

THE DISTRIBUTION OF *URANOETAENIA SAPPHIRINA* AND *UR. SOCIALIS* IN TABASCO, SOUTHERN MEXICO

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ABSTRACT. In Mexico, the genus *Uranotaenia* includes 11 species distributed mainly in the tropical and subtropical regions in the southeast of the country. *Uranotaenia sapphirina* has been reported in 18 states in Mexico: Campeche, Coahuila, Colima, Chiapas, Guerrero, Hidalgo, Jalisco, Mexico City, Mexico State, Michoacán, Morelos, Oaxaca, Quintana Roo, Sinaloa, Tabasco, Tamaulipas, Veracruz, and Yucatán; whereas *Ur. socialis* has been reported in Chiapas and Quintana Roo. In recent surveillance studies of mosquito species in Tabasco, *Ur. sapphirina* and *Ur. socialis* were omitted due to the lack of recent collection records, but in historical records, the presence of *Ur. sapphirina* and one species consistent with the description of *Ur. socialis* were mentioned. During a mosquito survey collection, immature stages from ground-level natural habitats in conservation areas of Tabasco, *Ur. sapphirina* and *Ur. socialis* were collected in association with *Anopheles albimanus*, *Culex erraticus*, *Mansonia titillans*, and *Ur. lowii*. Additionally, 2 Mexican entomological collections were reviewed, searching additional records of those species. An identification key to separate larvae and adult females of *Ur. sapphirina* and *Ur. socialis* is provided. With the addition of *Ur. sapphirina* and *Ur. socialis* to the mosquito fauna of Tabasco, there are currently 107 species in the state, being the 3rd state in Mexico with the highest richness of mosquito species. Specimens collected during this study were deposited in the Collection of the Entomological and Bioassay Research Unit of Tabasco.

KEY WORDS Distribution, Mexico, Tabasco, *Uranotaenia sapphirina*, *Uranotaenia socialis*

INTRODUCTION

The genus *Uranotaenia* includes small-sized mosquitoes distributed mainly in the Afrotropical and Southeast Asia regions, but some species occur in the Neotropical, Australasian, the Indian subcontinent, and the Nearctic regions; and a few species occur in the Palearctic region. The genus is divided into 2 subgenera: *Pseudoficalbia* with 150 species and *Uranotaenia* with 121 species (Wilkerson et al. 2021). Immature stages of the subgenus *Uranotaenia* are mainly found in habitats at ground level, such as swamps, ponds, springs, stream margins, rock holes,

and crab holes. However, some species are found in phytotelmata habitats and artificial containers. Adult females of some species are known to feed on frogs, birds, mammals, and annelids but are normally not attracted to humans (Reeves et al. 2018). Historical studies involving *Uranotaenia* species in Mexico include the 1st species record in the country: *Uranotaenia coatzacoalcos* Dyar and Knab, which was discovered and described from specimens collected in Coatzacoalcos, Veracruz, by Dyar and Knab (1906); *Ur. syntheta* Dyar and Shannon, *Ur. geometrica* Theobald, *Ur. leucoptera* (Theobald), *Ur. lowii* Theobald, *Ur. pulcherrima* Lynch Arribálzaga, and *Ur. sapphirina* (Osten Sacken) were first reported in Mexico by Martini (1935). Field observations of *Ur. syntheta* were documented by Dampf (1943), whereas *Ur. apicalis* Theobald was reported for 1st time in Mexico by Galindo et al. (1954); *Ur. anhydor* Dyar by Vargas (1956); *Ur. nataliae* Lynch Arribálzaga by Díaz-Nájera and Vargas (1973); and *Ur. socialis* Theobald by Ortega-Morales et al. (2010). Recently, the 1st observational record of the behavior of female *Ur. lowii* collected using frog-sounds traps in Tabasco (Méndez-López et al. 2015); the description of the larvae and pupa of *Ur. coatzacoalcos* with keys for identification of Mexican species of *Uranotaenia* was published by Rivera-García et al. (2019); and some new distributional records of *Ur. sapphirina* were published by Navarrete-Carballo et al. (2020) and Canto-Mis et al. (2021). In Mexico, 11 species of *Uranotaenia* have been reported: 2 within the subgenus *Pseudoficalbia*—*Ur. anhydor* and *Ur.*

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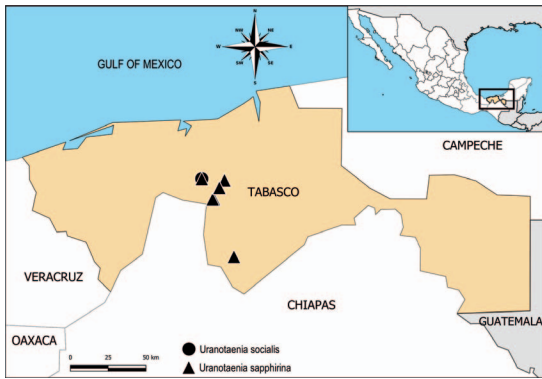


Fig. 1. Study area showing the mosquito collection sites in Tabasco, Mexico.

syntheta—and 9 within the subgenus *Uranotaenia*—*Ur. apicalis*, *Ur. coatzacoalcos*, *Ur. geometrica*, *Ur. leucoptera*, *Ur. lowii*, *Ur. nataliae*, *Ur. pulcherrima*, *Ur. sapphirina*, and *Ur. socialis*. Mostly in states of Mexico, systematic mosquito collections are conducted for entomological surveillance purposes and updating the mosquito species that are occurring in each state. In recent mosquito surveys in conservation areas of Tabasco, specimens belonging to the *Uranotaenia* genus specimens were collected. Specimens collected were preserved, mounted, and identified to species level. Collection of both *Ur. sapphirina* and *Ur. socialis* confirm the presence of these species in the state, as well the presence of *Ur. socialis* in Mexico. To determine the distributional ranks of *Ur. sapphirina* and *Ur. socialis* in Mexico, we examined recently collected specimens in Tabasco; additionally, reviewed historical Mexican records published in available literature where *Ur. sapphirina* and *Ur. socialis* have been mentioned, and reexamined specimens of those species deposited in 2 Mexican entomological collections.

MATERIALS AND METHODS

Study area

Tabasco is located in southeastern Mexico (17°15'00" and 18°39'20"N, 91°00'00" and 94°17'10"W). The state has an area of 25,567 km² and it is bordered to the north by the Gulf of Mexico, to the west by Veracruz, Chiapas at the south, while

Campeche and Guatemala make up the western borders (Fig. 1). The climate is warm-humid and tropical subhumid, with rains during the summer with an annual average rainfall of 1,400–1,800 mm (INEGI 2018).

Mosquito collection

Mosquito collections were conducted from diverse conservation areas in Tabasco state from 2017 to 2021 (Fig. 1). Immature stages were collected using a larval dipper (No. 1132; BioQuip Products, Rancho Dominguez, CA) from ground-level aquatic habitats with partial shade and abundant emerging aquatic vegetation. Live specimens were carefully preserved in bags with the same water from original habitat, labeled, and transported to the Entomological and Bioassay Research Unit (UIEB) in Villahermosa, Tabasco. The collected larvae were reared to adult stages; immature exuviae and dead larvae were mounted on microscope slides using Euparal (BioQuip, Santo Domingo, CA) as mounting medium. Adult mosquitoes were collected using the Centers for Disease Control and Prevention (CDC) light traps (No. 2836BQ; BioQuip Products) set at the same location where immature stages were collected. The light traps were baited with octenol placed 1–5 m above the ground and operated at night (1800–2200 h) (Table 1). Collected mosquitoes were preserved in liquid nitrogen and transported to the UIEB for mounting using insect pins and identification. The identification keys of Galindo et al. (1954), Belkin et al. (1970), and Rivera-García et al. (2019) were used for mosquito identification.

Review of entomological collections

The 2 most robust entomological collections of mosquitoes in Mexico were reviewed for additional documented presence of *Ur. sapphirina* and *Ur. socialis*. Catalogued specimens were reexamined to corroborate their taxonomic identity. The mosquito collections used were from the Department of Parasitology of the Universidad Autónoma Agraria Antonio Narro, Laguna Unit (CC-UL) in the city of Torreon, Coahuila; and the Collection of Insects and Mites of Medical Importance, deposited in the Institute of Epidemiological Diagnosis and Reference (CAIM) in Mexico City.

Table 1. Collection sites of *Uranotaenia sapphirina*¹ and *Ur. socialis*² in Tabasco.

Collection date	Habitat	Location	Latitude (°N)	Longitude (°W)	Associated species
February 20, 2017 ¹	Swamp	Tacotalpa	17°35'34.8"	–92°49'27.2"	—
August 20, 2019 ¹	Sewer	Villahermosa	17°56'59.3"	–92°56'53.4"	<i>Anopheles albimanus</i> , <i>Culex erraticus</i>
August 21, 2019 ¹	Pond	Villahermosa	17°56'59.3"	–92°57'22.8"	<i>Cx. erraticus</i> , <i>Mansonia titillans</i>
April 6, 2021 ¹	Pond	Villahermosa	18°4'0.5"	–92°52'59.2"	<i>Cx. erraticus</i>
April 6, 2021 ¹	Swamp	Villahermosa	18°1'16.8"	–92°54'52.5"	<i>Ur. lowii</i>
April 6, 2021 ¹	Stream	Villahermosa	18°1'12.9"	–92°54'53.1"	<i>Cx. erraticus</i>
October 6, 2021 ²	Adults	Jalpa de Méndez	18°4'26.9"	–93°1'25.7"	—

RESULTS

Mosquito collections from Tabasco that included *Ur. sapphirina* and/or *Ur. socialis* were found in 7 locations: immature stages of *Ur. sapphirina* were collected from 6 locations in the counties of Tacotalpa and Villahermosa, while adult females of *Ur. socialis* were collected from a single location in the county of Jalpa de Méndez (Table 1). Mosquito records obtained from CAIM that were positive to *Ur. sapphirina* (mostly immature stages, preserved in glass vials with 80% ethanol) confirm the presence of this species in 13 Mexican states: Campeche, Guerrero, Hidalgo, Jalisco, Mexico City, Mexico State, Michoacán, Oaxaca, Quintana Roo, Sinaloa, Tabasco, Tamaulipas, and Veracruz. Collection data such as location, position or coordinates, habitat, and collection date were not available. Mosquito records obtained from CC-UL positive to *Ur. sapphirina* included 3 records: 1) On July 31, 2008, 1 adult female of this species was collected directly from vegetation using a backpack aspirator (model 1412; John Hock Company, Gainesville, FL) in Acapulco, Guerrero (16°48'45.5"N, 99°47'4.7"W; 10 m above sea level [masl]), associated with *Culex nigripalpus* Theobald, *Coquillettia nigricans* (Coquillett), and *Ur. lowii*, accession number: 02310708-D. In the same year of this collection record, Dzul-Manzanilla et al. (2013) confirmed the presence of *Ur. sapphirina* in the state of Guerrero and declared the species as a new state record; 2) On July 15, 2009, 2 adult females of *Ur. sapphirina* were collected at the same conditions as the previous record in Ometepec, Guerrero (16°42'19.5"N, 98°25'21"W; 320 masl, associated with *Ur. pulcherrima*, accession number: 06150709-LI. The 2 previous records were published as *Ur. sapphirina-socialis* by Ortega-Morales et al. (2013); and 3) On September 21, 2012, 1 single larva of *Ur. sapphirina* was collected from a flower vase with clear water and without vegetation in Tenango de Doria, Hidalgo (20°20'13.4"N, 98°12'22.8"W; 1,709 masl), with *Aedes epactius* Dyar and Knab and *Ae. podographicus* Dyar and Knab in a habitat with pH of 8.5, dissolved salts 132 ppm, and temperature of 23°C; accession number: 08210912-TD (Ortega-Morales et al. 2018). *Uranotaenia socialis* was found in a single record from CC-UL collection: on September 27, 2006; 1 single larva of this species was collected from a pond with water colored with leaf tannins with abundant emerging vegetation and partial shade in Nuevo Becar, Quintana Roo (18°35'58"N, 89°6'51.7"W); the associated species included *Anopheles neomaculipalpus* Curry, *An. punctimacula* Dyar and Knab, *Ae. euplocamus* Dyar and Knab, *Ae. serratus* (Theobald), *Psorophora ferox* (von Humboldt), and *Cx. conspirator* Dyar and Knab; and the habitat water quality parameters were: pH 7.5 and dissolved salts 0.28 ppm (Ortega-Morales et al. 2010). This record constituted the 1st report of this species in Mexico. No record of *Ur. socialis* was found in the CAIM collection. Specimens of *Ur.*

socialis collected in Chiapas by Casas-Martínez et al. (2012) were presumably deposited in the Biological Collection of Mosquitoes of Medical Importance of the Regional Center for Public Health Research in the city of Tapachula, Chiapas, but this collection was not reviewed for this study.

DISCUSSION

Uranotaenia sapphirina was originally described by Osten Sacken (1868) from specimens collected in the USA, 1 female collected in Washington, DC, and 1 male collected in Brooklyn, NY. Type material is deposited in the Museum of Comparative Zoology, Harvard University, Cambridge, MA. The species has been reported in Canada, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Mexico, Puerto Rico, Suriname, and USA (Martini 1935, García-Ávila 1977, WRBU 2005). In Mexico, *Ur. sapphirina* has been reported in the states of Chiapas, Colima, Guerrero, Morelos, Tabasco, Veracruz (Martini 1935); Michoacán, Mexico City, Sinaloa (Vargas 1956); Campeche, Jalisco, Oaxaca, Quintana Roo, Tamaulipas (Díaz-Nájera and Vargas 1973, Canto-Mis et al. 2021); Coahuila (Ibáñez-Bernal and Martínez-Campos 1994); Hidalgo (Ortega-Morales et al. 2018); Yucatán (Navarrete-Carballo et al. 2020); and Mexico State (Adeniran et al. 2021). *Uranotaenia socialis* was originally described by Theobald (1901) from reared specimens collected in a stagnant permanent pool in Kingston district, Jamaica. Type material was deposited in the Natural History Museum, London, United Kingdom. The species occurs in Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Puerto Rico, Trinidad and Tobago, and Virgin Islands (WRBU 2005). In Mexico, *Ur. socialis* has been reported in the states of Quintana Roo (Ortega-Morales et al. 2010) and Chiapas (Casas-Martínez et al. 2012).

Immature habitats of *Ur. sapphirina* occur commonly in permanent pools, ponds, and lakes that contain emergent or floating vegetation exposed to sunlight. The adults have been observed resting on vegetation near the larval habitat and are readily attracted to artificial light. While the adult females may approach and land on humans they rarely bite (Carpenter and LaCasse 1955), recent studies in Florida show that *Ur. sapphirina* is in fact, a specialist feeder of invertebrate hosts such as worms and leeches of the phylum Annelida (Reeves et al. 2018). *Uranotaenia sapphirina* has been implicated as a potential vector of some arboviruses such as eastern equine encephalitis virus found in field-collected mosquitoes in several states of the USA (Cupp et al. 2003, Hassan et al. 2003, Armstrong and Andreadis 2010, Molaei et al. 2016) and West Nile virus (Andreadis et al. 2004). Based on the feeding pattern of *Ur. sapphirina* in the search and selection of hosts belonging to groups of annelids, Reeves et

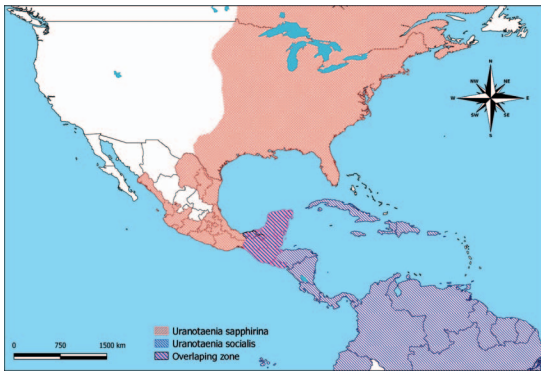


Fig. 2. Distribution of *Uranotaenia sapphirina* and *Ur. socialis*.

al. (2018) stated that *Ur. sapphirina* was unlikely to become infected with the aforementioned viruses throughout feeding on vertebrate hosts. It is possible that by feeding in hematophagous leeches, which themselves often parasitize competent arbovirus hosts. Currently, the routes of infection of *Ur. sapphirina* to acquire these viruses remain unknown. *Uranotaenia sapphirina* occurs in the Nearctic region; the species has been reported in Canada in the provinces of Quebec (Twinn 1949), Ontario (Judd 1950), and Manitoba (Stuart 2007), which represents its northernmost distribution. The species is distributed throughout the eastern half and other portions of the USA, where it is commonly found, although documentation establishing populations within this geographic location in the USA is lacking (Burkett-Cadena 2013, Rehbein and Viadero 2021). In Mexico, the presence of *Ur. sapphirina* has been documented in 4 major regions of the country: the tropical region of the Pacific coast in the states of Chiapas, Colima, Guerrero, Michoacán, Jalisco, and Oaxaca; the tropical region of the Gulf coast in the states of Tabasco, Tamaulipas, and Veracruz; the Yucatán Peninsula in the states of Campeche, Quintana Roo, and Yucatán; and some inland regions with Nearctic conditions in the states of Coahuila, Hidalgo, Mexico City, Mexico State, and Morelos. *Uranotaenia sapphirina* could also be present in Nayarit, Nuevo León, Tlaxcala, and Puebla, but recent mosquito surveys carried out in some of these states failed to find this species (Muñoz-Cabrera et al. 2006, Ortega-Morales et al. 2019b). The presence of *Ur. sapphirina* in Central American countries such as El Salvador and Guatemala could represent the southernmost distributional limit for this species, where it is also sympatric with local populations of *Ur. socialis* (Fig. 2). Belkin et al. (1970) separated the species of the “*sapphirina* complex” in Jamaica by the characters and additional features mentioned in the diagnosis. Specimens from West Indies and Central America differ in some specific characters in the immature and adult stages from Nearctic *Ur. sapphirina*, so the Neotropical populations within the

sapphirina complex are considered *Ur. socialis*. Based in the distribution of species within the *sapphirina* complex, all records where *Ur. sapphirina* have been previously reported in the West Indies, such as Cuba, Dominican Republic, Haiti, Puerto Rico, and South America could actually belong to *Ur. socialis* (Fig. 2). In Jamaica, immature stages of *Ur. socialis* are commonly found in the margins of swamps, ditches, and streams with permanent, clear, and fresh water in full sunlight with algae (Belkin et al. 1970); in Belize, adults were collected using CDC miniature light traps (Heinemann and Belkin 1977); in Guyana, immature stages were collected from canals with abundant floating vegetation and deep shade (Heinemann and Belkin 1978); whereas in Trinidad and Tobago, adults were collected using Chamberlain light traps baited with dry ice (Heinemann and Belkin 1980). Females of *Ur. socialis* are not usually attracted to warm-blooded vertebrates, but they are attracted to light traps and could be readily collected using CDC light traps. Nothing is known about the adult bionomics of this species (Belkin et al. 1970), but is possible that females of *Ur. socialis* feed on amphibians, toads, or another group of invertebrate annelids. *Uranotaenia socialis* occurs in the Neotropical region and the West Indies; in Brazil the species reaches its southernmost distributional point and is found throughout Ecuador, Colombia, the Guianas, Central America, Cuba, Dominican Republic, Haiti, Jamaica, and Puerto Rico, and probably, occurs in Venezuela. In Mexico, *Ur. socialis* reaches its northernmost distributional rank (Fig. 2), occurring in the southeastern states of Chiapas, Quintana Roo, and Tabasco, where *Ur. sapphirina* populations begin to overlap. *Uranotaenia sapphirina* is easily confused with *Ur. socialis*, mainly in the areas where the distribution of both species overlap; however, differences in morphological characteristics found in larvae and adults aid in classification of the 2 similar species, using the following keys:

Larvae

- a) Lateral plate of 8th abdominal segment with more than 12 comb scales. Pecten teeth usually more than 12 (Fig. 3A). Head hair 4-C usually single or double (Fig. 3B) *Ur. sapphirina*
- b) Lateral plate of 8th abdominal segment with 8 or fewer comb scales (Fig. 3C). Pecten teeth usually fewer than 12. Head hair 4-C usually triple (Fig. 3D) *Ur. socialis*

Adults

- a) Median line of bluish scales extending to scutellum. Line of blue scales along of vein Cu extending more than half distance to its furcation *Ur. sapphirina*
- b) Median line of bluish scales interrupted at the prescutellar space. Line of blue scales along of

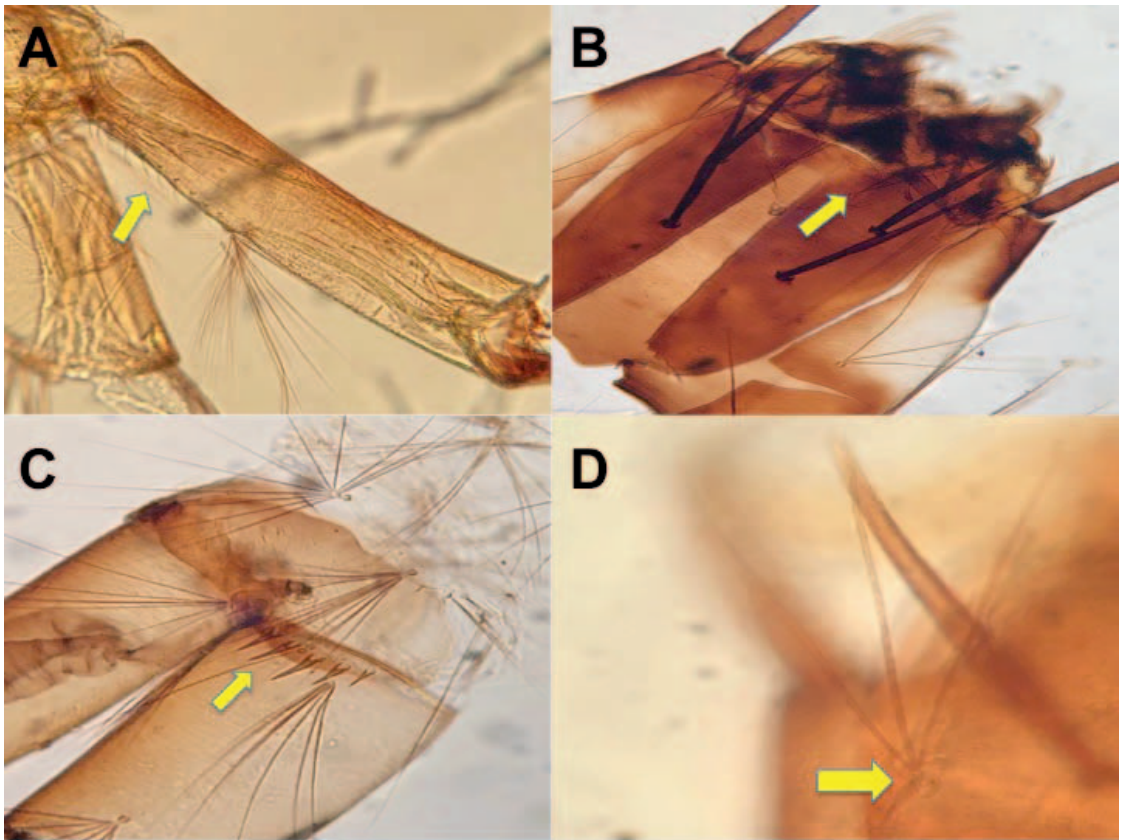


Fig. 3. Diagnostic characters for identifying larvae of *Uranotaenia sapphirina* and *Ur. socialis*. All images shown in dorsal view. (A) More than 12 pecten teeth. (B) Head hair 4-C single or double. (C) Eight or fewer comb scales. (D) Head hair 4-C triple.

vein Cu not reaching half distance to its furcation
Ur. socialis

In the last inventory of mosquito species of Tabasco, Ortega-Morales et al. (2019a) documented the presence of 104 species, including 7 within the genus *Uranotaenia*: *Ur. syntheta*, *Ur. coatzacoalcos*, *Ur. geometrica*, *Ur. leucoptera*, *Ur. lowii*, *Ur. nataliae*, and *Ur. pulcherrima*. *Uranotaenia sapphirina* and *Ur. socialis* were omitted due the lack of recent collection records for these species. However, specimens collected in Frontera, Tabasco, on June 17, 1928, included *Ur. sapphirina* and this finding represented the 1st record of this species in Tabasco (Martini 1935). In the same location, specimens collected on June 8, 1928, and a single male collected on November 12, 1925, in La Candelaria, Petén, Guatemala, were also identified as *Ur. sapphirina*, but the author declared that those specimens varied in coloration than the typical forms of *Ur. sapphirina*. These mosquitoes have in the mesonotum an interrupted line of grayish-pale scales, the scutellum and pleura are of the same color, and the cubital vein has pearly scales at the base (Martini 1935). Undoubtedly,

these specimens corresponded with the description of *Ur. socialis*; consequently, this species had also been previously found in Tabasco. With the addition of these 2 species and including the *Ae. fulvus* record previously reported in Tabasco by Rodríguez-Martínez et al. (2020), currently 107 mosquito species are known in Tabasco, being the 3rd state of Mexico with the highest richness of mosquito species, after Chiapas (138 species) and Veracruz (141 species). Specimens collected during this study were deposited in the Collection of the Entomological and Bioassay Research Unit in Tabasco. Future works should be conducted to deduce how the species within the *sapphirina* complex (until now, only known for *Ur. sapphirina* and *Ur. socialis*) are distributed. Studies involving molecular biology techniques such as sequencing the mitochondrial gene cytochrome oxidase gene may be useful to determine the distribution patterns of these species, especially in areas where populations overlap, as well as to investigate the possibility of the existence of cryptic species within the *sapphirina* complex.

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