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A survey of Nairobi sheep disease antibody in sheep and goats, wild ruminants and rodents within Kenya

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SUMMARY

The distribution of antibody to Nairobi sheep disease in sheep and goats in Kenya was found to coincide closely with that of the tick, *Rhipicephalus appendiculatus*. The proportions of a population in an enzootic area with antibody was similar in the different age groups. No antibody to the virus was found in rodent sera and while some low titres were found in some wild ruminant sera, these were considered to be most likely cross reactions with antibody to related viruses.

INTRODUCTION

Nairobi sheep disease (NSD) is the most pathogenic virus infection affecting sheep and goats in Kenya, with mortality rates of up to 90 %. Montgomery (1917) defined the condition, and his work was substantiated by Daubney & Hudson, (1931, 1934). They showed that NSD was a virus disease transmitted by the tick *Rhipicephalus appendiculatus* and that sheep and goats kept in areas where this tick was prevalent were immune, but animals moved into such areas died in large numbers. Daubney & Hudson (1934) described 2 outbreaks which occurred in areas where *R. appendiculatus* was not found and where they thought that *Amblyomma variegatum* could transmit the virus. Their experiments showed that while this was so, the tick was a far less efficient vector than *R. appendiculatus*.

Clearly the distribution of a tick-borne disease must be closely related to the distribution of the vector. An accurate distribution study of NSD antibody in Kenya would be of value in determining whether the distribution of antibody to NSD and that of *R. appendiculatus* coincided. The study might reveal that certain populations of the tick were free from infection with the virus, or that the distribution of the antibody correlated with tick species other than *R. appendiculatus*, such as *Amblyomma variegatum*, as suggested by Daubney & Hudson (1934).

The known reservoir and amplifying hosts for NSD in Kenya are sheep and goats, but it is possible that there is another vertebrate reservoir for the virus. Other Kenyan arboviruses involve the wild ruminant populations as maintenance hosts (Davies & Walker, 1974; Davies, Shaw & Ochieng, 1975). Daubney & Hudson (1934) suggested that the rat *Arvicanthus abyssinicus* might be able to amplify the virus and infect ticks.

The results are important as a template for effecting the control of the disease

by restricting movement to endemic areas from NSD-free zones; and to provide some rational basis for the use of a vaccine against NSD, which has been prepared in the laboratory (Davies, Mungai & Shaw 1974).

MATERIALS AND METHODS

Virus

The I 34 strain which was isolated in Kenya from an outbreak of disease in wool sheep was used to prepare antigen for the serological tests. This strain has been used in most work with the virus in the laboratory. (Davies, Mungai & Shaw, 1974; Davies, Mungai & Taylor 1977; Davies, Jesset & Otieno 1976).

Sera

Sheep and goats are normally kept in mixed flocks, and sera were collected from both species by members of the Kenya Veterinary Department. Clusters of 10–20 animals were sampled, in as representative a geographical and ecological pattern as a district represented. The husbandry encountered was of 2 main types, nomadic and sedentary. In the nomadic pastoral areas where most sheep and goats are kept, the animals move regularly with the available water and grazing, and sampling is clearly not so relevant to the actual collection site. The ecological characteristics of the zones are similar however, as are the tick species found, the results are thus representative of the area. The sedentary farm units are found in all the higher potential areas where the principal tick vector of NSD is common. The small stock graze enclosed paddocks of variable size or often follow a local, common grazing pattern.

All sera were stored at -20 °C until used.

Sera were also collected by the FAO Wildlife Project at Kabete (Ken 68/13) from a wide range of wild ruminant and rodent species.

Serological methods

Antibody responses to NSD in sheep were assayed by Davies, Jesset & Otieno (1976). Four methods were used, the complement fixation test (CFT), indirect fluorescent antibody test (FAT), indirect haemagglutination test (IHA) and serum neutralization. Titres were found to be 1/80 or greater by FAT after two years and this method was used for the survey. The other methods were also used, however.

The anti-ovine gamma globulin preparations made in the laboratory were shown *to react with sera from wild game animals. Tests with these sera and other viruses* showed that the specificity of FAT positive sera could be confirmed by serum neutralization tests (Davies & Walker, 1974; Davies, 1975).

Both anti-rat and anti-mouse gamma globulin preparations which had been conjugated with fluorescein isothiocyanate, were found to cross-react with the positive control sera prepared in mice. The anti-mouse conjugated preparation was used to screen the field sera.

The results were interpreted as positive when there was specific fluorescence identical with that seen in the controls. The intensity was subjectively graded 1 plus to 4 plus by the observer (author). Most sera were screened at 1/20 dilutions

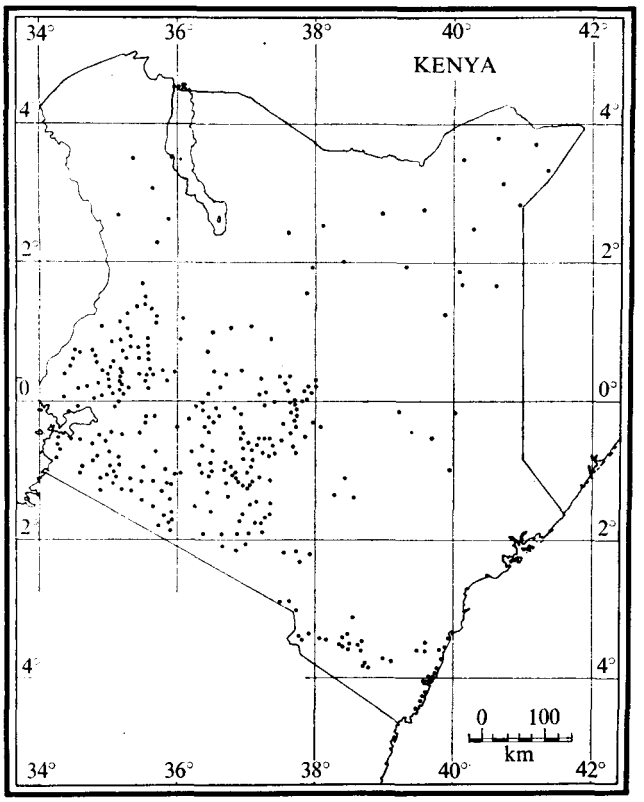

Fig. 1. Shows the sampling sites throughout Kenya.

in phosphate buffered saline. Some wild ruminant sera were positive at 1–2 plus intensity of fluorescence which was qualitatively recognized as different from positive sheep or goat sera. They were tested by CFT and IHA.

Expression of Results

The results have been described in relation to the distribution of the principal known vector *R. appendiculatus*; and also *Amblyomma variegatum* and *R. evertsi* and *R. pulchellus*.

RESULTS

The distribution of antibody in sheep and goats

A total of 4915 sera were tested from 350 different sampling sites. Figure 1 shows the sampling sites throughout Kenya. Figure 2 shows the distribution of positive clusters in relation to the distribution of *Rhipicephalus appendiculatus*, *R. evertsi*, *R. pulchellus* and *Amblyomma variegatum*.

There was no difference in the proportions of positive sera in sheep and goats from the same clusters and the results are considered together. In those areas where most clusters were positive for antibody to NSD, 60–100 % of the animals tested were positive. Some islands in the middle of such zones, where tick control has been extensively practised on enclosed farms, 0–10 % of the animals were positive.

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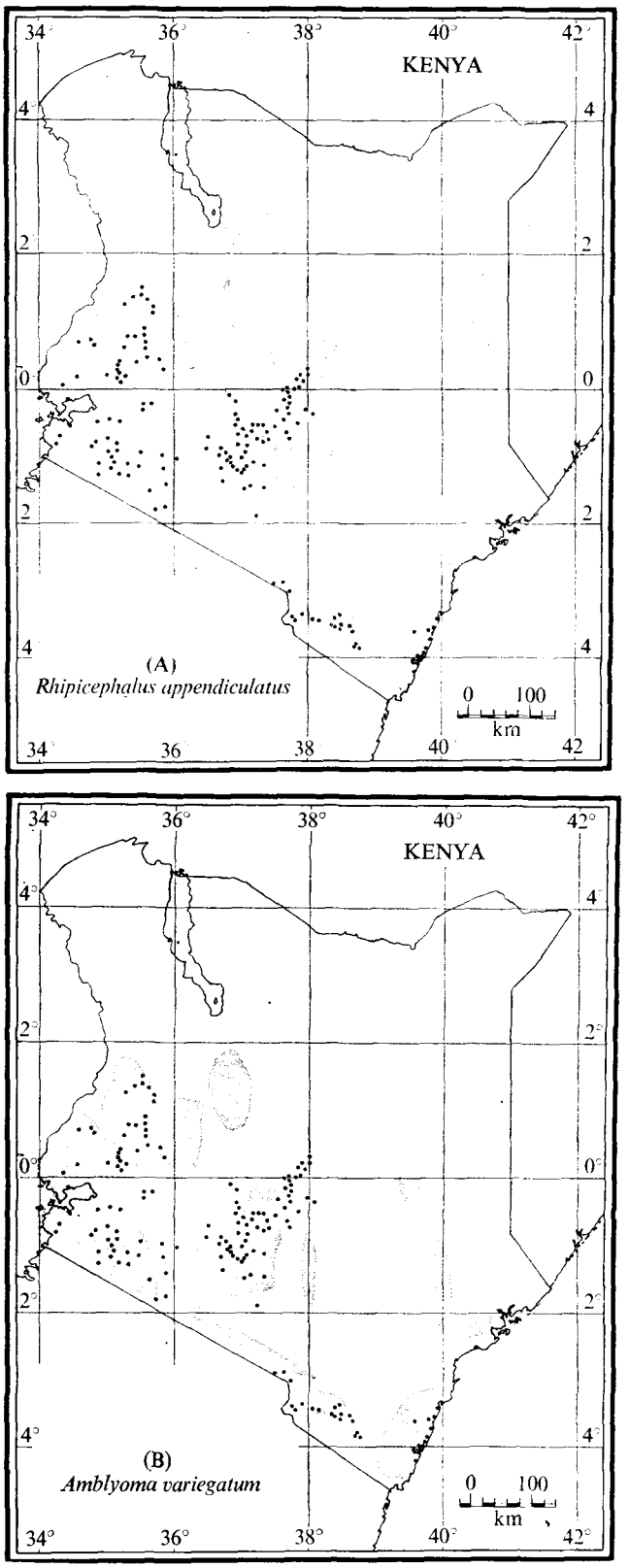

Fig. 2A and B. For legend see facing page.

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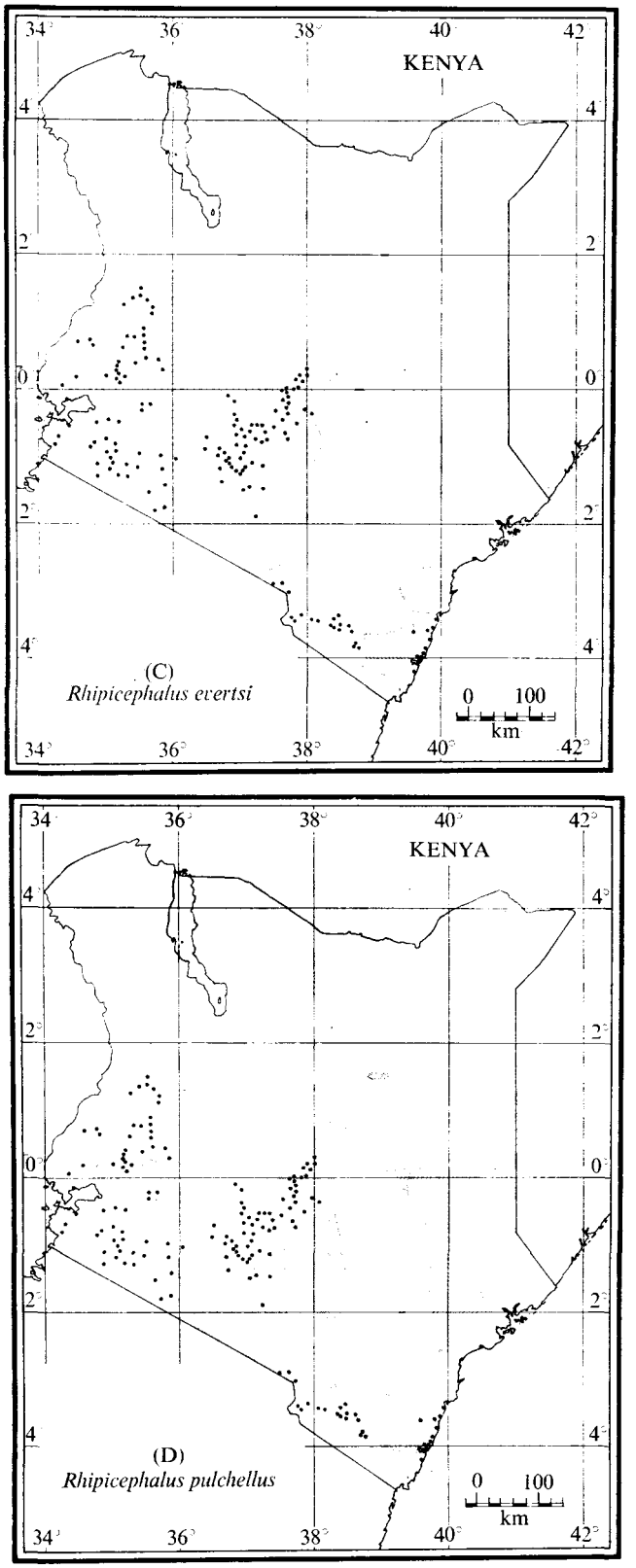

Fig. 2. Shows the distribution of sampling sites positive to Nairobi sheep disease in relation to the distribution of *Rhipicephalus appendiculatus*, *evertsi* and *pulchellus* and *Amblyomma variegatum*.

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Table 1. *The proportions of different age groups of sheep and goats kept in an area enzootic for NSD which were positive at 1/40 serum dilution on FAT*

Age (in months)	Number positive	Number tested	Per cent
4	9	14	64
6	8	11	73
8	18	30	60
12	27	41	66
18	28	39	72
24	26	42	62
36	13	19	68
48	11	14	79

Table 2. *The results of serological examinations for antibody to NSD in wild ruminant species and rodents*

	Positive*	FAT	CFT	IHA	No. tested
Ruminants					
Wildebeest, *Connochaetes taurinus*	3	20†	0	320	27
Cokes hartebeest, *Alcelaphus buselaphus*	9	20	0	80	39
Thomsons gazelle, *Gazella thomsonii*	1	20	0	160	42
Grants gazelle, *Gazella grantii*	7	20	0	80	51
Reedbuck, *Redunca fulvorfula*	0	0	—	—	28
Impala, *Aepyceros melampus*	1	20	0	80	53
Waterbuck, *Kobus ellipsiprymnus*	0	0	—	—	28
Oribi, *Ourebia ourebia*	0	0	—	—	20
Eland, *Taurotragus oryx*	0	0	—	—	11
Giraffe, *Giraffa camelopardalis*	4	10	0	nd‡	18
Rodents					
Rattus rattus	0	—	—	—	1
Otomys tropicalis	0	—	—	—	8
Mastomys natalensis	0	—	—	—	16
Crocidyra spp.	0	—	—	—	3
Lemniscomys striatus	0	—	—	—	18
Mus musculus	0	—	—	—	1
Acomys ignitus	0	—	—	—	6
Lophuromys flavopunctatus	0	—	—	—	3
Tatera vicina	0	—	—	—	9

* Positive at screening titre of 1/10 on FAT.
† Reciprocal of highest serum titre. ‡ n.d., not done.

The distribution of antibody in sheep and goats by age

The proportions of animals showing antibody to NSD in different age groups in an enzootic area are shown in Table 1.

Antibody to NSD in wild ruminants

The results of screening different game animals for antibody to NSD are shown in Table 2. The animals were killed in areas where *R. appendiculatus* was prevalent or they included such areas in the seasonal grazing movements.

A small number gave apparently positive results on FAT, but titration showed that these were only at a low titre with a low intensity of fluorescence. Dilution of these sera beyond 1/40 and 1/80 gave no fluorescence, while positive sheep showed specific fluorescence at 1/10240.

These sera were tested by CFT and IHA. None gave any titre on CFT and only low titres on IHA, of up to 1/320. The results are shown on Table 2. These results might be due to an earlier challenge with NSD virus and be a specific low titre reaction. On the other hand as no animal with a high titre was found, the titres were more likely to be cross reactions with other viruses which have recently been shown to be related to NSD, and which show serological reactions with NSD comparable with these (Davies *et al.* 1978).

Antibody to NSD in rodent sera

The results of screening the rodent sera are given in Table 2. No sera gave any positive reaction and it would appear that these rodents are not reservoirs for the virus.

DISCUSSION

This study largely confirms the observation by Daubney & Hudson (1934) that sheep and goats originating in areas where *Rhipicephalus appendiculatus* is prevalent are immune to NSD. The clusters with antibody specific to NSD were found entirely in such areas. The results do not support a view that *Amblyomma variegatum* transmits the virus to any significant extent. In those parts of the southern pastoral areas of Masailand where this tick is found in the absence of *Rhipicephalus appendiculatus*, the sheep and goat populations were free from antibody to NSD virus. The distribution of the vector and of antibody to the virus transmitted by the vector should coincide. This is so for *Rhipicephalus appendiculatus* in Kenya. On the same basis *Rhipicephalus pulchellus* and *R. evertsi* cannot be considered as vectors of NSD.

Many clusters within the *Rhipicephalus appendiculatus* zones were free from antibody. These may reflect the continuous effective control of the tick in the cattle populations; ticks in such areas are absent or rare. The continuous effort to control East Coast Fever in cattle, which is also transmitted by *Rhipicephalus appendiculatus*, has probably broken the maintenance cycle for NSD virus. The effects are especially significant where the game populations have been eliminated or reduced, which prevents reinfestation of the pastures. The trend will be increased with the extension of dipping services in the higher potential areas.

The serological results from wild ruminants and rodents show that they are not involved in the maintenance cycle for NSD virus. The low titre positives to NSD in the wild ruminants are considered to be cross reactions with antibody to other arboviruses with which NSD is related. None were positive on CFT and the titres were low on FAT and IHA tests. Had there been specific antibody to NSD, at least one of the 23 sera might have shown a higher titre. The possibility that they are low titre specific reactions to NSD virus cannot be completely rejected however.

The different age groups in an area where NSD is enzootic show similar proportions with antibody to NSD, and confirm the high challenge rate with NSD virus. The presence of such a high challenge with louping ill, which is a tick-borne virus disease of sheep with which NSD might reasonably be compared, was considered by Smith *et al.* (1964) to create a situation where there was little or no clinical disease. An experiment carried out recently by Reid & Boyce (1976) with this virus, has shown that lambs with maternal antibody do not develop clinical disease on challenge and generally show an active immune response. A similar immunity is probably developed by the young sheep and goats in an NSD enzootic area.

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