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RESPONSE

Feline leukaemia virus outbreak in the Iberian lynx in 2007: analysing partial data may lead to misconceptions

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In López *et al*. (2009), we reported an outbreak of feline leukaemia virus (FeLV) in the Doñana Iberian lynx population, and described the management measures adopted for its control. Among the factors suspected to increase the individual contact rate (and thus the potential for favouring the dispersion of the FeLV), we discussed the implication of supplementary feeding stations (SFS). However, the SFS were not considered to play a central role in the spreading of the virus throughout the population (see López *et al*., 2009). Palomares, López-Bao & Rodríguez (2010) provide a potential explanation for the evolution of the FeLV outbreak in the Doñana population based only on partial data (video- and photo-trapping inside the SFS and radio-tracking data), which may lead to fundamental misconceptions when interpreting the possible scenarios for the evolution of this outbreak: only 10 individuals out of the 16 living in the Coto del Rey subpopulation (CRS) in late 2006 were radio-tagged, while video- and photo-trapping conducted inside the SFS does not provide complete knowledge of the use of space by the Iberian lynx.

All FeLV-viraemic Iberian lynxes detected in 2007 were from the CRS subpopulation. Coto del Rey is an area of about 10 000 ha of suitable habitat for the Iberian lynx (according to Palomares, 2001), with stable breeding territories in the north and south and a central connecting area commonly used in dispersal (Fig. 1). During 2007, two of the six juveniles living in CRS were recorded both in the north and in the south (Fig. 1), and two more were also suspected to move between the two breeding cores. Moreover, no lynx from any other subpopulation was recorded that year in CRS. Under this scenario, we consider that Coto del Rey acted as a single subpopulation when the FeLV was circulating.

Because Román (a male living in the south of CRS) was the first detected FeLV-positive individual, Palomares and colleagues assume that he was also likely to be the first FeLV-infected Iberian lynx in the population. Given that two of the 10 Iberian lynxes (Inesperado and Cacao) found to be FeLV-viraemic had neither been radio-tagged nor analysed by late 2006, we believe that this is a risky assumption. A plausible alternative explanation for the origin of the outbreak is that either Inesperado or Cacao (who comes from the same territory in north CRS) were first infected by contact with a domestic cat and that the virus reached south CRS as one of these untagged individuals moved between the two breeding cores in CRS. Thus, although the hypothesis proposed by Palomares and colleagues is plausible, we cannot discard other ecologically possible scenarios either.

Although the SFS may seem not to be the main factor explaining the transmission of FeLV throughout the population, we consider that its potential role in the spread of the outbreak cannot be neglected. Although both the intersexual differences in the response to FeLV observed in the Iberian lynx and the low sample size prevent the drawing of definitive conclusions, explanations regarding the role of the SFS that do not take these two factors into account may be oversimplistic. All five adult males living in CRS were positive and became persistently infected, while only two of the adult females were positive and both turned the virus into latency. Only one adult female (Wari) out of the three females sharing the SFS with Román in 2006 was analysed in 2007, and tested negative. In our opinion, the fact that Wari was negative in September does not mean that she was not infected during the mating season, as a complete clearance from infection can occur in both domestic cats (Barr & Bowman, 2006) and the Iberian lynx (LIFE project, unpubl. data). Support for this idea comes from the fact that Wari and Román copulated after the male tested positive, and copulation is thought to be one of the most effective ways of transmitting FeLV (Rojko & Kociba, 1991). One of the two other females sharing the SFS with Román in 2006

Figure 1 Map of the Coto del Rey subpopulation in 2007. Grey patches are suitable habitat for the Iberian lynx according to Palomares (2001). Thick-line polygons represent the minimum convex polygon resulting from photo-trapping in 2007, direct sightings and radio-tracking locations of all individuals living in the area in late 2006. The thin line represents the boundaries of the Doñana Natural Space.

(an untagged lynx) was detected in north CRS by photo-trapping in 2007 and so the infection of this female by Román and previous dissemination throughout CRS cannot be ruled out. Moreover, two adult females living in south CRS were detected as FeLV-positive, possibly due to contact with infected males both in SFS and/or in copulations. Given that FeLV is transmitted through direct contact, all sources of contact will have favoured the dispersion of this virus. In agreement with the letter from Palomares *et al*. (2010), we consider that the presence of the SFS does not provide a good explanation for the inter-territorial transmission of the virus, as the use of neighbouring SFS is uncommon. As we proposed in López *et al*. (2009), male–male contact during the mating season could have been one of the main sources of inter-territorial transmission, although subadults moving between populations could have also favoured this dispersion. However, when discussing the transmission of the virus between individuals sharing territories, all sources of contact – including those generated by the use of the SFS – should be taken into account. The presence of the SFS for the Iberian lynx in Doñana has been shown to reduce individual core activity areas to just the surroundings of the SFS (López-Bao *et al*., 2010), thereby ensuring that the probability of inter-individual contact increases within home ranges. Thus, although the SFS alone cannot explain the spread of the virus throughout the CRS Iberian lynx population, its role in the outbreak cannot be ignored.

Besides the increased probability of inter-individual contact, the SFS supplied with several domestic rabbits at a time has been shown to lead to inter-individual prey sharing. We believe that Palomares and colleagues did not record this behaviour due to the design of their SFS research experiment (small 9 m^2 enclosures with photo- or video-cameras). Within the conservation measures developed in the framework of the LIFE project 'Conservation and Reintroduction of the Iberian Lynx in Andalusia', we accumulated around 3200 h of direct observation of lynxes feeding in the SFS (mean surface: 64 m^2) and more than 12 000 photo-capture events of Iberian lynxes inside and around the SFS. On about 8% of the occasions that an Iberian lynx entered an SFS baited with domestic rabbits, at least two individuals shared a prey item. We have also recorded the following types of behaviour in both Doñana and Sierra Morena Iberian lynx populations:

(1) *Female or juvenile hunting for an adult male*: This behaviour represents about 60% of the detected occasions of two Iberian lynxes sharing a prey item. The adult male usually waits outside the enclosure while the subordinate lynx (female or juvenile) captures the domestic rabbits and brings them to the male, which then eats them. The subordinate individual usually stays in the surrounding area and feeds on the remains once the dominant male has left. This behaviour cannot be detected with cameras placed inside the SFS.

(2) *One individual kills more prey items than it can eat and then another individual eats the rest*: This behaviour represents about 30% of the detected occasions of Iberian lynxes sharing prey. Given that domestic rabbits are easy to hunt, a lynx entering an SFS baited with several domestic rabbits can kill more than one individual. When this happens, the next lynx to enter feeds on the remains left by the previous animal. This behaviour has been recorded both inside and outside the SFS, although it is more frequently recorded outside small SFS, such as the ones studied by Palomares and colleagues

(3) *One individual steals the prey another one has captured*: This behaviour represents about 10% of the detected occasions in which two Iberian lynxes share a prey item. It is similar to the first case, although on this occasion, one individual steals a prey item captured by another. This behaviour has been recorded both inside and outside the SFS, but has yet to be recorded in small SFS, such as those studied by Palomares and colleagues

Finally, Palomares *et al*. (2010) discuss the potential relevance in the persistence of the outbreak of the antibiotic residuals found in the domestic rabbits used in the SFS. Recognized as one of the potential factors increasing the susceptibility of individuals to FeLV (López *et al*. 2009), the role of antibiotics deserves further attention, and is currently under study.

Finally, we believe that the importance of the SFS in the FeLV outbreak that hit the Doñana Iberian lynx population in 2007 should not be underestimated. Along with the other factors that encourage lynx–lynx contact in the population, and that are described in López *et al*. (2009), the SFS may play an important role in the spread of the virus in CRS. Although we have not been able to evaluate the effect of each of the techniques implemented to control the outbreak, the measures described in López *et al*. (2009) were efficient in an overall sense in controlling this disease.

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