Parasites in red-fox: the environmental risk factors (Valencia, Spain)

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Introduction

Red foxes are definitive hosts for several parasites, representing a health risk for animals and humans. The aim of this work was to build a spatial model to predict the occurrence of parasites in foxes in the Valencian Community.

Methods

Foxes from the Valencian Community (N=287) were analysed, and a database on the occurrence of *Angiostrongylus vasorum*, *Spirocerca vulpis*, *Toxocara canis*, *Toxascaris leonina*, *Crenosoma vulpis* was created. Prevalence, abundance and intensity were computed for each parasite. Records of presence were incorporated into **ArcMap 10.6** and the parasite richness was displayed by mean of a heatmap. Maxent modeling was used to predict parasites distribution using 17 environmental variables. AIC values were used for model selection. Permutation importance (PI) was used to assess the contribution of each factor.

Results Parasite epidemiological indexes are reported in table 1. Heatmap and predictive distribution of parasites are reported in figure 1 and 2 respectively. Influence of each variable is reported in table 2.

Table 2. Environmental variables influencing parasite distribution

Parasite	Environmental variables
S.vulpis	Minimum temperature (Wet Period) (PI=51.5) Average temperature (Dry Period) (PI= 33.9) Altitude (PI= 4.2).
A.vasorum	Average temperature (Dry Period) (PI= 67.7) Precipitation (Dry Period) (PI= 6.2)
C.vulpis	Average temperature (Dry Period) (PI= 33.5) Minimum temperature (Wet Period) (PI= 29.7)
T.canis	Distance from urban areas (PI=62)
T.leonina	Minimum temperature (Wet Period) (PI= 54.9)

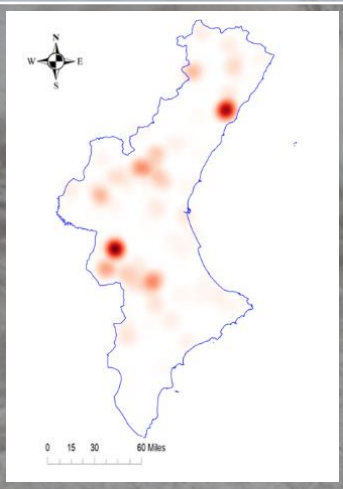

Figure 1. *Heat map: distribution of parasitic cluster in the study area*

Table 1. Parasite epidemiological indexes: prevalence, abundance and intensity

	C. vulpis	*A.vasorum*	*S. vulpis*	*T. canis*	*T. leonina*
Prevalence	28% [27.6-28.4]	40.4% [40.1-40.7]	22% [21.7-22.3]	27% [26.5-27.5]	25% [24.7-25.3]
Abundance	1.8 [1.2-2.4]	7.5 [5.3-9.7]	2.1 [1.4-2.8]	0.8 [0.6-1.0]	2.9 [1.8-4.0]
Intensity	6.3 [4.3-8.3]	18.7 [13.6-23.8]	9.6 [6.9-12.3]	7.8 [7.2-8.4]	11.7 [7.6-15.8]

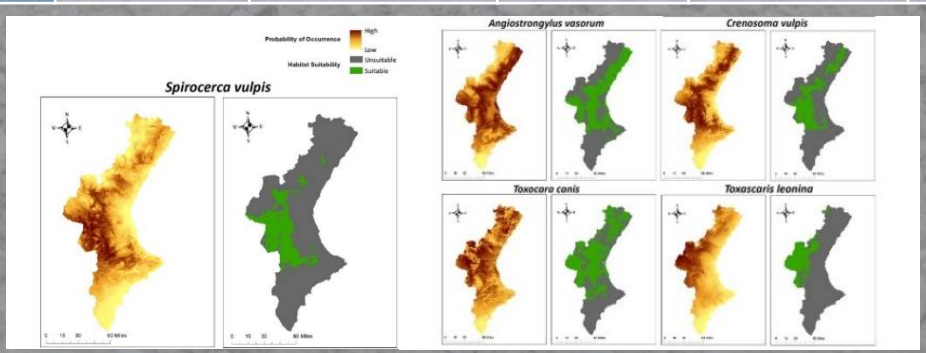

Figure 2. *Predictive models for the five parasites. Continuous and binary output are reported.*

Discussion. The results of the study highlight that:
1) climate influences the distribution of the parasite limiting the presence of intermediate hosts for *S.vulpis*;
2) distribution of *A.vasorum* and *C.vulpis* is related to the larval sensitivity to high temperature, and the need of humidity for the presence of the intermediate hosts;
3) the probability of *T.leonina* occurrence decreases with increasing temperature;
4) *T.canis* has a higher probability of occurrence close to urban areas, representing a risk for public health.