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New records of mosquito species (Diptera: Culicidae) for Bahia (Brazil)

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Abstract

We provide seven new identified mosquitoes in the Bahia State, Brazil: *Coquillettidia nigricans*, *Johnbelkinia longipes*, *Limatus pseudomethysticus*, *Psorophora albipes*, *Sabethes belisarioi*, *Sabethes cyaneus* and *Sabethes quasicyaneus*. This new finding which expands the known distribution of these seven species of mosquitoes, is of great importance as we work for the development of preventive measures for arboviruses in Brazil and globally. In other regions of the world, the culicids we report are known vectors of important arboviruses of human and non-human animal concern, including *yellow fever*, *Saint Louis encephalitis*, *equine encephalitis*, *Guama*, *Una*, *Mayaro*, *wyeomyia* and *Kairi* viruses, and may play a role in the epidemiology of these diseases in Bahia as well. Our work also highlights the paucity of data on the insect diversity in different environments in Brazil.

Keywords: Culicidae, Insects, Arbovirus, Atlantic Forest, Agroforestry system, Brazil

1. Introduction

The Diptera, family Culicidae, includes several epidemiologically important species, mostly related to their role in the transmission of arboviruses and malaria parasites, but also due to the physical annoyance caused by their bites [1, 2, 3]. The Brazilian northeast state of Bahia is included in the geographical distribution of several arboviruses [4, 5], with the first case of Zika virus in humans in Brazil occurring in this state in 2015 [6]. However, few studies have described the mosquito fauna in Bahia state and the information available is mostly restricted to those species associated with dengue and malaria transmission, such as *Aedes* and *Anopheles* genus, respectively [7-14]. Knowledge of the distribution of mosquito species is essential for understanding the risks to human and animal health and for development of future control measures [1, 3]. The objective of the present paper is to present new records of seven mosquito species belonging to five genera in the State of Bahia, Brazil and to discuss the role of these species in the transmission of arboviruses [1-3].

2. Materials and methods

2.1 Collection sites

We collected mosquitoes in six different localities of Ilhéus and Una municipalities, belonging to the Bahia Atlantic Forest domain, in Northeast Brazil (Fig. 1 and Table 1). The Atlantic Forest biome is characterized by dense ombrophiles forest and a tropical climate [15]. The mean annual temperature of this region is 24°C and rainfall average is 1500 mm/yr [16, 17]. The collection sites were selected in sylvatic (Lagoa Encantada, Una Biological Reserve and Ecoparque de Una) and rural environments (Almada, Santa Rita and Colônia de Una Farms) (Table 1). Except for the forest fragments, all other study sites were areas of high human activities, and were classified as either agriculture or agroforestry systems. Agriculture sites were those that had been clear-cut into open area agricultural plantations. The agroforestry system in Bahia is called cabruca, where cacao is grown in the shade of native canopy trees [18]. Mosquitoes were captured opportunistically by State and Health Entomological Services during their surveillance programs between 2009 to 2014.

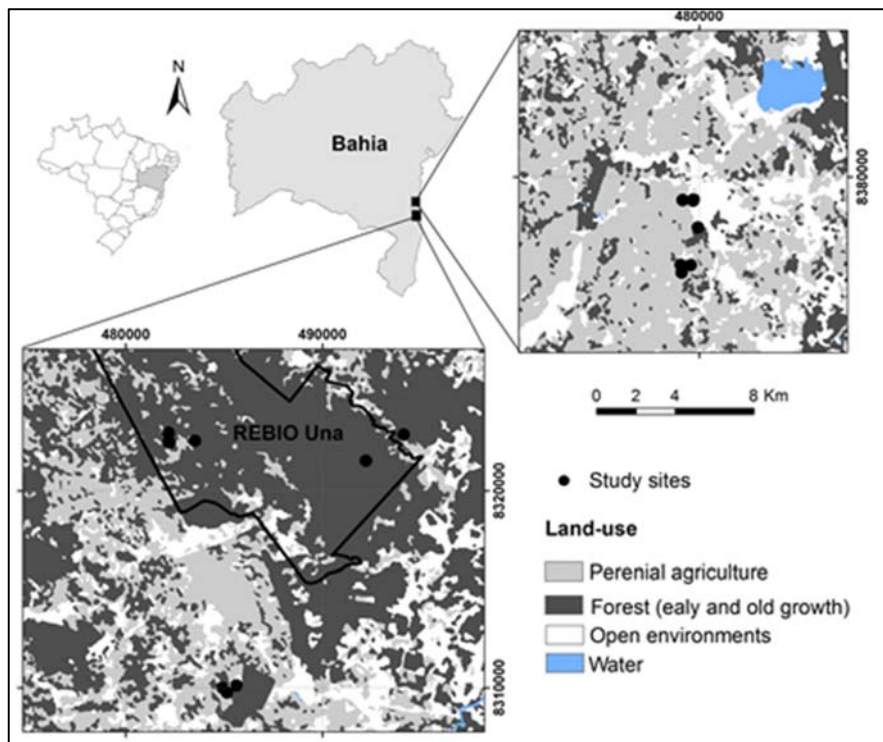


Fig 1: Study sites where the mosquitoes were captured: Ilhéus city (on the top) and Una city (on the bottom), Bahia State, Brazil.

Table 1: Study sites where the culicids were captured, including the dominant type of vegetation, the municipalities and the geographic coordinates.

Study site	Predominant type of vegetation	Cities, State	Coordinates
Almada Farm	Agroforestry (cacao) with second-growth forest Neighbor of Santa Rita Farm	Ilhéus, Bahia	14°39'49.4"S 39°11'36.8"W
Santa Rita Farm	Agroforestry (cacao) with second-growth forest	Ilhéus, Bahia	
Lagoa Encantada	Second-growth forest close to a big lake Close to Almada Farm	Ilhéus, Bahia	14°37'10.5"S 39°08'14.6"W
Colônia de Una Farm	Clear cut agricultural plantation surrounded by forest Close to REBIO	Una, Bahia	15°17'11.1"S 39°08'25.0"W
Una Biological Reserve (REBIO)	Primary-growth and Second-growth forest Neighbor of Ecoparque de Una		
Ecoparque de Una	Second-growth forest close to a big river	Una, Bahia State	15°10'11.7"S 39°03'16.4"W

2.2 Capturing mosquitoes

During daylight sampling, the team members collected mosquitoes using a hand net. The adult specimens were transferred immediately to entomological receptacles using manual suction tube (Castro catcher) and transported with adequate humidity and temperature conditions to the field laboratory, following Serra *et al.* (2016). For nocturnal sampling, the automatic CDC light trap, without bait, was used. All captured mosquitoes in the trap were collected the following morning. Mosquitoes were maintained in -80 C and shipped in dry ice to the Entomology Laboratory of the Section of Arbovirology and Hemorrhagic Fevers at the Evandro Chagas Institute (SAARB-IEC), in the Evandro Chagas Institute (Pará, Brazil). Mosquito identification was determined using the descriptions and keys of Consoli (1994). All specimens were incorporated in the SAARB-IEC, for future studies.

3. Results & Discussion

We recorded seven mosquito species, from five genera, for the first time in Bahia State, Brazil: *Coquillettidia nigricans*, *Johnbelkinia longipes*, *Limatus pseudomethysticus*, *Psorophora albipes*, *Sabethes belisarioi*, *Sabethes cyaneus* and *Sabethes quasicyaneus*. (Table 2). Most of the new records were in the Sabethini tribe, followed by Aedini and Mansoniini. The species *An. (Ste.) nimbus* had already been registered in Bahia state [13], but not in Ilhéus or Una municipalities (Table 2).

The species in the Sabethini tribe were from the genus *Sabethes* and included *Sa. (Sabethes) belisarioi*, *Sa. (Sabethes) cyaneus* and *Sa. (Sabethes) quasicyaneus*. Mosquitoes of the *Sabethes* genera grow in tree holes, bromeliads, bamboos and palm axils, and are frequently found in wild places, having a secondary role in the enzootic cycle of arboviruses [19, 20, 21]. The high presence of bromeliads in the Bahia Atlantic Forest and the cacao agroforestry systems could explain the presence of these species [22, 23]. They were

collected in the canopy and on the forest floor in forest fragments and the ground in agroforestry systems, but not in the agriculture site (Table 1 and 2). The *Sa. belisarioi* is an exclusively sylvatic mosquito with adults often present on the ground, but also with acrodendrophilous habitat [24]. Mosquitoes of this species have previously been detected with *Saint Louis* virus in Belém city (Para State, Brazil), and its geographic distribution includes Argentina, Bolivia, Colombia, French Guiana, Guyana, Panama, Peru, Suriname, Trinidad and Tobago, Venezuela [24, 25, 26]. Corroborating with other studies, adults of *Sa. cyaneus* rarely are found at ground level and thus are thought unlikely to directly transmit *yellow fever* virus (YFV) to humans [27, 28]. However, few studies have addressed the role of this species as a secondary vector in the enzootic cycle of YFV, [25, 26]. It has a distribution in all South American countries and Antilles, Belize, Costa Rica, Honduras, Mexico, Nicaragua, Panama, Trinidad and Tobago. Although we registered the *Sa. quasicyaneus* on the forest floor, previous researchers [29] described this culicid dominant in canopies during an entomological surveillance at the Serra dos Órgãos National Park, Rio de Janeiro. Brazil. The species has also been collected in other countries, including Colombia and Peru [24, 25] but no arboviruses were isolated from this species of mosquitoes.

Limatus pseudomethysticus mosquitoes were collected primarily from the ground level in rural and sylvatic environments, corroborating with Guimarães *et al* (1985), who found the *Limatus* genus mostly on the ground (Table 2). The sylvatic environments are the dominant habitat reported for this species, once bromeliads, axilla of trees their main breeding sites [2]. *Li. pseudomethysticus* occurs only in Brazil, French Guiana and Suriname [25, 26]. Based on previous studies, the finding of *Johnbelkinia longipes* inside of an exclusive agriculture site was not expected, once this species prefers preserved areas to lay eggs [2, 5]. It is known in Bolivia,

Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Nicaragua, Panama, Paraguay, Peru, Suriname and Venezuela, while No findings are available about medical importance for *Li. Pseudomethysticus* and *J. longipes*, although other *Limatus* species already were infected with *Maguari* and *Guama* virus in Brazil.

The only new record of the Aedini tribe in Bahia State, *Ps. albipes*, were collected in a agriculture area in Una City, Bahia (Table 1 and 2). This finding corroborated with previous studies, in which adults were found in open natural areas, such as savannas, or in rural areas close to plantations [2]. Individuals have been registred in Argentina, Belize, Bolivia, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago and Venezuela [25, 26]. This species is important in the epidemiology of many arboviruses including *yellow-fever*, *Venezuelan equine encephalitis*, *Guama*, *Una*, *Mayaro*, *wyeomyia* and *Kairi* virus [25].

The representative of the Mansonini tribe, *Coquillettidia (Rhynchoetaenia) nigricans*, were collected in all forest fragments (Table 2) mostly at ground level. Its geographic distribution includes Argentina, Belize, Bolivia, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, French Guiana, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago and Venezuela (24)(25). *Coquillettidia* spp. mosquitoes are considered aggressive, avid blood feeders of humans and/ or other animals [2]. Previous studies described other species for the same genera hosting forest and areas close to residence, because of these feeding behaviors or because of their attraction to artificial light [5, 30]. Although the *C.(Rhy.) nigricans* is not known to be naturally infected with arboviruses, other *Coquillettidia* spp. have been detected with *Una*, *Oriboca*, *bussuquara*, *Oropouche* and *wyeomyia* virus [24, 25].

Table 2: Identification of the new records of culicids in Bahia State, Brazil, including the habitat, the numbers of individuals captured.

Tribe	Genus	Sub genus	Species	Habitat collected	Individuals collected (N)	Site name	City
	<i>Anopheles</i>	<i>Stethomyia</i>	<i>nimbus</i>	floor	2	Ecoparque	Una
Aedini	<i>Psorophora</i>	<i>Janthinosoma</i>	<i>albipes</i>	floor	3	Almada Farm	Ilhéus
Mansoniini	<i>Coquillettidia</i>	<i>Rhynchoetaenia</i>	<i>nigricans</i>	floor	57	Lagoa Encantada	Ilhéus
				floor	1	Ecoparque	Uma
				floor	5	REBIO	Uma
				canopy	1	REBIO	Uma
Sabethini	<i>Johnbelkinia</i>		<i>longipes</i>	floor	5	Colônia de Una	Uma
	<i>Limatus</i>		<i>pseudomethysticus</i>	floor	264	Almada Farm	Ilhéus
				floor	2	Santa Rita Farm	Ilhéus
				floor	1700	Ecoparque	Una
				canopy	6	Ecoparque	Una
				floor	258	REBIO	Una
	<i>Sabethes</i>	<i>Sabethes</i>	<i>belisarioi</i>	canopy	1	Ecoparque	Una
	<i>Sabethes</i>	<i>Sabethes</i>	<i>cyaneus</i>	canopy	1	Ecoparque	Una
				floor	1	Ecoparque	Una
			canopy	3	REBIO	Una	
	<i>Sabethes</i>	<i>Sabethes</i>	<i>quasicyaneus</i>	floor	1	Almada Farm	Ilhéus

4. Conclusions

To the authors’ knowledge, this is the first time any of these seven culicids species have been identified in Bahia, State, Brazil.

Many of the mosquito species found in this study have vector competence for pathogens and parasites of human and non-

human animal health concerns, although their full capacity is poorly understood. The ongoing studies addressing ecological aspects and geographical distribution of mosquitoes may provide information on the potential risks for animal and human populations living in rural areas in Bahia state, including the Una and Ilhéus municipalities. Currently these

cities have no recommendations for yellow-fever vaccine, although based on our findings we know that secondary vectors of this arbovirus are present in the region. Furthermore, the new reports of insect fauna in different environments; forest, agroforestry systems and traditional agriculture, emphasizes the need for entomological studies focusing on different landscapes across Brazil.

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