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Full Length Research Paper

Effect of color, cow dung and clay suspension on oviposition behavior of gravid female mosquitoes in Zaria, Kaduna state, Nigeria

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Abstract

An investigation was conducted to assess the influence of color, organic (Cow dung) and inorganic (Clay) substrate environment on the oviposition behavior of different gravid female mosquitoes found in Zaria, Kaduna state – Nigeria. Of the fifty six (56) colored cylindrical cups, eight each of Blue, Red, Green, Orange, Pink and Brown containing de-chlorinated water assessed, 34% of the gravid female mosquitoes preferred Red cups, followed by Purple and Brown cups with 17.9% and 13.5% respectively. Green colored cups were the least preferred. In addition, cups enriched with Cow dung had a significantly higher mean larval recovery than cups containing clay suspension. However, the combined effect of color and substrate environment shows that colored cups enriched with Cow dung had significantly higher mean larval recovery than similar colored cups containing clay suspension ($P<0.05$). These findings are of significance for developing an effective, non polluting mosquito control technologies such as 'ovitraps'; and also for targeting oviposition sites for treatment with bio-control agents or bio-pesticides.

Keywords: Color, cow dung, clay, oviposition, preference, Zaria.

INTRODUCTION

Although mosquitoes are found all over the world they are more predominant in northern countries like Nigeria (Belding, 1965). In these areas, in addition to being a nuisance they are responsible for transmitting diseases like malaria, yellow fever, dengue hemorrhagic fever and bancroftian filariasis among many others (Anonymous, 2007). In other parts of the world, mosquitoes transmit dog heartworm and several diseases of equine (Anonymous, 2005).

Despite several control measures, mosquito transmitted diseases have continued to be a major public health problem with more than 2.5 billion people in tropical countries at risk of infection (Kakkilaya, 2009). It has being reported that over a million deaths are recorded annually as a result of mosquito transmitted disease while several hunting and camping grounds are closed to the public, and vast areas of land remain uninhabited as a result of their depredations (Anonymous, 2005, Belding, 1965).

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With the ever increasing quest for cheaper, more effective and environment friendly mosquito control measures over the last decades, research emphasis have shifted to strategies that make humans less attractive to mosquitoes; and on mosquito behavior and their ecology (Mark, 1998).

Of recent, knowledge of oviposition behavior in female mosquitoes has shown some promise in the control of mosquito and mosquito borne diseases. As in many species of insects, oviposition has been reported to be an important component of the life cycle of mosquitoes as it influences their density and distribution (Bentley and Day, 1989; Azzam, 1998; David *et al.*, 2007).

However, oviposition by female mosquito has been shown to be affected by both biotic and abiotic factors which in turn influence mosquito abundance and disease transmission (Kaw Bing Chua *et al.*, 2004). Although there are several reports on the behavior of many ovipositing female mosquito species from other parts of the world, this information are scanty or in some cases lacking in Kaduna State. There is therefore the need for adequate knowledge of the ecology of the mosquito

vector and the mechanism of disease transmission considering the variation in biotic and abiotic factors which may affect ovipositon behavior.

The present study was therefore aimed at assessing the effect of different colors, organic (Cow dung) and inorganic (Clay) substrate environment on the oviposition behavior of different gravid female mosquito species found in Zaria, Kaduna State – Nigeria. It is hoped that the result will be found useful in the control of mosquito and mosquito transmitted diseases especially with the on-going "Roll Back Malaria" campaign embarked by the Federal Government of Nigeria.

MATERIALS AND METHODS

Study site

Zaria is located on latitude 11^{O} 30^{I}N and longitude 7^{O} 50^{I}E; and lies about 686m above sea level (Musa *et al*., 2009). The vegetation of Zaria is typical of the Northern Guinea Savanna type characterized by grasses and shrubs.

Determination of color preference

Fifty six (56) colored cylindrical plastic cups of 600ml capacity were used to assess color preference of different mosquito species in the field. Eight cups each of blue, red, green, orange, pink, purple and brown containing 550ml of de-chlorinated water were arranged randomly 1m above ground level in the field and allowed to stay for 10 days after which larvae were pipetted into labeled sample bottles containing 10% formalin and transported to the laboratory for identification and counting.

Identification and counting of mosquito larvae

Larvae collected from each cup were identified and counted as described by Hopkins (1952). Some specimens were also sent to the British museum for confirmation.

Determination of the effect of substrate environment on oviposition by gravid females

Sixteen (16) labeled black plastic cups of 600ml capacity containing 550ml of de-chlorinated water were set up 1ml above ground level in the open field. To each of the first eight cups, 2 grams of dried powdered cow dung was added and mixed thoroughly while 2gms of clay was suspended in each of the remaining eight cups to obtain a clay suspension. All the set ups were allowed to stand for 10days after which larvae in each cup were collected and transferred into labeled sample bottles containing 10% formalin. Larvae for each plastic cup were later identified and counted (Hopkins, 1952).

Determination of the combined effect of cup color and substrate environment on oviposition of different mosquito species

Two grams of powdered cow dung and two gm of clay were added separately to eight plastic cups each of Red, Purple, Blue and Green containing de-chlorinated water. The set up was left to stand for 10 days after which larvae were collected and transported to the laboratory in labeled sample bottles. Larvae in each plastic cup were identified and counted.

Statistical analysis

Data generated from the experiments were subjected to analysis of variance and Chi-square (X^2) test respectively using a computer statistical package for Social Scientist (SPSS). Figures and tables were drawn using Microsoft excel.

RESULT

The effect of color on oviposition by gravid female mosquitoes is shown in figure I. Most gravid female mosquitoes show preference for red colored cups than any other color. Green cups were however the least preferred by most gravid females for oviposition purposes.

However, substrate environment was found to significantly affect oviposition of different species of gravid female mosquitoes ($p<0.05$) (Table 1). Out of the total larvae recovered from all cups enriched with cow dung, *Culex nebulus* larvae were highest with mean larval recovery of 232 ± 220.9, followed by *Aedes aegypti*, *C. fatigans*, *C. trigripase* and *C. simpsoni* with mean larval counts of 125 ± 183.9, 13 ± 31.0, 6 ± 13.3 and 4 ± 14.3 respectively. However, with the exception of *A. aegypti* and *C. simpsoni* whose larvae were recorded in cups containing clay suspension as substrate environment, most of the species identified in the present study were absent.

Table 2 showed the combined effect of color and substrate environment on site selection for oviposition by different species of gravid female mosquitoes found in Zaria, Kaduna State. There was a significant preference for red cups enriched with cow dung than any other colored cup ($p<0.05$). Red cups enriched with cow dung had the highest mean larval recovery of 139 ± 18.3 followed by purple 110 ± 40.0, Green 95 ± 47.9 and Blue

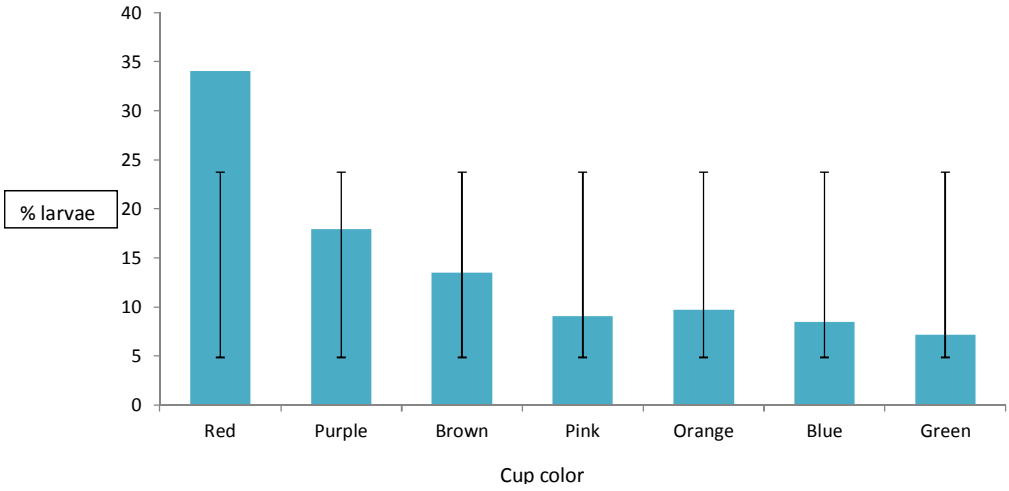

Figure 1. Percentage of mosquito larvae collected as index of oviposition in colored cups containing dechlorinated water in Zaria, Nigeria.

Table 1. Effect of substrate environment on oviposition behavior of different mosquito species in Zaria, Nigeria

Substrate Environment				
	Cow dung		Clay suspension	
Mosquito species	**No. of larvae collected**	**Mean ± SD**	**No. of larvae collected**	**Mean ± SD**
Aedes aegypti	1003	125 ± 183.9	422	53 ±15.7
Culex nebulus	1857	232 ± 220.9	0	0
C. fatigans	107	13 ± 31.0	0	0
C. simpsoni	33	4 ± 14.3	27	3 ± 11.7
C. tigripase	49	6 ± 13.3	0	0

Table 2. Combined effects of cup color and substrate environment on oviposition behavior of different mosquitoes in Zaria, Nigeria.

Substrate Environment				
	Cow dung		Clay suspension	
Colour of cup	**No. of larvae collected**	**Mean ± SD**	**No. of larvae collected**	**Mean ± SD**
Red	1,111	139 ± 18.3	96	12 ± 16.2
Purple	882	110 ± 40.0	90	11 ± 15.1
Blue	325	41 ± 18.4	105	13 ± 13.5
Green	758	95 ± 47.9	131	16 ± 20.2

with mean larval recovery of 41 ± 18.4. Significantly lower mean counts were however recorded with all colors when cow dung was replaced with clay suspension.

DISCUSSION

Many factors have been reported to affect oviposition of gravid female mosquitoes (Azzam, 1998). In addition to biotic factors such as predation and competition other component found to influence oviposition behavior in mosquitoes include light intensity, size and color of container, depth, turbidity, temperature, PH and dissolve oxygen (Collins and Blackwell, 2000). It has been shown that the presence of a particular mosquito species sometimes acts to attract gravid females of the same species as it indicates the presence of a safe and healthy pool, while at the same time repelling gravid female of other species to prevent competition (ICIPE, 2009). The absence of most mosquito species in colored cups containing only de-chlorinated water could not be unconnected with absence of cues that serve as attract-

tants to most mosquito species found in the area. Ikeshoji (1966) reported that some *Culex species* prefer highly polluted water for oviposition probably due to high population of microbes in such environment. Most importantly however, it may be due to the presence of *A. aegypti* larvae which could have serve to repel other gravid female mosquito species from ovipositing.

However, the large number of larvae collected in dark colored cups (Red, purple and Brown) containing de-chlorinated water in this study is comparable to laboratory observations of Yap *et al.*(1995) who reported *Aedes albopictus* to show preference for dark colored glass jars over light colored jars.

The significantly higher larval recovery for all species in cups enriched with cow dung is to be expected. Cow dung has been reported to contain high nitrogen content which enhances the growth of microorganisms and algae on which the larvae feeds, thus helping to accelerate larval development (Azzam, 1998; Mark, 1998; Mathew Spencer *et al*., 2002)).

According to Kaw Bing Chua *et al*. (2004), salinity and odor significantly influence the oviposition of *A. aegypti*. Although no soil analysis was conducted on the clay used as substrate environment, clay is known to be rich in inorganic minerals. It is also possible that the clay used in this study contains some conspecifics that serve as attractants to *A. aegypti* and *C. simsoni,* the only mosquito species found in cups containing inorganic substrate. It is also an indication of the ability of the two species to survive in environment poor in organic nutrient.

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