PUBLIC HEALTH

Evaluation of the Sticky MosquiTRAP™ for Detecting *Aedes* (*Stegomyia*) *aegypti* (L.) (Diptera: Culicidae) during the Dry Season in Belo Horizonte, Minas Gerais, Brazil

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Avaliação da MosquiTRAP na Detecção de *Aedes* (*Stegomyia*) *aegypti* (L.) (Diptera: Culicidae) durante Estação Seca em Belo Horizonte, MG

RESUMO - MosquiTRAP é uma armadilha desenvolvida para a captura de fêmeas grávidas de *Aede*s *aegypti* (L.) e permite a identificação do mosquito em campo, durante a vistoria da armadilha. O objetivo desse estudo foi comparar essa armadilha com a pesquisa larvária e a ovitrampa para o monitoramento do *A. aegypti* em campo durante a estação seca. O trabalho foi realizado de março a junho 2003 em 20 quarteirões no bairro Itapoã, Belo Horizonte (MG). O monitoramento das armadilhas foi semanal e a pesquisa larvária foi realizada mensalmente. O Índice Predial (IP) e o Índice de Breteau (IB) apresentaram valores iguais durante todo o experimento (1,72 nos primeiros dois meses e zero nos dois últimos) e o Índice de Recipiente (IR) nos dois primeiros meses foi de 0,09 e 0,1% respectivamente e nos dois últimos foi zero. O Índice de Positividade de Ovitrampa (IPO) variou de 16,7 a 76,9% e o Índice de Positividade de MosquiTRAP (IPM) variou de 0 a 31,5%. O Índice de Densidade de Ovos (IDO) variou de 26,6 a 82,8 enquanto o Índice de Densidade de Adultos (IDA) variou de 0 a 1,6 durante todo o experimento. A temperatura e a precipitação não influenciaram os Índices de Positividade e de Densidade, mas parecem ter influenciado os índices larvários. Apesar de a MosquiTRAP ter coletado um número pequeno de *Aedes*, observou-se que ela foi mais sensível para detectar a presença de *Aedes* do que a pesquisa larvária.

PALAVRAS-CHAVE: Monitoramento, dengue, mosquito

ABSTRACT - MosquiTRAP™ is a sticky trap specifically designed to capture gravid females of *Aedes aegypti* (L.) and allows the identification of the mosquito in the field during the inspection of the trap. This study aims to compare this sticky trap to larval and ovitrap surveys for field monitoring of *A. aegypti* during the dry season. The study was conducted from March to June of 2003 in 20 blocks of the district of Itapoã, Belo Horizonte, MG. The traps were monitored every week while the larval survey was conducted on a monthly basis. The larval index: Premise Index (PI) and Breteau Index (BI) had equal values throughout the experiment (1.72 in the first two months and zero in the last two). The container index (CI) during the first two months was 0.09 and 0.1%, respectively and zero in the last two. The Ovitrap Positive Index (OPI) ranged from 16.7 to 76.9%, and the MosquiTRAP Positive Index (MPI) ranged from 0 to 31.5%. The Egg Density Index (EDI) ranged from 26.6 to 82.8, while the Adult Density Index ranged from 0 to 1.6 throughout the experiment. Temperature and rainfall did not affect the Positive and Density Indices, although these environmental variables seemed to have affected the larvae indices. Although the MosquiTRAP caught a low number of *Aedes* mosquitoes during the study, it was more sensitive than the larval survey to detect the presence of *Aedes* mosquitoes.

KEY WORDS: Monitoring, dengue, mosquito

According to the data recorded by the Health Surveillance Secretariat, the number of reported dengue cases from January to May increased by 29.9% in 2005 as compared to the same period in 2004 (107,575 cases). The increase in the number of dengue cases was localized to the north and northeastern states of Brazil, whereas cases decreased in southern states (Ministério da Saúde 2005).

Currently, the number of dengue cases has decreased, yet the potential for further epidemics exists due to the simultaneous circulation of dengue serotype 1, 2 and 3 in 24 Brazilian States and the circulation of dengue 4 in neighboring countries (Ministério da Saúde 2005). The presence of the mosquito vector *Aedes* (*Stegomyia*) *aegypti* (L.) in all states of Brazil and the increase in the number of areas infested with *Aedes* (*Stegomyia*) *albopictus* (Skuse) (Diptera: Culicidae) creates cause for concern (Ministério da Saúde 2005). The mosquito *A. albopictus* was not shown to be responsible for dengue epidemics in the Americas, but it was shown to be susceptible to infections under laboratory conditions and it was found naturally infected in the field in Campos Altos (MG, Brazil) and in Reynosa (Mexico) (Serufo *et al*. 1993, Ibáñez-Bernal *et al*. 1997).

Currently, Brazil monitors *A. aegypti* populations using larval surveys and oviposition traps (ovitraps) (FUNASA 2001). Although ovitraps were proved to be more sensitive to detect *A. aegypti* populations in the field when compared with larval surveys (Braga *et al.* 2000), the latter method is employed as a standard by the National Program of Dengue Control (NPDC) in Brazil (PNCD 2002). Unfortunalety, the larval survey does not detect the presence of *A. aegypti* during the dry season.

Methods for collecting adult mosquitoes such as human bait, backpack aspirators, or traps have not been used by the Health Ministry on a routine basis due to the risk of exposure of field technicians to infected mosquitoes and a shortage of specific and efficient traps for this species. Monitoring adult populations has several advantages in that it provides a better estimate of vector density and risk of transmission while providing specimens for analyses of spatial distribution, parity, ovarian development, mid-gut content, susceptibility to pathogens and resistance to insecticides (Barata *et al.*2001, Focks 2003, Ritchie *et al.* 2003).

The MosquiTRAP™ (Version 1.0, Ecovec Ltda) is a stickytrap developed by Eiras (2002; patent pending), which was developed based upon the behavior of gravid female *Aedes* when they explore breeding sites. It consists of a 1 L black plastic cylinder filled with water, oviposition attractant and an adhesive card. This trap exploits both visual (black color) and olfactory stimuli (synthetic volatiles) attrative for gravid females. When the females enter the trap and land on the walls of the MosquiTRAP, they adhere to the black sticky card. In laboratory and field tests, this trap was shown to be effective and low cost; thus making it viable for use in large scale operations. The MosquiTRAP also enables the identification of the vector during field inspections, thereby avoiding intensive labor of identifying insects in the laboratory. Similar sticky traps were used to entomological investigation of dengue transmission (Ritchie *et al*. 2004) and for dispersal studies of *A. aegypti* in Australia (Russel *et al*. 2005).

The aim of this study was to compare the effectiveness, sensitivity and practicality of the MosquiTRAP, larval survey and the ovitrap to detect the presence of *A. aegypti* mosquito in the field during the dry season.

Materials and Methods

Experimental area. The present study was conducted during 17 weeks (from March to June 2003) in the district of Itapoã, which is located in the Pampulha region of the city of Belo Horizonte, Minas Gerais, Brazil. This area was selected because of the reliable presence of *A. aegypti* mosquitoes during previous larval surveys and ovitrap monitoring (Data supplied by the Zoonoses Control Center of Belo Horizonte City Council). Most of the premises in this district consist of brick houses with gardens, backyards, good sanitary conditions, water supply, and garbage disposal service three times a week. All the streets are paved with asphalt and the local "Lagoa do Nado" park is a pleasant green area for leisure and recreation for the local residents with a middle class socioeconomic level.

Larval survey. Monthly larval surveys were carried out by nine field agents as recommended by the National Program of Dengue Control (PNCD 2002). Ten percent of all the premises within the experimental area were sampled during the first week of every month (March to June). All containers which might serve as breeding sites for *A. aegypti* larvae were inspected both inside and outside premises. Larval samples were sent to the Laboratório de Culicídeos, Instituto de Ciências Biológicas, at the Universidade Federal de Minas Gerais, for species identification. Information from the larval surveys was used to calculate the following indices: Premise Index (PI) (number of positive houses / total of inspected houses x 100), Container Index (CI) (number of positive containers/ total number of containers inspected x 100) and Breteau Index (BI) (number of positive containers / total number of houses inspected x 100).

Trap placement. An area encompassing 20 blocks was selected for the 17 weekly surveys. Two houses were selected within each block, and one house received an ovitrap whereas the other house received MosquiTRAP so that a total of 40 houses were being monitored. Each trap was installed within a shaded area and protected from the rain. Within each block, the traps were rotated so that each house had only one trap type for a maximum of one week, to avoid bias in the results by having a highly productive breeding site in the premise.

Ovitrap. The ovitrap consists of a 700 ml black plastic container filled with 300 ml of solution (10%) of the cow grass infusion (*Panicum maximum,* Jacq) prepared according to Santana (2006). A wooden paddle (10 x 2.5 cm) was used as oviposition substrate and positioned vertically inside the trap by means of a clip. In order to prevent this trap from becoming a breeding site, an insect growth regulator containing the active ingredient triflumuron (Starycide™ SC 4, 8 Bayer) was added to the infusion. A preliminary study demonstrated that triflumuron does not affect the ovipostion by *A. aegypti* (data not published). The trap was monitored weekly, and during the inspections larvae detected in the infusion and eggs on the paddle were collected and the infusion and the paddles were replaced. Eggs and larvae were sent to the laboratory, counted, and all larvae from the infusion or hatted eggs were identified to specie. Informations from ovitrap surveys was used to calculate the indices: Ovitrap Positive Index (OPI) (number of positive traps / total number of inspected traps x 100), and Egg Density Index (EDI) (number of eggs/ positive traps) (Gomes 1998).

MosquiTRAP. The MosquiTRAP consists of a 700 ml matte-black container with 300 ml of solution (10%) of the cow grass infusion (Santana 2006). A black adhesive card was placed inside the container wall to trap the mosquitoes (Eiras 2002; Fig. 1). A growth regulator was added to the MosquiTRAP to prevent it from becoming a breeding site. The MosquiTRAP were monitored on a weekly basis, and the inspection included the identification and quantification of adult mosquitoes captured on the sticky card and the presence of immature forms in the infusion. The adult mosquitoes were removed from the trap by means of forceps and identified in the field using a magnifying glass (10 x). The infusion was changed every week and the card was replaced once a month. Informations from MosquiTRAP surveys was used to calculate the indices: MosquiTRAP Positive Index (MPI) (Number of positive traps for *Aedes* sp./ total number of inspected traps x 100) and Adults Density Index (ADI) (Total number of adult mosquitoes of *Aedes* sp. captured / total number of traps) were calculated.

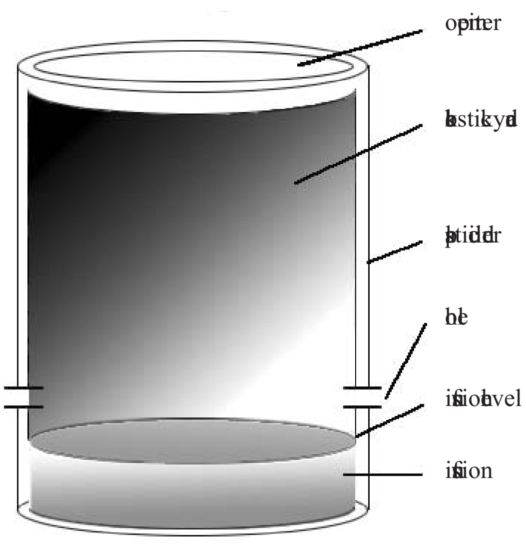

Fig. 1. Diagram of the sticky MosquiTRAP (version 1.0).

Meteorological data. Daily temperature and rainfall data were provided by INFRAERO of Belo Horizonte's Pampulha Airport, and the data were used to assess how these variables affect the entomological indices obtained from the ovitrap, the MosquiTRAP and the larval surveys.

Statistical analysis. Correlation between the indices obtained by the ovitraps (OPI and ODI) and the MosquiTRAPs (MPI and ADI) was assessed by using Pearson's correlation. Linear regressions were carried out for temperature and rainfall variables, which were likely to have affected both the number of eggs and adults collected and the indices of the MosquiTRAP and ovitrap.

Results

Meteorological data. During the experimental period, the average weekly temperature ranged from 17.7ºC to 21.0ºC. During the 10th to the 17th epidemiological week, the minimum temperature ranged from 17.7ºC to 21.0ºC, while the maximum ranged from 28.0ºC to 32.5ºC. The temperature dropped over the 18th to the 26th week, and a minimum temperature of 12.0ºC and a maximum of 28.3ºC were observed (Fig. 2). Rainfall occurred between the 10th and 15th week and at the 18th week, and the mean weekly

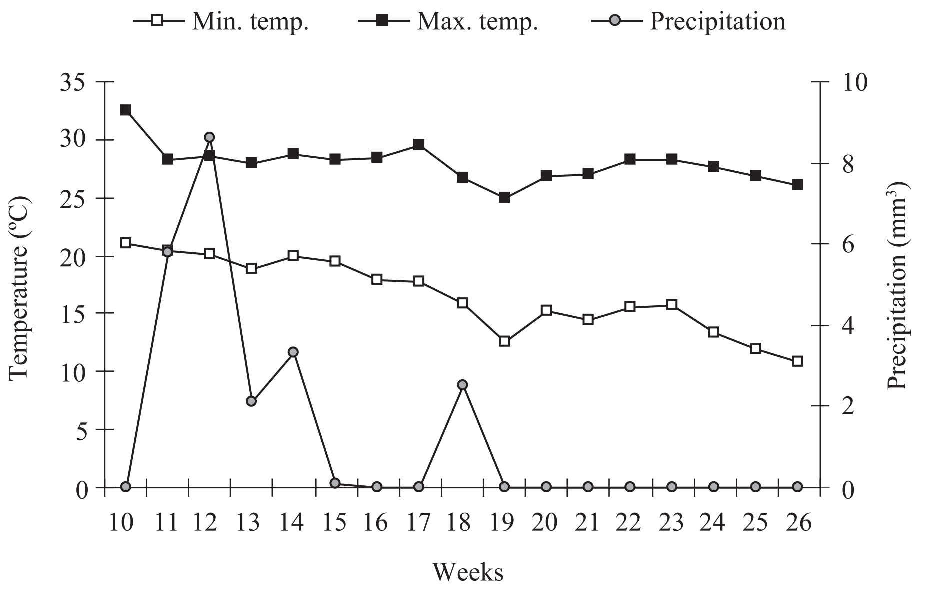

Fig. 2. Variation of temperature (maximum and minimum) and precipitation during the 17 epidemiological weeks study at the district of Itapoã. Belo Horizonte, MG (2003).

rainfall volume ranged from 0.11 mm^3 to 8.60 mm^3 (Fig. 2). During the experiment, a rainy period was observed from the 10th to the 18th epidemiological week, and a dry period from the 19th to 26th week.

Temperature and rainfall did not affectthe number of adult collected by the MosquiTRAP ($P > 0.05$) and rainfall did not affected the egg colection by the ovitrap. The influence of the temperature and of the rainfall volume on the OPI was not significant ($P > 0.05$), but the amplitude of the temperature affected this index ($y = 35.4 + 64x$; $r^2 = 0.01$). There was no relation between the density of eggs and of adults and rainfall volume or temperature.

Larval survey. Larvae were only found during the rainy season of the first two months of the surveys (week 10th and 15th) and both the House and the Breteau Indices had identical values (Table 1).

Ovitraps. During the four months of work, a total of 7,771 eggs of *Aedes* sp. were collected in the ovitrap (Table 2). Eggs were collected throughout the experiment (17 weeks). Out of this total, 2,356 larvae hatched (30.2%) of which 2,116 were *A. aegypti* (89.8%) and 240 were *A. albopictus* (10.2%) (Table 2). The median of *Aedes* eggs collected was 35.1, and the mean number of eggs per paddle was 25.4. There was evidence of a positive asymmetric distribution and high dispersion of the eggs (Fig. 4), and that the 2nd, 5th, and 8th week were the most representative of these distributions. Rainfall did not affect the egg collection by the ovitrap ($P > 0.05$). The OPI ranged from 16.7 to 80.0% while the MPI ranged from zero to 31.5% (Table 3).

MosquiTRAP. During the experient, a total of 37 adults were collected in MosquiTRAPs, of which 27 were *A. aegypti* and 10 were *A. albopictus*. Most adults were captured during the 10th and the 13th week. The median of adults collected was 1, and the mean number of *Aedes* sp. per trap was 0.08 (Table 3). Adult mosquitoes were collected only in 13 weeks and the positive index of MosquiTRAP for *A. aegypti* ranged from zero to 26.3% and for *A. albopictus* from zero to 5.5% (Fig. 5).

Table 1. House (HI), Recipient (RI) and Breteau Indices from larval survey in Itapoã, Belo Horizonte, MG (March - June, 2003).

Month (epidemiological week)	H	R	B
March (10th)	1.72	0.09	1.72
April (15th)	1.72	0.10	1.72
May (19th)	0	0	0
June (24th)	0	0	0

Table 2. Performance of ovitrap in collecting *Aedes* eggs and MosquiTRAP catching adult mosquitoes in Itapoã district, Belo Horizonte, MG (March - June, 2003).

Weeks	Ovitrap				MosquiTRAP®		
	N. of eggs	Egg hatched (%)	*A. aegypti* (%)	*A. albopictus* (%)	*Aedes* sp. Total	*A. aegypti* (%)	*A. albopictus* (%)
10	1042	345 (33.1)	345 (100.0)	0 (0.0)	6	5 (83.3)	1 (16.7)
11	351	181 (51.6)	97 (53.6)	84 (46.4)	1	1 (100.0)	0 (0.0)
12	350	139 (39.7)	125 (89.9)	14 (10.1)	3	3 (100.0)	0 (0.0)
13	517	218 (42.2)	193 (88.5)	25 (11.5)	8	6 (75.0)	2 (25.0)
14	678	344 (50.7)	323 (93.9)	21 (6.1)	1	1 (100.0)	0 (0.0)
15	562	132 (23.5)	132 (100.0)	0 (0.0)	3	1 (33.3)	2 (66.7)
16	533	91 (17.0)	87 (95.6)	4 (4.4)	0	0 (0.0)	0 (0.0)
17	1077	327 (30.4)	241 (73.7)	86 (26.3)	3	1 (33.3)	2 (66.7)
18	667	94 (14.1)	94 (100.0)	0 (0.0)	0	0 (0.0)	0 (0.0)
19	677	151 (22.3)	145 (96.0)	6 (4.0)	1	1 (100.0)	0 (0.0)
20	105	86 (81.9)	86 (100.0)	0 (0.0)	5	4 (80.0)	1 (20.0)
21	151	60 (39.7)	60 (100.0)	0 (0.0)	0	0 (0.0)	0 (0.0)
22	133	22 (16.5)	22 (100.0)	0 (0.0)	2	1 (50.0)	1 (50.0)
23	303	86 (28.4)	86 (100.0)	0 (0.0)	1	1 (100.0)	0 (0.0)
24	224	28 (12.5)	28 (100.0)	0 (0.0)	2	1 (50.0)	1 (50.0)
25	292	52 (17.8)	52 (100.0)	0 (0.0)	0	0 (0.0)	0 (0.0)
26	109	0 (0.0)	0 (0.0)	0 (0.0)	1	1 (100.0)	0 (0.0)
Total	7,771	2,356 (30.2)	2,116 (89.8)	240 (10.2)	37	27 (73.0)	10 (27.0)

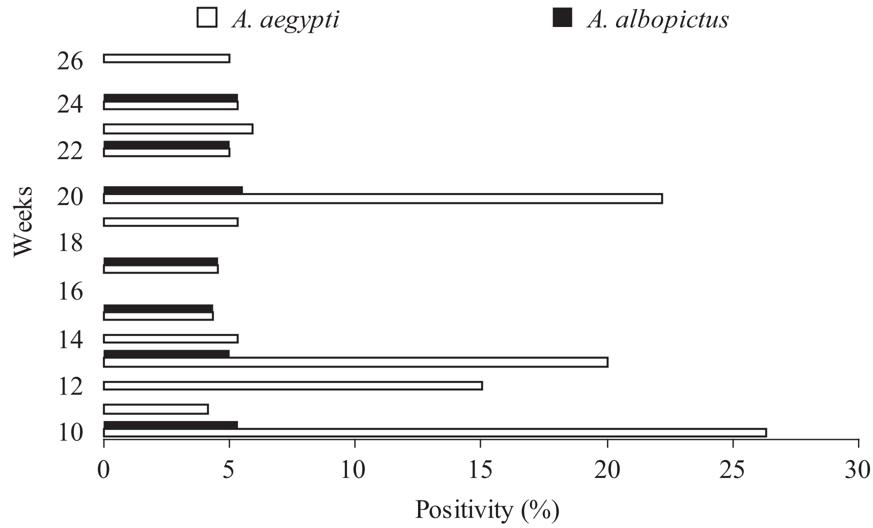

Fig. 3. MosquiTRAP Positive Index (MPI) for *A. aegypti* and *A. albopictus* during the 17 epidemiological weeks study at the district of Itapoã. Belo Horizonte, MG (2003).

By comparing the variation in the positive indices of both traps during the field experiment, a weak positive correlation between the two indices was detected (Pearson = 0.13). However, if the positive indices of the ovitrap and the MosquiTRAP are only compared up to the eighth week of the study (17th epidemiologica week), a stronger positive correlation between the indices can be observed (Pearson = 0.53). It is apparent that from the 17th epidemiological week on ward there was a drop in this correlation (Pearson = -0.47), thus suggesting a stronger wet season correlation as compared to a dry season correlation.

The egg density index (EDI) ranged from 26.6% to 82.0% and the adults density index (ADI) ranged from 0 to 1.6% (Table 3). The density indices for the ovitrap and the MosquiTRAP did not show similarities in their variation pattern all over the trial (Pearson = -0.05).

Discussion

A wide range of indices obtained through larval surveys have been described as tools in the monitoring of *A. aegypti* populations (Focks 2003). Larval surveys consist of an active search for positive breeding sites of the mosquito, both indoors and outdoors, and of collecting the immature forms that are found (FUNASA 2001). The larval and/or pupae

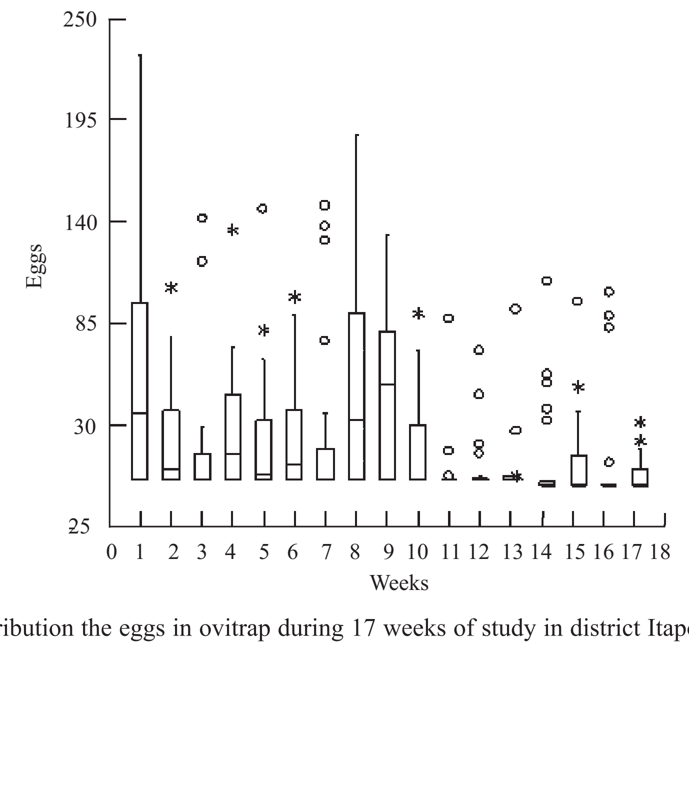

Fig. 4. Variation of distribution the eggs in ovitrap during 17 weeks of study in district Itapoã, Belo Horizonte, MG (March - June2003).

Table 3. Positive indexes for ovitrap and MosquiTRAP and the mean number of eggs/ovitrap and adult mosquito/ MosquiTRAP®, district Itapoã, Belo Horizonte, MG (March - June, 2003).

Weeks	Ovitrap		MosquiTRAP®		Density index		Mean per trap	
	Number	Positive	Number	Positive	EDI[1]	ADI[2]	Eggs	Adults
10	18	13	19	6	80.15	1.00	57.9	0.31
11	16	8	24	1	43.87	1.00	21.9	0.04
12	19	9	20	3	38.89	1.00	18.4	0.15
13	19	14	20	5	36.93	1.60	27.2	0.40
14	21	14	19	1	48.43	1.00	32.3	0.05
15	17	12	23	2	46.83	1.50	33.1	0.13
16	21	10	15	0	53.30	0.00	25.4	0.00
17	18	13	22	2	82.85	1.50	59.8	0.14
18	13	10	27	0	66.70	0.00	51.3	0.00
19	21	11	19	1	61.54	1.00	32.2	0.05
20	18	3	18	5	35.00	1.00	5.8	0.28
21	19	5	19	0	30.20	0.00	7.9	0.00
22	16	5	20	2	26.60	1.00	8.3	0.10
23	21	6	17	1	50.50	1.00	14.4	0.05
24	16	4	19	2	56.00	1.00	14.0	0.10
25	19	4	17	0	73.00	0.00	15.4	0.00
26	18	8	20	1	13.62	1.00	6.0	0.05
Total	310	149	338	32	52.15	1.16	25.07	0.11

[1]EDI = Eggs Density Index; [2]ADI = adult density index

that are collected are sent to a laboratory for identification and the breeding containers are usually classified as positive or negative for *A. aegypti.* Under normal circumstances the larval survey data takes up to 2-3 weeks to be collected and organized which results in a delay to characterize the area as a risk area requiring control measures.

Among the existing indices, some are recommended by the World Health Organization to be used in vector

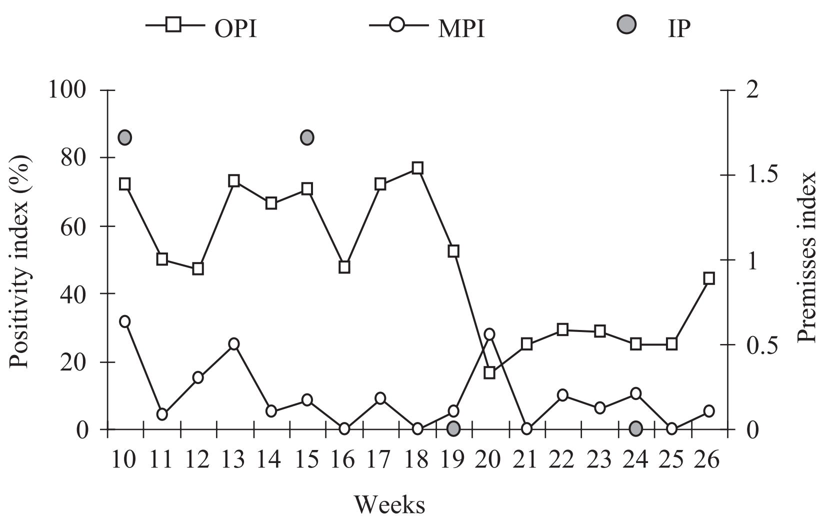

Fig. 5. Premise Index (PI) and Positive index for ovitrap (OPI) and MosquiTRAP (MPI) during 17 epidemiological weeks of study in bairro Itapoã. Belo Horizonte (MG) (March - June, 2003). Shaded area corresponds to the rainy period of the study.

surveillance and identification of hotspots. These include the HI, the BI and the CI, of which the first two the most commonly used. In Brazil, they are used for determining the potential areas of risk for dengue outbreaks (FUNASA 2001). PI values above 1.0% and BI above 5% indicate risk areas where dengue transmission is likely to occur (FUNASA 2002). The use of larval surveys in assessing the risk of dengue outbreaks and transmission has been under a lot of criticism because the transmission of the disease can still occur when seemingly safe indices were obtained (Tun-Lin *et al.* 1996, Focks 2003).

In the present study, the four larval surveys conducted showed a positive relation between HIs and BIs with the same values, indicating that each positive house had just one positive breeding site. This low number of positive containers was reflected in the low Container Indices in the two months. The CI is not suited to assess larval density when multiple containers are located in the vicinity of the premises, as observed by Bang *et al*. (1981) in the southeast of Nigeria. These authors pointed out that even when the CI is low, the production of *Aedes* can be relatively high.

In Brazil, the most common entomological surveillance indices for *A. aegypti* are the PI and the BI (FUNASA 2001). According to Tun-Lin *et al.* (1996), they are the most representative indices, and are often correlated. In areas with low infestations, the PI and the BI are essentially the same, but as the rate of infestation increases, the two indices begin to diverge due to the large number of houses with multiple breeding places (Service 1993).

In 2003, Belo Horizonte's City Council conducted three larval surveys (with a sample of 6.66%) during January-March and October in the same area of the present experiment, and the PIs obtained were 2.47, 1.11, and 0.0%, respectively. Although the sampled area was larger than the area covered by the present experiment, there is a remarkable similarity between the results. The same reduced trend during the dry months of May and June. Similarly, the present study revealed a reduced trend in the larval indices whenever the temperature and the rainfall dropped, but due to the reduced number of samples, it was impossible to do a statistical analysis correlating these variables.

Not only do the indices obtained through larval surveys show a low correlation with the number of adults (Service 1993, Tun-Lin *et al.* 1995, Tun-Lin *et al.* 1996), but they also make it difficult to verify those containers that had *A. aegypti* mosquitoes, since different species of the *Aedes* mosquito can share the same container. Furthermore, if just one larva is used in the sampling, the result can be false-negative, for it is practically impossible to distinguish different species of *Aedes* in the field without proper equipment such as stereo microscope. The wide variety of containers natural and human- made where this vector can be found and the possible lack of skill of some field workers are factors that interfere with the quality of the results obtained from larval surveys.

A study in San Domingo, Dominican Republic, that utilized the capture of adult females (through active search) and the ovitrap did not see any relation between the density of adults and the three larval indices or the number of eggs collected (Service 1993). They concluded that entomological indices based on adult density are more suitable for assessing the efficacy of control actions than for monitoring immature forms. Tun-Lin *et al.* (1996) expressed the need for low cost monitoring methods targeting adult *A. aegypti,* and suggested utilizing traps with a sticky lure to monitor adults of this vector.

At present, the oviposition trap is an important tool in monitoring programs, providing relevant information about vector distribution. However, calculating the density of the adult population of the vector is still a challenge. Monitoring by means of the ovitrap requires laboratory labor, where those collected *Aedes* eggs have to be counted and hatched before the larvae can be identified. Thus this method, after the removal of the paddles from the ovitrap, it still needed at least one week to have the complete results (Focks 2003). Despite being faster and more practical for surveillance than larval surveys, the ovitrap also takes from one to two weeks to analyze and characterize the hotspot areas.

In the present work, the egg hatching rate was low (30.2%), and was likely due to damage to the eggs when the paddles were transported from the field to the laboratory. In addition, the growth regulator added to the infusion may have impregnated the paddles and affected egg hatching.

A greater proportion of the identified larvae were *A. aegypti* (89.8%), whereas the others were *A. albopictus* (10.2%). These proportions were slightly different from the adult catching by the MosquiTRAP (72.9% of *A. aegypti* and 27.1% of *A. albopictus*). The *Aedes* female needs just one successful blood feeding to lay up to 120 eggs, and since the eggs are not all oviposed in the same container, they can be found scattered in many ovitraps (Consoli & Oliveira 1994). It has also been speculated from studies of other species of *Aedes* (Kitron *et al*. 1989), a likely reduction in the laying of more eggs when the surface of the oviposition paddle is already full of eggs, which would require a search for new containers and the dispersion of the eggs. These may increase the number of positive breeding places in the environment. In contrast, the MosquiTRAP captures females attempting to lay eggs in the trap thereby eliminating the ability to lay eggs in other traps or increase the number of positive breeding sites.

Conducting field studies with a sticky ovitrap, quite similar to MosquiTRAP®, Ritchie *et al*. (2003) observed that the positive index for the sticky ovitrap was 67.5%, while the positive index of the ovitrap was 64.1%, with the former being slightly more effective in detecting *A. aegypti*. In this same study, the authors compared the efficacy of this sticky trap with the ovitrap and the larvitrap installed in an airport (vector entrance site) over a period of nine weeks. They observed that the sticky ovitrap detected the vector more frequently than the other two traps.

In Pedro Leopoldo city, Minas Gerais, Eiras (pers. Comm.) obtained indices ranging from 21.4% to 72.4% with the MosquiTRAP and from 52.8% to 92.9% with the ovitrap. In this same study, a high correlation (Pearson = 0.863) between the positive indices of the two traps was observed, suggesting that the MosquiTRAP is suitable for detecting the vector in *A. aegypti* monitoring programs. However, the same positive correlation of the MosquiTRAP observed in previous studies was not observed in the present experiment.

During the 17 weeks of the present work, the positive index ranged from zero to 31.5% and adults were only collected during 13 weeks. This may be attributed to mosquitoes being able to fly within the MosquiTRAP and escape without landing, and consequently not being trapped. Thus, this suggests that the MosquiTRAP needs further modifications in order to increase capture of all mosquitoes entering the trap. Low numbers of mosquitoes caught in sticky traps has also been reported in Australia (Ritchie *et al*. 2004, Russel *et al*. 2005).

The ovitrap detected the presence of the *Aedes* mosquitoes during the entire experimental period (17 weeks), whereas the MosquiTRAP detected its presence for only 13 weeks. The larval survey was able to detect the presence of *Aedes* mosquitoes only at the 10^{th} and 15^{th} epidemiological weeks. Therefore, the MosquiTRAP was more sensitive to detect *Aedes* than the larval survey. Although the sensitivity of the ovitrap was higher than the MosquiTRAP in detecting the presence of the *Aedes* sp. Mosquito, the ovitrap was not able to detect *A. albopictus* as the MosquiTRAP did during the 10^{th}, 15^{th}, 20^{th}, 22^{nd} and 24^{th} epidemiological weeks.

No significant influence of temperature and rainfall was observed in the indices calculated for the two traps during the experiment, although the effects of these variables on mosquito biology cannot be ignored. Two marked periods were observed during the experiment – a rainy one, from the 10^{th} to the 18^{th} epidemiological week, and a dry one, from the 19^{th} to the 26^{th} week. When each period is analyzed separately, the influence of the rainfall on the number of eggs collected can be observed ($P < 0.05$) (Fig. 4). During the rainy period 65.7% of all the eggs (n = 5,110) and 70.0% of the total adults (n =26) were collected. Thus, this suggests a strong correlation between the volume of rainfall and the number of adults caught.

The capture of adults by the MosquiTRAP and of eggs by the ovitrap was sustained even during the dry season (18^{th} to the 26^{th} epidemiological week). However, the larval survey was unable to locate positive breeding sites with larvae during the dry season (IP = 0.0 in 19^{th} and 24^{th} weeks). As temperature increased the number of collected eggs and adults caught also increased, while the opposite was true in relation to the volume of rainfall. This reduction in the number of eggs and adults captured is probably due to an increase in the number of breeding places and available in the area, creating a competition between the natural breeding places and the ovitraps and the MosquiTRAP.

The use of sticky ovitraps, such as the MosquiTRAP, has potential use for detecting *Aedes* sp. populations and perhaps for monitoring in hotspot areas to further develop new entomological indices for dengue outbreaks in urban areas. The functionality, practicality and low cost of the MosquiTRAP are feasible to use in a large scale of monitoring dengue vector programs. Although the MosquiTRAP caught a low number of *Aedes* mosquitoes during the study, the results clearly showed that the MosquiTRAP was more sensitive to detect the presence of *Aedes* mosquitoes larval survey, methods which are corrently employed by the NPDC in Brazil. At the moment, a new updated version of the MosquiTRAP (version 2.0) is under development which uses synthetic oviposition attractant identified from grass infusion volatiles (Santana 2006).

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References

Bang, Y.H., D.N.Bown & A.O. Onwubiko. 1981. Prevalence of larvae of potential yellow fever vectors in domestic water containers in south-east Nigéria. Bull. WHO 59: 107-114.

Barata, E.A.M.F., A.I.P. Costa, F. Chiaravalloti Neto, C.B. Glasser, J.M.S. Barata & D. Natal. 2001. População de *Aedes aegypti* (L) em área endêmica de dengue, Sudeste do Brasil. Rev. Saúde Publ. 35: 237-242.

Braga, I.A., A.C. Gomes, M. Nelson, R.D. Mello, D.P. Bergamaschi & J.M. De Sousa. 2000. Comparative study between larval surveys and ovitraps to monitor population of *Aedes aegypti*. Rev. Soc. Bras. Med. Trop. 33: 347-53.

Consoli, R.A.G.B. & R.L. Oliveira. 1994. Principais mosquitos de importância sanitária no Brasil. Ed. Fio Cruz, Rio de Janeiro, 228p.

Eiras, A.E. 2002. Armadilha para captura de insetos 2002. Depósito de patente no Brasil: PI0203907-9.

Focks, D.A. 2003. A review of entomological sampling methods and indicators for dengue vectors. WHO Gainsville, 40p.

Fundação Nacional de Saúde (FUNASA). 2001. Dengue - Instrução para pessoal de combate ao vetor: Manual de normas técnicas. 3ª ed. Ascom/Pre/FUNASA, Brasília, 84p.

Fundação Nacional de Saúde (FUNASA). 2002. Programa nacional de controle da dengue (PNCD). Ed. Min. da Saúde - FUNASA, Brasília, 32p.

Gomes, A.C. 1998. Medidas dos níveis de infestação urbana para *Aedes aegypti* (*Stegomyia*) *aegypti* e *Aedes* (*Stegomyia*) *albopictus* em programas de vigilância entomológica. Inf. Epidemiol. 7: 49-57.

Ibañez-Bernal, S., B. Briseño, J.P. Mutebi, E. Argot, G. Rodríguez, C. Martínez-Campos, R. Paz, R.P. Fuente-San, R. Tapia-Conyer & A. Flisserv. 1997. First record in America of *Aedes albopictus* naturally infected with dengue virus during the 1995 outbreak at Reynosa, México. Med. Vet. Entomol. 11: 305-309.

Kitron, U.D., D.W. Webb & R.J. Novar. 1989. Oviposition behavior of *Aedes triseriatus* (Diptera: Culicidae): Prevalence, intensity, and aggregation of eggs in oviposition traps. J. Med. Entomol. 26: 462-67.

Ministério da Saúde. 2005. Todos contra a dengue. http://portalweb02.saude.gov.br/saude/visualisar-texto.cfm?idtxl=17972. 20/01/2005

Ritchie, A.S., S. Long, A. Hard, C.E. Webb & R.C. Russell. 2003. An aduticidal sticky ovitrap for sampling container-breeding mosquitoes. J. Am. Mosq. Control. Assoc. 19: 235-42.

Ritchie, A.S., S. Long, A. Hard, G. Smith, A. Pyke & T.B. Knox. 2004. Entomological investigations in a focus of dengue transmission in Cairns, Queensland, Australia, by using the sticky ovitrap. J. Med. Entomol. 4: 1-4

Russel, R.C., C.E. Webb, C.R. Willians & A.S. Ritchie. 2005. Mark-release-recapture study to measure dispersal of the mosquito *Aedes aegypti* in Cairns, Quennsland, Australia. Med. Vet. Entomol. 19: 1-7.

Sant'Ana, A.L., Roque, R.A. & A.E. Eiras. 2006. Characteristics of grass infusions as oviposition attractants to *Aedes* (*Stegomyia*) (Diptera: Culicidae). J. Med. Entomol. 43: 214-20.

Serufo, J.C., H.M. Oca, V.A. Tavares, A.M. Souza, R.V. Rosa, M.C. Jamal, J.R. Lemos, M.A. Oliveira, R.M.R. Nogueira & H.G. Schatzmayr. 1993. Isolation of dengue vírus type 1 from larvae of *Aedes albopictus* in Campos Altos city, state of Minas Gerais, Brazil. Mem. Inst. Oswaldo Cruz 88: 503-504.

Service, M.W. 1993. Mosquito ecology-field sampling methods. Second edition. London, Chapman & Hall, 988p.

Tun-Lin, W., B.H. Kay & A. Barnes. 1995. The premise condition index: A tool for streamling surveys of *Aedes aegypti*. Am. J. Trop. Med. Hyg. 53: 591-594.

Tun-Lin, W., B.H. Kay & A.S. Barnes. 1996. Forsyth. Critical examination of *Aedes aegypti* indices: correlations with abundance. Am. J. Trop. Med. Hyg. 54: 543-547.

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