Pakistan J. Zool., vol. 45(2), pp. 503-510, 2013.

Study on Mosquitoes of Swat Ranizai Sub Division of Malakand

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Abstract.- A survey of mosquito larval habitats was conducted to determine species composition, relative abundance and habitat preference of mosquitoes of Swat Ranizai sub division of Malakand District. The survey was conducted from April to August and then from October to December, 2010. Mosquitoes immature stages were collected from different temporary and permanent breeding sites such as streams, springs, rock pool, ponds, drain and rice fields in three selected villages *viz*., Thana, Dheri-alladhand and Zormandai in Swat Ranizai subdivision of Malakand district. The immature stages were reared to adults. The analysis was carried out on adult stages. Fifteen species belonging to five genera; *Culex, Anopheles, Aedes, Culiseta* and *Armigeres* were identified. The species were *Cx. quinquefasciatus* Say (79.43%), *Cx. tritaenorhynchus* Giles (4.43%), *Cx. bitaenorhynchus* Giles (0.59%), *Cx. theileri* Theobald (2.14%), *Cx. mimecticus* Noe (2.14%), *Cx. vishnui* Theobald (0.22%), *An. stephensi* Liston (6.22%), *An. fluviatilis* James (0.39%), *An. maculatus* Theobald (1.34%), *An. culicifacies* Giles (0.32%), *An. subpictus* Grassi (0.17%), *An.* lindesayi Giles (0.02%), *Ae. vittatus* Bigot (3.93%), *Cu. longiareolata* Macquart (0.59%) and *Ar. subalbatus* Coquillett (0.04%). *Cx. quinquefasciatus* (79.4%) and *An. stephensi* (6.2%) were the dominant and constant species, regarding relative abundance and distribution recorded in most of the months and from majority of the habitats. Four species, *An. maculatus, Cx. theileri, Cx. tritaenorhynchus* and *Ae. vittatus,* were subdominant with the former two as moderate and the latter two as constant and infrequent respectively. The rest of the species were satellite with various distribution status. Streams were the richest habitats inhabited by 11 mosquito species followed by springs harboring 10 species of mosquitoes. The lowest species diversity (3 species) was recorded from rice fields and drains. The highest (2028) mosquito density was observed in November and lowest (55) in December.

Key words: *Anopheles, Culex,* Swat Ranizai, mosquito immatures, breeding habitats

INTRODUCTION

Mosquitoes are vectors for a number of infections like malaria, dengue, yellow fever etc. and are involved in transmission of diseases to millions of people annually. Several factors have been reported to affect the role of mosquitoes as vectors and in disease transmission (Noutcha and Anumudu, 2009). They have a worldwide distribution and breed in a variety of permanent and temporary water bodies (Aigbodion and Anyiwe, 2005). Mosquitoes exhibit spatial and temporal distribution on the basis of species, climatic conditions and environment (Wanji *et al.*, 2009).

They breed in natural or manmade temporary, semi-permanent as well as permanent water bodies with a variety of oviposition sites such as ground water sites (pools, rivers and lakes) and container sites including bottles, cups, tree holes (Rattanarithikul *et al.*, 2005). Larval distribution is greatly influenced by several factors such as elevation, water movement, water condition (polluted, fresh etc.), water temperature, vegetation, types of water source and many others (Rattanarithikul *et al.*, 2005). Oviposition, development of larva, adult emergence and many other processes take place in mosquito larval habitats, which thus play an important role in determining adult distribution and abundance (Overgaard *et al*., 2002). Mosquito species have also been classified on the basis of their larval habitat characteristics (Schafer and Lundstrom, 2001; Devi and Jahauri, 2007).

Mosquito faunistic studies in Khyber Pakhtukhwa have been carried out in Kohat–Hangu valley by Qutubuddin (1960), Gilgit (Tariq, 1967), Abbottabad (Suleman and Khan, 1993) and Peshawar valley and adjacent areas by Suleman *et al.* (1993) to determine species composition and relative abundance of mosquitoes. Ali and Rasheed (2009) carried out a study on immature stages of mosquitoes in Peshawar and reported nine species belonging to two genera *Culex* and *Anopheles*.

The present study was aimed at determining mosquito fauna of Swat Ranizai by sampling of immature stages of mosquitoes from a variety of

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0030-9923/2013/0002-0503 $ 8.00/0

permanent and temporary habitats. This survey also aimed to study potential larval habitats in the study area as detailed information on ecology and biology of mosquitoes is of great importance for vector management and effective control strategies against mosquito-borne diseases (Reinert, 1989).

MATERIALS AND METHODS

Study area

The survey was conducted to determine the species composition of mosquitoes from aquatic habitats of three villages: Thana, Dheri-Alladhand and Zormandai of Ranizai subdivision of District Malakand. Malakand District, with a total area of 952 km^2acts as a gateway to Dir, Chitral, Swat and Bajaur. It is bound by lower Dir district towards North; by Swat district (East), Mardan (South East) Charsadda districts (South West) while on theWest it is surrounded by Mohmand and Bajaur agencies. Malakand pass located near Dargai is a connection between district Swat and Mardan. Swat River, flowing through district Malakand and Charsadda finally joins Kabul River.

Sampling of immature mosquitoes

Mosquito larvae and pupae were collected from April to August and then October to December, 2010 from fresh as well as polluted water bodies from a variety of breeding sites of mosquitoes in three selected villages.

Sampling sites

Sampling was done from 15 sites of slow moving and standing water bodies including both temporary and permanent breeding habitats of mosquitoes scattered over the three villages. The sites were surveyed monthly and sampling was made with the help of a 50 ml dipper. The number of dips taken from a site was 10. Except the rock pool the rest of the habitats were perennial as some water was present almost all the time. While in the rock pool water was present in the rainy season from May to August. Following is the detail of sampling sites.

a) Rice fields: Five rice fields in large marshy areas including three near Pull Chock Alladhand two in the Thana region. Some water was there for most of the time.
b) Drain : A large size drain near Baro null in Allahdand.
c) Streams: Of mostly polluted,slow running water, one each in Thana, Allahdand and Zormandai .
d) Rock pool: In Sarkhandai Tangi mountain near Allahdand Dheri.
e) Springs: Three springs in Allahdand at Nmar tangi mountain, Umerdher Chena.
f) Ponds – Two polluted water pond filled with garbage at Cheenarrubbu, one grassy pond in Allahdand.

Laboratory processing

Larvae and pupae along with the water from each site were transferred to plastic jars. All the jars containing immature stages were covered with net of small mesh size to avoid escape of adult mosquitoes. A small hole was made in the net for collection of adult mosquitoes from the jars. No artificial food was given because the water from sampling sites was rich in nutrients.

Emerging adult mosquitoes were collected with the help of a manual aspirator and killed with cotton swab of chloroform. Samples were preserved in glass tubes over dry silica gel and were later identified using Taxonomic keys provided in “The fauna of British India, including Ceylon and Burma” by Christophers (1933) and Barraud (1934).

Data analysis

All the analysis was performed on adult mosquitoes obtained in the laboratory by rearing the collected immature stages. Seasonal variation was analyzed in terms of relative abundance and distribution using the following formulae (modified as the term density, “D” is changed to relative abundance) (Rydzanicz and Lonc, 2003; Sengil *et al.*, 2011).

$$\text{Relative abundance} = 1/L \times 100$$

where `1’ is number of specimens of each mosquito species and L is the total number of specimens.

The mosquito species were classified in following relative abundance classes: Satellite species, relative abundance <1%; sub-dominant

species, relative abundance <5% and dominant species, relative abundance >5% (Trojan, 1992).

$$\text{Distribution (C)} = n/N\ 100$$

where n is number of sites where species was found, and N is total number of sites.

The following classes were used to represent distribution status of different species according to Dzieczkowski (1972): C1 (sporadic) 0-20%; C2 (infrequent) 20.1-40%; C3 (moderate) 40.1-60%; C4 (frequent), 60.1-80%; and C5 (constant) 80.1-100%.

RESULTS

Mosquito species

A total of 4033 adult mosquitoes comprising 2059 female and 1974 male individuals were collected from rearing jars. Taxonomic identification revealed fifteen species of mosquitoes belonging to five genera *Culex, Anopheles, Aedes, Culiseta* and *Armigeres.* Both *Culex* and *Anopheles* were represented by six species each, whereas each of the other three genera was represented by one species.

Relative abundance and distribution status of recovered mosquito species

In terms of relative abundance, two species were dominant, four subdominant and nine satellite species, whereas on the basis of distribution three species were constant, five moderate, three infrequent and four sporadic species (Table I).

Monthly variation in larval abundance

The highest number of mosquitoes, 2028 (50.28%) was collected in November and lowest, 55 (1.36%) in December but in both the cases almost all the individuals belonged to *Cx. quinquefasciatus.* It was the commonly occurring species represented by the highest number 3205, 79.4%) and observed throughout the study period followed by *An. stephensi* (253, 6.27%) recorded in all the months except November and December. The rest of the species represented by relatively less number were found mostly in warmer months while in November and December least number of individuals as well as species were observed (Table II).

Habitat preferences of different mosquito species

Most preferred breeding site was observed to be the streams where 11 different species of mosquitoes were recorded followed by springs with 10 species, ponds and rock pools with eight species each. Drains and rice fields both were inhabited by only three species, indicating the least preferred habitats for mosquito breeding. Streams inhabited the highest number of individuals (2962) as well as species (11), while in rest of the habitats the number of individuals was independent of the number of species (Table III).

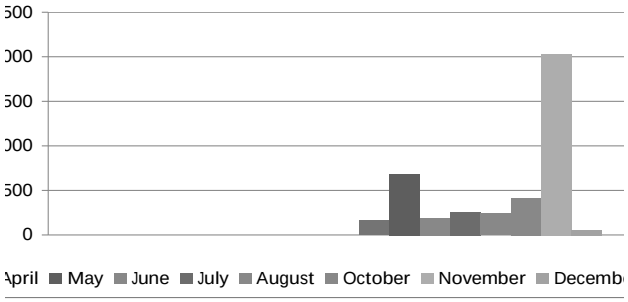

Fig 1. Seasonal variation in number of mosquito in Swat Ranizai.

DISCUSSION

For an effective control of mosquito larvae, knowledge of the type of habitat where mosquitoes breed is very important so that most productive habitat is given prime consideration (Ijumba and Lindsay, 2001). In comparison to highly mobile flying adults, mosquito eggs, larvae and pupae are confined to aquatic habitats and cannot readily escape mosquito control measures (Killeen *et al*, 2002).

There is no published information regarding species composition of mosquitoes in Swat Ranizai sub division of district Malakand. With the aim of contributing to this knowledge, occurrence of species and habitats used by mosquito larvae were investigated. This preliminary survey emphasized on collection of immature mosquitoes from variety of breeding habitats since it is the best, most productive method and yields maximum number of

Table I.- Relative abundance and distribution of mosquito species in different breeding habitats in Swat Ranizai.

Species	Total	Rel. abun.	Distribution	Rel. abun. status	Distribution status
Cx. quinquefacitus	3205	79	86	Dominant	Constant
Cx. tritaenorhynchus	177	4	86	Subdominant	Constant
Cx. bitaenorhynchus	24	1	43	Satellite species	Moderate
Cx. theileri	86	2	57	Subdominant	Moderate
Cx. mimeticus	4	0.01	43	Satellite species	Moderate
Cx. vishnui	9	0.2	57	Satellite species	Moderate
An. stephensi	253	6	86	Dominant	Constant
An. *fluviatilis*	16	0.3	29	Satellite species	Infrequent
An. maculatus	54	1	43	Subdominant	Moderate
An. culicifacies	13	0.3	14	Satellite species	Sporadic
An. subpictus	7	0.1	14	Satellite species	Sporadic
An. lindesayi	1	0.02	14	Satellite species	Sporadic
Ae. vittatus	158	4	29	Subdominant	Infrequent
Cu. longiareolata	24	0.6	29	Satellite species	Infrequent
Ar. subalbatus	2	0.04	14	Satellite species	Sporadic

species (Suleman *et al.,* 1993). A total of fifteen species were recovered during the survey, although the number is lower than that recorded from other parts of the province, like Peshawar (31) (Suleman *et al.,* 1993) and Charsadda (17) (Noreen, 2009). The probable reason, for the difference in number and species may be due to sampling procedure and variation in ecological conditions in different study areas. However, many species found in the present survey are shared with the above studies.

The present study has some similarity to the study of mosquito immature carried out in India by Devi and Jauhari (2007) sharing eight species with the present data. The similarity is largely in the species collected from stream, in both the surveys. Both the studies showed streams as the most preferred breeding habitat regarding number of mosquito species. The second preferred habitat in their study was found to be rock holes while this study indicated springs and rock pools second in number, showing similarity in some respects.

Culicine mosquito larvae were reported from variety of habitats but their presence was predominant in streams. Four of the six *Culex* species observed in present study, are also in accordance with those recorded by Hamidian (2007) in Iran again from the stream as the favoured breeding habitat. *Cx. quinquefasciatus* (cosmo-tropical mosquito) was found to be dominant and constant species found throughout the study period in accordance with some earlier studies regarding mosquito fauna in different localities (Ali and Rasheed, 2009; Suleman *et al*., 1993); Ali and Rasheed, 2009; Suleman *et al.,* 1993). It was sampled from all habitats except rice field, since it shows preference for large water bodies whether clean or organically rich or polluted water like wells, pools, drainage etc. In the present study this species was sampled from April till November, this observation was in confirmity with the findings of Hamidian (2007). It is an anthropophilic species, the primary cause of mosquito bites throughout the country and also considered as an important vector of West Nile Virus in Pakistan (Aslamkhan and Pervez, 1981; Pieris and Amerasinghe, 1994).

In this study *Cx. tritaenorhynchus*, possible vector of Japanese encephalitis (Barnett, 1976) and also vector of West Nile Virus in Pakistan and India (Pieris and Amerasinghe, 1994) was observed to be the second most abundant culicine species. It was found in all the habitats except drains, indicating its preference for small or large clean water bodies as reported by Alten and Bosgelmez (1996). *Cx. tritaeniorhynchus* showed its first appearance in the month of May reaching the highest peak in June, declining in the next two months of July and August followed by complete disappearance onwards. Ali and Rasheed (2009) also reported its highest number in the month of June. In contrast Hamidian (2007)

Table II.- Seasonal variation of different mosquito species in Swat Ranizai.

	April	May	June	July	August	October	November	December	Total
Rice fields									
Cx. tritaenorhynchus			43	23	19	0	0	0	85
Cx. bitaenorhynchus			1	2	16	0	0	0	19
An. stephensi	0		2	0	0	0	0	0	2
Total			**46**	**25**	**35**				**106**
Streams									
Cx. quinquefacitus	23	42	22	93	33	306	2023	54	2596
Cx. tritaenorhynchus	0	5	0	5	21	0	0	0	31
Cx. theileri	11	56	0	0	0	0	0	0	67
Cx. vishnui	0	0	0	0	0	2	0	0	2
Cx. mimeticus		1		0	0	0	0	0	1
An. stephensi	66	99	0	21	3	14	0	0	203
An. fluviatilis				0	0	6	5	0	11
An. maculatus	14	9	0	7	0	0	0	0	30
An. culicifacies					0	13	0	0	13
An. subpictus					0	7	0	0	7
Cu. longiareolata		1			0	0	0	0	1
Total	**114**	**213**	**22**	**126**	**57**	**348**	**2028**	**54**	**2962**
Drains									
Cx. quinquefacitus	4	77			86	62			229
Cx. theileri	3								3
An. stephensi		16							16
Total	**7**	**93**			**86**	**62**			**248**
Ponds									
Cx. quinquefacitus	11	122		13	47				193
Cx. tritaenorhynchus			6	17	2				25
Cx. bitaenorhynchus			2						2
Cx. theileri		10							10
Cx. vishnui				2					2
An. stephensi			1	3	1				5
Cu. longiareolata	23								23
Ar. subalbatus					2				2
Total	**34**	**132**	**9**	**35**	**52**				**262**
Springs									
Cx. quinquefacitus	1	43							44
Cx. tritaenorhynchus		2	19						21
Cx. bitaenorhynchus			1	2					3
Cx. theileri	6								6
Cx. mimeticus		1							1
Cx. vishnui			4						4
An. stephensi		4							4
An. maculatus				23					23
An. lindesayi								1	1
Ae. vittatus		74							74
Total	**7**	**124**	**24**	**25**				**1**	**181**
Rock pool									
Cx. quinquefacitus		113	1	29	0	0	0	0	143
Cx. tritaenorhynchus			7		8				15
Cx. mimeticus		2							2
Cx. vishnui				1					1
An. stephensi		5		18					23
An. fluviatilis		5							5
An. maculatus		1							1
Ae. vittatus			84						84
Total		**126**	**92**	**48**	**8**	**0**	**0**		**274**
Grand total	**162**	**688**	**193**	**259**	**238**	**410**	**2028**	**55**	**4033**

Table III.- Number of adult mosquitoes belonging to different species recovered from rearing of immature stages collected from different breeding habitats in Swat Ranizai.

Habitats	Rice fields (%)	Streams (%)	Drain (%)	Ponds (%)	Springs (%)	Rock pool (%)	Total (%)
Cx. quinquefacitus	0	2596 ((88)	229 (92.3)	193 (73.6)	44 (24.3)	143 (52.2)	3205 (79)
Cx.tritaenorhynchus	85 (80)	31(1)	0	25 (9.5)	21 (11.6)	15 (5.5)	177 (4)
Cx.bitaenorhynchus	19 (18)	0	0	2 (0.76)	39 (1.65)	0	24 (1)
Cx.theileri	0 -	67 (2.3)	3 (1.2)	10	6 (3.3)	0	86 (2)
Cx.mimeticus	0 -	1 (0.03)	0	0	1 (0.5)	2 (0.72)	4 (2)
Cx.vishnui	0 -	2 (0.06)	0	2 (0.76)	4 (2.2)	1 (0.36)	9 (0.2)
An.stephensi	2 (2)	203 (6.8)	16 (6.5)	5 (2)	4 (2.2)	23 (8.4)	253 (6)
An.fluviatilis	0	11 (0.37)	0	0	0	5 (1.82)	16 (0.3)
An.maculatus	0	30 (1)	0	0	23 (12.7)	1 (0.36)	54 (1)
An.culicifacies	0	13 (0.43)	0	0	0	0	13 (0.3)
An.subpictus	0	7 (0.23)	0	0	0	0	7 (0.1)
An.lindesayi	0	0	0	0	1 (0.5)	0	1 (0.02)
Ae.vittatus	0	0	0	0	74 (40.8)	84 (30.6)	158 (4)
Cu.longiareolata	0	1 (0.03)	0	23 (8.77)	0	0	24 (0.6)
Ar.subalbatus	0	0	0	2 (0.76)	0	0	2 (0.04)
No. of individuals	106 (2.62)	2962 (73.44)	248 (6.14)	262 (6.49)	181 (4.48)	274 (6.79)	4033 (100)
No. of species	3	11	3	8	10	8	15

reported its presence till November indicating marked differences in ecological conditions making more suitable scenario for this species in Iran than this part of Pakistan.

Two species of *Anopheles, An. stephensi* and *An. culicifacies* are considered to be mainly responsible for the transmission of malaria in Pakistan. *An. culicifacies* is thought to be the primary vector, especially in rural areas, whereas *An. stephensi* is considered to be of secondary importance in rural areas and only partially responsible for urban malaria transmission (Reisen and Boreham, 1982; Mahmood *et al.,* 1984; Mahmood and Macdonald, 1985), however, *An. stephensi* is an important vector in other parts of its range, such as the Persian/Arabian Gulf (Manouchehri *et al.,* 1976; Rao, 1984), KP province of Pakistan and eastern Afghanistan (Hewitt *et al.,* 1996; Rowland *et al.,* 1997; Graham *et al.,* 2002). *An. stephensi* being the main malaria vector in KP is evident in a study by Rowland *et al.* (2000) where they demonstrated that *Plasmodium falciparum* malaria cases in the KP peaked in October, when *An. culicifacies* had completely disappeared but *An. stephensi* was still present. *An. stephensi* appeared to be more abundant than *An. culicifacies* in the present study. The same trend was observed by Klinkenberg *et al* (2004), where a major shift in vector species composition was reported over the past 30 years, with an increase in abundance of *An. stephensi*.

In this survey *An. maculatus* and *An. fluviatilis* appeared to be mainly stream breeders (recorded in large number in streams as compared to other habitats). *An. fluviatilis* (considered to be malaria vector in Afghanistan, Iran and India) was observed in November indicating its high resistance and tolerance to cold as compared to other anopheline species (which were not observed in this month). This explains the high prevalence of the species in northern areas, a suspected vector of *Plasmodium* especially in mountainous and hilly areas of northern KP (Suleman *et al.,* 1993).

An. subpictus is found only in the month of October and as a satellite and sporadic species while Reisen *et al.* (1981) reported its dominance during summer season in Lahore. Similarly, Herrel *et al.* (2001) and Mukhtar *et al.* (2003) regarded it as a prevailing species during most part of the year in South Punjab. Geographical and ecological factors may be the contributing factors for this strong difference.

The finding of this study necessitates further entomological investigations of mosquitoes using different sampling methods to describe their feeding, resting behaviours and role in disease transmission especially malaria which is the main mosquito-borne disease in Pakistan. Ecological factors should also be taken into consideration for better evaluation of the status of mosquito borne diseases in this part of the country.

ACKNOWLEDGEMENTS

The authors offer their gratitude to Professor Dr. Mohammad Aslamkhan Department of Human Genetics and Biotechnology, University of Health Sciences, Lahore for his useful suggestions in making the manuscript of this paper. Mr Ghulam Mohammad, Laboratory Assistant Department of Zoology, University of Peshawar also deserves thanks for his help in field collections.

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(Received 15 January 2013, revised 27 February 2013)