

The epidemiology of bluetongue in Malawi

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SUMMARY

A 4 year survey was undertaken in 1982–6 to examine the seasonal nature of bluetongue virus activity in Malawi. Bluetongue infection at Bwemba in Lilongwe district and Likasi in Mchinji district, both in the Central Region of Malawi, was detected by examining sera taken from calves at each site, at monthly intervals. The proportion of seronegative calves undergoing seroconversion each month was used as a measure of virus activity. At both sides bluetongue virus activity was found to be most marked during the rainy season, with no activity detected during the dry season from July to September. Thus the pattern of bluetongue infection in Malawi is highly seasonal. Examination of type-specific neutralizing antibody showed that the prevalent serotypes varied from year to year.

INTRODUCTION

Bluetongue virus is distributed throughout virtually the whole of Africa but disease attributable to its presence is relatively rare, generally occurring where sheep industries have been established by the introduction of European fine-wool and mutton breeds (Davies & Walker, 1974; Howell, 1979). In other areas, attempts to import foundation stock have had to be abandoned due to the high number of deaths from bluetongue (Bida, Njoku & Eid, 1975; Ekue *et al.* 1985). In contrast, native sheep have a high level of innate resistance, rendering most infections totally benign: cattle and goats are involved in maintaining the virus wherever it occurs but disease is seldom seen in any breed. Therefore, although bluetongue does not appear to be a major economic constraint to African livestock breeders, it could adversely affect the success of livestock improvement projects.

Costly large-scale vaccination programmes have been necessary for maintenance of exotic flocks in Kenya and South Africa and would certainly be required in any other part of Africa where similar developments were being considered, even if only for cross-breeding. However, there is evidence that in some parts of Africa bluetongue virus has a seasonal occurrence (Theiler, 1908; Herniman, Boorman & Taylor, 1983; Mohammed & Taylor, 1987) and that within the continent as a whole, endemic and epidemic zones occur (Sellers, 1981). This suggests the

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possibility that in some countries there will be periods when the virus is absent, during which stock introductions and preliminary vaccinations could take place without threat. The present approach to bluetongue vaccination is based on the application of multivalent vaccines incorporating a large number of virus serotypes but there is evidence that vaccination could be simplified after studying the virus types prevalent in a given area (Jeggo & Wardley, 1985).

Therefore there are still valid grounds for investigating the epidemiology of bluetongue in Africa. The present results are from a 4-year study of the seasonality and distribution of bluetongue virus types in the Central Region of Malawi. It was based on the use of sentinel cattle rather than sheep, because calves were more readily available and had been used successfully in this capacity in previous studies (Herniman, Boorman & Taylor, 1983).

Malawi's sheep industry has always been small, consisting of a few private producers, though there have been recent plans to extend it through the use of imported breeds. Bluetongue was suspected in crossbred sheep (Dopper × Malawi fat tail) in 1982 at Bwemba farm on the outskirts of Lilongwe in the Central Region of Malawi. Several animals died and a tentative clinical diagnosis of bluetongue was made (B. Bedard, personal communication) but no laboratory confirmation was obtained. There have been no other recorded field reports of bluetongue, though there is serological evidence of its presence. Of 660 bovine sera collected from various parts of Malawi in 1974–6, 110 (16·7%) were seropositive (T. Wallgren, unpublished results). Of 40 sera from Dopper sheep collected in 1982, 15 (37·5%) were seropositive, and of 68 sera collected from nyala (*Tragelaphus angasi*) from Lengwe National Park in the Southern Region during a cull in 1984, 27 (39·7%) were seropositive (J. Haresnape, unpublished results).

MATERIALS AND METHODS

Animals

Two herds were used for sampling, both Government stock. One was located at Bwemba, on the outskirts of Lilongwe city (14° 00' S, 33° 44' E), and the second at Likasi, 65 km west of Lilongwe (13° 54' S, 33° 11' E). The dairy herd at Bwemba consisted mainly of pure-bred Friesians and cross-bred animals (Friesian × Malawi Zebu) plus a few Jerseys, and calving was throughout the year. There was little regular movement of animals on or off the farm apart from the occasional transfer of bull calves to Likasi and heifers to farmers for milk production. The animals were housed in stalls at night, and given concentrated feed as well as being put out to graze daily. At Likasi all the animals were cross-breds, some Friesian × Brahman and some Friesian × Malawi Zebu, the herd being under beef management with two calving seasons, September to December and May to July. Steers were regularly sold for stall feeding or to supply beef for the city, and some heifers were transferred to Bwemba or sold for milk production. Purebred Brahman and Friesian cows were brought in regularly from other Government stations. The herd was free-range. Each animal at each station was individually tagged.

In March 1982, sera were taken from 15 adult cattle at Bwemba to be examined for evidence of bluetongue infection. Following this serum was obtained from

newborn calves at both Bwemba and Likasi shortly after birth and then at monthly intervals until it was clearly established that an individual animal had experienced bluetongue infection. Calves from seropositive dams were only considered when maternal antibodies could no longer be detected. In an attempt to maintain a constant supply of calves which were susceptible to bluetongue, animals were recruited into the trial at different times throughout the year. The investigation was continued for 4 years. At Bwemba the number of calves remained close to 20 for the first 3 years of the investigation, and 34 calves were involved in the fourth year. At Likasi 18 calves were used in 1982, and this was increased to more than 40 in subsequent years.

Sera

All serum samples were stored at -20°C in both Lilongwe and Pirbright. Shipment between the two laboratories was made by airfreight in insulated containers.

Serological tests

Agar-gel immunodiffusion tests were done at the Central Veterinary Laboratory, Lilongwe to detect specific bluetongue virus antibodies using the method outlined by Eisa *et al.* (1983). Final results were obtained by testing all sera from a given animal at the same time. Conversion from seronegative to seropositive indicated bluetongue virus activity. Sera were tested for group specific antibodies using the blocking ELISA test of Anderson (1985) at the Institute for Animal Disease Research, Pirbright Laboratory, UK. For each calf, sera collected immediately after seroconversion were examined for type-specific neutralizing antibody to bluetongue virus (Herniman *et al.* 1983).

Meteorological data

Daily rainfall records for Bwemba were obtained from a rain gauge at the National Seed Company of Malawi site at Njewa farm, 4 km northwest of Bwemba. Records for Likasi were obtained from a rain gauge situated at the Likasi farm office. The mean daily rainfall for the period between each sample collection was calculated for each site (Figs. 1 and 2).

RESULTS

The seasonal nature of bluetongue infection and the apparent close relationship between virus activity at Likasi and the duration of the rains is seen in Fig. 1. No bluetongue virus activity was detected in sentinel calves during July or August 1982. A single calf seroconverted in September, and this was followed by two seroconversions in October and one in November. Rainfall commenced in October and rose sharply to an average of 6 mm per day in December during which month 14 susceptible calves were exposed and 8 of them were infected with bluetongue virus. Virus activity continued into January and February 1983 after which no further uninfected sentinel calves remained at Likasi. The rainy season lasted from October 1982 until April 1983 and was followed by a dry season lasting until the following October. During this dry period further calves were recruited into

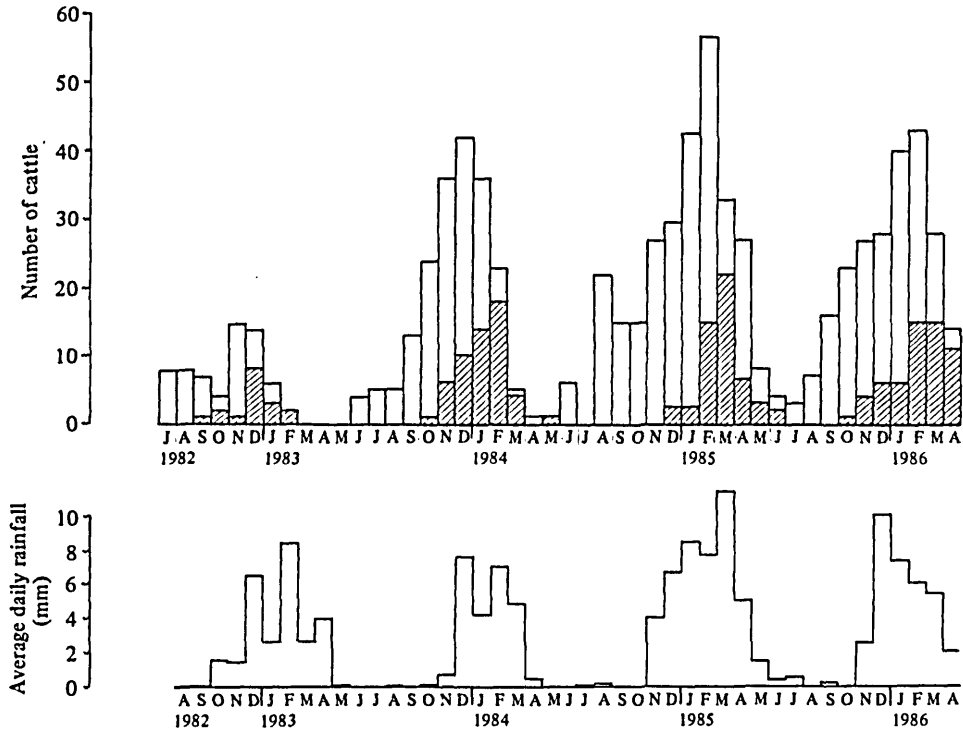


Fig 1. Bluetongue virus activity (upper histogram) and rainfall (lower histogram) at Likasi over a 4-year period. Upper histogram shows: unshaded area; number of susceptible cattle (seronegative cattle excluding those with maternal antibodies); shaded area; number of seroconversions.

the trial and between June and September 1983 no seroconversions were detected in a total of 27 calf months of exposure. A single calf seroconverted in October, and a further 6 calves were infected in November at the start of the rains. Bluetongue virus activity continued until the end of the rainy season, with one further seroconversion being detected in May, just after the last rain. No virus activity was detected between June and November 1984 in a total of 85 calf months of exposure. Virus activity recommenced in December 1984, continuing until June 1985. No seroconversions were detected between July and September 1985, a single calf seroconverted in October, and a further 4 in November at the start of the rains. Virus activity again continued throughout the rainy season.

The coincidence of rainfall and bluetongue infections for Bwemba is shown in Fig. 2. Bluetongue virus activity was apparently not as marked as at Likasi although an underlying similarity existed. Seventy-three seroconversions were detected out of a total of 665 calf months of exposure (11%), compared with 183 seroconversions out of 774 calf months (24%) at Likasi. In 1982 the rainy season started in September; a single bluetongue seroconversion occurred in September but there was no subsequent amplification of infection, and October, November, December, January and February were uneventful months with regard to bluetongue. Four calves were infected in March and three in April at a time when rainfall was diminishing. As at Likasi, the dry seasons of 1983, 1984 and 1985 were

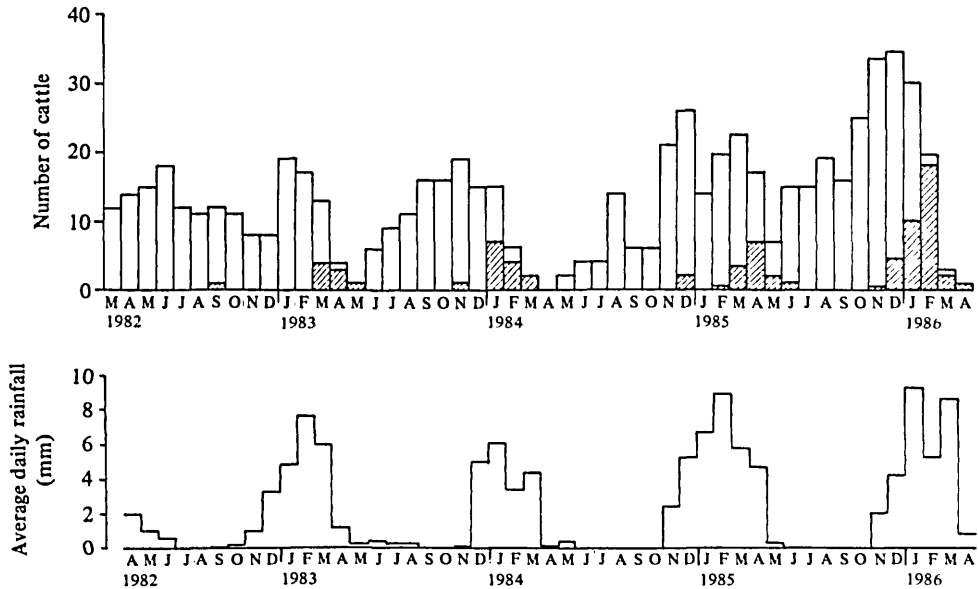


Fig 2. Bluetongue virus activity (upper histogram) and rainfall (lower histogram) at Bwemba over a 4-year period. Upper histogram shows: unshaded areas; number of susceptible cattle (seronegative cattle excluding those with maternal antibodies); shaded area; number of seroconversions.

marked by a total lack of bluetongue virus activity. One or two seroconversions occurred at the beginning of each of the subsequent rainy seasons, and this was followed in some years by a month in which no virus activity was seen. The major peak of activity was towards the middle or end of the rains.

Of the 15 adult animals at Bwemba examined in 1982 at the start of the investigation 13 showed serological evidence of bluetongue infection. The results of neutralization tests indicated that serotypes 1, 2, 5, 8, 10, 14 and 15 had possibly been active in this group some time prior to 1982 and that most other types had not occurred. Examination of sera collected from newly infected calves at Likasi early in 1983 showed that there had been 12 seroconversions to BTV3, 2 to BTV8, 3 to BTV14 and 2 to BTV15 showing that these serotypes had been active at Likasi. In three cases there appeared to have been seroconversions to two different viruses, and in four cases the result was not clear. The results from early 1984 indicated that types 1, 3, 20 and 22 had been present at Bwemba. The results from Likasi at the beginning of 1984 were more confusing with few post conversion sera showing a monospecific reaction with a single virus serotype, so no attempt was made to identify seroconversions, but in early 1985 types 3, 8, 20 and 21 were active at Likasi. Thus the prevalent types vary from one year to the next.

DISCUSSION

Little is known about the detailed epidemiology of bluetongue in East and Central Africa. In Kenya bluetongue virus activity can be measured in terms of outbreaks of frank disease among exotic sheep and on this basis occurs all the year

round without any clearly seasonal bias (Walker & Davis, 1971). The same authors were able to show that *Culicoides* vectors were also abundant throughout the year and able to support a continual virus activity. Sellers (1981) postulated the occurrence of a series of zones based on climatic differences within which bluetongue virus activity would differ. He envisaged an endemic zone such as Kenya bordered to the north and south by a zone characterized by distinct wet and dry seasons but with virus present throughout the year. Malawi was clearly considered to fall within the endemic zone and yet the present studies show that bluetongue virus activity in Malawi is highly seasonal. Based on the evidence now available we would suggest that bluetongue should no longer be considered endemic in Malawi; rather that the virus is introduced into the country at the beginning of each annual period of rain giving rise to a seasonal epidemic. Although the source of infection has not been clearly established it is possible that *Culicoides* midges infected with bluetongue virus could be transported to Malawi by winds crossing southern Tanzania or northern Mozambique in September or October each year. One seroconversion, at Likasi in September 1982, was detected just before the start of the rainy season, but this could be attributed to the arrival of infected *Culicoides* with the strong winds which often precede the first rain. It is interesting to note that the seasonal pattern of bluetongue virus activity in Malawi mirrors that in Sudan, with virus becoming active in Malawi following the rapid retreat of the Inter Tropical Convergence Zone in Sudan in October, and gradual cessation of virus activity which follows (Mohammed & Taylor, 1987). It is also possible that Malawi acts as a source of virus for countries further south which experience a highly seasonal bluetongue pattern, such as South Africa where the typical bluetongue season runs from March to May (Theiler, 1906).

The relationship between virus activity and the duration of the rains was closer at Likasi than at Bwemba. This may be because the cattle at Likasi, being free-range and hence outside at all times, are in more direct contact with the *Culicoides* vectors. At Bwemba, the cattle are housed in stalls and graze outside for just a part of each day, so are less likely to be bitten by *Culicoides*, which are most active in the evenings. This may be why bluetongue virus activity was not as marked in the cattle at Bwemba, and why the peak of virus activity occurred later than at Likasi. Assessment of the months in which virus is most likely to be absent is therefore best made on the basis of the Likasi data, as being between July and September.

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REFERENCES

- ANDERSON, J. (1985). Monoclonal antibodies and bluetongue virus diagnosis. In *Bluetongue and Related Orbiviruses*. Progress in Clinical Biological Research 178 (ed. T. L. Barber and M. M. Jochim), pp. 497-504. New York: Alan R. Liss.
- BIDA, S. A., NJOKU, C. O. & EID, F.I.A. (1975). Bluetongue in Wiltshire-horn sheep. *Veterinary Record* 97, 496.
- DAVIES, F. G. & WALKER, A. R. (1974). The distribution in Kenya of bluetongue virus and antibody, and the *Culicoides* vector. *Journal of Hygiene* 72, 265-272.
- EISA, M., McGRANE, J. J., TAYLOR, W. P. & BALLOUGH, A. (1983). Survey of precipitating antibodies to Bluetongue virus in domestic animals of the Sudan. *Bulletin of Animal Health and Production in Africa* 31, 95-99.
- EKUE, F. N., NFI, A. N., TSANGUE, P., TAYLOR, W. P. & GUMM, I. D. (1985). Bluetongue in exotic sheep in Cameroon. *Tropical Animal Health and Production* 17, 187-188.
- HERNIMAN, K. A. J., BOORMAN, J. P. T. & TAYLOR, W. P. (1983). Bluetongue virus in a Nigerian dairy cattle herd. I. Serological studies and correlation of virus activity to vector population. *Journal of Hygiene* 90, 117-193.
- HOWELL, P. G. (1979). The epidemiology of Bluetongue in South Africa. *Proceedings of the 2nd Symposium on Arbovirus Research in Australia* (ed. T. D. St. George and E. L. French), pp. 117-123. Queensland Institute of Medical Research, Brisbane, Australia.
- JEGGO, M. H. & WARDLEY, R. C. (1985). Bluetongue vaccine; cells and/or antibodies. *Vaccine* 3, 57-58.
- MOHAMMED, M. E. H. & TAYLOR, W. P. (1987). The seasonal activity of bluetongue virus in sentinel calf herds in Sudan. *Epidemiology and Infection*. In press.
- SELLERS, R. F. (1981). Bluetongue and related diseases. In *Virus Diseases of Food Animals, II: Disease Monographs* (ed. E. P. J. Gibbs), pp. 567-584. New York: Academic Press.
- THEILER, A. (1906). Bluetongue in sheep. Transvaal Department of Agriculture, Annual Report for 1904-1905, pp. 110-121. Government Printer, Pretoria.
- THEILER, A. (1908). The inoculation of sheep against bluetongue and the results in practise. *Veterinary Journal* 64, 600-607.
- WALKER, A. R. & DAVIES, F. G. (1971). A preliminary survey of the epidemiology of bluetongue in Kenya. *Journal of Hygiene* 69, 47-60.