Journal of the Egyptian Society of Parasitology, Vol. 47, No. 1, April 2017
J. Egypt. Soc. Parasitol. (JESP), 47(1), 2017: 167- 176

MOSQUITOES (DIPTERA: CULICIDAE) OF THE WESTERN COASTAL AREA, KINGDOM OF SAUDI ARABIA: SPECIES COMPOSITION, ABUNDANCE, DIVERSITY AND MEDICAL IMPORTANCE

By

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Abstract

An entomological survey was undertaken for two years to update the mosquito fauna of the 3 regions (Mecca, Al Madinah and Tabouk), of the western coast, Kingdom of Saudi Arabia. Six localies representing such Regions (Taif, Mecca, Jeddah, Yanbu, Daba and Haql) were sampled for larvae and adults. Nineteen species of six genera were reported of which genus *Culex* (57.89% sp.) were the most common followed by *Anopheles* (21.05%) and *Stegomyia, Ochlerotatus, Aedes* and *Culesita* (5.26% each). Three species (*Cx. sitiens, Cx. torrentium* and *Am. v. arabiensis*) were new reports in study area. A total of 10930 larvae and 33108 adults were collected of which those representing genus *Culex* were predominating (92.74% larva, 93.46% adult). Of the reported species, *Cx. quinquefasciatus* (47.11% larva, 57.52% adult) and *Cx. pipiens* (22.24% larva, 27.42% adult) were the common ones. Both Taif and Tabouk reported the highest number of species (13 sp., 68.42%), followed by Jeddah (12 sp., 63.16%), Mecca (10 sp., 52.63%) and Yanbu (8 sp., 42.11%). Tabouk represented the maximum diversity with the highest Simpson index (1-D=0.65) and Shannon index (H=1.25) followed by Taif (1- D=0.54, H=1.01). Per sampling site, Jeddah reported the highest number of larvae (313.70), and Mecca had the highest adult number (670.18). A complete list of mosquito fauna of the western coast including 35 spp. was presented based on the present and previous surveys. The role of the reported mosquito species as disease vectors was discussed. The study concluded that the diversity and abundance of the different mosquito species, among which several vectors of diseases mainly malaria, Rift Valley fever, lymphatic filariasis and dengue fever may pause a risk of transmission and more spread of such disease in this part that contains the holy places which are visited all year round by millions of people from several countries.

Key words: Mosquito fauna, Species diversity, Mosquito larvae, Mosquito adults, Relative abundance, Saudi Arabia.

Introduction

The Kingdom of Saudi Arabia "16° & 33° N, 34° & 56° E" (Wikipedia: https://en.Wikipedia.org/wiki/KSA) occupies about 80% of the Arabian Peninsula with an area of 2,149,690 Km^2 & a population of 30,770, 375 (2014 estimate). Saudi Arabia's geography is dominated by the Arabian Desert and associated semi-desert. The Western Region (the Hijaz) of the Kingdom includes the west coast, north of Asir. It contains the mountain chain (with peaks rising to 3,000 meters), running south to north and decreasing gradually in elevation as it moves northward, and the coastal plain bordering the Red Sea. It also includes the city of Jeddah; it is the main port for thousands of pilgrims arrive annually as the first step on their trip to Holy cities of Mecca (to the east) and Al Madinah (to the north). In the mountains above Mecca and Jeddah is the town of Taif. Its elevation gives it a climate far cooler than either Jeddah or Mecca and without the uncomfortable humidity of the former cities. The coastal area of the Western Region is notorious for its humidity, with summer temperatures rising to above 40°C. Mosquitoes of the different parts of Saudi Arabia were investigated through several surveys conducted by many workers

(Mattingly and Knight, 1956; Büttiker, 1981; Wills *et al*, 1985; Jupp *et al*, 2002; Miller *et al*, 2002; Abdoon and Alshahrani, 2003; Abdoon, 2004; Alahmed *et al*, 2007; Alahmed, 2012). As a result of these surveys, fifty three species belonging to 11 genera: *Anopheles* (19 spp.), *Culex* (22), *Ochlerotatus* (3), *Culiseta* (2) and one species each of *Lutzia*, *Stegomyia*, *Aedes*, *Aedimorphus*, *Fredwardsius*, *Uranotaenia* and *Orthopodomyia* were reported. In addition, some of scattered surveys were conducted in the western part of the Kingdom (Abdullah and Merdan, 1995; AI Ali *et al*, 2008; Al Ghamdi *et al*, 2008; Alahmed *et al*, 2009; Al Ahmed *et al*, 2010; Kheir *et al*, 2010; Al Ahmad *et al*, 2011; Khater *et al*, 2013; Al Ashry *et al*, 2014; Alikhan *et al*, 2014; Bakr *et al*, 2014; Mahyoub *et al*, 2015). Several species mainly: *An. arabiensis, An. stephensi, An. sergenti, An. fluviatilis, An. multicolor, Cx. pipiens, Cx. quinquefasciatus, Cx. tritaeniorhynchus, Cx. perexiguus, St. aegypti* and *Am. v. arabiensis* are involved in transmission of several diseases. The most common mosquito-borne diseases include filariasis (Sebai *et al*, 1974; Omar, 1996; Haleem *et al*, 2002), RVF (Jupp *et al*, 2002; Miller *et al*, 2002; Al-Hazmi *et al*, 2003; Balkhy and Memish, 2003; Madani *et al*, 2003; Flick and Bouloy, 2005; Elfadil *et al*, 2006; Al-Qabati and Al-Afaleq, 2010), malaria (Warrel, 1993; Al-Seghayer *et al*, 1999; Abdoon and Alshahrani, 2003; Al-Tawfiq, 2006) and dengue fever (Fakeeh and Zaki, 2001; 2003; Ayyub *et al*, 2006; Khan *et al*, 2008; El-Gilany *et al*, 2010; Aziz *et al*, 2014). For the past few decades, Saudi Arabia has witnessed tremendous advances in social development and urbanization in almost all Regions (Alahmed, 2012) which presumably have affected the insect fauna, particularly mosquitoes (Al Ahmed *et al*, 2010). Thus, the present work was planned to update the species composition and distribution of mosquitoe fauna in the different regions representing the western part/coast of Saudi Arabia.

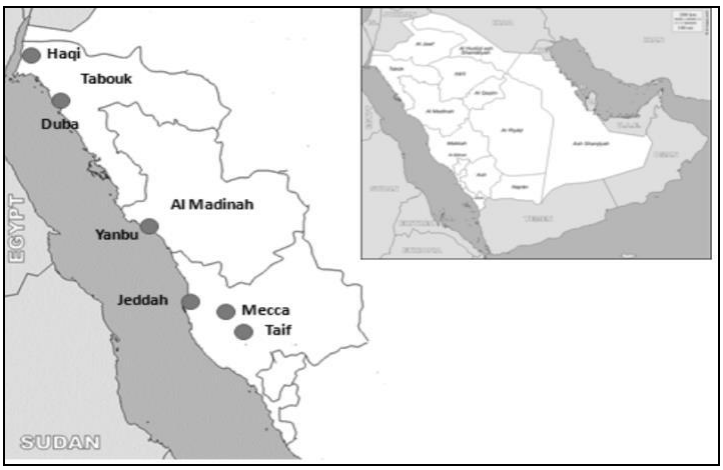

Fig. 1: Map of Saudi Arabia showing study localities in western part

Materials and Methods

The study was carried out in the three regions of the western part of the Kingdom namely Mecca, Al Madinah and Tabouk (Fig. 1).

The Mecca Region (Makah) "21°25′N, 39°49′E" is the most populous region in Saudi Arabia. In this region the study included Mecca, the capital and 2 large cities, Jeddah & Taif. Mecca or Makah "21°30′N, 41°0′E" is located in a narrow valley at a height of 277 m above sea level. It occupies an area of 153,148 km^2. Its resident population is 6,915,006 (2010 census). In addition, more than triple this number of the visitors comes every year during the Hajj (Pilgrimage) period. Mecca features a hot desert climate. Jeddah "21°32′36″N, 39°10′22″E" is the largest sea port on the Red Sea, and the second-largest city in Saudi Arabia after

the capital, Riyadh with a population of 3.4 million (2007 Census) and an area of 1,600 km^2. Jeddah features an arid climate. Taif "21°26′N, 40°21′E" is a city at an elevation of 1,879 m on the slopes of Al-Sarawat mountains. The city is the centre of an agricultural area known for its grapes, figs, roses and honey. Taif has a hot desert climate, with hot summers and mild winters. The Al Madinah (Al-Madīnah al-Munawarah) Region "25°0′N, 39°30 E" is located along the Red Sea coast. It has an area of 151,990 km² and subdivided into seven governorates. The study was carried out in Yanbu (Yanbu'al Bahr) "24°05′N, 38°00′E" which is a major Red Sea port approximately 300 kilometers northwest of Jeddah. A large number of the residents are foreign expatriates working in the oil refineries and petro-chemical industry. Tabouk (Tabuk) Region "28°0′N, 37°0′E" is located along the north-west coast of the country, facing Egypt across the Red Sea. It has an area of 146,072 km². The study was carried out in-Haql and Duba. Haq1 "29°17′N, 34°56′E" is a town near the head of the Gulf of Aqaba, adjacent to Aqaba across the Jordanian border with a small population of 25,000. Duba "27°20′57.3″ N, 35°41′46.2 ″E" is a small port city on the northern Red Sea coast. Duba has a population of about 22,000 & a hot desert climate. The study included a total of 28 sites in the 6 localities (Taif: 21, Mecca: 11, Jeddah: 20, Yanbu: 9, Haql: 11, Duba: 10). Each site was bi-weekly surveyed during the period from January 2013 to December 2014. In each site, inspections of the water bodies for mosquito larvae were carried out using a plastic dipper, 125 mm in diameter with a 90 cm aluminum telescoping handle. Three samples of 10 dips (a survey unit, SU) per breeding site were taken. Collected larvae were placed in labeled plastic bags (Nasco whirl pack 4002 filline USA) and transported to the laboratory in a picnic ice box containing cold water to prevent overheating. At the laboratory, 3rd and 4th larval instars were killed with hot water and preserved in labeled specimen tubes containing 70% ethanol to be ready for identification. Adults were collected using three different types of traps: (1) the CDC (Center for Disease Control) miniature light traps (Model 512, John W. Hock Co., Gainesville, FL, USA), (2) the V-Mart Super photocatalyst "Black Hole (BH) traps" (Venus Technology Co., Ltd. Wangthonglang, Bangkok, Thailand) and (3) the CDC Fay-Prince Blacklight (UV) Trap (Model 812, John W. Hock Company, Gainesville, Florida, USA). The traps were set before sunset and collected after sunrise next morning. A total of 329, 1350 and 484 CDC, BH, and UV traps, respectively were used in all the study localities during the study period. The collected mosquitoes were aspirated, placed in labeled paper cups that kept in a picnic ice box while being transported to the laboratory. In the laboratory, mosquitoes were preserved in 70% alcohol till identification. Larvae and adults were identified according to keys of-Mattingly and Knight (1956), Glick (1992) and Al Ahmad *et al.* (2011).

Data analysis: Data obtained during 2013 and 2014 were compiled altogether. The species diversity of the mosquito adults based on the Simpson (1-D) and Shannon (H) indices was examined for the different localities. The PAST (Paleontological Statistics Version 2.08; Hammer *et al*, 2001) computerized software was used.

Results and Discussion

The present study is a report of the results of entomological surveys of mosquito fauna in the different regions representing the western part/coast of Saudi Arabia. A total of 19 species belonging to 6 genera (*Culex, Anopheles, Stegomyia, Ochlerotatus, Aedi*

The present study is a report of the results of entomological surveys of mosquito fauna in the different regions representing the western part/coast of Saudi Arabia. A total of 19 species belonging to 6 genera (*Culex, Anopheles, Stegomyia, Ochlerotatus, Aedimorphus* and *Culiseta*) were reported (Tab.

1), these were: *Cx. pipiens, Cx. perexiguus, Cx. sinaiticus, Cx. quinquefasciatus, Cx. tritaeniorhynchus, Cx. theileri, Cx. sitiens, Cx. torrentium, Cx. simpsoni, Cx. Iaticinctus, Cx. pusillus, An. dthali, An. multicolor,* An. *sergentii, An. fluviatilis, St. aegypti, Oc. caspius, Am. v. arabiensis* and *Cs. longiareolata.*

Table 1: Species composition and distribution of the reported mosquito species

Species	Taif	Mecca	Jeddah	Yanbu	Tabouk	All
Culex (*Culex*) *pipiens* L.	●	●	●	●	●	●
Cx. (*Cux*.) *perexiguus* Theobald	●	●	●	●	●	●
Cx. (*Cux*.) *sinaiticus* Kirkpatrik	●		●	●	●	●
Cx. (*Cux*.) *quinquefasciatus* Say	●	●	●	●	●	●
Cx. (*Cux*.) *tritaeniorhynchus* Giles		●	●	●	●	●
Cx. (*Cux*.) *theileri* Theobald	●		●		●	●
Cx. (*Cux*.) *sitiens* Wiedemann			●	●	●	●
Cx. (*Cux*.) *torrentium* Martini		●	●			●
Cx. (*Cux*.) *simpsoni* Theobald	●				●	●
Cx. (*Cux*.) *laticinctus* Edwards	●	●	●	●		●
Cx. (*Barraudius*) *pusillus* Macquart	●					●
Anopheles (*Cellia*) *dthali* Patton	●	●	●			●
An. (*Cel*.) *multicolor* Cambouliu	●				●	●
An. (*Cel*.) *sergentii* Theobald	●					●
An. (Cel.) *fluviatilis* James					●	●
Stegomyia (*St*.) *aegypti* (L.)	●	●	●	●	●	●
Ochlerotatus (*Oc*.) *caspius* (Pallas)		●	●		●	●
Aedimorphus vexans arabiensis (Patton)		●				●
Culiseta (*Allotheobaldia*) *longiareolata* Macquart	●				●	●
Total number of species	13	10	12	8	13	19

According to the previous surveys in the western part (AI Ali *et al*, 2008, Al Ghamdi *et al*, 2008; Alahmed *et al*, 2009; Kheir *et al*, 2010; Al Ahmad *et al*, 2011; Khater *et al*, 2013; Alikhan *et al*, 2014; Mahyoub *et al*, 2015), 17 species were missed during the present study. These are: *Cx. duttoni, Cx. decens, Cx. arbieeni, Lutzia tigripes, An. culicifacies, An. gambiae, An. turkhudi, An. pharoensis, An. subpictus, An. stephensi, An. rhodesiensis, An. azaniae, An. cinereus, An. pretoriensis, Oc. detritus, Fredwardsius vittatus* and *Uranotaenia unguiculata.* Moreover, three species (*Cx. sitiens, Cx. torrentium* and *Am. v. arabiensis*) were not encountered before so that they may be considered a new report in the western part of the Kingdom. However, these 3 species were reported to be present in the neighboring region of Asir (Miller *et al*, 2002; Al Ahmad *et al*, 2011; Al Ashry *et al*, 2014). Consequently, the mosquito fauna of the western part/coast comprises 36 species: 14 *Anopheles*, 14 *Culex*, two *Ochlerotatus*, and one species each of *Lutzia, Stegomyia, Aedimorphus, Fredwardsius, Culiseta* and *Uranotaenia* (Tab. 2). The distribution, number of the reported species and relative abundance of larvae and adults (mean number of larvae /adults per sampling site) varied in the surveyed localities. Both Taif and Tabouk reported the highest number of species (13 sp., 68.42%), followed by Jeddah (12 sp., 63.16%), Mecca (10 sp., 52.63%) and Yanbu (8 sp., 42.11%) (Tab.1). The species diversity for the mosquito adults sampled during the study period in the different localities (Fig. 2) reflected similar findings. The results revealed maximum diversity in Tabouk with the highest Simpson index (1-D=0.65) and Shannon index (H=1.25) followed by Taif (1-D=0.54, H=1.01) due to the high richness of the species in the two localities (n=13/19 sp.) whereas, Mecca (1-D=0.48, H=0.94) and Yanbu (1-D=0.44, H=0.94) represented the areas with the minimum diversity indices due to their minimum richness (n = 10 and 8 sp., respectively). On the other hand, Jeddah exhibited intermediate values (1-D=0.49 and H=0.99). This may be attributed mainly to climate prevailing in Tabouk and Taif of being much cooler during the summer time than it is in other parts of Saudi Arabia

(Wikipedia:https://en.wikipedia.org/wiki/KSA), for example Mecca and Jeddah which retains their warm temperatures in winter and summer temperatures are extremely hot, often breaking 40°C (Mecca) or 43°C (Jeddah) in the afternoon and dropping to 30°C in the evening. However, Al-Ahmad *et al*. (2011) indicated that out of 25 reported species, 17 were reported in both Jeddah and Mecca, 15 in Taif, 12 in Madinah and only 8 in Tabouk.

Table 2: Mosquito fauna of the western part of Saudi Arabia (Present survey: A, Previous surveys: B)

Species	Survey	Species	Survey
Cx. pipiens	AB	*An. fluviatilis*	AB
Cx. perexiguus	AB	*An. culicifacies*	B
Cx. sinaiticus	AB	*An. gambiae*	B
Cx. quinquefasciatus	AB	*An. turkhudi*	B
Cx. tritaeniorhynchus	AB	*An. pharoensis*	B
Cx. theileri	AB	*An. subpictus*	B
Cx. sitiens	A	*An. stephensi*	B
Cx. torrentium	A	*An. rhodesiensis*	B
Cx. simpsoni	AB	*An. azaniae*	B
Cx. laticinctus	AB	*An. cinereus*	B
Cx. pusillus	AB	*An. pretoriensis*	B
Cx. duttoni	B	*St. aegypti*	AB
Cx. decens	B	*Oc. caspius*	AB
Cx. arbieeni	B	*Oc. detritus*	B
L. tigripes	B	*Am. v. arabiensis*	A
An. dthali	AB	*Fr. vittatus*	B
An. multicolor	AB	*Cs. longiareolata*	AB
An. sergentii	AB	*Ur. unguiculata*	B

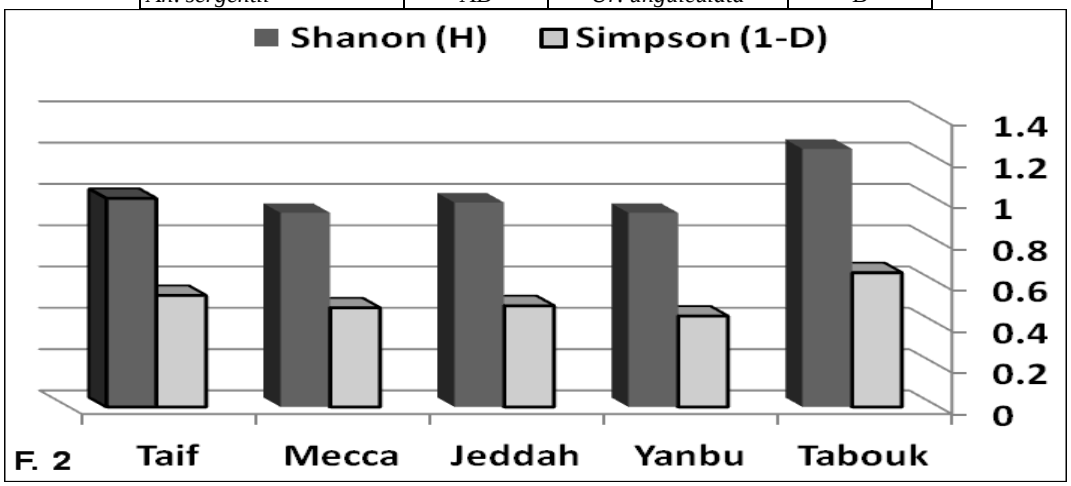

Fig. 2: Diversity indices for collected mosquito adults

Based on the mean number of larvae and adults per sampling site (Fig. 3), Jeddah reported the highest number of larvae (313.70) followed by Taif (118.10), Yanbu (112.56), Mecca (69.82) and Tabouk (18.81). Regarding adults, Mecca reported the highest number (670.18) followed by Jeddah (510.60), Tabouk (334.57), Yanbu (304.78) and Taif (274.05). In 3936 larval collections (2950 positive SU), 10930 larva of 11 species (4 genera) and in 2820 light trap collections, 33108 adult of 19 species (6 genera) were collected. The relative abundance of the reported genera was examined based on the number of species and number of collected larvae and adults (Tab. 3). The compiled result of all localities revealed that: (1) Of the four larval genera, genus *Culex* was predominating (7: 63.64% sp, 92.74% larva). The other three genera were *Anopheles* (2:18.18% sp., 1.99% larva), *Stegomyia* (1:9.09% sp., 2.91% larva) and *Culiseta* (1:9.09% sp., 2.36% larva). (2) Of the six adult genera, genus *Culex* was predominat-

ing (11: 57.89% sp., 93.46% adult) followed by genus *Anopheles* (4: 21.05% sp., 0.60% adult). The other genera: *Stegomyia* (1:5.26% sp., 2.18% adult), *Ochlerotatus* (1:5.26% sp., 0.82% adult), *Aedimorphus* (1:5.26% sp., <0.01% adult) and *Culesita* (1:5.26% sp., 2.94% adult).

More or less similar results were obtained by other workers in some localities of the western part of the Kingdom. Khater *et al.* (2013) carried out a survey in Makkah, Al-Baha and Jezan and collected 2766 larva of 21 species from six genera of which 52% were *Anopheles*, 44.3% were *Culex*, 0.51% were *Aedes* and 3.1% were from three other genera. (*Ochlerotatus, Lutzia* and *Uranotaenia*). Mahyoub *et al.* (2015) reported that in Makkkah city, larvae of *Culex* genus were the most dominant in terms of geographical distribution followed in terms of density to genus *Anopheles* while larvae of genus *Aedes* were less in population. The wide spread and abundance of *Culex* larvae may be due to the fact that they can exploit a wide variety of aquatic habitats for their development and survival, and can tolerate highly polluted aquatic environment and relatively saline water (Alahmed, 2012).

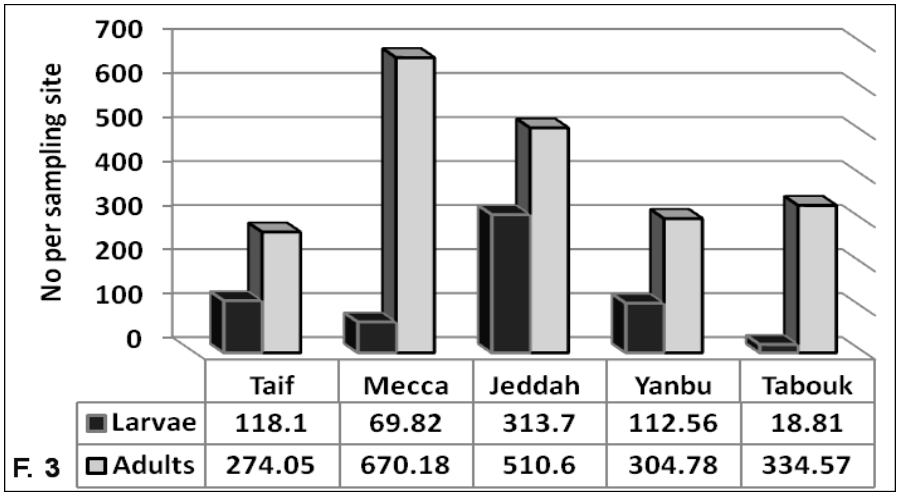

Fig. 3: Number of larvae and adults per sampling site for surveyed localities

Table 3: Relative abundance of the reported mosquito genera

Genus	Species		Larvae		Adults	
	No	%	No	%	No	%
Culex	11	57.89	01051	92.74	30942	93.46
Anopheles	4	21.05	217	1.99	200	0.60
Stegomyia	1	5.26	318	2.91	721	2.18
Ochlerotatus	1	5.26	0	0	270	0.82
Aedimorphus	1	5.26	0	0	1	<0.01
Culesita	1	5.26	258	2.36	974	2.94
Total	19		10930		33108	

The relative abundance of larval and adult species (% collected from the total collection) was examined in the different studied localities (Tab. 4). The compiled results revealed that the *Cx. quinquefasciatus* (47.11% larva, 57.52% adult) and *Cx. pipiens* (22.24% larva, 27.42% adult) were the common species similar to previous reports from El Madina Region where *Cx. pipiens* represented 59.3% of collected adults and 60% of larvae while *Cx. quinquefasciatus* represented 22.1% of adults and 20% of larvae (AI Ali *et al*, 2008) and Makkah where *Cx. quinquefasciatus* adults (99.3%) were predominating (Khater *et al*, 2013). As larvae, *Cx pipiens* (11.89%), *Cx. theileri* (8.02%), *St. aegypti* and *Cx tritaeniorynchus* (2.91% each), *Cs. longiareolata* (2.36%) and *An. multicolor* (1.84%) were less common. *Cx. perexiguus* (0.43%), *An. d'thali* (0.15%) and *Cx. torrentium* (0.14%) were rare species. As adults, the

descending order of abundance was *Cx sitiens* (3.91%), *Cs. longiareolata* (2.94%), *St. aegypti* (2.18%), *Cx. tritaeniorynchus* (1.65%), *Cx. perexiguus* (1.24%), *Oc. caspius* (0.82%), *Cx. theileri* (0.69%), *Cx. lacticinchus* (0.54%), *Cx. sinaiticus* (0.42%), *An. multicolor* (0.35%), *An. sergentii* (0.14%), *An. d'thali* (0.10%), *Cx. torentium* (0.05%), *Cx. simposoni* (0.02%), An. *fluviatilis* (0.01%), *Cx. pusillus* (<0.01%) and *Am. v. arabiensis* (<0.01%).

Table 4: Relative abundance of the reported mosquito larval and adult species

Species	Larvae		Adults	
	No	%	No	%
Cx. pipiens	2431	22.24	9077	27.42
Cx. perexiguus	47	0.43	411	1.24
Cx. sinaiticus			138	0.42
Cx. quinquefasciatus	5149	47.11	19045	57.52
Cx tritaeniorynchus	318	2.91	546	1.65
Cx. theileri	877	8.02	227	0.69
Cx sitiens	1300	11.89	1293	3.91
Cx. torrentium	15	0.14	16	0.05
Cx. simposoni			8	0.02
Cx. lacticinchus			180	0.54
Cx. pusillus			1	<0.01
An. d'thali	16	0.15	34	0.10
An. multicolor	201	1.84	116	0.35
An. sergentii			47	0.14
An. fluviatilis			3	0.01
St. aegypti	318	2.91	721	2.18
Oc. caspius			270	0.82
Am. v. arabiensis			1	<0.01
Cs. longiareolata	258	2.36	974	2.94

Some of the reported mosquito species of the western coast during this study are implicated as vectors of diseases either in this part or in several other parts of the Kingdom (Tab. 5). Of the *Culex* mosquitoes, *Cx. pipiens* and *Cx. quinquefasciatus,* are the chief vectors of bancroftian filariasis, *Wuchereria bancrofti* in many parts of the world including the Middle East and Eastern Mediterranean countries (AI-Ali *et al*, 2008). The disease has been reported from the southwestern districts of the Kingdom. Omar (1996) identified *W. bancrofti* among expatriate workers from five South-East Asian countries in Abha and reported that the local *Cx. pipiens* is highly susceptible to the parasite and concluded that this mosquito species may act as a potential vector of introduced bancroftian filariasis to Saudi Arabia. Haleem *et al*. (2002) reported three filarial cases from Saudi residences in Armed Forces Hospital, Riyadh. Jupp *et al.* (2002) and Miller *et al.* (2002) indicated that *Cx. tritaeniorhynchus* and *Am. v. arabiensis* are the main proven vectors of the Rift Valley Fever virus in the southern part of Saudi Arabia. In mid-September 2000, RVF outbreak began in Jizan and Yemen, and then extended northwards into Asir and Al Quenfadah. It was the first time to report RVF outside Africa and its first incursion into Saudi Arabia and Yemen (Miller *et al,* 2002; Jupp *et al*, 2002; Shoemaker *et al,* 2002). Seventy six people have died from an outbreak of Rift Valley fever and 408 people had contracted the disease (Ahmad, 2000). The outbreaks of RVF were reported since 1995 in the Tehama Red Sea coastal plateau in the western and southern regions, due to floods following heavy rainfall and agricultural activities that created ideal habitats for larvae of its vectors (Balkhy and Memish, 2003). Wills *et al.* (1985) isolated Sindbis virus, a human pathogen causing a dengue-like illness from *Cx. univittatus* (*Cx. perexiguus*) in the Eastern Region. Besides, *Cx. pipiens* was found to harbor West Nile Virus (WNV) in the examined mosquitoes

from Al Madinah (Al-Ali *et al*, 2008). The author concluded that there is a potential danger of the transmission of WNV in Al Madinah especially by *Cx. pipiens*. It was reported that *Ae. aegypti* (*St. aegypti*) is the primary established indigenous domestic vector of Dengue fever (DF) in Jeddah and Makkah (El-Badry and Al-Ali, 2010).

The virus was isolated for the first time from an adult in Jeddah in 1994 (Ahmed *et al*, 2011) and from February 1994 via December 2002 the total proved cases were 319 (Fakeeh and Zaki, 2003). Moreover, a total of 2357 laboratory confirmed cases were reported to the primary health care in Jeddah (Alzahrani *et al*, 2013). Ayyub *et al*, (2006) reported 39 out of 80 (48.75%) cases admitted with suspected diagnosis of DF in a large public hospital in Jeddah from May 2004 till April 2005. Alwafi *et al.* (2013) analyzed dengue fever data collected by the Vector-Borne Disease Unit in the Ministry of Health from 2008 to 2012 and reported that in 2008, the incidence rate was 6.2 per 100,000. This rate increased in 2009 to 110.6, then declined in 2010 to 62.95. In 2011 it declined further to 56.5 and in 2012 to 37.6. Of the anopheline species, *An. sergentii* is a secondary vector responsible for malaria transmission in southwest of the Kingdom (Al-Seghayer *et al*, 1999; Abdoon and Al-shahrani, 2003) and in the Eastern Province (Daggy, 1959; MOH, 1983) where *An. arabiensis* and *An. stephensi* act as the primary vectors in the two areas, respectively (Al-Seghayer *et al*, 1999). Malaria is endemic since 1900, and health reports showed that there is active transmission although at small level, with <10% of the reported cases were locally-transmitted and the rest were imported (Khater *et al*, 2013). Malaria was highly endemic in the Southwest (Jizan and Asir) where 83% of the Kingdom total cases are reported (Al-Seghayer *et al*, 1999). Moreover, *An. fluviatilis* is considered as secondary malaria vector in the Eastern Province (Daggy, 1959; MOH, 1983). *An. multicolor* is another important species in malaria transmission in other countries as well as in Saudi Arabia. The species is a suspected oases vector in Egypt (Kenawy *et al*, 1986) and North Africa (Zahar, 1974) and is regarded as a secondary malaria vector in some localities of Saudi Arabia (Abdoon and Alshahrani, 2003).

Table 5: Status of reported mosquitoes in western coast as vectors of diseases in Saudi Arabia

Species	Filariasis	Rift Valley	Sindbis Virus	West Nile Virus	Dengue Fever	Malaria
Cx. pipiens	◙			◙		
Cx. quinquefasciatus	◙					
Cx. tritaeniorhynchus		◙				
Cx. perexiquus			◙			
An. sergentii						◙
An. fluviatilis						◙
An. multicolor						◙
St. aegypti					◙	
Am. v. arabiensis		◙				

Conclusion

The diversity and abundance of different mosquito species, among which several vectors of diseases mainly malaria, Rift Valley fever, lymphatic filariasis and dengue fever have to draw attention to the western part of the Kingdom. Realizing that this area contains the holy places which are visited by millions of people from different countries all year round, the situation that pause a risk of transmission and more spread of such disease. So that control efforts have to be continued and intensified to overcome such situation. The results may be of importance for health officials in planning and implementing vector/disease control programs.

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