

## **The Arguments against Cloning the Pyrenean wild goat**

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In recent years, new technology has revived the scientific debate regarding the feasibility of recovering extinct species (Stone 2013; Minter 2014). However, due to the various pros and cons of back breeding, cloning, and genetic engineering, these techniques remain controversial (Sherkow & Greely 2013). The term *de-extinction*, used to express the restoration of extinct species, appears frequently in the literature, particularly in reference to the de-extinction by cloning of the Pyrenean wild goat (*Capra p. pyrenaica*) (Folch et al. 2009; Kupferschmidt 2014). The recent extinction of this Iberian subspecies (of which the last individual died in January 2000) makes this project an attractive one for policy makers, conservationists, and hunters because ecosystem characteristics are unchanged and the factors affecting the conservation of this subspecies are well known. Nevertheless, while these are necessary conditions to ensure the success of reintroduction, they may not be sufficient (Sherkow & Greely 2013).

After a failed attempt in 2003 (Folch et al. 2009), Folch and colleagues have recently resumed trials aimed at re-cloning the Pyrenean wild goat (Kupferschmidt 2014). However, there are a number of special circumstances that make this cloning process inadvisable.

First, cloning is very expensive (Cottrell et al. 2014). Substantial amounts of public money have been invested in this project, which leaves less funding for other conservation efforts. Some authors argue that the hypothetical reversibility of the extinction process could lead to a relaxation or deactivation of many of the programs currently under way for the recovery of other threatened species (Sherkow & Greely 2013). This will be especially true if the funds for the cloning are deducted from budgets allocated to other monitoring and conservation programs. Given the current economic crisis, cuts in research funding are already affecting biodiversity conservation (Margalida 2012).

Second, Spanish scientists have used somatic cell nuclear transfer (SCNT) and cryopreserved tissue from the last known Pyrenean wild goat in their attempts to revive this extinct subspecies. However, to date only one fetus has been brought to term and it died minutes after being born from lung abnormalities (Folch et al. 2009). Furthermore, the tissues available for this particular cloning project originate from the last known specimen – an old, infertile, highly homozygous female, possibly suffering from hereditary heart disease (Jiménez et al. 1999; M. Fernández Caso et al. , unpublished ). These tissues are unlikely to provide adequate and diversified genetic material to produce healthy individuals able to give rise a viable wild population. It is known that cloning produces high levels of abnormalities and deformities and often results in premature death (Chavatte-Palmer et al. 2012).

The systematic identification of this subspecies and its relationship to its phylogenetic neighbors are still not completely clear (García-González 2012). *C. pyrenaica* is an endemic species of the Iberian Peninsula. The few phylogenetic studies available seem to indicate a clear genetic and morphological differentiation between the extinct subspecies *C. p. pyrenaica* and the other two living subspecies *C. p. victoriae* and *C. p. hispanica*. *C. p. pyrenaica* presents an equidistant genetic position between living subspecies and *C. ibex* (a taxonomic neighbor species from the Alps) (Manceau et al. 1999). In addition, *C. p. pyrenaica* is larger and exhibits particular skeletal differences with respect to living subspecies (García-González 2011). This lack of certainty regarding the genetic identity of the Pyrenean wild goat means that any attempt at a recovery program will be unlikely to succeed.

Finally, a population of more than 100 individuals of another subspecies (*C. p. hispanica*) thrives in the pre-Pyrenees, just 20 km from where the last Pyrenean wild goat lived (Herrero et al. 2013). This population has been reproducing normally in the wild and has expanded into surrounding areas.

If *C. pyrenaica* must be reintroduced in the Pyrenees, alternatives to the cloning of the last Pyrenean wild goat individual exist. An easy and economic solution could be to favor the wild goats that currently exist in the pre-Pyrenees. Their genetic distance from *C. p. pyrenaica* is probably not as distant as those of any of the currently planned genetically artificial products that may be obtained by cloning and genetic engineering (Kupferschmidt 2014). In this regard, a recent project aimed at reinforcing and reintroducing other Pyrenean megafauna, such as the threatened brown bear (*Ursus arctos*), with individuals from genetically neighboring populations from central Europe (Swenson et al. 2011) is a good model to follow. The economic investment will be less and the chances of success are likely to be substantially higher.

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