



Long-Term Dynamics of Bluetongue Virus in Wild Ruminants: Relationship with Outbreaks in Livestock in Spain, 2006–2011

Cristina Lorca-Oro^{1*}, Jorge Ramón López-Olvera², Francisco Ruiz-Fons³, Pelayo Acevedo^{3,4}, Ignacio García-Bocanegra⁵, Álvaro Oleaga^{3,6}, Christian Gortázar³, Joan Pujols^{1,7}

1 Centre de Recerca en Sanitat Animal (CRESA), UAB-IRTA, Campus de la Universitat Autònoma de Barcelona, Bellaterra (Cerdanyola del Vallès), Spain, **2** Servei d'Ecopatologia de Fauna Salvatge (SEFaS), Departament de Medicina i Cirurgia Animals, Universitat Autònoma de Barcelona (UAB), Bellaterra, Barcelona, Spain, **3** SaBio IREC, Instituto de Investigación en Recursos Cinegéticos (CSIC-UCLM-JCCM), Ronda de Toledo s.n., Ciudad Real, Spain, **4** CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBio Laboratório Associado, Universidade do Porto, Vairão, Portugal, **5** Departamento de Sanidad Animal, Facultad de Veterinaria, UCO, Campus Universitarios de Rabanales, Córdoba, Spain, **6** SERPA, Sociedad de Servicios del Principado de Asturias, S.A., Gijón, Asturias, Spain, **7** Institut de Recerca i Tecnologia Agroalimentàries (IRTA), Barcelona, Spain

Abstract

Wild and domestic ruminants are susceptible to Bluetongue virus (BTV) infection. Three BTV serotypes (BTV-4, BTV-1 and BTV-8) have been detected in Spain in the last decade. Even though control strategies have been applied to livestock, BTV circulation has been frequently detected in wild ruminant populations in Spain. The aim of the present study is to assess the role for wild ruminants in maintaining BTV after the vaccination programs in livestock in mainland Spain. A total of 931 out of 1,914 (48.6%) serum samples, collected from eight different wild ruminant species between 2006 and 2011, were BTV positive by ELISA. In order to detect specific antibodies against BTV-1, BTV-4 and BTV-8, positive sera were also tested by serumneutralisation test (SNT). From the ELISA positive samples that could be tested by SNT (687 out of 931), 292 (42.5%) showed neutralising antibodies against one or two BTV serotypes. For each BTV serotype, the number of outbreaks in livestock (11,857 outbreaks in total) was modelled with pure autoregressive models and the resulting smoothed values, representing the predicted number of BTV outbreaks in livestock at municipality level, were positively correlated with BTV persistence in wild species. The strength of this relationship significantly decreased as red deer (*Cervus elaphus*) population abundance increased. In addition, BTV RNA was detected by real time RT-PCR in 32 out of 311 (10.3%) spleen samples from seropositive animals. Although BT outbreaks in livestock have decreased substantially after vaccination campaigns, our results indicated that wild ruminants have been exposed to BTV in territories where outbreaks in domestic animals occurred. The detection of BTV RNA and spatial association between BT outbreaks in livestock and BTV rates in red deer are consistent with the hypothesis of virus circulation and BTV maintenance within Iberian wild ruminant populations.

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* Email: cristina.lorca.oro@gmail.com

Introduction

Bluetongue (BT) is a vector-borne infectious disease that has geographically expanded in Europe during the last decades [1–5]. The causal agent, bluetongue virus (BTV), is transmitted by *Culicoides* biting midges and both wild and domestic ruminants and camelids are considered susceptible hosts. Vector and host density, as well as environmental factors, are implicated in the distribution of BT, which is considered endemic in wild ruminants in large parts of Africa and North America [6,7]. Except for mouflon (*Ovis aries musimon*), European wild ruminants are mostly asymptomatic to BTV infection [8–10], and they have potential to participate in BTV epidemiology [11–14]. However, the role of European wild

ruminants in BTV transmission and maintenance is still under debate [15–17].

In Europe, BTV serotype 4 (BTV-4) was firstly detected in 2004 in Southern Spain and was detected in livestock until the end of 2007. Spain was declared free from BTV-4 in 2009, but this serotype reappeared in 2010. BTV-1 was detected in livestock from Southern Spain in 2007, and as with BTV-4, both BTV strains reached the Iberian Peninsula probably from infected *Culicoides* carried by the wind from North Africa [18], and spread in the following years to northern areas. BTV-8 appeared in Central Europe in 2006 and reached Northern Spain in 2008. Vaccination against BTV-4 was compulsory in susceptible domestic ruminants from 2005 to 2008, when the epidemiological