Pakistan J. Zool., vol. 53(2), pp 757-760, 2021 **DOI**: https://dx.doi.org/10.17582/journal.pjz/20191001191052

Short Communication

Biodiversity of Culicidae Mosquitoes in District Bagh, Azad Jammu and Kashmir

Muhammad Shahbaz[1,*], Nosheen Farooq[1], Abu ul Hassan Faiz[1], Arshad Javid[2], Irfan Baboo[3], Misbah Shoukat[1] and Muhammad Aslam Khan[4]

[1]*Department f Zoology, Women University, Azad Jammu and Kashmir, Bagh*
[2]*Department of Wildlife and Ecology,University of Veterinary and Animal Sciences, Lahore*
[3]*Department of Zoology, Cholistan University of Veterinary and Animal Sciences, Bahwalpur*
[4]*Department of Human Genetics and Molecular Biology, University of Health Sciences, Lahore*

ABSTRACT

Present study explored the biodiversity of mosquitoes (Diptera: Culicidae) in the district of Bagh, and at some adjoining areas, Azad Jammu and Kashmir, during the period May 2017 to October 2017. The specimens were identified under the binocular microscope by following the taxonomic keys of Christophers (1933), Barraud (1934) and Rueda (2004). A total of 2895 specimens of mosquitoes were collected from the study area, belonging to family Culicidae and two subfamilies, Anophilinae and Culicinae. Eleven species were identified as *Anopheles barianensis* (sub-family Anophilinae), *Culex barraudi, Cx. epidesmus, Cx. fuscocephala, Cx. pipirms fatigans, Cx. pipiens pipiens, Cx. pseudovishnui, Cx. vishnui, Aedes aegypti, Ae. micropterus and Armigeres subalbatus* (subfamily culicinae). The most abundant species was *Armigeres subalbatus*.

Article Information
Received 01 October 2019
Revised 11 December 2019
Accepted 03 January 2020
Available online 26 February 2021

Authors' Contributions
MS and AHF conceived, designed and executed the experiment. NF and MS collected the specimens. NF and MA identified the species. AJ analyzed the data. IB wrote the article.

Key words
Biodiversity, mosquitoes, Culicidae, *Culex* spp., *Anopheles* spp.

Because of its geographical location and ecology Pakistan is one of the hotspots for mosquito-vectorial diseases (Chan *et al*., 1995; Stark and Schoneberg, 2012), that's why as early as 1971, mosquito biodiversity was initiated in Pakistan (AslamKhan, 1971, 1972). Due to the latest occurrences of dengue (Shakoor *et al*., 2012), it has created greatest attention in mosquito study in Pakistan (Mukhtar *et al*., 2011; Ilahi and Suleman, 2013; Rasheed *et al*., 2013).

Earlier in 1969, from the Changa Manga National Forest, AslamKhan and Salman (1969) studied the bionomics of mosquitoes and described 29 species of mosquitoes, many of which were uncommon, rare and reported for the first time from Pakistan. In Pakistan, the first ever effort to describe the Culicidae fauna was done by Aslamkhan (1971, 1972) who recorded 134 species of mosquitoes from Pakistan, of which 91 species from West Pakistan and 89 from East Pakistan (now Bangladesh). From 1934 to 1971, one species of *Anopheles* and three species of *Culex* were included in the mosquito fauna of Pakistan (AslamKhan, 1971). Later, AslamKhan (1972) documented 16 endemic species of mosquito from Pakistan.

* Corresponding author: shahbazchattha_pk@yahoo.com
0030-9923/2021/0002-0757 $ 9.00/0

More than 3500 species of mosquitoes have been documented, which belong to 42 genera and divided into three subfamilies such as Culicinae, Anophelinae and Toxorhynchitinae (Knight and Stone, 1977).

Currently the family Culicidae is divided into two subfamilies, 113 genera, 11 tribes and 3526 species (Harbach, 2007). Nearly 3523 species have been documented globally in 111 genera from different regions up till now (Harbach, 2012). The genus *Anopheles* has 7 subgenera and 460 species. *Culex* has 763 species belonging to 26 subgenera. The genus *Aedes* has 927 species, which belong to 70 subgenera. Most members of the family Culicidae are public health importance (Wilkerson *et al*., 2015; Freitas *et al*., 2015).

The purpose of this study was to enhance the knowledge of the culicids.

Materials and methods

The present study was carried out at District Bagh (Supplementary Fig. S1). The biodiversity of mosquitoes of the study area was never documented before.

The current study on the culicidae was accomplished in the district of Bagh, Azad Jammu and Kashmir from May, 2017 to October, 2017. Azad Kashmir is located at latitude 33° to 36° and longitude 73° to 75° and covers an area of about 13,297 square kilometers. This state of

Azad Kashmir is the western part of Himalayan range. The geography of the study area is commonly mountainous and woody with fertile valleys and small grasslands. Its climate is sub-tropical highlands form. Average extreme temperature of district Bagh varies from 20°C to 32°C while the average lowest temperature varies from 4°C to 7°C. Average yearly rain fall ranges from 1000 to 2000 millimeter. The general elevation above sea level, ranges from south to north from 360 meters to 6325 meters, respectively (Hussain, 2013).

The mosquitoes of the study area were explored, from May, 2017 to October, 2017 in the morning and evening. The priority of collection was given to the city of Bagh and surroundings areas due to estimated advanced definite abundance in these regions while urban and agricultural zones were also measured.

The mosquitoes were collected from human dwelling (indoor) and adjoining of human dwelling (outdoor) using pyrethrum spray technique as defined by WHO (1992) in the morning between 6 am to 8 am and 6 pm to 9 pm. Apart from this, catches in outdoor shelters like gardens, nurseries and wild vegetation was also made in day time. The mosquitoes were collected at outdoor using mouth aspirator and torch light and the collected mosquitoes were identified by using the keys (Christophers, 1933; Nagpal and Sharma, 1995; Smart, 2003).

The mosquitoes were killed with the help of ethyl acetate vapours and then mounted on piece of thick paper maintained by entomological pin and nail polish. These specimens were preserved in collection boxes comprising naphthalene balls.

Mosquitoes were put into the plastic cups and shifted into the laboratory, where orphometric characters such as palpis, 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 documentation and generation of keys (Barraud, 1934; Becker *et al*., 2010). Culicine and other anopheline species were identified by following standard taxonomic keys (Barraud, 1934; Christophers, 1933; Srivanakarn, 1976; Huang, 1972, 1979; Reuben *et al*., 1994).

The Shannon diversity index (H) was used to characterize species diversity at eight study sites. [H = -∑Pi log Pi] were worked out. Species Shannon-Weiner index: H= -∑ Pi log Pi, where H= Shannon-Weiner index, Pi=ni/N, ∑ = Sum, ni = Number of individuals of each species in the sample, N= Total number of individuals of all species in the sample.

Results and discussion

A total of 2895 specimens of mosquitoes were collected from the study area. A total of eleven species were identified (Table I).

Data show eight areas and eleven species of which the most abundant species was *Armigeres subalbatus* and minimum species was *Aedes aegypti*. *Culex pipiens* was present in all 8 areas of district Bagh. A total of 431 specimens of *Culex pipiens* were collected, greatest number was 143 from the Hodda Bari and least number was 25 which was from Kiayat. The total number of *Culex vishnui* was 244, the greatest number was 56 from the Hodda Bari and minimum number was 16 from the Kiayat. It was not present in Kotayra. The total number of *Culex pseudovishnui* was 231, the mixmum number was 47 from Hodda Bari and minimum number was 20

Table I.- Number of various collected species in different areas of district Bagh.

Recorded species	Selected area									Pi	LogPi	PiLogPi
	Rey	Nom	Kot	Nor	Hod	Gha	Kia	Dhi	Total			
Culex pipiens	40	50	35	60	143	48	25	30	431	0.14	-0.82	-0.12
Culex vishnui	40	17	0	45	56	42	16	28	244	0.08	-1.074	-0.090
Cules pseudovishnui	35	29	33	37	47	0	20	30	231	0.079	-1.09	-0.08
Culex fatigan	0	0	16	0	38	33	0	26	113	0.039	-1.40	-0.05
Culex barraudi	15	36	29	39	23	47	17	0	206	0.071	-1.14778	-0.081
Culex fuscocephala	0	21	45	55	0	26	42	24	213	0.073	-1.17	-0.08338
Culex epidesmis	20	19	35	32	41	54	24	32	257	0.088	-1.05172	-0.09336
Anopheles barriensis	10	28	34	46	36	37	33	35	259	0.089465	-1.04835	-0.09379
Aedes aegypti	0	0	18	0	20	0	0	21	59	0.02038	-1.6908	-0.03446
Aedes micropterus	0	26	24	44	34	29	24	14	195	0.067358	-1.17161	-0.07892
Armigeres subalbatus	213	48	65	80	135	27	65	54	687	0.237306	-0.62469	-0.14824
Total	373	274	334	438	573	343	266	294	2895	1	-12.2763	-0.97011

Rey, Reyara; Nom, Nomanpora; Kot, Kotayra; Nor, Norgala; Hod, Hoddabari; Gha, Ghaziabad; Kia, Kiayat; Dhi, Dhirkot.

from the Kiayat. It was not present in Ghaziabad. The total number of *Culex fatigan* was 113, the maximum number was 38 from Hodda Bari and minimum number was 16 from Kotayra. It was not present in Reyara, Noman Pora, Norgala, and Kiayat. The total number of *Culex barraudi* was 206, the maximum number was 47 from Ghaziabad and minimum number was 15 from Reyara. It was not present in Dhirkot. The total number of *Culex fuscocephala* was 213, the maximum number was 55 from Norgala and the minimum number was 21 from Noman Pora. It was absent in Reyara and Hodda Bari. The total number of *Culex epidesmis* was 257, the maximum number was 54 from Ghaziabad and minimum number was 19 from Noman Pora. The total number of *Anopheles barrianensis* was 259, the maximum number was 46 from Norgala and minimum number was 10 from Reyara. The total number of *Aedes aegypti* was 59, the maximum number was 21 from Dhirkot and minimum number was 18 from Kotayra. It was not present in Reyara, Noman Pora, Norgala, Ghaziabad and Kiayat. The total number of *Aedes micropterus* was 195, the maximum number was 44 from Norgala and minimum number was 14 from Dhirkot. It was absent Reyara. The total number of *Armigeres subalbatus* was 687, the maximum number was 213 from Reyara and minimum number was 27 from Ghaziabad (Table I).

The data revealed that *Culex pipiens* was present in in all the eight sites, *Culex vishnui* was present in all the sites except Kotayra. *Culex pseudovishnui* was present in all the sites except Ghaziabad. *Culex fatigan* was present in Kotayra, Hodda Bari, Ghaziabad and Dhirkot and it was absent in Reyara, Noman Pora, Norgala and Kiayat. *Culex barraudi* was present in all eight sites. *Culex fuscocephala* was present in all sites except Reyara and Hodda Bari. *Culex epidesmis* and *Anopheles barrianensis* was present in all sites. *Aedes aegyti* was present in Kotayra, Hodda Bari, Kiayat and Dhirkot. *Aedes micropterus* was present in all sites except Reyara. *Armigeres subalbatus* was present in all sites.

The data revealed a total of 1481 specimen of female mosquitoes: *Culex pipiens* was 211, *Culex vishnui* was 135, *Culex pseudovishnui* was 105, *Culex fatigan* was 54, *Culex barraudi* was 114, *Culex fuscocephala* was 108, *Culex epidesmis* was 140, *Anopheles barrianensis* was 116, *Aedes aegypti* was 32, *Aedes micropterus* was 92 and *Armigerus subalbatus* was 374.

Maximum percentage was *Armigeres subalbatus* (25.25%) and minimum percentage was *Aedes aegypti* (2.16%).

The number of male specimen from the eight areas of district Bagh, AJK. Total 1414 species of female mosquitoes were collected from this district. The number of female *Culex pipiens* (220), *Culex vishnui* (109), *Culex pseudovishnui* (126), *Culex fatigan* (59), *Culex barraudi* (92), *Culex fuscocephala* (105), *Culex epidesmis* (117), *Anopheles barrianensis* (143), *Aedes aegypti* (27), *Aedes micropterus* (103) and *Armigerus subalbatus* (313). Maximum percentage was *Armigeres subalbatus* (22.13) percent and minimum percentage was *Aedes aegypti* (1.90%). This study shows that the percentage of male *Culex pipiens* was lesser than the female, the percentage of male *Culex vishnui* was greater than the female, the percentage of male *Culex pseudovishnui* was less than the female, the percentage of male *Culex fatigan* was less than the female, the percentage of male *Culex barraudi* was greater than the female, the percentage of male *Culex fuscocephala* was almost equal to the female, the percentage of male *Culexepidesmis* was greater than the female, the percentage of male *Anopheles barrienensis* was less than the female, the percentage of male *Aedes aegypti* was greater than the female, the percentage of male *Aedes micropterus* was less than the female, and the percentage of male *Armigeres subalbatus* was greater than the female.

Conclusion

Out of a total of 2895 specimens of mosquitoes were collected from the study area 11 species were identified as *Anopheles barianensis*, 7 species as *Culex pipiens, Cx. epidesmus, Cx. pseudovishnui, Cx. fuscocephala, Cx. fatigans, Cx. vishnui, Cx. barraudi*, 2 species as *Aedes aegypti* and *Ae. micropterus* and one species as *Armigeres subalbatus*. The most abuntant species was *Armigeres subalbatus*.

Supplementary material

There is supplementary material associated with this article. Access the material online at: https://dx.doi.org/10.17582/journal.pjz/20191001191052

Statement of conflict of interest

The authors declare no conflict of interest.

References

AslamKhan, M. and Salman, C., 1969. *Pakistan J. Zool*., **1**: 183-205.

AslamKhan, M., 1971. *Mosq. System.*, **3**: 147-159.

AslamKhan, M., 1972. *Mosq. System.*, **4**: 98-102. https://doi.org/10.2307/3957597

Barraud, P.J., 1934. *Int. J. Mosq. Res*., **5**: 1-463. https://doi.org/10.1136/bmj.1.3818.463

Becker, N., Petric, D., Zgomba, M., Boase, C., Dahl, C. and Madon, N., 2010. *Mosquitoes and their control*, II edn. Springer Verlag, S Berlin, Germany,

pp. 608.

Chan, Y.C., Salahuddin, N.I., Khan, J., Tan, H.C., Seah, C.L., Li, J. and Chow, V.T., 1995. *Trans. R. Soc. trop. Med. Hyg*., **89**: 619-620. https://doi.org/10.1016/0035-9203(95)90412-3

Christophers, S.R., 1933. *The fauna of British India, including Ceylon and Burma*, *Diptera* Vol. 4, *Family Culicidae*. *Tribe Anophelini*., Vol. 12, London, pp. 371.

Freitas, L.A., Russu, C.A.M., Voloch, C.M., Mutaquiha, O.C.F., Marques, L.P. and Schrago, C.G., 2015. *PLoS One*, **10**: e0134462. https://doi.org/10.1371/journal.pone.0134462

García-Rivera, E.J. and Rigau-Pérez, J.G., 2002. *Lancet*, **360**: 261. https://doi.org/10.1016/S0140-6736(02)09481-3

Harbach, R.E., 2007. *J. Zootaxa*, **1668**: 591-638. https://doi.org/10.11646/zootaxa.1668.1.28

Harbach, R.E., 2012. *Mosquito taxonomic inventory*. Available at http://mosquito-taxonomic-inventory.info/ (Accessed on 17 January, 2020).

Huang, Y.M., 1972. *Contrib. Am. entomol. Inst*., **9**: 1-109.

Huang, Y.M., 1979. *Contrib. Am. entomol. Inst*., **15**: 1-79.

Hussain, S.A., 2013. *Azad Jammu & Kashmir, at a glance*. Planing and Development Department, Muzaffarabad, pp.6.

Ilahi, I. and Suleman, M., 2013. *Int. J. Innov. appl. Stud*., **2**: 454-463.

Knight, K.L and Stone, A., 1977. *A catalogue of the mosquitoes of the world (Diptera: Culicidae)*, 2nd edition. Thomas Say Foundation, Entomological Aspects Society of America, pp. 611.

Mukhtar, M., Tahir, Z., Baloch, T.M., Mansoor, F. and Kamran, J., 2011. *Dengue Bull*., **35**: 99-115.

Munstermann, L.E. and Conn, J.E., 1997. *Annu. Rev. Ent*., **42**: 351-369. https://doi.org/10.1146/annurev.ento.42.1.351

Nagpal, B.N and Sharma, V.P., 1995. *Indian Anopheles*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp. 416.

Rasheed, S.B., Boots, M., Frantz, A.C. and Butlin, R.K., 2013. *J. Med. Vet. Ent*., **27**: 430-440. https://doi.org/10.1111/mve.12001

Reuben, R., Tewari, S.C., Hiriyan, J. and Akiyama, J., 1994. *Mosq. System*., **26**: 75-96.

Sirivanakam, S., 1976. *Contrib. Am. entomol. Inst*., **12**: l-272.

Shakoor, M.T., Ayub, S. and Ayub, Z., 2012. *WHO South-East Asia J. Publ. Hlth*., **1**: 229-231. https://doi.org/10.4103/2224-3151.207018

Stark, K. and Schoneberg, I., 2012. *Euro Surveill*., **17**: 20320. https://doi.org/10.2807/ese.17.47.20320-en

Smart, J.A., 2003. *Handbook for the identification of insect of medicinal importance*, ed 2. Biotech Book, New Delhi, India, pp. 295.

WHO, 1992. *Entomological field techniques for malaria control,* part I & II: *Learner and tutor's UIDC*. World Health Organization, Geneva, Switzerland, pp. 114.

Wilkerson, R.C., Linton, Y.M., Fonseca, D.M., Schultz, T.R., Price, D.C. and Strickman, D.A., 2015. *PLoS One*, **10**: e0133602. https://doi.org/10.1371/journal.pone.0133602