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Article in *Oryx* · September 2007

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## Extirpation and reintroduction of the Corsican red deer *Cervus elaphus corsicanus* in Corsica

Nicolas Kidjo, Gérard Feracci, Eric Bideau, Georges Gonzalez, César Mattéi, Bernard Marchand and Stéphane Aulagnier

**Abstract** The Endangered Corsican red deer *Cervus elaphus corsicanus* was extirpated from Corsica in the early 1970s, at which time the Sardinian population fell to <250 individuals. The Sardinian authorities agreed to protect this subspecies and to secure its reintroduction in Corsica, a natural choice, considering ethological and historical descriptions. Since the beginning of 1985, when the first deer destined for captive breeding and eventual reintroduction arrived in Corsica, the population increased from 13 Sardinian founders to 106 captive animals under constant monitoring in three enclosures (Quenza, Casabianda and Ania di Fium'Orbu). The sites of Quenza, Chisà and Santo

Pietro di Venaco were selected by the Regional Nature Park of Corsica for the reintroduction into the wild that began in 1998. Currently the size of the whole Corsican population is c. 250 individuals. These deer are still closely monitored and studied, both in enclosures and in the wild, to secure the long-term conservation of this subspecies. The Corsican and Sardinian populations together now total slightly >1,000, and the subspecies could therefore be downgraded to Near Threatened on the IUCN Red List.

**Keywords** Captive breeding, *Cervus elaphus corsicanus*, Corsica, Endangered, red deer, reintroduction, Sardinia.

### Introduction

Information from early publications (Fitzinger, 1874; Lydekker, 1898; Miller, 1912; Joleaud, 1925; Ellerman & Morrison-Scott, 1951) indicates that the Corsico-Sardinian endemic subspecies of the red deer, *Cervus elaphus corsicanus* Erxleben, 1777, has probably been present on Corsica and Sardinia since the end of the Middle Ages (Vigne & Marinval-Vigne, 1988). Two hypotheses have been proposed concerning the arrival of red deer on Corsica and Sardinia: (1) Migration of a small species of red deer from Italy, at the maximum marine Würmian regression, which then survived until the present day in Sardinia and Corsica (Stasi & Regalia, 1904; Joleaud, 1926). (2) An introduction by the Romans in Sardinia,

where remains of red deer dating from the end of the Nuragic period (8th-7th century BC) have been found (Vigne & de Lanfranchi, 1981); red deer from either Sardinia or the continent were then introduced to Corsica, where the earliest identified fossils (at Castellu) have been dated to the 6th century BC (Vigne, 1988).

Other bone remains dated to the 14th century AD were discovered in the medieval city of Bonifacio and at the Genoese tower of Castello d'Istria on Corsica (Gauthier & Thibault, 1979). Giustiniani recorded red deer in his 1530 description of Corsica (Giustiniani, in Letteron, 1887), and the species is depicted being hunted by a dog on Licinius' 1560 map of Corsica. The Corsican word *cervu* (deer) is associated with several places on the island, e.g. Cervione, Punta di u Cervu, Casa di a Cirvanecchia and Piedicerviu. In 1756 Buffon described the Corsican deer, pointing out morphological differences with the continental species. The presence of red deer in Corsica was reported by a local survey in the valley of the Golo river in 1802, and later by Galetti (1863) and Fertton (1898, 1899).

### Description of *Cervus elaphus corsicanus*

Morphological, biological and ecological differences between Corsican and continental red deer are slight, and support the hypothesis of a relatively recent colonization of Corsica. The main characteristics of *Cervus elaphus corsicanus* are a smaller size (Buffon, 1756; Erxleben,

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Received 16 December 2005. Revision requested 24 April 2006.

Accepted 3 August 2006.

1777), with a shoulder height of 75–90 cm for females (Cetti, 1774; Miller, 1912; Von den Driesch & Boessneck, 1974), and 80–110 cm for males (Vigne, 1988), a stockier morphology with notably shorter legs (Buffon, 1756; Cetti, 1774), the presence of a single tine (Gervais, 1854; Joleaud, 1913, 1925; Vigne, 1988), and a darker coat, especially in winter (Fitzinger, 1874; Lydekker, 1898; Miller, 1912).

According to Vigne (1988) the Corsican red deer belongs to the *Cervus elaphus* L. species, and clearly differs from the North African *Cervus elaphus barbarus* Bennett, 1833, contrary to the opinion of several authors, including Corbet (1978). The reversibility of some characters indicate an ongoing evolution of a phenotype that resulted from insular isolation after a relatively recent immigration (Vigne, 1992). Genetic studies, however, based on the complete mitochondrial cytochrome b gene (Ludt *et al.*, 2004; Pitra *et al.*, 2004) indicate the existence of a North African/Corsico-Sardinian clade that represents at least a subspecies differing from all other European deer.

### Decline of the Corsican deer populations

An 1802 survey recorded the presence of red deer in the area of the Golo valley (Corte, Luggo di Nazza, Moita, Pancheraccia, Prunelli, Ventiseri, Pietroso, Vezzani and Calenzana) and, according to Vigne (1983), the species was thought to have been distributed throughout Corsica in the 19th century. Extinction was later reported from several regions (Fig. 1): the Porto-Vecchio and

Cagna areas in 1900, the Fango valley in 1910, the district of Vezzani in 1920, Castagniccia in 1939, Ghisoni in 1940, and the low district of Solenzara in 1958 (Vigne & Marinval-Vigne, 1988).

Hunting was the main cause of local extinctions and the last remaining population was restricted to the north-eastern coastal area by the 1930s (Vigne & Deméautis, 1987). Habitat loss because of human activities such as scrub clearance and vine cultivation, as well as heavy hunting by the Italian and Allied armies during World War II, dramatically reduced this last population. Hunting, already restricted to 1 day per year, was legally halted in 1948. In 1950 an unpublished report described the red deer population as restricted to Pinia forest, south of Urbinu pond; Degos (1958) reported the survival of only 8–10 deer. Seven years later, poaching had further reduced the population in Pinia forest to two males, one female and a calf (Chartron, 1968; Degos, 1968). As the Pinia forest was intended to be transformed for agricultural and tourism purposes, Degos (1958) suggested transferring the remaining animals to the protected area of Casabianda. Unfortunately, capture attempts by enclosures and nets failed in 1960, 1961 and 1968, and the Pinia forest was designated a hunting reserve. The Corsican red deer was finally extirpated in 1970 (Jenkins, 1972; Gauthier, 1979; de Beaufort & Maurin, 1983).

In Sardinia there were populations of red deer in all five provinces until the beginning of the 20th century (Schenk, 1976). During 1900–1920 the size of the populations

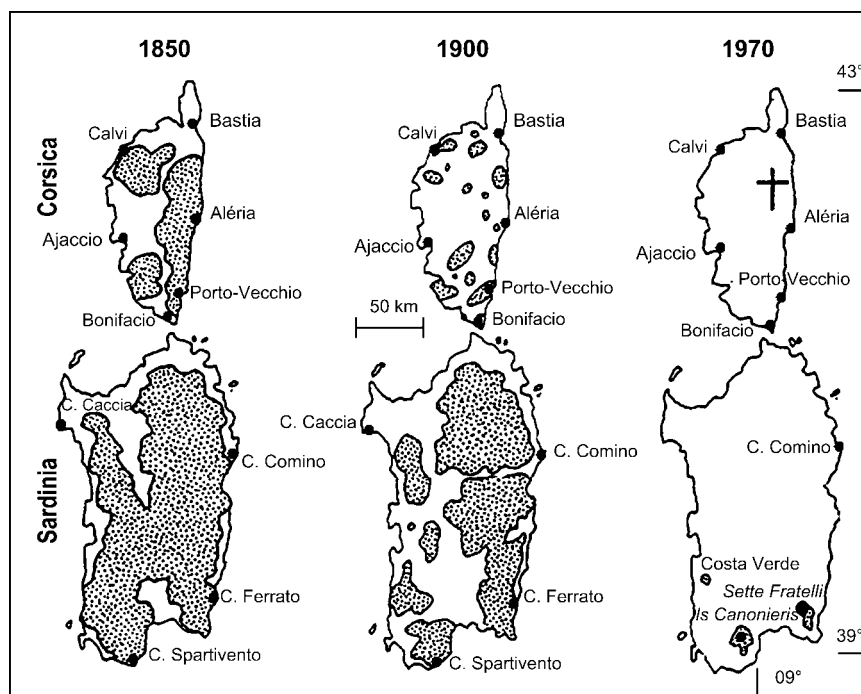


Fig. 1 Decline in range of the Corsican red deer in Corsica and Sardinia from 1850 to 1970 (after Deméautis, 1984).

decreased dramatically, although their distribution diminished only slightly. Later, in reports for WWF Italy, Jenkins (1967, 1968) recorded only 200 animals ranging over 20,000 ha: 10 in Costa Verde, 60-80 in Sette Fratelli-Castiadas, and 80-120 in Capoterra-Monte Arcosu. The decline was due to severe hunting, poaching and habitat loss resulting from agricultural changes and building activity. Following a further report by WWF Sardinia, conservation measures, such as the creation of protected areas, the monitoring of the size and distribution of populations and captive breeding, were initiated by the Azienda Foreste Demaniali della Regione Sarda. In 1975 Massoli-Novelli (1976) estimated, by counting rutting males, a total population of 150-200 individuals. By capturing some deer in cage traps (Leoni, 1978b) and subsequent captive breeding, Sardinia averted the extinction of *Cervus elaphus corsicanus* and thus made possible its later translocation to Corsica (Leoni, 1985).

### Captive breeding in Corsica

Soon after the extirpation of *Cervus elaphus corsicanus* from Corsica a reintroduction was planned using the Sardinian populations. In 1975 M. Leoni of the Parc Naturel Régional de Corse and R. Massoli-Novelli of the University of Cagliari, Sardinia, prepared the first bilateral project. Several French authorities were invited to join: the Directorate of Nature Conservation, the Regional Council, the local Directorate of Agriculture, the National Office of Forests, the National Hunting Office, and the Hunters' Union. The aim was to have populations of Corsican red deer on both islands to guard against any stochastic events such as disease epidemics (Gindre, 1978). A long-term agreement of reciprocal translocations was considered necessary to reduce inbreeding in populations on both islands (Leoni, 1978b). Representa-

tives of various authorities visited Corsica and Sardinia to define the reintroduction scheme (Leoni, 1978a,b, 1980).

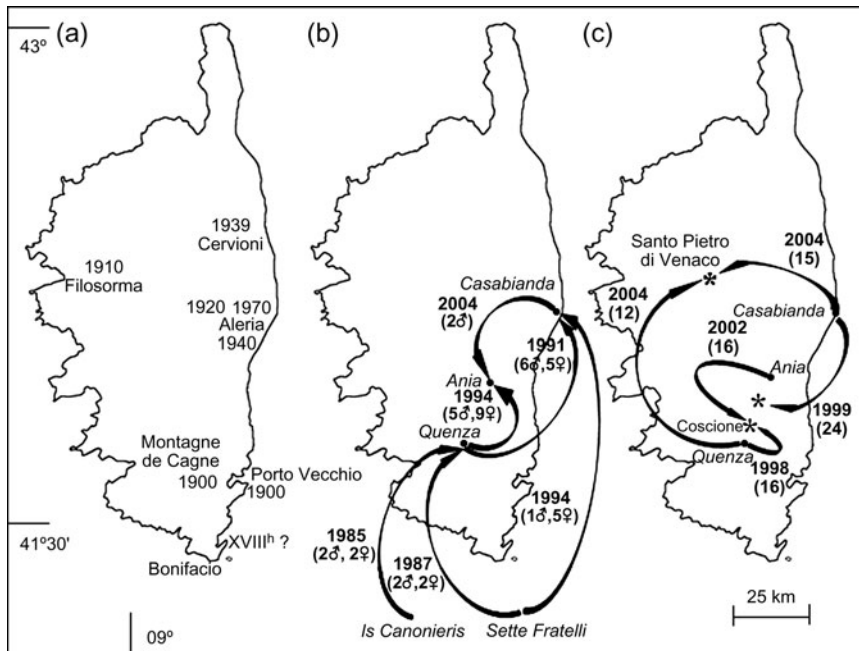
The Corsican captive breeding programme started with the creation of an enclosure at Quenza, on the southern slope of the Incudine mountain (Table 1). Later, two additional enclosures were established, in 1991 at Casabianda, on the eastern plain, and in 1994 at Ania, in the mountainous area of Fium'Orbu (Fig. 2). In November 1985 four deer were captured and anaesthetized in the Sardinian enclosure of Is Canonieris and released in Quenza (Table 2), but the adult male died soon after. In November 1987 four deer were brought to Quenza from the Sardinian enclosure of Sette Fratelli (Roux & Dubray, 1988). Deer were successively released in Casabianda and Ania di Fium'Orbu (Table 2), and one male was translocated back to Sardinia (Feracci, 2000). From, respectively, 3 and 4 founders in Quenza, 11 and 6 in Casabianda and 14 in Ania di Fium'Orbu, the three populations steadily increased and were artificially restricted to *c.* 35 deer in Quenza and Ania di Fium'Orbu, and 50 deer in Casabianda (Fig. 3), equating to densities of up to 3.2 deer ha<sup>-1</sup>.

However, since 1997 the reproductive rate has been irregular, and in 2001 the Regional Nature Park of Corsica, in charge of the reintroduction programme, initiated a comprehensive study to identify the behavioural, genetic and ecological determinants of breeding success of the Corsican deer in captivity (Gonzalez & Kidjo, 2002). This information will orientate the management of the captive populations and future reintroductions. It is planned that the number of deer, population structure and genetic diversity will be adjusted to maximize the fecundity of females and the survival of offspring.

A survey in 2002 (Boutier & Kidjo, 2002) showed that the vegetation in the three enclosures is different to the

**Table 1** Main features of the three Corsican enclosures (Fig. 2) established for the captive breeding programme (Boutier & Kidjo, 2002).

Enclosure	Location	Area (ha); altitude (m)	Soil	Vegetation
Quenza	Alta Rocca in S. Corsica	13; 800	Abundant litter interspersed with blocks of granite	Belongs to the Supra-Mediterranean stage. Green oak <i>Quercus ilex</i> , strawberry tree <i>Arbutus unedo</i> , heath tree <i>Erica arborea</i> , pines <i>Pinus</i> sp. & ash <i>Fraxinus</i> sp..
Casabianda	Coastal plain in N. Corsica	18; 0	Flat, dry & dense, covered by poor litter, rises above Quaternary alluvia	Belongs to the lower Meso-Mediterranean stage. Narrow-leaved cistus <i>Cistus monspelliensis</i> , heath tree & cork-oak <i>Quercus suber</i> are dominant.
Ania	Fium'Orbu in N. Corsica	15; 400-500	Usually thin, sometimes gives way to granite out-crops, blocks or gravels	Belongs to the upper Meso-Mediterranean stage. Dense heath tree & strawberry tree, & sparse maritime pines <i>Pinus pinaster</i> . Chestnut trees <i>Castanea sativa</i> occur in the southern part of the enclosure.



**Fig. 2** Extinction and reintroduction of the Corsican red deer in Corsica. (a) Dates of red deer extinctions in various parts of Corsica. (b) Location of the three enclosures for the captive breeding programme and founding events, showing the date and number of animals. (c) Location of Corsican red deer reintroductions in three areas in Corsica, showing the origin of the reintroduced individuals, dates of reintroduction and the number of animals released.

original because grazing by an increasing number of deer is preventing regeneration. At Quenza several species selectively eaten by deer, such as hairy thorny broom *Calycotoma villosa* and Etruscan honeysuckle *Lonicera etrusca*, have decreased dramatically in numbers since a 1994 survey (Maillard & Casanova, 1994; Maillard *et al.*, 1995). A similar decrease in dog rose *Rosa canina* and bramble *Rubus* sp. numbers is reported from Casabianda, where Finidori (2000) compared vegetation inside and outside the enclosure. Grain and hay have been regularly provided for the deer in the last few years to allow some regeneration. For the same purpose, grasslands were recently created in the enclosures.

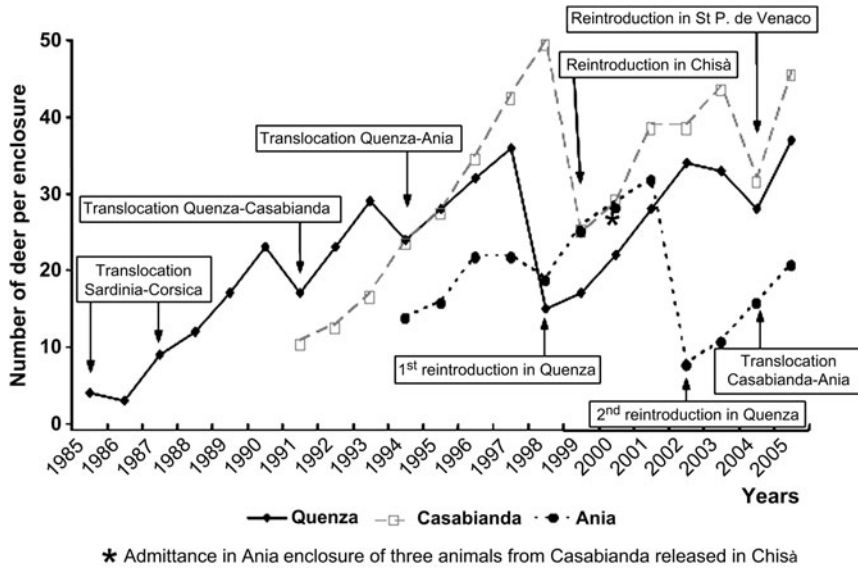
## Reintroductions

Prior to reintroduction in the wild, suitable sites were chosen according to the ecological requirements of the deer (Démeautis, 1984), as well as local socio-economic and cultural constraints (Dubray, 1989, 1990). From 1998 to 2004 four reintroductions were carried out in three localities (Fig. 2, Table 3). Each time at least five animals were fitted with radio collars and then located daily by staff of the Regional Nature Park of Corsica. This monitoring was used to assess the home ranges of female groups. It also revealed the higher dispersal rate of males, which often moved away from the release site.

**Table 2** Translocations of captive Corsican red deer among Sardinian and Corsican enclosures (Fig. 2) within the scope of the captive breeding programme (Feracci *et al.*, 2000, 2002, 2003, 2004), showing the number and origin of all reintroduced deer, and the date of translocation.

Original enclosure	Site where deer reintroduced			
	Quenza (Corsica)	Casabianda (Corsica)	Ania (Corsica)	Sette Fratelli (Sardinia)
Is Canonieris (Sardinia)	Nov. 1985: 4 (1 5-year ♂*, 1 3-year ♀ & 2 yearlings)			
Sette Fratelli (Sardinia)	Nov. 1987: 4 (2 ♀, 6 & 3 years; 2 ♂, 1 yearling & 1 calf)	Nov. 1994: 6 (1 ♂ & 5 ♀)		
Quenza (Corsica)		1991: 11 (3 adult ♂, 5 adult ♀ & 3 ♂ calves)	1994: 14 (1 adult ♂, 6 adult ♀, 4 ♂ & 3 ♀ calves)	
Casabianda (Corsica)			Mar. 2004: 2 adult ♂	Nov. 1994: 1 adult ♂

\*The adult male was found dead some days later



**Fig. 3** Growth of the three captive populations of Corsican red deer in Corsica including founding and reintroduction events (Is Canonieris and Sette Fratelli are the two Sardinian origins, for Corsican localities see Fig. 2).

Each year since 1998 females with calves have been observed in the wild, mainly by Park staff, and the population appears to be increasing. Presently the size of the whole population of Corsican red deer in Corsica is *c.* 250 individuals (including both captive and wild animals).

With the yearly expansion of the deer’s range some damage to meadows and crops has been reported in Asinao valley, and four requests for damage compensation have been deposited with the local agriculture authorities (Feracci *et al.*, 2000, 2002, 2003). The population in this valley is estimated to number *c.* 100 deer (Feracci *et al.*, 2004), which is the carrying capacity of the area estimated by Levadoux (2000) on the basis of the natural vegetation of the valley. Matching population growth with human activities and impact on the environment is the challenge for the future of this reintroduction.

**Discussion**

The subspecies *Cervus elaphus corsicanus* is categorized as Endangered on the IUCN Red List (IUCN, 2007) on the

basis that the population is <250 mature individuals (IUCN, 2001). However, this assessment was made in 1996 (IUCN, 2007). Based on our data and on the growth of the Sardinian population (Toso, 2002) the subspecies could be downgraded to Near Threatened (population size slightly >1,000 mature individuals; IUCN, 2001). It is listed in Appendix II of the Bern Convention (entered into force in 1979, ratified by France in 1990), as well as in Appendices II and IV of the European Community’s Habitats Directive (no. 92/43/CEE). In French law hunting of this deer is authorized by the decree of 26 June 1987 but departmental decisions, renewed annually in northern and southern Corsica, prohibit killing, capture, transport and trade of this species.

From an early recognition of the need to restore Corsican red deer populations to Corsica, the subspecies is again wild on both Sardinia and Corsica and in at least five separate locations (excluding the five captive populations). The expansion of the reintroduced populations, and thus the survival of the subspecies, now relies on public awareness and support, as well as on further studies to improve captive breeding and reintroduction

**Table 3** Reintroductions of Corsican red deer into the wild within Corsica (Fig. 2), with the original enclosure, number and type of released individuals, and status of the reintroduced population in 2004 (Feracci *et al.*, 2000, 2002, 2003, 2004).

Original enclosure	Asinao	Chisà	Santo Pietro di Venaco
Quenza	3 Feb. 1998: 11 (1 ♂, 8 ♀ & 2 calves) 26 Feb. 1998: 8 ♂		18 Mar. 2004: 12 (3 ♂, 1 ♀ & 8 ♂ yearlings)
Casabianda		24 Feb. 1999: 24 (6 ♂, 12 ♀, 2 ♂, 2 ♀ yearlings & 2 calves)	15 Mar. 2004: 15 (4 ♀, 2 ♂ yearlings, 4 ♀ yearlings & 5 calves)
Ania	13 Feb. 2002: 16 (7 ♂, 7 ♀ & 2 calves)		
Total estimated population, with area & altitude	100 over 6,700 ha at 590–2,040 m	60 over 6,500 ha at 20–1,800 m	40 over 400 ha at 800–2,200 m

processes (four reintroductions are planned for the next 5 years in the scope of an EU Life-Nature project). These studies include investigating reproductive success in relation to habitat and population structure in the enclosures. In the wild, studies will focus on investigating patterns of spatial use, feeding habits and the ecological characteristics of the subspecies' preferred habitat, and evolution of genetic polymorphism.

## Acknowledgements

Initiated by the Parc Naturel Régional de Corse (PNRC), this reintroduction programme involves many partners and participants. We particularly thank all authors of unpublished reports, as well as PNRC scientists and technicians. We also thank M. Salotti and E. Pereira for information and review, and our Institut National de la Recherche Agronomique (INRA) colleagues for discussions and support. NK was funded by the Direction Régionale de l'Environnement, the Office de l'Environnement de la Corse, PNRC, and the INRA.

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### Biographical sketches

Nicolas Kidjo is currently studying the ecology, behaviour and genetics of captive bred Corsican red deer. The project aims to improve knowledge of the biology of this subspecies, determine the origins of the variability of demographic parameters, and record morphological and genetic characteristics of individuals, vegetation use and habitat characteristics. Gérard Feracci and Cesar Mattéi are working for the Parc Naturel Régional de Corse, the former heading the Park's wildlife project, the latter focusing on the conservation of the Mediterranean mouflon. Eric Bideau and Georges Gonzalez are studying behaviour, management and conservation of ungulates in Western Europe. In particular, they are involved in conservation projects in protected areas. Bernard Marchand has conducted research on parasites of vertebrates, mainly helminths, in Western Africa and the Mediterranean. Stéphane Aulagnier's research focuses on the evolutionary biology and conservation of Palaearctic mammals.