

## Mosquito (Diptera: Culicidae) of Murree Hills, Punjab, Pakistan

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**Abstract.** Four anopheline and nine culicine mosquito species have been reported from Murree Hills. *Culex raptor* has been recorded for the first time from Pakistan. All other species, *Anopheles stephensi*, *An. maculatus*, *An. theobaldi*, *An. fluviatilis*, *Aedes aegypti*, *Ae. albopictus*, *Culex fatigans*, *Cx. vagans*, *Cx. nilgircus*, *Cx. fuscitarsis*, *Cx. raptor*, *Culiseta longiareolata* and *Armigeres obturbans* are recorded from new localities like Baroha, Terrat, Ghora Gali, Pindi Point, Kashmir Point and Jhika Gali during 2012-2013. A tentative key for all recorded species has been given. All species have been illustrated with identification characters along with their distribution range in Murree Hills. Main objective of this study was to explore the mosquito fauna of Murree Hills and to determine the distribution of various species during various months of the year.

**Key words:** Mosquito, Anophelinae, Culicinae, Diptera, Culicidae.

### INTRODUCTION

Mosquitoes are the members of family Culicidae, consisting of a monophyletic taxon in order Diptera. A large number of groups occur in this family, found throughout the tropical and temperate terrains of the world. All mosquito species belonging to this family have a pair of wings with elongated body (Service, 2008; Harbach, 2007). About 3523 species have been recorded in 111 genera from different areas up till now (Harbach, 2012; Reinert *et al.*, 2009). This family includes three subfamilies *viz.*, Culicinae (Culicines), Anophelinae (Anophelines) and Toxorhynchitinae (Service, 2008). Many mosquito species live in fresh water habitats and play important role in food chain. Some species are biters and transmit human health diseases like malaria, West Nile virus and dengue fever (Rueda, 2008).

Different mosquito species have been reported from different regions of the world like 113 species from Bangladesh (Ameen and Moizuddin, 1973; Ahmed, 1987); 22 species of *Culex*, *Aedes* and *Anopheles* from India (Sathe, 2011); 25 species from southern Israel (Margalit *et al.*, 1987); 39 from Egypt (Glick, 1992); 41 species Lombok Island (Miyagi *et al.*, 1994); 21 species from Turkey

(Sengil *et al.*, 2011); 384 species from Thailand, 249 from Malaysian (Tsukamoto *et al.*, 1987); 20 species from the Island of Japan (Toma *et al.*, 2011); 124 from Guatemala (Clark-Gil and Darsie, 1983); 309 species from Philippine (Tsukamoto *et al.*, 1985) and 191 from Vietnam (Phuong and Darsie, 2008).

Barraud (1934) and Christopher (1933) described 252 *Culex* species and 43 *Anopheles* species of mosquitoes in Indian subcontinent including 66 *Culex* species and 34 *Anopheles* in Pakistan. Three *Culex* species and one *Anopheles* species were added in mosquito fauna of Pakistan from 1934 to 1971 (Khan, 1971). Khan (1972) recorded 16 valid species of mosquito from Pakistan. Twenty-four Anopheline (seventeen species of subgenus *Cellia* and seven species of subgenus *Anopheles*) were recorded from Pakistan (Felix *et al.*, 2002). Suleman *et al.* (1977) reported 30 species of mosquito from Changa Manga Lahore, and described *Cx. tritaeniorhynchus*, *Cx. quinquefasciatus* and *Aedes lineatopennis* responsible in the transmission of West Nile virus. Twenty nine species of mosquito were recorded for first time in Lahore, Pakistan (Khan and Salman, 1969). Suleman *et al.* (1993) reported various species of mosquitoes from Peshawar Valley and adjoining areas along with their relative abundance. Keeping in view the up-gradation of mosquito fauna of Pakistan, a survey of Murree hills was done with the aim to explore mosquito. Murree

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falls into the Himalayan foothills or sub-Himalayan tract, with an approximate elevation up to 2200 m above sea level, is quite rich in species diversity (Zeitler, 1985). There was a need to explore the mosquito fauna of this area with their seasonal occurrence.

## MATERIALS AND METHODS

Adult mosquitoes were collected from various localities *i.e.* Baroha, Terrat, Ghora Gali, Pindi Point, Kashmir Point and Jhika Gali of Murree hills during 2012-2013. The collection was made from both indoor and outdoor sites of their resting habitats, using the net sweeping and mouth/ battery operated aspirator technique (the geographical location of collected specimens was specified during their labeling).

Specimens were photographed with SONY Cyber Shot *DSC-W650* (16 MP) and further identified under the Labomed stereoscope with digital camera (CE 990, eCAM 3000) fixed on Labomed (CZM6). Digi-Pro 4.0 software was used to capture and record the images. Identification of the mosquitoes was done using the keys of Barraud (1934), Rueda (2004), Becker *et al.* (2010). The Walter Reed Biosystematics Unit (WRBU) was used for the description confirmation. After the preliminary identification based on external morphological characters, the specimens were deposited in the Biosystematics Laboratory, Department of Entomology, PMAS- Arid Agriculture University, Rawalpindi (Pakistan). Morphometric characters like palpi, proboscis, scutellum, hind tarsomeres IV and entire V, femora and tibia, pulvilli, postspiracular, mesepimeral bristles, pleurae scales, coloration of pleural integument and abdominal band were used for identification and generation of keys following Barraud (1934), Rueda (2004) and Becker *et al.* (2010).

## RESULTS AND DISCUSSION

Thirteen mosquito species were identified from 6 different localities. *Cx. raptor* has been recorded for the first time from this region. The locality records for each species have also been added (Table I).

## KEY TO SUBFAMILIES OF FAMILY CULICIDAE

1. Palpi equal to proboscis or slightly shorter, scutellum rounded or slightly trilobed ..... Subfamily Anophelinae
- Palpi shorter than proboscis, scutellum strongly trilobed, setae are arranged on scutellum in three sets..... Subfamily Culicinae

### Genus *ANOPHELES* Meigen, 1818

Genus *Anopheles* Meigen belongs to subfamily Anophelinae and is worldwide in distribution. Spotted wings are the key character to recognize this genus. In appearance they make a specific angle while resting on wall. In female, palpi are equal to proboscis while in the male last two segments are swollen. Male fore legs with spur, claws with long segments.

### Genus *CELLIA* Theobald (1902)

Four pale spots present on costa, in addition to basal and humeral spots.

## KEY TO SPECIES

1. Apical part of the hind tarsomeres IV and entire V with pale scaled ..... *Cellia maculatus*
- Last two segment of hind tarsomeres completely white..... *Cellia theobaldi*
2. Palpi with pale rings on apical and subapical equal in width and having three pale rings. Femora and tibia spotted or speckled ..... *Cellia stephensi*
- Palpi with dark ring on subapical, wider than the apical pale ring. Femora and tibia not speckled .. *Cellia fluviatilis*

## KEY TO GENERA OF CULICINAE

1. Pulvilli are present ..... *Culex*
- Pulvilli are not present or simple..... 2
2. Postspiracular area without bristles, tip of male palpai spatulate ..... *Culiseta*
- Postspiracular area with bristles, tip of male palpai not spatulate ..... 3
3. Proboscis stout and tip turn downward ..... *Armigeres*
- Proboscis fairly straight and selender ..... *Aedes*

## KEY TO SUBGENERA

1. One or two number of lower mesepimeral bristles are present or none; proboscis with pale ring in middle... *Culex*.
- Four or more number of lower mesepimeral bristle are present ..... *Lutzia*

**Table I.- Distribution of various species of mosquito in different localities\* of Murree Hills.**

Sr. No.	Name of species	Baroha	Terrat	Jhika Gali	Ghora Gali	Kashmir Point	Pindi Point
1.	<i>Anopheles maculates</i>	+	-	-	-	-	-
2.	<i>Anopheles theobaldi</i>	+	-	-	-	-	-
3.	<i>Anopheles stephensi</i>	+	+	-	-	-	-
4.	<i>Anopheles fluviatilis</i>	+	-	-	-	-	-
5.	<i>Culex nilgircus</i>	+	+	+	+	-	+
6.	<i>Culex vagans</i>	+	+	-	+	+	+
7.	<i>Culex fatigan</i>	+	+	-	-	-	-
8.	<i>Culex fuscitarsis</i>	+	+	+	+	+	+
9.	<i>Theobaldia longiareolata</i>	-	+	-	-	-	-
10.	<i>Culex raptor</i>	-	-	-	-	-	+
11.	<i>Armigeres obturbans</i>	+	+	+	+	+	+
12.	<i>Aedes aegypti</i>	+	+	+	+	+	+
13.	<i>Aedes albopictus</i>	+	+	+	-	-	+

+ indicates species were found  
 - indicates species were not found

*Localities	Coordinates	Elevation (m)
Baroha	33.8084 N° & 73.23 E°	807
Terrat	33.5088 N° & 73.18 E°	967.74
Jhika Gali	33.54 N° & 73.25 E°	2079.95
Ghora Gali	33.53 N° & 73.20 E°	1529.79
Kashmir Point	33.54 N° & 73.24 E°	2134.20
Pindi Point	33.53 N° & 73.22 E°	2144.57

**KEY TO SPECIES**

1. Pleurae scales are absent, proboscis black ..... *Culex nilgircus*
- Pleurae with broad scale, proboscis pale beneath in the middle .....2
2. Fore and middle femora and tibia striped from front. Hind femur from beneath with pale line base to knee ..... *Culex vagans*
- Fore and middle femora not striped or dark in front. Hind femur not paled from base to knee .....3
3. Pleural integument with uniform coloured. Abdomen with basally bands ..... *Culex fatigans*
- Pleural integument with blackish area situated above and below the patch of white scales. Abdomen with bands..... *Culex fuscitarsis*

**Genus LUTZIA Theobald, 1903**

Large mosquito, four or more mesepimeral bristal present at lower side. Pulvilli well-developed. Female palpi is one fourth length.

*Culex (Lutzia) raptor* Edwards, 1922

Pale scale present on hind-femur on basal ½ exopt dorsally, on apical ½ with pale scales

forming a line to tip. Abdominal tergites with orcherous or whitish bands apically, last few segments broader then anterior segments.

**Genus THEOBALDIA Neveu-Lemaire, 1902**

In general appearance large species resembling with *Culex* species. This species having five to ten spiracular bristles but without postspiracular bristle. Tip of palpi spatulate. Palpi little shorter or slightly longer then proboscis.

**Genus ARMIGERES Theobald, 1901**

Proboscis is compressed laterally or bend downward. White scales and several bristles present at postspiracular area. One lower mesepimeral bristle. Palpi in female are one third length of the proboscis

*Armigeres (Armigeres) obturbans* Walk, 1860

Mesonotum without well defined golden lines, abdominal sternite 3<sup>rd</sup>, 4<sup>th</sup> segments with

apically black band and palpi of female one third length of proboscis.

Genus *Aedes* Meigen, 1818

This genus includes more than 400 species, 100 of them are recorded from Oriental region. Adult differs in ornamentation and size. Palpi of male are one fourth length of proboscis.

Genus *Stegomyia* Theobald, 1901

Small to medium size black and dark species. More than two white basal bands on tarsal segments. Proboscis entirely black. Broad and flat scales are on vertex and scutellum. Palpi of male are slender. Tarsal claw is simple, black species with white marking.

**KEY TO SPECIES**

1. A pair of submedian- longitudinal yellowish or white strip present on scutum with lyre-shaped white marking. Two well separated patch present on mesepimeron. White scales present on clypeus .....*Stegomyia aegypti*
- Narrow median-longitudinal yellowish or white strip present on scutum. V shaped patch present on mesepimeron. White scales not present on clypeus.....*Stegomyia albopictus*

*Anopheles maculatus* Theobald, 1901

*Material examined*

Baroha: 13-V-12, 1♂, 1♀.

*Comments*

Specimens collected from Pakistan were compared with published literature by Barraud (1934) and Becker *et al.* (2010). This species is widely distributed in oriental region and also in China. It is different on the basis of femora and tibia spotted.

*Anopheles theobaldi* Giles, 1901

*Material examined*

Baroha: 13-V-12, 2♂

*Comments*

Species specimens were compared with description by Barraud (1934). This is widely

distributed in Philippines, India and Burma. This species is distinct due to last two segments of hind tarsomeres completely white.

*Anopheles stephensi* Liston, 1901

*Material examined*

Baroha: 14-V-12, 2♂, 3♀. 4-VI-12, 3♀. 10-VIII-12, 1♀. Terrat: 4-VI-12, 1♂, 1♀.

*Comments*

Specimens were compared with the published description of *An. stephensi* given by Barraud (1934) and Becker *et al.* (2010). This species is distinct on the basis of speckled femora and tibia.

*Anopheles fluviatilis* James, 1902

*Material examined*

Baroha: 4-VI-12, 1♂, 3♀.

*Comments*

Specimens were compared with Barraud (1934) and Becker *et al.* (2010). This species is distinct on the basis of without speckled femora and tibia. *An. fluviatilis* is mostly found in the month of June.

*Culex (Culex) nilgircus* Edwards, 1916

*Material examined*

Baroha: 4-VI-12, 4♂, 3♀. 8-VII-12, 5♂, 9♀. Terrat: 1-V-12, 6♂, 13♀. 10-VIII-12, 3♂, 2♀. 4-IX-12, 3♂, Jhika Gali: 8-VII-12, 3♂, 1♀. Ghora Gali: 9-VII-12, 1♂, 1♀. Pindi Point: 29-VII-12, 7♂, 11♀.

*Comments*

Specimens were compared with the published description of *Cx. nilgircus* given by Barraud (1934), this species is quite different with respect to plurae without scales.

*Culex (Culex) vagans* Wiedemann, 1828

*Material examined*

Baroha: 1-V-12, 3♂, 10♀. 4-VI-12, 2♂, 6♀. 8-VII-12, 6♂, 9♀. Terrat: 1-V-12, 6♂, 3♀. 4-IX-12, 3♂, Kashmir Point: 20-X-12, 3♂, 5♀. Ghora Gali:

9-VII-12, 1♂, 1♀. Pindi Point: 17-XI-12, 5♂, 6♀.

*Comments*

Species was compared with the published explanation by Barruad (1934). This species is mostly found in mountainous area where temperature is low. *Cx. vagans* mostly found in the month of May, June, July, September, November and October. It is different due to colour of hind femur pale base to knee from beneath.

*Culex (Culex) fatigans* Wiedemann, 1828

*Material examined*

Baroha: 4-VI-12, 3♂, 5♀. 8-VII-12, 2♂, 3♀. Terrat: 4-VI-12, 1♂, 3♀. 8-VII-12, 3♂, 5♀.

*Comments*

*Cx. fatigans* mostly found in the month of June and July.

*Culex (Culex) fuscitarsis* Barraud, 1924

*Material examined*

Baroha: 15-IV-12, 1♂, 2♀. 1-V-12, 3♂, 3♀. 4-VI-12, 5♂, 3♀. 8-VII-12, 4♂, 7♀. Terrat: 1-V-12, 6♂, 3♀. 10-VIII-12, 0♂, 2♀. 4-IX-12, 1♂, Jhika Gali: 8-VII-12, 3♂, 7♀. Ghora Gali: 9-VII-12, 1♂, 6♀. Pindi Point: 29-VII-12, 3♂, 2♀. Kashmir Point: 25-IV-12, 3♂, 2♀.

*Comments*

This species mostly found in the month of April, May, June, July, August and September.

*Culex (Lutzia) raptor* Edwards, 1922

*Material examined*

Pindi Point: 29-VII-12, 0♂, 1♀.

*Comments*

This species is widely distributed in Western side of India from Punjab, Bombay and central provinces of Bangal and Burma, mostly found where temperature is low. Specimens were compared with the published description of *Cx. raptor* given by Barruad (1934).

*Culiseta longiareolata* (Macquart), 1838

*Material examined*

Baroha: 8-VII-12, 1♂, 0♀.

*Comments*

This species common in Western Himalayas: Murree, Sanawar, Kasauli. Baluchistan: Quetta, Pishin, Chaman. Sindh: Karachi. N. W. Frontier: Malakand, Bannu, Peshawar.

*Armigeres (Armigeres) obturbans* (Walk), 1860

*Material examined*

Baroha: 8-VII-12, 11♂, 6♀. 4-IX-12, 2♂, 2♀. 11-VIII-12, 1♂, 3♀. Terrat: 10-VIII-12, 7♂, 5♀. 4-IX-12, 3♂, 9♀. 7-X-12, 3♂, 7♀. Jhika Gali: 9-VII-12, 3♂, 5♀. Ghora Gali: 9-VII-12, 1♂, 3♀. Pindi Point: 29-VII-12, 3♂, 2♀. 4-IX-12, 5♂, 3♀. Kashmir Point: 25-VI-12, 1♂, 2♀.

*Comments*

This species mostly found in the month of June, July, August, September and October. *Armigeres obturbans* were collected from green vegetation and dense forest near foul standing water. This species is commonly occurring from Assam to Punjab, Burma and throughout India to Ceylon Barruad (1934).

*Aedes (Stegomyia) aegypti* (Linnaeus), 1762

*Cx. argenteus* Poiret, 1787; *Cx. fasciatus* Fabricius, 1805; *Cx. calopus* Meigen, 1818

*Material examined*

Baroha: 4-VI-12, 2♂, 1♀. 8-VII-12, 1♂, 5♀. 10-VIII-12, 0♂, 3♀. 7-X-12, 1♂, 2♀. Terrat: 10-VIII-12, 1♂, 3♀. 4-IX-12, 2♂, 4♀. Jhika Gali: 8-VII-12, 3♂, 5♀. Ghora Gali: 9-VII-12, 1♂, 4♀. Pindi Point: 29-VII-12, 3♂, 2♀. Kashmir Point: 29-VIII-12, 2♂, 1♀.

*Comments*

Specimens collected from Murree were compared with the published literature of *Ae. aegypti* given by Barruad (1934) and Rueda, (2004). This species is distinct due to specific character of white scales present on clypeus.

*Aedes (Stegomyia) albopictus* (Skuse), 1894*Material examined*

Baroha 8-VII-12, 3♂, 2♀. 10-VIII-12, 1♂, 4♀. Terrat: 8-VII-12, 1♂, 4♀. 10-VIII-12, 3♂, 2♀. Jhika Gali: 8-VII-12, 1♂, 2♀. Pindi Point: 29-VII-12, 3♂, 1♀. 10-VIII-12, 2♀.

*Comments*

Specimens collected from Pakistan were compared with the published literature by Barraud (1934) and Rueda (2004). This species was collected in the month of July and August. This species can be identified by specific character of white scales absent on clypeus.

### GENERAL DISCUSSION AND CONCLUSIONS

As a whole 13 species were reported from various localities of Murree area in comparison to 11 species recorded by Ahmed (2012) from Rawalpindi and Islamabad regions. Seven species namely *Anopheles theobaldi*, *An. fluviatilis*, *Culex nilgircicus*, *Cx. fatigans*, *Cx. fuscitarsis*, *Cx. raptor* and *Culiseta longiareolata* are different species as reported from Rawalpindi and Islamabad. Results (Table I) showed that *Aedes aegypti*, *Armigeres obturbans* and *Cx. fuscitarsis* are the most abundant species in the surveyed localities followed by *Cx. nilgircicus* and *Cx. vagans*. Maximum number of species were recorded from Baroha viz., *An. maculatus*, *An. stephensi*, *An. theobaldi*, *An. fluviatilis*, *Armigeres obturbans*, *Ae. aegypti*, *Ae. albopictus*, *Cx. nilgircicus*, *Cx. fatigans*, *Cx. fuscitarsis* and *Cx. vagans*. Minimum species were recorded from Kashmir Point viz., *Armigeres obturbans*, *Cx. vagans*, *Cx. fuscitarsis* and *Ae. aegypti*. All species reported are the same as reported by Barraud (1934) excepting *Cx. raptor*. The maximum number of species was recorded in the month of July and minimum numbers of species were recorded in April. There was no adult specimen collected in the month of January, February, March and December due to snow fall in the surveyed area.

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