P: ISSN No. 0976-8602 RNI No. UPENG/2012/42622 VOL.-9, ISSUE-4, October 2020

E: ISSN No. 2349-9443 Asian Resonance

# Effect of Breeding Habitat by Solid Wastes for Aedes Albopictus Mosquitoes (Culicidae)

Paper Submission: 10/10/2020, Date of Acceptance: 26/10/2020, Date of Publication: 27/10/2020

**S.M. Mahboob Hassan**
Head & Associate Professor,
Dept. of Zoology,
Patna Science College,
Patna University
Patna, Bihar, India

**Shayeba Hasan**
Research Scholar,
Dept. of Zoology,
Patna Science College,
Patna University
Patna, Bihar, India

**Abstract**

Aedes albopictus mosquito has become a significant pest in many communities because it is closely associated with humans and typically flies and feeds in the day time. Household wastes generated by human in cities and towns contribute largely to the solid wastes. Although the management of the solid wastes is a common feature in planned cities and towns, still, the contribution of the solid wastes in public health is considered a serious problem. Recent empirical studies on the household wastes as breeding ground for the mosquitoes have raised the issue of abundance of solid waste and the incidence of dengue. Keeping this in view, a study in the garden of Patna Science College Patna was carried out to substantiate the role of household wastes in the form of earthen and plastic containers as prospective breeding sites of dengue vectors. Repeated sampling of the small and large plastic and earthen containers in the concerned space revealed the presence of immature of Aedes albopictus mosquito in varying numbers. Further assessment of the pupal productivity of the sample containers justified the differences in the life history traits of the mosquitoes emerging from the container habitats. While the mosquito Aedes albopictus is known as container breeders, the exploitation of the household waste suggested the possible link of the solid waste with the propagation and population expansion of the mosquito. The present study, apart from providing evidence towards the link between household waste and mosquito breeding calls for enhanced management of the solid wastes originating from human households in reducing the mosquitoes and mosquito borne diseases. Aedes albopictus is capable of hosting the Zika virus and is considered a potential vector for Zika transmission among humans.

**Keywords:** Household Wastes, Solid Wastes, Aedes Albopictus Dengue, Plastic, Earthen Containers.

**Introduction**

Aedes albopictus also known as tiger mosquito and forest mosquitoes and forest mosquitoes which are medically important insect vectors of various life threatening diseases like Malaria, Dengue, Chikungunya etc. Among the insect suborder about 3500 species are container breeder (Service 1995). Resource availability and habitat permanence are two major factors which decides the relative and absolute abundance of container breeding mosquitoes, as well as play the decisive role in larval development and fitness of individual mosquito, hence in disease transmission potential (Strickman & Kittayapong 2003; Arrivillaga and Barrera 2004; Banerjee et al. 2013a,b).

**Review of Literature**

Container habitats constitute a distinct group with unique ecological properties (Washburn 1995) like they are generally smaller in size which allow them to serve as habitat for fewer species and hence larval mosquito populations can be regulated by various competitive interactions due to resource limitations rather than predation (Washburn 1995; Sunahara et al. 2002; Arrivillaga and Barrera 2004), Container habitats are mainly categorized as natural (tree holes, rock pools, leaf axils etc.) and artificial (water tanks, tires, flower vases, bottle etc.) (Service 1995).

Artificial container habitats mainly generate from disposables, like left over food (Gustavsson et al. 2011), plastic, glass and earthen containers (Banerjee et al. 2015) etc. Normal ecosystem stability gets affected due to the interference of the household wastes with the natural ecosystem process (Gomez-Dantes and Guutierrez 1992; Gupta et al. 1998; Hamer 2003; Nath 2003; Kumar et al. 2008; Sujauddin et. al. 2008; Chakrabarti et al. 2009). Entrapped water in these household disposables allow them to act suitable breeding habitat of various vector mosquitoes, like Dengue vector Aedes spp. Various studies as well as entomological surveillance around the globe suggest that Aedes mosquitoes use various containers with varying materials and origin as their breeding habitats (Tun-Lin et al. 1995a, 1995b, 1996; Vezzani and Schweigmann 2002; Vezzani 2007; Vezzani and Albicocco 2009; Burke et al. 2010; Banerjee et al. 2013b, 2015; Hawely & Castner 2018). In Indian context specifically in Kolkata, Banerjee and co workers in 2013 made an effort to link between the waste and public health by analyzing the contribution of the household wastes or environmental pollutants towards breeding of Aedes mosquitoes. In view of their work the present short study was done to assess Aedes mosquito availability in the household containers of varying material and origin and also effect of the type and size of the containers on various life history traits of Aedes mosquito to assess the fitness of individual mosquito which is directly linked with disease transmission potential.

**Material and Methods**

Sampling procedure and laboratory experiments.

Experimental garden of Patna Science College campus (22.5275$^0$N, 88.3627$^0$E.), Patna, Bihar were considered as sampling site. Two different types of containers Earthen and Plastic of two and three varying size according to the water holding capacity respectively were considered as household waste. Three consecutive sampling were carried out following Krebs (1999); Focks and Alexander (2006), Banerjee et al. (2013b, 2015) with few modifications to fulfill the aim and objective of the study. Total content of each container were poured into separate sampling bags (35.5x25.5 cm, 60x45 cm) and bring to the laboratory where each content was poured from the sampling bags into plastic tray (38x28x7.5 cm) to count and record the number of larvae and pupae from each container. To analyze the effect of different type and size of containers on life history trails (only Pupal weight, PW and Wing length, WL considered) of mosquito pupal weight were measured up to the nearest 0.1 mg using pan balance (ADAM®, ADA 71/L, Adam Equipment, UK) and then individual pupa was placed in small glass vial (15 x 50 mm) containing 5 ml of distiller water. Each vials were covered with fine cloth and allowed the pupa to emerge as adult. Larvae from each container were maintained separately and allowed them to become pupae. Upon emergence to adult the sex and species were identified according to specific keys (Barraud 1934) and they were starved to die. One wing of the dead mosquito were taken and fixed onto a glass slide using Mayer's albumin to measure the wing length nearest 0.1 mm using a binocular with 3x10 X magnification (meopt8, Czechoslovakia) fitted with a graduated eyepiece (Erma®,Japan),

**Statistical Analysis**

Presence of larvae and pupae in each container were assessed by calculating the mean ± SE values and represented in a box plot. A three way

ANOVA was performed to assess the significant of variability in the life history traits as a function of varying container type and size taking the life history traits as response variable and type, size of container and sex as explanatory variables. Also the mean values of PW and WL as a function of varying container type and size was represented in a column diagram and the data of life history trait was compared using Kruskal-Wallis test with multiple comparisons using XLSTAT software (Addinsoft 2010). The statistical analysis was performed following Zar (1999).

**Instruments and Gadgets used**

Gadgets and instruments required for the present study are follows : sampling bag (35.5 x 25.5 cm, 60 x 45 cm), strainer, tray (38 x 28 x 7.5 cm), dropper, bucket, plastic containers, (500 ml, 250 ml), small vials (15 x 50 mm), measuring cylinder (1 lit), fine cloth, rubber bands, glass slide (25.4 x 76.2 mm), brush (0, 2, 4 no.), tissue paper, Instruments: Weighing machine (ADAM®, ADA 71/L, Adam Equipment, UK), Binocular 3 x 10 X magnification (meopt8, Czechoslovakia) fitted with a graduated eyepiece (Erma®, Japan).

**Results and Discussion**

The household wastes observed in the garden in the campus of Patna Science College at Patna Bihar, India were found to be positive as the larval habitats of Aedes mosquitoes. (Tables 1) Both the plastic and the earthen containers were found to hold mosquito larvae in varying numbers (Fig.1). Perhaps, the collected rain water was the primary factor for the household waste to serve as breeding habitat for Aedes mosquitoes. The box plot in Fig. 2 explains the mean median values for each presence data of mosquito immature. The horizontal line corresponds to the median value whereas the round marker represents the mean value. The lower and upper limits of the box are the first and third quartiles, respectively Points above or below the whiskers' upper and lower bounds may be considered as outliers. Colour filled markers are minimum and maximum value for the availability of mosquito immature. From Fig.2 it was evident that plastic containers contain higher number of Aedes immature than the earthen containers. When the life history traits of Aedes considered it was evident that irrespective of type and size of the containers female mosquito bears higher value for both the traits than male except in earthen larger container (Fig.3), Also from Kruskal-Wallis test it was evident that male mosquitoes showed significant effect due to varying container type and size (Fig.3). Results of three way ANOVA showed that only type of container bear significance effect on two life history traits dealt in this study (Table 2).

The present study showed that household wastes or solid wastes serve as breeding habitats for Aedes species In. Presence of Aedes mosquitoes in each container indicate that both plastic and earthen container serve as a suitable breeding and larval habitat for Aedes sp Rapid urbanization across the globe leads to an increase of use of different artificial containers. Among various artificial containers, due to high durability, resistance to physical and chemical factors and slow degradability, plastic containers serve as better choice for breeding habitats of Aedes species (Banerjee et al. 2015).

In the present study the same result was evident (Fig. 2). Improper usage, and disposal of various artifact of daily use and inappropriate management increases the possibilities of plastic wastes to serve as a preferable choice as breeding habitat of many container breeding mosquitoes, Aedes in particular. Disease transmission potential of Aedes mosquitoes is correlated with the fitness of the individuals and different life history traits like pupal weight, adult weight, wing length etc. act as indicator of fitness of individual mosquito as reported from previous studies across the globe (Alto et al. 2005. 2008a, b, 2015; Reiskind and Lounibos 2009, Banerjee et al. 2013b, 2015). In the present study it was clearly evident that type of container had significant impact on both the life history traits dealt with, which may influence disease transmission potential of the dengue vector. Hence the significance of this study was link the environmental pollutants with breeding site of dengue vector Aedes sp. Which will help in prioritization of the mosquito control programme in association with waste management strategies.

**Table 1**
**Outline of Experimental Study**

| **Parameters** | **Details** | **Remarks** |
|---|---|---|
| **General** | | |
| Study area | Patna Science College Campus, Bihar India (22.5275$^0$N, 88.3627$^0$E) | Experimental garden were considered as sampling site. |
| Characterization of containers | 5 earthen and 5 plastic containers with varying water volume capability | LaRGE = > 1 LITR<br>Medium = < 1 litr<br>Small = 500 ml |
| Period of study | Sampling experiment set up and analysis of the data within a period of ~1 month. | 27$^{th}$ May 2020 – 4$^{th}$ July 2020 |
| Methodology | | |
| Sampling | 3 consecutive sampling in an interval of 7 days following standard protocols | The collection of Aedes immature was random |
| Data analysis | Data analysis was done following Zar (1999) | |
| Analysis | 3 day factorial ANOVA was done taking container size and type and sex as explanatory variable and pupal weight and wing length as response variable Nonparametric Kruskal-Wallis test with multiple comparison | One box plot showing the count of smaller larger larvae and pupae in each container and means± SE values represented in a column diagram. |
| Hypothesis tested | Solid wastes as breeding habitat for dengue vector Aedes sp. and effect of life history traits in varying material and origin of breeding habitat. | |

**Table 2**
**Result of three ways ANOVA where the life history traits i.e. pupal weight (PW in mg) and wing length (WL in mm) are response variables and container type, container size and sex corresponds to explanatory variable. Values marked in bold are significant in P<0.0001 level.**

| **PW (in mg)** | **DF** | **SS** | **MS** | **F** | **Pr>F** |
|---|---|---|---|---|---|
| Container | 2 | 250.441 | 125.221 | 288.395 | <0.0001 |
| Type Container size | 1 | 0.215 | 0.215 | 0.494 | 0.484 |
| Sex | 1 | 0.866 | 0.866 | 1.994 | 0.161 |
| Error | 114 | 49.499 | 0.434 | | |
| Total | 118 | 301.020 | | | |
| WL (in mm) | | | | | |
| Container Type | 2 | 587.733 | 293.867 | 2483.076 | <0.0001 |
| Container size | 1 | 0.011 | 0.011 | 0.095 | 0.758 |
| Sex | 1 | 0.424 | 0.424 | 3.584 | 0.061 |
| Error | 114 | 13.492 | 0.118 | | |
| Total | 118 | 601.660 | | | |

**Figure 1: Experimental Design**

| | |
|---|---|
| Sample collection was accomplished in experimental garden of Patna Science College campus following standard protocols with necessary modifications (Krebs 1999; Focks and Alexander 2006; Banerjee et al. 2013b, 2015). Collected sample were brought to the laboratory for counting and data recording | Step 1 Sample Collections |

↓

| | |
|---|---|
| In laboratory mosquito immature from individual container were counted and pupal weight was measured nearest to 0.1 mg using a pan balance (ADAM®, ADA 71/L, Adam Equipment, UK) and then individual pupa was placed in a small glass vial (15 x 50 mm) containing 5 ml of distilled water. Each vials were covered with fine cloth and allowed the pupa to emerge as adult. Upon emergence to adult the sex and species were identified according to specific keys (Barraud 1934) and they were starved to die. One wing of the dead mosquito were taken and the wing length was measured nearest 0.1 mm using a binocular with 3x10 X magnification (meopt8, Czechoslovakia) fitted with a graduated eyepiece (Erma®, Japan). | Step 2 Laboratory Experiments |

↓

| | |
|---|---|
| Presence of larvae and pupae in each container were assessed by calculating the mean±SE values and represented in a box plot. A three way ANOVA was performed to assess the significance of variability in the life history traits as a function of varying container type and size taking the life history traits as response variable and type, size of container and sex as explanatory variables. Also the mean values of PW and WL as a function of varying container type and size was represented in a column diagram and the data of life history trait was compared using Kruskal-Wallis test with multiple comparisons using XLSTAT software (Addinsoft 2010). The statistical analysis was performed following Zar (1999)/ | Step 3 Data analysis |

↓

| | | | |
|---|---|---|---|
| Presence of immature of Aedes sp. in each containers, represented by a box plot Fig.2 | Descriptive analysis of life history traits as a function of explanatory variables. Fig.3 | 3 way factorial ANOVA Table 2 | Step 4 Results & Interpretation |

↓

| | |
|---|---|
| Solid wastes as breeding habitat for dengue vector Aedes sp. and effect of life history traits in varying material and origin of breeding habitat. | Step 5 Hypothesis tested |

**Figure 2: The box plot Figure 2: The box plot representing the availability of Aedes immature in different type and size of containers used in the experiment. SL – smaller larvae (I&II instar) , LL – Large Larvae (III&IV) , E – Earthen , P – Plastic , L – Large , M – Medium , S – Small.**

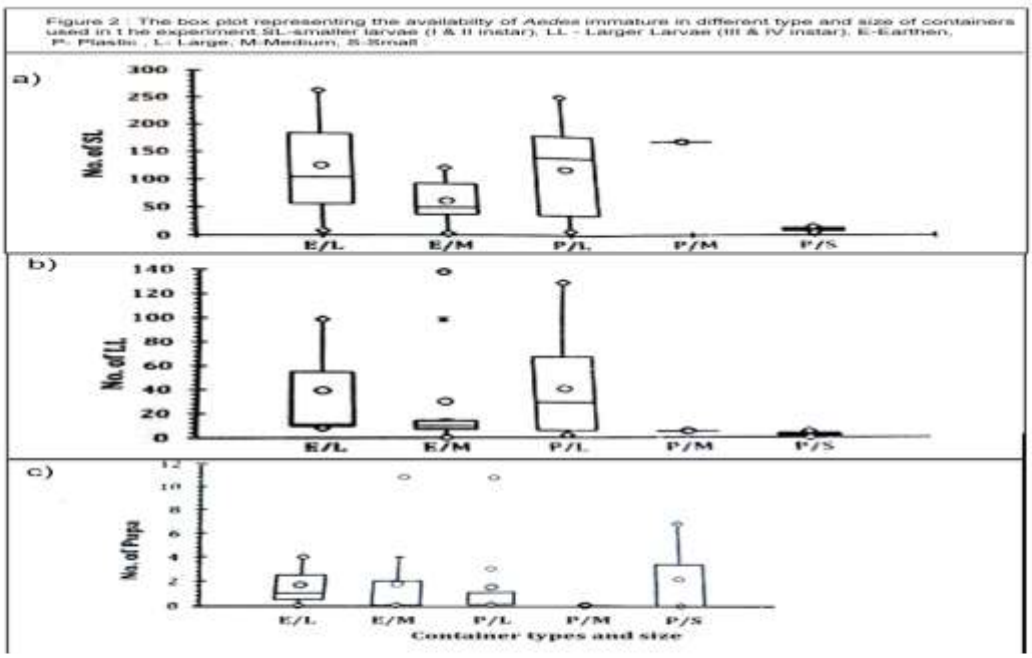
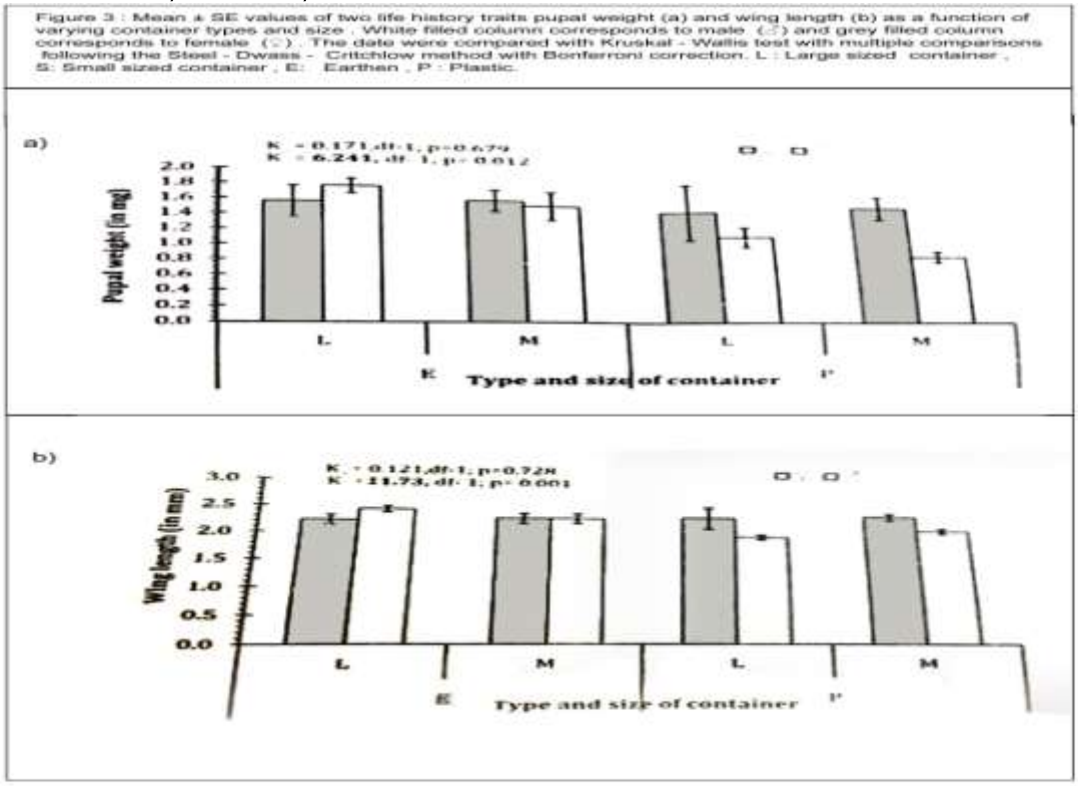


**Figure 3: Mean ± SE values of two life history traits pupal weight (a) and wing length (b) as a function of varying container types and size. White filled column corresponds to male (♂) and grey filled column corresponds to female (♀).The date were compared with Kruskal – Wallis test with multiple comparisons following the Steel – Dwass – Critchlow method with Bonferroni correction. L – Large sized container, S: Small sized container, E: Earthen, P: Plastic.**




## Conclusion

In conclusion it can be said that dengue vector Aedes sp. use different solid wastes as breeding habitat and prefer plastic material over earthen container and varying material and origin of breeding habitat influence the life history traits which in turn affect the disease transmission potential. The study substantiates the earlier findings on the househould wastes as prospective breeding site of dengue vector Aedes albopictus. As an extension it will be a prudent effort to consider enhanced management of solid wastes so as to reduce the possibility of breeding of dengue vectors particularly in the urban areas.

**Acknowledgements**

The authors are very grateful to the Deptt. of Zoology, Patna Science College, Patna for providing garden and laboratory facilities for Experiments.

**Aim of the Experiment**

1. The mosquitoes are vectors or transmitters of infectious disease. So, their biocontrol is necessary for public health.
2. The mosquito's populations are abundant in presence of vegetation and stacked materials.
3. The rainwater serves as primary factor for the household waste to serve as breeding habitat for Aedes mosquitoes.
4. Plastic containers serve as better choice for breeding habitat.
5. The environmental pollutants also assist the breeding site of dengue vector Aedes sp.
6. Monitoring of vector population through entomological surveillance makes it possible to identify areas with a high density of infestation and decide of appropriate measures.
7. The tiger mosquito also diminishes the quality of public health.

**References**

1. *Addinsoft SARL (2010) XLSTAT software, Version 10.0, Paris, France.*
2. *Alto BW, Lounibos LP, Higgs S, Juliano SA (2005) Larval competition differentially affects arbovirus infection in Aedes mosquitoes. Ecology, 86:3279-3288.*
3. *Alto BW, Lounibos LP, Mores CN, Reiskind MH (2008a) Larval competition alters susceptibility of adult Aedes mosquitoes to dengue infection. Proceedings of the Royal Society B, 275: 463-471.*
4. *Alto BW, Reiskind MH, Lounibos LP (2008b) Size alters susceptibility of vectors to dengue virus infection and dissemination. The American Journal of Tropical Medicine and Hygine, 79(5): 688-695.*
5. *Alto BW, Bettinardi DJ, Ortiz S (2015) Interspecific larval competition differentially impacts adult survival in dengue vectors. Journal of Medical Entomology, 52(2): 163-170.*

6. *Arrivillaga J, Barrera R. (2004): Food as a limiting factor for Aedes aegypti in water-storage containers. Journal of Vector Ecology, 29: 11-20.*
7. *Banerjee S, Aditya G, Saha GK (2013a) Pupil productivity of dengue vectors in Kolkata, India : implications for vector management. Indian Journal of Medical Researcvh, 137:549-559.*
8. *Banerjee S, Aditya G, Saha GK (2013b) Household disposables as breeding habitats of dengue vectors : linking wastes and public health. Waste Management, 33:233-239.*
9. *Banerjee S, Aditya G, Saha GK (2015) Household wastes as larval habitats of dengue vectors : comparison between ukrban and rural areas of Kolkata. India. PLos ONE, 10-(10):e0138082.*
10. *Barraud PJ (1934) Fauna of British India, including Ceylon and Burma. Diptera (Family Culicidae: Tribes Megarginini and Culicini), Vol. V. London, UK : Taylor and Francis.*
11. *Burke R, Barrera R, Lewis M, Kluchinsky T, Claborn D. (2010) Septic tanks as larval habitats for the mosquitoes Aedes aegypoti and Culex quinquefasciatus in Playa-Playita. Puerto Rico. Medical and Veterinary Entomology, 24 (2): 117-123.*
12. *Chakrabarti S, Majumder A, Chakrabarti S. (2009) Public-community participation on household waste management in India: An operational approach. Habitat International, 33: 125-130.*
13. *Pocks DA, Alexander N. (2006) Multicountry study of Aedes aegypti pupal productivity survey methodology: findings and recommendations. WHO TDR/IRM/DEN/06.1.*
14. *Gomez-Dantes H, Gutierrez LR. (1992) Dopmestic hygiene promotion and Aedes control. In : Halstead SB, Gomez-Dantes H. (eds.). Dengue: a Worldwide Problem, A Common Strategy. Mexico City : Mexican Ministry of Health and Rockefeller Foundation p. 311-317.*
15. *Gupta S, Mohan K, Prasad R, Gupta S, Kansal A. (1998) Solid waste management in India : options and opportunities. Resources Conservation and Recycling, 24: 137-154.*
16. *Gustavsson J, Cederberg C, Sonesson U, van Otterdijk R, Meybeck A. (2011) Global food loses and food waste: extent, causes; and prevention, Foods and Agriculture Organization of the United Nations, Rome. 38p.*
17. *Hawley S.R. & Castner P.K. (2018): Aedes albopictus is a contempt vector of many viruses and consider as a potential vector for the Zika virus. V.E.R. (26) pp. 128-132.*
18. *Hamer G (2003): Solid waste treatment and disposal: effects on public health and environmental safety. Biotechnology Advances, 22:71-79.*
19. *Krebs CJ. (1999): Ecological Methodology, second ed. Menlo Park, California: Benjamin Cummings. 306 p.*
20. *Kumar S, Mukherjee S, Chakrabarti T, Devotta S (2008): Hazardous waste management system in India: an overview. Critical Reviews in Environmental Science and Technology, 38 (1): 43-71.*
21. *Nath KJ (2003): Home hygiene and environmental sanitation: a country situation analysis for India. International Journal of Environmental Health Research, 13: S19-S28.*
22. *Reiskind MHK, Lounibos LP (2009): Effects of intraspecific larval competition an adult longevity in the mosquitoes Aedes aegypti and Aedes albopictus. Medical and Veterinary Entomology, 23(1) : 62-68.*
23. *Service MW (1995): Mosquitoes (Culicidae). In: Lane RP, Crosskey RW (eds.) Medical Insects and Arachnids. London, UK : Chapman & Hall. P. 120-240.*
24. *Strickman D, Kittayapong P (2003) : Dengue and its vectors in Thailand : calculated transmission risk from total pupal counts of Aedes aegypti and association of wing-length measurements with aspects of the larval habitat. The American Journal of Tropical Medicine and Hygine, 68(2): 209-17.*
25. *Sujauddin M, Huda SMS, Rafiqul Hoque ATM (2008): Household solid waste characteristics and management in Chittagong, Bangladesh. Waste Management, 28 : 1688-1695.*
26. *Tun-Lin W, Kayk BHK, Barnes A. (1995a). The premise condition index : a total for streamlining surveys of Aedes aegypti. The American Journal of Tropical Medicine and Hygiene, 53: 591-594.*
27. *Tun-Lin W, Kayhk BH, Barnes A. (1995b) : Understanding productivity, a key to Aedes aegypti surveillance. The American Journal of Tropical Medicine and Hygiene, 53 (6) : 595-601.*
28. *Tun-Lin W, Kay H, Barnes A, Forsyth S. (1996) Critical examination of Aedes aegypti indices : correlations with abundance. The American Journal of Tropical Medicine and Hygiene, 54 (5): 542-547.*
29. *Vezzani D, Albicocco AP. (2009) : The effect of shade on the container index and pupal productivity of the mosquitoes Aedes aegypti and Culex pipiens breeding in artificial containers. Medical and Veterinary Entomology, 23: 78-84.*
30. *Vezzani D, Schweigmann N. (2002) : Suitability of containers from different sources as breeding sites of Aedes aegypti (L.) in a cemetery of Buenos Aires city, Argentina. Memorias do Instituto Oswaldo Cruz, 97 (6) : 789-792.*
31. *Vezzani D. (2007) : Review : Artificial container-breeding mosquitoes and cemeteries : a perfect match. Tropical Medicine and International Health, 12 (2) : 299-313.*
32. *Washburn JO (1995): Regulatory factors affecting larval mosquito populations in container and pool habitats: implications for biological control. Journal of the American Mosquito Control Association, 11:279-283.*
33. *Zar JH. (1999) : biostatistical analysis. New Delhi : Pearson Education Singapore. 663 pp.*