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New introduction of *Aedes vittatus* (Diptera: Culicidae) into the East-Central region of Cuba: ecological characterization and medical relevance

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Abstract

Aedes vittatus (Diptera: Culicidae) has a wide distribution in the Old World, and it has recently been identified on the American continent. This mosquito has a marked preference for habitats close to human populations, and it is responsible for the transmission of arboviruses of medical importance. In early December 2020, after a routine inspection in a rural locality of Camagüey, Cuba, immature forms of culicids were captured in different types of reservoirs. After the development of the larvae and hatching of the captured pupae, 34 larvae and nine adults belonging to this species were identified, among other species of medical importance. This is the first detection of *Ae. vittatus* in Cuba outside the Guantanamo Bay Naval Base, and the third report in the Americas. It is necessary to deepen our understanding of the bioecology and distribution of this potential invasive species and determine the future impact of the presence of this mosquito in Cuba.

Keywords: *Aedes vittatus*; Invasive mosquito species; Arbovirus; Entomological survey; Insular Caribbean; Cuba.

Introduction

The global dispersal of mosquitoes (Diptera: Culicidae) is generally linked to human activities such as commercial transport and international trade (1). This has been the case for the invasive mosquito species *Aedes (Stegomyia) aegypti* (Linnaeus, 1762), *Aedes (Hulecoeteomyia) japonicus japonicus* (Theobald, 1901) and *Aedes (Stegomyia) albopictus* (Skuse, 1894) (2, 3). The rapid worldwide dispersal of *Ae. albopictus*, which occurred in recent decades, is the best example of the successful introduction of arboviruses, such as dengue and chikungunya, into non-endemic areas. The incursion of this synanthropic species from Southeast Asia, which occurred through the transport of eggs in used tires (4), led to outbreaks of these diseases in new areas colonized by this mosquito, such as in some southern European countries (5).

Due to the current epidemiological situation regarding vector-borne diseases, there has been increased attention on mosquitoes from the scientific community (6). There is an urgent need to expand research in the taxonomic field to improve our knowledge regarding the presence and distribution of different species of culicids in a given location, especially species that are recognized disease vectors. In the cases of *Ae. aegypti* and *Ae. albopictus*, surveillance and control strategies have been designed and implemented in Camagüey, located in the East-Central region of Cuba, due to their widespread dispersion in the province. These actions are aimed at

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reducing the damage to human health caused by these species, including the importance of having an inventory of culicids and their updated geodistribution, in order to carry out more accurate and efficient antivectorial interventions.

This article describes the presence of the species *Aedes (Fredwardsius) vittatus* (Bigot, 1861), an exotic mosquito involved in the biological transmission of important arboviruses (7), in the province of Camagüey for the first time, and explores its relationship to breeding sites under natural conditions.

Materials and methods

On December 3, 2020, an entomological survey was carried out by the Department of Vector Control of the Health Area of the Policlínico Previsora in the rural area of Isabel Hortensia, located 2 km from Circunvalación Sur road in the direction of Vertientes, on the Buey de Oro road (21°21'41.68 "N 77°58'38.28 "W, 97 m asl), belonging to the municipality of Camagüey, province of Camagüey. The survey, which was carried out as part of a routine inspection of the head municipality, included sampling of all natural breeding sites within a radius of approximately 1 km of the human settlement, as well as all artificial reservoirs present in and around houses. This locality is characterized by extensive farms dedicated to agriculture and domestic animal husbandry, where there are abundant bodies of water such as lagoons and seasonal ponds.

Water containers were classified according to the utility given to them by the families: permanent and useful (PU), those that always have water for different uses; non-permanent (NP), those that are not normally used to hold water and are generally abandoned in areas outside the house, such as the yard and garden; and natural (N) (8). For each container used by mosquitos as a breeding site, as many larvae and/or pupae as possible were collected using Pasteur pipettes, plastic trays and sealed jars.

In the insectary of the Vector Control Department of the Provincial Center of Hygiene, Epidemiology and Microbiology of Camagüey, the larvae were introduced into mosquito breeders for development until they reached larval stage L_4, after which they were killed with hot water at 60 °C and fixed in 70 % alcohol. Pupae were allowed to hatch for the classification of adults, which were subsequently killed by freezing. The biological material was classified using taxonomic keys (9–12).

Results

Eight mosquito species were captured in seven types of containers, all of them located outside houses: *Ae. vittatus, Ae. aegypti, Ae. albopictus, Culex coronator* (Dyar & Knab, 1906), *Culex nigripalpus* Theobald, 1901, *Culex quinquefasciatus* Say, 1826, *Culiseta inornata* (Williston, 1893), and *Anopheles albimanus* Wiedemann, 1820 (Table 1). The presence of *Ae. vittatus* was reported in three types of containers (42.85 %), and of the 14 total reservoirs with larvae, this species was detected in four (28.57 %). Used tires stood out, with 50 % positivity for this culicid detected for this container type. A total of 147 larvae were captured, with *Ae. albopictus* (41.49 %), *Ae. vittatus* (23.12 %) and *Cx. quinquefasciatus* (14.96 %) as the predominant species. The greatest proportion of pupae were *Ae. vittatus* (60.00 %). This species was associated with others of notable medical importance, such as *Ae. aegypti* and *Ae. albopictus*, with both species breeding in PU artificial reservoirs (a concrete water trough and a low tank; 50.00 %) and in NP reservoirs (two used tires; 50.00 %), respectively. Table 1 lists the reservoirs in which *Ae. vittatus* were not captured, but which represent potential breeding sites, and in which species associated with *Ae. vittatus* were captured, most of which are of medical relevance.

Six males and three females of *Ae. vittatus* developed from the samples of preimaginal forms placed in the insectary (Figure 1). The most relevant systematic characteristic was the scutum, with three pairs of small white spots distributed along the dorsocentral area, giving them their typical mottled appearance.

Discussion

The recent first report of *Ae. vittatus* in the Americas, in the Dominican Republic (13), together with the subsequent report at the Guantanamo Bay Naval Base (14), raises many questions from an epidemiological point of view, especially regarding the role of this species in outbreaks of arbovirus in the insular Caribbean. Both *Ae. aegypti* and *Ae. albopictus* have been able to maintain exotic epidemics of the chikungunya virus in the Americas

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and the Caribbean. *Aedes vittatus* has been shown to be a vector of these viruses, in addition to dengue and yellow fever (7, 15), and the epidemiological risk is increased when cohabitation of this species with *Ae. aegypti* and *Ae. albopictus* is identified, as in this case.

Aedes vittatus is distributed in the Old World throughout the African continent, tropical Asia and southern Europe, and shows intra- and peridomestic behavior. It usually colonizes natural reservoirs such as rock pools and tree holes (7, 16), but it also benefits from a recognized ecological plasticity that allows it to colonize artificial containers (11). Tolerance to the desiccation of eggs, a phenomenon present in many species of the genus *Aedes*, is one of the keys to its successful worldwide distribution through trade. It often remains undetected until populations are established, making it very difficult to control.

Used tires appeared to play a prominent role among the artificial containers colonized by this species in Camagüey, which strengthens the idea that this species may have arrived at the American continent through the trade of these products, specifically from the Indian subcontinent (13, 14). In fact, solid rubber waste tires have recently been ratified as one of the key containers that harbor mosquito species of medical interest in the insular Caribbean (17).

The fact that this species was captured in Cuban territory outside the Guantanamo Bay Naval Base, which is more than 400 km away, in a rural locality 5 km from the provincial capital and in the East-Central region of the island, leads us to suspect that its invasion throughout the country may have begun some years ago. Furthermore, it is possible that this species may be present in other Antillean countries, although it remains undetected at present. It is interesting to note that the environments in which larval captures were made are very similar to those reported in the Dominican Republic (13), with larvae found in fairly rural localities with open fields, swampy areas and the presence of domestic animals. This suggests a probable change in the epidemiological scenario of arboviruses, given that this species tends to prefer and colonize natural breeding sites (18), even though it was only found in artificial containers in this study. These environments are very different from those preferred by the two species of greatest medical relevance, *Ae. aegypti* and *Ae. albopictus*, the abundance of which are always notable in urban areas, especially for *Ae. aegypti*.

In summary, these results have significant implications for the ecosystem and human health. Certainly, this unintentional introduction may represent a change in the epidemiological scenario of endemic diseases such as dengue, adding a further degree of complexity to its control. Therefore, it is necessary to have in-depth knowledge of the bioecology of this species and the locations where this potential invader is established, as well as to determine the future impact that the presence of this new species of exotic culicid will have in Cuba.

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Table 1. List of mosquito-positive containers in the rural locality of Isabel Hortensia, Camagüey, in December 2020.

Containers	Number of containers positive for culicids	Containers infested with *Ae. vittatus*	Total number of *Ae. vittatus*	Other associated species	Total number of specimens
Water trough (PU)	1	1	16 L, 5P	*Cx. coronator* *Ae. aegypti*	2 L 4 L
Low tank (PU)	3	1	2 L	*Cx. quinquefasciatus* *Cs. inornata*	9 L 1 L
Used tire (NP)	6	2	16 L, 4 P	*Ae. aegypti* *Ae. albopictus* *Cx. quinquefasciatus*	6 L 54 L, 5 P 9 L
Milk churn (NP)	1	-	-	*Ae. aegypti*	5 L
Well (PU)	1	-	-	*Cx. quinquefasciatus*	3 L
Animal feeder (PU)	1	-	-	*Cx. coronator* *Cx. nigripalpus*	4 L, 1 P 2 L
Pond (N)	1	-	-	*Cx. coronator* *Cx. nigripalpus* *Cx. quinquefasciatus* *An. albimanus*	2 L 2 L 1 L 2 L
	14	4	34 L, 9 P		113 L, 6 P

Abbreviations: PU, container permanent and useful; NP, container non-permanent; N, natural container; L, larvae; P, pupae.

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Figure 1. Habitus of an *Aedes vittatus* female that emerged from the breeders.

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