Medical and Veterinary Entomology (1999) **13**, 333–335

SHORT COMMUNICATION

Heterogeneity in the risk of sleeping sickness in coffee and cocoa commercial plantations in Ivory Coast

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Key words. *Glossina palpalis palpalis*, human sleeping sickness, tsetse spatial distribution, epidemiological risk, land use, Ivory Coast.

Since 1945 in the forest area of Ivory Coast, human sleeping sickness due to *Trypanosoma brucei gambiense* (Dutton) has been continuously associated with the development of coffee and cocoa plantations. However, the studies in progress in the Département des Sciences Humaines Appliquées à la Santé of the Institut Pierre Richet show that the disease distribution is highly heterogeneous. Thus, sleeping sickness has always been sporadic in regions like Gagnoa, where agricultural forest development was achieved by large-scale commercial methods. By contrast, in the region of Daloa for instance, where there are small-holder plantations, the prevalence of the disease has always been high. These significant differences suggest that land use has a direct impact on sleeping sickness prevalence and incidence (Hervouët, 1992).

Zoukougbeu, which is an active focus of sleeping sickness, is located at 30 km on the western side of Daloa, between 6°05′ and 7° North, and between 6°50′ and 7°10′ West. Between April and June, there is a major rainy season, followed by a short dry season in July. The minor rainy season occurs in September and November and the long dry season occurs from December to March. The ombrophilic forest has mostly disappeared but remains in the centre western region. Coffee and cocoa small-holder plantations mainly prevail but there are also some commercial plantations where no sleeping sickness case has ever been detected.

In contrast with the rest of the area, the northern part of the Zoukougbeu focus is characterized by the presence of large agricultural developments all in one block. This is the case with the Tonykro plantation (130 ha) where coffee and cocoa plantations represent 19% and 16% of the whole area, respectively (Fig. 1). These plantations are located along the two main tracks of the area, although the forest reserves and the wastelands are found close to the inland valleys. At the cross-tracks, there is a settlement occupied by ten seasonal workers. The next Siluekro plantation covers 80 ha, with 19.5% of coffee plantations and 18% of cocoa plantations. The remains of the development comprises orange and kola trees together with wastelands. There is no forest reserve. Ten seasonal workers also live in this settlement. By contrast with Tonykro, many tracks cross the Siluekro plantation, used for agricultural activities and also for the movements of people living in the adjacent settlements.

Entomological surveys of two commercial plantations evaluated the epidemiological risk of sleeping sickness. Tsetse (Diptera: Glossinidae) were caught in November 1997, at the end of the short wet season, with 28 Vavoua traps (Laveissière & Grébaut, 1990): 15 in the Tonykro plantation and 13 in the Siluekro plantation (Table 1; Fig. 1). The placement of the traps was determined to evaluate the human–vector contact with regard to the spatial and temporal distribution of the agricultural activities. Thus, sites regularly frequented by humans (type 1) were distinguished from sites frequented before the catches (type 2), sites frequented during the catches (type 3) and sites not yet frequented (type 4) (Table 1). The environment of the traps was also noted.

The traps were operated 4 days continuously at each site. Tsetse were removed daily between 14.00 and 18.00 hours. They were identified and then counted according to sex, to evaluate the apparent densities per trap per day (ADT). The tsetse of the subspecies *Glossina palpalis palpalis* (Robineau-Desvoidy), the only vector of sleeping sickness in the Ivorian forest area, were dissected to determine the teneral female rate (Challier, 1965), as well as the survival rate (Challier & Turner, 1985). The bloodmeals were analysed to identify their origin (Diallo *et al.*, 1997). The epidemiological risk index was calculated using the method of Laveissière *et al.* (1994).

All the tsetse caught were *G. p. palpalis* with on average 0.3 fly/trap/day. In the Tonykro plantation, the averaged ADT was 0.2 fly/trap/day, although it was significantly higher in the Siluekro plantation with 0.4 fly/trap/day ($t = 25.6$; d.f. = 56; $[t\alpha/2] = 2.005$). The relative densities varied substantially according to the location of the traps (Fig. 1).

In the Tonykro plantation, the tsetse were more abundant near the track going to Belle-ville. The presence of the

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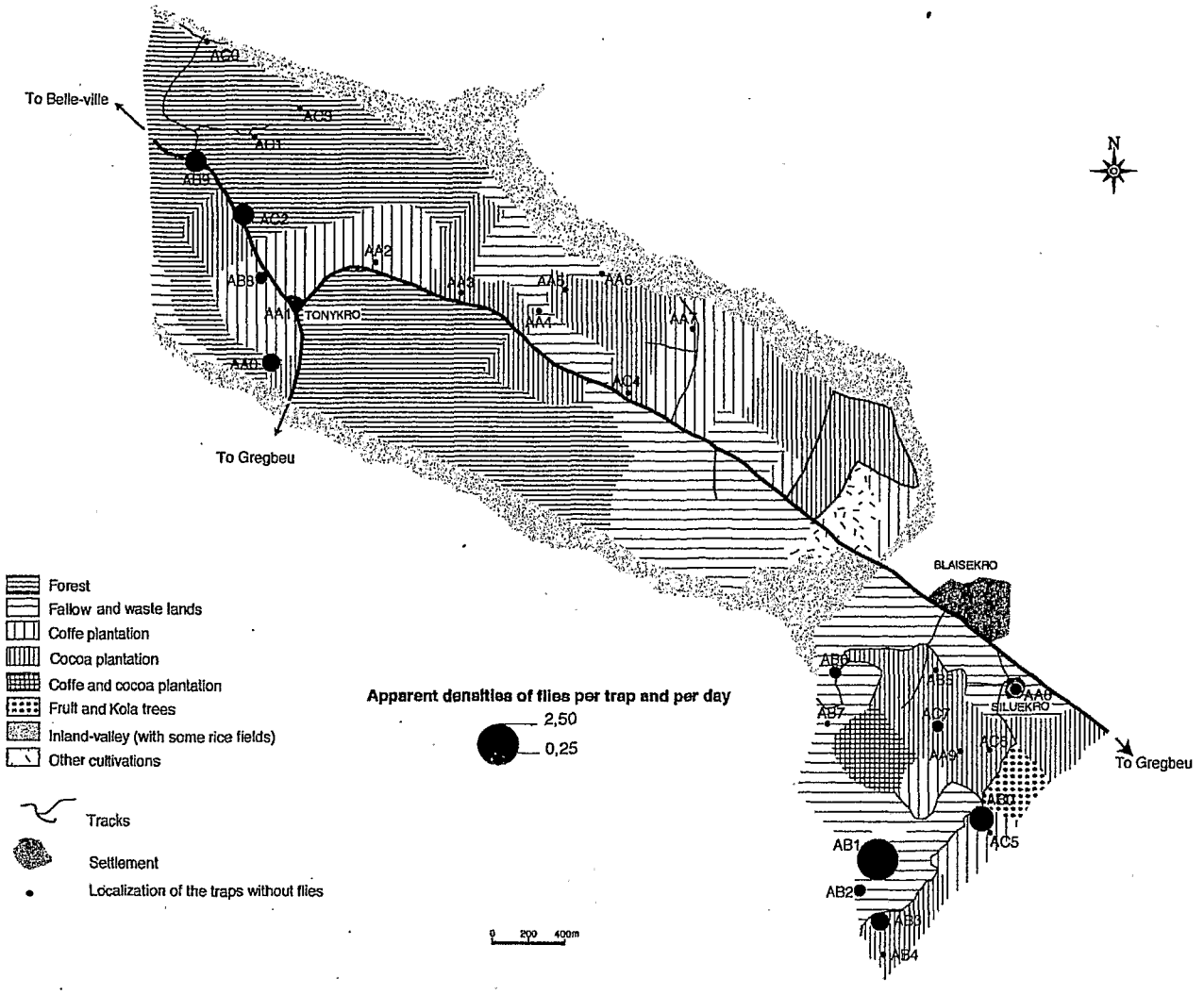

Fig. 1. Apparent densities of *Glossina palpalis* in the study area.

workers near trap no. AA6 did not seem to attract the flies. In the Siluekro plantation, the flies were also more abundant close to the tracks. They were found at trap no. AB0 where coffee and cocoa were harvested during sampling. In the areas frequented by the workers before sampling, the flies were found only close to trap no. AC7. The rate of teneral females was 4.8%, suggesting that the sites of sampling were not reproduction sites. This was confirmed by the statistically higher abundance of the females ($\chi^2 = 6.5$; d.f. = 1; $P = 0.01$). As no human blood-meal was identified, human–vector contact seemed to be low and the epidemiological risk of transmission could be considered as nil in the two plantations.

Our results support the hypothesis that land use has an impact on the distribution of sleeping sickness. The commercial plantations did not appear as risk areas. The human–vector contact was low, although the entomological survey was done during the harvest period which usually brings many people to the plantations.

The circulation of the workers in the plantations did not seem to affect the presence of the tsetse: the relative density of the tsetse was high especially in the regularly visited sites such as tracks or water holes (type 1). However, differences were observed between the plantations which may be associated with the opening of space. Thus, the Tonykro plantation may be considered as a socially closed space; only agriculture providing regular human presence. The Siluekro plantation is a more socially open space; the tracks are used by both the workers and outsiders, increasing the human presence in the space.

In contrast, when population and settlement densities induce a high human mobility, as in the small-holder plantations area, the sleeping sickness risk is increased (Koné *et al.*, 1998). Thus, in both the Nouroulaye and the Bahigbeu II areas, which

Table 1. Environmental characteristics of the traps.

Tonykro plantation			Siluekro plantation		
No. traps	Environment[1]	Human frequenting[2]	No. traps	Environment	Human frequenting
AA0	WH/CC	1	AA8	SET/Forest/CC	1
AA1	SET/CF	1	AC6	CC	2
AA2	Track/CF	3	AA9	WH/Forest	1
AA3	Track/CF	3	AB0	Track/CF	3
AA4	Track/CC	1	AC5	CF	3
AA5	Track/CC	1	AB1	TIV/CF	1
AA6	CC	2	AB2	Track	1
AC4	Track	1	AB3	CF	1
AA7	TIV/CC	1	AB4	Track	1
AB8	Track/CF	4	AB5	Track	1
AC2	Track/Forest	4	AC7	CC	2
AB9	Track	1	AB6	Track/CC	1
AC0	TIV/WL	1	AB7	TIV/CC	1
AC1	CC	1			
AC3	CC	1			

[1]WH, water hole; CC, cocoa; SET, settlement; CF, coffee; TIV, track in inland valley; WL, wasteland.
[2]1, regularly human-frequented; 2, frequented before catches; 3, frequented during catches; 4, not yet frequented.

were identified as risk areas, epidemiological risk indices were 9.93 and 8.62, respectively.

The risk of sleeping sickness development seems to be reduced since the activities are undiversified and the human displacements are only governed by agricultural developments. Consequently, the expression of the disease appears to be linked to the land use and it is then understandable that some regions may escape sleeping sickness.

Acknowledgement

This study has been supported by the Fonds d'Aide à la Coopération for the control of Trypanosomiasis (Ministère de la Coopération Française).

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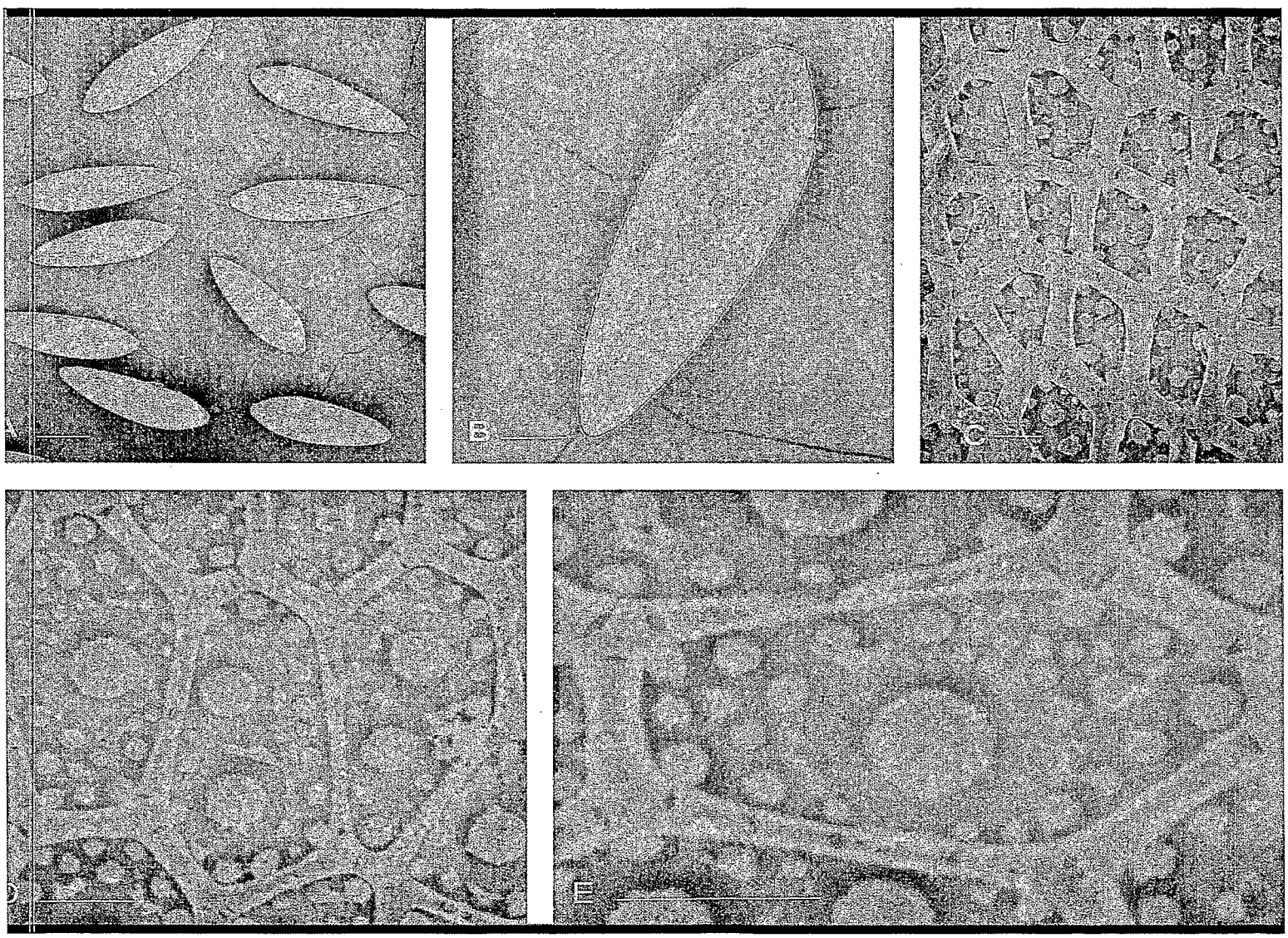
Accepted 26 November 1998

Volume 13 • Number 3 • July 1999

ISSN 0269-283X

Medical and Veterinary Entomology

Editors: G. B. White (Medical) and R. Wall (Veterinary)



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