THE EFFECTS OF CLIMATIC FACTORS ON THE DISTRIBUTION AND ABUNDANCE OF MOSQUITOES IN PHYTOTELMATA

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ABSTRACT

Climatic factors have been associated with abundance and distribution of mosquito-borne diseases in many parts of the world, especially in warm and tropical climatic regions. The main objective of this research is to determine the distribution and abundance of mosquitoes in phytotelmata in Zaria, Northern Nigeria. The sites were in three locations with five replications of *Delonix regia* including the control. Habitat evacuation method as described by Service (1993) was used to sample mosquito larvae and pupae in all the locations. The pre-adults collected were concentrated on a fine sieve in a white enamel bowl and later identified into specie level using X50 microscope and Hopkins manual. The Volume of water was measured using measuring cylinder and temperature was measured in situ using portable thermometer. T-test analysis of the results showed significant difference between the larvae and pupae population ($p<0.05$) with population of larvae (74.5%) higher than that of the pupae (25.5%). Two –way ANOVA showed significant difference ($p<0.05$) in the percentage composition and distribution of pre-adults with highest population (29.8%)) recorded in August and lowest population (4.2%) recorded in October. Two –way ANOVA of the species compositions showed significant difference ($p<0.05$) with *Aedes aegypti* having the highest percentage composition (48.8%) and *Toxorhynchite brevipalpis* having the lowest percentage composition (1.2%). The temperature range in which breeding was found is 24.7^{o}C -28.3^{o}C. In conclusion, the composition and distribution of mosquitoes in this habitat is significant enough to be of socio-economical and medical importance. Therefore we recommend that the phytotelmata should be considered in any mosquito-borne disease control programmes and tree that support mosquito breeding should not be planted closed to residential areas.
Keywords: Phytotelmata, climatic factors, *Delonix regia, Aedes aegypti*, Zaria.

INTRODUCTION

The biological performance of pre-imaginal mosquitoes results from the interaction between intrinsic attributes of the species and the environmental conditions of breeding site, with temperature and precipitation being few of the important abiotic factors affecting the development, growth, and survival of immature mosquitoes (Clements,1992).There is a positive relationship between these climatic factors and developmental rate of pre-imaginal stages of mosquitoes(Maria *et al.*,2008).The climatic factors of the breeding sites play a vital role in the selection of the oviposition site and subsequent growth, development and population density during aquatic stages (Sinha,1976). As a developmental and life history strategy, mosquitoes are known to colonise diverse surface collections and container-type of aquatic habitats, which afford their eggs, larvae and pupae the opportunity to develop into aerial adult stages (Service, 1993). Among the pre-imaginal habitats of mosquitoes are the phytotelmata. The term phytotelmata (plant-waters) was coined by Varga (1928) to describe bodies of water impounded by plants. Frank and Lounibos (1983) described phytotelmata as plant pond while kitching and Pimm (2000) defined it as aquatic habitats held in various plant parts. According to Fish (1983) over 1500 different species of plants with at least 26 families have been reported to impound water. Leaf axils of plants seem to be the most common type of phytotelmata (Greeney, 2001) with the Bromeliaceae alone believed to have more than 1000 species of trees capable of impounding water (Frank, 1983). Trees that are positive for phytotelmata include Albizia lebbeck (India walnut), Drimiopsis barterer (Barter squill), and Delonix regia. Among these trees, tree holes in hardwood trees are the most widespread and long-lived. The literatures on mosquitoes inhabiting phytotelmata are relatively extensive particularly due to bromeliad-breeding species and the public health significance in tropical regions (e.g. Olano et al., 1997, Forattini et al., 1998, Cunha et al., 2002). In addition, Okogun *et al* (2005) and Adebote et al (2008) highlighted the physicochemical parameters of water and phytotelmata respectively that are paramount to all ecological studies of vectors. A full understanding of climatic factors of phytotelmata and other mosquito habitats is a pre-requisite in planning effective vector control programmes. The previous physico-chemical studies showed that *Delonix regia* supported breeding of three genera and six species of mosquitoes, but Aedes mosquitoes are predominant in this habitat (Adebote *et al*., 2004 and 2008)

MATERIALS AND METHODS

This study was conducted in Ahmadu Bello University Samaru ($11^0 10^I$N,$07^0 39^I$ E), North West of Zaria. The choice of this site is due to the abundance of *Delonix regia* (Flamboyant trees) in the area and the *Delonix regia* was chosen among other phytotelmata in the area because of its capacity to support mosquito breeding and its adaptability to store water during raining season which remain for quite sometimes during dry season. In addition, the tree is perennial with discrete boundaries, the community established in it is well defined, and various abiotic and biotic factors within this system are easily replicated. The study site was in three locations with five replications each. In each site, five Delonix regia trees were randomly selected. The temperature of the habitat was taken using a portable thermometer while habitat evacuation methods as described by Service (1993) which involved the use of brass soup ladle dipper (9cm in diameter and holding 138ml of water) were used to sample mosquito larvae and pupae in all locations. Water obtained from the habitat was poured through a fine sieve in a white enamel bowl to concentrate the larvae and pupae. The larvae and pupae were carefully picked from the habitats by using aspirator and the number of larvae and pupae from each phytotelm was counted and recorded. The volume of water scooped from the tree holes was measured using 500ml measuring cylinder. Difference in larvae and pupae composition from April 2006 to October 2007 was analysed using T-test and Carl Pearson Correlation was used to determine the association between temperature, volume of water and pre-adult composition.

Results and Discussion

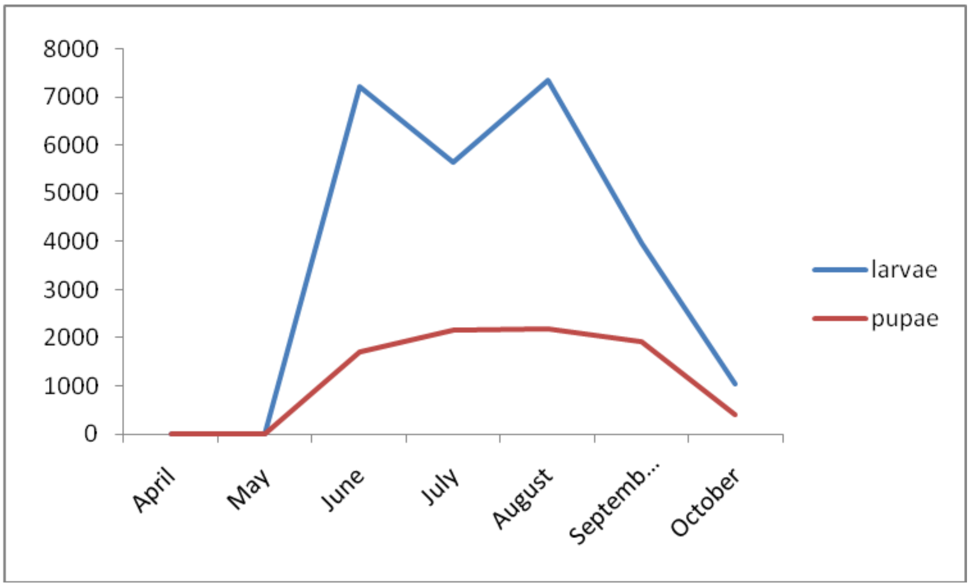

Figure 1 : Larvae and pupae population from April to October

Mosquito breeding in the selected phytotelmata did not commence until the month of June. Therefore immature stages were not observed in April and May. This is due to lack of rainfall during these months in the study area. A total of 33,574 immature stages of mosquitoes were collected during the breeding period (May to October). 25,189 (75%) were larvae and 8385 (25%) were pupae. Breeding in the habitat started in June when 7203 and 1697(larvae and pupae respectively) were recorded. Subsequently in July the larvae population declined to 21.62% while the pupae population increased by 21.83%. This suggests that frequency and pattern of rainfall affect the composition and distribution of larvae and pupae in tree holes. Increased rainfall with relatively short interval as observed in June favours larval population while it has little or no effect on pupal population. This finding was supported by the works of Gubler *et al.* (2001) which stated that increased rainfall may increased larval habitat and larval population. A sharp increased of about 30% in larval population was observed in August when the frequency of rainfall increased and the intervals of rains were very short. Though with excessive rains most mosquito habitats are likely to be flooded as stated in the work of Kelly-Hope *et al.*(2004) but tree hole habitat in Delonix regia is shaded with branches of trees which make the environment to be stable and immune to flooding. This finding was supported by the work of Adebote *et al.*(2004).The highest number of larvae 7336 (29.12%) and pupae 2195 (26.2%) were recorded in August. The pre-adult population declined from September to October with the lowest population of larvae 929 (4.2%) and 467 (5.7%) pupae recorded in October. T-test showed that there is no significant difference in the composition of larva and pupae ($t= 1.83$, $F= 2.18$, $p>0.05$) and two-way ANOVA showed that there is significant difference in the distribution of larvae and pupae among the months ($p<0.05$).

Locations/Replications		Temperature(°C)	Volume of Water(ml)	Larvae	Pupae
1	I	25.8	273.0	259	111
	II	25.1	238.0	249	113
	III	26.2	440.0	656	264
	IV	24.8	2344.0	2618	921
	V	26.5	433.0	1022	290
2	I	25.6	796.0	2002	672
	II	26.3	264.0	399	172
	III	25.7	301.0	367	141
	IV	25.5	990.0	2364	828
	V	25.1	569.0	2326	661
3	I	26.0	788.0	1877	523
	II	26.4	317.0	556	226
	III	25.8	365.0	583	245
	IV	25.9	870.0	2550	798
	V	25.6	365.0	721	301
4	I	27.9	375.0	963	334
	II	28.3	333.0	604	205
	III	28.6	390.0	737	276
	IV	29.0	369.0	646	218
	V	29.0	411.0	1040	385

Table 1: Larvae and Pupae Distribution at Different Temperature and Volume of Water

From table 1, it was observed that the temperature range that favours mosquito breeding in the study area is 24.8°C – 29.0°C. At the peak temperature of 29.0°C,1040 and 385 larvae and pupae respectively were recorded in the tree holes, while at the lowest temperature of 24.8°C, highest number of larvae and pupae (2618 and 921) were recorded in the habitat. This shows a negative correlation between the temperature and the pre adult population (r larvae=-0.3514 and r pupae =-0.3589). This suggests that mosquitoes breeding in tree holes prefer lower temperature than higher temperature. The habitat was found to hold considerable amount of water during the raining season and some of these trees especially the deep rooted one retained the water to the earlier part of the dry season as seen in Figure 1. The highest volume of water (2344.0ml) was recorded during the raining season when the population of pre-adult increased exponentially to 2618 and 921 (larvae and pupae respectively). The lowest pre-adult population (249 and 113) was recorded at the lowest volume of 238.0ml for larvae and pupae respectively. Carl Pearson Correlation shows a positive correlation between the volume of water and pre-adult population

Mosquito species	*Aedes aegypti*	*Aedes fraseri*	*Aedes simpsoni*	*Culex horidus*	*Culex nebulosus*	*Toxorhynchite brevipalpis*
Composition	2147	897	473	597	232	54
Percentage Composition (%)	48.8	20.4	10.8	13.6	5.3	1.2

Table 2: Composition and percentage composition of mosquito species in phytotelmata

Identification of the larvae to species level using morphological keys shows three genera and six species of mosquitoes inhabiting *Delonix regia*. A total of 4400 larvae were collected and identified in tree holes, 2147 of these larvae were Aedes aegypti which form 48.8% of the total population and 54 *Toxorhynchite brevipalpis* which form 1.2% of the total population collected as shown in table 2 above. The abundance *Aedes aegypti* in this habitat suggests the species is predominant in this habitat and also the presence of *Toxorhynchite brevipalpis* suggests a carnivorous feeding relationship in the habitat. This finding was in concordance with the work of Adebote *et al.(2004 and 2006).*Analysis of variance showed significant difference in the composition of mosquito species in the habitat ($p<0.05$).

CONCLUSIONS AND RECOMMENDATIONS

Rainfall is the main source of water in phytotelmata and water is an important component of the tree hole ecosystem. Water quality in the breeding site is an important determinant of whether or not the female mosquitoes will lay eggs and the resulting immature stages will successfully complete their development to the adult stage (Piyaratne *et al*., 2005). The parts in which water is collected are usually shallow, while in few cases deep. In this study, we discovered that flamboyant trees can hold water to the capacity of 2.3litres.Generally it can be concluded that the pre –adult population in phytotelmata is directly proportional to increase in volume of water and inversely proportional to decrease in temperature. This infers that increase in volume of water at temperature range of 24.8^{o}C-29.0^{o}C produces high degrading rate of leaf litters and leaching of soluble compounds into the water by the activity of microorganisms and this encourages increase in population of tree-hole dwelling mosquitoes. The abundance of *Aedes aegypti* in the study area suggests that the area might be at risk of Yellow fever and zoonotic dog filariasis. We therefore recommend that further study should be carried out in the study area to determine the incidence and prevalence of yellow fever and dog filariasis. Likewise research work should also be carried out to determine the effects of BOD (Basic Oxygen Demand) and COD (Chemical Oxygen Demand) on the fauna of the phytotelmata. Finally more vector control works should be carried out to control the population of tree hole mosquitoes in order to reduce mosquito borne diseases in northern Guinea Savanna and Nigeria as a whole.

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