



Expansion of *Aedes (Stegomyia) albopictus* (Skuse, 1894) in northern Brazil: new records and distribution in urban areas of Macapa city

Josiane Nogueira Müller^{1,2,3*}, Allan Kardec Ribeiro Galardo², Wellington Monteiro dos Santos², Evan Pinto Ferro², Luciana dos Santos Dias¹, Ana Paula Sales de Andrade Corrêa^{1,2,3}, Márcio Cláudio de Lima Nunes⁴, Josean Silva Jesus⁴, José Bento Pereira Lima^{1,3}

1 Laboratório de Fisiologia e Controle de Artrópodes Vetores, Instituto Oswaldo Cruz, Fundação Oswaldo Cruz, Rio de Janeiro, RJ, Brazil • JNM: jnmuller@outlook.com <https://orcid.org/0000-0001-8381-1025> • LSD: lucianad@ioc.fiocruz.br • APSAC: apsacorrea@gmail.com <https://orcid.org/0000-0001-6065-0070> • JBPL: jblima5464@gmail.com

2 Laboratório de Entomologia Médica, Núcleo de Biodiversidade, Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá, Macapá, AP, Brazil • AKRG: allangalardo@gmail.com <https://orcid.org/0000-0003-4721-3444> • WMS: monteirosantos.wellington@gmail.com <https://orcid.org/0000-0001-9618-1050> • EPF: evan_ferro@hotmail.com <https://orcid.org/0000-0002-6326-472X>

3 Programa de Pós-graduação em Medicina Tropical, Instituto Oswaldo Cruz, FIOCRUZ, Manguinhos, Rio de Janeiro, RJ, Brazil

4 Prefeitura Municipal de Macapá, Departamento de vigilância ambiental, Setor de Entomologia, Cabralzinho, Macapá, AP, Brazil • MCLN: marcionunes74@live.com <https://orcid.org/0000-0003-0529-0230> • JSJ: biomedicojj@bol.com.br

* Corresponding author

Abstract

New investigations using ovitraps showed its presence the *Aedes albopictus* (Skuse, 1894) in four neighborhoods in the metropolitan region of Macapa, capital of Amapa, Brazil. An *Aedes aegypti* (Linnaeus, 1762) Infestation Index Rapid Survey (LIR_{Aa}) held in January 2020 indicated the presence of *Ae. albopictus* in 10 different neighborhoods, demonstrating increase dispersion in the municipality. Monitoring the distribution of *Ae. albopictus* is necessary due to related arboviruses transmission, such as Dengue, Zika and Chikungunya. Therefore, this research is relevant to public health in Brazil.

Keywords

Arboviruses, Asian Tiger Mosquito, vector control

Academic editor: Fabio Laurindo da Silva | Received 18 December 2020 | Accepted 17 March 2021 | Published 11 June 2021

Citation: Müller JN, Galardo AKR, Santos WM, Ferro EP, Dias LS, Corrêa APSA, Nunes MCL, Jesus JS, Lima JBP (2021) Expansion of *Aedes (Stegomyia) albopictus* (Skuse, 1894) in northern Brazil: new records and distribution in urban areas of Macapa city. Check List 17 (3): 911–915. <https://doi.org/10.15560/17.3.911>

Introduction

After 30 years of the first report in Brazil (Forattini 1986) and more than 15 years of its record in the northern region (Segura et al. 2003), *Aedes (Stegomyia) albopictus*

(Skuse, 1894) (Diptera, Culicidae) was found in Amapa state on an island in the municipality of Santana (Saraiva et al. 2019). It is spreading in Macapa, the state capital of

Amapa. Known as the Asian Tiger Mosquito, this species is considered a secondary vector for important arboviruses, such as Dengue, Zika, and Chikungunya (Paupy et al. 2009; Smartt et al. 2017). It has a wide distribution within Brazil (Carvalho et al. 2014; Ferreira-de-Lima et al. 2020).

Amapa state is part of the Brazilian Legal Amazon and borders with Para, which is the state in the northern region where *Ae. albopictus* was first reported (Segura et al. 2003). Macapa, the capital of Amapa, is a city covered by the Amazon River and located about 4 km from Santana municipality, where the vector was first reported in the state (Saraiva et al. 2019). The continuous flow of people by road, river, and air transportation between the municipalities of Santana and Macapa, and the states of Para and Amapa, can lead to the spread of mosquitoes.

With a population of 500,000, Macapa is the most populous city in the state (IBGE 2020). The city is crossed by the Equator line with a hot and humid climate characterized by wet and drought season (December to July and August to November, respectively), and average daily temperature of 24.6–32.1 °C.

The climate is hot and humid, with the average daily temperature of 24.6–32.1 °C, characterized by wet and drought season (December to July and August to November, respectively). The annual accumulated rainfall is 2511.03 mm (NHMET/IEPA 2020). In Macapa, most people lack basic sanitation (Brazil 2016), which in combination with the climatic conditions are important factors for proliferation of the genus *Aedes* Meigen, 1818.

Methods

This study was conducted in Macapa urban area and divided in four different stages:

- **First stage September 2018.** Aiming to detect the presence of *Ae. Albopictus*, 170 ovitraps were

installed in four Macapa neighborhoods: Fazendinha, Pedrinhas, Infraero I, and Açai. Species identification was performed with ovitraps groups from each neighborhood according to the entomological keys of Rueda (2004) and Segura and Castro (2007). The collected specimens were examined in the laboratory using a Global Optics Series NO106 zoom stereoscope. All images were obtained by using an attached camera (Full HD 1080p) with AMCap v. 9.23 software. Photograph were edited in Adobe Photoshop v. 22.2.0.

- **Second stage.** The neighborhood with the greatest number of *Ae. albopictus* was selected and new ovitraps were installed to verify the mosquito geographic distribution. Species identification was performed for each ovitrap according to the entomological keys described in the previous stage.
- **Third stage (November 2019).** Health education with Endemic Disease Control Agents' in Macapa municipality.
- **Fourth stage (January 2020).** Data analysis in the *Aedes aegypti* Infestation Index Rapid Survey (LIRAA) in Macapa.

Ethics approval for this study was obtained from the Research Ethics Committee of the Institute of Scientific and Technological Research of Amapa (approval consent no. 1.944.859).

Results

Aedes (Stegomyia) albopictus (Skuse, 1894)

New records. BRAZIL • Amapa: Macapa, Fazendinha; 00°02'50.0"S, 051°06'51.6"W; 26 Sep. 2018; Josiane Nogueira Müller leg.; 9 ♂ and 9 ♀, adults; IEPA DIP 11235–11252.

Identification. For adult mosquitoes we used the thorax and head characteristics (Fig. 1). Scutum with a narrow,

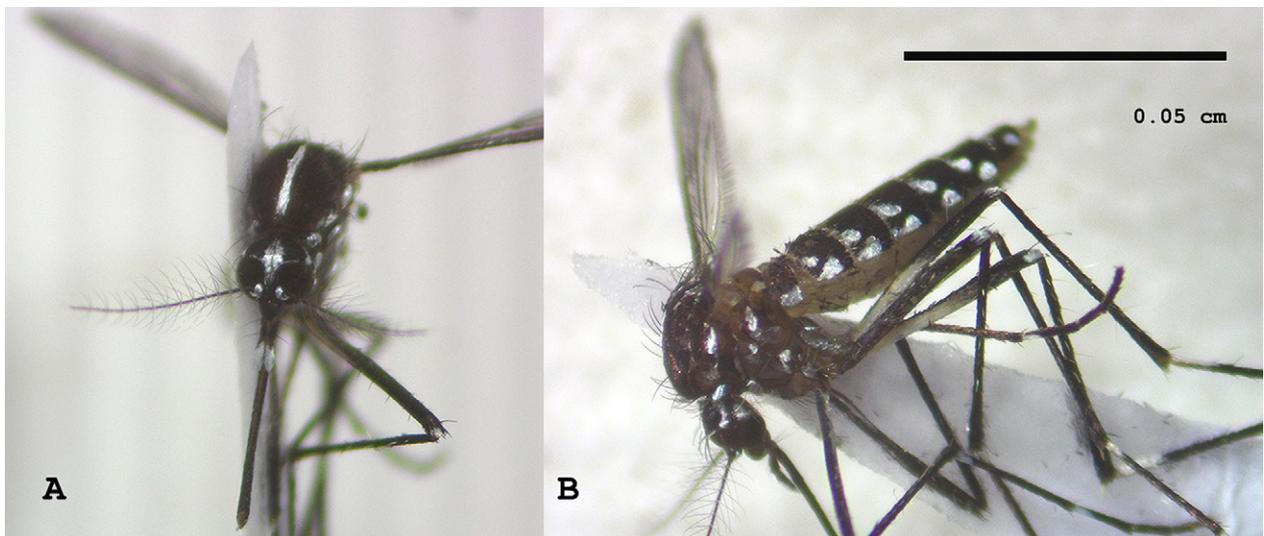


Figure 1. *Aedes (Stegomyia) albopictus* (Skuse, 1894) (Diptera: Culicidae). **A.** Dorsal view. **B.** Lateral view.

median-longitudinal, white stripe and clypeus without white scale patches, respectively (Rueda 2004; Segura and Castro 2007).

Comments. First stage. *Aedes albopictus* was found during sampling ovitraps for *Aedes aegypti* (L.) larvae. The traps were installed in July 2018 in four different neighborhoods in Macapa: Fazendinha, Pedrinhas, Infraero I, and Açai. Fazendinha and Pedrinhas are located in the south zone, and Infraero I and Açai in the north. Identified *Ae. albopictus* larvae were held in the Laboratório de Fisiologia e Controle dos Artrópodos Vetores – Laficave insectary, where they emerged from the pupa. The screening of adults found 81 female (♀) and 79 male (♂) individuals in Fazendinha neighborhood, 2♀ and 1♂ in Pedrinhas, 10♀ and 5♂ in Infraero I, and 12♀ and 6♂ in Açai neighborhood.

Second stage. Based on the results of the first stage, 39 ovitraps were installed in Fazendinha neighborhood for 7 days in November 2018. Egg deposition was recorded as negative or positive, with 23 ovitraps negative and 16 positive (Fig. 2). Among the positive ovitraps, *Ae. aegypti* was identified in nine ovitraps, *Ae. albopictus* in only one, and both species were found in six ovitraps (Table 1). Larvae were held in the Laboratório de Entomologia Médica (IEPA). Of the total number of adults, 106 were identified as *Ae. albopictus* (vouchers specimens were deposited in the entomological collection of

IEPA # 11235–11252). These represent the first records of *Ae. albopictus* in the municipality of Macapa.

Third and fourth stage. Following the previous findings, the vectors control staff in Macapa were provided a training session in November 2019, which emphasized characteristics of *Aedes* species and the importance of *Aedes* species both locally and nationally. Thus, in the

Table 1. Positive ovitrap to eggs from *Aedes* mosquito install in Fazendinha neighborhood in Macapa, Amapa state, Brazil.

Ovitrap	<i>Aedes albopictus</i>			<i>Aedes aegypti</i>		
	♂	♀	Total	♂	♀	Total
P1	0	0	0	8	11	19
P2	0	0	0	11	13	24
P3	10	7	17	7	15	22
P4	8	5	13	2	3	5
P5	9	8	17	15	21	36
P6	0	0	0	8	19	27
P7	0	0	0	0	2	2
P8	11	12	23	0	0	0
P9	0	0	0	13	23	36
P10	0	0	0	12	26	38
P11	0	0	0	24	28	52
P12	0	7	7	8	8	16
P13	0	0	0	23	33	56
P14	7	4	11	10	23	33
P15	10	8	18	25	17	42
P16	0	0	0	25	54	79
Total	55	51	106	191	296	487

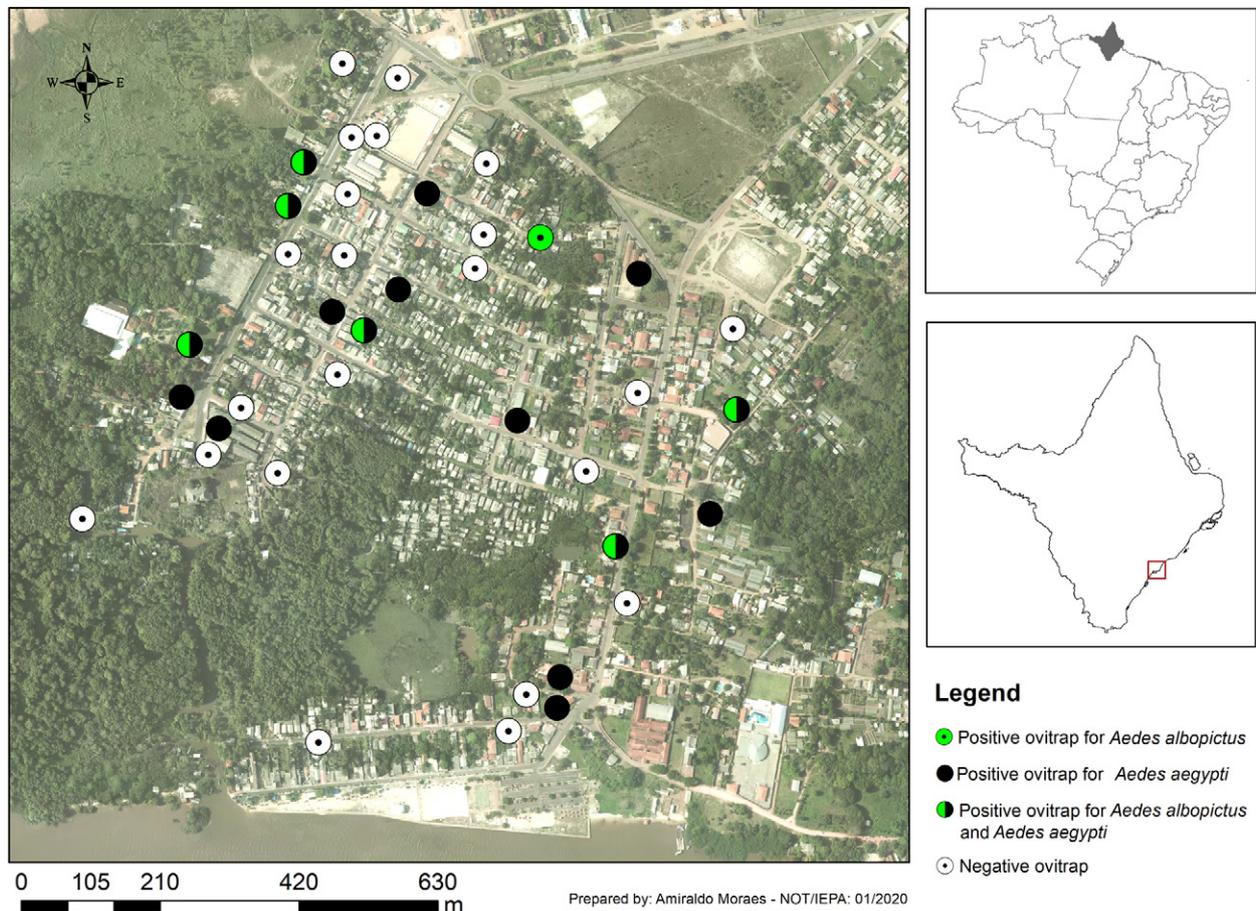


Figure 2. Ovitrap distribution in Fazendinha neighborhood, Macapa, Amapa state, Brazil. Source: NOT/IEPA.

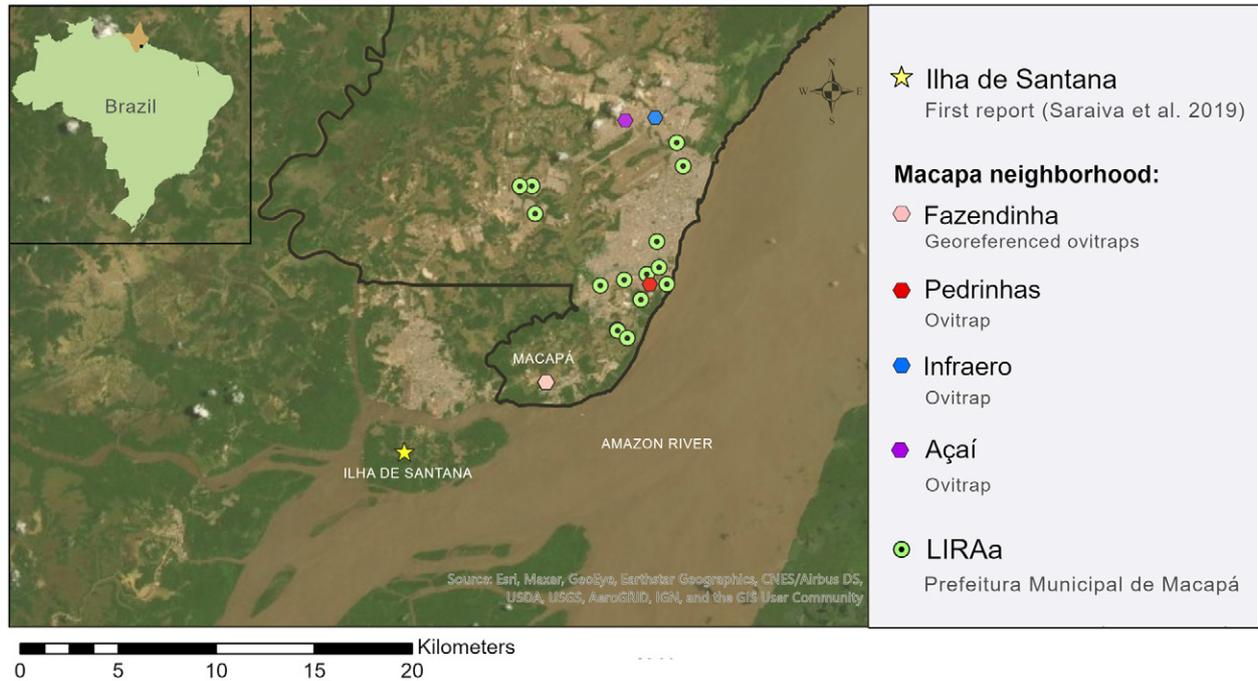


Figure 3. Neighborhoods in which *Aedes albopictus* were found in the city of Macapa, Amapa state, Brazil. Learn ArcGIS (<https://bit.ly/ArcGISProFree>).

first Infestation Index Rapid Survey (LIRAA) in 2020, breeding of *Ae. albopictus* were found in 10 neighborhoods of Macapa: Cabralzinho, Renascer, Marabaixo, Beiril, Pacoval, Zerão, Pedrinhas, Jardim Marco Zero, Universidade and Rodovia JK (Fig. 3).

Discussion

With the exception of Acre state, the presence of *Aedes albopictus* has been reported in all states of Brazil (Saraiva et al. 2019; Ferreira-de-Lima et al. 2020). Its spread in urban areas and its important capacity as a vector of arboviruses have been monitored in several studies (Arduino et al. 2020; Honorio et al. 2019; Melo Ximenes et al. 2020).

The state of Amapa borders French Guiana in the north and Suriname in the northwest. These countries have no record of the vector's presence (Talaga et al. 2015; WRBU 2020). However, one of the main routes for commodities in and out of Para and other states is by river, therefore we believe that commerce and river transportation may be a possible route of entry for *Ae. albopictus*. In addition, Amapa has socio-cultural characteristics and favorable environmental conditions for proliferation, maintenance, and spread of the vector. We are not entirely clear whether the vector's spreading in the state is related with the transport of people and/or goods, since the first record occurred during a study with other vector species (Saraiva et al. 2019). However, this hypothesis can be verified using molecular data to determine the genetic lineage of mosquitoes.

Based on the first report by Saraiva et al. (2019) of *Ae. Albopictus* in in Amapa, our study was undertaken and confirmed the presence of this species in the urban area

of Macapa. Thus, entomological surveillance is important in the discovery of new outbreaks of *Aedes* spp. and in monitoring and controlling their spread, which will help minimize the impact of virus diseases transmitted by these insects.

Acknowledgements

We thank Rodrigo José Farias and Elivaldo Nunes, Macapa City Hall technicians for assistance in installing ovitrap. We also thank Amiraldo Moraes (Núcleo de Ordenamento Territorial, IEPA) for providing maps, and Dr. Jefferson Vilhena (Núcleo de Hidrometeorologia e Energias Renováveis, IEPA) for comments on manuscript. We also thank Ana Paula Correa Cabral for writing assistance. This work was supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Brasil.

Authors' Contributions

JBL, AKG, JSJ, and MCL designed the study. JBL and AKG supervised the study. JNM, WMS, and EPF made the field collections and studied the specimens. JNM and LSD raised the mosquitoes in the insectary. JNM, APC, and WMS prepared the manuscript. JSJ and MCL performed the data analysis of LIRAA. JBL and AKG reviewed whole text.

References

Arduino MB, Mucci LF, Santos LMD, Soares MFS (2020) Importance of microenvironment to arbovirus vector distribution in an urban area, Sao Paulo, Brazil. *Journal of the Brazilian Society of Tropi-*

- cal Medicine 53: 1–10. <https://doi.org/10.1590/0037-8682-0504-2019>
- Brazil (2016) Sistema Nacional de Informações sobre Saneamento: Diagnóstico dos Serviços de Água e Esgoto. Ministério das Cidades, Secretaria Nacional de Saneamento Ambiental, Brasília, Brazil, 220 pp.
- Carvalho RG, Lourenco-de-Oliveira R, Braga IA (2014) Updating the geographical distribution and frequency of *Aedes albopictus* in Brazil with remarks regarding its range in the Americas. *Memórias do Instituto Oswaldo Cruz* 109: 787–796. <https://doi.org/10.1590/0074-0276140304>
- Ferreira-de-Lima VH, Camara DCP, Honorio NA, de Lima-Camara TN (2020) The Asian Tiger Mosquito in Brazil: observations on biology and ecological interactions since its first detection in 1986. *Acta Tropica*: 105386. <https://doi.org/10.1016/j.actatropica.2020.105386>
- Forattini OP (1986) Identification of *Aedes (Stegomyia) albopictus* (Skuse) in Brazil. *Revista de Saúde Pública* 20: 244–245
- Honorio NA, Wiggins K, Eastmond B, Camara DCP, Alto BW (2019) Experimental Vertical Transmission of Chikungunya Virus by Brazilian and Florida *Aedes albopictus* Populations. *Viruses* 11: 353. <https://doi.org/10.3390/v11040353>
- IBGE (2020) Brasil/Amapá/Macapá. <https://cidades.ibge.gov.br/brasil/ap/macapa/panorama>. Accessed on: 2020-7-15.
- Melo Ximenes MFF, Araujo Galvao JM, Inacio CLS, Macedo ESVP, Pereira R, Pinheiro MPG, Medeiros Siva MM, Gomes CES (2020) Arbovirus expansion: New species of culicids infected by the Chikungunya virus in an urban park of Brazil. *Acta Tropica* 209: 105538. <https://doi.org/10.1016/j.actatropica.2020.105538>
- NHMET/IEPA (2020) Annual accumulated rainfall. <http://www.iepa.ap.gov.br/>. Accessed on: 2020-6-5.
- Paupy C, Delatte H, Bagny L, Corbel V, Fontenille D (2009) *Aedes albopictus*, an arbovirus vector: from the darkness to the light. *Microbes and Infection* 11: 1177–1185. <https://doi.org/10.1016/j.micinf.2009.05.005>
- Rueda L (2004) Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with Dengue Virus Transmission. *Zootaxa* 589: 1175–5334. <https://doi.org/10.11646/zootaxa.589.1.1>
- Saraiva JF, Maitra A, Galardo AKR, Scarpassa VM (2019) First record of *Aedes (Stegomyia) albopictus* in the state of Amapá, northern Brazil. *Acta Amazonica* 49: 71–74. <https://doi.org/10.1590/1809-4392201802771>
- Segura MNO, Castro FC (2007) Atlas de culicídeos na Amazônia brasileira: características específicas de insetos hematófagos da família Culicidae. MS/SVS, Belém, Brazil, 67 pp.
- Segura MNO, Monteiro HAO, Lopes ES, Silva OV, Castro FC, Vasconcelos PFC (2003) Occurrence of *Aedes albopictus* in the state of Pará, Brazil. *Revista de Saúde Pública* 37: 388–389. <https://doi.org/10.1590/S0034-89102003000300020>
- Smartt CT, Stenn TMS, Chen TY, Teixeira MG, Queiroz EP, Souza Dos Santos L, Queiroz GAN, Ribeiro Souza K, Kalabric Silva L, Shin D, Tabachnick WJ (2017) Evidence of Zika Virus RNA fragments in *Aedes albopictus* (Diptera: Culicidae) field-collected eggs from Camacari, Bahia, Brazil. *Journal of Medical Entomology* 54: 1085–1087. <https://doi.org/10.1093/jme/tjx058>
- Talaga S, Dejean A, Carinci R, Gaborit P, Dusfour I, Girod R (2015) Updated Checklist of the Mosquitoes (Diptera: Culicidae) of French Guiana. *Journal of Medical Entomology* 52: 770–782. <https://doi.org/10.1093/jme/tjv109>
- WRBU (Walter Reed Biosystematics Unit) (2020) Systematic catalog of Culicidae. <http://www.mosquitocatalog.org/>. Accessed on: 2020-6-18.