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A STUDY OF THE EFFECTS OF HEARTWATER AND ITS CONTROL ON LIVESTOCK PRODUCTIVITY AND ECONOMICS IN ZIMBABWE

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La cowdriose est une maladie transmise par les tiques et due à la rickettsie Cowdria ruminantium, économiquement importante en Afrique et aux Antilles. La quantification de ces pertes est encore mal connue. Dans cette étude, un ensemble de données de la littérature et d'enquêtes horizontales et verticales a été combiné pour quantifier l'impact de la maladie au Zimbabwe. Le cadre de l'échantillonnage était les régions naturelles (hautes terres ou basses terres) et les systèmes de production (grande échelle, viande ou lait, petite échelle mixte, zones réorganisées et zones communales). Dans chaque région naturelle, les unités administratives avec les systèmes de production ont été sélectionnés en fonction de la présence de la cowdriose, la représentativité de la région et des critères de logistique. Des échantillons de fermes ont été tirés au hasard et une étude horizontale pour étudier le système de production, les maladies et l'économie agricole locale a été conduite. Puis une étude longitudinale a été faite sur un sous-échantillon de fermes pour confirmer les premiers résultats, pour connaître l'incidence de la cowdriose et d'autres données économiques. Les données des 2 enquêtes et encore d'autres sources ont été analysées pour déterminer les facteurs de risque associés aux pertes dues à la cowdriose et utilisées dans un modèle pour évaluer l'impact économique de cette maladie et des divers systèmes de contrôle.

INTRODUCTION

Heartwater, a disease of ruminants caused by the rickettsia *Cowdria ruminantium* and transmitted by ticks of the genus *Amblyomma*, is a significant cause of productivity losses in cattle, sheep and goats in most of sub-Saharan Africa. In southern Africa, the vector of *C. ruminantium* is *A. hebraeum.* In most of the rest of the continent, the main vector is *A. variegatum,* and it is in Zimbabwe that the distributions of these two vectors now overlap. In Zimbabwe, the disease has historically been confined to the southern lowveld of the country, but in recent years, this situation has changed as *A.hebraeum* has spread north. The disease has been prevented and controlled by the intensive use of acaricides, which have provided the mainstay for the control of this and other tick-borne diseases, such as theileriosis, babesiosis and anaplasmosis, for decades.

The USAID supported heartwater research project of the University of Florida and the Southern Africa Development Community (SADC) has been working on improved technologies for the control of the disease, in particular through the use of an inactivated tissue culture vaccine (Mahan, *et al.* 1995). This vaccine has demonstrated high levels of efficacy in clinical trials, and is presently undergoing evaluation on a wider scale in the SADC region. In addition to vaccine development, the project is studying the epidemiology of heartwater in Zimbabwe, the impact of the disease on productivity and the economic merits of future vaccine-based control strategies, in work co-ordinated by the International Livestock Research Institute (ILRI). An overview of the current progress in these studies is provided in this paper.

THE SPREAD OF HEARTWATER IN ZIMBABWE

The geographical area within which heartwater constrains livestock productivity in Zimbabwe has changed considerably over the last few years. Norval *et al.* (1994) predicted that *A. hebraeum* could spread northwards as a result of several factors, including a general relaxation in acaricide use and the movement of wildlife from the south to the central part of Zimbabwe to stock game ranches. A series of studies was set up to assess the extent of spread, and evaluate contributory factors (Peter *et al.*, in preparation).

Tick survey

With the assistance of the Department of Veterinary Services, Zimbabwe, a tick survey was conducted throughout the country between January and June 1996. Ticks were collected from dip tanks in communal, commercial and resettlement areas. The preliminary results illustrate that not only has *A. hebraeum* spread northwards, but that *A. variegatum,* historically only recorded in the northwest of the country, has spread southwards. There is now only a limited area of the north of the country free of either tick. A second survey targeted specifically at *Amblyomma* spp. has just been completed. The current distribution of vectors and disease is shown in Figure 1.

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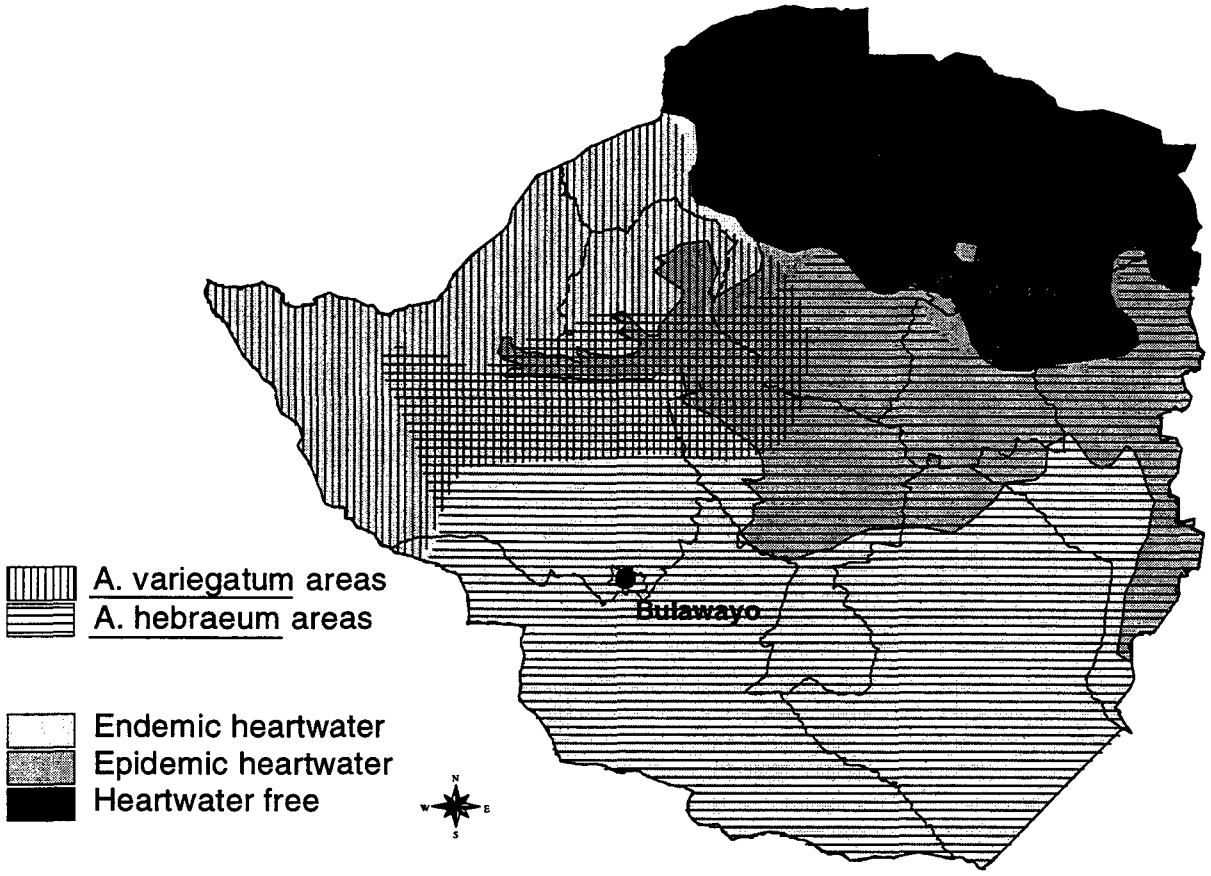

Heartwater outbreak investigation and retrospective analysis.
Premises reporting heartwater in the highveld were visited, and a questionnaire was applied. In addition, passive disease reporting systems were scrutinised for evidence of heartwater spread from 1980 onwards. Preliminary results suggest that cattle movements played a greater role than wildlife in the spread of the disease from the southern lowveld, and that once established in the highveld, contiguous spread from property to property was important in the spread of the tick. The retrospective analysis revealed that the first recorded occurrence of heartwater in the highveld was as early as 1986, when the vector was probably introduced to the communal lands, from where it spread to neighbouring commercial farms.

THE INFECTION DYNAMICS OF HEARTWATER

Various aspects of the infection dynamics of *C. ruminantium* have been studied to evaluate their effect on the establishment and maintenance of endemic stability (an ecological climax where all animals become infected early in life and little or no clinical evidence of disease is observed) and the role of vaccines in artificially inducing endemic stability in susceptible populations. Issues that have been investigated through a series of field and experimental epidemiology studies include :

- the role of vertical transmission (from dam to calf)
- the relative role of nymphal and adult tick infections
- the decay of infection in recovered animals and the effect of tick infection rates
- the tick attack rate under different conditions of ecological suitability and acaricide use.

Preliminary results from these studies can be summarised as follows. Vertical transmission, demonstrated previously by Deem *et al.*, (1996), has been repeated, but the precise mechanism is still not known. More important than the mechanism is an estimate of the prevalence of vertical transmission, and thus the role this mechanism plays in contributing to endemic stability. This work is underway. Results of studies on the relative role of nymphal and adult ticks in transmission, and the effect of decay of infection in recovered animals are presented and discussed in detail elsewhere in these proceedings (Peter et al., 1997). In longitudinal studies of tick attack rates at sites in the high and lowvelds, it has been demonstrated that there is very little difference between attack rates between the two areas. Some earlier reports had suggested that the climate of the highveld was unsuitable for *A. hebraeum,* but as Norval *et al.* (1994) predicted, it appears to be at least as suitable ecologically as the lowveld.

Outputs from the field and experimental epidemiology studies were used to develop a quantitative model of heartwater infection dynamics, presented elsewhere in these proceedings (O'Callaghan et al., 1997). The model generated estimates of heartwater incidence and case fatality, which were calculated for the cattle populations under different epidemiological states in the country.

THE IMPACT OF HEARTWATER ON LIVESTOCK PRODUCTIVITY

To assess the impact of heartwater on livestock productivity, a series of cross-sectional studies were carried out to characterise livestock production in the principal production systems affected by the disease. These are predominantly large scale commercial beef and dairy, small holder communal beef and traction and small scale commercial beef and traction. These cross-sectional studies, supported by a limited number of follow up longitudinal studies, generated data on key production and economics parameters including: scale of livestock production; crude mortality rates; gross margin of livestock enterprises; current heartwater control costs.

ECONOMIC IMPACT OF HEARTWATER AND ITS CONTROL

Using data generated a) on the predicted distribution of epidemiological states of heartwater in Zimbabwe (Perry et al., 1997), b) from the heartwater model on the incidence and case fatality of the disease by epidemiological states and c) from the cross-sectional and longitudinal studies on livestock production economics, the economic impact of the disease, and of the use of an inactivated vaccine, were calculated (Mukhebi *et al.*, in preparation). In summary, economic losses due to heartwater occur at much greater rates (25 times) in the commercial than the communal production systems. The greatest component of economic loss is acaricide cost (76%), followed by milk loss (18%) and treatment costs (5%). Immunisation with the inactivated tissue culture vaccine would be economically viable, with a benefit:cost ratio of 2.4:1 in the communal and 7.6:1 in the commercial systems. Immunisation against theileriosis, where it occurs, would enhance the economic benefits from heartwater immunisation.

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