Asian Journal of Advances in Research

4(1): 422-429, 2021

BITING BEHAVIOURS AND PEAK RANGE OF MOSQUITO *Armigerous subalbatus* IN DIFFERENT SITES

S. UTHIRASAMY[1*] AND T. CHITRA[1]

[1]Research Department of Zoology, Erode Arts and Science College, Erode-09, Tamilnadu, India.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author SU designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors TC read and approved the final manuscript.

Received: 20 March 2021
Accepted: 28 May 2021
Published: 29 May 2021

Original Research Article

ABSTRACT

The *Armigerous subalbatus* mosquitoes biting behaviour and peak values were observed from different sites at K.K nagar in Erode district, Tamilnadu. *Armigerous subalbatus* collected in five different sites**.** The *Armigerous subalbatus* high peak is observed from November to March. The *Armigerous subalbatus* numbers of mosquitoes were observed from five different sites. The maximum number of total mosquitoes was recorded as 178 and collected at the site of Open Dark Place (Sewage). The minimum total number of mosquitoes was observed as 37 from Open Light Place (Sewage). In the outdoor collection of total mosquitoes was recorded as 32. The *Armigerous subalbatus* mosquitoes were observed in the site of Open Place was noted as 14 and in Open place total mosquitoes were recorded as 8. The peak of the biting activity is observed by the intensity of ambient light at the time of sunrise and sunset. The standard deviation value of the morning peak falls was recorded as 06.30 ±0.173 at 06.30 hours in 50% value of morning time. The standard deviation value of the evening peak falls was noted as 18.30 ±0.223 at 18.30 hours. This noted that the rate of change in light intensity and not fixed level or value is the critical factor, which observes the activity peak of biting mosquitoes.

Keywords: *Armigerous subalbatus*, peak value, Open place, Open dark place.

1. INTRODUCTION

The *Armigerous subalbatus* is a widely distributed species throughout southeast and East Asia. It is also a very common mosquito species found abundantly in Punjab and prevalent throughout the year. *Armigerous subalbatus* have been incriminated in the laboratory as a competent vector of the JE [1]. The *Ar. subalbatus* is commonly found close to human dwelling especially in sub-urban areas with poor sanitation that contain polluted water such as septic tanks [2]. States that most species of mosquitoes bite for a restricted period 24 h cycle and those species which are active throughout this cycle bite most readily during one or two limited periods. Haddow [3] Suggests that the different types of biting behaviour fall into two main classes:

i) that in which there is a single, very short and very pronounced wave of biting activity, although there is always scattered biting at other times:
ii) that in which biting activity goes on over a prolonged period. The latter type is strikingly irregular apart from being either diurnal or nocturnal or crepuscular. Studies have been made on the biting activity rhythms in *Aedes aegypti* [4,5,6,7,8]. *Aedes simpsoni* [9,10]

**Corresponding author: Email: s.uthirasamy@gmail.com;*

Aedes polynesiensis and *Aedes pseudoscutellaris* [11] in *Culex vishuni, C.pseudovishuni, C. tritaeniorhynchus, C. bitaeniorhynchus, Anopheles hyrcanus, An. pallidus, An. subpictus* [12], *Culiseta inornata* [13] *An. gambiae, An. zcemanni, An. funestus* and *An. Pharoensis* [14,15]. Practically no information, however, is available on the fine structure of the biting cycles especially with reference to triggering, regulatory and modifying environmental factors. The studies conducted on *Armigerous subalbatus* and reported here seek to investigate:

1. The periodicity of the biting cycle
   i) The day-night cycle from day to day
2. The nature and persistence of the biting cycle
3. The effect of ambient light intensity on the biting cycle,
4. The fluctuation of the density of the population of host seeking females in relation to the phases sunset and sun rise
5. To identify the type of biting behaviour.

For successful implementation of vector management programs, adequate knowledge about the species diversity and density is essential. The purpose of these entomological observations was to determine present mosquito species and their possible density changes, population dynamics and diversity of species in an area which assumes significance due to their public health, medical and veterinary importance [16]. Evaluation of both biological and ecological data is the cornerstone of mosquito control programs in a public health perspective [17,18]. The aim of this study was to determine the total range of mosquito species diversity in terms of species richness and species rich sites in both wet and dry area which will serve as an important tool in disease forecasting and monitoring them.

2. MATERIALS AND METHODS

In the present study, *Armigerous subalbatus* has been selected. *Ar. subalbatus* is a large species occurring throughout the year but found in abundance from November to March in Erode. It breeds in foul smelling and stagnant water. Swarming behaviour has been observed in this species prior to the peak of biting activity. The female mosquitoes feed on the blood of human beings and also on that of other vertebrates, whereas the males exhibit nectar-feeding activity. Ingestion of a minimum amount of blood is necessary to initiate the development of eggs as in other species of mosquitoes. The females take one blood meal or more per geotropic cycle or before developing each batch of eggs. The time of feeding activity is presumably controlled by a circadian (or photoperiod) "clock" but the level of illumination during twilight hours affects the initiation, duration and 2. cessation of feeding. The collection site is located in Kalanar Karunanidhi nagar which is 9 km from Erode District and located in between Joshape hospital and IIT (1.3104° N, 77.7037° E). This site provides suitable breeding and roosting sites for the mosquitoes to occur in larger numbers.

As the female mosquitoes readily bite humans, legs below the knee of the investigator were exposed to be bitten. Mosquitoes alighting on the legs were collected with a transparent plastic vial (51/2 cm x 2 cm) continuously for 24 h. The catch was separated according to hours, identified and recorded. A red light source of 610 nm was used for illumination during dark periods. The collections were made for 24 h in the spots mentioned earlier to predict the nature of the biting cycle. The collection site located in the southern side of the house was used to study the effect of moon light, twilight and the timings of sunset and sunrise on the biting activity rhythm of these mosquitoes and the collections were made between 05.30 h and 07.30 h, 17.30 h and 19.30 h (peak hours) for twenty days. The collections were carried out in November and December. Since *Ar. subalbatus* is dawn and dusk active, the values of the midpoints of morning and evening peaks are correlated with those of sunrise and sunset. Sunrise and sunset times were obtained from the tables published by the Regional Meteorological Centre, Calcutta and were adjusted for longitude and latitude. The light intensities were measured during the morning and evening twilight with an optometer (UDT) by pointing the light receiving unit towards the horizon and keeping the apparatus at a fixed place very close to the collection site. The lowest level of light intensity that could be directly and reliably measured was 0.001 ft. c. At the end of a trial, the number of mosquitoes collected within each observation period (e.g. at hour 1, hour 2 and hour 3), for treatment and control, can be averaged for each replicate (i.e.full treatment rotation) [8].

3. RESULTS

The *Armigerous subalbatus* high density is observed from November to March. The maximum density is presented on November and December. The minimum range of density is present in January and February (Table-1 and Fig-1). Analysis of biting cycles shows that *Armigerous subalbatus* is distinctly two peaks of activity a smaller peak at dawn and a relatively larger peak at dusk. Peaks of the biting cycle coinciding with dusk are invariably larger (Table 3 and Fig. 3).

Studies conducted to analyse the pattern and periodicity of the biting cycle show that the rhythm is apparently under a state of strict "entrainment" by the light-dark cycles of the environment. The time interval between morning and evening peaks is about 12h (Fig.3 and 4). The biting activity rhythm manifests itself day after day without any marked qualitative changes (Fig.3 and 4). The peak of the biting activity is determined by a threshold intensity of ambient light at the time of sunrise or sunset. The median value of the morning peak falls at 06.30 h when the sunlight intensity is about 17 lx (Fig. 4a). The median value of the evening peak falls at 18.30 h when the sunlight intensity is about 4 lx (Fig. 4b). This shows that the rate of change of light intensity and not an absolute fixed level or value is the critical factor that determines the activity peak of crepuscular biting mosquitoes. The time of sunrise and the midpoint of the morning peak are congruent in time whereas the midpoint of the evening peak occurs 8 to 9 min past sunset (Table 2 and 3 and Fig2 and 3). Studies conducted to find out the influence of phases of moon reveal that the size of the catches increases with the waxing phase of the moon from a minimum at the new moon (22.11. 2018) to maximum at full moon (12.12. 2018) (Fig. 3 and 4). The total number of mosquitoes caught in the garden, outdoors, indoors and on the first floor shows that *Ar. subalbatus* is active predominantly outdoors. But, the peak of activity is maintained at the same hour in all the sites where collections were made (Table 3, Fig. 3 and 4).

4. DISCUSSION

The majority of mosquito species preferred to breed in permanent breeding sites, especially natural sites in urban, semi urban and peri urban areas, while some species are more abundant in temporary breeding places. Hence, the association between species of mosquitoes can provide clues to an understanding of their biology and their role in the transmission of pathogens [19]. In the present study the species density peak of both morning and evening time study, area is comparatively high and the peak value is 06.30 ± 0.173 and 18.30 ± 0.223. The high index may be due to the physicochemical and biological parameters of the breeding habitats since each habitat produces specific mosquito species and shows a seasonal progression [19]. A minute variation was noticed in the diversity of mosquitoes in both study areas because of the changing time morning and evening time.

The studies on the biting activity clearly confirm the predominantly crepuscular behaviour of *Armigerous subalbatus.* Peaks in landing and biting activity of females on man occurred at dawn and dusk and all catches have shown definite bimodality. The biting or landing of the mosquitoes outside the peak hours is very low. The amplitude of the evening peaks was higher than that of the morning peaks in all catches of *Armigerous subalbatus*. The bimodal biting cycle is also observed in the diurnal mosquitoes and the uni modal activity is reported in the nocturnal mosquitoes *Culex* spp. [12], *Culiseta inornata* [13] *Anopheles* spp [15]. The common occurrence of cycles with the asymmetry in the peak of bimodal biting activity amplitude may be due to the sections of populations involved.

Table 1. Density of *Armigerous subalbatus*

S. No	Month	Density (Max/Min)10%
1	November	High (+++++) 7%
2	December	High (++++) 6%
3	January	Normal (+++) 5%
4	February	Medium (++) 4%
5	March	Low (..) 3%

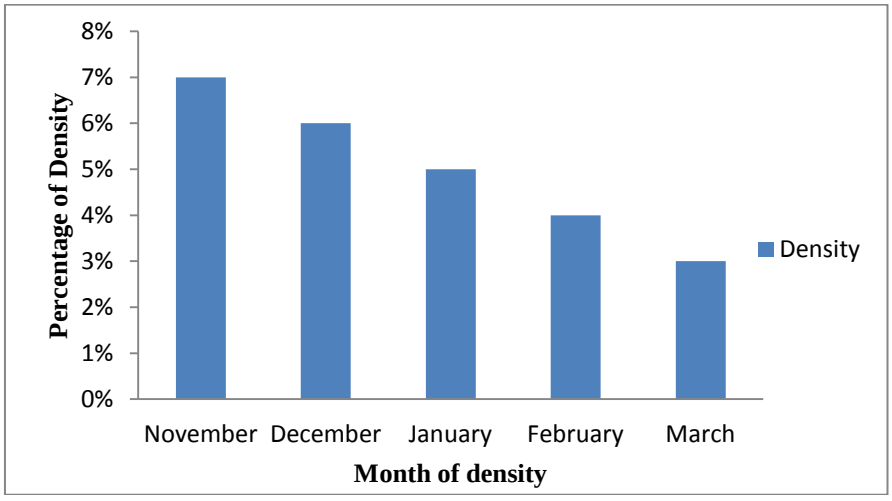

Fig. 1. Density of *Armigerous subalbatus*

Table 2. Number of *Armigerous subalbatus* collected in five different sites at K.K nagar, Chennimalai way, Erode

Place of collection	Number of *Armigerous subalbatus* mosquitoes collected at hours interval																				
	0100-0200	0100-0200	0200-0300	0300-0400	0400-0500	0500-0600	0600-0700	0700-0800	0800-0900	0900-1000	1000-1100	1100-1200	1200-1300	1300-1400	1400-1500	1500-1600	1600-1700	1700-1800	1800-1900	1900-2000	Total
OP	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**	
Indoor	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**6**	**0**	**2**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**14**
Outdoor	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**9**	**3**	**1**	**0**	**2**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**32**
OLP (S)	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**7**	**2**	**4**	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**37**
O D P(S)	**0**	**0**	**0**	**0**	**0**	**0**	**25**	**32**	**13**	**11**	**6**	**4**	**3**	**2**	**3**	**0**	**7**	**10**	**16**	**46**	**178**
Total	**0**	**0**	**0**	**0**	**0**	**0**	**52**	**54**	**18**	**19**	**10**	**9**	**6**	**6**	**4**	**3**	**9**	**14**	**19**	**47**	**269**

OP – Open place, Indoor – Garden, OLP – Open Light Place (Sewage), Open Dark Place (Sewage)

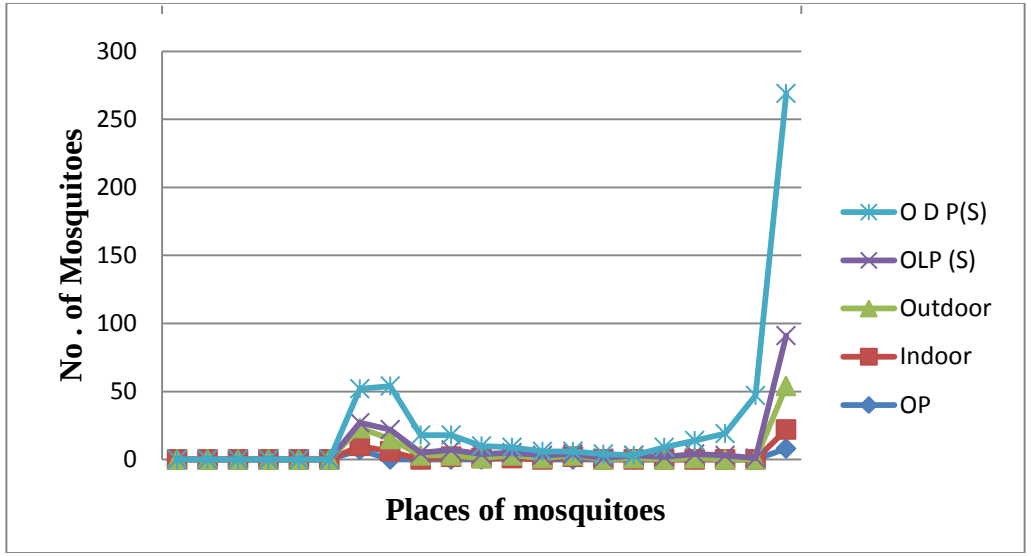

Fig. 2. Number of *Armigerous subalbatus* collected in five different sites at K.K nagar, Chennimalai way, Erode

Table 3. Data on the time of sunrise and sunset of *Armigerous subalbatus*

Date	Time of sunrise	50% value of morning peak	Sunset	50% value of evening peak
22.11.2018		06.30		18.30
23.11.2018		06.30		18.34
24.11.2018		06.31		18.34
25.11.2018	06.30	06.35	18.24	18.32
26.11.2018		06.35		18.36
27.11.2018		06.36		18.40
29.11.2018		06.34		18.44
30.11.2018	06.34	06.33	18.22	18.36
1.12.2018		06.34		18.38
2.12.2018		06.34		18.35
3.12.2018		06.35		18.30
4.12.2018	06.26	06.33	18.26	18.46
5.12.2018		06.33		18.40
6.12.2018		06.26		18.36
7.12.2018		06.27		18.38
8.12.2018	06.24	06.35	18.30	18.35
9.12.2018		06.26		18.30
10.12.2018		06.22		18.24
11.12.2018		06.24		18.26
12.12.2018		06.22		18.24

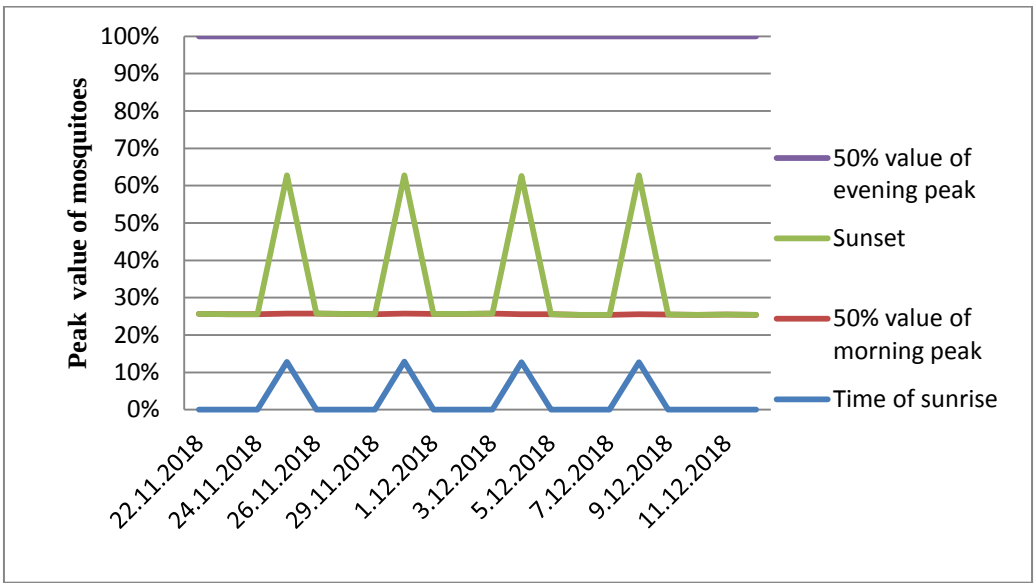

Fig. 3. Data on the time of sunrise and sunset of *Armigerous subalbatus*

Table 4. Data on the time of sunrise and sunset of *Armigerous subalbatus*

S. No	50% value of morning peak	50% value of evening peak
1	06.30 ±0.173	18.30 ±0.223
2	06.30 ±0.173	18.32 ±0.721
3	06.30 ±0.173	18.36 ±0.469
4	06.30 ±0.114	18.30 ±0.044
5	06.30 ±0.02	18.36 ±0.447
6	06.30 ±0.24	18.30 ±0.447

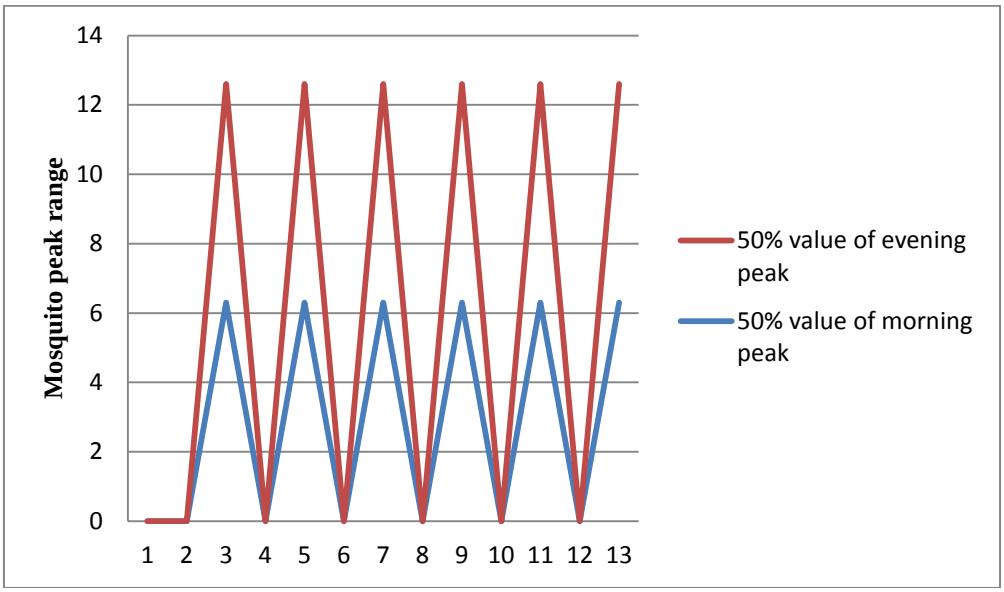

Fig. 4. Data on the time of sunrise and sunset of *Armigerous subalbatus*

Nayar [20] reported the entrainment of pupation rhythm in *Aedes taeniorhynchus.* Data obtained from an uninterrupted 20 day period of field studies reveal that the entrained biting cycle rhythm manifests itself day after day without any marked qualitative changes. The changes in light intensity might play a major role in defining the timings of an activity peak.

The present work *Armigerous subalbatus* numbers of mosquitoes were observed from five different sites. The maximum number of total mosquitoes was recorded as 178 and collected at the site of Open Dark Place (Sewage). The minimum total number of mosquitoes was observed as 37 from Open Light Place (Sewage). The onset of biting falls within a very short period when the rate of change is reaching its maximum [21]. Since *Ar. subalbatus* is a crepuscular form the sudden increase (up to ca. 17 ix) or decrease (down to ca. 4 lx) in the intensity of ambient light at the time of sunrise or sunset may determine the onset of biting activity and the mid-point values coincide with the time of local sunrise and sunset.

In present study the outdoor collection of total mosquitoes was recorded as 32. The peak of the biting activity is observed by the intensity of ambient light at the time of sunrise and sunset. Interestingly, the biting cycles of *Ar. subalbatus* (and possibly other species of mosquitoes) coincide with the steeply increasing or decreasing phases of light during dawn and dusk. Such transitions are abrupt in the tropics and remarkably precise in timing from day to day regardless of cloud cover and other conditions. Intensities of 17 lx and 4 lx at which biting commences during dawn and dusk are reminiscent of responses of plants [22,23] insects in temperate climates in measuring day lengths. Plants and insects apparently also exhibit threshold responses between 1-10 lx^4. The standard deviation value of the morning peak falls was recorded as 06.30 ±0.173 at 06.30 hours in 50% value of morning time. The standard deviation value of the evening peak falls was noted as 18.30 ±0.223 at 18.30 hours. This noted that the rate of change in light intensity and not fixed level or value is the critical factor, which observes the activity peak of biting mosquitoes.

When the indoor and outdoor components of hourly man biting of *Ar. subalbatus* were compared, it was noted that the time of biting was exactly similar in both indoor and outdoor environments as shown in the species of *Anopheles* [15]. The vertical stratification of biting activity in *Ar. subalbatus*, is probably a response to one or more of the differences in biological and physical parameters.

5. CONCLUSION

The data obtained from this study helps to determine the correct timing for fogging operation in order to maximize the mortality of the targeted mosquitoes. In addition, the biting peak of mosquitoes indicated the critical time for blood feeding, and is therefore the high risk period for disease transmission from mosquitoes to humans to occur. Thus, public awareness of these facts helps to promote the use of personal protection measures against diseases transmitted by mosquitoes

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chen WJ, Dong CF, Chiou LY, Chuang WL. Potential role of *Armigerous subalbatus* (Diptera: Culcidae) in the transmission of Japanese Encephalitis virus in the avesence of rice culture on Lie-Chiu islet, Taiwan. Journal of Medical Entomology. 2000;37(1):108-113.
2. Rakai IM, Naserua JD, MacNamara FN, Pillai JS. Mosquitoborne infections in Fiji IV. Biting times for village mosquitoes and human filaria transmission potential of *Aedes polynesiensis* and *Aedes pseudoscutellaris.* J Med Entomol. 1974;11:588 594.
3. Haddow AJ. Studies of the biting habits of African mosquitoes. An appraisal of methods employed, with special references to the twenty-four hour catch. Bull Entomol Res. 1954;45:199-242.
4. Trpis M, Gerberg EJDiel periodicity in the biting activity of *Aedes woodi* in East Africa. Mosq News. 1974;34:443-446.
5. McClelland GAH. Observations on the mosquito *Aedes (Stegomyia) aegypti* (L.) in East Africa II. The biting cycle in a domestic population on the Kenya Coast. Bull Entomol Res. 1960;50:68%696.
6. Boorman MA. Studies on the biting habits of the Mosquito *Aedes (Stegomyia) aegypti.* Lin., in a West Africa village. W Afr Med J. 1960;9:111-122.
7. WHO. World Health Organization Guidelines for efficacy testing of spatial repellents; 2012.
8. Trpis M, McCleiland GAH, Gillett JD, Teesdale C, Rao TR. Die1 periodicity in the landing of *Aedes aegypti* on man. Bull Wld Hlth Org. 1973;48:623-629.
9. Lumsden WHR. Entomological studies relating to yellow fever epideminology at Gede and Taveta, Kenya. Bull Entomol Res. 1955;46:149-183.
10. Gillett JD. *Aedes simpsoni* in Chaggalan, Tanzania. Ann Trop Med Parasit. 1969; 63:147.
11. Reuben R. Studies on the mosquitoes of North Arcot District, Madras State, India Part 2. Biting cycles and behaviour on human and bovine baits at two villages. J Med Entomo. 1971; l 8:127-134.
12. Rydzanicz K, Lonc E. Species composition and seasonal dynamics of mosquito larvae in the wrocalu Poland area, Journal of Vector Ecology. 2003;23(2):255266.
13. Barnard DR, Mulla MS. Diel periodicity of blood feeding in the mosquito *Culiseta inornata* in the Coachella valley of southern California. Mosq News. 1977;37:669-673.
14. Clements AN. The physiology of mosquitoes, London, Pergamon Press Rajavel, A.R.(1992). Larval habitat of *Armigeres subalbatus* (COQ) and its characteristics in Pondicherry. Southeast Asian J Trop Med Public Health. 1963;23:470–473.
15. Krafsur ES. The bionomics and relative prevalence of *Anopheles* species with respect to the transmission of *Plasmodium* to man in Ethiopia. J Med Entomol. 1977;14:180-194.
16. Pandian RS, Rethinavelu R, Manoharan AC. Species diversity and feeding behaviour of mosquitoes in a rural area associated with an agro ecosystem: A case study, Proceedings of the 2nd Symposium on Vector and Vector Born Diseases, Madurai. 1997; 207 211.
17. Simsek FM. Seasonal larval and adult population dynamics and breeding habitat diversity of *Culex theileri* Theobald, (Diptera: Culicidae) in the Golbasi District, Ankara, Turkey, Turkey Journal of Zoology. 2004; 28:337-344.
18. Teesdale C. Studies on the bionomics of *Aedes aegypti* (L) in the natural habitats in a coastal region of Kenya. Bull Ent Res. 1965;46:711-742.
19. Devi NP, Jauhari RK. Mosquito species associated with some western Himalayas Phytogeographic Zones in the Garhwal region of India. Journal of Insect Science. 2007;7:3337.
20. Nayar JK. The pupation rhythm in *Aedes taeniorhynchus.* IV. Further studies of the Endogenous Dirunal (circadian) Rhythm of Pupation. Ann Entomol Soc Amer. 1968;61:1408-1417.
21. Haddow AJ, Casley DJL, O'Sullivan JP, Ardoin PML, Ssenkubuge Y, Kitma A. Entomological studies from a high steel tower in Zika Forest, Uganda II. The biting activity of mosquitoes above the forest canopy in the hour after sunset. Trans Rent Soc Lond. 1968;120:219~36.
22. Buenning E. Symptoms, problems and common features of circadian rhythms in plants and animals. Proc Int Symp Circadian rhythmicity, Wageningen Centre for Agricultural Publishing and Documentation. 1971;11-31.

23. Buenning E. The physiological clock. London, The English Universities Press Ltd Chandler JA, Highton RM, Hill MN (1975) Mosquitoes of Kano Plain, Kenya I. Results of indoor collections in irrigated and non-irrigated areas using human bait and light traps. J Med Entomol. 1973;12:504-510.

© Copyright MB International Media and Publishing House. All rights reserved.