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MAPPING VECTOR BORN DISEASES RISK USING THE ENTOMOLOGICAL INOCULATION RATE: THE EXAMPLE OF AFRICAN ANIMAL TRYPANOSOMOSES

BOUYER J.*, GUERRINI L.

CIRDES, BP 454, Bobo-Dioulasso, Burkina Faso

ABSTRACT

In Burkina Faso, African Animal Trypanosomosis (AAT) is still a major hindrance to cattle breeding, especially in the Mouhoun river basin, which was identified as a priority area for tsetse control. The abundance of tsetse flies and AAT risk were mapped using remote sensing coupled to field environmental data, along the Mouhoun river loop (more than 700km long), where two tsetse species occur, Glossina palpalis gambiensis Vanderplank and G. tachinoides Westwood. The water course was classified into river sections of similar neighbouring where AAT risk was estimated using the entomological inoculation rate (EIR). Ten percent of the river course was sampled using biconical traps allowing measuring the relative densities of tsetse and their mature infection rates in the various landscapes which were used to estimate EIR distributions (@risk software). These results led to propose that the control of tsetse in this area should be focussed on the most dangerous sections.

INTRODUCTION

In Burkina-Faso like in most sub-Saharan West-African countries infected by tsetse flies, Tsetse and African Animal Trypanosomoses (AAT) are a major hindrance to cattle breeding (Itard *et al.,* 2003; Shaw 2003). The main vectors that remains are two riverine species: *Glossina palpalis gambiensis* Vanderplank 1949 (Diptera, Glossinidae) and *G. tachinoides* Westwood, 1850. The relation between these species and the type and disturbance levels of the gallery forests along the Mouhoun river course lead to discriminate three ecotypes (Guinean, Sudano-Guinean and Sudanean) and three disturbance levels (natural, half-disturbed, disturbed) well correlated to their distribution and abundance (Bouyer *et al.,* 2005). It was then possible to approximate the distur-bance of the gallery forests for each ecotype, using remote sensing data (Landsat 7TM) threw the analysis

* contact author: Email: bouyer@cirad.fr

of the pixels neighbouring the river in 500m buffers (Bouyer 2006; Bouyer *et al.,* 2006; Guerrini and Bouyer 2006).

A transversal study of the vectors using standardised biconic traps (Challier and Laveissière 1973), set on ten percent of the river course (700km long), allowed to estimate two main components of the trypanosomoses risk: the relative densities of the vectors (approximated by the apparent fly density per trap per day or ADT, a trap being considered as a substitutive host) and the percentage of infectious flies (PIF). A common risk indicator in mosquito born infections, the entomological inoculation rate (EIR) (Smith *et al.* 2004), is the product of this two parameters. It can be used to map trypanosomoses risk, and is called thereafter the DAPI, or apparent density of infectious tsetse flies per trap per day (Bouyer 2006; Bouyer *et al.,* 2006).

RESULTS

The identification of homogeneous riverine landscapes in each gallery forest ecotype along the main course of the Mouhoun river lead to the discrimination of 8 clusters, after a principal component analysis applied to the land-use class areas in the buffers followed by a hierarchical cluster analysis. The evolution of ADT, PIF and ADTI in 7 out of the 8 clusters is presented in Figure 1 (the number of dissected flies was not enough to estimate PIF in the eight one). As demonstrated for mosquito-borne infections in heterogeneous environments (Smith *et al.,* 2004), ADT and PIF were not correlated (Kendall's $\tau = -0.24$, p-value $= 0.56$) and the fly relative density formed the dominant component of ADTI.

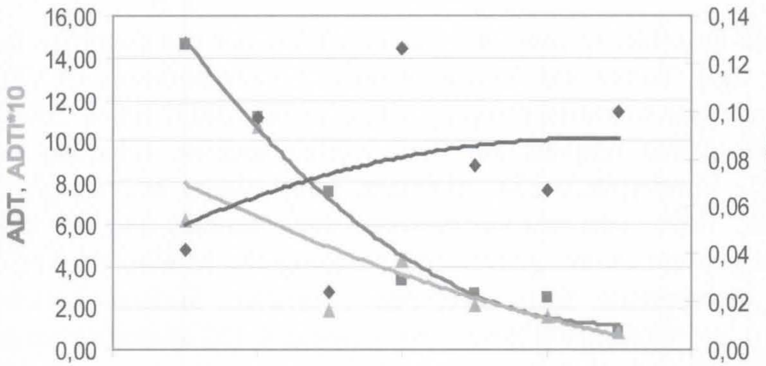

Figure 1. Distribution of ADT, PIF and ADTI (multiplied by ten for reading easiness) in 7 clusters discriminated using remote sensing analysis, ordered by ascending ADT.

The PIF were not significantly different between clusters (X-squared = 4.624, df = 6, p-value = 0.59). On the contrary, the ADT were significantly different between some clusters (Steel-type non parametric multiple comparisons test, p<0.05). The clusters of similar ADT (npmc, p>0.05) were thus merged together into three groups, where the distribution of the ADTI was estimated from bootstrapping in the ADT and PFI distributions (Figure. 2). Figure 3 shows their distribution along the Mouhoun river loop (700 km).

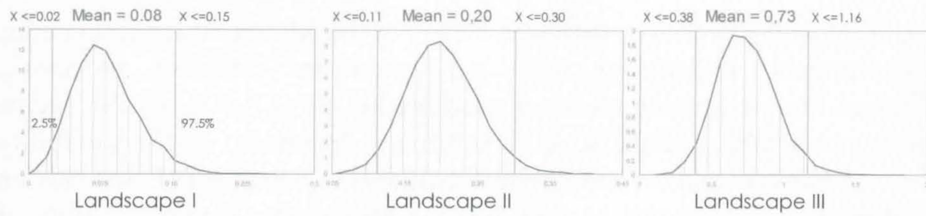

Figure 2. Distribution of the ADTI in three landscapes of the Mouhoun river, Burkina Faso, from bootstrapping in the ADT and PFI distributions (10 000 Monte Carlo simulations, @risk software).

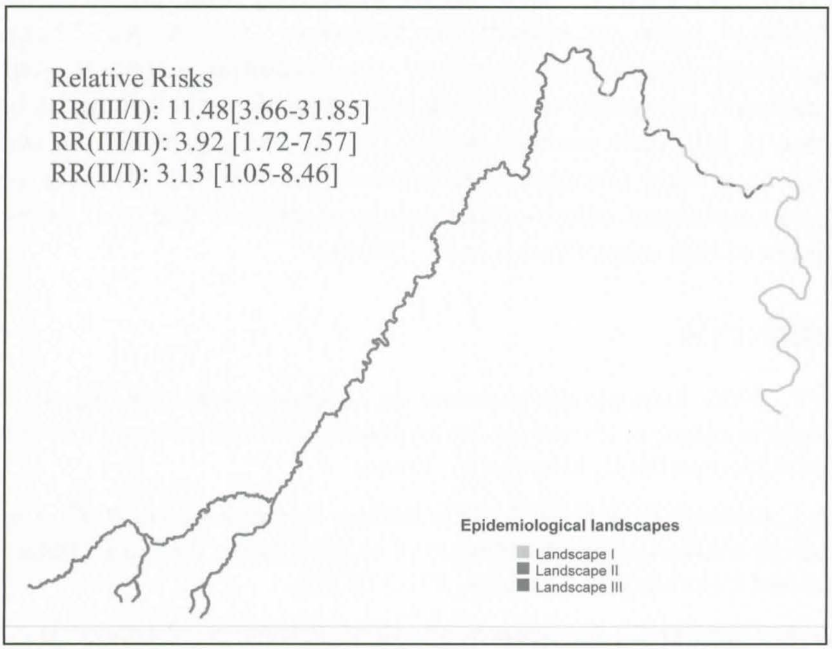

Figure 3. Distribution of three landscapes of various trypanosomoses risk level along the Mouhoun river loop (700 km), Burkina Faso and relative risks between these units.

The ADTI was 0.08 (95%CI, 0.02-0.15), 0.20 (0.11-0.30) and 0.74 (0.38-1.16) in landscapes I, II and III respectively. In landscape III, the Trypanosomosis risk was thus 11.48 (3.66-31.85) and 3.92 (1.72-7.57) times higher than in landscapes I and II respectively. It was 3.13 (1.05-8.46) higher in landscape II than I ($p < 0.05$, 1 excluded from the 95% confidence intervals).

DISCUSSION

The ADT and PIF follow different trends in the Mouhoun heterogeneous environments, underlying their generation by different processes. Whereas remote sensing allows a good prediction of ADT, the PIF seems hardly predictable. Actually, ADT is directly dependant on the suitability of tsetse habitats and on general host availability whereas PIF depends on additional characteristics like the feeding preferences, the availability of wild hosts (reservoirs or reptiles), the lifespan of the flies, their susceptibility to the parasites, that might depend on the stress, etc... Fortunately, the first component is dominant, and allowed a spatial risk classification that will be tested by implementing longitudinal studies in the Mouhoun basin, as part of the Welcome Trust project "Fragfly". During these longitudinal surveys, the vectorial capacity will be calculated and compared to the risk indicators described here, as to the incidence in 50 heads sentinel herds. The fly feeding behaviour will be studied, integrating complex mechanisms like learning (Bouyer *et al.*, 2007), to implement micro-epidemiological models that will allow the refinement of risk maps (Smith *et al.*, 2004).

REFERENCES

Bouyer J., 2006. Ecologie des glossines du Mouhoun au Burkina Faso : intérêt pour l'épidémiologie et le contrôle des trypanosomoses africaines: Parasitologie. Université Montpellier II, Montpellier, France.

Bouyer J., Guerrini L., J. César J., de la Rocque S., Cuisance D., 2005. A phyto-sociological analysis of the distribution of riverine tsetse flies in Burkina Faso. Medical and Veterinary Entomology, 19 : 372-378.

Bouyer J., Guerrini L., Desquesnes M., de la Rocque S., Cuisance D., 2006. Mapping African Animal Trypanosomosis risk from the sky. Veterinary Research, 37 (5) : 633–645.

Bouyer J., Pruvot M., Bengaly Z., Guerin P.M., Lancelot R., 2007. Learning influences host choice in tsetse. Biology Letters, 3 : 113-116.

Challier A., Laveissière C., 1973. Un nouveau piège pour la capture des glossines (Glossina: Diptera, Muscidae): description et essais sur le terrain. Cahier ORSTOM., série Entomologie médicale et Parasitologie, 10 (4): 251-262.

Guerrini L., Bouyer J., 2006. Mapping African Animal Trypanosomosis risk: the landscape approach. Use of Geographic Information Systems (GIS) in Veterinary Activities, Silvi Marina, Italy, OIE.

Itard J., Cuisance D., Tacher G., 2003. Trypanosomoses: Historique - Répartition géographique. pp. 1607-1615. In Editions Tec et Doc and EMI. Principales maladies infectieuses et parasitaires du bétail. Europe et Régions chaudes. Lavoisier, Paris, France.

Shaw, A.P.M., 2003. Economic guidelines for strategic planning of tsetse and trypanosomiasis control in West Africa. FAO, Rome. 75 p.

Smith, D.L., Dushoff J., McKenzie F.E., 2004. The risk of a mosquito-borne infection in a heterogeneous environment. Plos Biology, 2 (11) : 1957-1964.