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Aedes aegypti (Diptera: Culicidae): evolution of its population dynamics in the last 16 years in Villa Clara, Cuba

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Abstract

Throughout history, humanity has suffered the scourge of viral and parasitic diseases, and in most of these, a vector organism is a common factor. The objective of this research was to analyze the population dynamics of the *Aedes aegypti* mosquito species over the last 16 years in Villa Clara province, Cuba. In Villa Clara, specialists from the Provincial Unit for Surveillance and Antivectorial Fight (UPVLA) have recorded 316 370 homes and buildings in the general universe, out of which 236 391 belong to the urban universe. They have also registered in such homes or buildings distributed over the 13 municipalities, approximately 1 587 745 water containers with conditions for the breeding, proliferation, and dissemination of the afore-mentioned Culicidae. A descriptive, ecological, retrospective, and statistical study was conducted using an Excel database, covering the period from 2010 to 2025. The data recorded in this database corresponds to: a) the incidence of the *Aedes aegypti* mosquito species during the 12 months of the year, from 2010 to 2025; and b) the incidence of this species by municipality during the 16 years covered by the study. Therefore, the maximum of the mean value corresponds to October and the minimum to December, while the month with the greatest variability was October, and the month with the least was May. While in the case of the municipalities, Santa Clara, Sagua la Grande, Placetas, Manicaragua and Ranchuelo were the ones with the greatest focus. It is concluded that the trend of the *Ae. aegypti* mosquito species in terms of its focality and population dynamics in the Villa Clara province during recent years is towards an increase, which is due to a series of factors, both operational and environmental, that greatly favor the proliferation, adaptation and successful development of this mosquito species.

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Keywords: *Aedes aegypti*, focality, incidence, population dynamics, Villa Clara

1. Introduction

Throughout history, humanity has suffered from the scourge of potentially fatal viral and parasitic diseases [1-3], including: Yellow Fever, Dengue, Zika, Chikungunya, Malaria, Chagas, Leishmaniosis, Onchocercosis, Angiostrongylosis, Fasciolosis, among many others, and in most of them, a vector organism is often a common factor [4-6]. These diseases are widespread in the tropics, with local variations in terms of the risk of transmission and dispersal, and are therefore highly dependent on rainfall, temperature and rapid unplanned urbanization, among other factors [7-9].

Since the dawn of civilization, infectious diseases have affected humanity [10-12]. The early history of infectious diseases was characterized by sudden and unpredictable outbreaks, often of epidemic proportions [3,13,14].

Millions of people suffer from arthropod-borne vector-borne infections; Among these, culicids are undoubtedly the most important in terms of hygiene and health [2,15,16], because they are one of the priority health problems in almost all tropical and subtropical regions [17-19] and are responsible for the maintenance and transmission of the pathogens that cause Dengue, Yellow Fever, West Nile fever, Chikungunya, Zika, Malaria and lymphatic filariosis, among other deadly and debilitating infections [18,20-23].

Dengue has spread in recent decades and remains the leading arbovirus [10,24,25], while Chikungunya and Zika have emerged in recent years [3,26,27]. Malaria remains the world's leading parasitic health problem [28,29]. An estimated 429,000 deaths were recorded in 2015. Approximately 90% of malaria-related deaths globally occur in Africa, 70% of which are among children under five years of age [29].

The emergence and resurgence of arboviral infections has been a growing phenomenon in the last decade [8,27,30]. The changing epidemiology and the factors responsible for this dramatic resurgence of these diseases are diverse and complex [31-33]. A large proportion of human diseases are zoonotic. Furthermore, demographic, social, and environmental changes, both global and local, have facilitated the transmission and spread of infection to humans [34-36].

In Cuba, the incidence of these diseases, both parasitic and viral, undoubtedly constitutes a health problem [37], with a trend toward an increase in the number of cases, as well as in the populations of vector organisms [38-40].

The objective of this research was to analyze the population dynamics of the *Aedes aegypti* mosquito species over the last 16 years in Villa Clara province, Cuba.

2. Materials and Methods

2.1. Study area descriptions

The research was carried out in Villa Clara province, Cuba, whose provincial capital is Santa Clara municipality and covered the 13 municipalities that make up the province In Villa Clara, specialists from the Provincial Unit for Surveillance and Antivectorial Fight (UPVLA) have recorded 316 370 homes and buildings in the general universe, out of which 236 391 belong to the urban universe (74.7%). They have also registered in such homes or buildings distributed over the 13 municipalities, approximately 1 587 745 water containers with conditions for the breeding, proliferation, and dissemination of the afore-mentioned Culicidae (Figure 1).

***Source**:* Provincial Meteorological Center of Villa Clara

Fig 1: Administrative map of Villa Clara province

2.2. Type of study

A descriptive, ecological, retrospective, and statistical study was conducted using an Excel database, covering the period from 2010 to 2025 and encompassing the 13 municipalities of Villa Clara province, Cuba. The data recorded in this database corresponds to: a) the incidence of the *Ae. aegypti* mosquito species during the 12 months of the year, from 2010 to 2025; and b) the incidence of this species by municipality during the 16 years covered by the study.

2.3. Methods and techniques for the collection of data

A review of the existing statistical records and archives was made at the Provincial Unit for Surveillance and Antivectorial Struggle (UPVLA) and at the Provincial Department of Health Statistics in Villa Clara, where all the entomological history of the work cycles conceived in the 13 municipalities of the province is compiled. Such information is periodically reported in statistical tables established for such purposes by the National Directorate for Surveillance and Antivectorial Struggle (DNVLA) and the Department of

Health Statistics at the Ministry of Public Health (MINSAP). The information that will be collected is based on the work cycles established for vector surveillance and control, aimed at the focal work with the universe of houses and buildings in the urban and rural areas of the 13 municipalities of the province. Our research, however, will be focused on the urban universe (related to the ecology of the vector under study). The periodicity of the cycles is monthly, in the case of this universe.

2.4. Ethical aspects

For the conduct of the research, informed consent was considered, as well as the ethical standards that made it possible to promote and ensure respect for all participants in the study, so that their criteria/opinions and individual rights were respected, in order to generate new knowledge without violating the ethical principles of privacy and confidentiality of personal information [41].

3. Results and Discussion

Table 1 shows the descriptive statistics for the number of light bulbs per month, where we can see the maximum value per column in red and the minimum in green. Therefore, the maximum of the mean value corresponds to October and the minimum to December, while the month with the greatest variability was October, and the month with the least was May; results that coincide with those of other authors in previous years [6,40,42].

Table 1: Descriptive statistics for the number of mosquito breeding sites per month in the province of Villa Clara. 2010-2025

	N	Minimum	Maximum	Media	Standard deviation
Year	238	2010	2026	2018.00	4.909
January	225	0.0	1522.0	127.431	293.3698
February	225	0.0	1360.0	115.484	264.4775
March	225	0.0	1541.0	109.262	258.3486
April	225	0.0	1909.0	106.578	279.8831
May	225	0.0	1420.0	111.360	258.0832
June	225	0.0	2081.0	153.262	341.6121
July	225	0.0	1936.0	119.662	273,4179
August	225	0.0	2547.0	131.040	329,3270
September	225	0.0	1643.0	138.631	312,8787
October	225	0.0	1900.0	161.751	353,8550
November	224	0.0	2012.0	141.366	315,7494
December	225	0.0	1413.0	97.138	226,5387
Total	224	0.0	17429.0	1519.089	3256,8633
N válido (por lista)	223				

Table 2 shows the minimum, maximum, and average values for each month, where October also turned out to be the month with the highest data, while December had the lowest values. These results largely coincide with those obtained by other authors, with notable figures also for the months of June, August, September, and November [6,9,30].

Table 2: Descriptive statistics for minimum, maximum, and average values per month

Months	N	Minimum	Maximum	Media	Standard deviation
January	14	5.00	896.00	128.0000	273.66084
February	14	5.88	812.,00	116.0000	250.09010
March	14	4.38	76,25	109.7500	240.36076
April	14	4.69	749.38	107.0536	237.86659
May	14	6.06	783.00	111.8571	235.20544
June	14	8.00	1077.63	153.9464	315.76515
July	14	6.56	841.38	120.1964	244.04998
August	14	7.81	921.38	131.6250	275.93220
September	14	8.38	974.75	139.2500	290.10711
October	14	8.19	1137.31	162.4732	335.64613
November	14	8.00	989.56	141.6060	296.10563
December	14	3.00	683.00	97.5714	208.66549
Total	14	80.69	10633.63	1519.0893	3200.17396
N valid (by list)	14				

Figure 1 shows the average focus data for all months and by municipality. Note that there is uniformity, at least in the data collection, since in all months it is very similar, always with greater focus, in the months of October, June, November, September and August [9,35,36], while in the case of the municipalities, Santa Clara, Sagua la Grande, Placetas, Manicaragua and Ranchuelo stand out in that order, which agrees with results obtained in previous years [6,33,40,43].

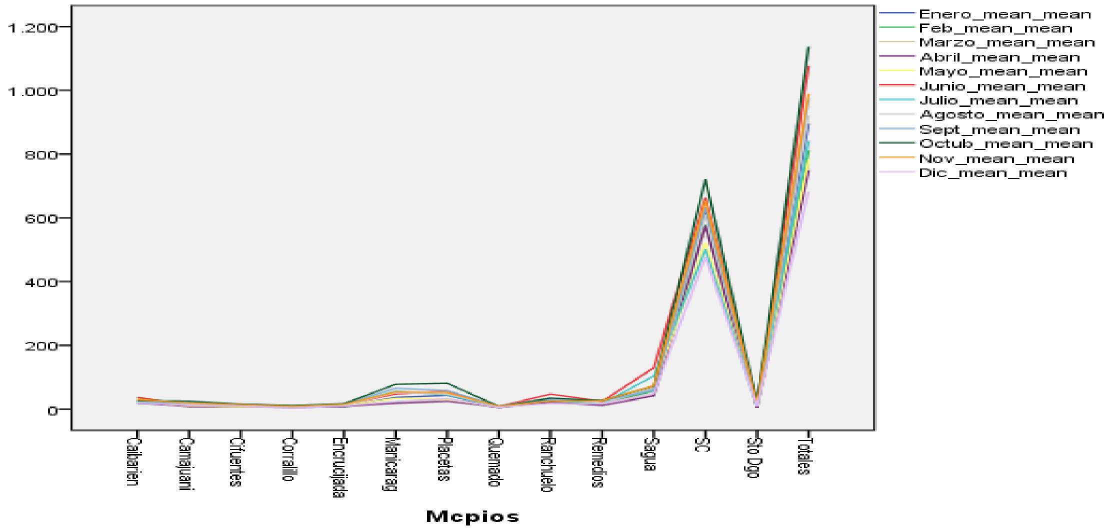

Fig 1: Average focal points by month and municipality

A better understanding of the situation regarding the concentration of *Ae. aegypti* mosquitoes, both by month and by municipality in Villa Clara province during the 16 years analyzed in the study, is shown in Figure 2, revealing a complete agreement and correspondence with the previously stated findings. This is not a problem that can be analyzed in isolation, as the causes of such high concentration and dispersion of *Ae. aegypti* are multifactorial, including: deterioration and deficient control programs, which have not been sustainable over time; co-infection with Dengue and Zika, which mutually enhances viral replication in this species; co-circulation of three arboviruses (Dengue, Zika, and Chikungunya) by *Ae. aegypti*, a reality in many places and countries; demonstrated vertical transmission in both *aegypti* and *albopictus*; and the species' high vector capacity and ecological plasticity [12,44-47].

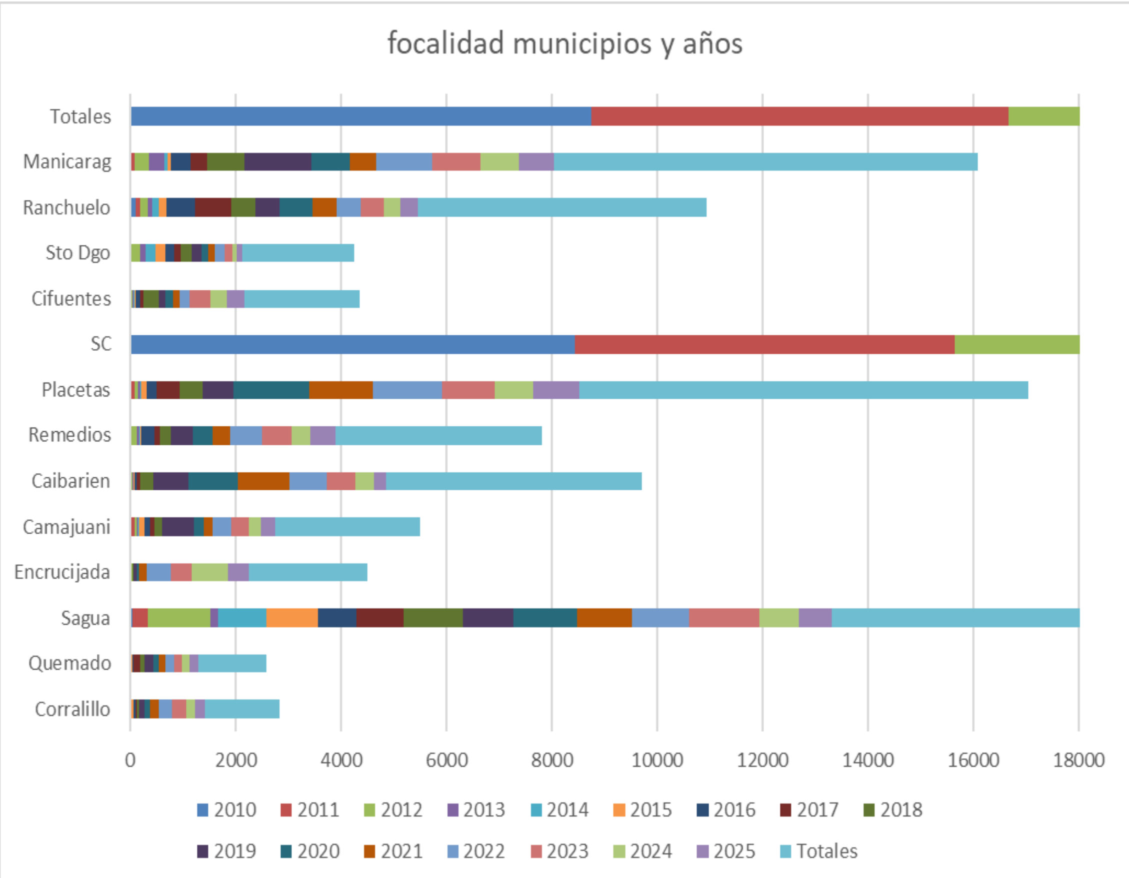

Fig 2: *Ae. aegypti* focus by year and municipality in Villa Clara province. 2010-2026

Table 3 and Figure 3 show the average values by municipality, with Santa Clara having the highest values, followed by Sagua la Grande, Placetas, Manicaragua, and Ranchuelo, while the municipalities of Quemado de Güines and Corralillo had the lowest values. It can be seen that the totals for the province can reach up to 10,633.63 hotspots, and a minimum of 81 cases, so the trend is upward over the years, which coincides with several authors on the matter [2,43,35,40,48].

Table 3: Descriptive statistics for mean values

	N	Minimum	Maximum	Media	Standard deviation
Total_mean_mean	14	80.69	10633.63	1519.0893	3200.17396
N valid (by list)	14				

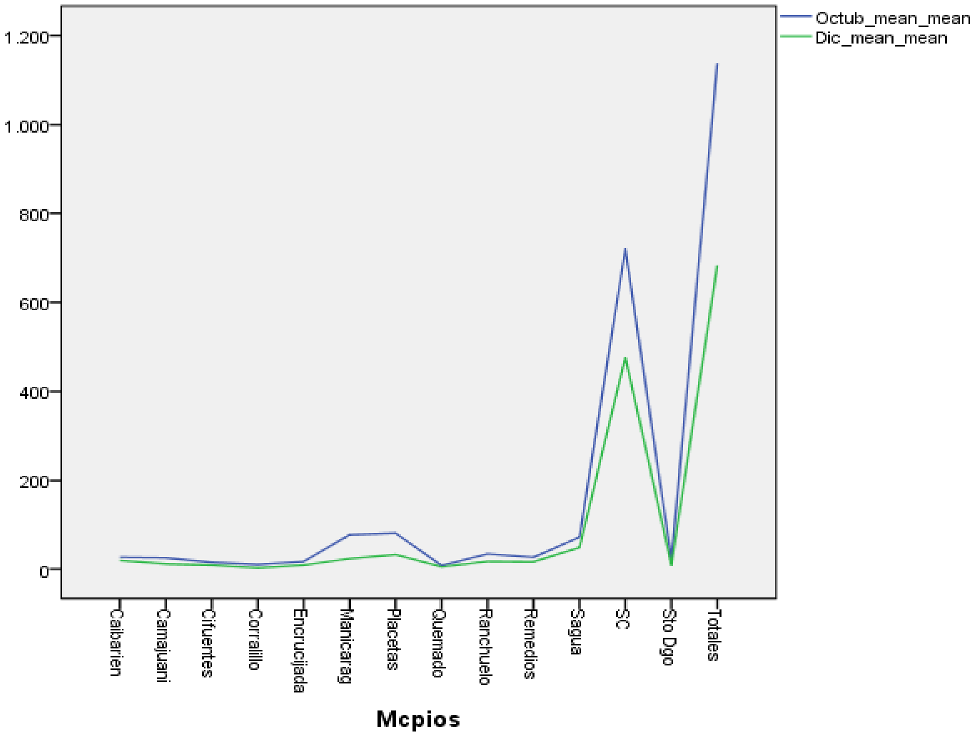

Fig 3: Behavior of the average number of hotspots per municipality

4. Conclusion

It is concluded that the trend of the *Ae. aegypti* mosquito species in terms of its focality and population dynamics in the Villa Clara province during recent years is towards an increase, which is due to a series of factors, both operational and environmental, that greatly favor the proliferation, adaptation and successful development of this mosquito species.

4.1. Transparency

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study, and that any iscrepancies from the study as planned have been explained.

4.2. Competing Interests

All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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