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Diversity and Composition of Mosquito Species in North Kosti Town, White Nile state, Sudan

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Abstract

Three genera of medically important mosquitoes are found in the Sudan (Anopheles, Culex and Aedes). This study was conducted in north Kosti town, White Nile State, Sudan, from July to October 2021 at autumn season to determine the diversity of Anopheles species in north Kosti Town, White Nile State, Sudan. Immature stages were reared to the adult stage and identified. Immature stages of mosquitoes were collected by the dipping method from the study area. The results revealed that the dominant adult species were Anopheles gambiae complex followed by An. Rufibesand An. pharoensis. Additional studies were recommended to be carried out to update mosquito species in other areas habitats of White Nile State.

Keywords: Mosquito Species, North Kosti Town, White Nile state, Sudan

INTRODUCTION:

Three genera of medically important mosquitoes are found in the Sudan (*Anopheles, Culex*and*Aedes*). A total of 156 species, two subspecies and seven varieties of Culicidae have been recorded in the Sudan [1]. These include 28 species and three varieties of *Anopheline*mosquitoes; 33 species and one variety of *Aedes*, 45 species and two variety of the genus *Culex*[1,2].

The subsequent genetic studies (crossing experiments) revealed that the only member of *An. gambiae* found in central Sudan was *An. gambiae* species B. This was followed by cytotaxonomy studies which showed that *An. gambiae* was the only malaria vector in central Sudan [3]. It is considered a species of dry, savannah environment and

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sparse woodland. Its larval habitats are small, temporary, sunlit, clear and shallow fresh water pools [4,5]. However, *An. pharoensis* is widely distributed in Ethiopia, Somalia and in the Sudan and also extends into Egypt [6] It plays a role as a potential vector of malaria in the Sudan [7] .

Mosquitoes in the southern region of the Sudan include *Anopheles gambiae, An. funestus, An. rufipes, An. squamosus, An. pharoensis, An. rupicolus, An. pretoriensis, An. dthali, An. Ziemanni,* [1]. The objective of this study was to determine the diversity of mosquitoes species composition in north Kosti, White Nile State, Sudan.

MATERIALS AND METHODS:

Study design

The study was carried out during the period of July to October 2021 at autumn season to determine the diversity and composition of mosquitoes species in north Kosti Town, White Nile State, Sudan.

Study area

This study was carried out in north Kosti town, in the White Nile State of Sudan. Kosti town is located in Central Sudan. It lies between longitudes (13° 12' -13° 40'E) and between latitudes (13° 39' – 13° 45' N), and at altitude 382 m above sea level. It has a long rainy season which lasts for five months (June-October). The mean annual rainfall is 600 mm; the monthly mean temperature is 22.5°C in winter and 34.5°C in summer and the mean annual relative humidity is 55% [8].

Collection of mosquito larvae:

Larvae were collected from the breeding sites in the residential area; Larvae were surveyed inside and outside the houses. Collection was carried out in the morning hours. Sampling was collected every day after day during the period of study (from July to October 2021); fifteen time at any month. Larvae were collected by the dipping method which was described by [9]. The dipper was lowered gently at an angle of about 45° until one site is just below the water surface. While dipping, care was taken not to disturb the larvae to prevent them to swim downwards. The surface of the water was skimmed with the dipper, then, the dipper was left out of the water and poured in a white tray containing some water. Size of the dipper, number of dipping and method and scooping were kept uniform throughout the study period. Three replicates of dipping were carried out at each site. Larvae and pupae of each dip were counted and recorded according to their instars and habitats and placed in containers containing water volume of about 800 ml. The containers were covered by gauze prior to keeping at 28 – 30°C. Each sample was labeled indicating date and site of collection.

Rearing of mosquitoes

It is often necessary to breed mosquitoes to the adult stage for the purpose of identification. Larvae were kept in water, to assist successful development to the adult stage [10]. Very small amount of rice were added to the water with larvae in trays for feeding. Water in trays was daily changed by clean water and rice. The pupae were sorted out by pipette and put in paper-cups of tea with netting; each fifty pupae in one cup were placed into cages (75×75×75 cm) with fine mesh, and used cotton impregnated with sugar solution inside the cages for adult feeding. After mosquito adult emergence,

they were collected by an aspirator and put in nylon bags and exposed for a few minutes to direct sunlight at ground level or put in a deep freezer for the purpose of killing them. They were kept in clean dry test tubes and covered by cotton wool until identified.

Identification of adult mosquitoes:

Adult mosquitoes were identified under a dissecting microscope according to [11],[12], [13], [14], [15], [16] and [17] methods. The identified adults were recorded according to the genera and species. Adults collected were identified by morphological characters using the *Anopheles* mosquito keys of the Sudan for larvae and adults [18, 19].

Statistical analysis:

Data collected from different habitats were entered using Microsoft excel data sheet and were analyzed using SPSS version 20 (Armonk, NY: IBM Corp). Chi squire test was used to compare the difference in frequency of malaria prevalence.

RESULTS:

Prevalence of immature stages of mosquitoes in north Kosti town:

Table 1: Total and percentage number of immature stages of mosquitoes in autumn of 2021 in Kosti town.

	Sum	%
Larva 1	1484	36.41
Larva 2	697	17.10
Larva 3	717	17.59
Larva 4	700	17.17
Pupa	478	11.73
Total	4076	100

The total number of immature stages during autumn in Kosti was 4076. The highest number of larvae was that of the first instar (1484 larva) with percentage (36.41*%*) while the lowest was that of the pupa stages (478 pupa), with percentage (11.73%).

Table 2: Total and percentage number of immature stages of mosquitoes among the different months of 2021 in Kosti town.

		Sum	%
July			
	Larva 1	424	45.44
	Larva 2	206	22.07
	Larva 3	115	12.35
	Larva 4	77	8.25
	Pupa	111	11.89
	Total	933	100
August			
	Larva 1	559	46.85
	Larva 2	199	16.68
	Larva 3	212	17.77
	Larva 4	138	11.57
	Pupa	85	7.13
	Total	1193	100
September			
	Larva 1	342	26.99

	Larva 2	179	14.13
	Larva 3	257	20.29
	Larva 4	269	21.23
	Pupa	220	17.36
	Total	1267	
October			
	Larva 1	159	23.28
	Larva 2	113	16.54
	Larva 3	133	19.47
	Larva 4	216	31.63
	Pupa	62	9.08
	Total	683	

In July the total number of immature stages in Kosti was (933 larvae). The highest number of larvae was that of the first instar (424larva) with percentage (45.44*%*) while the lowest was that of the four instars (77 larvae), with percentage (8.25 %).

In August the total number of immature stages in Kosti was (1193larvae). The highest number of larvae was that of the first instar (559 larvae) with percentage (46.85 *%*) while the lowest was that of the pupa stages (85 pupa), with percentage (7.13 %).

In September the total number of immature stages in Kosti was (1267 larvae). The highest number of larvae was that of the first instar (342 larva) with percentage (26.99) while the lowest was that of the second instars (179 larvae), with percentage (14.13 %).

In October the total number of immature stages in Kosti was (683 larvae). The highest number of larvae was that of the four instar (216 larva) with percentage (31.63 %) while the lowest was that of the second instars (62 larvae), with percentage (9.08 %) (Table2).

Table 3: Total and percentage number of adult mosquito species (♀and ♂) it was collected on Julyof 2021 in Kosti town.

	Sum	%
*An. gambiae*complex female	439	42.75
*An. gambiae*complex male	518	50.43
An. rufipes female	10	0.97
An. rufipes male	9	0.88
*An. pharoensis*female	11	1.07
*An. pharoensis*male	14	1.36
Cx. quinquefasciatus female	13	1.27
Cx. quinquefasciatus male	13	1.27
Cx. univittatus female	0	0.00
Cx. univittatus male	0	0.00
Cx. pipiens female	0	0.00
Cx. pipiens male	0	0.00
Total	1027	

In July *An. gambiae*complex male were collected with high number (439, 42.75%), the lowest number was that of *An. rufipes* male (9, 0.88%), and the other species was collected at this month were that of the *An. Pharoensis* female (11, 1.07%), *An. pharoensis*male (14, 1.36%), *Cx. quinquefasciatus* female (13, 1.27 %) and *Cx. quinquefasciatus* male with number (13, 1.27 %) (Table 3).

Table 4: Total and percentage number of adult mosquito species (♀and ♂) collected on August of 2021 in Kosti town.

	Sum	%
*An. gambiae*complex female	372	29.79
*An. gambiae*complex male	313	25.06
An. rufipes female	3	0.24
An. rufipes male	15	1.20
*An. pharoensis*female	16	1.28
*An. pharoensis*male	16	1.28
Cx. quinquefasciatus female	170	13.61
Cx. quinquefasciatus male	179	14.33
Cx. univittatus female	71	5.69
Cx. univittatus male	45	3.60
Cx. pipiens female	27	2.16
Cx. pipiens male	22	1.76
Total	1249	

In August *An. gambiae*complex female were collected with high number (372, 29.79%), the lowest number was that of *An. rufipes* female (3, 0.24%), and the other species was collected at this month were that of the *An. pharoensis*female (16, 1.28%), *An. pharoensis*male (16, 1.28%), *Cx. quinquefasciatus* female (170, 13.61 %) and *Cx. quinquefasciatus* male with number (179, 14.33%), *Cx. univittatus* female (71, 5.69%), *Cx. univittatus* male (45, 3.60%), *Cx. pipiens* female (27, 2.16) and *Cx. pipiens* male (22, 1.76) (Table 4).

Table 5: Total and percentage number of adult mosquito species (♀and ♂) collected on Septemberof 2021 in Kosti town.

	Sum	%
*An. gambiae*complex female	361	27.00
*An. gambiae*complex male	368	27.52
An. rufipes female	6	0.45
An. rufipes male	8	0.60
*An. pharoensis*female	6	0.45
*An. pharoensis*male	6	0.45
Cx. quinquefasciatus female	246	18.40
Cx. quinquefasciatus male	183	13.69
Cx. univittatus female	57	4.26
Cx. univittatus male	43	3.22
Cx. pipiens female	31	2.32
Cx. pipiens male	22	1.64
Total	1337	

In September *An. gambiae*complex male were collected with high number (368, 27.52%), the lowest numbers was that of *An. rufipes* female, *An. pharoensis*female and *An. pharoensis*male each of these species of Anopheles has been recorded with (6, 0.45 %), and the other species was collected at this month were that of the *Cx. quinquefasciatus* female (246, 18.40 %) and *Cx. quinquefasciatus* male with number (183, 13.69%), *Cx. univittatus* female (57, 4.26%), *Cx. univittatus* male (22, 1.64%) (22, 1.76) (Table5).

Table 6: Total and percentage number of adult mosquito species (♀and ♂) collected on Octoberof 2021 in Kosti town.

	Sum	%
*An. gambiae*complex female	249	36.30
*An. gambiae*complex male	204	29.74
An. rufipes female	13	1.90
An. rufipes male	11	1.60
*An. pharoensis*female	4	0.58
*An. pharoensis*male	9	1.31
Cx. quinquefasciatus female	117	17.06
Cx. quinquefasciatus male	0.00	0.00
Cx. univittatus female	35	5.10
Cx. univittatus male	16	2.33
Cx. pipiens female	15	2.18
Cx. pipiens male	13	1.90
Total	686	

In October *An. gambiae*complex female were collected with high number (249, 36.30%), the lowest numbers was that of *An. pharoensis*female (4, 0.58 %), and the other species was collected at this month were that of the *An. rufipes* female (13, 1.90), *An. rufipes* male (11, 1.60), *Cx. quinquefasciatus* female (117, 17.06%), *Cx. univittatus* female (35, 5.10%), *Cx. univittatus* male (16, 2.33%), *Cx. pipiens* female (15, 2.18) and*Cx. pipiens* male (13, 1.90) (Table 6).

DISCUSSION

Mosquito survey is a prerequisite to evaluate mosquito-borne diseases incidence in a community. Such survey shows the relative abundance of various species present at any given time. A study was carried out in north Kosti town, White Nile State, in autumn of 2021 to determine the mosquito species composition in the study area.

The study explained that the prevalence of malaria was more in females than the males; this finding was disagree with [20] who indicated that malaria infections were more prevalent in malesthan in females. Similar studies indicated that males were more infected with malaria than females in differentpart of Ethiopia[21, 22].

From this study was found the prevalence of malaria was moreprevalent in individuals above the age group more than 41.This is in agreement with a retrospective study conducted in Ethiopia [23, 24]. This age group was considering productive ages are activelyin the evening, which makes them vulnerable to outdoorAnopheles mosquito biting. Similarly, different reports indicated that outdoor activities in the evening contributed to high malaria transmission [20] mainly due to the fact that individualswith outdoor activities are exposed to outdoor biting by Anopheles mosquitoes [25].

In contrast, lower prevalence of malaria was reported in children less than 10 years of age. This finding agrees with [26] who work in guinea and found the prevalence was low in children under 5 years age. The observed lower prevalence of malaria in children under 10 years of age might be because of their less likely exposure to infected mosquito bite due to good awareness and practices of their parents/care takers on malaria control and prevention activities. In addition, the partially acquired immunity developed during childhood in such high malaria transmission area might have a protective role in this age group.

The presence of mosquito larvae differed significantly among the different months at autumn. These differences could result in seasonal transmission pattern of mosquito-borne diseases in White Nile State. The highest densities of immature stages of mosquitoes were recorded in September. This finding agrees with that of[27] who found the highest densities of larvae in the same area during the rainy season. [28] reported that during the rainy season, areas of rain-dependent agriculture have provision of ideal aquatic habitats that support high density of diverse mosquito species. The lowest density of immature stages was found in October this finding agree with [29] who found the lowest density of population in June, although, the peak of density of larvae occurred at the mid of the rainy season in September. He added that this may be explained by shortage of breeding sites due to completely evacuation of water from irrigation canals and relatively from broken pipes.

The first instar larvae were recorded with a high density during the study period, several breeding habitats were observed that resulted from the water of rain and water of broken pipes. Since the immature stages were sampled in the morning hours, it is assumed that hatching occurs in the morning hours. The peak density of larvae occurred at the mid of the rainy season in September [29], but the low prevalence of mosquito densities was during dry seasons which could be attributed to fluctuation of temperature [27, 30].

In the current study, adult *Anopheles* species reported included *An. gambiae*complex, *An. pharoensis*, and *An.rufipe*s and *Culex* species included *Cx. quinquefasciatus*, *Cx. univitattus*, and *Cx. pipien.* The prevalence of these species confirms the findings of many authors who conducted studies in Sudan including White Nile State [1, 31-34]. *An. gambiae*complex is apparently the sole vector of malaria in Kosti according to [34]. This species was found dominant in the study areas.*An. gambiae* complex was considering the main vector species of malaria disease in Kosti town.

Anopheles pharoensis which was recorded in study area is widely distributed in Ethiopia, Somalia and the Sudan and also extends into Egypt [6]. This species is reported in many part of Sudan [1,2, 27, 29]. It is a potential vector of malaria in the Sudan[7]. *An. rufipes* was found with low density during autumn. It was reported from Elmanagil by [29] and from Elgadrif by[5]. They explained that this species is not incriminated in malaria transmission because of its little contact with man. This was confirmed by [2] who mentioned that these species are of no importance in transmission of malaria because of their predominant zoophilic tendencies coupled with very low densities even during the rainy season. In conclusion, the most dominant Anopheles species in the study areas was *An. gambiae* complex and the most dominant, followed by *An. rufibes* and *An. pharoensis*.

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