur in any month. This breeding pattern is determined by the female's annual oestrous cycle, as males are fertile most of the year in most regions (Catling *et al.* 1992). Most wild females commence breeding at two years (Catling *et al.* 1992) and, in packs, the alpha female (usually the oldest) tends to come into oestrus before the subordinate females. Pro-oestrus and oestrous periods

for captive dingoes last about 10–12 days (Corbett 1995). However, in the wild, behavioural data suggest that pro-oestrus may last up to 60 days (Thomson 1992). Males reach full sexual maturity at 1–3 years. Gestation lasts 61–69 days in captive dingoes and is similar for wild dingoes. The average litter size for dingoes is five (range=1–10) throughout Australia and Thailand, and usually more males are born than females. Pups usually become independent at 3–6 months or if in a pack, at 12 months when the next breeding season begins (Corbett 1995).

In contrast to dingoes, female feral dogs and hybrids of similar size to dingoes may have two oestrous cycles each year, although it is unlikely that they successfully breed twice every year in the wild. Gestation is 58–65 days for hybrids and the average litter size is similar to dingoes.

In contrast to wolves in the northern hemisphere, where alpha wolves prevent subordinates from breeding, the Australian dingo's main method of suppressing reproduction is infanticide: all the pups of subordinate females are killed by the alpha female (Corbett 1988b).

In Australia most dens are 'underground' and have been recorded in enlarged rabbit holes, caves in rocky hills, under debris in dry creek beds, under large tussocks of spinifex, among protruding tree roots, hollow logs, fallen trees, enlarged goanna (*Varanus* spp.) holes and old wombat burrows (Thomson 1992; Corbett 1995).

Competition

The demise of two endemic marsupial carnivores, the thylacine (*Thylacinus cynocephalus*) and the Tasmanian devil (*Sarcophilus harrisi*), on the Australian mainland soon after the dingo's arrival about 4,000 years ago is attributed to competition. It is assumed that the dingoes' superior social organisation enabled them to better exploit scarce resources during droughts or after extensive wildfire (Corbett 1995).

Dingoes may now present red foxes (*Vulpes vulpes*) and feral cats, both exotic species to Australia, with a similar kind of competition. There is some evidence that dingoes limit fox and feral cat access to resources and there is evidence of an inverse density relationship between dingoes and foxes (Fleming *et al.* 2001). One implication of these findings is that reducing dingo density (via human control) might result in an increase in other predators with overlapping diets ('mesopredator release'). It is therefore possible that removing dingoes from a system where foxes and cats also occur will result in an increase in their numbers with consequent increased predation on small native mammals.

Mortality and pathogens

Natural sources of mortality Starvation and/or dehydration during drought or after extensive wildfire; infanticide; drowning by kangaroos (Corbett 1995);

snakebite; predation on pups by wedge-tailed eagles (Fleming *et al.* 2001); buffalo and cattle goring and kicking (Fleming *et al.* 2001).

Persecution A major cause of dingo mortality in Australia is a cycle involving dingo population density, food supply and human control. When food becomes scarce for a large population of dingoes in a 'safe' area (source), they disperse to pastoral and agricultural areas where there are fewer dingoes. At those sites, intense human control measures (poisoning, trapping or shooting) create vacant areas (sinks) and perpetuate the dispersal-mortality cycle (Thomson 1992). Dingoes have been eliminated in most of south-eastern Australia through such human control and loss of habitat, and this situation is maintained with a 5,614-km-long barrier fence (Breckwoldt 1988). In Australia dingoes are also chased and killed by people on horseback.

In Asia and Oceania, dogs (dingoes, hybrids and domestic dogs) are considered a delicacy (Titcomb 1969) and are regularly killed for human consumption. For example, in north-east Thailand, at least 200 dingoes are butchered each week and sold in markets for human consumption (Corbett 1985). Prior to the mid-20th century, dingoes were regularly eaten by Australian Aborigines (Breckwoldt 1988).

Persecution due to predation on stock has decreased over the past 30 years following the results of scientific research and better understanding of dingo movements, sociality and predation. It is recognised that in particular seasons, dingo predation may limit increases in competing feral and native herbivores.

A bounty system operated throughout mainland Australia from 1836 until recently, but despite the billions of dollars paid out, there is little evidence that bounty systems are (or were) an effective management tool for dingoes (Fleming *et al.* 2001).

Hunting and trapping for fur Not practiced.

Road kills Animals are occasionally run over by vehicles.

Pathogens and parasites Thirty-eight species of parasites and pathogens have so far been recorded in dingoes in Australia (Corbett 1995; Fleming *et al.* 2001), but in most cases diseases have little effect on the survival of adult wild dogs. Exceptions include: canine distemper, hookworms (*Uncinaria stenocephala* and *Ancylostoma caninum*) and heartworm (*Dirofilaria immitis*) in northern Australia and south-eastern Queensland. Pups are also killed by lungworm (*Oslerus osleri*), whipworm (*Trichurus vulpis*), hepatitis (Adenovirus), coccidiosis (*Isospora rivolta*, *Eimeria canis*), lice (*Trichodectes canis* and unidentified species) and ticks (*Ixodes holocyclus*, *Rhipicephalus sanguineus* and *Amblyomma triguttatum*). Sarcoptic mange

(causal agent *Sarcoptes scabiei*) is a widespread parasitic disease in dingo populations throughout Australia but it is seldom debilitating. Hydatidosis (caused by the cestode *Echinococcus granulosus* and part of a dingo-wallaby sylvatic cycle) results in serious illness in infected humans and in the devaluation of infected livestock carcasses at slaughter. However, this parasite does not cause mortality in dingoes (Fleming *et al.* 2001).

Longevity Dingoes live up to 7–8 years in the wild and up to 13 years in captivity (Corbett 1995).

Historical perspective

Dingoes often accompanied Asian seafarers when they migrated to Australia and other regions of the world several millennia ago (Corbett 1985). Those journeys and other associations continue to be an integral part of oral and written culture of native people in those areas including the traditional use of dingoes as food, of canine teeth in necklaces and hair for ceremonial costumes (Titcomb 1969; Medway 1977; Breckwoldt 1988; Corbett 1995). The dingo is also an important animal in Australian Aboriginal mythology; dingoes are associated with sacred sites, totems and Dreamtime characters (Breckwoldt 1988). Aborigines also used dingoes as hunting aids (for macropods and small game), camp dogs and their scalps as a form of currency (Corbett 1995).

Conservation status

Threats Cross-breeding with domestic dogs represents a significant threat to the long-term persistence of dingoes. Hybrids exist in all populations worldwide (including Fraser Island, Australia; Woodall *et al.* 1996) and the proportion of hybrids is increasing (see Relative abundance). A related threat to dingoes in Australia concerns the actions and consequences of ‘so-called’ dingo preservation societies, dingo ‘farms’ and legislation allowing legal ownership of dingoes by members of the public because most are based on known hybrids or untested dingo stock and thus effectively increase the hybridisation process (Corbett 2001). The increasing interest of private individuals and groups in keeping ‘dingoes’ as pets in Australia and other countries including Switzerland and USA, also poses a threat via human selection of form and behaviour.

Commercial use Bounties for dingo skin and scalps exist in some regions of Australia. Dingoes are also sold in human food markets in several Asian countries. They are also bred by private individuals and companies in Australia and USA and sold as pets.

Occurrence in protected areas Protected areas for dingoes only occur in Australia. Within Australia, dingoes are ‘legally protected’ in national parks, nature reserves

and the Arnhemland Aboriginal Reserve in the Northern Territory (NT), National Parks and Nature Reserves in New South Wales (NSW), National Parks in Victoria, and throughout the Australian Capital Territory (ACT). Dingoes occur in all of the NT’s 17 national parks including Kakadu, Litchfield, Gregory, Davenport Range, Nitmiluk and Uluru-Kata Tjuta. Dingo occurrence and abundance is unknown for most of the 117 national parks in NSW and the 20 national parks in Victoria. Known sites include Kosciusko, Barrington Tops and Kinchega National Parks and Nadgee Nature Reserve in NSW; Alpine, Mt Buffalo, Baw baw and Croajingolong National Parks in Victoria; and forested highland areas of the ACT.

Protection status CITES – not listed.

Current legal protection Although protected in Federal National Parks, World Heritage areas, Aboriginal reserves, and the Australian Capital Territory, the dingo is a ‘declared’ pest throughout much of its remaining range, and landholders are obliged to manage populations; the dingo is ‘undeclared’, but not protected, in the Northern Territory (Fleming *et al.* 2001). The dingo is not protected in any other countries of its range.

Conservation measures taken No conservation measures have been taken other than that the dingo has been nominated as a threatened species in the State of NSW and the Australian Federal Government has recently published ‘best practice’ guidelines to manage and conserve dingoes (Fleming *et al.* 2001). The efforts of dingo ‘preservation’ societies in Australia are currently ineffective because most of their stock is untested or known to be hybrid (Corbett 2001). There are no conservation measures for wild dingoes in Asia. However, in New Guinea, the Department of Environment and Conservation has indicated that measures will be initiated to protect New Guinea singing dogs (I.L. Brisbin pers. comm.).

Occurrence in captivity

Dingoes and/or dingo-like hybrids occur in many zoos and private facilities worldwide. Tests using skull measurements of deceased animals or valid DNA tests (see below) are required to assess the purity of captive populations.

Current or planned research projects

A. Wilton (University of New South Wales, Australia) is investigating methods to identify genetically pure dingoes (and hybrids, domestic dogs and New Guinea singing dogs). This research aims to provide a method to test the purity of live dingoes; however, it is essential that control samples in Australia should be taken from pre-European material, so that samples are unequivocally dingo. Unfortunately, this is not the case to date (Wilton 2001).

L. Corbett (EWL Sciences, Darwin, Australia) is involved in a comparative morphometric study of skulls of dingoes and hybrids from Australia, Thailand, New Guinea and Japan.

L. Allen (Queensland Department of Natural Resources, Australia) is examining relationships between dingo abundance, dingo predation on cattle and control methods in Queensland, Australia.

A dingo and wild dog management programme is underway in south-east New South Wales and ACT (Australia Capital Territory), which aims to integrate control of dingoes and other wild dogs to prevent predation of livestock with conservation of dingoes in national parks (D. Jenkins, Australian Hydatids Control and Epidemiology Program; P. Fleming, New South Wales Agriculture; H. Cathles, Yass Rural Lands Protection Board). The Program includes DNA studies (A. Wilton), movement and behaviour studies, and assessment of control strategies for dingoes and other wild dogs.

M. Feinstein (Hampshire College, Amherst, MA, USA) and A. Ortolani (Disney's Animal Kingdom, Orlando, FL, USA) are undertaking a comparative study of the larynx and throat anatomy of captive New Guinea singing dogs and domestic dogs.

J. Koler-Matznick is involved in ongoing behavioural studies of captive New Guinea singing dogs (New Guinea Singing Dog Conservation Society, Central Point, OR, USA).

Gaps in knowledge

1. Morphological and genetic assessment of the taxonomic status of dingo-like dogs in Papua New Guinea, Indonesia, Malaysia, Vietnam, Cambodia, Laos, China, Burma, India, Philippines, and where present, their distribution, abundance, ecology and behaviour.
2. The ecological role of hybrids in Australia. If pure dingoes become extinct, will hybrids alter predation rates on native fauna and livestock?
3. Rabbits are a major prey in Australia but their populations have recently been decimated by rabbit calicivirus disease. What will be the effect on dingo ecology including predation on livestock?
4. What are the ecological effects of dingo control on feral cat and fox populations in Australia (meso-predator release)?

Core literature

Corbett 1985, 1995, 2001, 2004; Fleming *et al.* 2001; Newsome and Corbett 1985; Thomson 1992.

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