DIVERSITY AND POPULATION DYNAMIC OF Tabanidae (Insecta: Diptera) IN THE CERRADO-PANTANAL ECOTONE

DIVERSIDADE E DINÂMICA POPULACIONAL DE TABANÍDEOS (Insecta: Diptera) NO ECÓTONO CERRADO-PANTANAL

Wilson Werner KOLLER[1]; Antonio Thadeu Medeiros de BARROS[1]; Paulo Eduardo TEODORO[2]

1. Embrapa Gado de Corte, Campo Grande, MS, Brasil; 2. Universidade Federal de Mato Grosso do Sul, Chapadão do Sul, MS, Brasil. eduteodoro@hotmail.com

ABSTRACT: Tabanid (Diptera) species are associated with the mechanical transmission of several pathogens to both domestic and wild animals around the world. The aim of this study was to evaluate the diversity, abundance, and seasonal dynamic of tabanids in the Cerrado-Pantanal ecotone in Miranda, state of Mato Grosso do Sul, Brazil. Tabanids were collected once a month, from June 2001 to May 2003, for seven consecutive days per collection, using canopy and nzi type traps baited with a chemical attractant (1-octen-3-ol). A total of 6,492 individuals from 39 species and 18 genera was collected, which increases from 25 to 34 the number of tabanid species reported for the studied region. *Tabanus occidentalis* Linnaeus, 1758 (62.21%) was the most abundant species throughout the collection period, followed by *Lepiselaga crassipes* (Fabricius, 1805) (7.19%) and *Tabanus sorbillans* Wiedemann, 1828 (5.68%). The peak of the tabanid population was reached during the rainy season, which is the period of the highest potential risk of mechanical transmission of pathogens by these insects in the studied region.

KEYWORDS: Canopy trap. Horsefly. Nzi trap. Seasonality

INTRODUCTION

Hematophagous dipterans of the Tabanidae family, known in most regions of Brazil as "mutucas," have epidemiological importance due to their association with the mechanical transmission of pathogens, including bacteria, helminths, protozoa, and viruses, to both domestic and wild animals (FOIL, 1989). In the Pantanal wetland, Brazil, horseflies of the genus *Tabanus* Linnaeus, 1758, as well as the common vampire bat *Desmodus rotundus* Geoffroy, 1810 (Chiroptera: Phyllostomidae) are reported as vectors of *Trypanosoma evansi* Steel, 1884 (Trypanosomatida: Trypanosomatidae) in the white-lipped peccary (*Tayassu pecari* Link, 1795; Artiodactyla: Tayassuidae) and the wild pig (*Sus scrofa* Linnaeus, 1758; Artiodactyla: Suidae), (HERRERA et al., 2005). *Tabanus nebulosus* DeGeer, 1776 is associated with the transmission of *Trypanosoma vivax* to cattle in South America (OTTE; ABUABARA, 1991) and tabanid with *T. vivax* in the Colombian Atlantic coast (OTTE et al., 1994) and the Pantanal region, Brazil (MARTINS et al., 2008). Besides the mechanical transmission of pathogens, the nuisance and damage caused by horseflies also lead to livestock economic losses (FOIL; HOGSETTE, 1994).

The diversity of tabanids in the Pantanal (Nhecolândia sub-region) of the state of Mato Grosso do Sul, Brazil is well-know. Important aspects of the ecology and vector-host interaction (BARROS; FOIL, 1999, 2007; BARROS, 2001), besides the taxonomic key of these pests (BARROS; GORAYEB, 1996), are also well-known.

Investigations on vector ecology are essential to develop strategies for preventing and/or controlling diseases on livestock in the studied region. The aims of this study were: 1) to survey tabanids; and 2) to identify the species name with collections carried out in a transition area between the Pantanal and Cerrado biomes, Brazil. The results obtained were utilized to evaluate the diversity, abundance, and seasonal behavior of this insect group in the studied region.

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MATERIAL AND METHODS

Characteristic of study area

The study was conducted from June 2001 to May 2003, at the Guaicurus Ranch (20°6' S, 56°48' W), located in a transition area between the Cerrado and Pantanal biomes (Miranda subregion), in the municipality of Miranda, state of Mato Grosso do Sul, Brazil. Pantanal is a seasonally flooded flat area that comprises about 140,000 m^2. The region is located to the west of the state of Mato Grosso do Sul and the southwest of the state of Mato Grosso, Brazil, and to the eastern border of Bolivia and northern Paraguay (ALLEM; VALLS, 1987). The altitude is of approximately 100 m above sea level, and its vegetation is influenced by surrounding biomes, such as the Amazon, Atlantic Forest, Cerrado, and Paraguayan Chaco.

Cerrado represents 25% of the Brazilian territory, mostly in the Central Plateau. This biome is distributed throughout the states of Bahia, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, and Tocantins, besides the Federal District, with fragments in the states of Maranhão, Pará, Piauí, Rondônia, Roraima, and São Paulo (RESENDE; GUIMARÃES, 2007). Cerrado's vegetation is mostly comprised by grasses interspersed with trees and shrubs with twisted trunks and thick barks. In the Cerrado-Pantanal ecotone, the rainy season follows the Brazilian Midwest pattern, which occurs from October to April. Although the study area does not flood during the rainy season, its water table is superficial, and the field capacity usually saturates during that season.

Collections and tabanid species name identification

Tabanids were collected using canopy (HRIBAR et al., 1991) and nzi (MIHOK, 2002) type traps, with three units per type. Traps were made using a 2-L pet bottle. The bottles were horizontally fixed to a pet funnel placed on the top opening of the bottles. A black beach ball (40 cm diameter) was suspended above the canopy-type traps as a visual target for the insects. The chemical attractant 1-octen-3-ol (Merck, Millipore) (TAKKEN; KLINE, 1989) was placed in all traps; this compost was placed in vials (5 mL) with a perforated lid pierced by a pipe cleaning rod and replaced when necessary.

The traps were installed in open areas of native grasses, approximately 10 m from wooded areas ["cerradão", remaining riparian or riparian forest, and/or a *Scheelea phalerata* (Mart. ex Spreng.; Arecales: Arecaceae) community], protected from cattle invasion by a square wire-fence (4 m side).

Trappings were conducted once a month each, for seven days, with daily removal of insects from traps. A cotton ball treated with ethyl-acetate was placed inside the collecting bottles after removed from traps; then, dead insects were transferred to plastic bags labeled according to the sample. Tabanids were identified using taxonomic keys such as type of wing, oral device, and legs (WILKERSON, 1979; BARROS; GORAYEB, 1996) and the species name was confirmed by Dr. Inocêncio Gorayeb (Museu Paraense Emílio Goeldi, Belém, state of Pará, Brazil). The specimens were mounted and deposited into the entomological collection of Embrapa Pantanal, in Corumbá, state of Mato Grosso do Sul, Brazil. Data regarding the air temperature (ºC), RH (%), and rainfall (mm) were obtained from the nearest weather stations.

Statistical Analysis

Data regarding the tabanid collections were analyzed using descriptive analyses by seasonal distribution, trap type, and frequency of individuals of the most abundant species. The negative effect of weather conditions (mean temperature, relative humidity, and rainfall) during the interval between collections (approximately three weeks) on the tabanid abundance was analyzed by the Pearson correlation. All analyses were performed using the R statistical software.

RESULTS AND DISCUSSION

The rainy and dry seasons were typical for the region during the first year of study. However, the dry season was longer in the second year (Figure 1). A total of 6,492 tabanid individuals, belonging to 39 species and 18 genera, was collected (Table 1). The most representative genera were *Tabanus* (13 species) and *Chrysops* (four species), which is similar to the results found in the Pantanal (Nhecolândia sub-region), state of Mato Grosso do Sul, Brazil (BARROS & GORAYEB, 1996). The diversity of tabanid species found in the Cerrado-Pantanal ecotone (n= 39) was higher

than that detected in the Pampa biome, Brazil (KRÜGER; KROLOW, 2015) and lower than that observed in Eastern (GORAYEB, 1993) and Central Amazon (FERREIRA-KEPPLER et al., 2010), Brazil. The number of tabanid species increased from 25 (BARROS; GORAYEB, 1996) to 34 species for the state of Mato Grosso do Sul, Brazil. Three unknown species obtained from collections carried out in this study were described: *Myiotabanus amazonicus* Rafael & Ferreira, 2004 (RAFAEL; FERREIRA, 2004); *Pityocera barrosi* Gorayeb & Krolow, 2015; and *Pityocera rhinolissa* Krolow & Henriques, 2015 (KROLOW et al., 2015).

Most tabanid species (71.79%) from the Cerrado-Pantanal ecotone showed a relative abundance (RA) lower than 1.00%, representing 4.08% of the total species collected. Three species, with RA above 5.00%, represented 75.05% of the total number of tabanids collected in the study (Table 1). A high frequency of the less abundant species (RA <1.00%) was also reported in the Brazilian Amazon (GORAYEB, 1993; FERREIRA-KEPLER et al., 2010) and in the Pantanal (Nhecolândia sub-region), Brazil (BARROS; FOIL, 1999).

The most abundant tabanid species in the Cerrado-Pantanal ecotone was *Tabanus occidentalis* Linnaeus, 1758 (62.2%), followed by *Lepiselaga crassipes* Fabricius, 1805 (7.2%), and *Tabanus sorbillans* Wiedemann, 1828 (5.7%). *Tabanus importunus* Wiedemann, 1828 (29.5%), *T. occidentalis* (25.4%), *Tabanus claripennis* Bigot, 1892 (12.3%), and *L. crassipes* (7.5%) were the most abundant species collected in a survey conducted at the Pantanal (Nhecolândia sub-region), Brazil (BARROS; FOIL, 1999).

The relative abundance of *T. occidentalis* in the Cerrado-Pantanal transition environment was over twice as much as that reported in the Pantanal and three to four times as much as that reported in the Amazon (GORAYEB, 1993; FERREIRA-KEPLER et al., 2010), Brazil, suggesting a possible adaptation of this species to the dry condition of the Cerrado biome, Brazil. Although *T. importunus* was relatively abundant in the Pantanal biome, it was not common near the Cerrado biome (3.28%), as evidenced by the collection using canopy (4.56%) and nzi (0.26%) type traps (Table 2). Similarly, *T. claripennis* was more abundant in the Pantanal (12.30%) than in transition areas of Pantanal-Cerrado (3.92%).

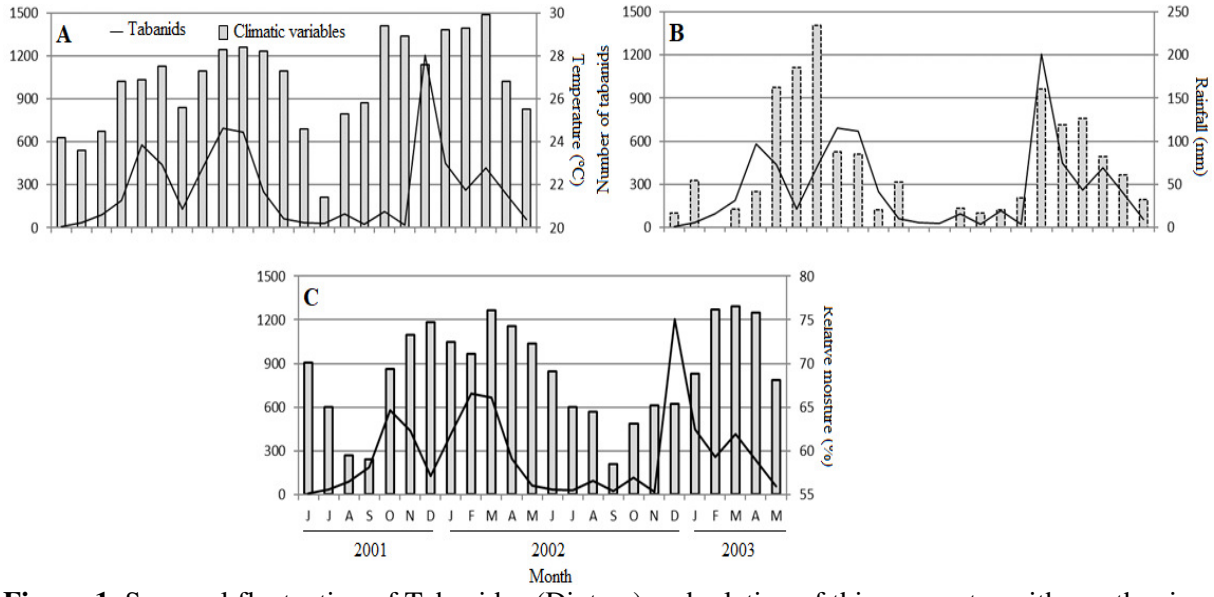

Figure 1. Seasonal fluctuation of Tabanidae (Diptera) and relation of this parameter with weather in a transition area between Cerrado and Pantanal biomes, municipality of Miranda, Mato Grosso do Sul state, Brazil from June 2001 to May 2003.

Table 1. Number of tabanid (Diptera) individuals per species collected per month and total besides relative abundance (RA) using canopy and nzi type traps, in a transition area between Cerrado and Pantanal, municipality of Miranda, Mato Grosso do Sul state, Brazil from June 2001 and May 2003.

Species	Jn	Jl	Au	S	O	N	D	Ja	F	Mr	Ap	Ma	Jn	Jl	Au	S	O	N	D	Ja	F	Mr	Ap	Ma	Σ	RA(%)
Acanthocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0.0
Chlorotabanus inanis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0.0
Chrysops bulbicornis	0	1	0	2	0	0	1	8	2	2	4	1	0	2	1	0	1	0	0	0	0	2	1	0	28	0.4
Chrysops patricia	0	2	2	0	0	3	1	5	1	1	2	0	0	0	0	0	0	0	5	8	0	0	0	0	30	0.5
Cryptotylus unicolor	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0.1
Chrysops variegatus	0	1	2	2	0	0	0	0	0	0	1	4	0	0	1	0	1	0	0	0	1	0	0	3	16	0.3
Diachlorus bimaculatus	0	0	1	0	5	4	0	0	24	3	6	8	4	8	35	1	1	1	2	2	3	1	7	8	124	1.9
Dichelacera sp.	0	0	0	0	2	3	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0.1
Esenbeckia sp.	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0.3
Esenbeckia arcuata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	7	0.1
Esenbeckia filipalpis	0	0	0	0	0	0	2	0	0	7	0	0	0	0	0	0	0	0	0	0	2	1	0	0	12	0.2
Fidena aureosericea	0	0	0	0	0	0	0	6	32	12 3	0	0	0	0	0	0	0	0	0	0	4	36	0	0	201	3.1
Fidena castanea	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
Lepiselaga crassipes	0	6	16	37	83	90	8	26	45	49	32	12	2	1	15	2	16	2	2	4	3	5	11	0	467	7.2
Leucotabanus sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
Leucotabanus procallosus	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	76	1.2
Myiotabanus amazonicus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
Phaeotabanus fervens	0	0	0	17	6	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	26	0.4
Phorcotabanus cinereus	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	4	0.1
Pityocera barrosi	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	4	2	0	11	0.2
Pityocera rhinolissa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2	1	0	5	0.1
Poeciloderas seclusus	0	1	6	5	3	3	2	8	7	12	12	0	2	1	0	0	1	0	5	1	0	6	2	5	82	1.3
Pseudacanthocera brevicorne	0	0	0	0	7	7	2	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	21	0.3
Selasoma tibiale	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0

Stypommisa sp.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0.1
Stypommisa rubrithorax	0	1	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0.2
Tabanus claripennis	4	9	13	45	21	7	3	10	18	10	1	2	4	5	7	6	10	2	68	21	20	12	6	8	312	4.8
Tabanus guyanensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.0
Tabanus importunus	0	1	2	3	16	27	0	16	57	8	1	1	1	4	1	0	17	8	24	23	0	0	2	1	213	3.3
Tabunus nebulosus	0	0	0	7	16	32	1	3	2	0	0	0	0	0	2	2	4	0	0	0	0	0	0	0	69	1.1
Tabanus nebulosus ornativentris	0	0	1	5	3	2	2	1	0	0	0	0	0	0	3	0	5	0	0	0	0	0	0	0	22	0.3
Tabanus occidentalis	1	11	33	60	33 5	20 1	55	31 7	45 0	36 2	13 4	28	20	8	25	9	34	3	108 4	32 4	75	29 0	15 7	22	403 8	62.2
Tabanus palpalis	0	0	0	0	2	16	31	5	4	23	18	0	0	0	0	0	1	0	3	23	10 9	17	18	1	271	4.2
Tabanus pseudonebulosus	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.0
Tabanus pungens	0	0	0	1	1	1	0	0	1	0	0	0	0	0	1	1	0	0	3	3	2	1	0	1	16	0.3
Tabanus sorbillans	0	0	0	0	10	41	19	8	47	45	35	3	0	0	0	0	10	2	5	37	39	34	27	7	369	5.7
Tabanus triangulum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0.0
Tabanus wilkersoni	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
Tabanus wokei	0	0	3	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	8	0.1
Undetermined species	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	1	0	7	0.1
Total	6	33	91	18 8	57 9	43 9	12 8	41 8	69 2	66 9	25 0	61	33	29	95	22	11 5	19	120 7	44 9	26 0	41 7	23 6	56	649 2	100

Jn-June, Jl-July, Au-August, S-September, O-October, N-November, D-December, Ja-January, F-February, Mr-March, Ap-April, Ma-May.

Table 2. Frequency of tabanids (Diptera) collected using canopy and nzi type traps in a transition area between Cerrado and Pantanal in Miranda, Mato Grosso do Sul state, Brazil from June 2001 to May 2003.

	Canopy		Nzi		Canopy + Nzi	
Species	n	%	n	%	n	%
Acanthocera sp.	2	0.04	0	0.00	2	0.03
Chlorotabanus inanis	1	0.02	0	0.00	1	0.02
Chrysops bulbicornis	28	0.61	0	0.00	28	0.43
Chrysops patricia	30	0.66	0	0.00	30	0.46
Chrysops variegatus	13	0.28	3	0.16	16	0.25
Cryptotylus unicolor	4	0.09	0	0.00	4	0.06
Diachlorus bimaculatus	80	1.75	44	2.28	124	1.91
Dichelacera sp.	1	0.02	7	0.36	8	0.12
Esenbeckia sp.	9	0.20	8	0.41	17	0.26
Esenbeckia arcuata	2	0.04	5	0.26	7	0.11
Esenbeckia filipalpis	0	0.00	12	0.62	12	0.18
Fidena aureosericea	201	4.41	0	0.00	201	3.10
Fidena castanea	1	0.02	0	0.00	1	0.02
Lepiselaga crassipes	421	9.23	46	2.38	467	7.19
Leucotabanus sp.	1	0.02	0	0.00	1	0.02
Leucotabanus procallosus	32	0.70	44	2.28	76	1.17
Myiotabanus amazonicus.	1	0.02	0	0.00	1	0.02
Phaeotabanus fervens	26	0.57	0	0.00	26	0.40
Phorcotabanus cinereus	4	0.09	0	0.00	4	0.06
Pityocera barrosi	1	0.02	10	0.52	11	0.17
Pityocera rhinolissa	3	0.07	2	0.10	5	0.08
Poeciloderas seclusus	81	1.78	1	0.05	82	1.26
Pseudacanthocera brevicorne	19	0.42	2	0.10	21	0.32
Selasoma tibiale	0	0.00	1	0.05	1	0.02
Stypommisa sp.	2	0.04	1	0.05	3	0.05
Stypommisa rubrithorax	1	0.02	12	0.62	13	0.20
Tabanus claripennis	179	3.92	133	6.89	312	4.81
Tabanus guyanensis	1	0.02	0	0.00	1	0.02
Tabanus importunus	208	4.56	5	0.26	213	3.28
Tabunus nebulosus	69	1.51	0	0.00	69	1.06
Tabanus nebulosus ornativentris	19	0.42	3	0.16	22	0.34
Tabanus occidentalis	2891	63.41	1147	59.40	4038	62.18
Tabanus palpalis	60	1.32	211	10.93	271	4.17
Tabanus pseudonebulosus	2	0.04	0	0.00	2	0.03
Tabanus pungens	16	0.35	0	0.00	16	0.25
Tabanus sorbillans	146	3.20	223	11.55	369	5.68
Tabanus triangulum	1	0.02	0	0.00	1	0.02
Tabanus wilkersoni	1	0.02	0	0.00	1	0.02
Tabanus wokei	3	0.07	5	0.26	8	0.12
Unidentified species	1	0.02	6	0.31	7	0.11
Total	4561	100.0	1931	100.0	6492	100.0

Two annual tabanid population peaks were recorded in the Cerrado-Pantanal ecotone, both related to the rainy season in the region. The first peak occurred at the beginning of the rainy season, while the second peak occurred at the end of the rainy season (February and March). A similar seasonality was found for tabanid populations from Pantanal, Brazil (BARROS; FOIL, 1999). The longer dry season (December) of the second year of study may have contributed to the tabanid population peak. This longer dry season delayed the beginning of the rainy season for about two months and influenced tabanid abundance. Actually, the general seasonality of tabanids in this study was highly influenced by the most abundant species (*T. occidentalis*) (Figure 2), which represented 62.2% of the total collected species. The climatic variables that influenced this behavior were average monthly temperature and monthly rainfall (Table 3).

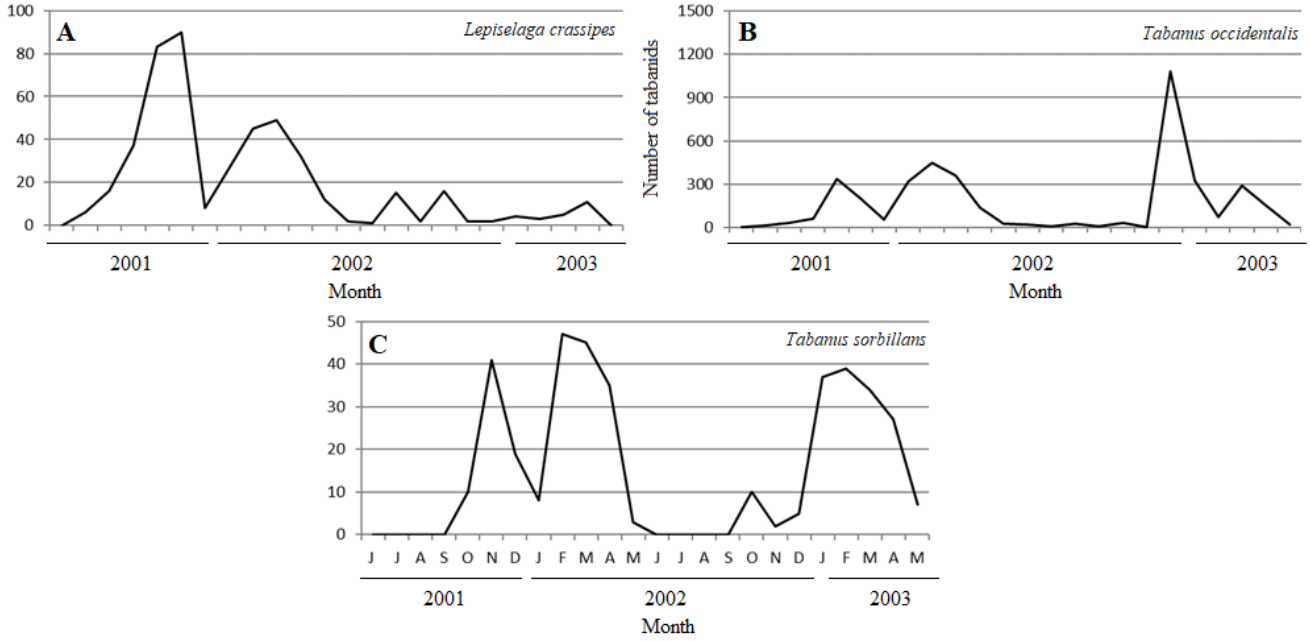

Figure 2. Population dynamics of the most abundant tabanid (Diptera) species (*Lepiselaga crassipes* – A, *Tabanus occidentalis* – B e *Tabanus sorbillans* – C) collected using two trap types, in the transition area between Cerrado and Pantanal in Miranda, Mato Grosso do Sul state, Brazil.

Although the relative abundance was different between the most abundant species, the seasonality of the tabanid species (Figure 2) was strongly influenced by the rainfall in the region. Except for *T. sorbillans*, which was not collected during the dry season, the other two species were collected throughout the year. The highest abundance of these species during the rainy season, with a subsequent decline, was similar to that observed in the Pantanal (BARROS; FOIL, 1999).

The number of specimens and species collected using the canopy type trap was higher than using nzi type trap, respectivelly. (Table 2). Seventeen (43.59%) and two (5.13%) species were collected exclusively using the canopy type trap and nzi type trap, respectively. The canopy type trap collected about 1.7-fold more species and 2.4-fold more specimens when compared with the nzi type trap, which may be explained by the bigger size (easier to be seen) and wider opening (easier to enter in) of the former. The correlation analysis showed a significant positive influence of both temperature and rainfall on tabanid collections during the two years study period (Table 3).

Table 3. Pearson correlation between monthly tabanid (Diptera) individuals collected and weather parameters between collections in the Cerrado-Pantanal ecotone in Miranda, Mato Grosso do Sul state, Brazil from June 2001 to May 2003.

Period	Average monthly temperature (° C)	Average monthly relative moisture (%)	Monthly rainfall (mm)
June/2001 – May/200	0.6775*	0.2345	0.5404*
June/2002 – May/2003	0.5102*	0.0890	0.7431*

*Significant at 5% probability by the t-test.

CONCLUSION

The diversity of tabanids in the Cerrado-Pantanal ecotone, Brazil shows a high degree of adaptation of this insect group to both biomes. The highest abundance of these insects during the rainy season increases the risk of mechanical transmission of pathogens to both livestock and wildlife in the studied region.

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RESUMO: Tabanídeos (Diptera) são importantes vetores de patógenos a animais domésticos e silvestres no mundo. O objetivo foi estudar a diversidade, abundância e dinâmica sazonal de Tabanidae no ecótono Cerrado-Pantanal em Miranda, Mato Grosso do Sul, Brasil. Uma captura foi realizada por mês cada por sete dias consecutivos de junho 2001 a maio 2003 utilizando armadilhas modelo canopy e nzi. As armadilhas foram iscadas com o atrativo químico "1-octen-3-ol". Um total de 6.491 tabanídeos, de 39 espécies e 18 gêneros, foi capturado, ampliando a lista de espécies de tabanídeos relatados para o Mato Grosso do Sul de 25 para 34. *Tabanus occidentalis* Linnaeus, 1758 (62,21%) foi o mais abundante durante o período de coleta, seguido por *Lepiselaga crassipes* (Fabricius, 1805) (7,19%) e *Tabanus sorbillans* Wiedemann, 1828 (5,68%). A maioria das espécies de tabanídeos teve pico populacional durante o período chuvoso, considerado o de maior risco potencial de transmissão mecânica de patógenos por estes vetores na região estudada.

PALAVRAS-CHAVE: Armadilha canopy. Armadilha nzi. Mutuca. Sazonalidade

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