Suitable habitats of Ornithodoros soft ticks in the Palearctic region

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Abstract

Ticks are economically and medically important due to injuries to livestock directly caused by their bite and their ability to transmit pathogens to humans and animals. While hard ticks (*Ixodidae*) have been extensively studied, the ability of soft ticks (*Argasidae*) to transmit pathogens to humans and domestic animals remains underestimated (Gray, Estrada-Pena, and Vial 2014). These ticks are nonetheless medically important, especially those belonging to the Ornithodoros genus. In the Palearctic region, five Ornithodoros tick species are considered able to transmit borreliae that cause Tick-Borne Relapsing Fever (TBRF) in humans, with many ocular, encephalitic, arthritic and pregnancy complications (Rebaudet and Parola 2006). The detection of human TBRF cases caused by *Borrelia hispanica* between 2002 and 2012 in Spain confirmed that the risk of human contamination through soft tick bites in Europe is real (Croche Santander et al. 2015). In the same region, the Iberian tick species *O. erraticus* was confirmed as a competent vector and natural reservoir for the virus of African Swine Fever (ASF) (Boinas et al. 2011). Knowing the spatial distribution of ticks is essential to assess the risk for pathogen transmission by ticks, so we set out to map suitable habitats for Ornithodoros ticks. In the Palearctic, presence data for Ornithodoros ticks are scarce and largely historical, and absence data are mostly unavailable (Vial 2009). Due to the relative scarcity of high-quality occurrence data, a GIS-based Multi-Criteria Decision Analysis was chosen to describe the range of environmental conditions enabling ticks to survive, grow and reproduce. Based on ecological knowledge on Palearctic *Ornithodoros* ticks

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distilled from an in-depth literature review, five criteria were identified. Two criteria were linked to temperatures allowing feeding activity and tick development. The three other criteria were related to the moisture availability for tick survival and development, either from precipitation, ambient humidity or other environmental factors that may provide sufficient moisture in arid zones. In order to incorporate uncertainty, a sensitivity analysis was done by performing different runs of the model and varying the environmental variables describing the respective criteria, the suitability response curves for each of the variables and the weights attributed to the different criteria for each run. Only in the final step, the available presence/absence data were used to validate the results. All models indicated similar trends. Several highly suitable areas were identified along the southern frontier between Portugal and Spain as well as the eastern coast of Spain from Catalonia to Andalusia. Also highlighted were the coastal areas in Sardinia, Sicilia and eastern Italy, as well as eastern Greece and western Turkey. To the east, the estimated distribution extended to the Ukrainian and south-west Russian region above the Black Sea.
The models were based on climate variables and did not aim to assess local heterogeneity. Nonetheless, this remains one of the rare examples where a knowledge-based approach was used to produce distribution maps for ticks. This approach compensated both for the scarcity of the presence data and the fuzzy nature of the knowledge available on the ecology of these *Ornithodoros* tick species. The high values of the accuracy measures, as well as major congruence between the different models for predicting suitable and highly suitable areas, inspired confidence in this methodology and the resulting suitability maps. This makes it a very useful tool to target the surveillance of *Ornithodoros* ticks and assess the risk for Tick Borne Relapsing Fever throughout Europe.

References

Boinas, Fernando S., Anthony J. Wilson, Geoff H. Hutchings, Carlos Martins, and Linda J. Dixon. 2011. "The Persistence of African Swine Fever Virus in Field-Infected Ornithodoros Erraticus during the ASF Endemic Period in Portugal." *PloS One* 6 (5): e20383. doi:10.1371/journal.pone.0020383.

Croche Santander, B., A. Sánchez Carrión, E. Campos, C. Toro, L. Marcos, J. C. Vargas, and T. Tort. 2015. "[Tick-borne relapsing fever in a rural area of southern Spain]." *Anales De Pediatria (Barcelona, Spain: 2003)* 82 (1): e73-77. doi:10.1016/j.anpedi.2013.10.052.

Gray, JS, A Estrada-Pena, and L Vial. 2014. "Ecology of Nidicolous Ticks." In *Biology of Ticks*, Oxford University Press, 39–60. Oxford, Uk.

Rebaudet, Stanislas, and Philippe Parola. 2006. "Epidemiology of Relapsing Fever Borreliosis in Europe." *FEMS Immunology and Medical Microbiology* 48 (1): 11–15. doi:10.1111/j.1574-695X.2006.00104.x.

Vial, L. 2009. "Biological and Ecological Characteristics of Soft Ticks (Ixodida: Argasidae) and Their Impact for Predicting Tick and Associated Disease Distribution." *Parasite (Paris, France)* 16 (3): 191–202.

Keywords: Ticks and tickborne diseases, Ornithodoros soft ticks, tickborne relapsing fever, African swine fever, species distribution modeling, Multi Criteria Decision Analysis, knowledge based modeling