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RESEARCH ARTICLE

FAUNA OF MOSQUITOES IN ENDEMIC AREAS OF MALARIA AND LYMPHATIC FILARIASIS AT ED DAMAZIN LOCALITY, BLUE NILE STATE, SUDAN

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ABSTRACT

Knowledge of mosquito vectors fauna is crucial to disease control measures. Entomological surveys were conducted in endemic areas of malaria and lymphatic filariasis at Ed Damazin locality, Blue Nile State, to investigate mosquito species composition. Mosquitoes were caught throughout the year, in dry and wet seasons during July 2007–August 2008. Mosquitoes were collected as larvae using WHO standard dipping method and as adults by CDC miniature light traps, a local made light traps (Madeni light trap; MLT 2008) and pyrethrum spray collections. A total number of 1953 collected adult mosquitoes; 191 using light traps and 1762 using pyrethrum spray collections, while 599 larvae specimens were collected. Nine species were recorded in the area namely; *An. arabiensis, An. squamosus, An. pharoensis, An. rufipes, An. funestus, Cx. quinquefasicatus, Cx. univitatus, Cx. anntenatus and Cx. sitiens* and the apparent density was compared.

INTRODUCTION

The mosquitoes were originally all contained in four genera; *Culex*, *Anopheles*, *Aedes* and *Corethra* (Theobald, 1906). They have a significant role as vectors of many serious human and animal diseases such as malaria, yellow fever, encephalitis, lymphatic filariasis and Rift Valley fever (Anosike *et al*., 2007). Three genera of medically important mosquitoes are found in Sudan (*Anopheles, Culex* and *Aedes*). One hundred and fifty six species, two subspecies of mosquitoes and seven varieties of Culicidae have been recorded in Sudan. These species included 45 species and one variety of the genus *Culex* (El Rayah, 2007); also 38 species of *Anopheles* were recorded, and few species transmit malaria (Nugud *et al*., 1997). Malaria remains an important public health problem in Sudan. Understanding malaria vector mosquitoes and their infectivity dynamics is of importance in setting up intervention and control programmes (Himeidan *et al*., 2011).

The Sudan Northern States Malaria Indicator Survey 2009 showed that the prevalence of malaria infections in Blue Nile state was the highest (12.5%) among all ages and 20.3% among febrile individuals. The disease of lymphatic filariasis is restricted to three regions in Sudan including Kordofan, Darfur and the Blue Nile States, but now it tends to include most of the States (NMCP, 2010). It is transmitted by mosquitoes including *Culex quinquefasicatus* and *Anopheles gambiae s.s.* (Hassan, 2007). The present study was carried out to study the fauna of mosquitoes in Ed Damazin Locality in Blue Nile State, Sudan during dry and wet seasons, which considered as endemic area of malaria and lymphatic filariasis.

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MATERIALS AND METHODS

Study areas

This study was conducted in Ed Damazin Locality, Blue Nile State, which lies entirely between latitudes 9° 30´ and 12° 45´ N and longitudes 33° 30´ and 34° 43´ E. The Blue Nile State is located in south-eastern part of Sudan bordering Sennar and Upper Nile States from the north and west, respectively, and Ethiopia from the east part. It covers a total area of about 26708 km^2 (Fig 1). The State is divided into 6 administrative units "*Mahaliat*", namely: Ed Damazin, Al Roseries, Baw, Geissan, El Tatamoon and El Kurmuk. Ed Damazin Town, the capital of Blue Nile State, is about 650 km south of Khartoum. The Blue Nile State is populated by 886350 persons of who 27%, 61% and 12% are urban, rural and nomadic, respectively, with an annual population growth rate of 3.01%. The majority of the population is agro-pastoralists, nevertheless a small proportion of employee and seasonal labor are present. The State is ethnically diverse, with eleven major tribes comprising a group collectively known as the Funj. The internal displacement and refugee population has been estimated of about 165000 persons representing 18.6% of the total population (MFEP, 2007). Ed Damazin Locality exhibits the highest population in the State, and is inhabited by infected people with malaria and lymphatic filariasis ((NMCP, 2010). It lies in open woodland forest vegetation zone with extensive clay (flood) plains. Only two types of building are dominant, including huts and concrete buildings. The field surveys were conducted in Ed Damazin Locality (Elevation 492 m) which lies along the Blue Nile River.

Collection of mosquitoes

The mosquito larvae were collected using a standard white ladle from large and small water bodies in Ed Damazin Locality mainly from El Fardos, El Saha, El Zohoor, El Nahda, El Riyad, Bant and Sika

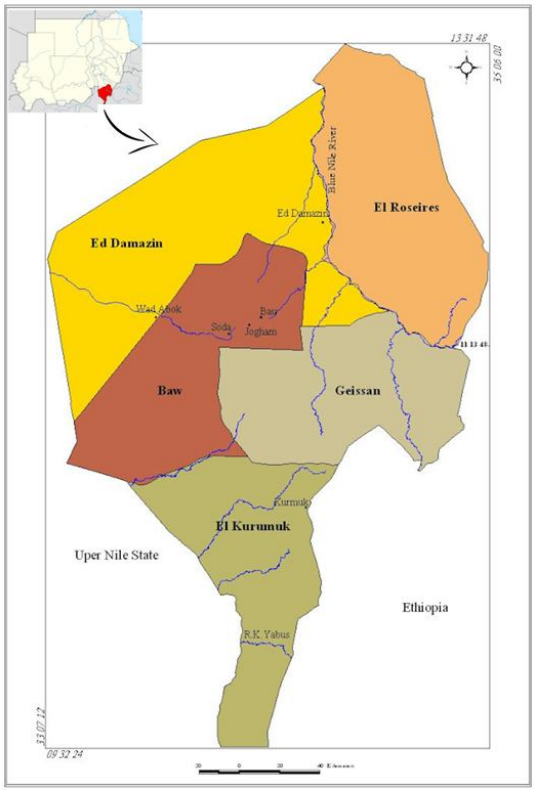

Fig.1. A map showing the study area of Ed Damazin Locality at Blue Nile State, Sudan

Hadied blocks, during wet season (July-December) 2007 and dry season (April-August) 2008. These natural breeding sites included marshes, pools and water-courses and rainy drainage systems "*Khors*". The pyrethrum spray collection (WHO, 1970) was used to collect adult mosquitoes resting indoor during wet and dry seasons (July 2007-August 2008) from 10 blocks in Ed Damazin Locality; these were El Fardos, El Saha, El Zohoor, El Nahda, El Riyad, Bant, Sika Hadied, El Ghasam, Gogish and El Rabeia blocks. The rooms at houses included huts and concrete buildings were selected randomly taking into consideration the presence of mosquito breeding sites near the location. Before spraying, the leader of the house was informed and requested to empty the rooms selected for collection. Two CDC light traps (model 512) and MLT-2008 were used every 7 days /month/season to collect mosquito populations outdoor from the same houses selected for indoor collection. The captured mosquitoes were collected and recorded.

Identification of mosquitoes

The 4th instar larvae were mounted (WHO, 2005) and classified using the keys of Hopkins (1952) and Ralf (1985). While the collected adult mosquitoes were identified morphologically using the pictorial keys of Edwards (1941), Abd-Elnur and Nugud (Department of Medical Entomology, Ministry of Health, Sudan, unpublished report, 1994) and Huang (2001). Also the software key of the Anopheline mosquitoes of the Afro-tropical Region (Hervy *et al.*, 1998) was used.

Data analysis

The data were analyzed using SPSS software (Ver.16). The descriptive analysis was used, the data was analyzed step-by-step and cross tabulation was done to explain possible relationship between the variables. Appropriate tests of significance were applied to determine the significance of association, χ^2 test for categorical variables at the significance level less than P<0.05.

RESULTS

A total number of 1953 adult specimens representing nine Culicinae species were recorded during dry and wet seasons. The collected *Anopheles* specimens consisted of *An. arabiensis*, *An. funestus*, *An. pharoensis*, *An. squamosus*, *An. rufipes* and those of *Culex* species were *Cx. quinquefasicatus*, *Cx. anntenatus*, *Cx. univitattus* and *Cx. sitiens*. The apparent densities of collected mosquitoes and methods of collection were summarized in Table 1. The results showed that there was a high significance difference (P<0.000) between indoor and outdoor collection of *Anopheles* and *Culex* mosquitoes in the study areas (Table 2).

DISCUSSION

Successful implementation of a vector control program requires accurate knowledge of the bionomics of the species involved in disease transmission. In Sudan the total number of species of the genera *Anopheles*, *Culex* and *Aedes* is 107 (Elrayah, 2007). Mosquito species of these genera reported by Lewis (1945, 1947, 1953, 1955). Mosquitoes of the *Anopheles gambiae* Giles complex are the main vectors of malaria and lymphatic filariasis in Africa (Zahar, 1974). They are generally vectors of malaria, particularly *An. arabiensis* the predominant member of *An. gambiae s.l.* in northern Sudan (Haridi, 1972; Akood, 1980; Petrarca *et al.*, 2000). It is considered a species of dry, savannah environments and sparse woodland. Its larval habitats are small, temporary, sunlit, clear and shallow fresh water pools (Sinka *et al.*, 2010). In spite of data recorded that the other Anopheline mosquitoes present in Sudan such as *An. nili*, *An. dthali* and *An. rufipes* are of no medical importance (Haridi, 1972; Akood, 1980), there is some studies showed that they may play a role in malaria transmission in Sudan. However, *Anopheles pharoensis* Theobald is widely distributed in Ethiopia, Somalia and Sudan and also extends into Egypt (Zahar, 1974) it plays as a potential vector in Egypt (Kenawy, 1988) and considered as potential vector in Sudan (Dukeen *et al.*, 2006). *Culex quinquefasciatus* is a sub-tropical species usually found within the latitudes 36° N and 36° S. Lewis (1945; 1947; 1953; 1955) has provided intensive reviews regarding the distribution of *Culex* species in Sudan. The species reported to spread almost all over the country including *Cx. nebulosus*, *Cx. sitiens*, *Cx. duttoni*, *Cx. univittatus*, *Cx. sinaiticus*, *Cx. laticinctus*, *Cx. fatigans (quinquefasciatus)*, *Cx. poicilipes*, *Cx. simpsoni* and *Cx. pipiens* (Lewis, 1956). *Culex quinquefasciatus* is known to be a domestic annoying mosquito.

It breeds abundantly in any collection of water such as barrels, tanks, culverts, etc. It can breed in fresh, brackish, and foul water such as cesspits and sinks. It is a vector of lymphatic filariasis in Sudan and encephalitis abroad (El Rayah, 2007). Mosquitoes in the eastern region of Sudan were including *An. gambiae*, *An. funestus*, *An. rupicolus*, *An. pretoriensis*, *An. dthali*, *Cx. nebulosus*, *Cx. sitiens*, *Cx. duttoni*, *Cx. univittatus*, *Cx. sinaiticus*, *Cx. laticinctus*, *Cx. fatigans (quinquefasciatus)*, *Cx. poicilipes*, *Cx. simpsoni*, *Cx. pipiens*, *Ae. aegypti*, *Ae. caspius*, *Ae. metallicus*, *Ae. vittatus*, *Ae. arabiensis* and *Ae. fowleri* (El Rayah, 2007). However, in Blue Nile State, no records were done regarding mosquitoes varieties hence the present study. So, the present study was the first one in the area to identify mosquito species. Since the magnitude of *Anopheles* and *Culex* species drastically differ based on collection technique applied (Gillies and Coetze, 1987), several methods of collection were adopted in the field surveys of the present studies. To hit the point, the ladle technique, pyrethrum spray collection and two different designs of light traps were used. Collected species were included five Anopheline species and four Culicine ones. However, the presence of other species is possible because many several factors may affect the performance of the collection techniques. These factors including breeding sites, seasonality, location, host abundance, changes in weather within time of day and the physiological status of mosquitoes (Godal *et al.*, 1998). Moreover, the successes so far recorded in sampling mosquitoes using the pyrethrum spray technique (WHO, 1970) have generally depended on susceptibility of endophilic mosquito to the residual insecticide sprayed. In consequence, the species obtained were only those susceptible to the insecticides and the dose applied. The results indicated that the *Anopheles* percentages indoor in Ed amazin (81.4%) were significantly higher than outdoor (29.8%) opposing to

Table 1. The number and percentages of adults and larvae of mosquitoes collected from Ed Damazin Locality, Blue Nile State, Sudan during 2007-2008

Mosquito species	Indoor collection Pyrethrum spray technique	Outdoor collection CDC & MLT light traps	Larvae collection
Anopheles arabiensis	61.3% (1080/1762)	19.9% (38/191)	75.3% (451/599)
An. funestus	0	6.3% (12/191)	0
An. pharoensis	0	1.6% (3/191)	0
An. squamosus	0	4.7% (9/191)	0
An. rufipes	20.1% (354/1762)	0	0
Culex quinquefasciatus	18.6% (328/1762)	54.4% (104/191)	19.4% (116/599)
Cx. antennatus	0	4.2% (8/191)	0
Cx. univitatus	0	7.3% (14/191)	5.3% (32/599)
Cx. sitiens	0	1.6% (3/191)	0

Table 2. The indoor and outdoor *Anopheles* and *Culex* percentages collected in dry and wet seasons in Ed Damazin Locality, Blue Nile State, Sudan

Collection site	Percentage of mosquitoes	
	Anopheles	*Culex*
Indoor	81.4% (1434/1762)	18.6% (328/1762)
Outdoor	32.5% (62/191)	67.5% (129/191)
P-value	0.000	

that of *Culex* ones (18.6%) and (70.2%) respectively. The behavior of mosquitoes is initial important factor in determining the prospective habitat. *Anopheles* species are known to be anthropophilic and highly prefer to feed on humans, most often feed indoors and remain there (endophilic) (Coluzzi *et al*., 1979; Curtis, 2008). The most dominant species found in Ed Damazin areas were *An. arabiensis* and *Cx. quinquefasciatus* respectively, and they are the main vectors of malaria and lymphatic filariasis in Sudan, so it is clear that why the Blue Nile State has the highest percentages of malaria and lymphatic filariasis cases in Sudan. In the larvae collection the highest density was for *An. Arabiensis*. This may be due to that, *An. arabiensis* breed in small, temporary pools of sunlit water found in areas created by human activity. As a result the current distribution pattern might be ascribed to behavior and performance of mosquitoes. Further intensive studies on mosquitoes bionomic are highly recommended to generate data necessary for planning a competent control strategy.

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