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physico-chemical parameters associated with mosquito abundance in rice farms at omor, anambra state, nigeria

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ABSTRACT

Mosquito larvae require an aquatic environment for breeding but the physico-chemical water parameters of any habitat may influence the survival and development of the species of mosquito larvae found in it. Mosquito larvae can breed in rice farms, hence rice farmers are potentially at risk of mosquito-borne diseases. A study to determine the physico-chemical parameters influencing mosquito larvae in two selected rice farms at Omor, Anambra State, Nigeria was conducted between May and August, 2017. Mosquito larvae were sampled with ladle dipper while physico-chemical water parameters (Temperature, pH, Total Dissolved Solids, Biochemical Oxygen Demand, Dissolved Oxygen, Total Suspended Solids, as well as Sulphate, Phosphate, Iron, Cadmium, Lead, Arsenic ion concentrations) were determined by standard methods. The mosquito larvae collected were reared to adult stages, and the 81 emergent adults were identified to species level using their external morphologic features. The same mosquito species were collected from both rice farms sampled but their total abundance *Culex quinquefasciatus* (46.83%), *Culex tigripes* (26.58%), *Aedes albopictus* (22.7%) *and Mansonia africana* (3.79%) was significantly different (χ^2=13.736). Mosquito abundance and physico-chemical parameters, excepting pH, TDS and Sulphate, were negatively correlated. These findings suggest that rice farmers in Omor are at risk of mosquito-borne diseases transmitted by the identified species. Since the mosquito species encountered in this study have been shown by other workers to be potential vectors of human diseases, rice-farming communities in Nigeria should be beneficiaries of mosquito-borne diseases control interventions in the country.

Keywords: Mosquito larvae, Rice Farms, Physico-chemical water parameters.

INTRODUCTION

Mosquitoes are important vectors of many tropical diseases in humans including malaria, filariasis and numerous viral diseases. There are about 3000 species of mosquitoes are distributed world-wide (Poinar *et al.*, 2000). Mosquitoes exploit almost all types of aquatic habitats for breeding. Larvae of *Anopheles* mosquitoes have been found to thrive in fresh or salt water marshes, mangrove swamps and rice fields (Oguoma and Ikpeze, 2008). The type of water required for mosquito oviposition is more or less specific to each species. Mosquito larvae are found in habitats possessing a wide range of physiochemical factors including salinity, turbidity, dissolved organic and inorganic matter, water temperature, pH and sunlight (Muturi *et al.,* 2008). *Anopheles* mosquito has been found to breed in clear water of suitable pH, temperature and nutrient composition but high water current and flooding have lead to mortality of larvae of *Anopheles* species due to reduction in oxygen tension (Okogun, 2005). Water of pH 6.8 to 7.2 is most optimal for *Anopheles* eggs to hatch but species abundance are also determined by the geographic location, water body dimensions, climate, as well as human and animal populations (Okogun *et al.,* 2003).

Rice is the most rapidly growing staple food in sub-Saharan Africa (SSA). In Nigeria rice fields are of three types. The first type is lowland rice which requires constant irrigation (Oguoma and Ikpeze, 2008) and maintained within 10-50 cm of water (Ijumba and Lindsay, 2001). The second type is upland rice grown without irrigation in areas with high rainfall. The third type is rice grown in floodplains where the rapidly elongating rice stems and panicles float on the water surface. Rice farms that are mostly stagnant water could therefore provide suitable environments for the breeding of mosquitoes that transmit malaria parasites, microfilaria and various arbo-viruses.

Yusuf and Olayemi (2015) had reported on spatial variations in physicochemical characteristics of Wetland rice fields mosquito larval habitats in Minna, North Central Nigeria. Physico-chemical parameters such as temperature, salinity, conductivity, total dissolved solids and pH have significant influence on mosquito larval abundance (Oyewole *et al.,* 2009; Mutero *et al.,* 2004). Abundance of adult mosquitoes could therefore be dependent on the number and suitability larval habitats and their proximity to human host whom the emergent adults depend on for blood meals.

There is paucity in published work from Anambra State on the influence of physico-chemical water parameters of rice fields on mosquito larvae abundance. The aim of this study was to determine influence of physico-chemical water parameters of rice fields in Omor, Anambra State of Nigeria on mosquito larval abundance.

MATERIALS AND METHODS

Study area

The study was carried out in Omor, Ayamelum Local Government Area of Anambra State. Omor, with geographical co-ordinates of latititude 6.511719ºE and longitude 6.961177ºN, has four rice-farming communities namely, Akanator, Aturi, Amikwe and Orenja. Before commencement of the study, advocacy visits were paid to rice farmers associations in the four villages to seek their permission and cooperation to work in the area.

Mosquito larval sampling and identification

Rice farms were randomly selected for larval sampling, which were carried out in the rice-planting months of May and August, 2017. Ladle was used to scoop the larvae at the sampling point of each of the selected rice farms between 8.00am and 11.00am on each sampling day. The ladle was gently dipped just below the water surface to enable larva and water to be scooped. The contents were passed through a strainer of 20 meshes/cm mosquito nylon and carefully pooled together into a plastic basin with the aid of a 3ml pipette. The larvae sampled were placed in different vials which were labeled according to the sampling points and locations of the rice farms. The larvae were reared to adulthood in the laboratory (Onyido *et al*., 2009). The adult mosquitoes that emerged into the mosquito cages were killed with Baygon® insecticide and preserved with silica gel in eppendorf tubes before being taken to the

National Arbovirus and Vectors Research Centre, Enugu for identification to species level. Identification was done using the external morphological features and Identification Keys of Gillet (1972).

Analysis of physical and chemical parameters of water from the mosquito larval habitats

Water samples were collected at the time of larval sampling in 500ml specimen bottles, 2ml of manganese sulphate solution and 2ml of alkali-iodide-azide solution added to fix the oxygen. However water temperature was determined at the sites during the larval collection using the ordinary mercury thermometer. Water depth at each mosquito breeding site was calculated using a measuring tape. The water depth at each breeding site was expressed as shallow (< 1 meter), moderate (≤ 1meter) and deep (>1metre). Water pH was measured using pH indicator while the distance from the each breeding site to the nearest human habitation was estimated by map observation.

Water samples from the different larval breeding sites in the rice farms were analyzed at the National Arbovirus and Vector Research Center Enugu according to the standard methods of APHA (Lenore *et al.,* 1989) for Salinity (%), Total Dissolved Solid (TDS), Total Suspended Solids (TSS), Biological Oxygen Demand (mg/L), Chemical Oxygen Demand (COD) and concentrations of metals ions (sulphate, phosphate, iron, cadmium, lead and arsenic).

Statistical analysis

Hypothesis testedare:

H_0: The physio-chemical parameters are depend on each other to be associated to mosquito abundance

H_1: The physio-chemical parameters are independently associated with mosquito abundance.

Data obtained were analyzed for mosquito abundance relative to physio-chemical parameters in the breeding sites using SPSS software version 20.0. The relative abundance of mosquitoes was obtained using χ^2 analysis of variables. Correlation analysis was used to determine the association between mosquito abundance and the physio-chemical parameters of rice field breeding habitats relative.

RESULTS

Distance from the nearest home to the rice farm A in Akanato was 10km, with the depth of water being 40cm (moderately deep) while the distance from the nearest home to the rice farm B in Aturi was approximately 6km, with the depth of the water being 10 cm (shallow). The mean temperature (°C) of the water body of both farms was 28.2±0.14.

Five species of adult mosquitoes identified from the larvae from the study sites comprised *Culex quinquefasciatus* (46.83%), *Culex tigripes* (26.58%), *Aedes albopictus* (22.7%) and *Mansonia africana* (3.79%).

However, the highest abundance of malaria vector was recorded in farm A (70.37%) while the least number was recorded in Farm B (29.63%). There was significant difference at χ^2 = 13.736 between the abundance of mosquitoes in farms A and B (Table 1).

Table 1: Abundance (No.; %) of mosquito species in Rice Farms sampled at Omor

Rice Farms	*Aedes albopictus*	*Culex quinquefasciatus*	*Mansonia africana*	*Culex tigripes*	Total
A	14(24.56)	30(52.63)	3(5.26)	10(17.54)	57(70.37)
B	4(18.18)	7(31.82)	0(0.00)	11(50.00)	22(27.16)
Total	**18 (22.7)**	**37 (46.83)**	**3 (3.79)**	**21 (26.58)**	**79 (100)**

(χ^2 = 13.736; P=0.01). Result is significant because P<0.05.The null hypothesis is rejected which means the physio-chemical parameters are independently related to mosquito abundance in ricefarms at Omor.

Physico-chemical properties of water samples from the rice farms are shown in Table 2.

Table 2: Physicochemical properties of water from two rice farms A and B

Parameters	Farm A	Farm B	Mean± SD
pH	6.22	6.01	6.11±0.07
°C	28.00	28.40	28.20±0.14
TDS	59.90	79.35	69.63±6.88
TSS	0.04	0.02	0.03±0.01
COD	40.80	47.55	44.18±2.39
BOD	18.01	55.49	36.75±13.25
SO_4	7.28	7.10	7.19±0.06
PO_4	0.03	0.04	0.03±0.00
Fe	0.59	0.78	0.68±0.07
Cd	0.02	0.41	0.22±0.14
Pd	0.15	0.15	0.15±0.00
Ars	0.10	0.15	0.13±0.02

The relationship existing between mean physio-chemical parameters and abundance of mosquito in Omor indicates that mosquito abundance is negatively associated with physicochemical parameters pH, Sulphate and TSS (r= -0.071; p= 0.72). Correlation analysis revealed that abundance of mosquitoes decreases with increase in physicochemical parameters.

DISCUSSIONS

Mosquito species identified from rice farms in Omor comprising *Culex quinquefasciatus, Culex tigripes, Aedes albopictus and Mansonia africana* were same with findings of Egbuche *et al.* (2016). These mosquito species are known to be vectors of pathogens that cause debilitating diseases such as *Wuchereria bancrofti* that causes lymphatic filariasis during heavy infection, and *Aedes* species that transmit yellow fever virus (Poinar *et al*., 2000). *Culex quinquefasciatus*, with highest distribution in the rice farms sampled, is responsible for the transmission of filariasis, especially Bancroftian filariasis in Africa (Amusan *et al.,* 2003). It has been reported that peak rainy season in Anambra State favours the density of *Culex* species (Obi *et al.,* 2014). This result indicated that individuals associated with the rice farms in Omor are potentially at risk of mosquito-borne diseases.The absence of Anopheline mosquitoes in the collection can be attributed to the fact that *Anopheles* spp.are mainly endophagic and endophilic (Oguoma *et al.*, 2010; Service 1980), hence tend to breed in habitats closer to human dwelling. Since the period of larval sampling was peak rainy season, flooding may have had deleterious effect on the larval population dynamics (Onyido *et al.,* 2011).

Water of a near neutral pH 6.8-7.2 was found most optimal for the weakening of the egg shells for the first instar larva stage to emerge (Okogun *et al.,* 2003) but results of this work showed a pH higher than 6.11±0.07, which suggested an increase in abundance of immature mosquito life stages, and which agrees with the work of Tadesse *et al.* (2011) that Culicine larvae were positively associated with pH of 5.86-9.85.

Culicines do not show association with water temperature, so factors other than water temperature might have played an important role in egg hatchability (Tadesse *et al.,* 2011). However, other studies have shown that *Culex quinquefasciatus* larval survival and development into adult was highest in temperature range 20-30ºC (Rueda *et al.,* 1990). The requirement of this range in which the rice farm is in between 28.2± 0.14 could be the reason for the negative association between this parameter (i.e. temperature).

According to Tadesse *et al.* (2011), Culicine species are positively associated with dissolved oxygen but in this work it was negatively associated, and this might be because larval samplingswere done at the peak of the raining season.

Results also showed that the abundance of *Culex* species were negatively associated with all the physico-chemical parameters except for pH, sulphate and TSS, which contradicts the work of Muturi *et al.* (2008) that TDS and dissolved oxygen has positive association with larval abundance. Adebote *et al.* (2008) also reported positive association with pH while Burke *et al.* (2010) observed that TDS and conductivity had negative association with larval abundance of *Culex* species, which indirectly indicated positive association with water transparency.

According to Briegel *et al.* (2001), flight distance of *Aedes albopictus* is 11-28km/night, and in *Mansonia* species it is less than 1km. This suggests that mosquitoes breeding in rice farms at Omor might be constituting nuisance in human dwellingthat are between5 to10km away from the farms; this distance being approximately the flight distance of each of the mosquito species identified.

CONCLUSION

Epidemiologically, encountered mosquito species are potential vectors of yellow fever, dengue, filariasis and encephalides. The observed anthropogenic activities and environmental conditions could be responsible for sustaining the ecology of mosquito larvae and the risk of mosquito-borne disease in the study area. These physio-chemical parameters can be manipulated to deter mosquitoes breeding. The findings of this study suggest that abiotic (Chemical and physical) factors play a significant role in larval habitat preference. Thus such factors should be considered when designing vector control program.

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