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Flight and Nutritional Status of Sylvatic *Triatoma sordida* and *Triatoma guasayana*

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Nutritional status relating to flight activity was investigated in natural populations of Triatoma sordida and T. guasayana during the dry season in the Bolivian Chaco. The peak flight activity of both species was unimodal and covered the period 61-180 min after sunset. The weight of insects was used as the indicator of nutritional status. Interspecies comparisons employing the same sex and type of capture showed a higher weight for T. guasayana. No significant difference according to weight was observed between flying insects and those collected in natural ecotopes (hollow trees and bromeliads). More than 87% of insects collected from natural ecotopes displayed flight ability under the study conditions, explaining their tendency to invade artificial structures during the dry season.

Key words: *Triatoma sordida* - *Triatoma guasayana* - flight activity - nutritional status - Bolivia

Triatoma sordida Stal and *T. guasayana* Wygodzinsky and Abalos are closely related species of Triatominae (Hemiptera, Reduviidae) which are morphologically very similar, occupy a comparable variety of ecotopes, and their distribution overlaps throughout northern Argentina and parts of the Chaco region in Bolivia and Paraguay (Usinger et al. 1966, Schofield 1994). Although they are originally sylvatic species, they are frequently found in peridomestic habitats and have been reported from houses (Forattini 1980, Wisnivesky-Colli et al. 1993, Gajate et al. 1996, Noireau et al. 1998b). Owing to this trend toward domesticity, they may be considered as candidates domiciliary vector for Chagas disease.

Recent studies have shown a high level of genetic differentiation within *T. sordida* populations that might be compatible with biological species (Panzer et al. 1997, Jurberg et al. 1998, Noireau et al. 1998c). In the Bolivian Chaco, *T. guasayana* and two biological species pertaining to the *T. sordida* complex (named *T. sordida* groups 1 and 2) occur in sympatry (Noireau et al. 1998b). Al-

though *T. sordida* group 2 has not yet received formal recognition as a new species, it is considered in this report as a separate species.

In the sylvatic environment, *T. sordida* and *T. guasayana* are found in a wide variety of ecotopes: bird nests, hollow trees, under bark and among roots of trees, palm tree crowns, clumps of bromeliads and under rocks (Barretto 1971, Forattini et al. 1971a, Carcavallo & Martinez 1985, Diotaiuti et al. 1993). In the Bolivian Chaco, these species were principally collected in hollow trees and bromeliads (Noireau et al. 2000). In the Chaco region, adults of these species have a high potential for dispersal by nocturnal flight during the hot and dry months (August-November) (Wisnivesky-Colli et al. 1993, Noireau et al. 1998b). Studies applied to various triatomine species have shown that starvation was apparently the main cause of flight initiation (Sjogren & Ryckman 1966, Ekkens 1981, Lehane & Schofield, 1982, McEwen & Lehane 1993). Therefore the nutritional status may allow a prediction of the proportion of wild adults likely to fly (Lehane & Schofield 1982). With regard to *T. sordida*, the relationship between flight initiation and nutritional status was previously studied: the proportion of insects initiating flight declined with increasing weight-length ratio and this species showed a much higher propensity for flight than did *T. infestans* (Schofield et al. 1991, McEwen & Lehane 1993). Nevertheless, no study has examined *T. guasayana* which may have a greater flying capacity than *T. sordida* (Abalos & Wygodzinsky 1951, Wisnivesky-Colli et al. 1993). The present study was designed (i) to compare the nutritional status of populations of *T. sordida* and

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T. guasayana collected during flight activity and in natural ecotopes and (ii) to predict the proportion of adults that would initiate dispersive flight amongst those collected in wild ecotopes.

MATERIALS AND METHODS

Study area - The fieldwork was carried out at La Choza (18°34'516''S; 62°40'108''W), an uninhabited site located in the phytogeographic region of the Chaco, southern part of the Department of Santa Cruz, Bolivia. The main environmental characteristics of this semi-arid region are: (i) 300 m altitude, (ii) mean annual temperature of 26°C, (iii) an average annual rainfall of about 600 mm, and (iiii) a marked seasonality, with a dry season from March to October and a wet season the rest of the year. The area is covered by dense vegetation of hardwood trees (4-6 m) with emerging trees up to 12 m high. In the lowest stratum thorn shrubs, bromeliads and cacti predominate.

Collection of triatomines - The collection of flying triatomines was performed by light trapping during the dry season of 1998 (from 20 August to 10 October). The light system, which operated for 6 h from the official time of sunset, consisted of a vertical white cloth simultaneously illuminated by a 12-V fluorescent black light tube and a 150-V mercury vapour light. Adult triatomines were also collected in September 1998 from bromeliads and hollow trees. The dissected bromeliads were terrestrial (mainly *Bromelia serra* and *B. hieronymi*) and epiphytic (*Tillandsia* spp.). Insects were captured in hollow trees by means of the trapping system described by Noireau et al. (1998a).

Processing of insects - All collected insects were stored at once in liquid nitrogen and transported to the laboratory. They were classified by sex, weighed individually to the nearest mg and measured from clypeus to abdominal terminalia using a dissection microscope with micrometer eyepiece (6.4 X magnification). The weight/length ratio or W/L (mg/mm), classically used as marker of nutritional status in Triatominae (Lehane & Schofield 1982), was calculated for each insect. Finally, the triatomines were taxonomically identified according to the key of Lent and Wygodzinsky (1979) and by isoenzyme analysis as described by Noireau et al. (1998c). Only the isocitrate dehydrogenase enzyme system (EC 1.1.1.42., IDH) was assayed because it provides a reliable differentiation between *T. sordida* group 1, *T. sordida* group 2 and *T. guasayana*.

RESULTS

The analyzed sample consisted of: (i) 82 *T. sordida* group 2 and 104 *T. guasayana* collected by light trapping; (ii) 42 *T. sordida* group 2 and 49 *T. guasayana* recovered from natural ecotopes. *T. sordida* specimens belonging to group 1 were discarded due to their low frequency of capture.

Earliest flights for both *T. sordida* G2 and *T. guasayana* were registered shortly after sunset (less than 15 min after dusk). The peak activity was almost unimodal and covered the period 61-180 min after dark, according to the species and sex (Fig. 1).

The calculation of the correlation coefficient between the weight and the classical W/L ratio ($R=0.98$) indicated that it was acceptable to con-

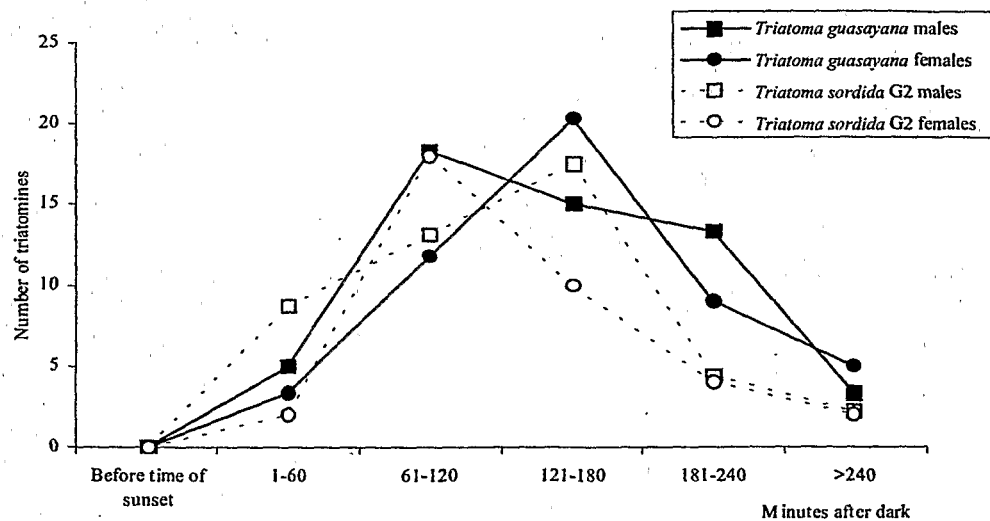


Fig. 1: number of triatomines collected during 60 min periods after sunset.

sider only weight for further study. Data relating to the frequency distribution of ranked weight classes according to species and sex were achieved for specimens from light collection and natural ecotopes. The pattern of lines was clearly unimodal but did not present a normal distribution (Fig. 2a,b). The mean and standard deviation of modes were calculated according to species, sex and method of collection (Table). The mean weight was consistently higher in females, with significant differences except for *T. sordida* collected by light trapping (Kruskal-Wallis test, $P=0.096$). For the same species and sex, no significant difference was detected in the mean value of weight according to the capture method (light trapping vs natural ecotopes). All interspecies comparisons for the same sex and type of capture showed a higher weight for *T. guasayana* ($P<0.0001$). If we consider, according to species and sex, the higher weight of adults captured by light trapping as an extreme value allowing flight, the majority of insects collected from natural ecotopes would be

expected to display flight ability under the study conditions (87% of *T. sordida* and *T. guasayana* females, 94.7% and 96.2% of males, respectively).

DISCUSSION

Many authors have reported nocturnal flights of Triatominae, among them the main vectors of Chagas disease *T. infestans* and *Rhodnius prolixus* which show peak flight activity just after sunset (Gómez-Núñez 1969, Lehane & Schofield 1976, 1981). Forattini et al. (1971b) reported that *T. sordida* had a substantial capacity for active dispersal and its flight behaviour was later studied by Schofield et al. (1991) and McEwen and Lehane (1993). Our data show that flight is initiated after sunset with a almost unimodal pattern in both species. The flight activity of *T. sordida* and *T. guasayana* is crepuscular and almost all our collections were made between sunset and the following 5 h, under total darkness but when temperature and saturation deficiency are still relatively high. These observations are in agreement with

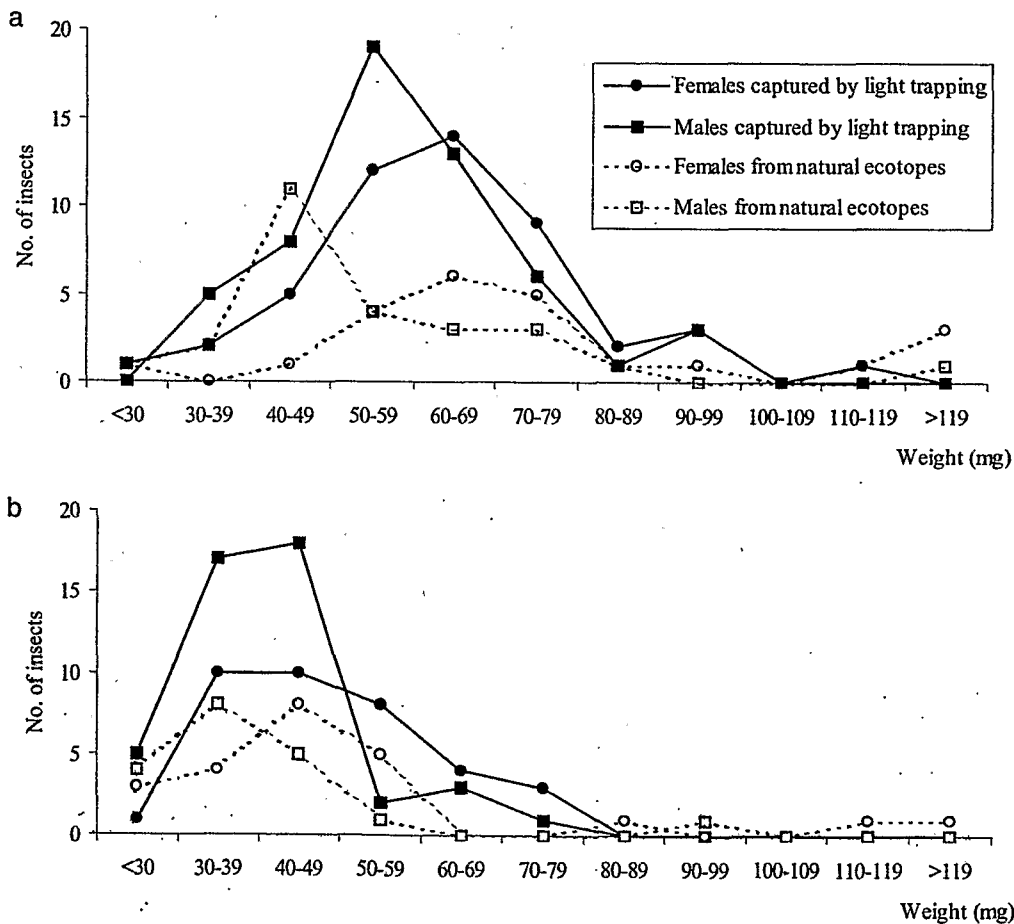


Fig. 2: weight distribution (mg) according to sex and type of collection method. a: *Triatoma guasayana*; b: *T. sordida*

TABLE
Mean weight (mg) of triatomines according to species and type of collecting method

	Sex	Light trap collection			Collection in natural ecotopes			Difference between sort of collecting
		No.	Weight: mean \pm SD	Difference between sex	No.	Weight: mean \pm SD	Difference between sex	
<i>Triatoma guasayana</i>	M	55	59.00 \pm 13.64		26	57.04 \pm 25.13		M: $P=0.081$
	F	49	63.61 \pm 16.40	$P=0.096$	23	80.52 \pm 43.58	$P=0.003^a$	F: $P=0.190$
	M + F	104	61.17 \pm 15.10		49	68.06 \pm 36.60		
<i>Triatoma sordida</i> group 2	M	46	40.65 \pm 11.41		19	39.42 \pm 15.33		M: $P=0.360$
	F	36	48.36 \pm 12.54	$P=0.005^a$	23	51.96 \pm 29.01	$P=0.026^a$	F: $P=0.692$
	M + F	82	44.04 \pm 12.45		42	46.29 \pm 24.39		

a: significant difference by Kruskal-Wallis test

studies performed on *T. rubida*, *T. recurva* and *T. sordida* (Ekkens 1981, Lehane & Schofield 1982, Schofield et al. 1991). Nevertheless, as *T. sordida* and *T. guasayana* were generally captured far away from the light source (radius of 5 m), it is worth noting that their arrival time was roughly estimated.

In the Argentinean Chaco where both species are endemic, Wisnivesky-Colli et al. (1993) captured more *T. guasayana* than *T. sordida* by light trapping from October to November and slightly more females than males. Our captures, performed early in the season (from August to October), show a predominance of males. For *T. recurva*, Ekkens (1981) observed that males were more common early in the season whereas later the majority of insects collected were females.

The flying dispersal of starved *T. sordida* and *T. guasayana* during the dry season may relate to the peak emergence time of adult forms (the biological cycle of *T. sordida* and *T. guasayana* has a duration of approximately one year; Carcavallo & Martinez 1985) and the seasonal climatic conditions favouring flight activity.

The only comparative field study on the nutritional status between flying/resting triatomines of the same species was performed by Schofield (1980) who examined domestic *T. infestans* vs flying adults and demonstrated a more favourable nutritional status (higher W/L ratio) among the insects collected inside houses. To compare the nutritional status of *T. sordida* and *T. guasayana*, we discarded the W/L ratio and used only weight. This change of variable allowed an improved statistical analysis of the data since ratios generally have poor statistical properties. Our data illustrate the typical weight profiles of wild populations of *T. sordida* and *T. guasayana*. Unexpectedly, we did not observe significant differences between flying insects and those collected in natural ecotopes. Two hypothesis may be suggested for explanation: (i) dur-

ing the dry season, the likely associated hosts (rodents and marsupials) enlarge their home range and a decrease of their populations occurs; consequently, the insects have less access to blood sources and become temporarily undernourished; (ii) in consequence of a limited access to mammalian hosts throughout the year, triatomines exhibit a chronic undernourished status. Only studies carried out during the rest of the year would clarify this issue. Our data concerning the nutritional status of *T. sordida* and *T. guasayana* during the dry season indicate the ability for dispersive flight for almost the whole of adult forms. This would explain their tendency to invade artificial structures during the dry season as observed in the Argentinean and Bolivian Chaco (Wisnivesky-Colli et al. 1993, Noireau et al. 1998b).

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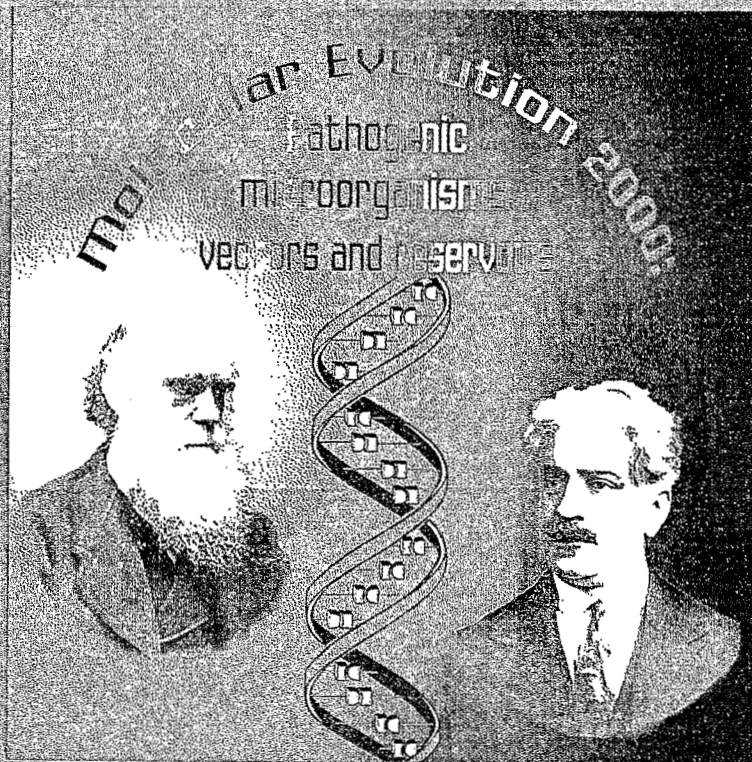
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