AFRIKA FOCUS — Volume 21, Nr. 2, 2008 — pp. 107-128

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Epidemiological studies on east coast fever in Rwanda

Thomas Bazarusanga

Promotoren: Jozef Vercruysse, Dirk Geysen

Department of Virology, Parasitology and Immunology, Ghent University

Public defence: 2 July 2008

East Coast fever (ECF), a tick-borne disease of cattle caused by a protozoan parasite *Theileria parva* and transmitted by the brown ear tick *Rhipicephalus appendiculatus* is one of the major limitations to the development of cattle industry in the eastern, central and southern Africa. The distribution and the abundance of the vector in a particular area determine the occurrence and the epidemiology of the disease. Depending on the relative suitability of climates for tick development and survival, epidemiological states ranging from epidemic to stable or unstable endemic are recorded over the entire range of *R. appendiculatus* distribution. The state of endemicity prevailing in a given area determines the control approach to be applied. Knowledge of the distribution of the vector and the disease is crucial in assessing the extent of the disease burden and in designing efficient control measures. Available field studies document important epidemiological differences of ECF between eastern and southern Africa and variable degrees of endemicity to ECF are recorded within a single geographic region. In central Africa, little is known about the endemic status of ECF and in Rwanda, there has been relatively no study aimed at specifically defining the field situation resulting from the complex interaction between the T. parva parasite, the cattle host and the tick vector in different regions.

The work described in this thesis aimed at gaining a better understanding of factors affecting the epidemiology of ECF in different seasons and ecological regions of Rwanda, in order to optimise the use of existing control methods. Based on climatic parameters, agricultural activities and altitude range, the study area was subdivided into four agro ecological zones (AEZs): the mountainous region in the northern highland at 1900 m altitude above sea level (AEZ 1), the high plateau which lies between 1500-1700 m altitude comprises the continental zone in central and southern Rwanda (AEZ 2) on the one hand and the coastal zone bordering lake Kivu in the western part of the country (AEZ 3) on the other hand, and the eastern plateau (AEZ 4) located between 1000-1500 m altitude. The approach adopted to collect epidemiological data in the four AEZs involved

cross-sectional field surveys on (1) the ecological distribution of the tick vector and its infection levels, (2) the factors affecting the vector-host transmission of T. parva infection and (3) the dynamic of the infection prevalence in different AEZs.

The results of the tick survey revealed the presence of six tick species but *R. appendiculatus* was the most predominant species and accounted for more than 90% of the total tick loads. *Boophilus decoloratus* (6.07%) and *Amblyomma variegatum* (1.24%) were the second and third most important species respectively, whereas other tick species [*R. evertsi evertsi* (0.46%), *R. compositus* (0.31%) and *Ixodes cavipalpus* (0.08%)] were rarely found. The season and the AEZ had no significant influence on tick abundances in most of Rwanda except in the marginally cold conditions in the high land (AEZ 1) areas where significantly reduced tick numbers were recorded. The average tick numbers per animal was high in all zones except in the AEZ 1. It transpires from these findings that suitable climatic conditions for tick development prevail in most of Rwanda, resulting in year-round overlap in different tick instars throughout the country.

Although *R. appendiculatus* was found widespread over the country, the proportions of infected ticks varied significantly between the three most common farming systems (free-range, restricted and fenced). Lower infection rate was found in the free-range [0.17 (0.02-1.16)], where the majority of ticks feed on low parasitaemic carrier adult animals, than in the fenced [4.37 (1.92-9.09)] and the restricted [3.89 (2.27-5.57)] farming systems, characterised by frequent contacts between ticks and both calves and adult cattle. The intensity of *T. parva* transmission expressed as entomological inoculation rates (EIR) was further measured through a model integrating data on infectivity in field ticks and the numbers of ticks infesting animals in different managerial systems.

The results showed a significant effect of the farming system in the overall *T. parva* transmission. The infection rate did not differ between the fenced and the restricted farming systems but the EIR was 9 times higher in the latter than in the former. Similarly, the restricted farming system had a much higher infection transmission than the free-range, although comparable tick numbers were collected in the two farming systems. The system of fencing and constraining animals favoured higher infectivity of *R. appendiculatus* than the free-range farming systems. However, a more regular tick control regime applied in the fenced system, compared to the restricted farming systems, led to lower *T. parva* transmission intensity in the former.

The prevalence distribution of the *T. parva* infection and the sensitivity of the PCR and serological methods in different *T. parva* transmission intensity areas were further assessed. The Bayesian model which integrates both methods showed a high prevalence (83-85%) of T. parva infection throughout the country. However, agreement between the sensitivity of PCR and serological methods was only achieved in AEZ 1, where the lowest tick challenge was found (< 20 ticks per animals). Furthermore, while the sensitivity of serological assays remained constant throughout all the AEZs, the PCR sensitivity declined from lower (AEZ 1) to higher tick challenge areas in AEZ 4. The same trend in sensitivity decline was shown when comparing dipped against undipped herds or calves against adult cattle. Dipped animals and calves had lower tick numbers. In contrast, the

sensitivity of the three serological methods used remained high and constant across tests and AEZs. It can therefore be stated from these results that serological methods are the most suitable tool to calculate the prevalence rates. However, a combination of PCR and serology would be a useful indicator of variations in transmission intensities.

This study has assessed the epidemiological status of ECF in Rwanda through cross-sectional surveys. The analysis of the results provided some insight into the dominant distribution of R. *appendiculatus* tick species and its repercussions on the transmission of T. *parva* infection. The outcome of this work showed that although the pressure of T. *parva* infection is generally high throughout the country, the intensity of infection challenge is highly correlated with managerial practices rather than the ecological risk factors. The study hypothesised that different endemic states for ECF may exist in Rwanda and these may results in different production losses. For an accurate assessment of the epidemiological states of ECF and production loss, data on ECF incidence and case-fatality are key epidemiological parameters and these can only be obtained from structured longitudinal studies.