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Mosquito species composition in White Nile state, Sudan

EGBAL BASHIR IBRAHIM ELMALIH
Department of Public Health
Faculty of Medicine and Health Sciences
University of El Imam El Mahdi, Kosti city, Sudan
SHAWGI MOHAMED HASSAN[1]
Department of Parasitology, Faculty of Veterinary Medicine
University of Khartoum, Khartoum city, Sudan

Abstract:

Three genera of medically important mosquitoes are found in the Sudan (Anopheles, Culex and Aedes). This study was conducted in Kosti and Jabalain towns, White Nile State, Sudan, during August to December 2015, to determine species composition of mosquitoes in different breeding habitats. Immature stages were reared to the adult stage and identified. Immature stages of mosquitoes were collected by the dipping method, from three residential areas in the two towns. Immature stages from the same habitats were reared ***to*** *the adult stage for identification purposes. The results revealed that the dominant adult species were Anopheles gambiae complex followed by Culex quinquefasciatus and Cx. univittatus. An. gambiae complex were higher in Jabalain (28.3±2.2) than in Kosti (10.7±1.1) while Cx. quinquefasciatus was higher in Kosti (8.4±101) than in Jabalain (0.7±0.3). Other species recorded in low numbers in a descending order were Cx. theileri, Cx. pipiens, An. pharoensis, An. rufipes, An. funestus, An. squamosus, Cx. duttoni, Aedes unilineatus and Ae. aegypti. Additional studies are recommended to be carried out to update mosquito specie in other areas habitats of White Nile State.*

[1] Corresponding author: shawgimhassan64@hotmail.com

Key words: Breeding habitats, Dipping method, Mosquitoes species, 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 (El Rayah, 2007). 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* (Lewis, 1956; and El Rayah, 2007).

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 (Elhassan *et al*., 2012). It is considered a species of dry, savannah environment and sparse woodland. Its larval habitats are small, temporary, sunlit, clear and shallow fresh water pools (Sinka *et al*., 2010 and Ibrahim, 2016). However, *An. pharoensis* is widely distributed in Ethiopia, Somalia and in the Sudan and also extends into Egypt (Zahar, 1974). It plays a role as a potential vector of malaria in the Sudan (Dukeen *et al*., 2006).

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, Culex nebulosus, Cx. sitiens, Cx. duttoni, Cx. univittatus, Cx. sinaiticus, Cx. laticinctus, Cx. fatigans (quinquefasciatus), Cx. poicilipes, Cx. simpsoni, Cx. pipiens, Cx. nebulosis* and *Cx.tigripes* (El Rayah, 2007). *Culex univittatus*, *Cx. quinquefasciatus* (Elnour, 2016) and *Cx. theileri* are dominant species in White Nile River, (Elhassan, 2009). *Aedes aegypti, Ae. caspius, Ae. unilineatus Ae. metallicus, Ae. vittatus,*

Ae. fowleri and *Ae. unlinatus* (El Rayah, 2007). The objective of this study to determine species composition of mosquitoes in White Nile State, Sudan.

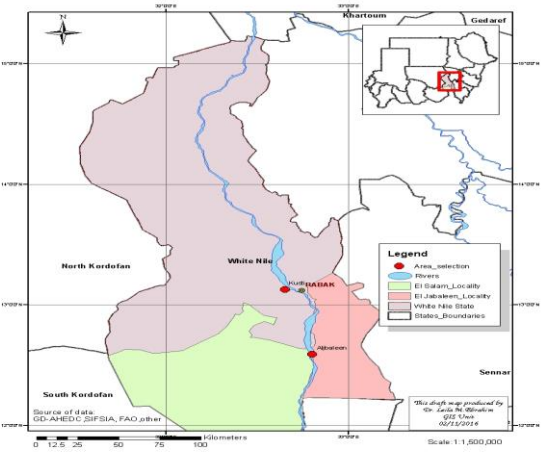
MATERIALS AND METHODS:

Study design: A two seasons study was conducted in selected houses and larval habitats in Kosti and Jabalain towns, White Nile State to determine the species composition of mosquitoes.

Study area: 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%.

Jabalain town is located in the eastern bank of White Nile River in southern parts of White Nile State. People live close to the White Nile River. The town lies between longitudes (32° 48' - 33° 15' E) and between latitudes (12° 30 '-13°N), and at altitude 382 m above sea level. It has a long rainy season which lasts for six months (May-October). The mean annual rainfall is 800 mm; the mean monthly temperature is 29.5°C in winter and 43°C in summer and the annual relative humidity 65% in autumn (Elhassan, 2009).

Map 1: White Nile state showing localities from where samples were collected



The source: General Directorate of Animal Health and Epizotic Diseases and Control 2016.

Collection of larvae: Larvae were collected from 5 breeding sites according to water habitats (water of broken pipes), clay pots, manholes near the bathroom, ponds and streams (khour) of water in each of Kosti and Jabalain towns. Larvae were surveyed inside and outside the houses. Collection was carried out in the morning hours from three residential areas in Kosti (Elnasr, Elshatee and Elrabaa) and three in Jabalain (Elsoug, Elshatee North and Eltadamon). From each residential area, larvae were collected by the dipping method which was described by WHO (2012). The dipper was lowered gently at an angle of about 45^{o} 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 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. Five replicates of dipping were carried out at each site. Larvae and pupae of each dip were

counted and recorded according to their instars 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 of collection, site and locality.

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 (Becker *et al.,* 2010). 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 Edward (1941), Russel *et al*. (1943), Hopkins (1952), Harbach (1985), Reuben (1994), Rueda. (2004) and Andreadis *et al*. (2005) 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 (Gillies and de Meillon, 1968, and Gillies and Coetzee, 1987).

Statistical analyses: Data collected from different habitats were subjected to an appropriate general linear model (GLM) procedure of the statistical analyses using the SAS package.

The SAS was used to perform mean separation using Ryan-Einot-Gabriel-Welsch Multiple F test (REGWQ) (Day and Quinn, 1989). Data when needed were subjected to transformation used ($\log_{10}(\bar{x}+1)$) (Day and Quinn, 1989).

RESULTS:

Prevalence of adult mosquitoes in Kosti and Jabalain:

The mean number of *Anopheles gambiae* complex adults was (28.32±2.19) in Jabalain significantly higher than (10.86±1.07) in Kosti (Table 1). In winter, it was (21.33±1.40) in Jabalain significantly higher than (09.45±1.88) in Kosti *Cx. univittatus* in Kosti was found with mean of (14.47±1.44) but not recorded in Jabalain. The lowest mean was in autumn (0.10±0.10) in Jabalain for *Cx. theileri*. In Kosti, in the same season, *Cx. pipiens* was observed with a low mean of (1.68±0.30). In winter *Cx. quinquefasciatus* was with a low mean of (0.14±0.10) in Jabalain. *An. pharoensis* in Kosti was recorded with a low mean of (0.05±0.04) (Table 1).

Anopheles gambiae complex in Kosti, was recorded with the means of (10.86±0.80) and (9.47±0.95) in autumn and winter, respectively; *Cx. quinquefasciatus* with the mean of (8.44±1.02) and (11.89±1.49) in autumn and winter, respectively; *Cx. univittatus* with the mean of (3.62±0.50) and (14.47±1.44) in autumn and winter, respectively; *Cx. pipiens* with the mean of (1.68±0.30) and (0.84±0.16) in autumn and winter, respectively (Table 1). *An. gambiae* complex in Jabalain was recorded with the mean of (28.32±2.03) and (21.33±1.40) in autumn and winter, respectively; *Ae. unilineatus* with the mean of (1.04±0.33) and (1.42±0.28) in autumn and winter, respectively; mean *Ae. aegypti* was (0.65±0.19) and (1.36±0.27) in autumn and winter, respectively (Table 20). Most of the adults were not found in Kosti in autumn and in Jabalain in winter. Along the WNR, the mean *Anopheles gambiae* complex in autumn was (11.24±1.98) and (26.17±3.07) in Kosti and

Jabalain, respectively (Table 21). In winter it was found by means (17.66±2.70) and (13.16±4.69) in Kosti and Jabalain, respectively.

Table 1: Mean (±SE) total number of adult mosquito species (♀and ♂) collected in autumn and winter of 2015 in Kosti and Jabalain.

	Autumn		Winter	
Mosquito species	Kosti (93)	Jabalain (106)*	Kosti (75)	Jabalain (90)*
An. gambiae complex	10.86±1.07 b	28.32±2.19 b	9.46±1.00 b	21.34±1.88 a
An. rufipes	0 a	0.66±0.18 b	0 a	0 a
An. pharoensis	0.25±0.10 b	0.77±0.25 b	0.05±0.04 a	0 a
An. funestus	0 a	0.57±0.16 b	0 a	0 a
An. squamosus	0 a	0.09±0.05 b	0 a	0 a
Cx. quinquefasciatus	8.44±1.02 b	0.66±0.31 b	11.89±1.49 a	0.14±0.10 b
Cx. univittatus	3.62±0.50 b	0 a	14.47±1.44 a	4.69±0.94 b
Cx. theileri	1.71±0.36 b	0.10±0.10 b	0 a	0 a
Cx. pipiens	1.68±0.30 b	0 a	0.84±0.16 a	0 b
Cx. duttoni	0 a	0 a	0 a	0.42±0.14 a
Ae. aegypti	0 a	0.65±0.19 b	0 b	1.36±0.27 a
Ae. unilineatus	0 a	1.04±0.33 b	0 b	1.42±0.28 a

Mean separation was based on values transformed to $\log_{10}(\bar{x}+1)$.
Means (±SE) with the same letter in each row for each season are not significantly different at 5% level according to REGWQ range test.
* Values in parenthesis = number of observations.

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 Kosti and Jabalain towns, White Nile State, in autumn and winter of 2015 to determine mosquito species composition.

In the current study, adult *Anopheles* species reported included *An. gambiae* complex, *An. pharoensis*, *An. funestus*, *An. rufipe*s and *An. squamosus*. *Culex* species included *Cx. quinquefasciatus*, *Cx. univitattus*, *Cx. pipiens*, *Cx. theileri*, and *Cx. duttoni* while *Aedes* species included *Ae. aegypti* and *Ae. unilineatus*. The prevalence of these species confirms the findings of many authors who conducted studies in Sudan

including White Nile State (Abdalla, 2005; El Rayah, 2007; Elnour, 2016 and Elhassan, 2009). *An. gambiae* complex is apparently the sole vector of malaria in Kosti according to Elhassan (2009). This species was found dominant in the two study areas. On the other hand, *An. funestus* which is another vector of malaria (Makhawi *et al*., 2015) was reported in Jabalain during autumn. They found that this species has a widespread distribution extending from northern Sudan to South Africa and across from West Africa to northern Mali and Senegal and was recorded in Gadrif State (Ibrahim, 2016). It was, also, *An. funestus* reported for the first time in at high larval density in White Nile State (Elrayah, 2007). The reason for its absence in Kosti could be possibly due to the fact that the favourable breeding ecological setting found for this species was irrigated channel associated with high vegetation density (Ibrahim, 2011).

Anopheles pharoensis which was recorded in both Kosti and Jabalain is widely distributed in Ethiopia, Somalia and the Sudan and also extends into Egypt (Zahar, 1974). This species is reported in many part of Sudan (Lewis, 1956, Elrayah, 2007, Ibrahim, 2011; Abubakr, 2012). It is a potential vector of malaria in the Sudan (Dukeen *et al*., 2006). *An. rufipes* was found only in Jabalain during autumn. It was reported from Elmanagil by Abubakr (2012) and from Elgadrif by Ibrahim (2016). They explained that this species is not incriminated in malaria transmission because of its little contact with man. This was confirmed by Lewis (1956) 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. These help explain possibility of its absence in Kosti. *An. squamosus* was found only in Jabalain during autumn. It was reported by Lewis (1956) and Elrayah (2007) in many parts of Sudan.

Culex quinquefasciatus was found abundant in both Kosti and Jabalain in autumn and winter according to El Amin

et al. (2013). It was recorded in Kosti by El-Rayah (2007; Elnour, 2016). This species transmits lymphatic filariasis (Rozendaal, 1997) which is a common disease in this area (Elhassan, 2009). *Cx. pipiens* was found in Kosti in the current study. It was recorded in Sudan by Lewis (1956) from Hasaheisa, Kabushiya, Karkoj, Khartoum, Kodok, El Obeid, Omdurman, Shambat, Wadi Halfa, Jebel Marra area, Suni and Zalingei. This species, also, acts as a vector of lymphatic filariasis (Rozendaal, 1997) and incriminated as a vector of Rift Valley fever Virus (RVFV) in White Nile and Khartoum States (Ibrahim, 2011). These diseases are expected to be endemic in White Nile ecosystem.

Aedes aegypti and *Ae. unilineatus* were reported in many parts of the Sudan by Elrayah (2007) which primarily transmit RVFV. These species were recorded in Jabalain in the current study. *Ae. aegypti* is considered as carrier for viruses that cause dengue haemorrhagic fever and yellow fever (Soonwera, 2015).

CONCLUSION:

Three genera of mosquitoes in the study areas (*Anopheles*, *Culex* and *Aedes*) were found. The most dominant *Anopheles* species in the study areas was *An. gambiae* complex and the most dominant *Culex* species were *Cx. quinquefasciatus* and *Cx. univittatus*.

Recommendations:

Additional studies are recommended to be carried out to update mosquito specie in other areas habitats of White Nile State.

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