Effect of Attraction Factors on the Sampling of *Chrysops silacea* and *C. dimidiata* (Diptera: Tabanidae), Vectors of *Loa loa* (Filaroidea: Onchocercidae) Filariasis

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ABSTRACT The effects of fire and human host density on *Chrysops silacea* and *C. dimidiata* abundance and age structure was evaluated at sites of *Loa loa* filariasis transmission in the Congo rain forest. Fire increased the catch of *C. silacea* 8.5-fold at ground level and 5-fold in the canopy, but did not modify the catch size of *C. dimidiata*. Catch size increased 2-fold when a pygmy camp located near the collecting station was inhabited. The presence of fire did not alter the parity and *Loa loa* infection rates in the populations.

KEY WORDS Insecta, *Chrysops silacea, Chrysops dimidiata,* attraction factors

DURING INVESTIGATIONS INTO the effects of human density on the biting rates of *Chrysops silacea* (Austen) and *C. dimidiata* (Van der Wulp), Gordon et al. (1950) demonstrated that although the tabanids were attracted from the forest canopy to ground level by the movement of people, they bit immobile subjects. In addition, biting rates increased markedly when baits were situated near fire (Duke 1955a), which contrasts most blood-sucking insects that are repelled by smoke of a wood fire. Subsequent studies incorporated these findings, particularly fire, in tabanid-sampling protocols (Duke 1959, Noireau et al. 1990a). However, the effects of these factors on the age and infection status of the attracted *Chrysops* has not been compared with the natural population. We report here on the effects of fire and human density on the composition of captured *Chrysops* populations and discuss their effects on host-seeking behavior.

Materials and Methods

Study Area and Collecting Sites. Two locations in the forested Chaillu Mountains of the Congo (medium altitude, 400–600 m) were chosen for study. *Loa loa* (Guyot) filariasis is hyperendemic in this region (Noireau et al. 1989). The first location was in the primary forest, 4 km from all human habitation and south of the River Lekoumou, near Missama village (03°36′ S–13°18′ E; altitude, 470 m). The tabanids were collected simultaneously on a platform built 26.5 m aboveground in the forest canopy, and at ground level under the forest canopy. The second location was situated within a pygmy hunting camp (Moutalango) situated in a clearing 3,600 m² (03°18′ S–13°17′ E; altitude, 360 m), north of the River Lekoumou. This forest camp was inhabited periodically by ≈30 pygmies.

Studies on *Chrysops*. *Chrysops* flying near or landing on humans were collected with a net during the rainy season from March to May 1989. Sampling was restricted to between 0600 and 1900 hours, because anthropophilic *Chrysops* were inactive at night (Duke 1960). The tabanids were kept in test tubes, identified, and counted. The attraction of a small fire, formed from two or three tree branches, was studied at location 1. Collectors on the ground and on the platform first caught *Chrysops* for 3 d without a fire and then caught flies for 7 d with a fire (fires were made on both the ground and on the platform). At location 2, tabanids were collected during 10 consecutive d at ground level by two collectors situated near a fire. The pygmies, who lived in the camp for the previous month before the sampling, were present in the clearing for the first 5 d, but were absent for the subsequent 5 d. *Chrysops* abundance was transformed by $\log_{10}(x + 1)$ and the geometric mean number of tabanids captured per person per hour was calculated.

The age composition and *L. loa* infection status of the tabanid populations were determined for a representative sample of *Chrysops* using the method of Duke (1960). Only parous females were examined for *L. loa* infection and all larval stages were combined to calculate the fly infection rates.

Results

A total of 3,275 (96.6%) *C. silacea* and 114 (3.4%) *C. dimidiata* were caught within 250 h at location 1. When there was no wood fire, *C. dimidiata* accounted for 19.1% of the catch at canopy level,

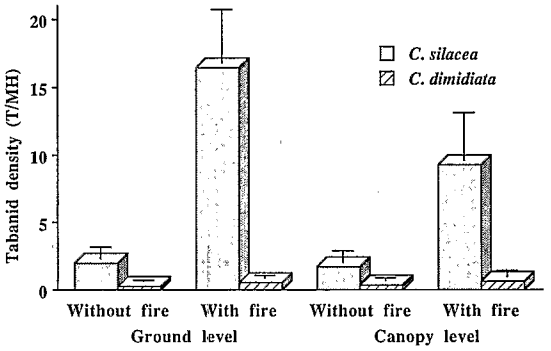

Fig. 1. Effect of fire at ground and canopy level on the geometric mean density of *C. silacea* and *C. dimidiata* captured per person per hour in the Missama forest. Bars represent SEM.

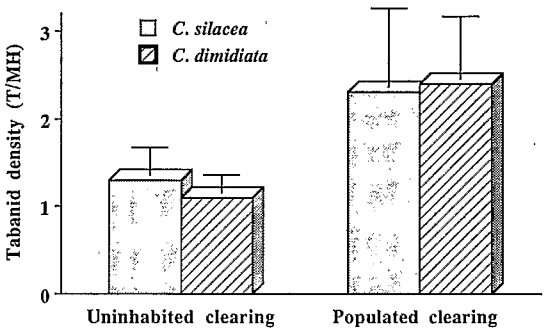

Fig. 2. Effect of habitation of a pygmy camp adjacent to a collecting station on the geometric mean density of *C. silacea* and *C. dimidiata* captured per person per hour in the clearing of Moutalango. Bars represent SEM.

compared with 5.7% on the ground ($\chi^2 = 5.2$, $P < 0.05$). Fig. 1 shows the effects of fire on *Chrysops* abundance. In the presence of fire, *C. silacea* catch increased 8.5-fold at ground level ($t = 4.89$, $P < 0.01$) and 5-fold at 26.5 m ($t = 3.42$, $P < 0.01$). Only a small number of *C. dimidiata* was collected, and fire seemed to be less of an attraction for this species (unchanged abundance at ground and at 26.5 m).

In the Moutalango clearing (location 2), a total of 559 (49.2%) *C. silacea* and 578 (50.8%) *C. dimidiata* were caught during 225 h of collecting. As shown in Fig. 2, the tabanid abundance increased by 1.8-fold for *C. silacea* ($t = 2.42$, $P < 0.05$) and 2.1-fold for *C. dimidiata* ($t = 4.16$, $P < 0.01$) when the camp was inhabited.

Parity and infection rates of *Chrysops* populations caught with or without fire (location 1) or extra hosts (location 2) are shown in Table 1. Despite a small number of tabanids being dissected, the presence or absence of smoke did not seem to modify the composition of the *Chrysops* populations at location 1. When the pygmy camp was uninhabited, the parity rate of the *C. silacea* population decreased from 16.4 to 9.8% ($\chi^2 = 4.33$; $P < 0.05$) but did not affect the *C. dimidiata* population at location 2. Although the infection rate of *C. silacea* decreased from 3.5 to 1.5%, it was not significantly modified by the departure of the pygmies.

Table 1. Parity and *L. loa* infection rates in *Chrysops* species collected using different attractants

Sampling area conditions	No. dissected	Parous tabanids No. (%)	Infected tabanids No. (%)
C. silacea			
No fire	25	6 (24.0)	1 (4.0)
Fire	2,276	424 (18.6)	69 (3.0)
Populated clearing	318	52 (16.4)	11 (3.5)
Uninhabited clearing	194	19 (9.8)	3 (1.5)
C. dimidiata			
No fire	7	1 (14.3)	0 (0.0)
Fire	71	12 (16.9)	2 (2.8)
Populated clearing	352	54 (15.3)	6 (1.7)
Uninhabited clearing	166	17 (10.2)	1 (0.6)

Discussion

The attack rate of *Chrysops* on the human population is considerable (up to 25 tabanids captured per person per hour in some forest sites), and humans are the preferred blood meal hosts in the Chaillu region (Gouteux et al. 1989, Noireau et al. 1990a). In agreement with the results reported at ground level in Cameroon by Duke (1955a, 1959), wood fire increased the catch of *C. silacea* 8.5-fold in the present study. In the canopy at 26.5 m above ground level, the increase in the catch of *C. silacea* in the presence of fire was only 5-fold, again corroborating the results of Duke (1955a), which demonstrated that the attractiveness of fire decreased with height increase in the canopy. The attraction to fire may be related to the diffusion of odorous molecules other than CO_2 contained in the smoke in the canopy (Duke 1955a, Fain 1978). The physical properties of the fire such as color and the flickering of flames apparently have no attractive effect (Connal & Connal 1922). In addition to fire, visual stimuli produced by the number and movement of humans also may attract *Chrysops* from the canopy to the ground (Connal & Connal 1922, Gordon et al. 1950, Duke 1955b). As reported by Duke (1959), this visual attraction to humans appears to be less than that of a wood fire. Thus, the marked anthropophilic nature of *C. silacea* and *C. dimidiata* suggested by Davey & O'Rourke (1951) and confirmed by the analysis of blood meals (Gouteux et al. 1989) may be related to the presence of fire. However, it has been demonstrated recently that only a small proportion of the *Chrysops* population attracted to fire actually bite humans (Noireau et al. 1990b). Fire essentially attracted non-

starved tabanids, and host-seeking *Chrysops* would fly to ground level independently of the presence of fire (F.N., unpublished data). The maintenance of several wood fires in the villages during the day would account for the presence of tabanids, whereas this open environment was generally unfavorable for their survival (Duke 1955c). Although the presence of fire increased catch size, it did not affect the physiological age or the infection rate of the tabanids collected. More parous and infected *Chrysops* were collected when a group of individuals resided near the collection station. Therefore, using both fire and a large number of collectors may increase considerably the number of tabanids collected.

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