Prevalence of *Anaplasma* species and habitat suitability for ticks in Sicily

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INTRODUCTION

The genus *Anaplasma* (Rickettsiales: Anaplasmataceae) includes the tick-transmitted pathogens *Anaplasma marginale*, *Anaplasma phagocytophilum* and *Anaplasma ovis* that have an impact on veterinary and human health [1]. *Anaplasma* spp. are endemic in Sicily, where they constitute a veterinary and human health problem [2,3]. Sicily represents a typical Mediterranean ecosystem and offers a good scenario to study the prevalence of *Anaplasma* spp. in relation to the habitat suitability for ticks. The aim of this study was to characterise the prevalence of *Anaplasma* spp. in most abundant host species in Sicily and to correlate these data with the habitat suitability (HS) for ticks at the province level.

MATERIALS AND METHODS

Animals and determination of *Anaplasma* spp. prevalence

Cattle (*n* = 374), goats (*n* = 134), sheep (*n* = 286), horses (*n* = 134), dogs (*n* = 46) and mice (*Mus domesticus*, *Apodemus sylvaticus*) (*n* = 69) were sampled in different Sicilian provinces. Blood was collected during 2006–2007 into sterile tubes with anticoagulant (EDTA) and stored at −20°C until used for DNA extraction. The prevalence of *A. marginale*, *A. phagocytophilum* and *A. ovis* was determined by species-specific major surface protein (*msp*) 4 PCR and sequence analysis of amplicons [3].

Modelling of HS for ticks

Habitat (climate and vegetation) suitability models describing the expected distribution area for the most prevalent tick species in the Mediterranean region were built using presence-only data with the MaxEnt method [4]. Maps were constructed from the WorldClim public climate dataset at 1 km resolution. Vegetation-derived features were taken from a Landsat TM high-resolution sensor and incorporated into MaxEnt as qualitative layers [4].

RESULTS

Anaplasma marginale was detected in cattle only and *A. ovis* was identified in sheep and goats with prevalence significantly higher when compared with other hosts (p <0.001, Fisher's exact test). *Anaplasma phagocytophilum msp*4 amplicons were amplified from cattle, sheep, horses, dogs and mouse DNA samples but were significantly higher in dogs (p <0.05, Fisher's exact test). Although these hosts are present throughout Sicily, pathogen prevalence was different between Sicilian provinces and these differences correlated with HS for the most abundant tick species in this region (Fig. 1).

DISCUSSION

The identification of *Anaplasma* spp. in analysed hosts reflected the host tropism previously described for these pathogens [2,3]. The differences in *Anaplasma* infection prevalence between Sicilian provinces may result from differences in husbandry practices, wildlife reservoir hosts and/or habitat suitability for ticks. Husbandry practices are common to all Sicilian provinces and wildlife reservoir hosts were not considered in this study. However, HS for the most abundant tick species in Sicilian provinces did correlate with *Anaplasma* spp. prevalence (Fig. 1).

The information about common tick vectors and hosts for *Anaplasma* spp. [5], together with predicted tick HS and *Anaplasma* spp. prevalence, allowed predicting vectors for these pathogens in Sicily. The results suggested that *Rhipicephalus bursa* may be the vector for *A. marginale* and *A. ovis* for cattle and sheep, respectively. *A. ovis*

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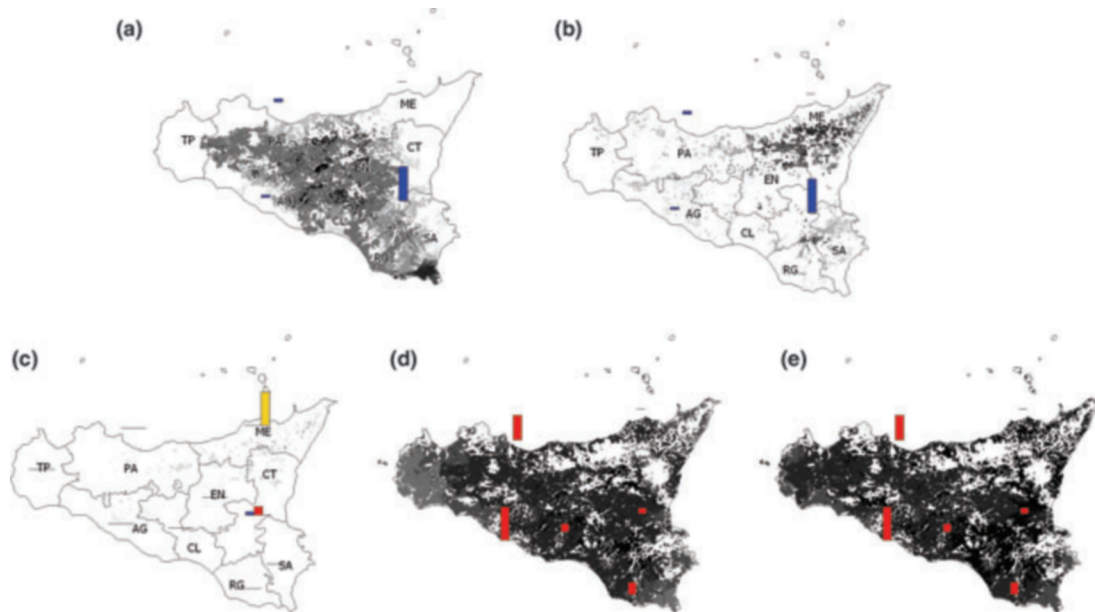E-mail: jose_delafuente@yahoo.com

Fig. 1. Maps showing the distribution of habitat suitability (HS) for ticks, together with the prevalence of *Anaplasma* spp. in Sicilian provinces. Shades of grey show the expected HS (darker is higher) for (a) *Rhipicephalus bursa*, (b) *Dermacentor marginatus*, (c) *Ixodes ricinus*, (d) *Hyalomma marginatum* and (e) *R. turanicus*. Prevalence of pathogens is included as histograms for (a) *Anaplasma marginale* in cattle (blue) and *Anaplasma ovis* in sheep (red), (b) *A. ovis* in goats, (c) *Anaplasma phagocytophilum* in horses (blue), rodents (red) and dogs (yellow), and (d and e) *A. marginale* in cattle. Labels for provinces in Sicily have been removed in panels d and e to avoid visual overlapping with the greyed background.

may be transmitted to goats by *Dermacentor marginatus*. The vector for *A. phagocytophilum* may be *Ixodes ricinus* but other tick species may subsequently prove to be vectors of this pathogen in Sicily and other Mediterranean ecosystems. The other tick species analysed, *Rhipicephalus turanicus* and *Hyalomma marginatum*, may be also involved in the transmission of *Anaplasma* spp. in Sicily. Finally, other tick species that are found in Sicily for which habitat suitability was not predicted due to lack of information (e.g. *Hyalomma lusitanicum* and *Haemaphysalis punctata*) may also act as vectors of *Anaplasma* spp. together with mechanical transmission, at least for *A. marginale*. The results reported herein have important implications for the control of *Anaplasma* spp. in Sicily and may be used to construct models to predict the risks for tick-borne pathogens in Mediterranean ecosystems.

ACKNOWLEDGEMENTS

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