Proceedings of the Seventh International Conference on Urban Pests
William H Robinson and Ana Eugênia de Carvalho Campos (editors) 2011
Printed by Instituto Biológico, São Paulo, SP. Brazil.

SURVEILLANCE AND CONTROL OF *AEDES AEGYPTI* (DIPTERA: CULICIDAE): A NEW PROPOSAL

[1]MARIA ALICE VARJAL DE MELO SANTOS, [2]RIDELANE VEIGA ACIOLI, [3]CANDIDA MARIA N. RIBEIRO, [4]JULIANA SERAFIM, [4]KARINA BRITTO, [1]JOSÉ CONSTANTINO SILVEIRA JR, [1]WAYNER VIEIRA DE SOUZA, [1]PAULO JUSTINIANO RIBEIRO JR, [6]ANTONIO MIGUEL V. MONTEIRO, AND [1]LÊDA REGIS

[1]Centro de Pesquisas Aggeu Magalhães/CPqAM, FIOCRUZ, Recife-PE
[2]Secretaria Estadual de Saúde de Pernambuco
[3]Secretaria Municipal de Saúde de Santa Cruz do Capibaribe-PE
[4]Secretaria Municipal de Saúde de Ipojuca
[5]Universidade Federal do Paraná/UFPR, Curitiba-PR
[6]Instituto Nacional de Pesquisas Espaciais/INPE, São José dos Campos-SP

Abstract Entomological indices based on larval surveillance methods are not sensitive enough to accurately monitor *Aedes aegypti* population densities in areas differing in levels of infestation. Here, we present and discuss results obtained from a pilot program using a new approach, the Monitoring System and Population Control of *Aedes aegypti* (SMCP- *Aedes*), based on spatial information technology utilizing data on the spatial and temporal distribution of *Aedes*. The SMCP-*Aedes* data was continuously generated by a set of sentinel-ovitraps (OVT-S) in Santa Cruz do Capibaribe and Ipojuca urban areas, two municipalities of Pernambuco, Brazil, which have different patterns of settlement and biogeography. The first results, recorded in June 2008, showed that both areas were highly infested by *A. aegypti*, with more than 90% of OVT-S positive for *A. aegypti*, and detected densities of 1223 eggs/OVT-S/month in Sta Cruz and 561.2 eggs/OVT-S/month in Ipojuca. A significant reduction in population densities to 363.5 eggs/OVT-S/month and 138.6 eggs/OVT-S/month, respectively, was observed after six rounds of control intervention consisting of massive egg elimination using 8,000 control-ovitraps (OVT-C). Over this period, approximately 5 million eggs and 2,700 adult mosquitoes were removed from those areas. The strategies and tools used in the SMCP-*Aedes* allowed us to quantify the active population of *A. aegypti*, indicating periods and places of higher human exposure to the mosquito. The instruments used for mechanical removal of eggs and adults are effective and can be integrated in a sustainable control program.
Key Words Dengue vector, entomological surveillance, ovitraps, GIS, mosquito control

INTRODUCTION

Dengue persists as a major public health problem in Brazil. The strategies employed by the National Program for Dengue Control (PNCD) to control *Aedes aegypti* cost more than half a billion US dollars every year. The elimination of *Aedes* larval breeding sites, or their treatment with chemical or biological insecticides, appear to have failed in reducing the spread of *A. aegypti* over the last fourteen years (Barreto et al., 2011). Population monitoring of *A. aegypti* is based on larval surveys (House Index and Breteau Index). However, several studies have proven that these indices are not sensitive enough to reveal the true level of infestation by this mosquito specie in urban areas (Braga, 2000; Morato et al., 2005; Regis et al., 2008). Aspects of *A. aegypti* behavior, such as its ability to colonize different types of water containers, skip oviposition behavior (spreading of eggs in many breeding sites by individual females) and the fact that their eggs are resistant to desiccation could result in a dramatic underestimation of *Aedes* population size, especially if small numbers of potential natural breeding sites are monitored solely by larval detection. These aspects have, to date, been neglected by the vector control programs. A recent approach involving complementary methods aimed at control of other phases of the mosquito's life cycle, (e.g, eggs and adults) has shown better results and can be easily incorporated into the operations of vector control programs (Gama et al., 2007; Kay and Nam 2005; Maciel-de-Freitas et al., 2006; Regis et al., 2008; 2009).

The Monitoring System and Population Control of *Aedes aegypti* (SMCP-*Aedes*) was recently developed by a multidisciplinary team from Fiocruz/Recife, INPE, UFPR, UFPE, and the Health Department of the state of Pernambuco (Monteiro et al. 2005, Regis et al. 2008, Bonat et al. 2010). This system has been applied to monitor and control *Aedes* populations through the use of spatial information on the density of eggs collected by a network of sentinel-ovitraps (OVT-S), the massive elimination of eggs attracted to control-ovitraps (OVT-C) and the capture of adults by aspiration. The complexity of modern urban environments necessitate the testing of new tools for epidemiological practice and entomological surveillance in order to increase the capacity of the health sector for controlling transmissible diseases such as dengue. Here we present some data on the implementation process of the SMCP-*Aedes* in two different urban settlements.

MATERIALS AND METHODS

Study area and monitoring tool: The SMCP-*Aedes* is currently implemented in a large-scale pilot program in Santa Cruz do Capibaribe (Sta Cruz), and Ipojuca located in the arid zone and the coast of Pernambuco respectively. In this system, monitoring is based on the detection and quantification of eggs deposited in a series of geo-referenced, sentinel ovitraps (OVT-S), distributed throughout the urban area. The OVT-S contain two wooden paddles (5.0 x 15 cm) and are filled with 2 L of water, treated with biological larvicide based on *Bacillus thuringiensis israelensis* (*Bti*), and installed in the peri-domestic area of 262 properties in Sta Cruz and 75 in Ipojuca. Every thirty days, the content of each OVT-S is renewed and wooden paddles are collected and sent to the laboratory for drying. Digital images of the paddles are then obtained by a scanning system (SDP) for counting of eggs by a semi-automated computer-assisted system (Mello et al., 2008), generating data that feeds into a geographic database (Regis et al., 2009).

Monitoring Outputs

Reports about *Aedes* spp spatio-temporal distribution are derived from the information collected continuously by the OVT-S and deposited in a database (BDG-SAUDAVEL). The system combines spatial technology information and free software to analyze data and generate situational maps, indicating the distribution of infestation and highlighting the most critical points (hotspots). This information helps to drive the actions of vector control.

Strategy of *Aedes aegypti* Control

The SMCP-*Aedes* includes a set of integrated interventions for mosquito control based on social participation (Regis et al., 2009). The strategy consists of the removal and massive incineration of mosquito eggs collected by ovitraps used for control proposal (OVT-C). This action is reinforced by the use of aspirators for indoor collection of adult mosquitoes, in areas with higher risk of viral transmission. The OVT-C, adapted for control, was built with community participation, using recycled 2 L black plastic bottles. These bottles are filled with 1.5 L of water, treated with *Bti* larvicide. A cotton tissue which is used as a substrate for oviposition, covers the inner wall of the ovitrap, as suggested by Lenhart et al. (2005), to expand the space for egg deposition. About 5,600 C-OVT (two per house) were installed in Sta Cruz and 2,700 in Ipojuca. After each 60 day cycle, the OVT-C is renewed and tissues are removed for incineration. At the same time field staff inspect houses for treatment of water containers using larvicide.

RESULTS AND DISCUSSION

The SMCP-*Aedes* has been demonstrated to have high sensitivity to detect and quantify vector density, and to identify locations with higher population density, driving specific control actions. We detected high levels of infestation in urban spaces in both municipalities, with > 90% of OVT-S positive for *A. aegypti*, levels similar to those previously detected in seven districts of Recife (Regis et al., 2008). The system allowed measurement of the impact of mechanical removal of eggs and adults on mosquito population density, revealing that the average number of eggs collected dropped from 1223.2 eggs/S-OVT/month to 363.5 in Sta Cruz, and from 561.2 to 138.6 eggs/S-OVT/month in Ipojuca as a result of the elimination of nearly 5 million eggs from both areas over a six month period. In addition 2,700 adult mosquitoes were eliminated by aspiration.

CONCLUSIONS

The tools and strategies used in SMCP-*Aedes* allowed quantification of the active population of *A. aegypti*, indicating periods and places of high human exposure to the contact with the mosquito. It was observed that: (i) the instruments used for mechanical removal of eggs and adults are effective; (ii) they can be integrated into sustainable control programs; (iii) the strategies, methods and tools used in the SMCP-*Aedes* motivated the assimilation of knowledge and encouraged social participation.

ACKNOWLEDGEMENT

This work was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Fundação Oswaldo Cruz – Programa de Desenvolvimento e Inovação Tecnológica em Saúde Pública (Fiocruz–PDTSP)/Rede Dengue, Ministério da Saúde/Departamento de Ciência e Tecnologia (MS-Decit)/UNESCO, and Fundação de Amparo à Ciência e Tecnologia de Pernambuco (FACEPE).

REFERENCES CITED

Barreto, M., Teixeira, M., Bastos, F., Ximenes, R., Barata, R., and Rodrigues, L. 2011. Successes and failures in the control of infectious diseases in Brazil: social and environmental context, policies, interventions, and research needs. The Lancet. Doi:10.1016/50140-6736(11)60202-x.

Bonat, W., Dallazuanna, H., Ribeiro, J., Monteiro, A., Regis, L, Silveira, Jr, Acioli R., and Souza W. 2009. Investigando fatores associados a contagens de ovos de *Aedes aegypti* coletados em ovitrampas em Recife. Revista Brasileira de Biometria. 27: 519-537.

Braga, I., Gomes A., Nelson, M., Mello, R., Bergamaschi, D., Souza, J. 2000. Comparação entre pesquisa larvária e armadilha de oviposição para detecção de *Aedes aegypti*. Rev Soc Bras Med Trop 33: 347-353.

Gama, R., Silva, E., Silva, I., Resende, M., Eiras, A. 2007. Evaluation of the sticky MosquiTRAP for detecting *Aedes* (*Stegomyia*) *aegypti* (L.) (Diptera: Culicidae) during the dry season in Belo Horizonte, Minas Gerais, Brazil. Neotrop Entomol 36: 294-302.

Kay B. and Nam, V. 2005. New strategy against *Aedes aegypti* in Vietnam. Lancet 365: 613-617.

Lenhart, A., Walle, M., Cedillo, H., and Kroeger, A. 2005. Building a better ovitrap for detecting *Aedes aegypti* oviposition. Acta Trop 96: 56-59.

Maciel-De-Freitas, R., Eiras, A., and Lourenço-De-Oliveira, R. 2006. Field evaluation of the BG-sentinel, a new trap for capturing adult *Aedes aegypti* (Diptera: Culicidae). Mem Inst Oswaldo Cruz 101: 321-325.

Mello, C., Santos, W., Rodrigues, M., Candeias, A., and Gusmão, C. 2008. Image Segmentation of Ovitraps For Automatic Counting of *Aedes aegypti* Eggs. *In*: 30th Annual International Conference of The IEEE Engineering In Medicine and Biology Society, August 20-24 2008, Vancouver, Canada. Paper Frdpo07.14. Http://Www.Embc2008.Com/.

Monteiro, A., Carvalho, M., Assunção, R., Souza, W., Ribeiro, Jr P., Davis, J., and Regis, L. 2005. SAUDAVEL: Bridging the Gap between Research and Services in Public Health Operational Programs by Multi- Institutional Networking Development and Use of Spatial Information Technology. Innovative Tools (cited 2008 Jan 10). Available from: http://www.dpi.inpe.br/saudavel/publicacoes.html.

Morato V., Teixeira M., Gomes A., Bergamaschi D., and Barreto M. 2005. Infestation of *Aedes aegypti* estimated by oviposition traps in Brazil. Rev Saude Publica 39: 553-558.

Regis, L, Monteiro, A., Melo-Santos, M., Silveira, Jr., Furtado, A., Acioli, R., Santos, G., Nakazawa, M., Carvalho, M., Ribeiro Jr, Souza W. 2008. Developing new approaches for detecting and preventing *Aedes aegypti* population outbreaks: basis for surveillance, alert and control system. Memórias do Instituto Oswaldo Cruz, 103: 50-59.

Regis, L., Souza, W., Furtado, A., Fonseca, C., Silveira, Jr, Ribeiro, Jr, Melo-Santos M., Carvalho, M., Monteiro A. 2009. An Entomological surveillance system based on open spatial Information for participative Dengue control. Anais da Academia Brasileira de Ciências 81: 655-662.