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Seasonality and Relative Abundance of Tabanids (Diptera, Tabanidae) on Marambaia Island, Rio de Janeiro, Brazil

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Abstract. Tabanids collections were conducted on Marambaia Island, Atlantic Forest biome, Rio de Janeiro, Brazil. Thirty-one species were identified belonging to 16 genera. Seasonal variation and its relationship with the most important climatic factors during 1981 and 2013 and observations on the bionomics of each species are presented.

Keywords: Atlantic Forest; Biodiversity; Deer fly; Horse fly; Insect vector.

Variação sazonal e abundância de tabânidas (Diptera, Tabanidae) na Ilha da Marambaia, Rio de Janeiro, Brasil

Resumo. Coletas de tabânidas foram realizadas na ilha de Marambaia, bioma da Mata Atlântica, Rio de Janeiro, Brasil. Trinta e uma espécies foram identificadas pertencentes a 16 gêneros. São apresentadas a variação sazonal, observações sobre bionomia e a relação com os fatores climáticos mais importantes durante os anos de 1981 e 2013.

Palavras-chave: Biodiversidade; Inseto vetor; Mata Atlântica; Moscas dos veados; Moscas dos cavalos.

The family Tabanidae Latreille comprises about 4,400 described species, of which 1,205 are present in the Neotropics (Henriques *et al.* 2012). Tabanids are the largest bloodsucking diptera, reaching up to 2.5 cm, robust body and some with a well-developed proboscis, looks imposing and awe. Repeatedly attack humans, domestic and wild animals, among primates, rodents, alligators, snakes, turtles and birds, especially during the drier seasons. They are known worldwide for its painful sting and being mechanical and biological transmission of more than 35 pathogens among helminths, viruses, bacteria and protozoan, etiologic agents of diseases that can affect humans and wild and domestic animals (Krinsky 1976; Pechuman & Teskey 1981; Foil 1989; Foil & Issel 1991; Marcondes 2001; Luz-Alves *et al.* 2007; Turcatel *et al.* 2007). Around the world more and better evidence has been gathered to assess the importance of Tabanids in an epidemiological context.

Several studies show a correlation between the period of greatest activity of tabanids and the appearance of animal and human diseases. The season of year in which these vectors are most common means greater health risk to human and animal populations exposed, and information about these facts are essential for the election of control strategies (Francis 1919; Klock *et al.* 1973; Krinsky 1976; Foil 1989; Otte & Abuabara 1991; Silva *et al.* 1996). Due to the increasing knowledge of tabanids role in disease transmission, more studies are held in places of more immediate human interest, such as settlements, farms, pastures, attractions. However, the role of wild areas in maintaining natural foci of zoonosis should not be overlooked (Pavlovsky 1966).

The first studies on tabanids on Atlantic Forest biome were conducted by Lutz between 1905 and 1914, in which he described 144 species of which 72 are still valid (Lutz 1905, 1907, 1909, 1910, 1913a, b, 1914; Lutz & Neiva 1909, 1914; Benchimol & Sá 2005). Despite the importance of tabanids in transmission of bovine and equine tripanosomosis in South and southern Brazil, the studies of tabanids are mainly conducted for knowledge of ecology (Bouvier 1952, Dutra & Marinoni 1994, Bassi *et al.* 2000, Krolow *et al.* 2010, Miletti *et al.* 2011, Guimarães *et al.* 2016) and taxonomy (Turcatel *et al.* 2007; Krolow & Krüger 2007).

This study aimed to know the seasonality of more abundant tabanid species occurring in Marambaia Island, Rio de Janeiro

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state, in southeast coastal Atlantic Forest biome, as well as the main climatic factors related.

MATERIALS AND METHODS

Marambaia Island is a strip of land 42 kilometers long, with an area of approximately 81 km², south of State of Rio de Janeiro, in Mangaratiba county, at the entrance of Sepetiba Bay, between 23°0023°06'S and 43°45'44°41' West (Figure 1). The island landscape is a mosaic of large areas of originating preserved and secondary Atlantic Rainforest, sandbank vegetation, little areas of grasslands and mangroves.

In 1981, as well as in 2013, monthly collections were made on Marambaia Island, using four Manitoba modified canopy trap seated in an ecotone area between rain forest and dunes. The traps were placed near Armação Beach (Bravo 10), located at 23°02.54'S and 43°57.07'W. At this region, and in Vacaria Velha (23°03'47"S, 43°59'13"W), specimens were also collected using insect hand net. Tabanids specimens were identified by Drs. GB Fairchild, AL Henriques, IS Gorayeb, and RR Guimarães. Meteorological data of 1981 were provided by a higrothermograph and a pluviometer seated in Armação Beach; and at 2013, data were provided by National Institute of Meteorology, from the Auto-Meteorological Station of Marambaia Island (Rio de Janeiro Station-Marambaia-A602) located on sandbank, near the area of research (23°05.00'S and 43°60.00'W). Access to the research site was authorized by command of the Assessment Center Marambaia Island, Navy of Brazil; for the collection and transport of samples was issued the license nº 33382-1, SISBIO-IBAMA.

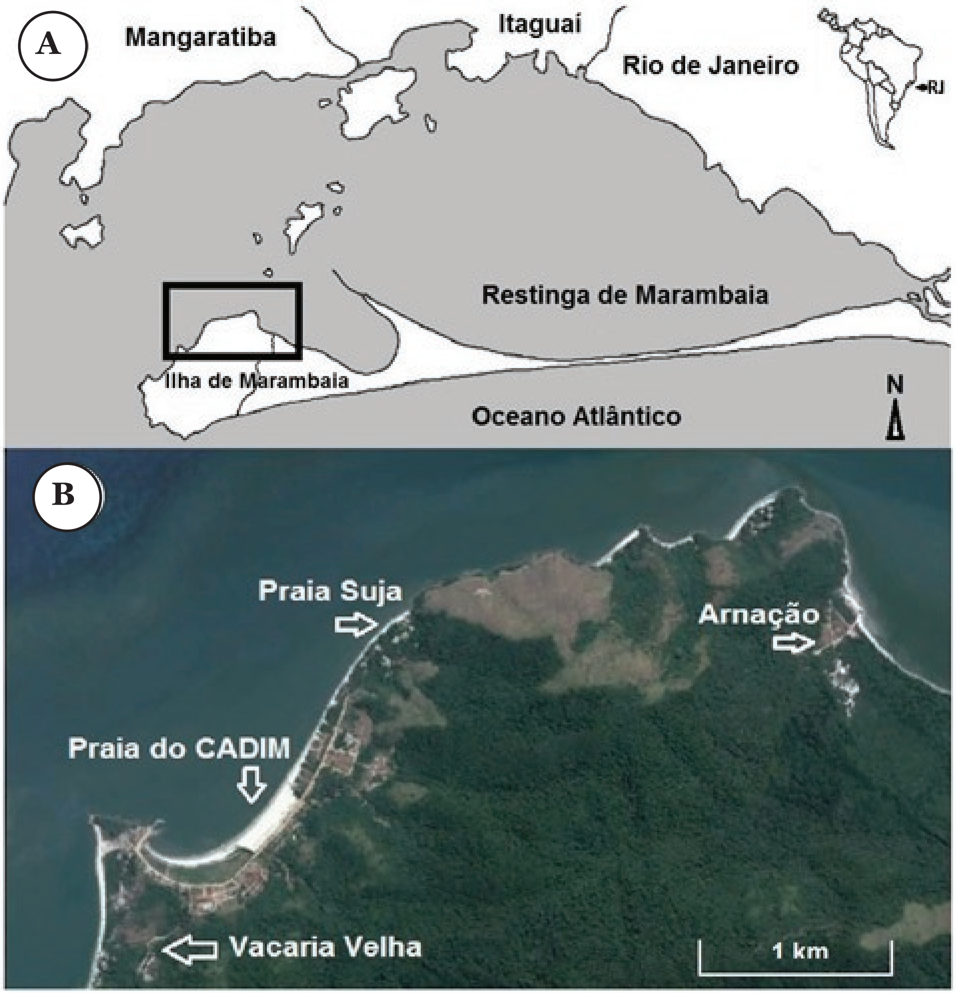

Figure 1. 1a. Geographic location of Restinga and Marambaia Island, county of Mangaratiba, Rio de Janeiro state, Brazil. 1b. Tabanid sampling sites on Marambaia Island. Sources: (a) - Scielo. Available on: <http://www.scielo.br/img/revistas/abb/v21n1/06f1.gif>. [Accessed in: 12.iii.2014]. (b) - GoogleMaps. Available on: <http://www.google.com.br/maps/@-23.0316476,-43.9261133,19073m/data=!3m1!1e3?hl=pt-BR>. [Accessed in: 12.ii.2014].

RESULTS AND DISCUSSION

During the two periods of study, 3016 specimens belonging to 31 tabanid species were collected by canopy trap, distributed in 16 genera of Tabanidae. Diachlorini was the most representative, with 16 species in 9 genera, followed by Tabanini with 9 species in 2 genera, Scionini with 2 species in 2 genera, and Pangoniini and Scepsini with 1 species in 1 genus each, and 2 species of Chrysopsini, in 1 genus. In the first period of study (1981), 619 specimens were captured by canopy traps, distributed in 15 species: the most abundant species was *Diachlorus bivittatus* Wiedemann (70.44%), followed by *Diachlorus distinctus* Lutz (7.59%), *Tabanus occidentalis* Linnaeus (6.62%), *Chrysops variegatus* (De Geer) (5.17%), *Tabanus triangulum* Wiedemann (2.58%), *Dichelacera walteri* (Guimarães *et al.*) (1.94%), *Phaeotabanus cajennense* Fabricius) (1.45%) and *Tabanus fuscus* Wiedemann (1.45%); *Chrysops varians* Wiedemann, *Rhabdotylus planiventris* (Wiedemann), *Acanthocera longicornis* (Fabricius), *Phaeotabanus litigiosus* (Walker), *Scaptia seminigra* Ricardo, *Stigmatophtalmus altivagus* Lutz, *Rhabdotylus viridiventris* Macquart were less abundant than 1% each one (Table 1). During 2013 were captured 2102 specimens of tabanids, distributed in 12 species listed according the order of decreasing number of specimens, and similarly than in 1981, the most abundant species was *D. bivittatus* (86.25%) followed by *D. distinctus* (4.33%), *T. occidentalis* (3.90%), *T. triangulum* (2.19%), *D. alcicornis* (2.05%), *D. walteri* (1,14%), *P. cajennensis* (0.33%), *T. fuscus* (0.29%), *C. varians* (0.24%)

Table 1. Seasonality and relative abundance of species tabanids captured using canopy traps, in 1981, in Armação Beach, in an ecotone area between sandbank forest and Atlantic Rainforest, Marambaia Island, Mangaratiba county, Rio de Janeiro state, Brazil.

Species	Months and collected specimens												Total	RA (%)
	J	F	M	A	M	J	J	A	S	O	N	D		
Chrysopsinae														
Chrysops variegattus	1			1						13	12	5	32	5,17
Chrysops varians	1									4			5	0,81
Pangoninae														
Scaptia seminigra						2							2	0,32
Tabaninae														
Acanthocera longicornis					1					1			2	0,32
Diachlorus bivittatus	6	22	78	42	39	12	4		34	75	105	19	436	70,44
Diachlorus distinctus	1	3	5	3	2	3			1	12	16	1	47	7,59
Dichelacera walteri									1	5	5	1	12	1,94
Phaeotabanus cajennensis	8										1		9	1,45
Phaeotabanus litigiosus	1										1		2	0,32
Rhabdotylus planiventris	1									1	1		3	0,48
Rhabdotylus viridiventris										1			1	0,16
Stigmatophtalmus altivagus			1							1			2	0,32
Tabanus occidentalis	2	2	6	3	4	2			6	4	8	4	41	6,62
Tabanus fuscus										9			9	1,45
Tabanus triangulum		1	4	2	2				1		5	1	16	2,58
Total	**21**	**28**	**94**	**51**	**48**	**19**	**4**	**0**	**43**	**126**	**154**	**31**	**619**	**100**
RA (%)	**3,39**	**4,52**	**15,19**	**8,24**	**7,75**	**3,07**	**0,65**	**0,00**	**6,95**	**2,36**	**24,88**	**5,01**	**100**	

and *R. planiventris* (0.19%). Others species were *P. litigiosus*, *S. altivagus*, and *R. viridiventris*, each one with 0.01% or less of the total collected specimens (Table 2). Others species captured in both two periods by insect hand net were *Esenbeckia lugubris* (Macquart), *Scepsis appendiculata* Macquart, *Fidena winthemi* (Wiedemann), *A. longicornis*, *Catachlorops flavus* (Wiedemann), *Catachlorops leptogaster* Barreto, *Chlorotabanus inanis* (Fabricius), *Diachlorus varipes* (Rondani), *Phaeotabanus limpidapex* (Wiedemann), *Poeciloderas quadripunctatus* (Fabricius), *Tabanus claripennis* (Bigot), *Tabanus discus* Wiedemann, *Tabanus importunus* Wiedemann, *Tabanus pungens* Wiedemann, and *Tabanus obsoletus* Wiedemann, of which was not determined the seasonal fluctuation.

Diachlorus bivittatus was the most prevalent species in both periods of study. This species is distributed in Brazil, from Rio de Janeiro to Santa Catarina (Fairchild 1971; Coscarón & Papavero 2009), Paraná (Dutra & Marinoni 1994; Bassi *et al.* 2000), but it also occurs in Espírito Santo (Lutz & Neiva 1909). Coscarón & Papavero (2009) cast doubt on the records of the species at Amazonas, Mato Grosso and Bahia made by Contreras-Liechtenberg (2002). Dutra & Marinoni (1994) captured this species in Island of Mel, Paraná, throughout the study period in 1988 and 1989, except in the months from November to March; the species represented 4.08% of the total number of collected samples. Turcatel *et al.* (2007) recorded this species on Paraná from specimens collected by Dutra in November 1990 and by Bassi in January 1993. On Marambaia Island this species was the most abundant, collected by canopy trap, representing 70.44% and 86.25% of the total specimens collected during 1981 and 2013, respectively, and it was active throughout the year, even in winter, when the number of captured specimens was lower, at the months from June to August. It is most abundant species during the months from March to May and September to December, when occurred two population peaks, featuring two annual generations of the species, leading to believe that it is bivoltine species.

The second species more prevalent was *D. distinctus* (7.59% in 1981 and 4.33% in 2013), a species similar to anterior one, both in morphology and behavior; it was prevalent during the same period as *D. bivittatus*. *D. distinctus* was also recorded by Turcatel *et al.* (2007) in Paraná, from a specimen collected by Bassi in November 1991.

Tabanus occidentalis was the third more prevalent species (6.62% in 1981 and 3,9% in 2013), and was captured by canopy trap all over the year, except for July and August, in both period of study. It is a very large distributed species, from Mexico to Argentina. According to Rafael and colleagues, *T. occidentalis* is one of the most abundant species in the tropical region: in Brazil was reported in Mato Grosso, Amazonas, Rio de Janeiro and Paraná (Rafael & Charlwood 1980; Raphael *et al.* 1991; Bassi *et al.* 2000; Barros 2001; Henriques 2004; Ferreira-Keppler *et al.* 2010). In Central Amazon region it was the second more prevalent species (15.40%), after *Phorcotabanus cinereus* (Wiedemann) (15.66%) (Oliveira *et al.* 2007; Ferreira-Keppler *et al.* 2010). *Tabanus occidentalis* was recorded being active in opened areas by anthropic activity, and in forest canopy (Henriques 2004; Oliveira *et al.* 2007). In Amazon region the species is active throughout the year with peak population occurring in December and February. In Central Amazonas the peak of the species occurs between July and December, on forests and natural or artificial unsheltered areas, but it seems to be more frequent in savanna environments, and is also commonly observed and captured on water depth (Rafael & Charlwood, 1980; Raymond 1986; Raymond & Rousseau 1987; Bassi *et al.* 2000; Krolow *et al.* 2010; Henriques 2004; Ferreira-Keppler *et al.* 2010). In Pantanal, Mato Grosso, *T. occidentalis* was prevalent all over the year, being more abundant from April to September, in dry season (Barros 2001; Barros *et al.* 2003). On Marambaia Island specimens of *T. occidentalis* were commonly observed throughout the two periods of study, flying over streams or freshwater collections, landing on rocks or driftwood above the water surface or on bathers. Miletti *et al.* (2011) did not record *T. occidentalis* in the study of tabanids in the Planalto Serrano of Santa Catarina.

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Table 2. Seasonality and relative abundance of species tabanids captured using canopy traps, in 2013, in Armação Beach, in an ecotone area between sandbank forest and Atlantic Rainforest, Marambaia Island, Mangaratiba county, Rio de Janeiro state, Brazil.

Species	Months and collected specimens												Total	RA (%)
	J	F	M	A	M	J	J	A	S	O	N	D		
Chrysopsinae														
Chrysops varians	3									2			5	0,24
Tabaninae														
Diachlorus bivittatus	55	70	117	113	89	33	18	25	212	348	418	315	1813	86,25
Diachlorus distinctus	4	9	16	8	6	3			6	17	18	4	91	4,33
Dichelacera alcicornis										8	10	1	19	0,9
Dichelacera walteri									1	9	12	2	24	1,14
Phaeotabanus cajennensis	5										2		7	0,33
Phaeotabanus litigiosus	1										1		2	0,1
Rhabdotylus planiventris	2									1	1		4	0,19
Rhabdotylus viridiventris										1			1	0,05
Stigmatophtalmus altivagus			1							1			2	0,1
Tabanus fuscus										6			6	0,29
Tabanus occidentalis	8	6	8	9	8	2			8	8	13	12	82	3,9
Tabanus triangulum		2	12	5	4				2		18	3	46	2,19
Total	**78**	**87**	**154**	**135**	**107**	**38**	**18**	**229**	**229**	**493**	**493**	**337**	**2398**	**100**
RA (%)	**3,25**	**3,63**	**6,42**	**5,63**	**4,46**	**1,58**	**0,75**	**9,55**	**9,55**	**20,56**	**20,56**	**14,05**	**100**	

Tabanus triangulum was the fourth more abundant species (2.58% in 1981 and 2.19% in 2013) and was prevalent from February to May and from September to December, in both years of study, with regard to probably bivoltine species. This is a southern South America species, ranging from Paraguay, Uruguay, Bolivia and Argentina, and in Brazil, in the states of Espírito Santo, Rio de Janeiro, São Paulo, Paraná and Rio Grande do Sul (Bouvier 1952; Fairchild 1971; Bassi *et al.* 2000; Barros 2001; Krolow *et al.* 2010). At Paraná, Campo Largo, this species was identified as the second most abundant species during the years 2002-2004, after *Dichelacera alcicornis* Wiedemann. It was present in Mato Grosso Pantanal throughout the year (Barros 1994).

Curiously, *C. variegattus* reached 5.17% of total collected species in 1981, but it was not captured by canopy trap in 2013. On Marambaia Island this species was more prevalent during October to December; in Central and East Amazon it was prevalent during throughout the year of collection (Ferreira-Keppler *et al.* 2010; Rafael 1982). It was not captured in the Planalto Serrano of Santa Catarina, southeast Brazil (Miletti *et al.* 2011). Each one of others species represented less than 2% of total captured specimens.

Among the species that was not captured by canopy trap, *T. importunus* is the most important, being considered a pest to human and animals, and because the transmission of equine and bovine tripanosomosis in Central and southearn Brazil, Bolivia and Paraguay. In Amazon it was the commonest species during November (Rafael *et al.* 1991). It also was recorded in Central Amazon (Rafael 1982; Henriques & Rafael 1999; Henriques 2004). In Mato Grosso Pantanal it was prevalent all over the years of collections and it was the most abundant (56%) of the species captured by canopy trap (Barros 2001), and ranged 44.4% when it was captured by insect hand net on an equine bait (Barros *et al.* 2003). On Marambaia Island it was captured in the months of October and November.

The number of specimens collected during 1981 (619) was significantly lower than that collected in 2013 (2398) (X^2= 6,32; GL = 1; P = 0,5%). But the five most prevalence species in both periods were *D. bivittatus*, *D. distinctus*, *Tabanus occidentalis*, *T. triangulum* and *D. walteri*, excepting *C. variegatus* that was not caught by cannopy trap in 2013. Although *D. walteri* was described in 2015 (Guimarães *et al.* 2015), the specimens had already been collected since 1981.

In both years of 1983 and 2013, as a general trend, tabanids were most active from January to March and September to December, i. e., when the rain fall, temperature and air humidity were highest (Figures 1 and 2; Tables 1 and 2). This also occurs in Amazonian region (Gorayeb 1995), in Pantanal (Barros *et al.* 2003) and was first recorded in southeast region by Bouvier (1952) in São Paulo state. During the two studies periods, tabanids on Marambaia Island demonstrated a low or weak positive correlation between the number of specimens collected by traps and the temperature (ρ temp = 0,28 in 1981; ρ temp = 0,08 in 2013) and humidity (ρ hum = 0,67 in 1981; ρ hum = 0,03 in 2013) and monthly rainfall (ρ pluv = 0,50 in 1981; ρ pluv = 0,01 in 2013).

Several other studies for diagnosis of tabanids in other regions have used Malaise traps, Shannon, suspended Gorayeb traps, animals or artificial lures, or canopy traps baited with octenol, carbonic gas, and has brought mixed results, more or less satisfactory, both in terms of number and variety of captured and diagnosed species (Rafael & Gorayeb 1982; Takken & Kline 1988; Rafael *et al.* 1991, Hribar *et al.* 1991; Barros *et al.* 2003; Oliveira *et al.* 2007; Krolow *et al.* 2010). The modified Manitoba canopy trap used in this study is low cost and easy to handle, and may provide subsidies for early studies of tabanofauna, when supplemented with other collection techniques.

The species on Marambaia Island, Rio de Janeiro also occur in other regions with different characteristics, particularly with respect to the time of appearance and relative abundance of other species present in the same region. These facts may be linked to the limitations imposed by climate, where temperature and humidity can play important roles as balancing factors between different tabanids species populations composing the biocenosis of the different regions.

The different behaviors of each species identified in the Marambaia Island compared to the behavior of the same species in other regions, characterize a unique and individualized environment, i. e., each of the holarchical systems to which the species belong in different biocenosis. Although climatic factors

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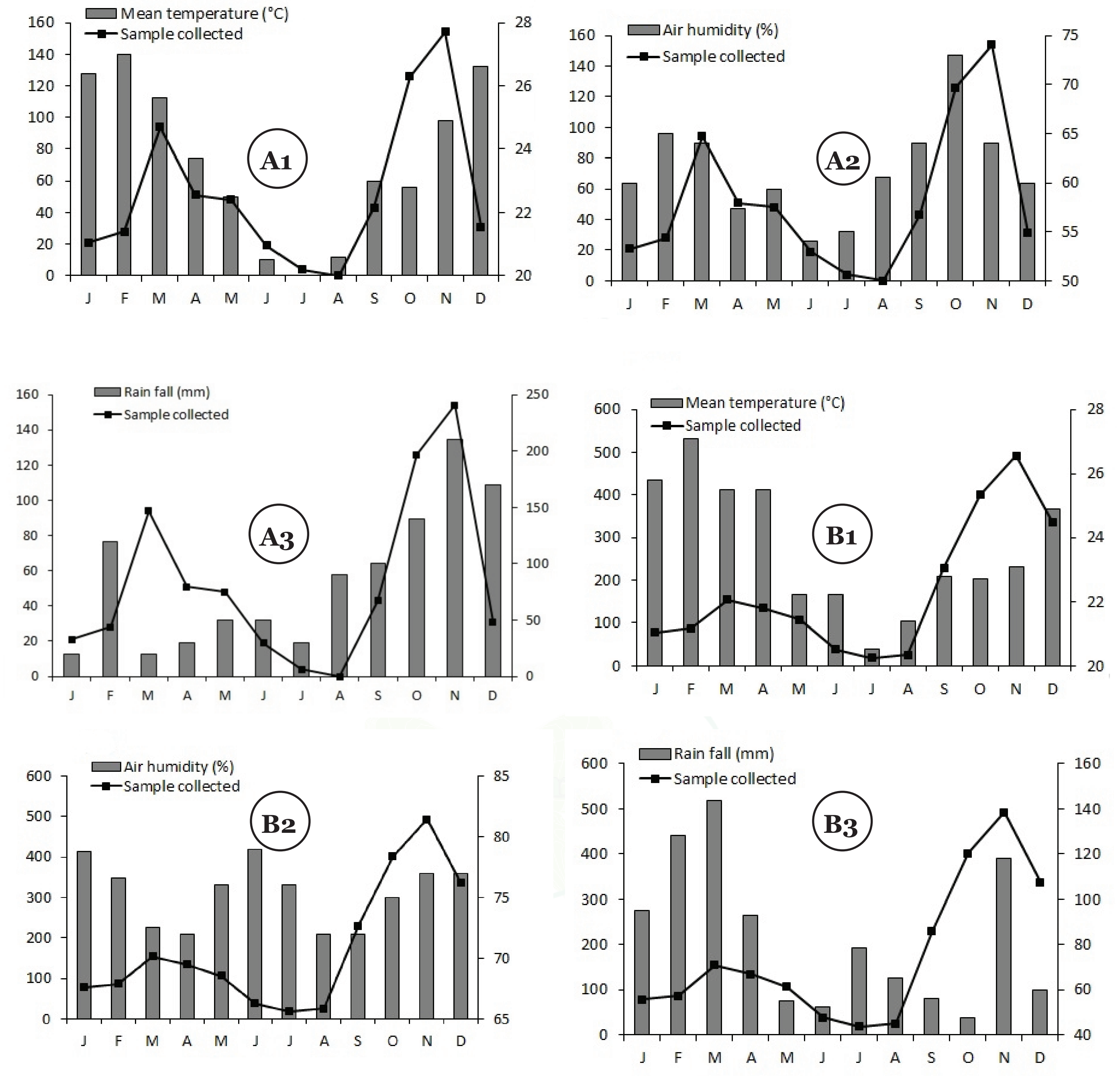

Figure 2. Number of tabanid specimens collected, monthly mean temperature, air humidity and rain fall during years 1981 (A1, A2, A3) and 2013 (B1, B2, B3), on Marambaia Island, Mangaratiba county, Rio de Janeiro state, Brazil.

play an important role in the differences in population behavior, the numerous other factors, biotic and abiotic, that are involved in the landscape structure should not be overlooked. The samples of species from the populations collected at intervals of 30 years also seem to be different, although it is not possible to state what factors determine this phenomenon.

The methodology for collecting tabanids has become varied and efficient allowing accurate diagnosis of the species present in different regions. Several traps can be used to collect specimens in different habitats, which contributes to a more accurate knowledge of biodiversity in the study areas. The trap used in our study has limitations such that the use of other tools for a better understanding of tabanofauna of studied sites is required. Manitoba canopy trap is low cost, but do not have enough attractive ability to be used as the only tool to perform a complete diagnosis of the endemic tabanids region. Certainly exist in Marambaia Island several other species that were not captured by the trap used. The capture using an animal equine bait was an attempt to compensate for this difficulty, but in this case, not enough to know the seasonal variation.

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