International Journal of Applied and Natural Sciences (IJANS)
ISSN(P): 2319-4014; ISSN(E): 2319-4022
Vol. 7, Issue 3, Apr - May 2018; 65-72

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

DRY SEASON ECOLOGY AND SPECIES COMPOSITION OF MOSQUITO'S FAUNA IN WHITE NILE AREA CENTRAL SUDAN

Nagwa E Azrag[1] & Mostafa M. Mahgoub[2]

[1]Department of Biology, University of Bahari, Collage of Applied and Industrial Sciences, Khartoum, Sudan

[2]Department of Medical Entomology, Blue Nile National Institute for Communicable Disease, Gezira University, Wad Medani, Sudan

[2]Department of Basic Science, Preparatory Year Deanship, Prince Sattam Bin Abdulaziz University, Alkharj Kingdom of Saudi Arabia

ABSTRACT

This study carries out in Ed Dueim town, White Nile State Sudan from April, to June 2011 to update mosquito species, their ecology, and the resting places. Three methods adopted for mosquito survey: standard dipper for the larval survey, knockdown, and aspirator techniques for adult collection. Out of 916adult mosquito collected by knockdown and aspirator collection, 591 (64.5%) were Culex univittatus, 129 (13.4%) were Culex quinquefasciatus, 144 (15.7%) were Culex antennatus, 48 (5.2%) were Anopheles arabiensis and four (0.4%) where Anopheles pharoensis. The percentages of emerged adult mosquitoes from the collected pupae were 46.8%, 41.4%, 11.2%, and 0.7% of C. univittatus, C. quinquefasciatus, A. arabiensis, and An. pharoensis respectively. Culicinae and Anopheline mosquito were be found throughout the study period, with Culexspp being more abundant. Culex univittatus was dominant over all mosquito species. Anopheles arabiensis was dominant, but A. pharoensis was rare. Jars water "Zeers" and water barrels found as resting places for mosquito species studied. The study revealed that the mosquito breeding sites were; Irrigation canals, leaking drinking water pipes, hoof print holes, cement basin. The main source of the breeding sites in was leakages of water pipes. Out of 3655, larvae collected from all breeding sites 1616 (44.2%) larvae, were collected from the latter site. All specimens of larvae and adults mosquitoes were identified morphologically in details

KEYWORDS: *Anopheles Spp, Culex Spp., Dry Seasons, Mosquito Habitats, Sudan*

Article History

Received: ***23 Apr 2018*** **|** ***Revised:*** ***05 May 2018*** **|** ***Accepted:*** ***15 May 2018***

INTRODUCTION

Mosquito-borne diseases are becoming a serious global burden. Malaria is an important mosquito-borne disease in Sudan. Sudan is one of the countries with a high malaria burden in Sub-Saharan Africa. Many recent outbreaks of mosquito-borne disease has occurred in central Sudan, including malaria, filariasis, and hemorrhagic fevers [1, 2]. The prevalence of mosquito-borne diseases are associated with flooding of the major rivers and unusual weather conditions such as heavy rain Climatic factors effect on mosquito includes precipitate, relative humidity, and temperature[3-5].

The climatic change led dramatic change in mosquito fauna in Sudan. In addition, socioeconomic factors effect on the presence of different mosquito species[6-8]. The mosquito-borne threats, White Nile state both parasitic and arbovirus diseases, they encounter the risk of border transmission of diseases due to a large border with South Sudan. Recently, many outbreaks of infectious diseases happened and a high disease burden reported for Malaria, Yellow fever (YF) and Rift valley Fever (RVF) [2, 6, 9].

Malaria still in control stage in Sudan, IRS, LIINTs and larval control. Our country belongs to malaria free-zone according to WHO 2009 which try to reduce mortality and morbidity due to malaria to a certain level. According to WHO Sudan distributed about 13.6 million LLITNS during 2014-2016. During this period, malaria burden in Sudan is estimated more than 40% [10]. The main obstacle malaria is insecticide resistance and drug resistance[11-13]. Moreover, many outbreaks of Rift Valley Fever (RVF)is reported in animal and human, followed by unusually heavy rainfall in the country with severe flooding and previous studies on suggested that RVFV is endemic in many parts of Sudan[5, 14]. An RVF outbreak results in human disease, but also large economic loss with an impact beyond the immediate influence of the directly affected agricultural producers [3, 6, 15]. However, vector sampling is the most important parameter for setting up an intervention and understanding disease dynamics endemic areas, and update of the mosquito fauna necessary to vector control and outbreak awareness[16, 17]. Although this area safer many diseases outbreaks of mosquito-borne, but little data available. Therefore, the objective of this study is to compare between different methods for collection mosquito and their distribution in Ed Dueim Town Sudan.

MATERIALS AND METHODS

Study Sites

This study was carried out in Ed Dueim town is located on the west bank of the White Nile On 130.57.34 N and 320.17.52 E from April to June 2011.The climatic condition of the White Nile is dry savannah with an estimated annual rainfall of 140– 225 mm. Relative humidity is high and fluctuates between 37 – 86%. The year divided into three seasons, rainy seasons extend from July to September, dry, cool from November to March and hot dry from April to June. The mean temperature varies between 15 - 21 Co in the cool, dry seasons and 32-42 Co in the hot, dry seasons (Sudan Meteorlogical Service, unpublished data). A population of about 295695 individuals (Department of statistics, census office, 1995) inhabits Ed Dueim and main socioeconomic activities are agriculture, animal breeding.

Study Design

Entomological surveys carried out in ED DueimduringApril, May, and June of 2011. A preliminary field survey carried out for a period of five days to locate the breeding sites and to obtain the permission of residents for knockdown collection in the selected houses. Six field surveys bi-monthly conducted five localities of the town selected for the survey. These were Al-Ingaz, Al-Salam, Abu- Gabra, Bakhtarruda, and Mabrouka. In each field survey, adult's mosquito and larval and pupal stages sampled and habitats identified.

Larval Survey

Bi-monthly entomological surveys conducted in three months. The breeding categorized as follows: irrigation channel, broken pipe, animal hoof print, barrel, building holes and Septic tank." A standard dipping method used for estimate the number of mosquito aquatic stage (1st, 2nd, 3rd, 4thand pupae). All larvae and pupae preserved at 25 ml vials with 75% alcohols for further identification.

Adult Collection

Captured *Anopheles* and *Culex* mosquitoes were classified as male or female and identified to species morphologically [18].Anopheline and Culicinae Female were be classified by abdominal status (fed, unfed, gravid, or half-gravid).

Data Analysis

The data obtained from the entomological surveys were analyzed using SPSS 17.1 software. Mean of larvae densities were been compared among the different seasons and sites using of Tukey-Kramer HSD test ANOVA. Association between habitats characters and larvae density tested using nominal logistic regression analysis.

RESULTS

Species Composition

The 4118 larval and pupae stage collected during the larval survey at period April to June 2011 in Ed Dueim. Out of collected mosquito, were being found 3655 larvae, belonged to four mosquito species as following: *Cx. Univittatus* 1470 (40.2%), *Cx. quinquefasciatus* 1293 (35.4%), *An. arabiensis*838 (22.9%)and *An. pharoensis*54 (1.5%). On the other hand916adult mosquito collected by two different techniques: knockdown (448) and aspiration (486), and identified morphological and found as following:*Culex univittatus* 591(64.5%), *Culex quinquefasciatus* 129(13.4%), *Anopheles arabiensis*, 48 (5.2%), *Anopheles pharoensis* 4(0.4%), in addition to *Culex antennatus* 144(15.7%) which found only in the adult stage.

Larval Habitats

Throughout the larval survey five types of breeding sites was report positive for aquatic stage, the significant difference was shown among larval species, as following: Irrigation canal Leakage 446 (12.2%), Hoofprints 1616 (44.2%), BWCB 825 (22.6%), and CHWAB 541 (14.8%) shown in "Table 1". Moreover were tested the impact of type of breeding site, the significant impact of breeding type on mosquitoes species was different, the most dominant of species of Irrigation canal (*Cx. univittatus*69%) Leakage (*Cx. univittatus* 58.1%), Hoofprints (*An. arabiensis* 91.18%), BWCB (*Cx. Quinque fasciatus* 79.51%), and CHWAB (*Cx. Quinque fasciatus* 93.53) Table "1"

Table "2" chi square test shows the relationship between habitats and species. The results indicate a positive association of the suitability for breeding mosquito. Moreover, the high significant association was observed between species (*P-value = 0.000*). In addition, the significant association between type of habitat and species were being observed in three type of breeding out of five.

Adult Survey

Adult mosquitoes collected from the resting sites by using knockdown aspiration techniques. Five mosquito species was captured, *Cx. univittatus, Cx quinquefasciatus, Cx antennatus, An. arabiensis,* and *An. pharoensis*. Among adult species 70% of all captured females had recently blood fed (n = 222). However, Higher proportions of fed females was *Cx. Quinquefasciatus*(95.24%) caught in resting place throughout dry seasons, which is one of the local competent vectors for West Nile virus (WNV) and other arboviruses[19]and followed by *Cx. Antennatus* (94.59%), *An. arabiensis* (84.21%), and *Cx. univittatus* (52.75%). However, the collection techniques show the variation in the collected species and their feeding status shows in Table "3"

Table 1: Number and Percentage of Larvae Collected Larvae from different Breeding Sites in Ed Dueim during April to June 2011

Type of Breeding Sites	Mosquitoes Species Larvae				
	Cx. Quinquefasciatus	*Cx. Univittatus*	*An. Arabiensis*	*An. Pharoensis*	Total (Larvae)
Irrigation canal	87 (6.26 %)	310 (21.09%)	49 (5.84 %)	0	446
Leakage	44 (3.40 %)	939 (63.89 %)	579 (69.09 %)	54 (100 %)	1616
Hoof prints	0	20 (1.36 %)	207 (24.70 %)	0	227
BWCB	656 (50.73 %)	169 (11.49 %)	0	0	825
CHWAB	506 (39.13 %)	32 (2.17 %)	3(0.004 %)	0	541
Total (Species)	1293	1470	838	54	3655
BWCB= Bath Water Collecting BasinsCHWAB= Cement Hands Washing and Ablution Basin					

Table 2: The Attractiveness of Breeding Site in Ed Duiem City during Dry Seasons 2011

Descriptive Statistics						T test		
	N	Mean	Std. Deviation	Minimum	Maximum	DF	Asymp. Sig.	Chi-Square
Species	4	2.50	1.291	1	4	3	1.000	.000[a]
Irrigation channel	4	111.5000	137.04136	.00	310.00	3	1.000	.000[a]
Water pipe Leakage	4	404.0000	435.48823	44.00	939.00	3	1.000	.000[a]
Hoofprint	4	56.7500	100.60939	.00	207.00	2	0.779	0.500[b]
BW	4	206.2500	310.23687	.00	656.00	2	0.779	0.500[b]
CH	4	135.2500	247.58753	.00	506.00	3	1.000	000[a]
BWCB= Bath Water Collecting Basins CHWAB= Cement Hands Washing and Ablution Basins								

Table 3: The Proportion between Fed and Unfed Female of Species During the Dry Seasons in Ed Duiem city 2011

Species	Feeding status			
	Fed %	Unfed %	Ratio (Fed – Unfed)	Total
Cx. univittatus	96 (52.75%)	86 (47.25%)	48:43	182
Cx. quinquefasciatus	40 (95.24%)	2 (4.76%)	20:1	42
An. Arabiensis	16 (84.21 %)	3 (15.79%)	16:3	19
Cx. antennatus	70 (94.59%)	4 (5.41%)	35:2	74

Table 3 presents the results of the bivariate multinomial regression analyses between the species and the habitats. Among the four study sites considered in the study, type of breeding site has a strong association with mosquito species. The results indicate a positive association of the suitability for breeding sites.

Table 4: Relationship between Mosquitoes Species and Habitats Type Logistic Regression Analysis

Species	*P- value*	95.0% Confidence	
		Upper	Lower
Culex Quinquefasciatus	0.001	0.002	0.005
Culex Univittatus	0.011	-.005-	-.001-
Anopheles Pharoensis	0.045	-0.070	-0.001
Anopheles Arabiensis	0.006	-0.007	-0.001

DISCUSSIONS

Mosquito-borne diseases are public health threats in White Nile State, numerous outbreaks has occurred in recent years, such as Rift valley fever, Yellow fever, and malaria, the seasonality is common features of mosquito-borne diseases in Sudan, mainly during rainy seasons and the Nile flooding, but also recorded the outbreak of malaria during dry seasons. Several factors determines the seasonality of mosquito-like temperature, relative humidity, rural and urban setting [6, 14, 20-22].

In the current study was investigating the mosquito fauna during dry seasons in Ed-Dueim town. Moreover, the ecological factor facilitates breeding mosquito during dry seasons. The following mosquito species were been recorded during this study: *Anopheles arabiensis Anopheles pharoensis, Culex univittatus, Culex antennatus,* and *Culex quinquefasciatus.Culex univittatus*is dominant over all mosquito species in the study area during the dry season, which is commonest and most widely distributed Culicine in Sudan, which is a potential vector of West Nile Virus (WNV) and Rift Valley Fever (RVF)[3, 23]. Show's high density during dry seasons due to the abundance of the breeding site, about 46.8% of a total number of emerged adult mosquito species from collected pupae from study area were this species. This indicated that this species was dominant in the town during the study period.

Moreover, the present study showed that *Anopheles arabiensis*is dominant species of Anopheline mosquitoes, which is the main vector of malaria in Sudan and agreed with many evidences showed that the most prevalent species in different regions of the Sudan [24-26]. The main outdoor resting place as reported during the dry seasons for *Anopheles arabiensis* jars and barrels during. Bite humans and animals indoors or outdoors and rest outdoors after feeding and *An.pharoensis* showed low density in dry seasons, only two females were recorded[24, 27, 28].

The survey revealed that the main source of breeding was broken of water pipes in dry seasons in the study sites. However, finding agree with other areas broken water pipe is a problem in many urban settings mainly in summer and winter, which affect directly in malaria prevalence in summer [22, 29, 30]. Within this entomological survey, higher proportions of feding females recoded by*Cx. Quinquefasciatus*(95.24%) in dry seasons, which is a potential vector of West Nile virus and lymphatic filariasis [19, 31-33].

CONCLUSIONS AND RECOMMENDATIONS

Five species of mosquitoes were been collected from Ed Dueim namely: *Culex univittatus, Culex quinquefasciatus, Culex antennatus, Anopheles arabiensis,* and *Anopheles pharoensis*. *Culex univittatus* was dominant species in study area through the dry season. Moreover, five types of mosquito breeding sites observed and the main breeding sites where water bodies resulting from leakages of water pipes. Therefore, rehabilitation and maintenance of water pipes will be an excellent measure to decrease mosquito population. Community participation is necessary to achieve effective vector control. More investigations are needed to clarify its importance as a vector, regarding its susceptibility to infection, longevity, feeding and resting behavior. In addition, recommend that further studies in Ed Dueim cover all seasons to improve mosquito control measure.

AUTHORS' CONTRIBUTIONS

NEA performed the data collection, interpreted the results, and designed the study. MMM framed, drafted, and wrote up the manuscript. All authors approved the final paper for submission.

ACKNOWLEDGEMENTS

My sincere thanks are due to the Unit of Vector Control, White Nile State, Ed Dueim, for their assistance in the fieldwork.

REFERENCES

1. *Suliman, M.M., et al., Molecular Evidence of High Proportion of Plasmodium vivax Malaria Infection in White Nile Area in Sudan. J Parasitol Res, 2016.* ***2016****: p. 2892371.*
2. *Elmosaad, Y.M., et al., Communication for behavioural impact in enhancing utilization of insecticide-treated bed nets among mothers of under-five children in rural North Sudan: an experimental study. Malar J, 2016.* ***15****(1): p. 509.*
3. *Sang, R., et al., Effects of Irrigation and Rainfall on the Population Dynamics of Rift Valley Fever and Other Arbovirus Mosquito Vectors in the Epidemic-Prone Tana River County, Kenya. Journal of Medical Entomology, 2017.* ***54****(2): p. 460-470.*
4. *Himeidan, Y.E., et al., Pattern of malaria transmission along the Rahad River basin, Eastern Sudan. Parasites & Vectors, 2011.* ***4****.*
5. *Nájera, J.A., et al., Malaria epidemics: detection and control, forecasting and prevention. 1998.*
6. *Hassan, O.A., et al., The 2007 Rift Valley fever outbreak in Sudan. PLoS Negl Trop Dis, 2011.* ***5****(9): p. e1229.*
7. *Onwujekwe, O., et al., Do malaria preventive interventions reach the poor? Socioeconomic inequities in expenditure on and use of mosquito control tools in Sudan. Health Policy Plan, 2006.* ***21****(1): p. 10-6.*
8. *Wu, X., et al., Impact of climate change on human infectious diseases: Empirical evidence and human adaptation. Environ Int, 2016.* ***86****: p. 14-23.*
9. *Seufi, A.M. and F.H. Galal, Role of Culex and Anopheles mosquito species as potential vectors of rift valley fever virus in Sudan outbreak, 2007. BMC Infect Dis, 2010.* ***10****: p. 65.*
10. *WHO, World malaria report 2015. 2016: World Health Organization.*
11. *Abdalla, H., et al., Insecticide resistance in Anopheles arabiensis in Sudan: temporal trends and underlying mechanisms. Parasites & Vectors, 2014.* ***7****.*
12. *Ismail, B.A., et al., Temporal and spatial trends in insecticide resistance in Anopheles arabiensis in Sudan: outcomes from an evaluation of implications of insecticide resistance for malaria vector control. Parasit Vectors, 2018.* ***11****(1): p. 122.*
13. *Hassan, M.M., et al., Insecticide resistance in the sand fly, Phlebotomus papatasi from Khartoum State, Sudan. Parasites & Vectors, 2012.* ***5****.*
14. *El Sayed, B.B., et al., A study of the urban malaria transmission problem in Khartoum. Acta Tropica, 2000.* ***75****(2): p. 163-171.*
15. *Seufi, A.M. and F.H. Galal, Role of Culex and Anopheles mosquito species as potential vectors of rift valley fever virus in Sudan outbreak, 2007. Bmc Infectious Diseases, 2010.* ***10****.*
16. *Wong, J., et al., Standardizing operational vector sampling techniques for measuring malaria transmission intensity: evaluation of six mosquito collection methods in western Kenya. Malar J, 2013.* ***12****: p. 143.*
17. *Kweka, E.J. and A.M. Mahande, Comparative evaluation of four mosquitoes sampling methods in rice irrigation*

*schemes of lower Moshi, northern Tanzania. Malar J, 2009. **8**: p. 149.*

18. *Hopkins, G.H.E., Mosquitoes of the Ethiopian region, I. –larval Bionomics of mosquitoes and taxonomy of Culicine larvae.. 2 ed. Vol. 2. 1952, London: British Museum (Natural History). 291.*
19. *Samy, A.M., et al., Climate Change Influences on the Global Potential Distribution of the Mosquito Culex quinquefasciatus, Vector of West Nile Virus and Lymphatic Filariasis. PLoS One, 2016. **11**(10): p. e0163863.*
20. *Musa, M.I., et al., A climate distribution model of malaria transmission in Sudan. Geospat Health, 2012. **7**(1): p. 27-36.*
21. *Gadalla, A.A.H., et al., Associations between Season and Gametocyte Dynamics in Chronic Plasmodium falciparum Infections. Plos One, 2016. **11**(11).*
22. *Mahgoub, M.M., E.J. Kweka, and Y.E. Himeidan, Characterisation of larval habitats, species composition and factors associated with the seasonal abundance of mosquito fauna in Gezira, Sudan. Infect Dis Poverty, 2017. **6**(1): p. 23.*
23. *Uejio, C.K., A. Kemp, and A.C. Comrie, Climatic Controls on West Nile Virus and Sindbis Virus Transmission and Outbreaks in South Africa. Vector-Borne and Zoonotic Diseases, 2012. **12**(2): p. 117-125.*
24. *Haridi, A.M., Partial exophily of Anopheles gambiae species B in the Khashm Elgirba area in eastern Sudan. Bull World Health Organ, 1972. **46**(1): p. 39-46.*
25. *Kumar, Ashutosh, Et Al. "Mosquito A Global Threat: Control By Herbal Approach."*
26. *Petrarca, V., et al., Cytogenetics of the Anopheles gambiae complex in Sudan, with special reference to An. arabiensis: relationships with East and West African populations. Med Vet Entomol, 2000. **14**(2): p. 149-64.*
27. *Omer, S.M. and Cloudsle.Jl, Dry Season Biology of Anopheles Gambiae Giles in Sudan. Nature, 1968. **217**(5131): p. 879-&.*
28. *Dandalo, L.C., et al., Population Dynamics and Plasmodium falciparum (Haemosporida: Plasmodiidae) Infectivity Rates for the Malaria Vector Anopheles arabiensis (Diptera: Culicidae) at Mamfene, KwaZulu-Natal, South Africa. Journal of Medical Entomology, 2017. **54**(6): p. 1758-1766.*
29. *Mala, A.O., et al., Plasmodium falciparum transmission and aridity: a Kenyan experience from the dry lands of Baringo and its implications for Anopheles arabiensis control. Malaria Journal, 2011. **10**.*
30. *Mahgoub, M.M. and N.E. Azrag, Impact of Attitude and Knowledge of Insecticide Safety Household and Spray-Men on Gambiae Control Project Area Northern State, Sudan. International Journal of Zoology and Research (IJZR), 2018. **8**(1): p. 10.*
31. *El Sayed, B.B., et al., A study of the urban malaria transmission problem in Khartoum. Acta Trop, 2000. **75**(2): p. 163-71.*
32. *Elimam, A.M., K.H. Elmalik, and F.S. Ali, Larvicidal, adult emergence inhibition and oviposition deterrent effects of foliage extract from Ricinus communis L. against Anopheles arabiensis and Culex quinquefasciatus in Sudan. Tropical Biomedicine, 2009. **26**(2): p. 130-139.*

33. *Irish, S.R., et al., Evaluation of gravid traps for the collection of Culex quinquefasciatus, a vector of lymphatic filariasis in Tanzania. Trans R Soc Trop Med Hyg, 2013.* ***107****(1): p. 15-22.*

34. *WHO position statement on integrated vector management to control malaria and lymphatic filariasis. 2011/03/29 ed. Wkly Epidemiol Rec. Vol. 86. 2011. 121-7.*