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Research Article

Studies on the Larval Habitats and Distribution of Anopheline Mosquitoes (Diptera: Culicidae) in Elgenaina Locality - West Darfur State (May 2016 to April 2017)

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Abstract

Mosquito-borne diseases are becoming a serious global burden. The objective of the study purposed to determine anopheline mosquito fauna in Elgenaina locality, West Darfur State. Across-sectional entomological surveys were run during April 2016 to March 2017 to determine some aspect on ecology of anopheline mosquitoes in Elgenaina locality, West Darfur State. Randomly selection of the stations was conducted, larval habitats were surveyed, fully described, and hence density of anopheline larval in each habitat was recorded using standard dipping method (WHO, 1992). Larvae from these habitats were also being sampled, preserved in 70% ethanol in appendorff tubes for species identification. In addition, larvae were taken to the insectary and reared to adult for species identification. The results showed that, from 667 larvae collected; a number of 260 larvae were identified (39%). From 260 identified a number of 244 were identified as *An. arabiensis* (93.8%), 17 (6.5%) were *An. rufipse* and 1 (0.4%) were *An. phareoensis*. The mean total of water pipe leakage was significantly greater in rainy season (25.9) compared to dry season (10.4). The high mean total of swamp was significantly increased in rainy season (55.3) compared to 17.8 in dry season. The mean total of early instar mosquito larvae was significantly greater in rainy season compared to dry season. In addition, late instar mosquito larvae was significantly greater in rainy season versus dry season. It was clear that, *An. arabiensis* was the common *Anopheles* species found in the different sentinel sites of Elgenaina City, West Darfur State followed by *An. rufipse* and *An. phareoensis*. This study recommends applying of larval source management during dry season to reduced habitats of anopheline larvae. In addition to maintenance of leakage water pipes or modernization of water net lines.

Keywords: *Anopheline Mosquito; West Darfur State; Sudan*

Introduction

Malaria exerts excessive continuous huge public health burden in most of developing poor countries [1]. Currently, the disease burden is estimated at 45.6 million DALYs (disability-adjusted life years) [2]. Hence, it has been identified as a key contributor to weak economic growth and investment in Africa because it experiences the most intense malaria transmission in the world [3]. Likewise, malaria causes

high morbidity and mortality in Sudan. It is estimated that 9 million cases, 44,000 deaths due to malaria infection in the country [4]. *Anopheles arabiensis* the member of *An. gambiae* complex is the only malaria vector and in other part of Sudan [5]. This species is the most widespread member of *An. gambiae* complex, endemic throughout most of the Afrotropical region, extending northwards along the River Nile to 20°N in Sudan [6]. Moreover, this species has been found breeding throughout the year in different types of breeding sites including the temporary flood pools created by the Nile River during the flood season when mosquito densities reach their highest level [7]. The recent Malaria Indicator Survey (MIS) indicated malaria prevalence in Western Darfur State less than 10% [8].

Aim of the Study

The present study aimed to obtained information on fauna, distribution and larval habitats of anopheline mosquitoes provide baseline data on the species prevailing in the area, their seasonal geographical abundance, and the preferred breeding sites.

Materials and Methods

Study design and study area

A cross sectional descriptive study was conducted in Elgenaina locality, West Darfur State (13 44 35o′ N, 30o 22 44 52 28′ E). The area located at the western Sudan, almost about 1200 km west of Khartoum. The landscape is flat but in many areas but interrupted with small hill and seasonal khors. The ground on many part of the state is rocky. However, more sand and silt soils are dominant in the area. The climate of the area characterized by extreme temperatures with its maximum reaches 47°C in summer (May to August). The mean monthly temperature of around 43°C and the minimum temperature is 7 - 10°C in winter (December to February). The rainy season starts in late July and lasts in mid-September and the precipitation varies from 150 mm in the northern part to 750 mm at southern part of the area. The majority of the resident in the area, live in typical African huts constructed wood and grasses. Whereas few of them live in houses constructed of mud walls that roofed with dry grasses and iron roof.

Sampling techniques and sample size

Four sites Elgenaina town were selected namely ardamata, Umdwain, Alshati and Albuhaira. all larval habitats were surveyed possible numbers of immature stages were sampled to determine larval density, and for species identification and well as for rearing in the insectary. Moreover, in each area, 8 - 10 rooms were sprayed every month during the study to collect wild adult anopheline. In addition, the possible numbers of different resting places were surveys to collect adult mosquitoes.

Specimen rearing and identification

For identification of species, only the 4th larval instars was selected and then identified morphologically to species level using proper anopheline mosquito entomological keys [9,10]. Moreover, the emerged adult *Anopheles* from the colony-reared mosquitoes as well as the wild field-collected ones from different sites were identified based on morphological features using proper entomological keys [11,12].

Data collection and analysis

Larval collection

Regular monthly surveys were conducted for larvae and wild adult sampling. Standard dipping using enamel bowls was employed for sampling larvae from possible sites. At least 10 dips were made in each larval habitat examined. Eight well-trained personnel [13] did larval surveys for 3 days/month.

Adult collection

Adult mosquitoes were collected from different habitats by knockdown method and possible resting places by hand catches (aspirator). The knockdown was done early in the morning between 06:00 - 08:00 am. In each site, 8 - 10 rooms every month were sprayed [13].

Data analysis

The data was analyzed using SPSS software ver. 20. Descriptive test was used to analyze data of mosquito fauna. Analysis of variance (ANOVA) was used to compare abundance of anopheline mosquitoes in months, locations and habitats.

Results

Types of breeding sites in Elgenaina city

Table 1 shows the mean total of water pipe leakage was significantly greater in rainy season (25.9) compared to dry season (10.4), $p < 0.05$. High mean of water leakage pipe during dry season was recorded in Ardamat sentinel site while the lowest mean was recorded in Alshati and Albohaira sentinel site (3.7). The high mean of water leakage pipe during rainy season was recorded in Umdwain sentinel site and the lowest one was observed in Albohaira sentinel site (7). However the also the high mean total of swamp was significantly increased in rainy season (55.3) compared to 17.8 in dry season, $p< 0.05$. While the high mean of swamp was reported in Ardamata during dry season (16.4) and the lowest mean was reported in Umdwain (9.2). While the high mean of swamp in rainy season was reported in Ardamat (52) and the low mean was achieved in Albohaira (25).

Season	Sentinel site	No. of water pipe leakage	No. of swamp
Dry	Ardamata	12.8 ± 5.4	16.4 ± 7.4
	Umdwain	5. 9 ± 2.5	9.2 ± 4.1
	Alshati	3. 7 ± 1.6	9.4 ± 3.9
	Albohaira	3.7 ± 1.8	9.3 ± 4.5
	Total	10.4 ± 2.7	17. 8 ± 4.4
Rainy	Ardamata	17.0 ± 3.6	52.0 ± 7.1
	Umdwain	25.0 ± 6.1	32.3 ± 5.0
	Alshati	15. 7 ± 2.9	29.0 ± 6.1
	Albohaira	7.0 ± 1.5	25.0 ± 7.7
	Total	25.9 ± 5.8	55.3 ± 12.6
P-value (ANOVA)		.009*	.001*

Table 1: *Mean of water pipe leakage and swamps during dry and rainy season in Elgenaina City, West Darfour State, 2017.*
**P-Value significant at less than 0.05 levels*

Densities of mosquito's larvae in Elgenaina City

Table 2 indicates the mean of early instars and late instars mosquito larvae collected from different sentinel sites of Elgenaina City. The mean total of early instar mosquito larvae was significantly greater in rainy season compared to dry season (37.1:10.7), $p < 0.05$. And

also late instar mosquito larvae was significantly greater in rainy season versus dry season (41.4:13), $p < 0.05$. The high mean of early instars larvae during dry season was recorded in Ardamata (9) followed by Umdwain (8.7), while the high mean of early instars larvae during rainy season was recorded in Ardamata (35.3) followed by Umdwain (33.7). The high mean of late instars mosquito larvae during dry season was recorded in Ardamata (20.2) followed by Alshati (8.1), while the high mean of late instars observed during rainy season was 33.7 in Ardamata.

Sentinel site	Season	No. of early instars larvae	No. of late instars larvae
Ardamata	Dry	9.0 ± 3.1	20.2 ± 5.4
	Rainy	35.3 ± 6.2	33.7 ± 4.3
	Total	15.6 ± 5.2	23.6 ± 5.6
Umdwain	Dry	8.7 ± 2.4	6.4 ± 2.1
	Rainy	33.7 ± 5.8	23.7 ± 5.3
	Total	14.9 ± 4.5	10.7 ± 3.2
Alshati	Dry	5.0 ± 2.3	8.1 ± 3.7
	Rainy	25.7 ± 6.0	19.0 ± 3.5
	Total	10.2 ± 1.2	10.8 ± 1.4
Albohaira	Dry	6.5 ± 1.3	3.8 ± 1.1
	Rainy	13.0 ± 1.1	18.0 ± 2.2
	Total	8.2 ± 1.3	7.3 ± 1.5
Total	Dry	10.7 ± 1.2	13.0 ± 2.1
	Rainy	37.1 ± 4.2	41.4 ± 2.7
P-value (ANOVA)		.010*	.001*

Table 2: *Mean of Early and late instars mosquito larvae in different sentinel sites of Elgenaina City, West Darfour State, 2017.*
**: P-Value significant at less than 0.05 levels.*

Distribution of Adult *Anopheles* species in Elgenaina City

Table 3 shows the distribution of adult *Anopheles* species in Elgenaina City. From 658 adult mosquito collected a number of 318 were identified (48.3%) and from 318 identified a number of 311 adult mosquito identified as *An. arabiensis* (97.8%) followed and 7 adult mosquito *An. rufipse* (2.2%). High percent of *An. arabiensis* identified was recorded in Alshati (100%) and Ardamata (98.1%). High percent of *An. rufipse* was recorded in Albohaira (5.7%).

Sentinel site	No. collected adult	No. adult identified	% adult identified	*An. arabiensis*	*An. Rufipese*	*An. phareoensis*
Ardamata	488	210	43.0	206 (98.1%)	4 (1.9%)	0 (0.0%)
Umdwain	29	24	82.8	23 (95.8%)	1 (4.2%)	0 (0.0%)
Alshati	89	49	55.1	49 (100%)	0 (0.0%)	0 (0.0%)
Albuhaira	52	35	67.3	33 (94.3%)	2 (5.7%)	0 (0.0%)
Total	658	318	48.3	311 (97.8%)	7 (2.2%)	0 (0.0%)

Table 3: *Distribution of adult Anopheles species in different sentinel sites of Elgenaina City, West Darfour State, 2017.*

Distribution of larvae of *Anopheles* species in Elgenaina City

Table 4 shows that from 667 larvae collected a number of 260 larvae were identified (39%). From 260 identified a number of 244 were identified as *An. arabiensis* (93.8%), 17 (6.5%) were *An. rufipse* and 1 (0.4%) were *An. phareoensis*. High percent of *An. arabiensis* were identified in Umdwain (100%) and high percent of *An. rufipse* was found in Albuhaira (16.4%). However, *An. phareoensis* was found in Alshati (1.4%).

Sentinel site	No collected larvae	No. larvae identified	% larvae identified	*An. arabiensis*	*An. Rufipes*	*An. phareoensis*
Ardamata	283	70	24.7	65 (92.9%)	5 (7.1%)	0 (0.0%)
Umdwain	129	65	50.4	65 (100%)	0 (0.0%)	0 (0.0%)
Alshati	130	70	53.8	66 (94.3%)	3 (4.3%)	1 (1.4%)
Albuhaira	125	55	44.0	48 (87.3%)	9 (16.4%)	0 (0.0%)
Total	667	260	39.0	244 (93.8%)	17 (6.5%)	1 (0.4%)

Table 4: *Distribution of Anopheles larvae species among larvae identified in different sentinel sites of Elgenaina City, West Darfur state, 2017.*

Discussion

In many parts of the world, larval control through source reduction and routine application of larvicides considered as a key intervention in eradicating malaria [14]. Larval control measures intended to reduce malaria transmission by preventing propagation of mosquito vectors and subsequently reducing human vector pathogen contacts [15,16]. Control of larval mosquito populations is often advantageous because the larvae are usually concentrated, relatively immobile, and often readily accessible. Moreover, mosquito larvae unlike adults cannot change their habitat to avoid control activities [16]. The present study found that the mean total of water pipe leakage was significantly greater in rainy season compared to dry season. This may be due to increased water from ground water during rainy season, which increased pressure for water network that lead to leakages or broken of pipes. The finding of the study consistent with the fact that habitats of *An. arabiensis* are often created by activities of human or domestic animals [17]. Similar finding obtained by she found that broken pipe leakage (23.95%) in a survey of Blue Nile State [18]. Moreover, the study indicated that the high mean total of swamp was significantly increased in rainy season compared to dry season. This may be returned to the increasing the level of water during rainy season composed the swamp habitats in the study area. From previous literature, leakages water pipes and swamp were preferred habitats for anopheles mosquito. The predominance of *An. arabiensis* in the swamp was similar to earlier results [19]. The study revealed that the mean total of early instar mosquito larvae was significantly greater in rainy season compared to dry season and also late instar mosquito larvae was significantly greater in rainy season versus dry season. This may be mosquito larval habitats were significantly more and diverse during the rainy season than the dry season. This may not be unrelated to the fact that virtually all the larval habitats identified during the rainy season had dried up following the stoppage of rains. The rainy season is known to be associated with abundant rainfall and flooding, supporting the growth and development of aquatic larval stages and abundant recruitment of young adults. A similar finding was reported by Okogun., *et al.* [20] working in Midwestern Nigeria and Onyido., *et al* [21]. Variations in number of larvae in the study may be due to differences in mosquito densities between dry and rainy seasons, which could be attributed to the availability of water and fluctuations in temperature and relative humidity as mentioned by different previous literature [22-24].

Our study showed that *An. arabiensis* was the predominant species in the study area followed by *An. rufipse* and *An. phareoensis*. Other study showed that *An. arabiensis* is currently the only known malaria vector mosquito in Northern and Central Sudan [4]. Also, similar findings obtained by [25-27] who stated that, *An. arabiensis* prevailed in some localities in arid savanna zones, as expected, but it also was

the prevalent species in some forest zones. Studies of malaria transmission in Tanzania confirmed that *An. Arabiensis* are most commonly involved in malaria transmission in Tanzania [28]. However, *An. Arabiensis* is the dominant *Anopheles* species in Sudan (and was considered the main malaria vector in the country) [5,29].

Conclusion

In conclusion, it was clear that, *An. arabiensis* was the common *Anopheles* species found in the different sentinel sites of Elgenaina City, West Darfur State followed by *An. rufipse* and *An. phaeroensis*. This study recommends applying of larval source management during dry season to reduced habitats of anopheles larvae. In addition to maintenance of leakage water pipes or modernization of water net lines.

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