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A method for the assessment of blackfly (Diptera: Simuliidae) attraction to and engorgement on sheep in South Africa

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ABSTRACT

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A suspended-net technique was used to capture blackflies attracted to and engorging on Dorper and Merino sheep on irrigated pastures. Two bait animals of each breed were restrained individually in wire-mesh enclosures located within four larger pens, each containing nine more animals of the same breed. Nets were suspended partly over the restrained animals and blackflies were collected at the end of 2-hour or longer periods. Mean numbers of blackflies captured in association with Merino (73,3/h) and Dorper sheep (89,1/h) did not differ significantly. Numbers of captured blackflies correlated (rho = 0,8361) with levels of irritation shown by sheep. Engorgement on Merinos was significantly ($p = 0,009$) higher than on Dorpers. Percentage engorgement was low, mostly below 10% on Merinos and below 5% on Dorpers. When high wind speeds and high saturation deficits (associated with temperatures in the mid-thirties) occurred, the success of capture was impaired. The technique is useful for quantifying the abundance of irritating blackflies in the immediate proximity of smallstock under experimental conditions.

INTRODUCTION

Much of the research on Simuliidae in South Africa concerned the water phase of the life cycle (*cf.* Chutter 1972; O'Keeffe 1985; De Moor, Chutter & De Moor 1986) and control measures directed against the water-dependent larval and pupal stages (Howell & Holmes 1969; Howell, Begemann, Muir & Louw 1981; Car 1983, Car & De Moor 1984). An estimate of annoyance of livestock, caused by adult Simuliidae, was published by Jordaan & Van Ark (1990). This extensive survey, which provides useful information on the general trends of blackfly activity along the lower Orange River, is based on an analysis of questionnaires to stock farmers and did not involve any direct trapping of blackflies attracted to livestock. In the present study a trapping method for the assessment of blackfly activity directly associated with sheep was tested.

Service (1987) reviewed methods for the collection of adult blackflies. In some of these methods live hosts are used as an attractant and McCreadie, Colbo & Bennett (1984) assigned such methods to three categories, namely (a) those in which flies are collected directly from the host and those in which nets are used, either (b) as enclosed structures into which flies must enter or (c) as suspended structures which

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are periodically lowered to capture flies. The trap described by McCreadie *et al.* (1984) for the collection of various hematophagous Diptera, falls into the last category, although it differs in that the net is not suspended above the host animal, but is folded on the ground to avoid the possible negative influence of a suspended net, which may deter host-seeking insects because of its visibility. The sheep-baited trap tested during the present study was a suspended-net trap designed to collect blackflies over an extended period rather than capture only those present on and around the host during the specific period when the net was lowered.

The technique described will enable researchers to quantify blackfly attraction to and engorgement on smallstock. The method will also be useful in efficacy tests of insecticides intended to reduce levels of irritation and tissue damage caused to smallstock by blackflies.

TABLE 1 Simuliidae were captured in nets suspended above Merino (M) and Dorper (D) sheep for varying periods and at different times between 8 November and 13 December 1991

Date	Time	Duration (h)	No. captured/h	
			M [a]	D [b]
8 Nov.	12:00–18:00	6,0	6,67	8,17
9 Nov.	09:00–14:00	4,5	0,44	2,44
27 Nov.	11:00–18:00	7,0	144,60	32,00
28 Nov.	09:00–14:00	5,0	73,60	45,40
29 Nov.	08:30–10:30	2,0	164,50	102,00
29 Nov.	11:00–13:00	2,0	385,00	237,00
12 Dec.	10:30–12:30	2,0	196,00	320,50
12 Dec.	13:30–15:30	2,0	59,00	49,00
12 Dec.	16:30–18:30	2,0	10,00	8,50
13 Dec.	08:30–10:30	2,0	24,50	52,00
13 Dec.	11:00–13:00	2,0	2,50	8,50
13 Dec.	14:00–16:00	2,0	2,50	3,50

[a] Merino sheep
[b] Dorper sheep

MATERIALS AND METHODS

Location

Trials were conducted during November and December 1991 on the farm "Bakgat" (29°35'S/24°00'E) in the Hopetown district, approximately 3 km from the Orange River and 10 km north-west of Hopetown. The farm has a known history of Simuliidae attacks on livestock. Experimental animals were kept in an irrigated paddock with tall fescue grass for the duration of the trials.

Animals

Twenty Dorper and 20 Merino sheep, 5–8 months old with full wool growth, were used in the trials. Only wethers were used so as to ensure homogeneity of experimental animals.

Trial conditions

The sheep, breeds separated, were divided randomly into four groups of ten animals each. The groups were confined separately in wire-mesh pens (120 m^2), erected alongside each other. In each pen one sheep, chosen at random, was restricted inside a small (1,2 m^2), circular, square-mesh (openings 10 x 20 cm) wire enclosure. A cylindrical (diameter 1,2 m), fine-mesh (apertures 0,25 x 0,50 mm) net, made of soft material, was suspended above and partly over the wire enclosure. The lower edge of the net was secured at a height of 600 mm above the ground, which is approximately equal to that of the animal's head (Fig. 1).

Observations

At the end of each period of observation, which varied from 2–7 h (Table 1), the lower edges of the nets were lowered manually to ground level, and captured Simuliidae, which had accumulated inside the nets, were collected with a hand-held suction device. Samples were stored in a deep-freeze at –18 °C. Simuliidae were later counted and dissected to determine percentage blood feeding.

The degree of irritation to experimental animals, excluding the individual animals under the nets, was quantified, at 5-min intervals, by counting, for a period of 15 s, the number of individuals which displayed any form of behaviour indicating possible irritation. These were mainly head and ear shaking, feet stamping and scratching. Some degree of bunching together and attempts to hide their heads were observed, but not recorded separately since this confirmed, but did not supplement, the recordings of irritation. Observations on irritation levels were transformed to hourly means and expressed as percentages.

Air temperature and relative humidity (RH), in a Stevenson screen at standard height, were recorded at 10-min intervals by means of an MCS data logger. Saturation deficit was calculated by the formula [SVP–(RH x SVP)/100] x 0,133323, where SVP = saturation vapour pressure in kPa. An anemometer was used to record wind speed at 10-min intervals.

RESULTS

Numbers of Simuliidae [mainly *Simulium (Metomphalus) chutteri* Lewis, but also some *S. (Afrosimulium) gariepense* de Meillon] captured in nets suspended above restrained sheep, did not differ significantly (t-tests) within breeds and the two samples for each

FIG. 1 An experimental animal restricted in a small, circular, wire-mesh enclosure with a fine-mesh net suspended above, and partly over, the wire enclosure

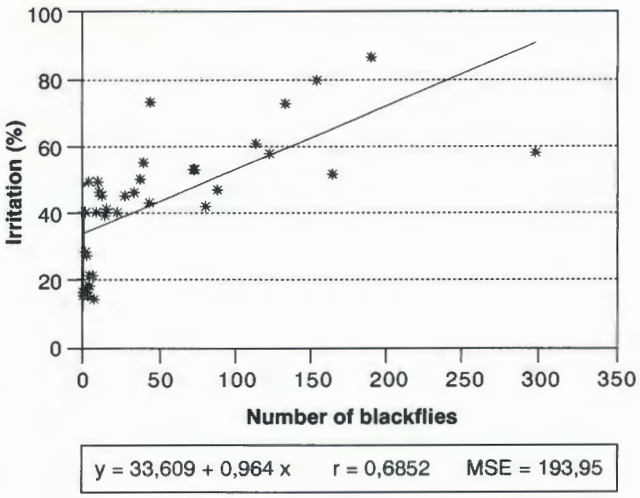

FIG. 3 The relationship between level of irritation and number of blackflies captured

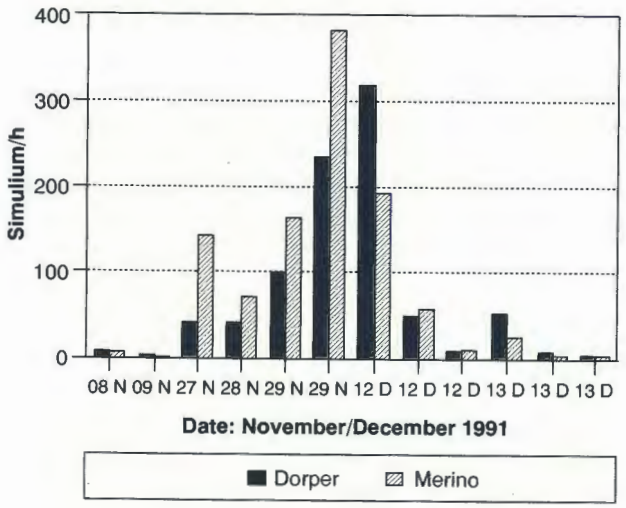

FIG. 2 Histogram showing numbers of Simuliidae captured per h in nets suspended above Dorper and Merino sheep between 8 November and 13 December 1991. Each bar represents the mean of two samples

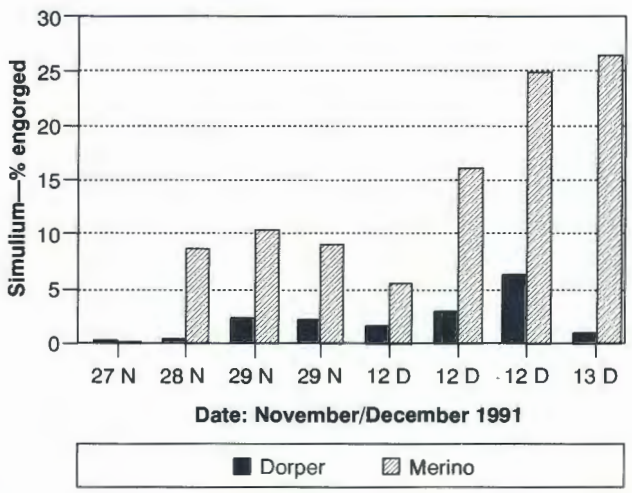

FIG. 4 The percentage engorgement of Simuliidae captured between 27 November and 13 December 1991 in nets suspended above Merino and Dorper sheep. Mean difference = 10,48. Highly significant, p = 0,0091 (paired two-tailed t-test)

breed were therefore pooled. Mean numbers of Simuliidae captured per h were generally low, between less than one and 385 (Fig. 2), and mean numbers captured in association with Merino (73,3) and Dorper sheep (89,1), did not differ significantly (paired two-tailed t-test; p = 0,4373). The largest numbers of blackflies were captured during the period 27 to 29 November and on the morning of 12 December (Fig. 2). The numbers of captured blackflies correlated with the levels of irritation (Fig. 3). The correlation coefficient rho = 0,8361 (Spearman's rank correlation, used because irritation was measured on an ordinal scale). Some degree of irritation was recorded even when no blackflies were captured, as the sheep were hardly ever completely without movement.

The catch size did not correlate with the meteorological data available. Although low catch sizes occurred during periods of high wind speeds (above 10 km/h), and also at high saturation deficits (above 4 kPa) associated with temperatures in the mid-thirties, both wind speeds and saturation deficits were mostly of an order apparently well tolerated by the blackflies. Flies captured inside nets were adversely affected when exposed to high saturation deficits and high wind speeds for extended periods. Samples were therefore collected every 2 h during the latter part of the investigation (*cf.* Table 1).

To determine percentage engorgement on blood only eight samples (*cf.* Fig. 4) were taken into account, since total numbers of flies captured in the remaining samples were very small (*cf.* Table 1). Engorgement on Merinos was significantly ($p = 0,009$) higher than on Dorpers (Fig. 4). The percentage of engorgement was low, mostly below 5 % on Dorpers and below 10 % on Merinos, although higher percentages were recorded for the Merinos, but only in some of the smaller samples (*cf.* Fig. 4 and Table 1).

DISCUSSION

Despite the low numbers of blackflies captured during the study, there was a positive correlation between catch size and level of irritation to animals. The latter was used as a measure of relative abundance of simulids, and the findings indicate that the method used can give reliable estimates of the abundance of those blackflies directly responsible for irritation of livestock. The trap was constructed to capture that proportion of blackflies, attracted to the sheep, which flew directly or diagonally upwards on leaving the immediate vicinity of the restrained animal. Once inside the net, the Simuliidae moved upwards, a behaviour known for many insects, and used also in traps such as the Malaise trap. It was necessary to collect simulids at regular intervals to avoid possible adverse effects of extended exposure to unfavourable environmental conditions. Under such conditions counts may become unreliable owing to blackfly mortality, or blackflies may become exhausted, move downwards and escape from the opening at the base of the net.

The effects of meteorological factors on simulid activity are well documented (*cf.* McCreadie, Colbo & Bennett 1986; Shipp, Grace & Janzen 1988; Fredeen & Mason 1991). Blackfly catches could not be correlated with meteorological factors during the present study, but it was shown that when high values of wind speed or saturation deficit were registered, very low numbers of Simuliidae were captured in the nets. This was evident especially during certain periods of observation on 12 and 13 December when such factors apparently contributed to the small catches.

The percentage of captured flies that were fully engorged on host blood was generally low. McCreadie *et al.* (1984) recorded, for the most part, between 24 and 69 % of blood-engorged Simuliidae in their cattle-baited traps in Newfoundland. The fact that they allowed captured blackflies a feeding period of ten min after closure of the nets, would account at least partly for their greater success in this regard. Since blood feeding would be an important measure of the efficacy of chemical formulations intended to act as repellents, this aspect of the trapping method described here, needs further investigation.

McCreadie *et al.* (1984) referred to the possible deterrent influence which a suspended net might have on the trapping of Simuliidae attracted to live bait. Sutcliffe (1986) reviewed the factors influencing host location and pointed out the importance of olfactory and visual cues. These may act over fairly long distances, especially in open country, but become more important over short distances and during the landing of flies on a host. According to Sutcliffe (1986) surface area, and not overall silhouette shape, influences attraction most at close range. The net used during the present study was suspended at a height selected to ensure the exposure of a large area of the bait animal. The large mesh size of the wire enclosure in which the animal was restrained was chosen so as to have little effect on silhouette shape and exposed surface area. Furthermore, the attraction of blackflies did not depend on the single restrained sheep only, but was effected by the whole group of sheep in the enclosure. During most of the time at least some of the sheep were in close proximity to the restrained sheep, so that blackflies would react to all sheep in the group, including the restrained one, in a similar way.

Despite some problems with the trapping method, the method is considered to be useful for quantifying the abundance of irritating blackflies in the immediate proximity of livestock. As such the method can be invaluable in studies on the role of environmental factors in blackfly activity and the efficacy of protective insecticides.

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