Feeding and Defaecation Patterns in *Triatoma sordida*

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Triatoma sordida *is a peridomestic Triatominae that could play an important role in the transmission of* Trypanosoma cruzi, *although its vectorial competence is not well known. The aim of this work was to evaluate two aspects of the vectorial competence: the feeding behaviour and defaecation patterns, and to compare them with* T. infestans. *The feeding and defaecation patterns were studied in adults and fifth instar nymphs of* T. sordida *fed* ad libitum *on a restrained pigeon. The results showed how the blood meal size controls excretion behaviour. Blood intake and time to first defaecation showed a significant negative correlation. Adults and nymphs frequently defaecated during the blood meal, reaching the maximum frequency within the first 10 minutes.*

Key words: *Triatoma sordida* - feeding - defaecation - peridomestic

Among peridomiciliary vector species of Chagas disease, *Triatoma sordida* is showing increasing importance as a potential vector. In Brasil, *T. sordida* has been found invading houses from which *T. infestans* had been eliminated by insecticide spraying (Freitas et al.1960, Forattini et al.1982, 1983, 1984). Nymphal instars of *T. sordida* have been found in human dwellings in Argentina (in the provinces of Corrientes, Chaco and Santa Fe), indicating domiciliary colonization behaviour (Carcavallo et al.1988).

These observations allow us to presume that *T. sordida* could play an important role in the transmission of *Trypanosoma cruzi* to man. However, there is no knowledge about how competent *T. sordida* is in the transmission of this parasite. Vectorial competence was defined by WHO (1983) as the species physiological ability to develop and to transmit a pathogenic agent. In Triatominae, the feeding habits and defaecation patterns are important among these abilities and differences between species may indicate differences in competence in disease transmission.

In order to understand better the efficiency of *T. sordida* in *T. cruzi* transmission, the aim of this work was to evaluate the feeding and defaecation characteristics and to compare them with *T. infestans*, the primary vector of Chagas disease in Argentina and other countries of the Latin American southern cone.

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MATERIALS AND METHODS

This work was carried out with adults and fifth instar nymphs of *T. sordida*, provided by the Servicio Nacional de Chagas (Argentina). The insects were maintained in the laboratory at 27 ± 1ºC and 60-70% humidity.

The insects were starved for 15 days after moulting and marked with acryllic paint on their thorax and/or tergites. After fasting, they were fed on a restrained pigeon. Each insect was observed continuously during feeding and for 10 min afterwards. For each feeding the following variables were obtained:

Blood meal size: as females and nymphs generally defaecate during feeding or within 10 min after feeding, the weight of the excreted faeces was included in the calculation of blood meal size (BMS):

$$BMS = (AF - BF) + Wf$$ where,

AF: insect weight (mg) 10 min after feeding
BF: insect weight (mg) before feeding
Wf: faeces weight (mg) excreted during feeding or within 10 min after feeding. The faeces were collected with microhaematocrit capillaries. These tubes were weighed without faeces and with the faeces to calculate the faeces weight. All the weights were measured using a Mettler balance with a precision of 0.01 mg.

Attack time: time (in seconds) since the insect was placed on the host until it began to feed was timed with a stopwatch.

Feeding time: was the time (in minutes) since the rostrum of the insect contacted the host skin until it detached the rostrum. This time represents the minimum contact time between vector and host.

Number and volume of defaecations emitted by the insect during feeding and within 10 min after

feeding: the number of defaecations was registered by direct observation. In order to obtain the volume of the defaecations the microhaematocrit capillaries were previously calibrated in µl. Immediately after feeding each insect was transferred to a Defaecation Frequency Recorder (DFR) (Zarate et al. 1984, modified to allow 24 hr registration), that permitted recording of the defaecations emitted in the 24 hr after feeding (Fig. 1).

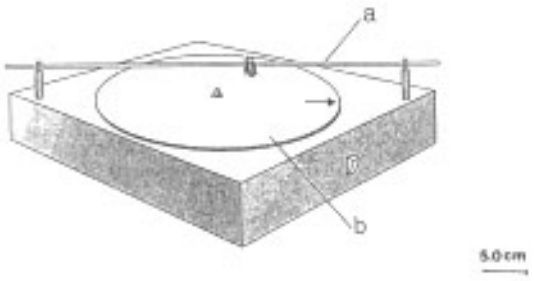

Fig.1: defaecation frequency recorder. a: stationary bar for positioning bugs; b: the platform is covered with filter paper and rotates once every 24 hr to collect faecal spots.

In order to compare the excretion data with those obtained for *T. infestans* by other authors, the Defaecation Index of Zeledon et al. (1977) was used:

$$DI = \frac{A \times B}{100}$$

where

A: percentage of insects that defaecated within 10 min after feeding

B: average number of defaecations by the insect emitted within 10 min after feeding.

To compare the meal size between nymphs and adults of *T. sordida* with those of other species having different body sizes, a relative meal size index (RMS, relating meal size with insect weight before feeding) was obtained

$$RMS = \frac{\text{meal size (mg)}}{\text{insect weight (mg)}}$$

The results obtained for feeding habits were compared with data obtained for *T. infestans* by other authors.

The Student t-test was used for comparison between means, and correlation between variables was carried out by standard liner regression.

RESULTS

Feeding patterns - Both nymph and adult *T. sordida* attacked the host soon after exposure, the females being the fastest (Table I). No significant relationship was found between attack time and insect weight before feeding either for nymphs or adults.

The BMS and the RMS were significantly higher in the fifth instar nymphs, which required more time to become completely engorged than adults. Females ingested significantly more blood than the males. Regression of BMS on insect weight before feeding showed significant negative correlation for females and males (FF $r = -0.43$, $n=40$, $p<0.0001$; MM $r = -0.32$, $n=51$, $P<0.0001$) (Fig. 2). No significant relationship was found between these variables for nymphs ($n = 66$, $r = -0.05$).

Defaecation patterns - The highest proportion of defaecations from the first 24 hr after feeding was emitted during the first 10 min (Fig. 3). Females and nymphs showed the highest percentages of insects defaecating while they were taking blood (Fig. 4). During the first 10 min after feeding the females defaecated more frequently and emitted urine drops much faster than males and nymphs (Table II). The volume of faeces emitted one hour after feeding, was significantly lower for males (4.0±1.9 µl) than for females or nymphs (8.7±7.7 and 7.9±7.0 µl respectively).

Blood meal size influenced the dejection emission time. Females that ingested 46.2mg or less and males and nymphs whose blood meals were equal to, or lower than 39.2 and 36.7mg respec-

TABLE I

Feeding pattern of adults and fifth instar nymphs of *Triatoma sordida*

Instar	n	Attack time (min)		Feeding time (min)		Blood meal (mg)		RMS[a]	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Females	49	1,6[b]	2,5	18,9[d]	10,6	91,1[d]	41,1	1,3[d]	0,8
Males	59	2,9[b]	2,5	22,5[d]	12,1	46,8[d]	17,2	0,9[d]	0,6
Nymphs	61	2,0[c]	3,1	33,7[d]	15,6	121,2[d]	73,0	4,1[d]	2,6

a: RMS relative meal size; *b:* females differ significantly from males ($p<0,001$); *c:* nymphs differ significantly from females and males ($p<0,0001$); *d:* significant differences between females and males and nymphs ($p<0,0001$); $\bar{x}$: mean; SD: standard deviation.

TABLE II

Defaecation pattern of fifth instar nymphs and adults of *Triatoma sordida*

Instar	Time first defaecation (min)		Defaecations per insect 10'		60'		24hr	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Females	1,0[a]	4,0	2,2[a]	1,6	2,9[b]	1,7	4,9	2,6
	n=49		n=15		n=16		n=15	
Males	4,3	9,5	1,0	0,3	1,5	0,5	2,0	1,1
	n=59		n=25		n=11		n=13	
Nymphs	6,1	10,2	1,2	0,8	2,3[b]	1,7	7,3[d]	5,1
	n=52		n=27		n=22		n=21	

a= females differ significantly from nymphs and males (p<0,0001); *b*= females and nymphs differ significantly from males (p<0,0001); *c*= males differ significantly from females and nymphs (p<0,0001); *d*= nymphs differ significantly from females and males (p<0,0001); $\bar{x}$= mean; SD= standard deviation; n= number of insects

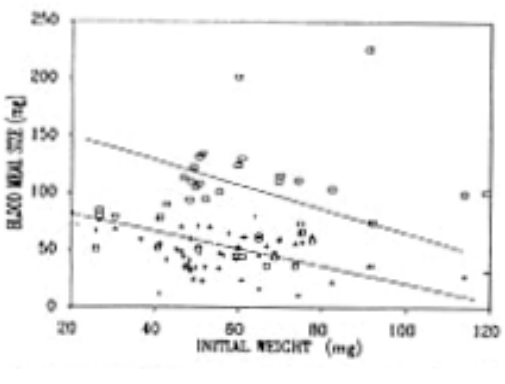

Fig. 2: relationship between insect weight before feeding (mg) and blood meal size (mg) in females and males of *Triatoma sordida*. (□) females y = 139.48 + 0.59x ; (+) males y = 64.15 + 0.30x.

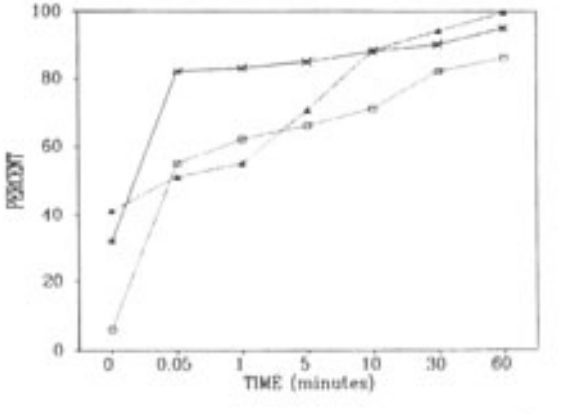

Fig. 4: accumulated percentage of insects which defaecated during feeding (time 0) and at different times afterwards nymphs ( ) females (X) males (□)

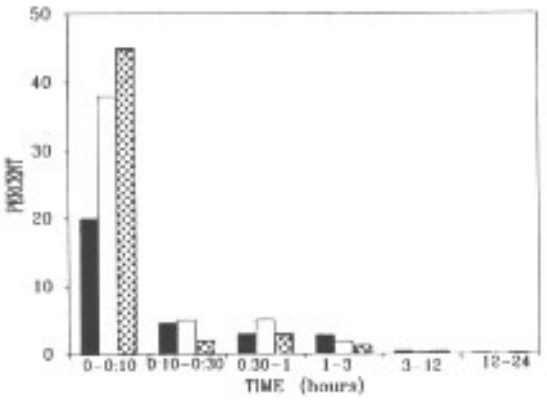

Fig. 3: percentage of defaecations emitted in 10 min within each time period by fifth instar nymph (■) , females (□) and males (□) of *Triatoma sordida.*

tively did not defaecate. For the insects that defaecated, the blood meal size was correlated with the time to first dejection in females (r = -0.64, n = 35, p<0.005) and nymphs (r = -0.64, n = 45, p<0.005). These relationships were significant (multiplicative model) and allow us to deduce that females must ingest more than 80 mg of blood and nymphs must ingest more than 60 mg in order to promote defaecation during feeding (Fig. 5).

The number and volume of the defaecations emitted during and immediately after the feeding also depends on the amount of ingested blood in females and fifth instar nymphs. In males, a significant relationship was not found.

DISCUSSION

The results obtained demonstrate that in *T. sordida* the blood meal size controls the excretion behaviour in the following way: (1) defaecation time is negatively correlated with the blood meal size; (2) the volume of emitted faeces is directly related to the blood meal size, and (3) the frequency of the emissions is also directly related to the blood meal size. The dependence of defaecation time on the quantity of blood ingested was also observed for *T. infestans* (Trumper & Gorla 1991) and *R. prolixus* (Kirk & Schofield 1987). The relation-

TABLE III

Feeding and defaecation behaviour of *Triatoma sordida* and *Triatoma infestans*

Species	RMS[a]			% insects[b]			index[c]		
	N	FF	MM	N	FF	MM	N	FF	MM
T. infestans	3,3[d]	1,1[d]	1,2[d]	3,3[e]	0[e]	0[e]	1,2[e]	1,0[e]	0,9[e]
T. sordida	4,1	1,3	0,9	41	88	71	1,0	1,9	0,7

a= RMS relative meal size; *b*= % of insects that defaecated during feeding; *c*= defaecation index; *d*=RMS were derived from Perlowagora (1973); *e*=percentage of insects that defaecated during feeding and the index were derived from Zeledón et al. (1977).

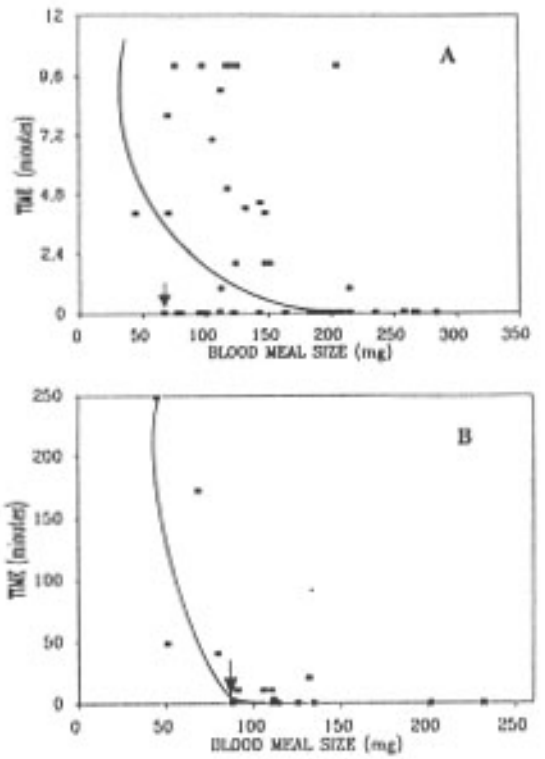

Fig. 5: relationship between time to first faecal drop and blood meal size in fifth instar nymphs (A) and females (B) of *Triatoma sordida*. Females $y = 34.10 \times ^{-7.55}$; nymphs $= 12.81 \times ^{-2.95}$

ship between these two variables shows a similar slope in the three species. A minimum blood meal of 80 mg was enough to produce defaecations during feeding on fifth instar nymphs of *T. sordida*,, while nymphs of *T. infestans* that took the same quantity defecated 15 min after feeding (Trumper & Gorla 1991).

The comparison of feeding and defaecation patterns observed here for *T. sordida*, and in *T. infestans* by other authors (Perlowagora 1973, Zeledón et al. 1977), shows that the females of *T. sordida* are the most efficient in terms of number of defaecations emitted (Defaecation Index, Table III).

The fifth instar nymphs of *T. sordida* had a greater relative meal size than *T. infestans* nymphs, ingesting up to four times the body weight. This is probably the reason for this species surviving more time under fasting conditions after a single meal (Perlowagora 1973, Juarez & Castro 1982). Moreover, nymphs and adults of *T. sordida* not only defaecate immediately after feeding, they frequently emit defaecations during feeding.

This work demonstrates that in adults of *T. sordida* the size of the blood meal depends on the nutritional status of the insects at the moment of feeding. This dependence is important when it is related with active dispersal. Studies have demonstrated that a low nutritional status determines the dispersive flight of the adults (Schofield et al. 1991). This means that adults of *T. sordida* with a low body weight are the insects that would disperse and try to establish a new population. The results obtained here, suggest that these insects would take blood meals greater than 100mg and would emit dejections immediately after a feeding. Also, they would show an increased frequency and volume of emitted defaecations and would consequently lead to a higher *T.cruzi* transmission risk.

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