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Aedes (Stegomyia) aegypti and *Aedes (Howardina) cozumelensis* in Yucatán State, México, with a summary of published collection records for *Ae. cozumelensis*

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Abstract

We collected mosquito immatures from artificial containers during 2010–2011 from 26 communities, ranging in size from small rural communities to large urban centers, located in different parts of Yucatán State in southeastern México. The arbovirus vector *Aedes* (*Stegomyia*) *aegypti* was collected from all 26 examined communities, and nine of the communities also yielded another container-inhabiting *Aedes* mosquito: *Aedes (Howardina) cozumelensis*. The communities from which *Ae. cozumelensis* were collected were all small, rural communities (<6,000 inhabitants) in the north-central part of Yucatán State. These new collection records for *Ae. cozumelensis* demonstrate that this mosquito has a far broader geographic range in the Yucatán Peninsula than previously known. *Ae. cozumelensis* immatures were collected from both residential premises and cemeteries, with specimens recovered from rock holes as well as various artificial containers including metal cans, flower vases, buckets, tires and a water storage tank. The co-occurrence with *Ae. aegypti* in small rural communities poses intriguing questions regarding linkages between these mosquitoes, including the potential for direct competition for larval development sites. Additional studies are needed to determine how commonly *Ae. cozumelensis* feeds on human blood and whether it is naturally infected with arboviruses or other pathogens of medical or veterinary importance. We also summarize the published records for *Ae. cozumelensis*, which are restricted to collections from México's Yucatán Peninsula and Belize, and uniformly represent geographic locations where *Ae. aegypti* can be expected to occur.

Keyword Index

Aedes aegypti; *Aedes cozumelensis*; Yucatán State; Méxic

INTRODUCTION

The mosquito *Aedes (Howardina) cozumelensis* Diaz Najera was first described in 1965 from the island of Cozumel, which is located to the east of the Yucatán Peninsula in

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southeastern México (Diaz Najera 1966). The original collection consisted of larvae recovered from plastic flower pots and reared to adults. Additional collections of *Ae. cozumelensis* in the Yucatán Peninsula include: (i) a single larva recovered from the city of Tizimin in northeastern Yucatán State (Berlin 1969), (ii) adults collected from human bait in Cancún in northeastern Quintana Roo State (Pletsch 1977), and (iii) immatures collected from standing water in various artificial containers, leaf axils or leaves in multiple locations (Buena Vista, Bacalar, Ejido Lázaro Cárdenas, Limones, Vigía Chico, Chunyaxchen, and Ocom) in Quintana Roo State (Ortega-Morales et al. 2010a). Records of *Ae. cozumelensis* outside of the Yucatán Peninsula are restricted to Belize, which is located just to the south of the Yucatán Peninsula (Figure 1). The mosquito was first recorded from Belize in 1967,, through collection of adults coming to human bait, and then again in 1990–1992 through larval collections from artificial containers (1 l plastic bottles) placed at ground level (Bertram 1971,, Heinemann and Belkin 1977a, Pecor et al. 2002). The above-mentioned collections are summarized, together with new records presented herein, in Table 1 and the approximate collection locations are shown in Figure 1.

Our knowledge of the biology of *Ae. cozumelensis* is very restricted. The mosquito has been recovered from both urban areas (Pletsch 1977) and rural settings (Bertram 1971). It exploits artificial containers as development sites for the immature stages (Diaz Najera 1966,, Pecor et al. 2002,, Ortega-Morales et al. 2010a) but also can be found in natural water-holding substrates such as leaf axils (Ortega-Morales et al. 2010a). Adults can be collected using human bait (Pletsch 1977,, Bertram 1971,, Heinemann and Belkin 1977a), which suggests that the females are potential human-biters. The primary activity period, as determined by landing catches on humans, appears to be diurnal (Bertram 1971).

There are two key areas in which *Ae. cozumelensis* may be of importance in the context of medical entomology. Firstly, it may compete with container-inhabiting arbovirus vectors, such as *Aedes* (*Stegomyia*) *aegypti* (L.) and *Aedes* (*Stegomyia*) *albopictus* (Skuse), for larval development sites. There is a rich literature on the effects of competition between immatures of *Ae. aegypti* and *Ae. albopictus* (e.g., Macdonald 1956,, Black et al. 1989,, Leisnham et al. 2009,, Reiskind and Lounibos 2009). In some settings, *Ae. albopictus* immatures can, under certain circumstances, outcompete *Ae. aegypti* leading to reductions in the abundance of the latter species (Juliano 1998,, Braks et al. 2004,, Juliano et al. 2004,, Lounibos et al. 2010). It therefore is interesting to speculate on the potential effects of a third container-inhabiting *Aedes* species competing for larval development sites with these two important arbovirus vectors. The primary dengue virus vector *Ae. aegypti* is ubiquitous in urban settings in the Yucatán Peninsula and Belize, and *Ae. albopictus*, which also can transmit dengue virus, recently was recorded from Cancún in the Yucatán Peninsula as well as from Belize (Ortega-Morales et al. 2010b, Salomón-Grajales et al. 2012). The geographic range of *Ae. cozumelensis* thus overlaps with those of *Ae. aegypti* and *Ae. albopictus*. Moreover, *Ae. cozumelensis* previously was collected together with *Ae. aegypti* from artificial containers in Quintana Roo State in the eastern part of the Yucatán Peninsula (Ortega-Morales et al. 2010a).

Secondly, we cannot rule out the possibility that *Ae. cozumelensis* bites humans as well as domestic or wild animals, and thus may serve as a vector of known or yet to be discovered arboviruses in the Yucatán Peninsula or Belize. Dengue is a major health problem in the Yucatán Peninsula (Loroño-Pino et al. 1993,, 2004;; García-Rejón et al. 2008), and recent studies in this area revealed the presence of other mosquito-borne viruses (e.g., Cache Valley virus, Cholul virus, Kairi virus, South River virus, T'Ho virus, and West Nile virus) with known or potential human health relevance but poorly understood local enzootic transmission cycles (Farfán-Ale et al. 2004,, 2006,, 2009,, 2010;; Soto et al. 2009;; Blitvich et al. 2012a, b). Moreover, the recognition of mosquito species potentially serving as secondary vectors can change our perception of virus transmission cycles. For instance, transmission dynamics of dengue virus may differ between areas where *Ae. aegypti* is the sole vector compared to areas where other, secondary vectors also are involved. Salomón-Grajales et al. (2012) speculated that the introduction of *Ae. albopictus* to the Yucatán Peninsula could result in dengue virus transmission being intensified in rural areas because *Ae. albopictus* is more likely to occur in this setting compared to *Ae. aegypti*, which more commonly is encountered in densely populated urban areas in the Americas (Braks et al. 2003). The association of *Ae. cozumelensis* with peridomestic environments (Table 1) enhances its potential to serve as a vector to humans of pathogenic organisms and underscores the importance of future studies to determine the potential importance of this species as a pathogen vector.

Our previous studies on mosquito immatures and adults in Yucatán State, with collection of immatures from artificial containers and indoor/outdoor backpack aspiration of adults, focused on urban settings within the city of Mérida and did not produce any specimens of *Ae. cozumelensis* (García-Rejón et al. 2008,, 2011a, b). However, during 2010–2011 we visited a number of other communities in different parts of Yucatán State to recover immatures of *Ae. aegypti* from artificial containers for rearing to adults and subsequent insecticide resistance profiling. We report here on the collection of *Ae. aegypti* and *Ae. cozumelensis* from these communities in Yucatán State, and present a summary of published collection records for *Ae. cozumelensis*.

MATERIALS AND METHODS

This study included 26 communities located in different parts of Yucatán State in southeastern México (Table 2, Figure 2). The population size of the examined communities ranged from <2,000 to >750,000 (Table 2). Collections of mosquito immatures, primarily from artificial containers, were undertaken in these communities from March 2010 – February 2011 to provide material for a state-wide survey of the presence and frequency of a mutation (Ile1,016) in the voltage-gated sodium channel of *Ae. aegypti* that confers knockdown resistance to synthetic pyrethroid insecticides. Yucatán State has a subtropical climate with seasonal heavy rainfall from June-October (typically >100 mm rainfall per month) and sporadic rainfall during the remaining, drier part of the year (García-Rejón et al. 2011b). With the two notable exceptions of the city of Mérida (where immatures were collected continuously during the March 2010 – February 2011 study period) and Ciudad Caucel (where collections were made during the wet season from August-October 2010), collections in the remaining 24 communities were made during the drier part of the year from November 2010 – February 2011. Monthly rainfall for this 4-mo period ranged from 5–19 mm in the city of Mérida (based on data from a weather station at the Mérida airport operated by Comision Nacional del Agua).

Specific collection locations within the communities were subjectively classified as urban (homes with small yards or cemeteries located within densely populated areas) versus rural (homes in rural settings with larger yards and more vegetation, or homes or cemeteries located on the edge of a populated area). The mosquito collection locations were georeferenced using a Global Positioning System receiver (Garmin, Olathe, KS) and mapped in a Geographic Information System (ArcGIS 9.2; ESRI, Redlands, CA).

Mosquito immatures were collected from a wide range of artificial containers encountered on residential premises (including small containers such as bottles, cans and flower pots, medium-sized containers such as buckets and tires, and larger containers such as cement water troughs and water tanks) or in cemeteries (including flower vases, bottles, cans, buckets, and water storage tanks). Immatures also were occasionally recovered from "natural containers" including rock holes and tree holes. Because the purpose of the mosquito collection was to gather sufficient numbers of specimens of *Ae. aegypti* for insecticide resistance profiling, no specific efforts were made to collect all immatures present in the collection locations or to determine the overall abundance of immatures.

The collected immatures were transported to a laboratory at Universidad Autónoma de Yucatán in Mérida, and all *Aedes* immatures were reared to the adult stage. During the subsequent species identification, we discovered that some of the adult *Aedes* specimens belonged to a species not previously encountered by us in Yucatán State. Selected specimens were shipped to the Walter Reed Biosystematics Unit (WRBU) of the Walter Reed Army Institute of Research, United States Army Medical Research and Materiel Command, Silver Spring, MD, for identification. This confirmed their identity as *Aedes (Howardina) cozumelensis* (courtesy of James Pecor of WRBU) based on the identification key for the neotropical subgenus *Howardina* of *Aedes* published by Berlin (1969). Subsequent species identification was done at Universidad Autónoma de Yucatán using the identification key of Berlin (1969) together with the identification key of Darsie and Ward (2005).

RESULTS

All 26 examined communities in Yucatán State, ranging from very small rural communities to large urban centers, yielded at least 200 *Ae. aegypti* immatures (Table 2, Figure 2). From nine of these communities (Cantamayec, Hoctun, Huhi, Mayapan, Sanahcat, Sudzal, Tepakan, Teya, and Xocchel), we also collected immatures of *Ae. cozumelensis* (Figures 1–2; Table 2). The communities from which *Ae. cozumelensis* were collected were all small, rural communities (<6,000 inhabitants) located in the north-central part of Yucatán State (Figure 2, Table 2). Collections of *Ae. cozumelensis* were made during January–February 2011 and came from residential premises (Cantamayec, Hoctun, Mayapan, Sanahcat, and Tepakan) as well as cemeteries (Hoctun, Huhi, Sudzal, Teya, and Xocchel). *Ae. cozumelensis* was recovered from rock holes as well as various artificial containers including metal cans, flower vases, buckets, tires and a water storage tank.

The published records for *Ae. cozumelensis*, which currently is known to occur in México's Yucatán Peninsula and in Belize, are summarized in Table 1 and the approximate collection locations are shown in Figure 1. The known range of *Ae. cozumelensis* falls entirely within the larger geographic range of *Ae. aegypti* in the Americas, and the geographic locations where *Ae. cozumelensis* has been collected uniformly represents settings where *Ae. aegypti* can be expected to occur.

DISCUSSION

Our study confirmed that, as expected, the arbovirus vector *Ae. aegypti* is present throughout Yucatán State. This mosquito was readily collected in large urban centers (Mérida) and medium-sized cities (e.g., Kanasín, Progreso, Tizimín, Umán, and Valladolid) as well as in small towns and rural communities. Another important container-inhabiting arbovirus vector, *Aedes* (*Stegomyia*) *albopictus*, was recently recorded from Cancún, which is located in Quintana Roo State in the eastern part of the Yucatán Peninsula (Salomón-Grajales et al. 2012). *Ae. albopictus* was not encountered by us in Yucatán State but, should the mosquito become established in Cancún, it likely will spread across the Yucatán Peninsula, similar to its previous rapid spread across the southeastern U.S. (Moore 1999). The potential implications of the introduction of *Ae. albopictus* into the Yucatán Peninsula for *Ae. aegypti* bionomics and local dengue virus transmission cycles were reviewed previously by Salomón-Grajales et al. (2012).

A third container-inhabiting *Aedes* species, *Ae. cozumelensis*, had previously been recorded from several locations in Quintana Roo State (Diaz Najera 1966,, Pletsch 1977,, Ortega-Morales et al. 2010a) but only from a single location (Tizimín) in Yucatán State (Berlin 1969). We collected *Ae. cozumelensis* from an additional nine locations in Yucatán State (Cantamayec, Sudzal, Hoctun, Huhi, Mayapan, Sanahcat, Tepakan, Teya, and Xocchel; Figures 1–2), which demonstrates that this mosquito has a far broader geographic range in the Yucatán Peninsula than previously known. Our collections of *Ae. cozumelensis* all came from small rural communities (<6,000 inhabitants) in the north-central part of Yucatán State, located between the urban centers of Mérida to the west and Tizimín and Valladolid to the east. Because collections were made during the drier part of the year, when the availability of water-holding containers is most limited and abundance of container-inhabiting mosquitoes presumably is reduced, we speculate that further sampling during the wet season may reveal the presence of *Ae. cozumelensis* in additional locations in Yucatán State. The exception in this regard is the city of Mérida, where extensive collections of immatures during the rainy season have failed to produce *Ae. cozumelensis* (Table 2; García-Rejón et al. 2008,, 2011b). The collections of *Ae. cozumelensis* produced larvae but no pupae (Table 2). This could have resulted from the low overall number of *Ae. cozumelensis* specimens collected (~130 larvae) or from pupae of this species behaving in such a way that they evade capture during cursory surveys where no special efforts are made to ensure that all specimens are removed from the containers.

The new records for *Ae. cozumelensis* in Yucatán State, and the co-occurrence with *Ae. aegypti* in small rural communities, poses intriguing questions regarding linkages between these mosquitoes, including the potential for direct competition for larval development sites, feeding by both species on human blood, and transmisson of arboviruses. Indeed, the geographic locations where *Ae. cozumelensis* has been collected (Yucatán State and Quintana Roo State in México's Yucatán Peninsula, and the neighboring Belize to the south; Figure 1, Table 1) uniformly represents areas where *Ae. aegypti* can be expected to occur (Table 2; Heinemann and Belkin 1977a, b; Pletsch 1986;; Ortega-Morales et al. 2010a). The manner in which immatures were collected in our study unfortunately precludes a quantitative analysis of the respective abundance of *Ae. aegypti* and *Ae. cozumelensis* in containers where they occurred separately versus together, but this should be addressed in future studies.

Aedes cozumelensis has been collected from human bait and thus may take blood from humans (Pletsch 1977,, Bertram 1971,, Heinemann and Belkin 1977a). We speculate that *Ae. cozumelensis* potentially could serve as a vector for arboviruses to humans in rural areas of the Yucatán Peninsula. As a case in point, another member of the *Aedes* subgenus *Howardina*, *Ae. bahamensis*, is capable of transmitting St. Louis encephalitis virus (Shroyer 1991). Future studies are needed to determine how commonly *Ae. cozumelensis* feeds on human blood and whether it is naturally infected with arboviruses or other pathogens of medical or veterinary importance.

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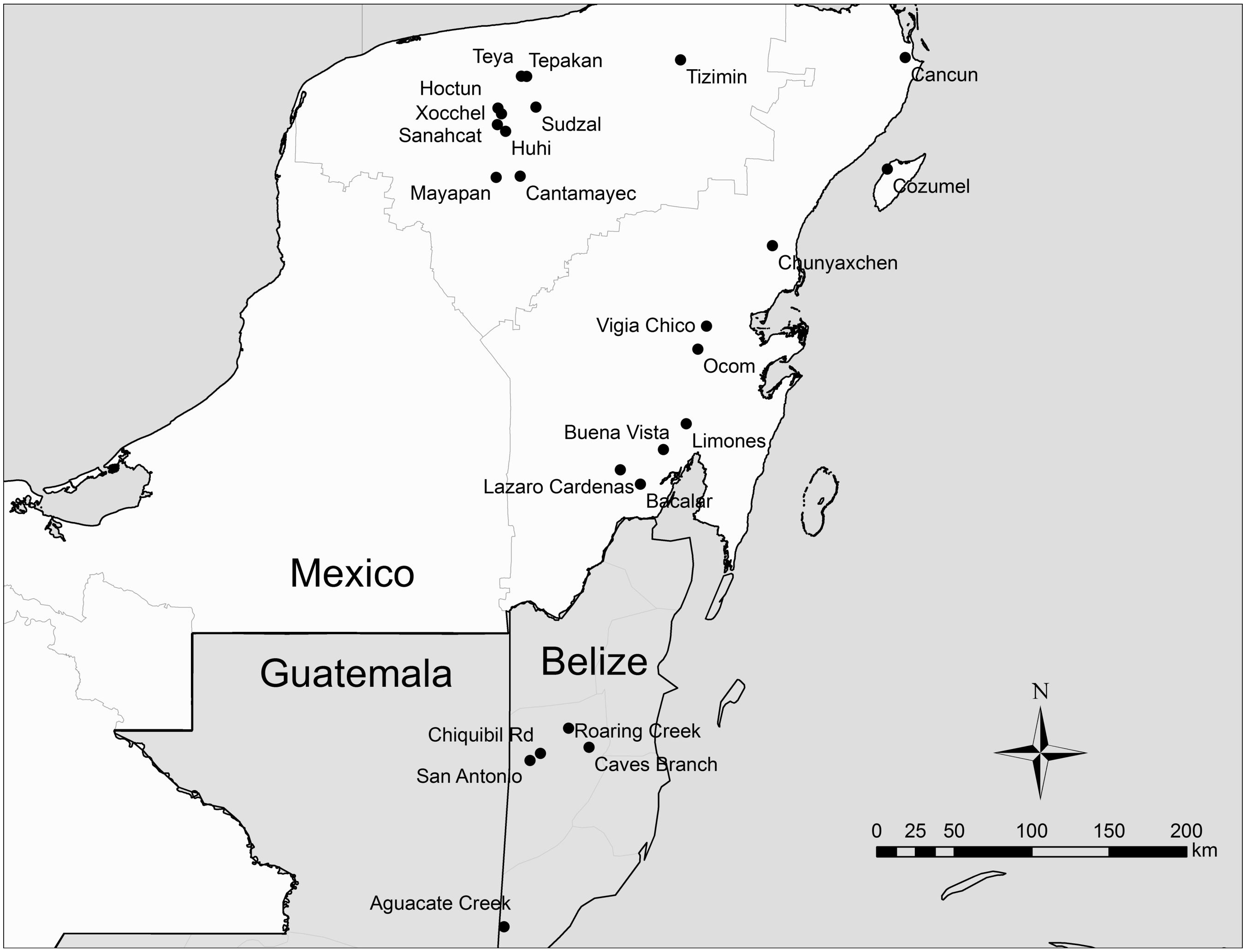

Figure 1.

Locations in México's Yucatán Península (in Yucatán State to the north and Quintana Roo State to the east) or Belize where *Ae. cozumelensis* was collected in the present or previous studies (black circles ●). See Table 1 for more detailed information about the collections.

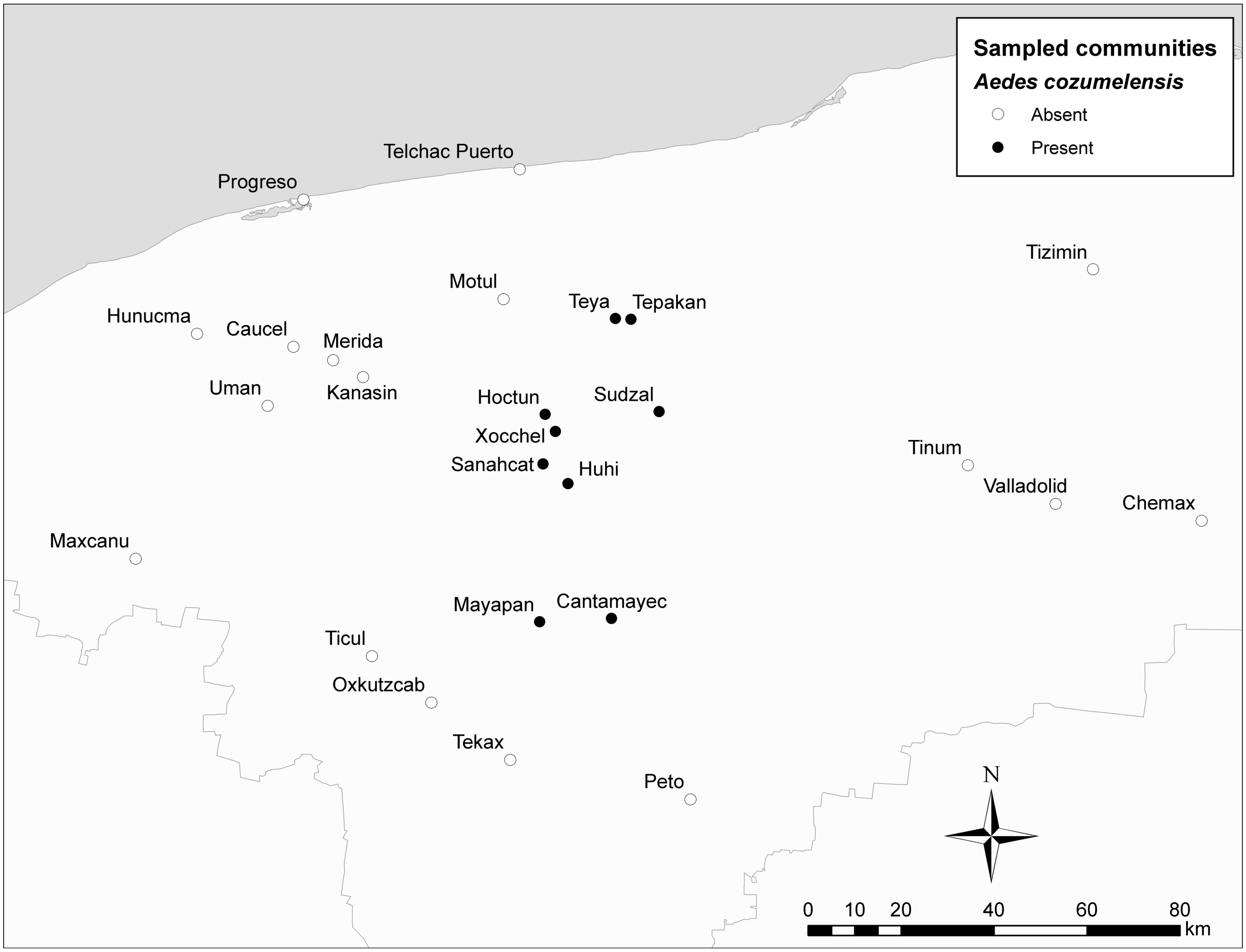

Figure 2.
Mosquito collection locations in Yucatán State from March 2010 – February 2011. All 26 collection locations produced *Ae. aegypti*. Locations from which both *Ae. aegypti* and *Ae. cozumelensis* were collected are denoted by black circles (●); locations producing *Ae. aegypti* but not *Ae. cozumelensis* are shown as hollow circles (○). Tizimin yielded *Ae. cozumelensis* in a previous study (Berlin 1969) but not in this one. See Table 2 for more detailed information about the collections.

Table 1

Summary of collections of *Ae. cozumelensis* from the present and previous studies.

Collection location	Approximate coordinates	Year of collection	Life stage collected	Source of collection	Environment	Reference[a]
México – Yucatán State						
Cantamayec	20°28.23', −89°04.89'	2011	Larva	Rock hole	Rural; Homes	*8*
Hoctun	20°51.92′, −89°12.59′	2011	Larva	Bucket, metal can, tire	Rural; Cemetery, Homes	*8*
Huhi	20°43.87', −89°09.94'	2011	Larva	Flower vase	Rural; Cemetery	*8*
Mayapan	20°27.83′, −89°13.23′	2011	Larva	Water storage tank	Rural; Homes	*8*
Sanahcat	20°46.17′, −89°12.83′	2011	Larva	Rock hole; Bucket, tire	Rural; Homes	*8*
Sudzal	20°52.24', −88°59.37'	2011	Larva	Metal can	Rural; Cemetery	*8*
Tepakan	21°02.94′, −89°02.62′	2011	Larva	Tire	Rural; Homes	*8*
Teya	21°03.05', −89°04.43'	2011	Larva	Metal can	Rural; Cemetery	*8*
Tizimin[b]	21°09', −88°09'	1960	Larva	Unknown	Not specified	*2*
Xocchel	20°49.94′, −89°11.39′	2011	Larva	Bucket, metal can	Rural; Cemetery	*8*
México – Quintana Roo State						
Bacalar	18°41′, −88°23′	2006	Larva/Pupa[c]	Artificial containers and/or leaf axil[d]	Not specified	*7*
Buena Vista	18°53′, −88°15′	2006	Larva/Pupa[c]	Artificial containers and/or leaf axil[d]	Not specified	*7*
Cancún[b]	21°09′, −86°51′	1972–75	Adult	Human bait	Urban, Forest edge	5
Chunyaxchen	20°04′, −87°37′	2006	Larva/Pupa[c]	Artificial containers and/or leaf axil[d]	Not specified	*7*
Ejido Lázaro Cárdenas	18°46′, −88°30′	2006	Larva/Pupa[c]	Artificial containers and/or leaf axil[d]	Not specified	*7*
Limones	19°02′, −88°07′	2006	Larva/Pupa[c]	Artificial containers and/or leaf axil[d]	Not specified	*7*
Ocom	19°28′, −88°03′	2006	Larva/Pupa[c]	Artificial containers and/or leaf axil[d]	Not specified	*7*
San Miguel de Cozumel[b]	20°30′, −86°57′	1965	Larva	Flower pot	Cemetery, Homes	1
Vigía Chico	19°36′, −88°00′	2006	Larva/Pupa[c]	Artificial containers and/or leaf axil[d]	Not specified	*7*
Belize – Cayo District						
Caves Branch[b]	17°08′, −88°42′	1967	Adult	Human bait	Forest	*3_4*
Chiquibil Rd	17°07′, −88°58′	1990, 1991	Larva/Pupa[c]	Plastic bottle	Forest	*6*
Roaring Creek[b]	17°16′, −88°48′	1967	Adult	Human bait	Forest	*3_4*
San Antonio[b]	17°05′, −89°01′	1967	Adult	Human bait	Forest	*3_4*

Collection location	Approximate coordinates	Year of collection	Life stage collected	Source of collection	Environment	Reference[a]
Belize – Toledo District						
Aguacate Creek	16°09′, −89°05′	1992	Larva/Pupa[c]	Plastic bottle	Forest	*6*

[a]1, Diaz Najera 1966; 2, Berlin 1969; 3, Bertram 1971; 4, Heinemann and Belkin 1977a; 5, Pletsch 1977; 6, Pecor et al. 2002; 7, Ortega-Morales et al. 2010a; 8, Present study;

[b]Approximate coordinates were determined, based on the description of the collection locations, using Google Earth (Google, Mountain View, CA);

[c]Stage of immatures (larva or pupa) collected not given;

[d]Collection source for *Ae. cozumelensis* was not specified by artificial container versus natural habitat (rock hole, leaf axils, fallen leaves).

Table 2

Collections of mosquito immatures from homes and cemeteries in communities inYucatán State, March 2010 – February 2011.

Community	Approximate coordinates	Population size[a]	Collection environment[b]	Collection period	Source of collection	Number collected: *Ae. aegypti* Larvae	*Ae. aegypti* Pupae	*Ae. cozumelensis* Larvae	*Ae. cozumelensis* Pupae	Other species[c] Larvae	Other species[c] Pupae
Cantamayec	20°28.23', −89°04.89'	1,695	Rural	Jan 2011	Artificial containers	260	15	0	0	160	0
					Rock holes	20	0	15	0	0	0
Chemax	20°39.56′, −87°56.38′	14,885	Rural	Dec 2010	Artificial containers	210	20	0	0	150	20
Ciudad Caucel	Multiple sites within Ciudad Caucel[d]	6,988	Urban	Aug–Oct 2010	Artificial containers	2,525	81	0	0	200	15
Hoctun	20°51.92′, −89°12.59′	4,686	Rural	Jan 2011	Artificial containers	310	16	14	0	200	0
Huhi	20°43.87', −89°09.94'	4,745	Rural	Jan 2011	Artificial containers	220	15	10	0	150	0
Hunucma	21°01.27′, −89°53.01′	24,910	Rural	Nov 2010	Artificial containers	250	30	0	0	200	30
					Rock holes	30	5	0	0	0	0
Kanasin	20°56.24′, −89°33.74′	7,724	Rural	Nov 2010	Artificial containers	200	30	0	0	150	20
Maxcanu	20°35.15', −90°00.15'	12,621	Rural	Nov 2010	Artificial containers	330	25	0	0	200	30
Mayapan	20°27.83′, −89°13.23′	3,263	Rural	Jan 2011	Artificial containers	330	20	10	0	400	0
Mérida	Multiple sites within Mérida[d]	777,615	Urban[e]	Mar 2010–Feb 2011	Artificial containers	6,990	555	0	0	1,063	286
					Rock or tree holes	80	15	0	0	0	0
Motul	21°05.29′, −89°17.43′	23,240	Rural	Dec 2010	Artificial containers	200	30	0	0	200	35
Oxkutzcab	20°18.46′, −89°25.81′	23,096	Mixed	Nov 2010	Artificial containers	205	15	0	0	150	10
Peto	20°07.21′, −88°55.72′	19,821	Rural	Dec 2010	Artificial containers	200	20	0	0	150	10
Progresso	21°16.84′, −89°40.67′	37,369	Mixed	Nov 2010	Artificial containers	280	21	0	0	400	100
Sanahcat	20°46.17′, −89°12.83′	1,619	Rural	Jan 2011	Artificial containers	260	13	20	0	400	20
					Rock holes	30	1	15	0	0	0
Sudzal	20°52.24', −88°59.37'	1,261	Rural	Feb 2011	Artificial containers	280	21	10	0	200	20
Tekax	20°11.80′, −89°16.65′	25,751	Rural	Dec 2010	Artificial containers	300	35	0	0	100	20
Telchac Puerto	21°20.36′, −89°15.56′	1,722	Rural	Jan 2011	Artificial containers	320	15	0	0	195	15
Tepakan	21°02.94′, −89°02.62′	2,064	Rural	Jan 2011	Artificial containers	240	25	10	0	0	0
Teya	21°03.05', −89°04.43'	1,975	Rural	Jan 2011	Artificial containers	250	16	10	0	200	0
Ticul	20°23.84′, −89°32.71′	32,796	Mixed	Nov 2010	Artificial containers	250	25	0	0	180	30

Community	Approximate coordinates	Population size[a]	Collection environment[b]	Collection period	Source of collection	Number collected					
						Ae. aegypti		*Ae. cozumelensis*		Other species[c]	
						Larvae	Pupae	Larvae	Pupae	Larvae	Pupae
Tinum (Piste)	20°45.99', −88°23.52'	2,111	Rural	Dec 2010	Artificial containers	200	20	0	0	150	20
Tizimin	21°08.75', −88°08.99'	46,971	Mixed	Nov 2010	Artificial containers	330	33	0	0	200	35
					Tree holes	40	5	0	0	0	0
Valladolid	20°41.53′, −88°13.34′	48,973	Mixed	Nov 2010	Artificial containers	230	27	0	0	150	30
Uman	Multiple sites within Uman[d]	39,611	Mixed	Nov 2010 – Feb 2011	Artificial containers	990	91	0	0	280	80
Xocchel	20°49.94′, −89°11.39′	3,229	Rural	Jan 2011	Artificial containers	195	16	15	0	100	0

[a]Based on data for 2010 obtained from Mexico's Instituto Nacional de Estadística Geografía e Informática;

[b]Rural, Urban or Mixed rural and urban;

[c]Predominantly *Culex* spp. with sporadic collections of *Aedes* (*Ochlerotatus*) *taeniorhynchus* and *Toxorhynchites* spp.;

[d]General coordinates for the cities: 20°59.75', −89°41.82' (Ciudad Caucel), 20°58.20', −89°37.20' (Mérida), and 20°52.91', −89°44.81' (Uman);

[e]Predominantly urban environment with a few rural collection sites at the edges of the city.