Journal of Mosquito Research, 2012, Vol.2, No.3, 19-24
http://jmr.sophiapublisher.com

Research Report Open Access

Entomological Remarks on *Culex quinquefasciatus* (Diptera: Culicidae) in Camagüey (Cuba)

Lorenzo Diéguez Fernández[1], Pedro María Alarcón-Elbal[2], María Mantecón Estrada[3], Luis Acao Francois[4], Rigoberto Fimia Duarte[5], Ricardo Rodríguez de la Vega[6]

1. Departamento de Control de Vectores. Unidad Municipal de Higiene y Epidemiología. Calle República No. 217 e/ General Gómez e Ignacio Agramonte. Camagüey, Cuba
2. Parasitología y enfermedades parasitarias. Departamento de Patología Animal (Sanidad Animal). Facultad de Veterinaria. Universidad de Zaragoza, Calle Miguel Servet 177, 50013 Zaragoza, España
3. Unidad Municipal de Higiene y Epidemiología de Minas, Cuba.
4. Universidad de las Ciencias Médicas. Carretera Central Oeste. Camagüey, Cuba
5. Departamento de Control de Vectores. Centro Provincial de Higiene, Epidemiología y Microbiología Clara. Ave. Libertadores No. 99 e/ C y D. Reparto Santa Catalina, Santa Clara. CP 20100. Villa Clara. Cuba
6. Hospital Universitario de Canarias. San Cristóbal de La Laguna. Tenerife, Islas Canarias. España

Corresponding author email: lfdieguez@finlay.cmw.sld.cu; Authors

Journal of Mosquito Research, 2012, Vol.2, No.3 doi: 10.5376/jmr.2012.02.0003
Received: 29 Sep., 2012
Accepted: 09 Oct., 2012
Published: 22 Nov., 2012

Preferred citation for this article:
Fernández et al., 2012, Entomological Remarks on *Culex quinquefasciatus* (Diptera: Culicidae) in Camagüey (Cuba), Journal of Mosquito Research, Vol.2, No.3 19-24 (doi: 10.5376/jmr.2012.02.0003)

Abstract If introducing the West Nile virus in Cuba was formerly a hazard, it is now a verifiable fact due to the country's midway location, the confluence of migratory birds and the presence of potential vectors such as *Culex quinquefasciatus*. Therefore, an entomological study was conducted to estimate the environmental factors that condition the biotic variables for *Cx. quinquefasciatus* populations in a suburban health care area of the Province of Camagüey. Biweekly captures of adults were performed from February 2009 to January 2010 in accordance with the sampling design described by WHO. No close relation was observed between the population density and the parous rates, which were not analogous during the assessed period. There were large exophagia and population density values from February to June. The parous rate assessment was enough to take into consideration the entomological contribution of *Cx. quinquefasciatus* to epidemiologic risk in the locality studied. Neither the multifactorial association between the data pair population density rate-parous rate, nor the seasonal parameters revealed notable differences between indoor and outdoor capture settings.

Keywords *Culex quinquefasciatus*; West Nile fever; Population density; Parous rate; Ecological studies

1 Introduction

Several agent-borne diseases may have an alarming emergence and/or derived (re)emergence due to a complex combination of causes. A clear example is *Culex quinquefasciatus* (Say, 1813), a species related to human-hosted filaria (Rwegoshora et al., 2007) and the West Nile virus (WNV) (Diéguez et al., 2003) because it poses a serious threat for both animal and public health. Thus, carrier surveillance and control strategies regarding transmission processes should be improved. Since mosquitoes and migratory bird species come together in Cuba due to its halfway position, such an ecological mixture of causative factors, described as a potentially risky combination for vector-borne diseases (Diéguez et al., 2003), places Cuba at higher risk for WNV occurrence. Not surprisingly, WNV cases have been reported in three humans (in Villa Clara and Sancti Spiritus) and in four horses (Province of Havana and Havana City) (Pupo et al., 2006) from 2003 to 2004. That's why a migration monitoring system (aimed at tracking endemic birds, mammalians, mosquitoes and humans) operates nationwide since January 2002.

Among the species of mosquitoes existing in Cuba being reported as WNV-infected in other countries (Pupo et al., 2006), *Cx. quinquefasciatus* is the one with the largest population density in urban habitats, exhibiting great competitive force and breeding preferably in standing water reservoirs and water-filled containers (Bisset and Marquetti, 1983).

Taking into account the need for a bioecological characterization of *Cx. quinquefasciatus* populations, the present research sought to establish what environmental factors decide the biotic variables for the target species' occurrence in a suburban area of Camagüey City.

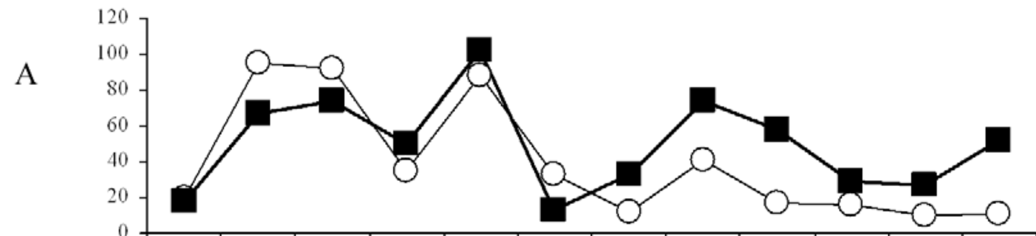
2 Results

Figure 1 shows that population density and parous rates were not analogous during the period assessed. No significant differences in data values among the sampling sites were reported. As no close relation was observed between the population density and the parous rate (which were not analogous during the assessed period) parous evaluation was then sufficient to estimate the entomological contribution of *Cx. quinquefasciatus* to epidemics in the locality studied.

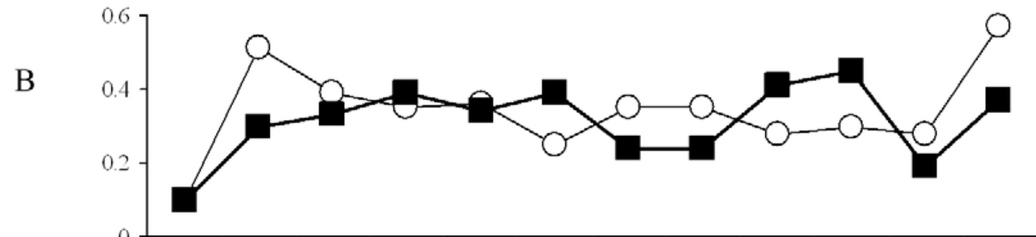
When grouping the population density rates (*PD*) according to their monthly occurrence, a first cluster (*M*), sampled from February to June, yielded the largest value ($p < 0.00114$); a second cluster comprised the rest of the months (*m*). When rearranging both clusters in regard to their capture settings (indoors: *I*) and (outdoors: *O*), the population density was catalogued into four clusters (*MIPD, MOPD, mIPD)* and (*mOPD*).

Table 1 confirmed major differences of favourable population density for *MIPD* and for *MOPD,* regarding *mIPD*; however, the parous rate showed no differences among the sites of capture.

Environmental influence, as displayed in Figure 2, indicates a certain degree of association between population density and parturition in the two collection settings, as well as a higher influence of recent precipitation (*P7*), wind speed, and high temperature values. The combination of these variables actually encourages the newly-parous females to pray inside houses at a higher frequency. A more detailed analysis of this figure shows two consecutive groups of nonoverlapping month periods: February-August and September-January, revealing the March-April period as the one that provides the best seasonal conditions for population density, i.e., high atmospheric pressure, little rain, and low relative moisture.



	F	M	A	M	J	J	A	S	O	N	D	J
—O— Inside	19.6	94.8	91.6	35.2	87.6	33.2	12.4	40.8	16.8	16	10	11.2
—■— Outside	18.4	66.8	74.4	49.6	102	13.2	33.2	74	58.4	28.8	26.8	52



	F	M	A	M	J	J	A	S	O	N	D	J
—O— Inside	0.1	0.51	0.39	0.35	0.36	0.25	0.35	0.35	0.28	0.3	0.28	0.57
—■— Outside	0.1	0.3	0.33	0.39	0.34	0.39	0.24	0.24	0.41	0.45	0.19	0.37

Figure 1 Fluctuations in population density (A) and parous rates (B) for *Culex quinquefasciatus* outdoor and indoor collecting settings.

Table 1 Post-hoc analysis of population density values among the month groups in relation to ANOVA through the Tukey test

parameters	*MIPD* (1) average =65.76	*MOPD* (2) average =61.76	*mIPD* (3) average =21.09	*mOPD* (4) average =44.686
MIPD (1)	−	−	−	−
MOPD (2)	0.990619	−	−	−
mIPD (3)	***0.002474***	***0.006964***	−	−
mOPD (4)	0.323837	0.511610	0.158824	−

Note: *MIPD*: month-indoor population density in the February-June period; *MOPD*: outdoor population density in the February-June period; *mIPD*: indoor population density in the July-January period, and *mOPD*: outdoor population density in the July-January period.

3 Discussions

Cx. quinquefasciatus, as a carrier of parasitic and viral illnesses into humans (Wondji et al., 2008), has adapted very well to urban milieus where its breeding spots have been fostered by human activity (Gingrich et al., 2006; Wallace, 2007; Metzger et al., 2008). Moreover, numerous chemical applications have resulted in pesticide resistance (Diéguez et al., 1999).

In North America the spread of WNV as conveyed by *Cx. quinquefasciatus*, among other species of culicids, has occurred at a rapid rate, reaching Mexico and the Caribbean (Mosha et al., 2008). Epidemiological surveillance of mosquitoes, birds and horses has likewise demonstrated wide circulation in Central and South America (Pupo et al., 2006; Artsob et al., 2009).

In the case of Cuba, the presence of antibodies in both birds and mammalians was connected to the first cases of WNV infection between 2002 and 2003, and to the establishment of a zoonotically amplified life history that involved a sequence of hosts from resident birds to horses and humans (Komar and Clark, 2006).

Unfortunately, further entomological studies involving these findings are limited in Cuba; hence the pressing need for a characterization of such zoologically-involved groups.

Local differences between rainfall-population density indicated that, contrary to the supposedly homogeneous seasonal conditions in neotropical areas, there are indeed dissimilarities as to what favours the proliferation of mosquito breeding settings under diverse weather influences (Pupo et al., 2011), basically, temperature and rainfall. It should be noted that Heft and Walton (2008) found a negative effect of precipitation on carrier population density as well.

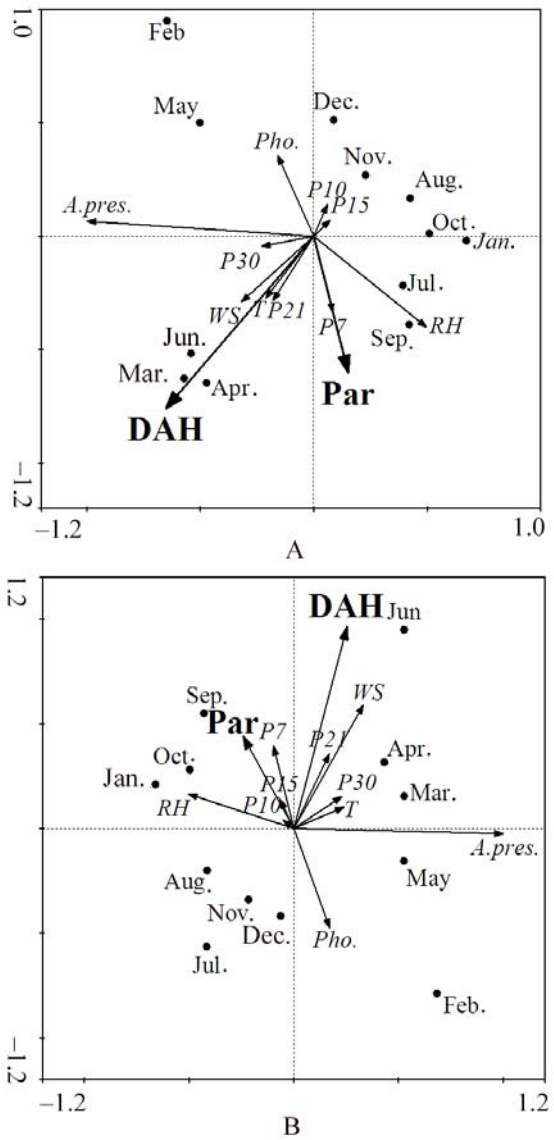


Figure 2 Relation between seasonal factors and indoor (A) outdoor (B) populational characteristics for *Culex quinquefasciatus.*

Note: populational characteristics: Par: parous rate and AHD: average hour-density; abiotic factors: WS: wind speed, A.press: atmospheric pressure, T: temperature, Phot.: daylight extent, RH: relative humidity, P7, P10, P15, P21 and P30: accumulated precipitation, 10, 15, 21 and 30 days prior to collection.

Concerning population density and haematophagic activity, the present paper's results differ from those of others authored in Cuba most likely in that environments of targeted localities were different, thereby accounting for the different behavioural strategies the species adopts, i.e., no differences were found in the number of *Cx. quinquefasciatus* females captured indoors and outdoors, even if larger population densities were reported in the lesser rainy season.

Consequently, Cuban sanitary authorities were able to adopt a more integrative approach toward entomological monitoring programs since *Cx. quinquefasciatus* parturition rate for the studied area suggested that, by calculating it, the entomological and epidemiological hazard posed by the mosquito population could be identified; on the other hand, large population density values were not related to significant parous rate values, which allowed for a better management practice and, ultimately, for an assessment of control campaigns' comparative efficacies.

Determining the environment's influence on the illnesses and on their vectorial component has permitted to analyze spatial incidence patterns for several of diseases, which, in conjunction with entomological indexes, not only enabled to explore and identify those areas at higher risk for infestation, but also their corresponding timeframes, months, as well as seasonal parameters, which, in turn, enabled to optimize surveillance campaigns by considering housing conditions and local community behavioural patterns.

The data pair environmental temperature-relative humidity stirred the blood-sucking activity of *Cx. quinquefasciatus*, while the precipitation levels being reported, in fact, favoured the fill-up of containers and other usual breeding spots.

The results will permit, as in city cases like Juárez (Mexico) and El Paso (United States) (Covarrubias et al., 2008), the establishment of a cost-effective surveillance for the target species.

Although diverse species of mosquitoes have been identified as amplifying species and/or bridge agents (Komar and Clark, 2006), it is unquestionable that *Cx. quinquefasciatus*, given its wide propagation throughout in Cuba, represents the highest danger, as confirmed by entomological research conducted in the central region of the country (Cruz and Cabrera, 2006).

4 Conclusions

No close relation was observed between the population density and the parous rates, which were not analogous during the assessed period. There were large exophagia and population density values from February to June. Parous rate assessment was enough to take into consideration the entomological contribution of *Cx. quinquefasciatus* to epidemiologic risk in the locality studied. Neither the multifactorial association between the data pair population density-parous rate, nor the seasonal parameters revealed notable differences between indoor and outdoor capture settings.

5 Material and Methods

5.1 Study setting

Collection of *Cx. quinquefasciatus* was carried out in Monte Carlo, a suburban neighbourhood of Camagüey City, capital of the Province of Camagüey, Cuba (Figure 3).

Figure 3 Map of Cuba highlighting the Province of Camagüey with its capital, Camagüey (●).

5.2 Entomological survey

Following WHO (1975) sampling design, biweekly captures of adults were executed between February 2009 and January 2010 in two capture settings (indoors and outdoors), from 18:00 to 23:30 hours, by assigning 30 minutes for capture and 30 minutes for recess. To avoid bias from human attraction, capturers-baiters exchanged sampling days and schedules. The biological material, once identified, sexed and counted, generated a database, which specified schedules, collection sites, species, and physiologic ages.

5.2.1 Formulation of the biotic variables

For the calculation of the average density-hour value, the formula was the following (DNCV, 1977):

$$ADH=(M/T)\times 60$$

Where: ADH=average density-hour, M=total of mosquitoes captured, T=time employed for capture, in minutes (a total of 120) and 60=constant (one-hour total of minutes).

The parous rate of females was determined in accordance with Detinova and Gillies's procedure (1963). For the calculation of this indicator, the formula was (OPS, 1996):

$$P= T_p/T_f$$

Where: P=proportion of females that had laid eggs at least once; T_p=total number of parous mosquitoes; T_f=Total number of female mosquitoes captured.

5.2.2 Determining the abiotic factors

Moreover, wind speed (*WS*), temperature (*T*), relative humidity *(RH)*, and accumulated precipitation 7 *(P7)*, 10 (*P10*), 15 (*P15*), 21 (*P21*) were recorded for up to 30 days prior to collection (*P30*), along with daylight extent (*Phot*) and atmospheric pressure (*A.press*).

5.3 Statistical analysis

Indoor and outdoor capture settings were *t* tested independently for sample population density and parous rates in order to determine whether there were variations among the reported data values by complementing—in the case of the population density rates, whenever it was rearranged in groups of months according to monthly occurrence—with an analysis of variance (ANOVA) Fisher proceeding, along with the post-hoc test of essentially significant differences from the Tukey test.

By using the Canoco 4.5 software (Braak and Smilauer, 2002), a principal component analysis (PCA) was performed to determine the correlation among the dependent variables (population density and parturition) and the independent variables (abiotic factors).

References

Artsob H., Gubler D., Enria D., Morales M., Pupo M., Bunning M., et al., 2009, West Nile virus in the new world: Continuing Spread and Proliferation of a Globally- Distributed Invasive Emerging Pathogen. Zoonoses Public Health., 56:357-69 http://dx.doi.org/10.1111/j.1863-2378.2008.01207.x PMid:19486320

Bisset J.A., and Marquetti M.C., 1983, Comportamiento relativo de las densidades larvales de *Aedes aegypti* y *Culex quinquefasciatus* durante la etapa intensiva de la campaña Anti-*aegypti*. Rev Cubana Med Trop., 35(2):176-81

Braak., J.F., and Smilauer P., 2002, Canoco for Windows Version 4.5. Wageningen, The Netherlands: Biometrics-Plant Research International

Covarrubias A., Rubio H.O., and Jiménez J.A, 2008, Vigilancia entomológica de *Culex quinquefasciatus* Say, 1823, vector de enfermedades arbovirales en la zona urbana de Ciudad Juárez, Chihuahua, México. Universidad y Ciencia., 24(2):101-110

Cruz C., and Cabrera M., 2006, Caracterización entomológica-ecológica de casos y sospechosos del virus del Nilo Occidental en la provincia Sancti Spíritus, Cuba. Rev Cubana Med Trop., 58(3):235-240

Departamento Nacional de Control de Vectores., 1977, Normas Nacionales para el Control de Vectores. Ciudad de La Habana: MINSAP., pp.164.

Detinova T.S., and Gillies M.T., 1963, Preliminary report on the possibility of determination of physiological age in *Anopheles gambiae* and *Anopheles funestus*. WHO/MAL / 379

Diéguez L., Bisset J.A., Rodríguez M.M., González T., Díaz C., and Vázquez R., 1999, Análisis comparativo de la resistencia a insecticidas en cepas de *Culex quinquefasciatus* provenientes de Camagüey. Rev Cubana Med Trop., 51(1):26-32

Diéguez L., García G., Herrera O., Ponce A., and Guerrero C., 2003, La difusión del virus de la Fiebre del Nilo Occidental (West Nile): Principales consideraciones para su prevención y control. Rev Archivo Méd Camagüey, 7(4). http://www.amc.sld.cu/amc/2003/v7n4/854.htm

Gingrich J.B., Anderson R.D., Williams G.M., O'Connor L., and Harkins K., 2006, Stormwater ponds, constructed wetlands, and other best management practices as potential breeding sites for West Nile virus vectors in Delaware during 2004. J Am Mosq Control Assoc., 22:282-291 http://dx.doi.org/10.2987/8756-971X(2006)22[282:SPCWAO]2.0.CO;2

Heft D.E., and Walton W.E., 2008, Effects of the El Niño-Southern Oscillation (ENSO) cycle on mosquito populations in southern California. J Vector Ecol., 33(1):17-29 http://dx.doi.org/10.3376/1081-1710(2008)33[17:EOTENS]2.0.CO;2

Komar N., and Clark G., 2006, West Nile virus activity in Latin America and the Caribbean. Rev Panam Salud Publ., 19(2):112-117 http://dx.doi.org/10.1590/S1020-49892006000200006 PMid:16551385

Metzger M.E., Myers C.M., Kluh S., Wekesa J.W., and Kramer VL., 2008, An assessment of mosquito production and nonchemical control measures in structural stormwater best management practices in southern California. J Am Mosq Control Assoc., 24:70-81 http://dx.doi.org/10.2987/5655.1 PMid:18437817

Mosha F.W., Lyimo I.N., Oxborough R.M., Matowo J., Malimar R., Feston E., et al., 2008, Comparative efficacies of permethrin-, deltamethrin- and *a*-cypermethrin-treated nets, against *Anopheles arabiensis* and *Culex quinquefasciatus* in northern Tanzania. Ann Trop Med Parasitol., 102(4):367–376 http://dx.doi.org/10.1179/136485908X278829 PMid:18510817

Organización Panamericana de la Salud., 1996, Biología y ecología de *Anopheles albimanus* Wiedemann en Centroamérica. Informe especial. OPS., 121(3):189-220

Pupo M., Guzmán M.G., Fernández R., Llop A., Dickinson F.O., Pérez D., et al., 2006, West Nile Virus infection in Human and Horses, Cuba. Emerg Infect Dis., 12(6):1022-1024 http://dx.doi.org/10.3201/eid1206.051235 PMid:16707068 PMCid:3373050

Pupo M., Cabrera V., Vázquez Y., Drebot M., Andonova M., Dickinson F., et al., 2011, Estudio serológico en localidades cubanas con infecciones confirmadas al virus del Nilo Occidental. Rev Cubana Med Trop., 63(3):227-230

Rwegoshora R.T., Simonsen P.E., Meyrowitsch D.W., Malecela-Lazaro M.N., Michael E., and Pedersen E.M., 2007, Bancroftian filariasis: house-to-house variation in the vectors and transmission-and the relationship to human infection in an endemic community of coastal Tanzania. Ann Trop Med Parasitol., 101(1): 51–60 http://dx.doi.org/10.1179/136485907X154610 PMid:17244409

Wallace J.R., 2007, Stormwater management and mosquito ecology: a systems-based approach toward an integrative management strategy. Stormwater., 8:20-46

Wondji C.H.S., Priyanka de Silva W.A.P., Hemingway J., Ranson H., and Parakrama S.H.P., 2008, Characterization of knockdown resistance in DDT- and pyrethroid-resistant *Culex quinquefasciatus* populations from Sri Lanka. Trop Med International Health., 13(4):548–555 http://dx.doi.org/10.1111/j.1365-3156.2008.02033.x PMid:18312471

WHO., 1975, Manual in practical entomology in malaria. Geneva. Part II., pp.191