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Authors: Rodríguez, Giselle A., Veggiani Aybar, Cecilia A., Claps, Guillermo L., and Lizarralde de Grosso, Mercedes S.

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Seasonal oviposition activity of *Aedes aegypti* (Diptera: Culicidae) in San Miguel de Tucumán, northwestern Argentina

Giselle A. Rodríguez[1,2,], Cecilia A. Veggiani Aybar[1,2,]*, Guillermo L. Claps[1], and Mercedes S. Lizarralde de Grosso[1,2]*

Aedes aegypti (L.) (Diptera: Culicidae) is known as an efficient vector of dengue, chikungunya, and yellow fever viruses (PAHO 2011). This domestic urban mosquito shares an important connection with humans because the immature stages develop in water storage containers that are used in both domestic and peri-domestic habitats (Juliano & Lounibos 2005). In 1986, the re-infestation of Argentina by *Ae. aegypti* occurred in the northern provinces and later attained its current distribution, which includes the north, center and south of the country with the southernmost record from Patagonia (Almirón 2002; Grech et al. 2012; Diez et al. 2014). In 1991, the vector was found in some urban areas of Tucumán, and in 2009, a dengue epidemic resulted in the first autochthonous cases in the province (Augier 2000; Ramirez et al. 2013).

In tropical and subtropical regions, the seasonal distribution of mosquito vectors typically follows precipitation patterns, whereas in temperate regions, population size is regulated by the duration and intensity of winter, precipitation levels, and temperature (Rossi & Almirón 2004). Studies in Argentina have shown that oviposition patterns of *Ae. aegypti* correlate with temperature, humidity, and precipitation (Domínguez et al. 2000; Micieli & Campos 2003; Vezzani et al. 2004; Stein et al. 2005; Micieli et al. 2006); for Tucumán, this relationship has not been established. The aim of our study therefore was to observe the relative abundance and seasonal patterns of oviposition by *Ae*. *aegypti* in San Miguel de Tucumán.

The study was conducted from Sep 2012 to Jun 2013 in 5 neighborhoods: Oeste II (26°48'S, 65°15'W), El Bosque (26°48'S, 65°13'W), Ciudadela (26°49'S, W 65°13'W), Norte (26°49'S, 65°11'W), and Modelo (26°48'S, 65°14'W). All neighborhoods were located in San Miguel de Tucumán, Tucumán Province (Fig. 1). Oviposition by *Ae. aegypti* was monitored weekly by placing 8 ovitraps at each sampling site (n = 40 traps). The abundance and percentage of total eggs oviposited (for all sites for that sampling week) was determined for each sampling site and these data examined for correlation(s) with temperature, precipitation level, and other climatic variables.

We collected 9,476 eggs in San Miguel de Tucumán with the greatest abundance at Ciudadela followed by El Bosque, Oeste II, Modelo, and Norte. The main peak of egg abundance was in summer (Dec-Jan-Mar) and was followed by secondary peaks of smaller scale in spring (Nov) and autumn (Apr). The first eggs were observed in ovitraps in late Oct 2012 and the last in mid-May 2013. Oviposition activity decreased towards autumn (May) and ceased with mean daily temperatures of approximately 15 °C; no eggs were collected in winter (Jun). Pearson's correlation coefficient revealed significant associations between oviposition activity and temperature (r = 0.77; P < 0.008) and precipitation level (r = 0.76; P < 0.010) in Ciudadela, and with temperature (r = 0.63; P < 0.049) in Oeste II (Fig. 2).

Although *Ae. aegypti* has previously been reported from Tucumán (Augier 1998), this is the first report of the oviposition patterns for this species in an epidemic area of the province. Other studies in Argentina have reported oviposition patterns similar to those observed in our study. For example, Micieli & Campos (2003) detected oviposition activity in Salta Province throughout the year, with peaks of abundance in Mar that correlated with precipitation levels. Stein et al. (2005) observed oviposition activity for *Ae. aegypti* from Oct to Jun in Chaco, which also correlated with the timing and amounts of precipitation. In Córdoba and Buenos Aires, oviposition by *Ae. aegypti* was observed from Oct/Nov to May/Jun, with peaks of activity associated with precipitation levels and temperature (Campos & Maciá 1996; Domínguez et al. 2000; Vezzani et al. 2004; Micieli et al. 2006).

Human activity could be a factor that affects the abundance of *Ae. aegypti* in Ciudadela and El Bosque. It is known that water-filled containers, improperly maintained swimming pools, unmanaged vegetation, and socio-economic factors favor proliferation of *Ae. aegypti.* Carbajo et al. (2006) reported the ready adaptation of this vector species to urban areas. Gürtler et al. (2009) and Fisher & Schweigmann (2010) noted the effects of vegetation, shade conditions, improperly maintained swimming pools, and housing and waste management in areas with high human densities as factors that maintain high infestation levels of mosquito vectors, including *Ae. aegypti*.

Our results show the presence of oviposition activity by *Ae. aegypti* in Tucumán and provide information that may be useful to future surveillance efforts targeted at *Ae. aegypti*. In this regard, it is important also to monitor changes in human density and activity in endemic areas, especially during times of high *Ae. aegypti* density when the potential for disease transmission may lead to a repetition of the 2009 dengue outbreak in Tucumán.

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[1]Instituto Superior de Entomología "Dr. Abraham Willink", Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán, Miguel Lillo 205, CP 4000, San Miguel de Tucumán, Tucumán, Argentina
[2]Consejo Nacional de Investigaciones Científicas y Técnicas, Crisóstomo Álvarez 722, CP 4000, San Miguel de Tucumán, Tucumán, Argentina
*Corresponding authors; E-mail G. A. R.: giselleodriguez@csnat.unt.edu.ar; E-mail C. A. V. A.: ceciliaveggianiaybar@csnat.unt.edu.ar

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Fig. 1. Aerial photograph of the study area in San Miguel de Tucumán, northwestern Argentina.

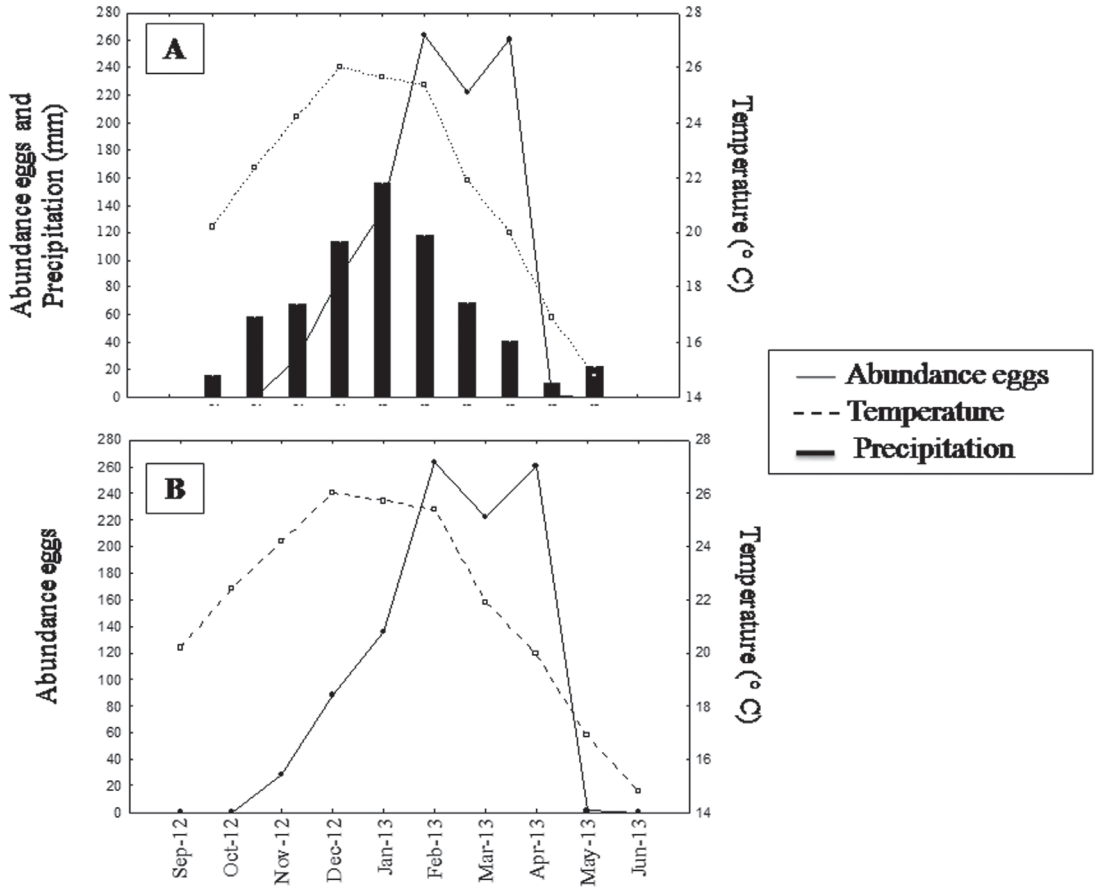


Fig. 2. Seasonal patterns of oviposition activity by *Aedes aegypti*, including temperature and precipitation in (A) Ciudadela and temperature in (B) Oeste II.

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where ovitraps where placed. We thank Andrés Angeletti, Maximiliano Rodríguez, Miguel Pomares, and Gabriel Herrera for their support in the field work. Also thanks to Sofia Nanni and Lucia Krapovickas for the help in translating the manuscript.

Summary

Aedes aegypti (L.) (Diptera: Culicidae) has recolonized many areas of Argentina. The purpose of this study was to determine the seasonal patterns of oviposition activity for this mosquito vector and the association between this factor and climate in an urban area (Tucumán Province) with a history of dengue transmission. We collected 9,476 eggs by ovitraps in San Miguel de Tucumán with the highest abundance of eggs observed in the 2 neighborhoods Ciudadela and El Bosque. Peak oviposition activity by *Ae. aegypti* occurred in the summer. The number of eggs laid was positively correlated with temperature and precipitation levels.

Key Words: emerging tropical disease; arbovirus; ovitrap; *Aedes (Stegomyia) aegypti*

Sumario

Aedes aegypti (L.) (Diptera: Culicidae) ha recolonizando diversas áreas de la Argentina. El objetivo de este estudio fue determinar los patrones estacionales de la actividad de oviposición para este mosquito vector, y la asociación entre este factor y el clima en un área urbana (Provincia de Tucumán) con antecedentes de transmisión de dengue. 9.476 huevos fueron recolectados con ovitrampas en San Miguel de Tucumán, con la mayor abundancia de huevos en los barrios Ciudadela y el Bosque. Picos de actividad de oviposición de *Ae. aegypti* ocurrieron en el verano. El número de huevos puestos fue correlacionado positivamente con la temperatura y los niveles de precipitación.

Palabras Clave: enfermedades tropicales emergentes; arbovirus; ovitrampas; *Aedes (Stegomyia) aegypti*

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