



Short communication

Threat or threatened species? A paradox in conservation biology

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ABSTRACT

The introduction of alien species is one of the main threats to conservation. However, the same species may be threatened and be a threat in nearby areas. This is the case of the Barbary sheep (*Ammotragus lervia*) and mouflon (*Ovis orientalis*), which greatly hinder the management and conservation of biodiversity outside their native range. To prevent the extinction of many endemic plants, it is necessary to overcome several methodological difficulties.

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Nomenclature

Taxonomical nomenclature according to Acebes et al. (2010).

The introduction of alien species on islands has been widely studied (Courchamp et al. 2003; Donlan et al. 2003; Drake et al. 2002; Reaser et al. 2007; Sax et al. 2002). Their negative effects on plants are well known (Campbell & Donlan 2005; Simberloff 1995; Vázquez 2002), and constitute one of the primary threats to endemic island floras and a principal cause of biodiversity loss (Brooks et al. 2002; Wilcove et al. 1998).

In the Canary Islands, where almost 40% of the native flora is endemic (Acebes et al. 2010), goats (*Capra hircus* L.) and European rabbits (*Oryctolagus cuniculus* L.) have disturbed the vegetation for hundreds of years (Nogales et al. 2006). The more recent arrival of Barbary sheep (*Ammotragus lervia* Pallas) and mouflon (*Ovis orientalis* Gmelin), has become a serious additional problem (Bañares et al. 2003; Garzón-Machado et al. 2010; Marrero-Gómez et al. 2003). These latter species were unfortunately introduced into the archipelago by ICONA (the former Institute for Nature Conservation, part of the Ministry of Agriculture) in the early 70s, for hunting purposes (Rodríguez et al. 1988). Barbary sheep are endemic to North Africa (Fig. 1), and have also been introduced into northern Mexico, Spain and the USA (Cassinello et al. 2008). Their population in the Canary Islands was about 300 individuals in 1994 (Blanco 1998), and at the beginning of the twenty-first century it was estimated at 250 individuals, mainly inside the Caldera de Taburiente National Park (Rodríguez & Cassinello 2008). The population seems to have stabilised due to hunting, but a current census

should be undertaken. Mouflon has a more eastern distribution (Fig. 1), occurring in Armenia, Azerbaijan, India, Iran, Kazakhstan, Oman, Pakistan, Tajikistan, Turkey, Turkmenistan, Uzbekistan and Afghanistan (Valdez 2008). The most recent population estimate in the Canaries was about 400 individuals (Durbán-Villalonga 2003).

The current distribution of both species is mainly restricted to Caldera de Taburiente National Park (La Palma) and Teide National Park (Tenerife), where a high percentage of endemic plants grow. Two studies on food habits revealed that Barbary sheep and mouflon affect 21 and 14 endemic species respectively, some of them strongly endangered like *Bencomia exstipulata*, *Cheirolophus santos-abreui*, *Helianthemum cirae* and *Lotus pyranthus* on La Palma, and *B. exstipulata*, *Cheirolophus mettlesicsii*, *Helianthemum juliae*, *Lotus berthelotii* and *Stemmacantha cynaroides* on Tenerife (Rodríguez 2008; Rodríguez & Cassinello 2008), although there could be many more.

The lists of threatened species provide a partial basis on which many governments responsible for the recovery of endangered species can draw up conservation priorities (Martín 2009). Similarly, lists of invasive species are also useful for this purpose. The Spanish Catalogue of Invasive Alien Species has recently been published (Gobierno de España 2011). It includes Barbary sheep and mouflon among the invasive species, and even considers the possibility of eradication. This action also appears as one of the main objectives of the Management Plans (PRUG) of the Canary Islands National Parks. However, these species appear paradoxically listed as vulnerable in their natural habitats by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Cassinello et al. 2008; Valdez 2008), because populations have decreased in recent years.

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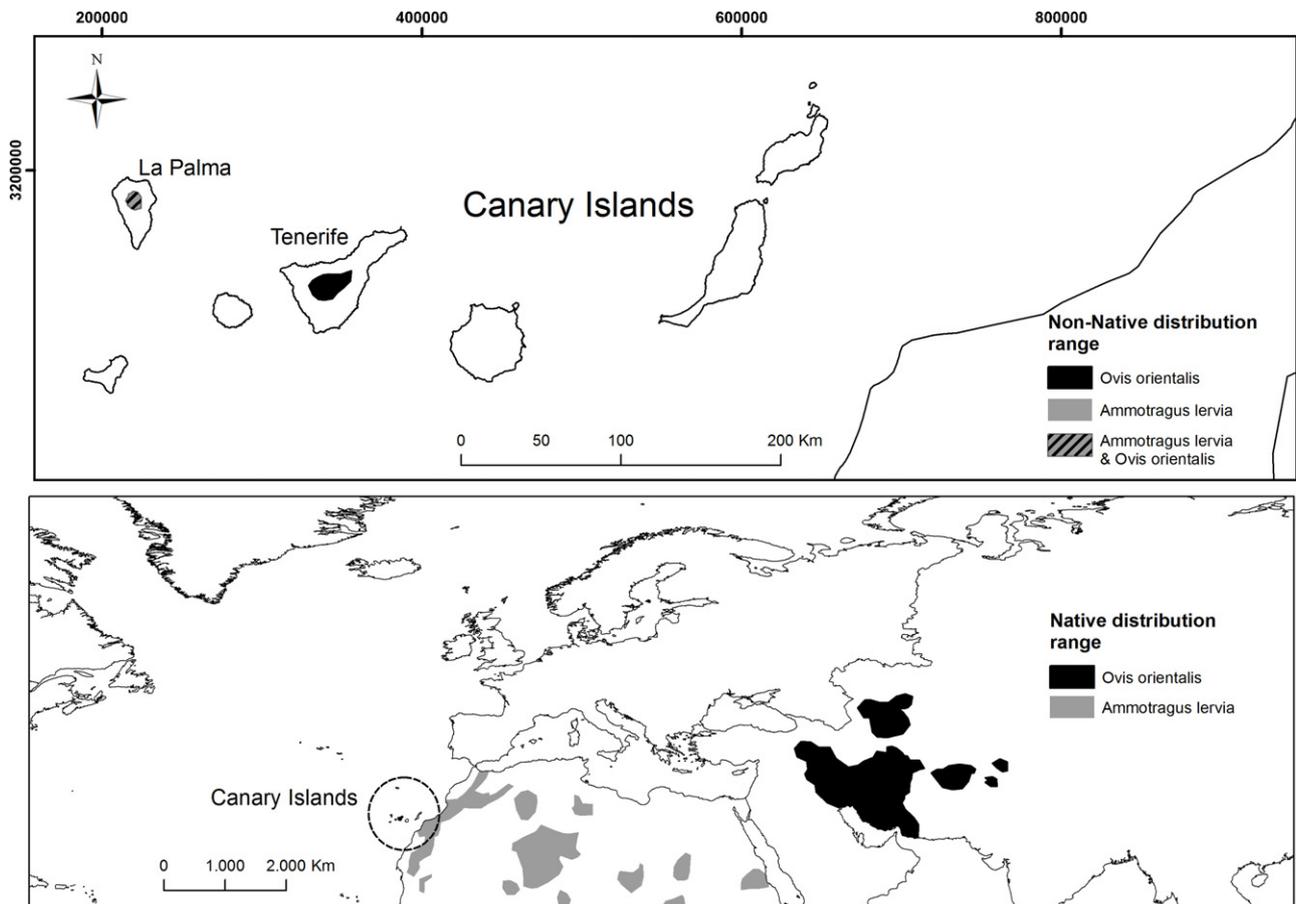


Fig. 1. Native distribution range of Barbary sheep (*Ammotragus lervia*) and mouflon (*Ovis orientalis*) vs. areas where they have been introduced in the Canary Islands. Adapted from Cassinello et al. (2008) and Valdez (2008).

Finding a solution

The negative effect of these species on the native endemic flora is a documented reality, since they eat and trample the plants, and alter the substrate, particularly the nitrogen balance through urine and feces (Bañares et al. 2003; Garzón-Machado et al. 2010; Hobbs 1996; Marrero-Gómez et al. 2003). This is affecting about 20% of the total threatened flora (Garzón-Machado 2011), leading several species to the brink of extinction, in only forty years. It is not only a problem in the Canaries. For instance, it also occurs in the south of the Iberian Peninsula, where the expansion of Barbary sheep could endanger the important endemic flora of Sierra Nevada National Park (Acevedo et al. 2007). But there, additional problems have arisen due to their competition with Iberian ibex (*Capra pyrenaica* Schinz): displacement of ibex to suboptimal habitats and a possible increase in infestation by parasites (Acevedo et al. 2007). These negative effects could also occur in other areas where these animals have been introduced.

How do we reconcile species listed under the Spanish Catalogue of Alien Species with their Vulnerable IUCN status?

From the viewpoint of conservation biology, the answer is not easy. Total eradication would be a drastic but effective solution (Genovesi 2005), and this measure is commonly suggested by researchers in that field, although it could mean killing a protected species that is in decline only a few hundred kilometers away on the mainland (Fig. 1).

The introduction of alien species, especially mammals, to new environments beyond their natural distribution ranges (Kumschick et al. 2011) is one of the main threats to conservation, causing paradoxical situations that complicate biodiversity conservation and management. In the Canaries, the strong negative impact of other alien species such as goats or European rabbits on Canary endemic plants has been continual for at least several hundred years (Nogales et al. 2006). Many species without effective mechanisms against these herbivores could have disappeared without ever being known to us. However, they are already part of the islanders' modern history, and eradication would be opposed. Furthermore, the life-cycle and reproductive strategy of the European rabbit makes it almost impossible to control on medium and large islands, such as those of the Canary archipelago. Conversely, the recent introduction of Barbary sheep and mouflon is a different case. It has been a great mistake, totally preventable if the conservation policy had been correct. Despite this, we could take advantage of this mistake and convert it into a solution, at least for Barbary sheep.

The re-introduction of Barbary sheep within its natural range of distribution would help to improve the current state of the natural populations, increasing the number of individuals and even enhancing genetic richness (a previous genetic study could be performed). The procedure to capture the animals would not be a problem, since there are hunters well trained in these techniques. In addition, Judas goat techniques could be a good tool for detecting these animals at low densities (Campbell & Donlan 2005).

Re-introduction of mouflon would not however be advisable, because its taxonomic status is still doubtful. In addition, this species has a strong tendency to hybridise with domestic sheep

(*Ovis aries* L.), so its genetic purity has deteriorated (Cugnasse 1994). Hybrid specimens (*O. orientalis* × *O. aries*) have already been detected in the Canaries (Acevedo-Rodríguez & Medina 2010). In this case, total eradication seems to be the most effective solution. Thus, two of the most harmful factors for the native endemic flora would disappear.

But there are two main barriers to such procedures. First, there is as yet no international agreement with the authorities administering the native range. In general, when the number of separate geopolitical planning units increases, conservation efficiency decreases (Bladt et al. 2009). Second, social opposition could be strong, especially from the hunting community. Proposals to remove these animals are frequently beset by public controversy (Marrero-Gómez et al. 2003). It would therefore be advisable to promote education for biological conservation in order to raise environmental awareness of this problem. Public figures and educators need to have clearer information and work together in favour of a solution. An agreement among politicians and managers of the different island administrations and parks (City Councils, Canary Government, and National Parks) is also necessary. This should lead to a subsequent agreement with hunters, and better acceptance of a solution.

Until these difficulties are overcome, only a stricter control or reduction of these alien species can prevent the extinction of many endemic plants.

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