



## Artificial container mosquitoes and first record of *Aedes aegypti* in the islands of the Paraná Lower Delta, Argentina



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### ABSTRACT

Mosquitoes in artificial containers include *Aedes aegypti* and the *Culex pipiens* complex, both recognized worldwide as vectors of diseases. The goal of this study was to characterize mosquito communities in water-filled artificial containers in the islands of one of the major temperate wetlands in South America, and to assess whether *A. aegypti* is present in the area. Five domestic areas located in the insular Tigre District (Buenos Aires Province, Argentina) were visited monthly between November 2011 and May 2012. A total of 1013 artificial containers (half of them with water) were inspected for mosquito immatures. 3359 specimens corresponding to seven species were collected in 88 containers. *A. aegypti* was recorded for the first time in this wetland, and in all land use categories examined from February to May. Among the remaining six species, only *Culex dolosus* and *C. pipiens* were highly abundant. 88% of the mosquito positive containers were buckets, dustbins and boats, whereas highly available bottles did not act as mosquito breeding habitats; the key breeding container was different for each land use. The Container Index showed differences among land uses, materials, water capacity and volume, and insulation levels. Generalized Linear Mixed Models suggested that the probability of finding mosquitoes was higher for containers located in dumps and recreational areas, made of resin/fiberglass, presenting intermediate water volumes, and not in use if partially or totally shaded but in use for sunlit containers. Recommendations for mosquito prevention and control in the islands are proposed.

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### Introduction

Mosquitoes are a great epidemiological concern due to their role as vectors of pathogens to humans and animals. From a socio-economic perspective, mosquito transmitted diseases are highly detrimental in terms of human deaths (CDC, 2013) and enormous costs to the sanitary system (WHO, 2013). Among the most world-known mosquitoes are *Aedes aegypti*, the main vector of dengue in America, and the members of the *Culex pipiens* complex, which transmit different arboviruses and filariasis (Becker et al., 2010).

In Argentina, *A. aegypti* was reintroduced in 1986; since then, its geographical distribution has expanded towards the south and the west, and dengue outbreaks have been recorded throughout the country (Vezzani and Carbajo, 2008; MSN, 2009). Also, the recent transmission of Chikungunya virus by *A. aegypti* in neighboring countries constitutes a new threat at the local level (Carbajo and Vezzani, 2015). Regarding *C. pipiens* transmitted diseases, St. Louis encephalitis caused nine

casualties in 2005 (Spinsanti et al., 2008) and the transmission of West Nile virus has been demonstrated in horses (Morales et al., 2006). Dengue and St. Louis encephalitis have both expanded towards the south of the continent during the past years, and autochthonous cases of both diseases have been reported in Buenos Aires Province (MSN, 2009; López et al., 2010).

The Lower Delta of the Paraná River stands as one of the most important wetlands in South America. Its islands have recently experienced drastic changes in land use and land cover, developing into a complex mosaic of natural and modified patches. Even though population density is low (<1 inhab/ha), around half of its extension is affected by human activities, mainly Salicaceae plantations and tourism (Kandus and Malvárez, 2004). These are reinforced by its close proximity to Buenos Aires City, the second megalopolis in South America with 14,308 inhab/km<sup>2</sup> (INDEC, 2010). As all wetlands, the Paraná Lower Delta offers a high availability and diversity of aquatic environments, which are optimal for the development of immature stages of mosquitoes (Dale and Knight, 2008). Among them, temporary or permanently flooded depressions in the ground and phytotelmata are abundant in the area and their mosquito communities have been studied during the past years (Albicocco et al., 2011; Cardo et al., 2011a, 2011b, 2012a, 2012b). On the contrary, artificial containers are scarce and

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limited to inhabited dwellings, recreation parks and their immediate surroundings.

Mosquitoes breeding in artificial containers have been widely documented due to their epidemiological importance and their intimate contact with human settlements, and the association with different characteristics of the containers has been studied in detail (e.g., Leisnham et al., 2006; Vezzani and Albićocco, 2009; Rubio et al., 2011). However, no research regarding mosquitoes in artificial containers has ever been performed in the Delta of the Paraná River and, in general, the structure and ecological characteristics of these communities in suburban or rural environments within the region have been poorly studied (e.g., Rubio and Vezzani, 2011). To contribute to the knowledge of mosquito ecology in the region, the main goal of this study was to characterize mosquito communities in water-filled artificial containers in a temperate wetland located near the biggest urban center in Argentina, and to assess if the main dengue vector in South America is present. Specifically, we attempted to: a) describe species composition and their relative abundance; b) determine the presence of *A. aegypti*; c) evaluate the effect of container characteristics and insolation levels on mosquito occurrence; and d) assess the relative importance of different domestic land uses as a source of mosquito infestation.

## Materials and methods

### Study area

The Paraná Lower Delta is a 2700 km<sup>2</sup> wetland macromosaic which extends over 300 km through the terminal portion of the Paraná River basin. The deposition of sediments by the river determines the constant development of newly formed pan shaped islands (Kandus et al., 2003). These are characterized by temporarily or permanently flooded central areas with herbaceous vegetations, and levees up to 3 m high dominated by forests. The climate is temperate sub-humid, with annual mean temperature and cumulative precipitation values of 16.7 °C and 1073 mm, respectively.

The study was carried out in the first section of islands from Tigre District, Buenos Aires Province, Argentina (34°25'S, 58°34'W). Five sites with a high degree of human activities were selected to guarantee the presence of artificial containers (Fig. 1).

### Study design

The five sites were visited monthly from November 2011 to May 2012, being the period of highest abundance of mosquito immatures in artificial containers in Buenos Aires Province throughout the urbanization gradient (Vezzani and Albićocco, 2009; Rubio and Vezzani, 2011; Rubio et al., 2011). Three land uses were distinguished: residential, recreational and dump. Two sites were residential areas composed of 15–20 houses including their front and back yards (each house in the range 35–150 m<sup>2</sup>), typically inhabited all-year. The other three sites were 8–16 ha plots used as recreational areas, usually maintained by a manager and visited by tourists mostly during the summer and weekends. In addition, within each island peridomestic areas with dumping grounds were distinguished because they constitute an important and distinct source of artificial containers.

### Field and laboratory work

During each visit all artificial containers were inspected, and the type (e.g. bucket, jar, boat) and number of containers with and without water were quantified. For those holding water, the total capacity was categorized as ≤1 L, 1.1–10 L, 10.1–100 L, 100.1–1000 L and > 1000 L. The water volume in each container was measured up to 5 L using graduated pipettes and buckets, and estimated for larger volumes. Also, the following qualitative variables were recorded: insolation level (sun, partial shade, total shade), material (plastic, metal, resin/fiberglass, others) and usage (with an apparent function or abandoned). The sampling effort was approximately 4 h/person for each site per month. All the field work was performed by the same person in order to guarantee consistent estimations of quantitative and qualitative variables.



Fig. 1. Location of the 5 sites surveyed (white rings) in the Buenos Aires Lower Delta of the Paraná River, Argentina.

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