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THE CONTROL OF *PARAFILARIA BOVICOLA* TRANSMISSION IN SOUTH AFRICA

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ABSTRACT

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Ivermectin treatment of all cattle on a badly infected farm failed to interrupt the transmission of *P. bovicola*, even though ovipositional blood spots were drastically reduced in numbers for an entire summer season following treatment.

Regular weekly to fortnightly dipping of all cattle in 50 ppm deltamethrin immediately reduced vector fly numbers to less than 1 fly per cow face. Sustained dipping for 9 months effectively reduced *P. bovicola* transmission from approximately 50 % to less than 2 %. However, cessation of fly control led to a return to pre-dipping *P. bovicola* infection levels.

Ovipositional blood spot counts and the ELISA technique for evaluating *P. bovicola* infection in a herd were compared and were both effective methods. Best results for the blood spot method, however, are obtained in spring at the peak of the bleeding season whereas the ELISA method does not have this limitation.

INTRODUCTION

Parafilaria bovicola was first recorded as a parasite affecting cattle in the Republic of South Africa in 1964 (Pienaar & Van den Heever, 1964). Further studies initiated in 1972 showed that *Parafilaria* lesions on carcasses had in the past been confused with bruising (Van den Heever, Nevill & Horton, 1973) and that infection led to considerable economic loss through down-grading, trimming and carcass condemnation (Carmichael & Koster, 1978; Wallace, Weaver, Kretzmann & Payne, 1983).

There are 2 basic approaches to diminish the losses caused by this filarial worm. The first is to kill the worm in the animal to be slaughtered while the second is to reduce or eliminate worm transmission on the farm where the cattle are raised.

The first approach has been in use for a number of years following successful research into the chemotherapy of parafilariasis conducted by Viljoen & Boomker (1977), Wellington (1978), Wellington & Van Schalkwyk (1982), Swan, Soll, Carmichael & Schröder (1983) and Soll, Carmichael, Chambers & Ziervogel (1984). Their studies led to the registration of nitroxynil[1] and ivermectin[2] which, if used according to directions, can reduce carcass lesion area by at least 90 %.

The second approach, namely to interrupt transmission, can be aimed at the worm or at the African face fly vectors or possibly at both (Nevill, 1975; 1985b; Nevill & Sutherland, 1987). In the studies to be reported on below the writers, using a registered drug, first attempted to kill most of the mature worms present in all the cattle on a badly infected farm. When this approach failed they successfully used a pyrethroid insecticide, registered for African face fly control, to drastically reduce vector fly numbers and thereby also the *P. bovicola* transmission rate.

MATERIALS AND METHODS

Zoutpan Research Station, about 40 km N.W. of Pretoria, has a well documented history of parafilariasis with an annual prevalence of around 90 % (Nevill, 1984) and with vector flies accounting for 75,2 % of the flies collected off cattle there (Nevill, 1985b). 'Zoutpan' was thus an ideal farm on which to undertake *P. bovicola* control studies.

Ivermectin trial

On 2 June 1982, the time of the year when no transmission occurs (Nevill, 1985b), all 410 cattle on 'Zoutpan' were injected subcutaneously with ivermectin at the recommended dosage rate of 200 μg ivermectin/kg live mass, the object being to kill most mature worms and thereby prevent them producing the egg-laden blood spots on the skin surface needed to infect the vector flies. To measure this reduction in blood spots 140 yearling cattle, born between September and December 1981, were examined monthly from June 1982 to April 1983 for the presence of positive blood spots using the method described by Nevill (1984).

To determine if transmission occurred during the spring and summer following treatment with ivermectin, all calves born during that period (September to December 1982) were examined monthly for blood spots from June to November 1983. Two-year-old cattle were also examined once in October 1983.

Pyrethroid trial

By July 1983 it was clear that the attempt to interrupt *P. bovicola* transmission by using ivermectin to reduce the number of egg-laden blood spots had failed. African face fly control using a pyrethroid spraywash containing 2,5 % m/v deltamethrin[3] was then attempted. All cattle on 'Zoutpan' were sprayed with 50 ppm deltamethrin in a spray race at weekly and occasionally fortnightly intervals. Spraying started on 3 August 1983 and continued to 24 April 1984, a total of 32 times over a period of 9 months. Spraywash samples taken before and after spraying were analysed to be sure that the insecticide concentration stayed within effective limits.

To determine the effect of spraying on the vector fly population all flies present on the faces of 40 cattle in the veld at 'Zoutpan' were counted, using binoculars, and the mean number of flies per face was calculated. Two counts were made prior to the start of spraying and 28 counts during the 264 day vector control period (Fig. 1). Four fly collections were made off cattle between February and June 1983 to confirm that African face flies were present in sufficient numbers.

Sixty-two calves were born between September and December 1983, 1–3 months after spraying started. These calves were used to monitor *P. bovicola* transmission during the spraying period by determining the

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[1] Trodax Injection (Reg. No. G1142 in terms of Act 36/1947) Maybaker (SA) (Pty) Ltd.

[2] Ivomec Injectable (G541 Act 36/1947) MSD (Pty) Ltd.

[3] Decatix Cattle Spray (G824 Act 36/1947) Coopers Animal Health (Pty) Ltd

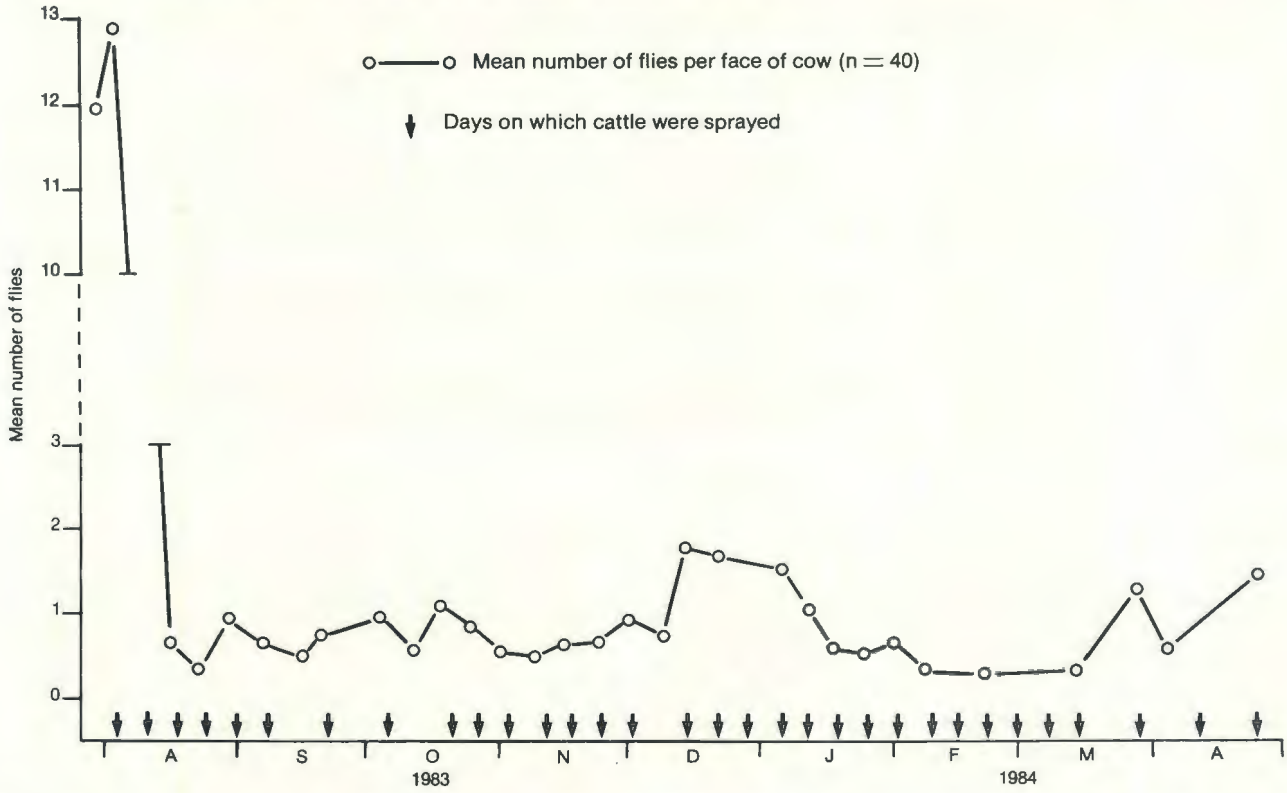

FIG. 1. *Parafilaria bovicola* control—the effect of regular spraying of cattle with deltamethrin on the prevalence of *Musca* spp. on cattle at Soutpan Research Station, July 1983–April 1984

monthly incidence of calves with *P. bovicola* blood spots from June 1984 onwards for 12 months. The same cattle were examined again in September and October 1985, 2 years after spraying for fly control was practised, to determine what the long-term effect of vector control was. During this 1984–1985 period the incidence of *P. bovicola* infection was monitored further by examining other 1 or 2 year old herds each October.

ELISA versus blood spot methods for P. bovicola *infection evaluation*

Swedish workers have developed an ELISA test to recognize infected cattle (Bech-Nielsen & Sundquist, 1984). It was agreed that the National Veterinary Institute at Uppsala should test the sera of the 59 cattle in the monitor herd. This would provide an opportunity to compare the 2 systems for evaluating *P. bovicola* infection. The ELISA test was performed on sera collected on 18 December 1984, 21 May 1985 and 8 October 1985, 8–18 months after vector control was stopped.

Sera were inactivated in a water bath at 56 °C for 30 min. Duplicate numbered filter paper strips 35 × 10 mm were soaked with serum, air dried and sent by air mail to Uppsala.

RESULTS

Ivermectin trial

The results of this trial are summarized in Tables 1 & 2. For purposes of comparison the mean percentage 1-year-old heifers with blood spots, recorded at 'Zoutpan' during the 3–4 year period 1973–1977, are also listed in Table 1.

Treatment with ivermectin in June 1982 led to a drastic reduction in the number of cattle with blood spots during the next 10 months. The highest blood spot incidence in the monitor group of 140 1-year-old treated cattle was 4,3 % compared with a mean of 49,2 % for the same age group in 1973–1976 (Nevill, 1984) (Table 1).

TABLE 1 *Parafilaria bovicola* control—ivermectin trial at Zoutpan Research Station (all cattle treated on 2 June 1982)

Month	Percentage 1-year-old cattle with blood spots		
	1973–1977	1982–1983	1983–1984
June	11,7	0,7	11,3
July	25,6	0,7	20,9
August	39,8	0	36,0
September	49,2	2,1	50,0
October	43,4	4,3	57,0
November	34,1	2,1	57,9
December	31,0	—	—
January	18,9	1,4	—
February	15,7	0,7	—
March	6,3	4,3	—
April	5,1	0	—
May	6,5	—	—
Total examined	234	140	115

TABLE 2 *Parafilaria bovicola* control—percentage cattle with *P. bovicola* blood spots at Zoutpan Research Station in October, 1982–1985

Age group	Percentage cattle with blood spots			
	1982	1983	1984	1985
1-year-old	4,3	57,0	1,6	60,4
2-year-old	—	50,0	11,4	72,9

Despite the sharp and sustained reduction in blood spot prevalence following the use of ivermectin in 1982 the crop of calves born during this period were again heavily infected with *P. bovicola*, their blood spot prevalence rising to pre-treatment levels of 57,0 % in October 1983 (Table 1). Even the group which had been treated in 1982 had a prevalence of 50,0 % in October 1983 (Table 2).

Pyrethroid trial

Of 873 flies caught off cattle prior to commencement of the trial, 81,1 % were vector flies. Fly counts can therefore be considered to refer mostly to African face flies.

Fig. 1 indicates the fly counts and spraying intervals during this trial. Before spraying started a mean of about 12 flies per face was recorded. By 15 August fly numbers had dropped to 0,65 per face and stayed below 1 per face for most of the time until 13 December when, for a period of a month, fly numbers rose to above 1 but below 2 per face. Thereafter until spraying was stopped fly numbers were kept below 1 for most of the time.

The spraywash concentration at the start of spraying fluctuated between 44 and 60 ppm (mean 50,6), but was stripped to between 28 and 45 ppm (mean 36,8) by the end of spraying.

The incidence of *P. bovicola* infection in cattle born during the vector control period appears in Table 3.

TABLE 3 *Parafilaria bovicola* control—deltamethrin trial at Zoutpan Research Station (all cattle dipped regularly from 3 August 1983 to 24 April 1984)

Month	Percentage 1-year-old cattle with blood spots		
	1983–1984	1984–1985	1985–1986
June	11,3	0	—
July	20,9	0	—
August	36,0	1,6	—
September	50,0	1,6	—
October	57,0	1,6	60,4
November	57,9	1,6	—
December	—	3,3	—
January	—	1,6	—
February	—	1,6	—
March	—	0	—
April	—	1,6	—
May	—	5,1	—
Total examined	115	62	101

There was a drastic reduction in *Parafilaria* transmission during the period that sustained pyrethroid spraying was practised. Only 1 animal was positive from August–November (1,6 %) compared with a mean of 34,1–49,2 % for the same period in the years 1973–1977 (Table 1 & 3). In December a 2nd animal became positive (3,3 %) but there were no further cases up to March 1985 (Table 3). At this time only 3,3 % of the trial cattle had ever shown blood spots, compared with 87,5 %–95,1 % for 4 herds of cattle of the same age in the period 1973/77 (Nevill, 1984).

In April and May 1985, however, a year after spraying ceased, new cases of bleeding were recorded in the same group of cattle (Table 3), and in October 1985 the blood spot incidence in these cattle had risen to 69,5 % compared with 1,6 % the previous year (Table 2). In calves born in 1984, 1 year after the vector control programme was practised, the *P. bovicola* incidence was equally high (60,4 % in October 1985) (Table 2).

The higher incidence of blood spots in the 2-year-old cattle in 1984 (11,4 %) compared to the 1-year-olds (1,6 %) is possibly due to the survival of worms already present in these cattle prior to vector fly control (Table 2).

ELISA versus blood spot method for P. bovicola *infection evaluation*

A comparison of the results of these 2 methods is given in Table 4.

There was close agreement in the total positive cattle, using the ELISA and blood spot evaluation techniques, in December 1984 and in October 1985, but not in May 1985. However, the total ELISA-positive cattle in May 1985 agreed closely with the numbers positive for blood spots in October 1985 (Table 4).

TABLE 4 Comparison of ELISA and blood spot methods for *P. bovicola* infection evaluation, Zoutpan Research Station 1984–85

Date examined	Positive cattle				
	ELISA				Blood spots
	+	++	+++	Total positive	
Dec. 1984	3	0	2	5/60	2/61
May 1985	20	15	3	38/59	3/59
Oct. 1985	27	6	5	38/59	43/59

+ = positive; ++ = strongly positive; +++ = very strongly positive

Although the results in Table 4 provide a useful indicator of the *prevalence* of *P. bovicola* infection, they may not reflect *incidence*. In other words both evaluation methods may not give the same results for the same animal. For this reason a comparison of the ELISA and blood spot evaluation results for each of the 59 cattle was made for October; the ELISA results for May were also compared with the ELISA and blood spot results for October. The following conclusions were made:

(a) ELISA results for May and October agreed in 79,7 % of the cattle tested.

(b) ELISA results for October compared with October blood spots results agreed in 71,2 % of the cattle.

(c) ELISA results for May compared with the October blood spot results agreed in 74,6 % of the cattle, and

(d) 62,7 % of all cattle were positive for the May and October ELISA tests as well as for the October blood spot evaluation.

DISCUSSION

Ivermectin trial

Despite the drastic reduction in ovipositional blood spots on cattle following *P. bovicola* control with ivermectin, transmission of this worm continued at the same high level as before. This is proof that African face flies are extremely competent vectors. They were able to locate the few remaining blood spots following treatment, become infected, survive long enough for *P. bovicola* larvae to develop to the infective 3rd stage and finally infect new hosts when feeding on them. The sole use of a registered drug against existing infections cannot therefore be recommended for the control of *P. bovicola* transmission on a farm.

Pyrethroid trial

The success of this trial is proof that good vector fly control over the entire period of *P. bovicola* transmission will lead to control of *P. bovicola* transmission on a farm for that season. However, since *P. bovicola* may survive for 2 years (Nevill & Viljoen, 1984), vector fly control should be continued for at least 2 years until no further cases occur on a farm. The necessity of this was shown in the present trial where very high *P. bovicola* infection levels were shown in the 2nd summer following cessation of vector fly control (Table 2).

A problem presented by weekly spraying for fly control is the strong likelihood of a loss of immunity in cattle to tick-borne diseases such as heartwater. A possible way of overcoming this problem, apart from immunization, is the use of pyrethroid-impregnated ear tags or spot treatments with pyrethroids aimed at control of the flies

found around the head. Proof that this approach can be successful for *Parafilaria* control has been provided by Dr Tor B. Wallgren (Animal Health Service, Linköping, Sweden, personal communication, 1985). He has achieved almost 100 % *P. bovicola* control in a 260 km^2 area by treating all 2 600 cattle with a fenvalerate-impregnated ear tag in each ear.

ELISA versus blood spot methods for P. bovicola *infection evaluation*

To understand why the May ELISA results were compared with the October blood spot results it is necessary to remember that the ELISA test can detect adult worms which have not yet created blood spots. In fact Bech-Nielsen & Sundquist (1984) were able to detect a *P. bovicola* infection 3–4½ months after the cattle had been experimentally infected. Blood spots on the other hand first appear after at least 6 months (Nevill, 1984; 1985a). Since blood spots reach a peak in September/October it is only then that a good indication of the incidence of infection can be obtained. A comparison of the October blood spot incidence with the May ELISA results is therefore justifiable and is supported by the infection incidence of 74,6 % as determined by these 2 tests. The good agreement (79,7 %) between the May and October ELISA tests on the same animals is further proof that the May ELISA test was in fact measuring the presence of as yet sexually inactive *P. bovicola*.

A comparison of the ELISA and blood spot *P. bovicola* evaluation methods in October 1985 was a little disappointing as there was only 71,2 % agreement. The same ELISA test on Swedish material has shown 95 % specificity and 92 % sensitivity (G. Zackrisson, unpublished data, 1987). Some of this difference could be due to the fact that it is impossible to determine all positive cases by clinical examination and in the present trial these cattle were only examined for blood spots in September and October 1985. Also some of the animals destined for marketing had recently been treated with nitroxynil; this would have reduced the number of blood spots.

In 18,6 % of the herd, however, ELISA results in October were negative in animals on which egg-laden blood spots had been observed. The explanation for this discrepancy must be sought in the serology techniques employed, from the preparation of the serum filter strips up to their analysis.

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REFERENCES

BECH-NIELSEN, S. & SUNDQUIST, B., 1984. Epidemiology and immunodiagnosis of *Parafilaria bovicola* in Swedish cattle—new prospects for control. *Proceedings of the 13th World Congress on Diseases of Cattle, Durban, 1984*, 436–441.

CARMICHAEL, I. H. & KOSTER, SUSAN, 1978. Bovine parafilariosis in Southern Africa: a preliminary report. *Onderstepoort Journal of Veterinary Research*, 45, 213–214.

NEVILL, E. M., 1975. Preliminary report on the transmission of *Parafilaria bovicola* in South Africa. *Onderstepoort Journal of Veterinary Research*, 42, 41–48.

NEVILL, E. M., 1984. Seasonal abundance and distribution of *Parafilaria bovicola* ovipositional blood spots on cattle in South Africa. *Onderstepoort Journal of Veterinary Research*, 51, 107–114.

NEVILL, E. M. & VILJOEN, J. H., 1984. The longevity of adult *Parafilaria bovicola* and the persistence of their associated carcass lesions in cattle in South Africa. *Onderstepoort Journal of Veterinary Research*, 51, 115–118.

NEVILL, E. M., 1985a. The effect of arsenical dips on *Parafilaria bovicola* in artificially infected cattle in South Africa. *Onderstepoort Journal of Veterinary Research*, 52, 221–225.

NEVILL, E. M., 1985b. The epidemiology of *Parafilaria bovicola* in the Transvaal Bushveld of South Africa. *Onderstepoort Journal of Veterinary Research*, 52, 261–267.

NEVILL, E. M. & SUTHERLAND, B., 1987. The colonization and life-cycles of *Musca lusoria*, *Musca xanthomelas* and *Musca nevilli*, vectors of *Parafilaria bovicola* in South Africa. *Onderstepoort Journal of Veterinary Research*, 54, ...

PIENAAR, J. G. & VAN DEN HEEVER, L. W., 1964. *Parafilaria bovicola* (Tubangui 1934) in cattle in the Republic of South Africa. *Journal of the South African Veterinary Medical Association*, 35, 181–184.

SOLL, M. D., CARMICHAEL, I. H., CHAMBERS, P. G. & ZIERVOGEL, A., 1984. The influence of pre-slaughter treatment with ivermectin on *Parafilaria bovicola* infestation in cattle in Zimbabwe. *Zimbabwe Veterinary Journal*, 15, 18–23.

SWAN, G. E., SOLL, M. D., CARMICHAEL, I. H. & SCHRÖDER, J., 1983. Efficacy of ivermectin against *Parafilaria bovicola*. *The Veterinary Record*, 113, p. 260.

VAN DEN HEEVER, L. W., NEVILL, E. & HORTON, B. G. W., 1973. Bovine parafilariasis. *Journal of the South African Veterinary Medical Association*, 44, 333–334.

VILJOEN, J. H. & BOOMKER, J. D. F., 1977. Studies on *Parafilaria bovicola* Tubangui, 1934. 2. Chemotherapy and pathology. *Onderstepoort Journal of Veterinary Research*, 44, 107–112.

WALLACE, H. G., WEAVER, D. B., KRETZMANN, P. M. & PAYNE, J. R., 1983. Bovine parafilariasis: condemnations at the Cato Ridge abattoir. *Journal of the South African Veterinary Association*, 54, 123–125.

WELLINGTON, A. C., 1978. The effect of nitroxynil on *Parafilaria bovicola* infestations in cattle. *Journal of the South African Veterinary Association*, 49, 131–132.

WELLINGTON, A. C. & VAN SCHALKWYK, L., 1982. The effect of a single injection of nitroxynil at 20 mg/kg live mass in the treatment of *Parafilaria bovicola* infestations in cattle. *Journal of the South African Veterinary Association*, 53, 91–94.

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