doi:10.12741/ebrasilis.v10i2.687
e-ISSN 1983-0572
Publication of the project Entomologistas do Brasil
www.ebras.bio.br

General Entomology/Entomologia Geral

Species composition and fauna distribution of mosquitoes (Diptera: Culicidae) and its importance for vector-borne diseases in a rural area of Central Western - Mato Grosso, Brazil

Fábio Alexandre Leal-Santos[1,2], Adaiane Catarina Marcondes Jacobina[1], Maria Madalena de Oliveira[1], Marinalva Brasilina Arruda Santana[1], Otacília Pereira Serra[1], Aldimara Vaillant Gonçalves[2], Angela Regina Serafine Garcêz[2], Sirlei Franck Thies[1], Renata Dezengrine Slhessarenko[1], Elisangela Santana de Oliveira Dantas[1] & Diniz Pereira Leite-Jr[1,2]✉

1. Universidade Federal de Mato Grosso (UFMT). 2. Centro Universitário de Várzea Grande (UNIVAG) Mato Grosso.

EntomoBrasilis 10 (2): 94-105 (2017)

Abstract. This study describes ecological data obtained in a rural area in the State of Mato Grosso, including the insects belonging to the family Culicidae, especially those framed as potential vectors of tropical diseases. In 2015, we collected adult mosquitoes in fragments of forest in a rural area located in Mato Grosso Central West of Brazil. We captured 18,256 mosquitoes of the sub-families Culicinae and Anophelinae and have identified 34 species belonging to 12 genera: *Aedes* (1 species), *Anopheles* (8 species), *Coquillettidia* (1 species), *Haemagogus* (1 species), *Culex* (5 species), *Psorophora* (5 species), *Ochlerotatus* (4 species), *Deinocerites* (1 species), *Mansonia* (4 species), *Sabethes* (2 species), *Limatus* (1 species), *Wyeomyia* (1 species). The family Culicidae presented high richness and abundance, established by diversity indexes (Margalef a =3.26; Shannon H ' = 2.09; Simpson D = 0.19) with dominance of the species *Anopheles* (*Nyssorhyncus*) *darlingi* Root (89.8%). This species has considerable epidemiological value, considered the main vector of malaria in Mato Grosso. Many species of mosquitoes are vectors of pathogens that cause disease in humans and domestic animals, transmitting pathogens including viruses (arboviruses), filaria worms (helminths) and protozoa.

Keywords: Culicidae fauna; Faunistic analysis; Mosquitoes; Vector ecology; Viruses.

Composição de espécies e distribuição da fauna de mosquitos (Diptera: Culicidae) e sua importância para doenças transmitidas por vetores em uma área rural do centro-ocidental - Mato Grosso, Brasil

Resumo. Este estudo descreve dados ecológicos de uma área rural do Estado de Mato Grosso e dos insetos da família Culicidae especialmente aqueles enquadrados como vetores potenciais de doenças tropicais. Em 2015, coletamos mosquitos adultos em fragmentos de floresta em localidades de áreas rurais no Mato Grosso região Centro Oeste do Brasil. Foram capturados 18.256 exemplares alados de mosquitos das subfamílias Culicinae e Anophelinae e identificadas 34 espécies pertencentes a 12 gêneros: *Aedes* (1 espécie), *Anopheles* (8 espécies), *Coquillettidia* (1 espécie), *Haemagogus* (1 espécie), *Culex* (5 espécies), *Psorophora* (5 espécies), *Ochlerotatus* (4 espécies), *Deinocerites* (1 espécie), *Mansonia* (4 espécies), *Sabethes* (2 espécies), *Limatus* (1 espécie), *Wyeomyia* (1 espécie). A família Culicidae apresentou alta riqueza e abundância, estabelecida por índices de diversidade (Margalef a = 3.26, Shannon H '= 2.09, Simpson D = 0.19) com predominância da espécie *Anopheles* (*Nyssorhyncus*) *darlingi* Root (89.8%). Esta espécie tem considerável valor epidemiológico, sendo considerada o principal vetor de malária em Mato Grosso. Muitas espécies de mosquitos são vetores de patógenos que causam doenças em humanos e animais domésticos, transmitindo patógenos incluindo vírus (arboviroses), filárias (helmintos) e protozoários.

Palavras-chave: Fauna Culicidae; Análise faunística, Mosquitos, Vetores ecológicos, Vírus.

The culicids breed in a wide variety of sites of different sizes and volumes of water. Some species have considerable plasticity, adapting to diverse sites for procreation and occurring in different types of habitats (John 2008).

There are over 3,500 species of Culicidae described worldwide, and that number, according to Harbach (2017) grows about 5% every decade. Current records indicate that the number of mosquito species recognized currently varies between about 3,601 to 3,700 species and subspecies distributed in 175 genera (Rueda 2008; Rafael *et al.* 2012; Harbach 2017; Wilkerson *et al.* 2015; Gaffigan *et al.* 2015). These values are subject to continuous changes as more species have been discovered, and due to the DNA studies requiring the rearrangement of the taxonomy of Culicidae families.

Rainforest environments representing Neotropics presents greater wealth, highlighting one of the most diverse and

Edited by:
Jeronimo Augusto Alencar
Article History:
Received: 09.iii.2017
Accepted: 29.vi.2017

✉ **Corresponding author:**
Diniz Pereira Leite-Jr
djbiologico@gmail.com
http://orcid.org/0000-0002-5934-8613

Funding agencies:
FAPEMAT

abundant environments, however species diversity is largely unknown in this ecosystem (Rueda 2008). Case studies of diseases by Culicidae fauna indicate the estimated number of dipteran present in Brazil is of about 470 species (Gaffigan *et al.* 2015), with species considered as wild and anthropogenic, with great adaptability to human-modified systems and with high probability of increase in this number.

Mosquitoes belonging to the family Culicidae present cosmopolitan distribution. Multiple species are adapted to tropical and subtropical regions. Geographic distribution data are essential to improve the knowledge of mosquito systematics, as well as the epidemiology of infectious diseases get by these insects (Nielsen 1980); since that several species are considered of epidemiological value and, approximately 5% of them are involved in transmission cycles of etiological agents, including malaria and arboviruses (Consoli & Lourenço-de-Oliveira 1994).

These winged insects of subfamily Culicinae comprise the largest group with in Culicidae, a family of Nematocera dipterans divided into two subfamilies, Anophelinae (488 species) Harbach & Kitching (2016) and Culicinae (3,525 species) (Harbach 2017). Within Culicinae, 11 tribes are recognized, with 110 genera (Forattini 2002; Rueda 2008; Rafael *et al.* 2012; Wilkerson *et al.* 2015; Harbach 2017).

Species of Culicidae related to etiological agents, especially those that occur more frequently in environments modified by humans, as species of the genus *Anopheles*, *Culex* and *Aedes*, accumulate more information and studies in literature (Mattos & Xavier 1965; Forattini 2002). In Central Western Brazil, the Cerrado (Savannah) biome contains a fauna of approximately 90 species of Culicidae, with records started in the 50's. These authors have catalogued the Culicidae fauna and were able to detect the presence of 164 species in 105 locations of 24 counties of Mato Grosso (Mattos & Xavier 1965).

Research on the ecology of sylvatic insects, vectors of potential diseases in natural areas, sometimes impacted, although scarce; provide subsidies for the relevant epidemiological understanding of these organisms. These studies facilitate the identification, tracking and control of these mosquitoes in relation to environmental changes infringed by the man, who can sometimes or not culminate in major epidemics. The knowledge of Culicidae biodiversity presents epidemiological importance, aiming to improve the understanding and the dynamics of the transmission of pathogens, as well as their importance as vectors, which may contribute for the adoption of control measures in infested areas (Forattini 2002).

The reported species of medically-important arboviruses associated to mosquitoes in Mato Grosso belong to three families and tree genera: Flaviviridae (genus *Flavivirus*), Togaviridae (genus *Alphavirus*) and Bunyaviridae (genus *Orthobunyavirus*) (Cardoso *et al.* 2015; Heinen *et al.* 2015a; Zuchi *et al.* 2014).

Surveys of the Culicidae fauna are important to enlarge the knowledge of areas where these insects occur, to subsidize conservation projects, to understand the population dynamics of these groups of insects transmitting arboviruses and to reveal ways for the implementation of epidemiological control policies (Forattini 2002).

The present study aimed at identifying the Culicidae fauna present in a wild area of Cerrado, checking its distribution and, animal protection parameters. This process of survey and taxonomic identification is of importance for environmental preservation, diagnosing the richness and abundance of the Culicidae fauna in the rural area of the municipality of Barra do Bugres, Mato Grosso, Brazil serving as a subsidy in the evaluation of the processes of changes and environmental degradation caused by the action of man.

MATERIAL AND METHODS

Area of study. The study area consists of flat land interspersed with forest and waste forests, swamps, marshes, pastures and human habitations, belonging to the localities of a private farm (15°04'21"S/57°10'52"W), municipality of Barra do Bugres, State of Mato Grosso, Brazil.

The study area is 97 km away from the capital of the State, Cuiabá; 45 Km from the city of Barra do Bugres, and is located in the central-southwestern region of Mato Grosso, with an altitude of 171 meters above sea level (Figure 1). This area belong to the catchment area of the Paraguay River, presenting characteristic vegetation, with predominance of the Cerrado and Amazon biomes. The region's climate is warm and tropical sub-humid, with four months of drought from June to September (Sano & Almeida 1998).

These meteorological data confirm that the climate of Barra do Bugres/MT is Aw, according to the climatic classification of Köppen-Geiger (1928). The local climate is Aw type presents tropical characteristics, with a dry winter and a rainy summer.

The study area has 42% of PPA (*Permanent Preservation Area*) and 31% refers to sites that should be protected, as streams, perennial rivers and springs. The area searched is the meeting between the Bugres river and the Paraguay River and has an area of around 1,329 Km² (Brasil 2010).

Landscape in the study area was severely modified by excessive land use. The environmental revels predominant open fields used for pasture and restricted spot of residual forest. The human settlements are restricted to rural habitations. Streams and pools for cattle water supplies permeate all the area. The region is characterized by possessing a drainage network with wide interfluves that favors accumulation of rainwater in areas demoted, with potential for the proliferation of mosquitoes.

Mosquito capture. The Culicidae collections were carried out in 20 x 20 m plots, located within Amazon forest fragments during the year seasons between January to December 2015, on a total of 12 inserts in the camp with the same sampling effort-taking place in the seasons during the study period.

The collections were made in the afternoon to twilight, comprising periods of 17:00 the 20:00, totaling 3 hours of capture in three consecutive days. Each catch is evaluated environmental aspects, such as temperature, relative humidity, wind speed and rainfall.

The Culicidae captured on a quarterly basis, sampling method consisted of "active collections" corresponds to the result of capture in live bait protected (Marcondes *et al.* 2007). The collections were made with the aid of suction type grabber "Castro" and flashlight (Service 1993).

After the capture, the insects were stored in Entomological pots plastic containers of 500 ml, with a maximum of 30 specimens per container. The specimens collected were, fed with cotton soaked in to 10% sugar water, and kept in a Styrofoam box, covered with a damp towel, avoiding the presence of predators and aiding the survival of the insects.

Were exploited capoeira environments, open field, swamp-open, forest-soil, canopy forest; distributed in 6 defined collection sections: Area A1 (Dyke forest [14°54'21"S 56°52'56"W]), Area A2 (Forest homemade house [14°53'59"S 56°52'54"W]), Area A3 (Paraguay river forest I [14°53'57"S 56°53'21"W]), Area A4 (Paraguay river forest II [14°55'00"S 56°53'34"W]), Area A5

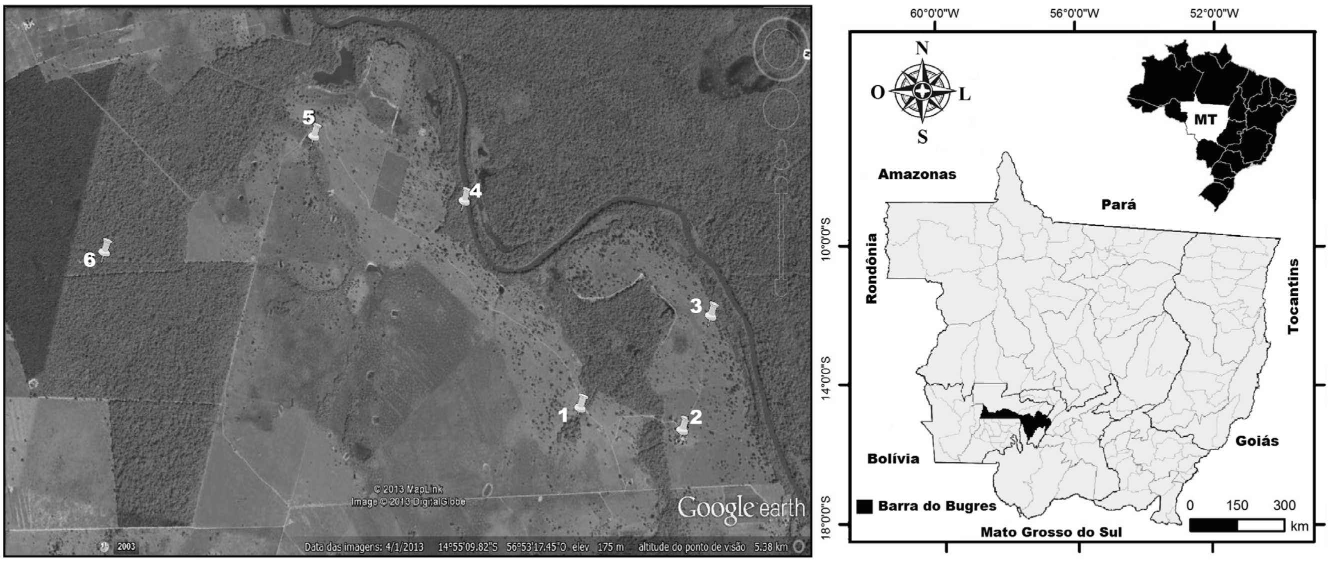

Figure 1. Localization of Diptera (Culicidae) capture sites the forests fragments in the municipality of Barra do Bugres, Mato Grosso, Brazil, in the period January to December 2015. Area A1 Dyke forest [14°54'21"S 56°52'56"W]; Area A2 Forest homemade house[14°53'59"S 56°52'54"W]; Area A3 Paraguay river forest I [14°53'57"S 56°53'21"W]; Area A4 Paraguay river forest II [14°55'00"S 56°53'34"W]; Area A5 Buritis's forest [14°55'40"S 56°53'45"W] and Area A6 Virgin forest [14°56'14"S 56°53'35"W].

(Buritis's forest [14°55'40"S 56°53'45"W]) and Area A6 (Virgin forest [14°56'14"S 56°53'35"W]) (Figure 1).

Identification of Diptera. Adult midges were captured, mounted and preserved following detailed techniques by Belkin (1967); Consoli & Lourenço-de-Oliveira (1994) and Forattini (2002). The specimens collected were identified at the Medical Entomology laboratory of the Faculty of Medicine of the Federal University of Mato Grosso in small groups (30 copies). Previously, mosquitoes were taken to the freezer at approximately -20° C for 5 minutes.

After each specimen, were placed in a dormant state on a slide and, using stereoscope microscopes at 40x, identified at specific level according to dichotomy keys of Deane *et al.* (1947); Zavortink (1927), Consoli & Lourenço-de-Oliveira (1994), and Forattini (2002). The classifications adopted to the genera and subgenera of Culicidae were abbreviated according to Reinert (2001) and Guimarães (1997) and to the genera *Aedes* and *Ochlerotatus* followed Reinert (2000; 2001), as well as the subgenera established according to WRBU (Gaffigan *et al.* 2015).

The Margalef, Shannon and Simpson diversity and dominance indexes were calculated to characterize the population of mosquitoes in the study area (Shannon 1948; Simpson 1949; Margalef 1951)

RESULTS

The collections resulted in the capture of 18,256 winged specimens of mosquitoes. Representatives of 34 species, distributed into two subfamilies (Culicinae and Anophelinae), five tribes (Aedini, Culicini, Mansonini, Sabhetini, Anophelini) and 12 genera (*Aedes*, *Ochlerotatus*, *Mansonia*, *Psorophora*, *Culex*, *Anopheles*, *Wyeomyia*, *Coquillettidia*, *Limatus*, *Haemagogus*, *Sabethes*, *Deinocerites*), all collected in wild areas sections of the farm.

Captured mosquitoes were identified and separated according to collection campaign, site of collection, species, and number of samples and frequency of captures (Table 1). These records represent twelve collection events; the ecological indices were calculated to better characterize the diversity and dominance among the species present in the samples: Margalef diversity index: α = 3.26; Shannon diversity index: H'=2.09; Simpson's diversity index: D=0.19.

The subfamily Culicinae was clearly the most abundant with 66% of the total of captured specimens, followed by Anophelinae with 34%, and by the tribe Aedini, responsible for 39% of the specimens captured. The species most often caught in each subfamily follow this trend: Culicinae: *Ochlerotatus* (*Ochlerotatus*) *scapularis* Rondani (21.7%), *Culex* (*Culex*) spp. (18.6%) and *Psorophora* (*Psorophora*) *ferox* Von Humboldt (8.0%). The subfamily Anophelinae, presented only specimens of the genus *Anopheles*, highlighting *Anopheles* (*Nyssorhyncus*) *darlingi* Root (30.5%) as the most commonly captured specimen (Table 2).

Tribes captured included the Aedini [*Oc.* (*Och.*) *scapularis*, 21.7%]; Culicini (*Cx.* (*Cux.*) spp. 18.6%); Mansonini [*M.* (*Man.*) *wilsoni* Barreto & Coutinho, 0.4%]; Sabethini [*Sa.* (*Sbo.*) *chloropterus* Humboldt (0.6%)] and Anophelini [*An.* (*Nys*) *darling*, 30.5%].

The greater eclecticism was observed between the Culicidae with 66% of the species present in the four seasons studied: 27.0% in the spring; 25.0% in the summer, 7.5% in winter and 7.0% in the autumn. *Oc. scapularis*, the most abundant, occurred preferentially in environments with wild characteristics.

The genus *Anopheles* presented the largest number of species (34%) and also the largest number of individuals captured 6,200; followed by the genus *Culex* with 4,462 (24%) of the identified species and the second number of individuals captured in the subfamily Culicinae. The rest is distributed among the other nine genera, with 7,594 (42%) individuals.

The genus *Ocherotatus* had the third largest number of individuals captured (22%), and although represent the third most abundant genera, in 4th place the genus *Psorophora* showed 17% percentage in the ranking of the genera collected (five species and 3,072 individuals) getting in front of the genus *Ocherotatus* (four species and 4,034 individuals).

It is interesting to note that more than 63.4% of the specimens collected (18,256 individuals) belong to the three most abundant genera (*Culex*, *Ocherotatus* and *Psorophora*) specimens belonging to tribes Culicini and Aedini; together representing more than 50% of identified taxa (14 species and morphospecies).

The most abundant species was *An. darlingi* with 5,566 individuals collected and, represented 30.5% of the copies identified, followed by *Oc. scapularis* (3,956; 21.7%), *Cx.* (*Cux.*)

e-ISSN 1983-0572

Table 1. Seasonality distribution of Diptera (Culicidae) in the forests fragments in the municipality of Barra do Bugres, Mato Grosso, Brazil, in the period January to December 2015.

Local / Species caught	Summer		Autumn		Winter		Spring		Total	
	N	%	N	%	N	%	N	%	N	%
Dyke forest (Area A1)										
Anopheles (*Nys.*) *darlingi*	816	38.0	92	19.5	138	22.9	680	29.5	1726	31.2
Anopheles (*Nys.*) *evansae*	0	0.0	0	0.0	0	0.0	10	0.4	10	0.2
Anopheles (*Nys.*) *triannulatus*	38	1.8	44	9.3	10	1.7	110	4.8	202	3.7
Culex (*Cux.*) spp. (1)	356	16.6	54	11.4	42	7.0	406	17.6	858	15.5
Culex (*Mel*). *ribeirensis*	8	0.4	0	0.0	0	0.0	0	0.0	8	0.1
Ochlerotatus (*Och.*) *scapularis*	542	25.2	204	43.2	300	49.8	708	30.7	1754	31.7
Ochlerotatus (*Prc.*) *aenigmaticus*	24	1.1	4	0.8	0	0.0	14	0.6	42	0.8
Psorophora (*Pso.*) *ferox*	226	10.5	42	8.9	68	11.3	166	7.2	502	9.1
Psorophora (*Pso.*) *albigenus*	126	5.9	30	6.4	44	7.3	204	8.8	404	7.3
Wyeomyia petrocchiae	14	0.7	2	0.4	0	0.0	8	0.3	24	0.4
TOTAL	**2,150**	**100**	**472**	**100**	**602**	**100**	**2,306**	**100**	**5,530**	**100**
Homemade house forest (Area A2)										
Aedes (*Stg.*) *aegypti*	0	0.0	0	0.0	0	0.0	8	0.7	8	0.3
Anopheles (*Nys.*) *albitarsis*	2	0.2	0	0.0	0	0.0	4	0.4	6	0.2
Anopheles (*Nys.*) *darlingi*	1094	87.1	64	94.1	106	88.3	984	92.1	2248	89.5
Anopheles (*Nys.*) *triannulatus*	30	2.4	0	0.0	0	0.0	26	2.4	56	2.2
Ochlerotatus (*Och.*) *scapularis*	130	10.4	4	5.9	14	11.7	46	4.3	194	7.7
TOTAL	**1,256**	**100**	**68**	**100**	**120**	**100**	**1,068**	**100**	**2,512**	**100**
Paraguay river forest I (Area A3)										
Anopheles (*Nys.*) *albitarsis*	20	7.4	0	0.0	4	6.3	20	6.4	44	6.3
Anopheles (*Nys.*) *argyritarsis*	16	5.9	0	0.0	0	0.0	8	2.5	24	3.4
Anopheles (*Nys.*) *darlingi*	30	11.0	10	20.0	12	18.8	50	15.9	102	14.6
Anopheles (*Nys.*) *evansae*	0	0.0	0	0.0	0	0.0	6	1.9	6	0.9
Anopheles (*Ano.*) *mattogrossensis*	10	3.7	2	4.0	0	0.0	4	1.3	16	2.3
Anopheles (*Ano.*) *minor*	4	1.5	0	0.0	4	6.3	8	2.5	16	2.3
Anopheles (*Nys.*) *triannulatus*	24	8.8	2	4.0	4	6.3	24	7.6	54	7.7
Coquillettidia (*Rhy.*) *nigricans*	10	3.7	0	0.0	0	0.0	10	3.2	20	2.9
Mansonia (*Man.*) *amazonensis*	16	5.9	0	0.0	4	6.3	4	1.3	24	3.4
Mansonia (*Man.*) *pseudotitilans*	6	2.2	0	0.0	0	0.0	18	5.7	24	3.4
Mansonia (*Man.*) *wilsoni*	14	5.1	4	8.0	6	9.4	12	3.8	36	5.1
Ochlerotatus (*Och.*) *bejaranoi*	4	1.5	2	4.0	2	3.1	4	1.3	12	1.7
Ochlerotatus (*Prc.*) *aenigmaticus*	4	1.5	0	0.0	2	3.1	6	1.9	12	1.7
Psorophora (*Pso.*) *champerico*	38	14.0	10	20.0	12	18.8	58	18.5	118	16.9
Psorophora (*Pso.*) *ferox*	12	4.4	2	4.0	4	6.3	6	1.9	24	3.4
Psorophora (*Pso.*) *lutzii*	10	3.7	4	8.0	2	3.1	12	3.8	28	4.0
Psorophora (*Pso.*) *albigenus*	16	5.9	4	8.0	0	0.0	10	3.2	30	4.3
Sabethes (*Sbo.*) *chloropterus*	16	5.9	4	8.0	4	6.3	20	6.4	44	6.3
Deinocerites spp.	22	8.1	6	12.0	4	6.3	34	10.8	66	9.4
TOTAL	**272**	**100**	**50**	**100**	**64**	**100**	**314**	**100**	**700**	**100**
Paraguay river forest II (Area A4)										
Anopheles (*Nys.*) *albitarsis*	20	2.6	2	1.1	4	2.2	16	2.6	42	2.4
Anopheles (*Nys.*) *argyritarsis*	10	1.3	0	0.0	0	0.0	20	3.2	30	1.7
Anopheles (*Nys.*) *darlingi*	196	25.3	30	16.5	20	10.8	172	27.7	418	23.7
Anopheles (*Nys.*) *triannulatus*	16	2.1	2	1.1	0	0.0	12	1.9	30	1.7
Mansonia (*Man.*) *amazonensis*	8	1.0	0	0.0	4	2.2	8	1.3	20	1.1
Mansonia (*Man.*) *wilsoni*	10	1.3	0	0.0	0	0.0	6	1.0	16	0.9
Ochlerotatus (*Och.*) *scapularis*	310	40.1	110	60.4	114	61.3	234	37.7	768	43.6
Psorophora (*Pso.*) *amazonica*	12	1.6	4	2.2	2	1.1	12	1.9	30	1.7

to be continued...

e-ISSN 1983-0572

Table 1. Continue...

Local / Species caught	Summer		Autumn		Winter		Spring		Total	
	N	%	N	%	N			%	N	%
Psorophora (*Pso.*) *champerico*	82	10.6	14	7.7	16	8.6	40	6.5	152	8.6
Psorophora (*Pso.*) *ferox*	80	10.3	12	6.6	20	10.8	58	9.4	170	9.6
Psorophora (*Pso.*) *lutzii*	6	0.8	0	0.0	2	1.1	12	1.9	20	1.1
Sabethes (*Sbo.*) *chloropterus*	8	1.0	2	1.1	0	0.0	20	3.2	30	1.7
Sabethes (*Sbo.*) *glaucodaemon*	16	2.1	6	3.3	4	2.2	10	1.6	36	2.0
TOTAL	**774**	**100**	**182**	**100**	**186**	**100**	**620**	**100**	**1,762**	**100**
Buritis's forest (Area A5)										
Anopheles (*Nys.*) *albitarsis*	2	0.1	4	0.7	0	0.0	4	0.2	10	0.2
Anopheles (*Nys.*) *darlingi*	466	22.6	144	24.6	132	22.4	330	14.0	1072	19.1
Anopheles (*Nys.*) *triannulatus*	12	0.6	0	0.0	0	0.0	0	0.0	12	0.2
Culex (*Cux.*) Coronator complex	24	1.2	14	2.4	0	0.0	30	1.3	68	1.2
Culex (*Cux.*) spp. (1)	460	22.3	116	19.8	124	21.1	368	15.6	1068	19.1
Culex (*Mel.*) spp. (2)	194	9.4	90	15.4	104	17.7	472	20.0	860	15.4
Culex (*Cux.*) *declarator*	72	3.5	2	0.3	0	0.0	18	0.8	92	1.6
Mansonia (*Man.*) *amazonensis*	4	0.2	2	0.3	0	0.0	4	0.2	10	0.2
Mansonia (*Man.*) *wilsoni*	0	0.0	0	0.0	0	0.0	4	0.2	4	0.1
Ochlerotatus (*Och.*) *scapularis*	426	20.7	100	17.1	126	21.4	554	23.5	1206	21.5
Ochlerotatus (*Prc.*) *oligopistus*	0	0.0	2	0.3	2	0.3	8	0.3	12	0.2
Psorophora (*Pso.*) *champerico*	174	8.4	20	3.4	20	3.4	200	8.5	414	7.4
Psorophora (*Pso.*) *ferox*	220	10.7	90	15.4	80	13.6	366	15.5	756	13.5
Psorophora (*Pso.*) *lutzii*	8	0.4	2	0.3	0	0.0	4	0.2	14	0.3
TOTAL	**2,062**	**100**	**586**	**100**	**588**	**100**	**2,362**	**100**	**5598**	**100**
Virgin forest (Area A6)										
Anopheles (*Nys.*) *albitarsis*	0	0.0	2	0.8	0	0.0	4	0.5	6	0.3
Anopheles (*Nys.*) *argyritarsis*	10	1.1	4	1.7	2	0.8	6	0.8	22	1.0
Anopheles (*Nys.*) *benarrochi*	0	0.0	0	0.0	0	0.0	18	2.3	18	0.8
Anopheles (*Nys.*) *evansae*	12	1.3	0	0.0	6	2.5	2	0.3	20	0.9
Anopheles (*Ano.*) *mattogrossensis*	4	0.4	0	0.0	0	0.0	0	0.0	4	0.2
Anopheles (*Nys.*) *triannulatus*	6	0.7	0	0.0	0	0.0	0	0.0	6	0.3
Culex (*Cux.*) spp. (1)	602	67.6	202	85.6	214	87.7	460	58.7	1478	68.6
Culex (*Cux.*) *declarator*	16	1.8	0	0.0	4	1.6	10	1.3	30	1.4
Haemagogus (*Con.*) *leucocelaenus*	26	2.9	8	3.4	2	0.8	16	2.0	52	2.4
Limatus durhamii	0	0.0	4	1.7	0	0.0	14	1.8	18	0.8
Mansonia (*Man.*) *titillans*	0	0.0	2	0.8	0	0.0	6	0.8	8	0.4
Mansonia (*Man.*) *wilsoni*	10	1.1	0	0.0	0	0.0	6	0.8	16	0.7
Ochlerotatus (*Och.*) *scapularis*	14	1.6	6	2.5	4	1.6	10	1.3	34	1.6
Psorophora (*Pso.*) *lutzii*	6	0.7	0	0.0	2	0.8	8	1.0	16	0.7
Psorophora (*Pso.*) *albigenus*	176	19.8	8	3.4	6	2.5	204	26.0	394	18.3
Sabethes (*Sbo.*) *chloropterus*	8	0.9	0	0.0	4	1.6	20	2.6	32	1.5
TOTAL	**890**	**100**	**236**	**100**	**244**	**100**	**784**	**100**	**2,154**	**100**
TOTAL GERAL	**7,404**	**#**	**1,594**	**#**	**1,804**	**#**	**7,454**	**#**	**18,256**	**#**

spp. (3,404; 18.6%); *Cx.* (*Mel.*) spp. (860; 4.7%); *Ps.* (*Pso.*) *ferox* (1,452; 8%); *Psorophora* (*Psorophora*) *albigenus* Coquillett (828; 4.5%). These five species records represent 57.5% of the specimens collected and identified. On the other hand, if we add the 23 species with less than 50 individuals, these represent 2% of the total species recorded in this study.

As the diversity of mosquitoes by location ranged between 0.19 and 3.26 (Margalef, 1951) for the forest homemade house (Area A2) and the forest Paraguay River I (Area A3), there was no difference in the number of species collected between the green areas of the farm.

In relation to the species caught in six set sections in the area of the farm, the Buritis's forest (Area 05) were considered the most representative with 5,598 (30.7%) specimens captured; being the species of *Culex*. (*Culex*) Coronator complex (1.2%) and *Ochlerotatus* (*Protoculex*) *oligopistus* Dyar (0.2%) captured exclusively at this section; followed by the Dyke forest (Area A1) with 30.3%; homemade house forest (Area A2) 13.7%; Virgin forest (Area A6) 11.8%; Paraguay river forest II (Area A4) 9.6%; Paraguay river forest I (Area A4) 3.8%, but in many species; forest river Paraguay I was the most representative with 19 species identified; followed by the virgin forest 16 species; Buritis's forest

e-ISSN 1983-0572

Table 2. Distribution of winged specimens of Culicidae and its subfamilies and tribes, captured as the seasons at private farm in the municipality of Barra do Bugres, Mato Grosso, Brazil, in the period January to December 2015.

SUBFAMILY/TRIBE/GENRE	SUBGÊNERO	SUMMER		AUTUMN		WINTER		SPRING		TOTAL	
		N	%	N	%	N	%	N	%	N	%
Subfamilya Culicinae											
Tribe Aedini											
Aedes aegypti (Linnaeus)	(*Stegomyia*)	0	0.0	0	0,0	0	0.0	8	0.3	8	0.1
Haemagogus leucocelaenus Dyar & Shannon	(*Conopostegus*)	26	1.0	8	1.2	2	0.2	16	0.5	52	0.7
Psorophora amazonica Cerqueira	(*Janthinosoma*)	12	0.4	4	0.6	2	0.2	12	0.4	30	0.4
Psorophora champerico (Dyar & Knab)	(*Janthinosoma*)	294	11.0	44	6.5	48	5.7	298	10.0	684	9.5
Psorophora ferox (Von Humboldt)	(*Janthinosoma*)	538	20.1	146	21.4	172	20.4	596	20.1	1452	20.3
Psorophora lutzii (Theobald)	(*Janthinosoma*)	30	1.1	6	0.9	6	0.7	36	1.2	78	1.1
Psorophora albigenus (Coqquillett)	(*Janthinosoma*)	318	11.9	42	6.2	50	5.9	418	14.1	828	11.6
Ochlerotatus bejaranoi (Martínez, Carcavallo & Prosen)	(*Ochlerotatus*)	4	0.1	2	0.3	2	0.2	4	0.1	12	0.2
Ochlerotatus scapularis (Rondani)	(*Ochlerotatus*)	1422	53.2	424	62.2	558	66.1	1552	52.3	3956	55.2
Ochlerotatus aenigmaticus (Cerqueira & Costa)	(*Protoculex*)	28	1.0	4	0.6	2	0.2	20	0.7	54	0.8
Ochlerotatus oligopistus (Dyar)	(*Protoculex*)	0	0.0	2	0.3	2	0.2	8	0.3	12	0.2
Total		**2,672**	**100**	**682**	**100**	**844**	**100**	**2,968**	**100**	**7,166**	**100**
Tribe Culicini											
Culex Coronator complex	(*Culex*)	24	1.4	14	2.9	0	0.0	30	1.7	68	1.5
Culex spp. (1)	(*Culex*)	1418	80.8	372	76.9	380	77.2	1234	68.6	3404	75.2
Culex spp. (2)	(*Melanoconion*)	194	11.1	90	18.6	104	21.1	472	26.3	860	19.0
Culex declarator (Dyar & Knab)	(*Culex*)	88	5.0	2	0.4	4	0.8	28	1.6	122	2.7
Culex ribeirensis (Forattini & Sallum)	(*Melanoconion*)	8	0.5	0	0.0	0	0.0	0	0.0	8	0.2
Deinocerites spp.		22	1.3	6	1.2	4	0.8	34	1.9	66	1.5
Total		**1,754**	**100**	**484**	**100**	**492**	**100**	**1,798**	**100**	**4,528**	**100**
Tribe Mansonini											
Coquillettidia nigricans (Coquillet)	(*Rhynchotaenia*)	10	12.8	0	0.0	0	0.0	10	12.8	20	11.2
Mansonia amazonensis (Theobald)	(*Mansonia*)	28	35.9	2	25.0	8	57.1	16	20.5	54	30.3
Mansonia pseudotitilans (Theobald)	(*Mansonia*)	6	7.7	0	0.0	0	0.0	18	23.1	24	13.5
Mansonia titillans (Walker)	(*Mansonia*)	0	0.0	2	25.0	0	0.0	6	7.7	8	4.5
Mansonia wilsoni (Barreto & Coutinho)	(*Mansonia*)	34	43.6	4	50.0	6	42.9	28	35.9	72	40.4
Total		78	100	8	100	14	100	78	100	178	100
Tribe Sabethini											
Sabethes chloropterus (Humboldt)	(*Sabethoides*)	32	51.6	6	33.3	8	66.7	60	65.2	106	57.6
Sabethes glaucodaemon (Dyar & Shannon)	(*Sabethoides*)	16	25.8	6	33.3	4	33.3	10	10.9	36	19.6
Limatus durhamii (Theobald)	-	0	0.0	4	22.2	0	0.0	14	15.2	18	9.8
Wyeomyia petrocchiae (Shannon & Del Ponte)	(*Davismyia*)	14	22.6	2	11.1	0	0.0	8	8.7	24	13.0
Total		62	100	18	100	12	100	92	100	184	100
Subfamily Anophelinae											
Tribe Anophelini											
Anopheles albitarsis (Lynch-Arribálzaga)	(*Nyssorynchus*)	44	1.6	8	2.0	8	1.8	48	1.9	108	1.7
Anopheles argyritarsis (Robineau-Desvoidy)	(*Nyssorynchus*)	36	1.3	4	1.0	2	0.5	34	1.4	76	1.2
Anopheles benarrochi (Gabaldón, Cova Garcia & Lopez)	(*Nyssorynchus*)	0	0.0	0	0.0	0	0.0	18	0.7	18	0.3
Anopheles darlingi (Root)	(*Nyssorynchus*)	2,602	91.7	340	84.6	408	92.3	2,216	88.0	5,566	89.8
Anopheles evansae (Brethes)	(*Nyssorynchus*)	12	0.4	0	0.0	6	1.4	18	0.7	36	0.6
Anopheles mattogrossensis (Lutz et Neiva)	(*Anopheles*)	14	0.5	2	0.5	0	0.0	4	0.2	20	0.3
Anopheles minor (Lima)	(*Anopheles*)	4	0.1	0	0.0	4	0.9	8	0.3	16	0.3
Anopheles triannulatus (Neiva et Pinto)	(*Nyssorynchus*)	126	4.4	48	11.9	14	3.2	172	6.8	360	5.8
Total		2,838	100	402	100	442	100	2,518	100	6,200	100
TOTAL		**7,404**	#	**1,594**	#	**1,804**	#	**7,454**	#	**18,256**	#

14 species; forest river Paraguay II with 13 species; Dyke forest with 10 species and homemade house forest five species.

In relation to other species caught in other set points, we can emphasize that *Aedes* (*Stegomyia*) *aegypti* Linnaeus (0.03%) was collected only in Area A2 (homemade house forest) due the proximity of residences. This Aedini present large phenotypic plasticity and adaptability to anthropophilic environments (Guimarães *et al.* 1987). We can highlight that *Wyeomyia petrocchiae* Shannon & Del Ponte still (0.4%) and *Culex* (*Melanoconion*) *ribeirensis* Forattini e Sallum (0.04%) were captured only in Area A1 (Dyke forest); *Deinocerites* spp. (9.4%), *Anopheles* (*Anopheles*) *minor* Lima (2.3%), *Ochlerotatus* (*Ochlerotatus*) *bejaranoi* Martinez, Carcavallo & Prosen (7%) and *Coquillettidia* (*Rhynchotaemia*) *nigricans* Coquillet (2.9%) were captured only in Area A3 (Paraguay river forest I); *Sabethes* (*Sabethoides*) *glaucodaemon* Dyar & Shannon (2.0%) was captured only in Area A4 (Paraguay river forest II) and *Haemagogus* (*Conopostegus*) *leucocelaenus* Dyar & Shannon (2.4%), *Limatus durhamii* (0.8%) Theobald, *An.* (*Nys.*) *benarrochi* Gabaldón, Cova Garcia & Lopez (0.8%) and *Mansonia* (*Mansonia*) *titillans* (Walker) (0.4%) were captured only in Area A6 (Virgin forest). *An.* (*Nys.*) *darlingi* (30.5%) was the dominant species, captured in five sections of the study, except for Area A6 (Virgin forest).

DISCUSSION

Pathogens are transmitted by mosquitoes and cause disease worldwide, some requiring more attention due to their epidemiological relevance for public health, such as malaria and dengue fever. Tropical countries, characterized by precarious socioeconomic conditions, are more exposed to these diseases, highlighting the growing number of human cases of disease transmitted by mosquitoes (Calzolari 2016).

The biodiversity of the study region includes many species of vectors of different ecotypes that hoods arthropods framed as potential vectors of diseases as malaria, filariasis and arboviruses.

The finding of these species may be associated to environmental changes caused by man and may also promote the emergence of new diseases, such as arboviruses, outbreaks of endemic diseases in places where they were never reported previously and the reemergence of pathogens controlled in the area in the past, causing new outbreaks (Tadei *et al.* 1998, 2000).

Ecological indexes frequently used to evaluate diversity and dominance used in the study include Margalef's diversity (a = 3.26) and Shannon diversity (H' = 2.09). These results indicate a diversity above average, which is expected in a sample obtained in manufactured environments, in a situation where the efforts were focused on the capture of populations in specific niches. Also, the Simpson's dominance index (D = 0.19) indicates a pattern of dominance of one or more species. Orlandin *et al.* (2016) demonstrated the transition of the biting activity that occurs between species of mosquitoes with diurnal and nocturnal habits, noting a few species with diurnal habits extend their activities beyond the sunset.

The locations in which the sampling was conducted are inserted into sections of the cerrado ecosystem with dense riparian areas, promoted by the presence of a high flow of the Paraguay River. The areas are in a relative conserved condition, since in this part of the country areas occupied by man are quite common. The conditions of preservation of the area studied are confirmed by the Culicidae fauna found, composed of species of winged specimens typically.

The study of ecology and wildlife of Culicidae vectors of tropical diseases is influenced by weather conditions, temperature, relative humidity, time of the season, especially during summer or high temperatures and humidity in certain areas and regions, and other factors that may contribute to the proliferation of mosquitoes.

Consoli & Lourenço-de-Oliveira (1994) discuss these influences, indicating the physical, chemical and biological factors, such as light intensity, Collection of breeding places, temperature, degree of water salinity and the presence of vegetables, which can create conditions for oviposition and proliferation of mosquitoes.

Mato Grosso is situated in the Central West of Brazil, predominating the Cerrado (Savanaah) biome. In addition, this location share specimens present in most of the Brazilian biomes (Amazonian rain forest, Atlantic forest and Caatinga). Characteristic of tropical regions, Cerrado presents two well-defined seasons: rainy summer and dry winter (Sano & Almeida 1998; Brasil 2013a).

The vast territorial extension of Mato Grosso provides a great diversity of climate conditions. Six types of climate exist in the State. The climate of the studied region is Tropical savanna, receiving the influence of tropical Monçoico climate, with a warm spring and average temperature of 24°C, varying among 20 and 30°C and 1,700 mm annual rainfall (Brasil 2013b). The rain typically hit the highest levels of precipitation during periods of higher temperature, during spring and summer.

Even before the environmental impact caused by cattle creation, Culicidae fauna in the search area is maintained wealth, with the potential for generating synanthropic nuisance species, the constant stings or serving of pathogens, as arboviruses and malaria.

The study of Culicidae fauna in the sections assessed in the study area showed that *An.* (*Nys.*) *darlingi* (30.5%) was the most dominant species, due to collecting areas and presence of mammals. The second most common species was *Oc. scapularis* (21.5%); this culicid develops in natural breeding sites in soil and transients in artificial breeding sites, drainage ditches, and its presence is strongly influenced by anthropogenic activities and with great synanthropic capacity, interacting with the man at all stages of their life cycle. This aspect raises interest and concern associated to epidemiological cycle of some arboviruses (Xavier & Mattos 1970; Santos *et al.* 1981; Consoli & Lourenço-de-Oliveira 1994).

Other species exhibited frequency, including *Cx.* (*Cul.*) spp. (19.1%); *Ps.* (*Pso.*) *ferox* Von Humboldt (9.6%), *Cx.* (*Mel.*) spp. (15.4%) and *Ps.* (*Pso.*) *albigenus* (18.3%). These species representative ness is important for wild environments (Table 1).

In 1965, several species of Culicidae were recorded and catalogued, but currently some of these species are unknown, and some studies: Santos *et al.* (1981); Charlwood *et al.* (1982); Ferreira (1999); Tadei & Thatcher (1998); Tadei *et al.* (1998); Hutchings *et al.* (2010); Misawa *et al.* (2011), Zuluaga *et al* (2012) describe then in specific environments. In this study we were able to find and catalogue 34 mosquito species, belonging to the subfamily Culicinae and Anophelinae, all represented in the State of Mato Grosso, with emphasis on the genus *Anopheles* and species *An.* (*Nys.*) *darlingi*, considered to be the main vector of malaria in Brazil (Sinka *et al.* 2012).

Among all the members of Culicidae, about 150 species, mainly the genus *Anopheles*, *Aedes*, *Haemagogus* and *Culex* are involved indirectly with the morbidity and mortality among humans (Forattini 2002; Rueda 2008; Gaffigan *et al.* 2015). The Culicidae receive special attention due to their haematophagic habits, through which become important vectors of diseases. World health organization consider mosquitoes as the most lethal animals worldwide. Among the species in the area, we can highlight the genera *Anopheles* (34%), *Culex.* (25%), *Aedes* (0.1%)

e-ISSN 1983-0572

and *Haemagogus* (0.3%) these species are considered potential vectors of arboviruses; as dengue (DENV-1.2.3.4), yellow fever (YFV), Mayaro fever (MAYV), St. Louis encephalitis (SLEV) and malaria (Segura & Castro 2007; Heinen *et al.* 2015b; Serra *et al.* 2016).

Despite these species present in their habits preferences wild environments, they are directly related to maintenance in nature of arbovirus transmission between hosts. Mosquito species *Ochlerotatus serratus* (Theobald 1901) were reported infected with St. Louis virus (SLEV), Oropouche (VORO) (Vasconcelos *et al.* 1998), Aura (AURAV) (Travassos *et al.* 2001; Sabattini *et al.* 1998) and (THUNDER) (Travassos *et al.* 2001; Turell *et al.* 2005) virus. Can still be prosecuted as potential vectors of the virus (ILHV) (Vasconcelos *et al.* 1998), recently reported in the Pantanal (Pauvolid-Correa *et al.* 2013). Similarly, *Ae. aegypti* is considered competent vector in the transmission of dengue virus (DENV), yellow fever (YFV), Mayaro (MAYV) (Degallier *et al.* 2003; Long *et al.* 2011), Rocio (ROCV) (Schatzmayr, 2001), Islanders (ILHV) (Laemmert & Hughes 1947), Bussuquara (BSQV) (Galindo *et al.* 1966) and Cacipacoré (CACV) (Figueiredo 2010).

According to Brazilian and American researchers, this lethal viral hemorrhagic fever caused urban epidemics spread by *Ae. aegypti* mosquitoes is of greater concern because urbanization and air travel put more than 130 countries infested with vector dipteran and more than 4 billion people at risk of introduction and spread of the disease (Vasconcelos & Monath 2016). This mosquito besides transmitting Yellow fever is the vector of Dengue, Chikungunya and Zika viruses in developing countries. Dengue serotype 2 is predominant in the Americas, but serotype 1 (DENV-1) predominates, although serotype four (DENV-4) was isolated in Culicidae in Cuiabá, central region of Brazil (Heinen *et al.* 2015a). This serotype were accompanied by a significant frequency in natural transovarian transmission in *Ae. aegypti* during 2015 (Cruz *et al.* 2015).

Eastern, Western and Venezuelan equine encephalitis viruses have as potential vectors *Ma.* (*Man.*) *titilans* (Rajendran & Prasad 1992), *Psorophora* spp, *An. nimbus* (Fernandez *et al.* 2000) and *Oc.* (*Och*) *scapularis* (Arnell 1976; Mitchell *et al.* 1985; Forattini *et al.* 1995). The species *Cx.* (*Cux.*) Coronator complex are related to SLEV transmission (Fernandez *et al.* 2000) and West Nile (WNV), which can also be transmitted by *Ps. ferox*, and ROCV (Arnell 1976). Recently, studies involving DENV, SLEV and MAYV reported by Zuchi *et al.* (2014) and Heinen *et al.* (2015b) demonstrate their circulation in humans in the State of Mato Grosso.

Among mosquitoes that cause the constant hassle of stings, predominated in this research *Cq.* (*Rhy.*) *nigricans* (2.9%) and the *genus Mansonia*. (1.0%) highlighting the species *M.* (*Man*) *amazonensis*, *Ma.* (*Man.*) *wilsoni*, *M.* (*Man.*) *titillans*, *M.* (*Man.*) *pseudotitillans*. In general, the genus *Mansonia* and *Coquillettidia* presented low abundance, even in the face of the massive presence of macrophytes and other aquatic plants in lakes and ponds of water present at the sections where these specimens were collected (sections 3, 4 and 5). Among the Mansoniini, we can observe that the genus *Coquillettidia* and *Mansonia* showed little tendency to the environment under anthropic action. These species have been catalogued and considered of low anthropophilic activity (Table 1).

The species of the genus *Psorophora* are also involved in LHV transmission, SSQV, ROCV (Schatzmayr, 2001), Maguari (MAGV), YFV, Guama (GUAV), Una (UNAV) and Mayaro (Segura & Castro, 2007). *Ps.* (*Pso.*) *ferox* Von Humboldt (8%) were located in four of the five sections area of intensively dense forest. This fact is due to species presenting preference for environments without human action, according to Galindo *et al.* (1966), and Forattini *et al.* (1995) (Table 2).

The specie *S. chloropterus* is a vector for YFV (Hutchings *et al.* 2010). ROCV and MAGV can be transmitted by *Oc. scapularis* and *Mansonia*. spp. respectively (Mitchell *et al.* 1984; Mitchell *et al.* 1986; Fernández *et al.* 2000). These arboviruses are described in the Brazilian Amazon region and, in the imminence of the introduction of one of these viruses in this region, these vectors could spread these arboviruses among susceptible hosts in the presence of ecological and environmental conditions favorable to arbovirus dissemination.

The species *Mansonia titillans*, *Oc. scapularis* and *Ps. ferox* were found infected naturally with a subtype of VEEV, ROCV and MAYV, respectively (Forattini *et al.* 1995, 1997; Travassos da Rosa *et al.* 1998; Mendez *et al.* 2001; Diaz *et al.* 2003; Silva *et al.* 2014).

Synanthropic species as *Ae.* (*Stg.*) *aegypti* and *Cx.* (*Mel.*) *ribeirensis* were less plentiful. Other species found, however, did not show any association with the anthropic environment, as is the case of the species *Ps.* (*Pso.*) *champerico*, *Ps.* (*Pso.*) *lutzii*, *Ps.* (*Pso.*) *amazonica*, *Ps.* (*Pso.*) *albigenu*, can be classified as asynanthopics, because these species do not tolerate changes in the environment (Forattini *et al.* 1993, 1995, 1997).

The females of the genus *Psorophora* are voracious, even when found in environments with high levels of population density showing a tendency to choose by the blood of mammals (Forattini 2002). The captured specimens of this genus *Ps.* (*Pso.*) *champerico*, *Ps.* (*Pso*) *albigenu*, *Ps.* (*Pso.*) *ferox*, *Ps.* (*Pso.*) *lutzii* and *Ps.* (*Pso.*) *amazonica* were observed in this study, due to the habit of this eclectic genre. Female *Psorophora* (*Pso*) *ferox* Von Humboldt (8.0%) *and Ps.* (*Pso.*) *albigenus* (4.6%) were species that were present when human exposure were performed during the collection campains. UNAV is widely distributed in South America, where infections have been detected in mosquitoes in this genre and hosted in vertebrates (Travassos da Rosa *et al.* 1998; Diaz *et al.* 2003). Although these studies only demonstrate the ability of these culicids to carry pathogens, they play a significant role in virus circulation in natural environments (Forattini 2002).

These behaviors probably can be directly favored by the diversity of food sources of animals as cattle and the fauna available in the region, which covers large amounts of dense forest which is home to a variety of mammals and birds and that are used as a food source for these gnats. These aspects should be considered highly relevant to maintenance of epizootic cycles of many pathogens from view of the activity of these hematophagous organisms.

Among the 6,200 anophelines captured, eight different species have been identified: *An.* (*Nys.*) *darlingi* (30.5%) set up as the most important malaria vector (Sinka *et al.* 2012), while the species: *Anopheles* (*Nyssorhynchus*) *triannulatus* Neiva et Pinto, *Anopheles* (*Ano.*) *mattogrossensis* Lutz et Neiva, *Anopheles* (*Nyssorhynchus*) *argyritarsis* Robineau-Desvoidy, *Anopheles* (*Nyssorhynchus*) *albitarsis* Lynch-Arribálzaga must be mentioned, *Anopheles* (*Anopheles*) *minor* Lima, *Anopheles* (*Nyssorhynchus*) *benarrochi* Gabaldón, Cova Garcia & Lopez and *Anopheles* (*Nyssorhynchus*) *evansae* Brethes together add up to 3.5% of the specimens captured.

Epidemiologically, the presence of individuals of the genus *Anopheles* indicate this can be considered an important genera which includes many vectors species of *Plasmodium* that cause malaria in humans. *An.* (*Nys.*) *triannulatus An.* (*Nys.*) *vestitipennis*, *An.* (*Nys.*) *oswaldoi*, *An.* (*Nys.*). *albitarsis*, *An.* (*Nys.*) *nuneztovari*, are considered auxiliary vectors of malaria; these species can be considered the main vectors of regional or local transmission (Forattini 2002).

Three species of anophelinae captured are important in the epidemiology of malaria transmission: *An. darlingi* is considered one of the most efficient malaria vectors in the region of the

e-ISSN 1983-0572

Americas (Forattini *et al.* 1993; Sinka *et al.* 2012); *An. triannulatus* considered one of the important vectors in Mato Grosso (Misawa *et al.* 2011) were found naturally infected with *Plasmodium* (Sinka *et al.* 2010) and is considered a vector for arboviruses as SLEV. *An. rondoni* and *An. albitarsis* must be mentioned as confirmed vectors of malaria in Brazil, Peru, Colombia and Venezuela (Sinka *et al.* 2012).

In Mato Grosso, the records of species obtained by Missawa *et al* (2011), captured with different collection techniques, demonstrate the importance of this genre in the State, quote: *An. benarrochi; An. darlingi*, *An. mediopunctatus*, *An. nigritarsis*, *An. oswaldoi*, *An. peryassui*, *An. rangeli*, *An. triannulatus*. Among the anophelines captured in this study, we highlight *An. darlingi* (30.5%); followed by *An. triannulatus* (2%) and *An. albitarsis* (0.6%). The natural history of this subfamily of mosquitoes has received attention of researchers from various parts of the world (Sinka *et al.* 2010; 2012), these studies have led to the knowledge of their biological characteristics, in order to discover its vulnerabilities to more easily monitor and control their populations (Forattini 2002).

Deane *et al.* (1947; 1948) and Lucena (1950) found a high degree of zoophilia related to *An. albitarsis*. This species presents sharp ease in performing blood repast in large animals such as cattle and horses. According to Guimarães *et al.* (1987) and Guimarães (1997), these researchers were able to observe a clear preference in another genre, identifying in *Oc. scapularis* a definite predilection for sucking large animals and this action would be influenced by the density and availability of these sources in the places, where there is the presence of these specimens.

The significant presence of *Oc. scapularis*, species adaptable to modified environments Forattini (1986), allows the interpretation that the preservation of the area has not yet reached the climax in addition to suffer influence of anthropogenic activity mainly in its surroundings. Still, there are many reports about the presence of *Oc. scapularis* in wild areas also under intense anthropogenic action (Guimarães *et al.* 1987; Guimarães 1997; Forattini *et al.* 1990, 1995, 1993). Despite the existing reports on this species, there is a certain tendency of the species being in the process of adaptation to human coexistence. These claims can be confirmed, when they accounted for the collections in the area searched; where the region receives constantly cattle all over the year, which justifies the high number of *An. darlingi* (30.5%) and *Oc. scapularis* (21.7%) in the inserts to the field. We can highlight the values collected in the seasons summer, autumn, winter and spring for the most numerous species, *An. darlingi* (2,602, 340, 408, 2,216) and *Oc. scapularis* (1,422, 424, 558, 1,552) (Table 2).

In relation to the species caught in six set sections in the area searched, the forest that were most representative were Buritis's forest with 30.7% of individuals collected. Culicidae populations, which are located at these sections and specific areas, must be the breeding grounds and water leases of these environments, some species demonstrate ability to vary in their biology and to adapt to different environmental conditions (Table 1).

The composition and species richness of Culicidae differed between study sites, probably by the conservation state of forest fragments. The presence, even if it is small; on wealth and on prevalence of wild species as representatives of tribes Sabethini (*Haemagogus leucocelaenus* Dyar & Shannon) and Aedini, suggests reduced anthropogenic action; on the other hand, the non-wild species dominance, especially *Oc. scapularis*, can indicate a high degree of environmental degradation in the place searched.

Attention observed to two species of mosquitoes interesting finding, *Ochlerotatus* (*Ochlerotatus*) *bejaranoi* Martinez, Carcavallo & Prosen, only related in Bolivia, the Paraguai River covers the Bolivian territory (Martinez *et al.* 1960) and brazilian territory. The same situation to *Psorophora* (*Ps.*) *champerico* (Dyar & Knab), related in Paraná state, in Brazil. Records of the distribution includes Central America and Amazon region (Reinert *et al.* 2005, Muller *et al.* 2012; Guedes & Navarro-Silva 2014). This is the first report of the species in the Cerrado, central-southwestern region, indicating estimation of its distribution.

In conclusion, the study area displays a culicid-rich fauna, with species relevant to public health. Studies of the behavior of mosquitoes and insect fauna are of great epidemiological relevance, since it may provide data that will support actions to combat and control vector species by the competent organs. In accordance to technical standards of monitoring and controlling malaria in Brazil, the region of Barra do Bugres can be taken as of sporadic transmission of this pathogen. An increasing number of large epidemics involving arboviruses pathogenic for humans (for example, DENV, CHIKV and ZIKV), seasonally in the State of Mato Grosso, these findings represent more and more risk of expansion of potential infections by these pathogens. In this regard, epidemics of arboviruses infections are recorded annually in the state with high incidence.

Preventive measures based on entomological surveillance that allow monitoring of the behavior of vectors of these tropical diseases and thus maintain the health of neighboring populations are fundamental in the State. The constant presence and abundance of *An. darlingi* and other species of the genus identified in this study constitutes an alert to the possibility of outbreaks of malaria in the region, since these species represents the main vector in the State and in other parts of Brazil. The richness of species involved in the transmission of emerging diseases and endemic in the area studied show and goes against the need for a permanent entomological surveillance; considering the presence of several species an issue as vectors for etiological agents. This fact requires special attention of health and sections to the need for additional studies.

ACKNOWLEDGEMENT

Financial support for this study were provided by FAPEMAT - Research Foundation in the State of Mato Grosso [Foundation for the Support of Science of the State of Mato Grosso].

REFERENCES

Arnell, J.H., 1976. A revision of the Scapularis group of *Aedes* (*Ochlerotatus*). Mosquito studies (Diptera: Culicidae) XXXIII. Control American Entomologist Institute; 13:1-144.

Belkin, A.P.G., 1967. Estudios sobre Mosquitos (Diptera: Culicidae). Ia. Um Proyecto para um estúdio sistemático de los mosquitos de Meso-America. IIa. Metodos para colecionar criar y preservar mosquitos. American Entomologist Institute, 89 p.

Brasil, 2013a. Mato Grosso e Seus Municípios. Avaliable on: <http://mteseusmunicipios.com.br/NG/conteudo.php?sid=294&cid=1328>. [Acessed: February 2016].

Brasil, 2013b. Decreto nº. 6321. Avaliable on: <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/Decreto/D6321.htm>. [Acessed: February 2016].

Brasil - IBGE. 2010. Instituto Brasileiro de Geografia e Estatística. Avaliable on: <http://www.ibge.gov.br/home>. [Acessed: September 2016].

Calzolari, M., 2016. Mosquito-borne diseases in Europe: an emerging public health threat. Reports in Parasitology, 1-12. DOI: https://doi.org/10.2147/RIP.S56780.

Cardoso, B.F., O.P. Serra, L.B.S. Heinen, N. Zuchi, V.C. Souza, F.G. Naeca, M.A.M.Santos & R.D. Slhassarenko, 2015. Detection of Oropouche virus segment S in patients and in *Culex quinquefasciatus* in the state of Mato Grosso, Brazil. Mem Inst Osvaldo Cruz, 110: 745-754. DOI: https://doi.org/10.1590/0074-02760150123.

Charlwood, J.D., J Lopes & P.C. Whalley, 1982. Light intensity measurement and the biting behaviour of some sylvatic mosquitoes of the Amazon basin (Diptera: Culicidae). Acta Amazônica, 12:61-64. DOI: https://doi.org/10.1590/1809-43921982121061.

Consoli, R.A.G.B & R. Lourenço-De-Oliveira, 1994. Principais mosquitos de importância sanitária no Brasil. 2ª. Ed. Rio de Janeiro: FIOCRUZ, 228p.

Cruz L.C.T.A, O.P. Serra, F. A. Leal-Santos, A.L.M. Ribeiro, R. Dezengrini Slhessarenko & M.A. Santos. 2015. Natural transovarial transmission of dengue virus 4 in *Aedes aegypti* from Cuiabá, State of Mato Grosso, Brazil. Revista da Sociedade Brasileira de Medicina Tropical, 48: 18-25. DOI: http://doi.org/10.1590/0037-8682-0264-2014.

Deane L.M, O.R., M.P. Causey & M.P. Deane, 1948. Notas sobre a distribuição e a biologia dos anofelinos das regiões Nordestina e Amazônica do Brasil. Revista de Saúde Pública. 1: 827-965.

Deane, L.M., O.R. Causey, M.P. & M.P. Deane, 1947. Chave ilustrada para identificação de 35 espécies de anofelinos das regiões nordestina e amazônica do Brasil pelos caracteres da fêmea com notas sobre os transmissores de Malária (Diptera: Culicidae). Memórias do Instituto Oswaldo Cruz, 71: 102.

Degallier, N., J.M.S. Teixeira, S.S. Soares, R.D. Pereira, S.C.F. Pinto, A.J.M. Chaib, P.F.C. Vasconcellos & E. Oliveira, 2003. *Aedes albopictus* may not be vector of dengue virus in human epidemics in Brazil. Revista de Saúde Pública 37: 386-387. DOI: https://doi.org/10.1590/S0034-89102003000300019.

Diaz, L.A., L.I. Spinsanti, W.R. Almiron & M.S. Contingiani, 2003. UNA virus: first report of human infection in Argentina. Revista do Instituto de Medicina Tropical de São Paulo, 45: 109-110. DOI: https://doi.org/10.1590/S0036-46652003000200012.

Fernández, Z., R. Richarts, R.A. Travassos & V.T. Soccol, 2000. Identification of the encephalitis equine virus, Brazil. Revista de Saúde Pública, 34: 232-235. DOI: https://doi.org/10.1590/S0034-89102000000300004.

Ferreira, R.L.M., 1999. Densidade de oviposição, e quantificação de larvas e pupas de *Mansonia* Blanchard, 1901 (Diptera: Culicidae), em *Eichhornia crassipes* Solms. E *Pistia stratiotes* Linn. na Ilha da Marchantaria, Amazonia central. Acta Amazônica, 29: 123-134. DOI: https://doi.org/10.1590/1809-43921999291134.

Figueiredo, M.L.G., 2010. Identificação de flavivirus infectando culicídeos de 1999 a 2007 no Brasil. Universidade de São Paulo. Tese. Instituto de Ciências Biomédicas – Universidade de São Paulo - São Paulo, 60 f.

Forattini, O.P., A.C. Gomes, J.L.F. Santos, I. Kakitani & D. Marucci, 1990. Frequency of occurrence in the human environment dispersal of Culicidae mosquitoes in an area adjacent to a primitive Atlantic plain forest. Revista de Saúde Pública, 24: 101-107. DOI: https://doi.org/10. 1590/S0034-89101990000200004.

Forattini, O.P., I. Kakitani & M.A.M. Sallum, 1997. Breeding places of *Aedes scapularis* (Diptera: Culicidae) in artificial containers. Revista de Saúde Pública, 31: 519-522. DOI: https://doi.org/10.1590/S0034-89101997000600013.

Forattini, O.P., I. Kakitani, E. Massad & D. Marucci, 1995. Studies on mosquitoes (Diptera: Culicidae) and anthropic environment: Synanthropy and epidemiological vector role of *Aedes scapularis* in South-Eastern Brasil. Revista de Saúde Pública, 29: 199–207. DOI: https://doi.org/ 10.1590/S0034-89101995000300007.

Forattini, O.P., I. Kakitani, E. Massad & D. Marucci, 1993. Studies on mosquitoes (Diptera: Culicidae) and antropic environment: 4-survey of resting adults and synanthropic behaviour in South-Eastern, Brazil. Revista de Saúde Pública, 27: 398-411. DOI: https://doi.org/10. 1590/S0034-89101993000600002.

Forattini, O.P., A.C. Gomes, D. Natal & J.L.F. Santos, 1986. Observations on mosquito activity in primitive highland rain forest in the Ribeira Valley, S. Paulo, Brazil. Revista de Saúde Pública, 20: 1-20. DOI: http://doi.org/10.1590/S0034-89101986000100001.

Forattini, O.P., 2002. Culicidologia Médica. Identificação, Biologia e Epidemiologia. São Paulo: EDUSP. Vol. 2. 864 p.

Gaffigan, T.V., R.C. Wilderson, J.E. Pecor, J.A. Stoffer & T. Anderson, 2015. Systematic Catalog of Culicidae - Walter Reed Biosystematics Unit. Available on: <http://www.mosquitocatalog.org/>. [Acessed January 2016].

Galindo, P., S. Srihongse, E. Rodaniche & M.A. Grayson. 1966. An ecological survey for arboviruses in Almirane, Panamá, 1959-1962. American Journal Tropycal and Hygiene, 15: 385-400. DOI: https://doi.org/10.4269/ajtmh.1966.15.385.

Guedes, M.L.P. & M.A. Navarro-Silva. 2014. Mosquito community composition in dynamic landscapes from the Atlantic Forest biome (Diptera, Culicidae). Revista Brasileira de Entomologia 58: 88-94. DOI: https://doi.org/10.1590/S0085-56262014000100014.

Guimarães, A.E., M. Arlé & R.N. Machado, 1987. Machado Mosquitoes in Serra dos Órgãos National Park, Rio de Janeiro State, Brazil. IV Feeding Preference. Memórias do Instituto Oswaldo Cruz, 82: 277-285. DOI: https://doi.org/10.1590/S0074-02761987000200016.

Guimarães, J.H., 1997. Systematic database of Diptera of the Americas South of the United States (Family Culicidae). São Paulo: FAPESP, 286 p.

Harbach, R.E & I.J. Kitching, 2016. The phylogeny of Anophelinae revisited: inferences about the origin and classification of Anopheles (Diptera: Culicidae). Zoologica Scripta, 45: 34-47. DOI: https://doi.org/10.1111/zsc.12137.

Harbach, R.E., 2017. Mosquito Taxonomic Inventory. Avaliable on: <http://mosquito-taxonomic-inventory.info/sites/mosquito-taxonomic-inventory.info/files/Valid%20Species%20%28composi-te%20Aedes%29_1.pdf>. [Acessed: May 2017].

Heinen, L.B.S., N. Zuchi, B.F Cardoso, F.A.L. Santos, M.A.M Santos, M.L. Nogueira & R. Dezengrini-Slhessarenko, 2015a. Dengue outbreak in Mato Grosso, West-Central Brazil in 2011-2012. Revista do Instituto de Medicina Tropical de São Paulo, 57: 1-8. DOI: https://doi.org/10.1590/S0036-46652015000600005.

Heinen, L.B.S., N. Zuchi, Serra, O.P., B.F. Cardoso, B.H.F. Gondim, M.A.M. Santos, F.J.D. Souto, D.A.J. Paula, V. Dutra & R. Dezengrine-Slhassarenko, 2015b. Saint Louis Encephalitis Virus In Mato Grosso, Central-Western Brazil. Revista do Instituto de Medicina Tropical de São Paulo, 57: 215-220. DOI: https://doi.org/10.1590/S0036-46652015000300006.

Hutchings, R.S.G., R.W Hutchings & M.A.M. Sallum, 2010. Culicidae (Diptera, Culicomorpha) from the western Brazilian Amazon: Juami-Japurá Ecological Station. Revista Brasileira de Entomologia, 54: 687-91. DOI: https://doi.org/10.1590/S0085-56262010000400022.

John, B., 2008. Mosquito Ecology – Field Sampling Methods. 3ª. Ed. Mosq. Ecol. Springer. Avaliable on: <http://www.springer.com/life+sciences/entomology/book/978-1-4020-6665-8>. [Acessed September 2016].

Köppen, W. & R. Geiger, 1928. Klimate der Erde. Gotha: Verlag Justus Perthes. Wall-map 150 cm x 200 cm.

Laemmert, H.W & T.P. Hughes. 1947. The virus of Ilhéus encephalitis; isolation, serological specificity and transmission. Journal of Immunology, 55: 61-67.

Long, K.C., A.S. Ziegler, S. Thangamani, N.L. Hausser, T.J. Kochel, S. Higgs & R.B. Tesh, 2011. Experimental transmission of Mayaro virus by *Aedes aegypti*. American Journal Tropical Medicine and Hygiene, 85: 750-757. DOI: https://doi.org/10.4269/ajtmh.2011.11-0359.

Lucena, D.T., 1950. Hábitos domiciliares do *Anopheles tarsimaculatus* Goeldi, 1905. Revista Brasileira de Malariologia e Doenças Tropicais, 2: 239-260.

Marcondes, C.B., J. Alencar, V.Q. Balbino & A.E. Guimarães, 2007. Description of three practical and inexpensive devices for the collection of mosquitoes and other small

insects. Journal American Mosquito Control Association 23: 84-86. DOI: https://doi.org/10.2987/8756-971x(2007)23[84:dotpai]2.0.co;2.
Margalef, R., 1951. Diversidad de espécies em las comunidades naturales. Public Institute Biological Apllicance, 6: 59-72.
Martinez, A., R.U. Carcavallo & A.F. Prosen, 1960. Una nueva especie de Culicidae (Diptera) de Bolivia. Buenos Aires. Faculdade de Ciências Medicas Catedra. Revista de Microbiologia y Parasitologia, 28: 125-129.
Mattos, S.S. & S.H. Xavier, 1965. Distribuição geográfica dos Culicídeos do Brasil (Diptera: Culicidae). Revista Brasileira de Malariologia e Doenças Tropicais, 17: 269-291.
Mendez, W., J. Liria, J.C. Navarro, C.Z. Garcia, J.E. Freier, R. Salas, S.C. Weaver & R. Barrera, 2001. Spatial dispersion of adult mosquitoes (Diptera: Culicidae) in a sylvatic focus of Venezuelan equine encephalitis virus. Journal of Medical Entomology, 38, 813-821. DOI: https://doi.org/10.1603/0022-2585-38.6.813.
Missawa, N.A., A.L.M. Ribeiro, G.B.M.L. Maciel & P. Zeilhofer, 2011. Comparison of capture methods for the diagnosis of adult anopheline populations from State of Mato Grosso, Brazil. Revista da Sociedade Brasileira de Medicina Tropical 44: 555-560. DOI: https://doi.org/10.1590/ S0037-86822011005000053.
Mitchell, C.J. & O.P. Forattini, 1984. Experimental transmission of Rocio encephalitis virus by *Aedes scapularis* (Diptera: Culicidae) from the epidemic zone in Brazil. Journal of Medicine and Entomology; 21: 34-37. DOI: https://doi.org/10.1093/jmedent/21.1.34.
Mitchell, C.J., T.P. Monath, M.S. Sabattini, C.B. Croop, J.F. Daffner, C.H. Calisher, D.L. Jakob & H.A.Christensen, 1985. Arbovirus investigations in Argentina 1927-1980. II. Arthropod collections and virus isolation from Argentine mosquitoes. American Journal Tropical Medicine and Hygiene, 34: 945-955. DOI: https://doi.org/10.4269/ajtmh.1985.34.945.
Mitchell, C.J., O.P. Forattini & B.R. Miller, 1986. Vector competence experiments with Rocio virus and three mosquito species from the epidemic zone in Brazil. Revista de Saúde Pública 20: 171-177. DOI: https://doi.org/10.1590/S0034-89101986000300001.
Muller, G.A., A.C. Dalla Bona, C.B. Marcondes & M.A. Navarro-Silva, 2012. Crepuscular activity of culicids (Diptera, Culicidae) in the peridomicile and in the remaining riparian forest in Tibagi river, State of Paraná, Brazil. Revista Brasileira de Entomologia, 56: 111-114. DOI: https://doi.org/10.1590/S0085-56262012005000006.
Nielsen, L.T., 1980. The current Status of Mosquito Systematics. Mosquito Systematic, 12: 1-6.
Orlandin, E., E.B. Santo, M. Piovesan, M.A. Faretto, A.H. Schneeberger, V.O. Souza, G.A. Muller & G. Wagner, 2016. Mosquitoes (Diptera: Culicidae) from crepuscular period in an Atlantic Forest area in Southern Brazil. Brazilian Journal of Biology, 77: 60-67. DOI: https://doi.org/10.1590/1519-6984.09815.
Pauvolid-Corrêa, A., J.L. Kenney, D. Couto-Lima, Z.M.S. Campos, H.G. Schatzmayr, R.M.R. Nogueira, A.C. Brault & N. Komar, 2013. Ilheus virus isolation in the Pantanal, west-central Brazil. PLoS Negligent Tropical Disease, 7: e2318. DOI: https://doi.org/10.1371/journal.pntd.0002318.
Rafael, J.A., G.A.R. Melo, C.J.B. Carvalho, S.A. Casari & R. Constantino. 2012. Insetos do Brasil: Diversidade e Taxonomia. 1ª. Ed. Ribeirão Preto. Holos, 810 p.
Rajendran, R. & R.S. Prasad, 1992. Influence of mite infestation on the longevity and fecundity of the mosquito *Mansonia uniformis* (Diptera: Insecta) under laboratory conditions. Journal of Bioscience, 17: 35-40. DOI: https://doi.org/10.1007/bf02716771.
Reinert, J.F., R.E. Harbach & M.A.M. Sallum, 2005. Checklist of aedine mosquito species (Diptera, Culicidae, Aedini) occurring in Middle and South America (south of the United States) reflecting current generic and subgeneric status. Revista Brasileira de Entomologia, 49: 249-252. DOI: https://doi.org/10.1590/S0085-56262005000200009.
Reinert, J.F., 2000. New classification for the composite genus *Aedes* (Diptera: Culicidae: Aedini), elevation of subgenus *Ochlerotatus* to generic rank, reclassification of the other subgenera, and notes on certain subgenera and species. Journal American Mosquito Control Association, 16: 175-188.
Reinert, J.F., 2001. Revised list of abbreviations for genera and subgenera of Culicidae (Diptera) and notes on generic and subgeneric changes. Journal American Mosquito Control Association, 17: 51-55.
Rueda, L.M., 2008. Global diversity of mosquitoes (Insecta: Diptera: Culicidae) in freshwater. Hydrobiologia, 595: 477-487. DOI: https://doi.org/10.1007/978-1-4020-8259-7_48.
Sabattini, M.S., G. Aviles & T.P. Monath, 1998. Historical, epidemiological and ecological aspects of arbovirus in Argentina: Flaviviridae, Bunyaviridae and Rhabdoviridae. An Overview Arbovirology in Brazil Neighboring Countries. p. 113-34.
Sano, S.M. & S.P. Almeida, 1998. Cerrado: Ambiente e Flora. 1ª. Ed. Planaltina: EMBRAPA. 556 p.
Santos, J.M.M.D, E.P.B. Contel & W.E. Kerr. 1981. Biologia de Anofelinos Amazônicos. I. Ciclo Biologico, Postura e Estadios Larvais de *Anopheles darlingi* Root 1926 (Diptera: Culicidae) da Rodovia Manaus - Boa Vista. Acta Amazonica, 11: 789-797. DOI: https://doi.org/10.1590/1809-43921981114789.
Schatzmayr, H.G., 2001. Viroses emergentes e reemergentes. Cadernos de Saúde Pública 17: 209-213. DOI: https://doi.org/10.1590/s0102-311x2001000700031.
Segura, M.N.O. & F.C. Castro, 2007. Atlas de Culicídeos na Amazônia Brasileira. Belém: Instituto Evandro Chagas, 77 p.
Serra, O.P., B.F. Cardoso, A.L.M. Ribeiro, F.A. Leal-Santos & R. Dezengrini-Slhessarenko, 2016. Mayaro virus and dengue virus 1 and 4 natural infection in culicids from Cuiabá, state of Mato Grosso, Brazil. Memórias do Instituto Oswaldo Cruz, 111: 20-29. DOI: https://doi.org/10.1590/0074-02760150270.
Service, M.W., 1993. Mosquito Ecology: Field Sampling Methods, 2nd ed. Elsevier Applied Science Publishers Ltd, London. 583 p.
Shannon, C.E., 1948. The Mathematical theory of communication. The Bell System Technical Journal, 27: 379-423.
Silva, J.R., M.F. Romeiro, W.M. Souza, T.D. Munhoz, G.P. Borges, A.O. Soares, C.H. Campos, R.Z. Machado, M.L. Silva, J.L. Faria, J.H. Chávez & L.T. Figueiredo, 2014. A Saint Louis encephalitis and Rocio virus sero survey in Brazilian horses. Revista da Sociedade Brasileira de Medicina Tropical, 47: 414-417. DOI: https://doi.org/10.1590/0037-8682-0117-2014.
Simpson, E.H., 1949. Measurement of diversity. Nature, 163: 688. DOI: https://doi.org/10.1038/163688a0.
Sinka, M.E., M.J. Bangs, S. Manguin, Y. Rubio-Palis, T. Chareonviriyaphap, M. Coetzee, C.M. Mbogo, J.Hemingway, A.P. Patil, W.H. Temperley, P.W. Gething, C.W. Kabaria, T.R. Burkot, R.E. Harbach & S.I Hay, 2012. A global map of dominant malaria vectors. Parasit Vectors, 5: 69. DOI: https://doi.org/10.1186/1756-3305-5-69.
Sinka, M.E., Y. Rubio-Palis, S. Manguin, A.P. Patil, W.H. Temperley, P.W. Gething, T. Van Boeckel, C.W. Kabaria, R.E. Harbach & S.I. Hay, 2010. The dominant Anopheles vectors of human malaria in the Americas: occurrence data, distribution maps and bionomic précis. Parasites and Vectors 4: 210. DOI: https://doi.org/10.1186/1756-3305-5-69.
Tadei, W.P. & Thatcher, B.D., 2000. Malaria vectors in the Brazilian amazon: Anopheles of the subgenus Nyssorhynchus. Revista do Instituto de Medicina Tropical de São Paulo, 42: 87-94. DOI: https://doi.org/10.1590/s0036-46652000000200005.
Tadei, W.P., B.D. Thatcher, J.M. Santos, V.M. Scarpassa, I.B. Rodrigues & M.S. Rafael, 1998. Ecologic observations on anopheline vectors of malaria in the Brazilian Amazon.

American Journal Tropical Medicine and Hygiene, 59: 325-335. DOI: https://doi.org/10.4269/ajtmh.1998.59.325.

Travassos Da Rosa, A.P., M.J. Turell, D.M. Watts, A.M. Powers, P.F. Vasconcelos, J.W. Jones, T.A. Klein, D.J. Dohm, R.E. Shope, N. Degallier, V.L. Popov, K.L. Russell, S.C. Weaver, H. Guzman, C. Calampa, A.C. Brault & A.P. Lemon, R.B. Tesh, 2001. Trocara virus: a newly recognized Alphavirus (Togaviridae) isolated from mosquitoes in the amazon basin. American Journal Tropical Medicine and Hygiene, 64: 93-97. DOI: https://doi.org/10.4269/ajtmh.2001.64.93.

Travassos Da Rosa, J.F.S., A.P.A. Travassos Da Rosa, P.F.C. Vasconcelos, F.P. Pinheiro, S.G. Rodrigues, E.S. Travassos Da Rosa, L.B. Dias & A.C.R. Cruz, 1998. Arboviruses isolated in the Evandro Chagas Institute, including some described for the first time in the Brazilian Amazon Region, their know hosts and their pathology for man. Instituto Evandro Chagas, Belém, p. 19-31.

Turell, M.J., M.L. O'guinn, J.W. Jones, M.R. Sardelis, D.J. Dohm, D.M. Watts, R. Fernandez, A. Travassos da Rosa, H. Guzman, R. Tesh, C.A. Rossi, G.V. Ludwig, J.A. Mangiafico, J. Kondig, L.P. Wasieloski, J. Pecor & M. Zyzak, G. Schoeler, C.N. Mores, C. Calampa, J.S. Lee & T. A. Klein, 2005. Isolation of Viruses from Mosquitoes (Diptera: Culicidae) Collected in the Amazon Basin Region of Peru. Journal Medical and Entomology, 42: 891-898. DOI: https://doi.org/10.1603/0022-2585(2005)042[0891:iovfmd]2.0.co;2.

Vasconcelos, P.F. & T.P. Monath, 2016. Yellow Fever Remains a Potential Threat to Public Health. Vector-Borne and Zoological Diseases, 16: 566-67. DOI: https://doi.org/10.1089/vbz.2016.2031.

Vasconcelos, P.F.C., J.F.S. Travassos & S.G. Rodrigues, 1998. Arboviruses pathogenic for man in Brazil, p. 72-99. *In*: Travassos da Rosa, A.P.A., P.F.C. Vasconcelos & J.F.S. Travassos da Rosa (Eds.). An Overview Arbovirology in Brazil Neighboring Countries. Belém: Instituto Evandro Chagas.

Wilkerson, R.C., Y.M. Linton, D.M. Fonseca, T.R. Schults, D.C. Price & D.A. Strickman, 2015. Making Mosquito Taxonomy Useful: A Stable Classification of Tribe Aedini that Balances Utility with Current Knowledge of Evolutionary Relationships. PLOS ONE, 10: e0133602. DOI: https://doi.org/10.1371/journal.pone.0133602.

Xavier, S.H. & S.S. Mattos, 1970. Distribuição geográfica dos culicíneos no Brasil (Diptera, Culicidae). II Estado de Mato Grosso. Revista Brasileira de Malariologia e Doenças Tropicais 22: 441-460.

Zavortink, T.J., 1927. Mosquito Studies (Diptera: Culicidae) XXVIII. The New World species formerly placed in Aedes (Finlaya). American Entomology Institute 8: 206.

Zuchi, N., L.B.S. Heinen, M.A.M. Santos, F.C. Pereira & R. Dezengrini-Slhessarenko, 2014. Molecular detection of Mayaro virus during a dengue outbreak in the state of Mato Grosso, central-west Brazil. Memórias do Instituto Oswaldo Cruz, 109: 820-823. DOI: https://doi.org/10. 1590/0074-0276140108.

Zuluaga, W.A., Y.L. López, L. Osorio, L.F. Slazar, M.C. González, C.M. Ríos, M.I. Wolff & J.P. Escobar, 2012. Vigilancia entomológica de insectos de importancia en salud pública durante la construcción de los proyectos hidroeléctricos Porce II y Porce III, Antioquia, Colombia, 1990-2009. Biomédica, 32. DOI: https://doi.org/10.7705/biomedica.v32i3.668.

****

Suggestion citation:

Leal-Santos, F.A., A.C.M. Jacobina, M.M.Oliveira, M.B. Arruda Santana, O.P. Serra, A.V. Gonçalves, A.R.S. Garcêz, S.F. Thies, R.D. Slhessarenko, E.S.O. Dantas & D.P. Leite-Jr, 2017. Species composition and fauna distribution of mosquitoes (Diptera: Culicidae) and its importance for vector-borne diseases in a rural area of Central Western - Mato Grosso, Brazil. EntomoBrasilis, 10 (2): 94-105.
Available on: doi:10.12741/ebrasilis.v10i2.687