

## THE CONTROL OF HEARTWATER BY MEANS OF TICK CONTROL

J. D. BEZUIDENHOUT and R. D. BIGALKE, Veterinary Research Institute, Onderstepoort 0110

### ABSTRACT

BEZUIDENHOUT, J. D. & BIGALKE, R. D., 1987. The control of heartwater by means of tick control. *Onderstepoort Journal of Veterinary Research*, 54, 525-528 (1987)

Two main methods are currently being used by farmers in the heartwater regions to control this disease in cattle and other stock, namely strategic control of ticks and total control of ticks.

Some farmers make successful use of the latter method, particularly in areas which are marginal for the disease. Total tick control requires top managerial skills, which includes continual expert supervision, a relatively rare asset.

The majority of farmers, often unintentionally, apply strategic control of ticks to control heartwater, either without or with vaccination against the disease. In this case the objective of tick control is to minimize "tick worry" without interfering too drastically with natural transmission of the disease. This method would make provision for natural immunization of young animals (a more uncertain method than vaccination) and the maintenance of immunity.

In practice these methods appear to diminish deaths from heartwater appreciably, but do not protect all animals from the disease. Furthermore, they appear to be more effective in cattle than other stock.

Although strategic control has an evolutionary background and considerable merit under African conditions, it is being applied in an empirical way because of paucity of information on the epidemiology of heartwater. More information on the infection rate in and infectivity of ticks (percentage of infected ticks) offer challenging research possibilities.

### INTRODUCTION

Since the earliest times, when the tick-borne status of heartwater was realised, tick control was advocated as a means to control the disease (Dixon, 1899; Theiler, 1905; 1909; 1921; Alexander, 1931). Even after a blood vaccine had been developed tick control was still propagated as a supplement (Henning, 1956) or in some cases even as an alternative control measure (Stampa, 1969; Norval & Lawrence, 1980).

Through the years it has become apparent that because of the great variation in the ecological conditions in the regions where heartwater vectors occur, and even between different farms in the same area, it is not possible to advocate a single control system. Two methods, namely, intensive tick control and strategic tick control, have been identified as possible ways to control heartwater. Both these systems have advantages and disadvantages and it is the farmer in particular who must decide which method is the most suitable for his specific circumstances and which he can consistently follow (Anon., 1983).

#### *Intensive tick control*

The objective of this method is to control all stages of ticks throughout the year in order to limit production losses and animal deaths resulting from ticks *per se* to a minimum.

Intensive tick control, with reference to heartwater, is usually advocated for marginal areas only where *Amblyomma* ticks are only found occasionally on animals or for farms where the ecological conditions are unsuitable for the survival of these ticks. Regular dipping will prevent a tick population explosion in such areas especially after good rains or accidental introduction of infected ticks. Top management is necessary for successful implementation of this method of control.

Eradication of ticks in general, and of *Amblyomma* spp. in particular, is extremely difficult and the chances of success very limited (Uilenberg, 1980; Howell, De Vos, Bezuidenhout, Potgieter & Barrowman, 1981). However, under certain conditions, especially where there are no alternative hosts for the tick, virtual elimination of *A. hebraeum* can be achieved (Baker & Du Casse, 1968; Norval & Lawrence, 1980). Neitz (1964)

reported that even when systematic dipping was applied at weekly intervals, heartwater has defeated many cattle improvement schemes.

The eradication of heartwater without the total eradication of the vectors has been reported as apparently achieved by Stampa (1969) and Norval & Lawrence (1980).

Intensive or total tick control on a farm has obvious advantages in that production losses due to tick worry or tick-borne diseases will be kept to a minimum. However, such a system unfortunately also has many serious disadvantages (Bigalke, 1976; Bigalke, De Vos & Barrowman, 1976; Norval, 1979; 1981; Bigalke, 1982; Howell *et al.*, 1981; Uilenberg, 1983). The main disadvantage of total tick control on a cattle ranch, apart from the considerable cost of such a method, is that it will result in the loss of immunity of the animals to tick-borne diseases owing to lack of natural challenge. Movement of cattle away from the farm, whether for commercial reasons or as a result of natural disasters, e.g. veld fires, droughts, etc., should be restricted to abattoirs, feedlots or other farms where intensive tick control is practised, or to areas such as the Highveld or Karoo where heartwater does not occur. Movement to endemic areas would require the administration of prophylactic measures which in the case of heartwater are risky and expensive, and veterinary supervision is usually essential.

#### *Strategic tick control*

The term strategic control, in this instance, implies the control of the vector in such a way that it promotes a stable disease situation and at the same time limits the adverse effects of tick worry. In many cases the vaccination of young animals forms an integral part of strategic control of heartwater.

Very little relevant information on exactly how to obtain such a goal is presently available. The main reasons for this are a lack of knowledge on the infection rate of ticks, the factors that influence such a rate, and the absence of a practical method to determine the percentage of infected ticks.

Strategic control of heartwater has definite advantages. Dipping costs will be much lower than in the case of intensive tick control. Most animals will acquire a natural immunity against heartwater which will be maintained by repeated infection. Such immune animals can be marketed more widely, irrespective of the level of tick

control on the farm of destination. It also has the advantage that incidental dissemination of infected ticks by stock movement or the development of dip-resistant tick strains poses no particular risk with regard to heartwater outbreaks on those farms.

As far as the disadvantages of strategic tick control are concerned, production will, depending on the tick burden on the animals, be adversely affected to a lesser or a greater degree. Limited losses due to heartwater may still occur and only animals immune to heartwater can be brought onto such a farm. The costs associated with vaccination will be higher in this instance than in the case of intensive tick control where vaccination is usually not done.

The implementation of strategic control for heartwater is furthermore usually complicated by the presence of other tick-borne diseases such as anaplasmosis, babesiosis and theileriosis. Each one of these diseases has its own requirements with regard to the vectors involved, ways and rate of transmission, duration of immunity, etc., and it is therefore difficult to formulate one policy of strategic control for all of them.

However, there are certain common factors which can be exploited in the planning and implementation of such a policy.

First of all, and most important, is the non-specific, or age resistance, to heartwater which prevails in young calves and to a much lesser extent in lambs and goat kids (Neitz & Alexander, 1941; Thomas & Mansvelt, 1957). This period of natural protection is a cornerstone in the creation of enzootic stability and should be exploited to the full, especially in cattle. This period can be utilized to establish the immunity against heartwater with relatively little danger of the occurrence of clinical cases. Immunity can be achieved through vaccination or by natural infection in which case infected ticks are allowed to transmit the organisms. Vaccination is probably the best and most practical way to ensure immunization of the majority of young animals without the possible adverse effects of tick worry. On most farms, however, immunity is obtained by means of natural tick-transmission, without the farmers actually being aware of it. This method naturally depends on the presence of infected ticks, a situation which is very difficult to assess, control or manipulate.

Another common factor in tick-borne diseases is the maintenance of immunity through natural infection. At present the necessary scientific information to determine the optimum numbers of ticks needed to maintain enzootic stability of heartwater is lacking. Furthermore, no infection rate models, such as those for babesiosis (McCosker, 1981) have been worked out for heartwater. However, it appears to be advisable to maintain a low level of tick infestation in order to boost the immunity at regular intervals.

Effective strategic control of heartwater not only depends on the number of ticks present, but also to a large extent on the percentage of infected ticks. It is unrealistic and certainly not beneficial to the animals to have high numbers of ticks on a farm if only a very low percentage are infected. The higher the percentage of infected ticks, the fewer would be needed to maintain enzootic stability (Bezuidenhout, 1985).

Before consideration is given to the possibility to increase the percentage of infective ticks, it is necessary to discuss factors that may influence this. Transovarial transmission of *C. ruminantium* in *A. hebraeum* does occur under laboratory conditions. However, this is the exception rather than the rule and it is doubtful whether it plays a role in the epidemiology of the disease (Bezuidenhout & Jacobsz, 1986).

If transovarial transmission does not occur in the field it means that ticks can only transmit the disease after they have become infected in the larval or nymphal stage. To keep the infection going in nature it is therefore crucial that these immature stages should have the opportunity to become infected.

In this regard it is an accepted fact, which has also been proven in many instances, that ticks can become infected while feeding on a reacting host (Lounsbury, 1900; Alexander, 1931). It appears, however, that the time during which ticks become infected is limited mainly to the febrile reaction and a short period thereafter (Alexander, 1931; J. D. Bezuidenhout, unpublished results, 1986).

If this was the only method of infection it would be very difficult to explain how enzootic stability is maintained in a heartwater endemic area because, under such conditions, there are very few clinical cases. Experience has also shown that the introduction of susceptible animals in such areas often results in major outbreaks of the disease, which is an indication that, under such conditions, many ticks are infected.

Neitz, Alexander & Adelaar (1947) found that the blood of animals which possess a partial or solid immunity to heartwater may again become infective for a short period after reinfection with viable organisms. There is thus a multiplication of *Cowdria* in such animals which, they maintained, explains the fact that so many larvae and nymphae can become infected in an enzootically stable area. It has also been established that the blood of calves that have been vaccinated during the period of age resistance is infective during the period in which a normal heartwater reaction is expected (Du Plessis, Bezuidenhout & Lüdemann, 1984).

In a stable situation where animals are constantly exposed to ticks one would expect a solid immunity to all strains of *Cowdria* present on the farm. It is difficult to see how such animals could act as efficient carriers of the disease, unless they have a rickettsaemia almost all the time.

Some game species such as the blesbok (*Damaliscus albifrons*) and the black wildebeest (*Connochaetes gnu*) have been identified as subclinical hosts and it was concluded that such animals can act as asymptomatic carriers of the disease (Neitz, 1933; 1935; 1937). They are, however, not indigenous to the heartwater regions and blesbok have only been introduced into these areas relatively recently.

Experimental proof was recently obtained that non-ruminants such as the crowned guinea fowl (*Numida meleagris*) and the leopard tortoise (*Geochelone pardalis*) may act as asymptomatic carriers of heartwater (J. D. Bezuidenhout, unpublished results, 1986). More work is necessary before conclusions can be drawn on the impact of these findings on the epidemiology of the disease.

#### Future studies

There is a great need for experimental evidence that the blood of the immune or subclinically infected host is in fact infective for ticks. In most studies the infectivity of blood from such animals has only been determined by subinoculation, which does not necessarily mean that it will also be infective for ticks.

One of the most interesting subjects for future study could be the development of strategies to increase the percentage of infected ticks on a farm. Furthermore, it would be of great value if one could determine how such ticks could be used best to stimulate and maintain immunity to heartwater without causing excessive direct damage to the host.

Before such studies are attempted, practical laboratory methods should be found to determine the percentage of infected ticks or, alternatively, the inoculation rate of animals. Specific staining or labelling techniques for *C. ruminantium* in ticks should be investigated further (Bezuidenhout, 1984; Neitz, Viljoen, Bezuidenhout, Oberem, Van Wyngaardt & Vermeulen, 1986; Yunker, Kocan, Norval & Burrige, unpublished results, 1986). The indirect fluorescent antibody technique (Du Plessis, 1981) or ELISA test (Neitz *et al.*, 1986) may be suitable to determine the inoculation rate.

Controlled laboratory experiments to prove the suitability of these tests should be carried out before going to the field.

An increase in the percentage of infected ticks on a farm may be obtained by vaccination or perhaps even revaccination of animals, especially young animals, during the period of peak larval or nymphal activity. This suggestion is made on the assumption that the blood of such vaccinated animals will be infectious for ticks.

Rotational grazing could perhaps be practised in such a way that it ensures simultaneous feeding of adult and immature ticks. Under such conditions there should be a better chance for larvae and nymphae to obtain the infection given off by the adults. There is some overlapping of adult and immature populations, but the adult ticks usually reach maximum numbers during summer, while the larvae peak in autumn and nymphae during spring (Londt, Horak & De Villiers, 1979; Rechav, 1982).

The possible role that other non-ruminants, such as birds and tortoises (J. D. Bezuidenhout & J. A. Olivier, unpublished results, 1986) or wild rodents (MacKenzie, 1984) may play in the production of infected ticks also needs further investigation.

There seems to be considerable scope for investigations on the manipulation of the epidemiology of heartwater which offers an exciting challenge to all workers in this field.

## REFERENCES

- ALEXANDER, R. A., 1931. Heartwater: The present state of our knowledge. *17th Report of the Director of Veterinary Science and Animal Industry*, 1, 89-150.
- ANON., 1983. Tick control in cattle. Information pamphlet compiled by representatives of the Agricultural and Veterinary Chemical Association of South Africa, the Veterinary Research Institute, Onderstepoort and the Division of Veterinary Services, 2.
- BAKER, M. K. & DU CASSE, F. B. W., 1968. Tick infestation on livestock in Natal. The role played by goats as reservoirs of the economically important cattle ticks. *Journal of the South African Veterinary Association*, 39, 55-59.
- BEZUIDENHOUT, J. D., 1984. Demonstration of *Cowdria ruminantium* in *Amblyomma hebraeum* by fluorescent antibody techniques, light and electron microscopy. *Onderstepoort Journal of Veterinary Research*, 51, 213-215.
- BEZUIDENHOUT, J. D., 1985. The epizootiology and control of heartwater and other tick-borne diseases in South Africa. *Onderstepoort Journal of Veterinary Research*, 52, 211-214.
- BEZUIDENHOUT, J. D. & JACOBSZ, CATHERINA, J., 1986. Proof of transovarial transmission of *Cowdria ruminantium* by *Amblyomma hebraeum*. *Onderstepoort Journal of Veterinary Research*, 53, 31-34.
- BIGALKE, R. D., 1976. Thoughts on the future control of ticks and tick-borne diseases of cattle in South Africa. *Journal of the South African Biological Society*, 17, 1-17.
- BIGALKE, R. D., DE VOS, A. G. & BARROWMAN, P., 1976. The control of some tick-borne diseases in South Africa. *Bulletin of International Epizootics*, 86, 89-100.
- BIGALKE, R. D., 1982. Closing address and tentative policy formulation. *Symposium on ectoparasites of cattle, 15 and 16 March 1982, South African Bureau of Standards, Pretoria*, 157-159.
- DIXON, R. W., 1899. Heartwater experiments. *Agricultural Journal of the Cape of Good Hope*, 15, 790-792.
- DU PLESSIS, J. L., 1981. The application of the indirect fluorescent antibody test to the serology of heartwater. In: WHITEHEAD, G. B. & GIBSON, J. D. (eds). *Proceedings of an International Conference on Tick Biology and Control, Rhodes University, Grahamstown*, 47-52.
- DU PLESSIS, J. L., BEZUIDENHOUT, J. D. & LÜDEMANN, C. J. F., 1984. The immunization of calves against heartwater: Subsequent immunity both in the absence and presence of natural tick challenge. *Onderstepoort Journal of Veterinary Research*, 51, 193-196.
- HENNING, M. W., 1956. Animal diseases in South Africa. 3rd edn. Onderstepoort, South African Central News Agency Ltd. 1115-1179.
- HOWELL, C. J., DE VOS, A. J., BEZUIDENHOUT, J. D., POTGIETER, F. T. & BARROWMAN, P., 1981. The role of chemical tick eradication in the control or prevention of tick-transmitted diseases of cattle. In: WHITEHEAD, G. B. & GIBSON, J. D. (eds). *Proceedings of an International Conference on Tick Biology and Control, Rhodes University, Grahamstown, South Africa*, 61-66.
- LONDT, J. G. H., HORAK, I. G. & DE VILLIERS, J. L., 1979. Parasites of domestic and wild animals in South Africa. XIII. The seasonal incidence of adult ticks (Acarina: Ixodidae) on cattle in the Northern Transvaal. *Onderstepoort Journal of Veterinary Research*, 46, 31-39.
- MACKENZIE, P. K. I., 1984. The culture of *Cowdria ruminantium* in mice: significance in respect of the epidemiology and control of heartwater. *Preventative Veterinary Medicine*, 2, 227-237.
- McCOSKER, P. J., 1981. The global importance of babesiosis. In: RISTIC, M. & KREIER, J. P. (eds). *Babesiosis*, 1-24. New York & London: Academic Press.
- NEITZ, A. W. H., VILJOEN, G. J., BEZUIDENHOUT, J. D., OBEREM, P. T., VAN WYNGAARDT, W. & VERMEULEN, N. M. J., 1986. The detection of antibodies to *Cowdria ruminantium* in serum and *C. ruminantium* antigen in *Amblyomma hebraeum* by an enzyme-linked immunosorbent assay. *Onderstepoort Journal of Veterinary Research*, 53, 39-41.
- NEITZ, W. O., 1933. The blesbuck (*Damaliscus albifrons*) as a carrier of heartwater and bluetongue. *Journal of the South African Veterinary Medical Association*, 4, 24-26.
- NEITZ, W. O., 1935. The blesbuck (*Damaliscus albifrons*) and the black wildebeest (*Connochaetes gnu*) as carriers of heartwater. *Onderstepoort Journal of Veterinary Science and Animal Industry*, 5, 35-40.
- NEITZ, W. O., 1937. The transmission of heartwater to and from blesbuck (*Damaliscus albifrons*) by means of the bont tick (*Amblyomma hebraeum*). *Onderstepoort Journal of Veterinary Science and Animal Industry*, 9, 37-46.
- NEITZ, W. O., 1964. Tick-borne diseases as a hazard in the rearing of calves in Africa. *Bulletin de l'Office International des Epizooties*, 62, 607-625.
- NEITZ, W. O. & ALEXANDER, R. A., 1941. The immunization of calves against heartwater. *Journal of the South African Veterinary Medical Association*, 12, 103-111.
- NEITZ, W. O., ALEXANDER, R. A. & ADELAAR, T. F., 1947. Studies on immunity in heartwater. *Onderstepoort Journal of Veterinary Science and Animal Industry*, 21, 243-249.
- NORVAL, R. A. I., 1979. Tick infestations and tick-borne diseases in Zimbabwe/Rhodesia. *Journal of the South African Veterinary Association*, 50, 289-292.
- NORVAL, R. A. I., 1981. Heartwater in tribal trust lands in southern Zimbabwe. *Zimbabwe Veterinary Journal*, 12, 56-57.
- NORVAL, R. A. I. & LAWRENCE, J. A., 1979. The control of heartwater in Zimbabwe/Rhodesia. *Rhodesian Journal of Agricultural Research*, 76, 151-165.
- RECHAV, Y., 1982. Dynamics of tick populations (Acari: Ixodidae) in the Eastern Cape Province of South Africa. *Journal of Medical Entomology*, 19, 679-700.
- STAMPA, S., 1969. Experiences with heartwater eradication. *Proceedings of a Symposium on Tick Biology and Control, Grahamstown, Republic of South Africa*, 133-150.
- THEILER, A., 1905. The advances of our knowledge respecting the stock diseases of South Africa. *Transvaal Agricultural Journal*, 1, 69-80.
- THEILER, A., 1909. Diseases, ticks, and their eradication. *Transvaal Agricultural Journal*, 7, 685-699.
- THEILER, A., 1921. Diseases of ticks and their eradication. *Journal of the Department of Agriculture of the Union of South Africa*, 2, 141-159.
- THOMAS, A. D. & MANSVELT, P. R., 1957. Immunization of goats against heartwater. *Journal of the South African Veterinary Medical Association*, 28, 163-168.

THE CONTROL OF HEARTWATER BY MEANS OF TICK CONTROL

UILENBERG, G., 1980. *In*: JOHNSTON, L. A. Y. & COOPER, M. O. (eds). Ticks and tick-borne diseases. pp. 1-3. Australian Veterinary Association, Sydney.

UILENBERG, G., 1983. Heartwater (*Cowdria ruminantium* infection): Current status. *Advances in Veterinary Science and Comparative Medicine*, 27, 427-480.