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STUDY ON *CULEX* MOSQUITOES OF BHELUKHEL, BODE AND TATHALI OF BHAKTAPUR DISTRICT, NEPAL

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ABSTRACT

An entomological study was carried out in Bhelukhel, Bode and Tathali of Bhaktapur district to compare fluctuation in population size of *Culex* mosquitoes in relation to relative humidity and temperature. Mosquitoes were collected during July-December 2012 around the pig enclosures and cattle sheds by means of dark activated rechargeable CDC light trap. The study resulted 73.41% of *Culex* mosquitoes out of the total mosquitoes collected (884). Total eleven species of *Culex*mosquitoes were recorded namely *Cx. tritaeniorhynchus, Cx. fuscocephala, Cx. gelidus, Cx. vishnui, Cx. pseudovishnui, Cx. bitaeniorhynchus, Cx. quinquefasciatus, Cx. edwardsi, Cx. hutchnsoni, Cx. whitei and Cx.whitmorei*. Distribution of *Culex*species was abundant in July and August. *Cx*. *quinquefasciatus,* the principal vector of *Lymphaticfilariasis* (LF) was recorded to be the most dominant species in all the three sites. *Cx*. *tritaeniorhynchus,* the principal Japanese encephalitis (JE) vector was collected in higher number during August from Tathali and Bode site and during July from Bhelukhel site. Significant variation was not observed in abundance of *Culex* mosquito in three study sites in six different months.

Keywords: *Culex*, vector, Japanese encephalitis, filariasis*,* Bhaktapur district

INTRODUCTION

Mosquitoes the important arthropod vectors are the carrier of some of the most lethal parasitic, bacterial and viral diseases like malaria, filariasis, dengue, encephalitis, yellow fever etc. that claim millions of lives around the world. Mosquito-borne diseases have been considered a serious public health threat as many of people are suffering from this (Gupta *et al*., 2004).Nepal has also been found vulnerable for different mosquito-borne diseases. Of the total population, about 64.6% are estimated to be at the risk of mosquito-borne diseases (Joshi *et al.,* 2004). Three diseases namely malaria, Lymphatic filariasis (LF) and Japanese encephalitis (JE) are prevalent in Nepal that causes much mortality and morbidity (Darsie & Pradhan, 1990). Malaria is transmitted by *Anopheles* mosquitoes while JE and LF are transmitted primarily by *Culex* mosquitoes.

The eco-system of Terai belt which is known to be favorable for the breeding of *Culex* mosquitoes has a humid subtropical climate, warm in the winter and hot in the summer. During monsoon season it receives heavy precipitation, ranging between 180-225 cm with relative humidity 80%-90% (Joshi, 2004; Joshi *et al*., 2004). In addition the region has huge rice field land mass which allows the *Culex* species remains throughout the year. While in mid

hilly regions like Kathmandu valley,they are active in summer season (Joshi *et al*., 2004). *Cx. quinquefasciatus, Cx. tritaeniorhynchus, Cx. gelidus, Cx. fuscocephala, Cx. bitaeniorhynchus* etc. are some of the important culicine mosquitoes that have great public health importance as vector. Of which,*Cx. tritaeniorhynchus* and *Cx. quinquefasciatus* are suspected to be the principal vector of JE and LF respectively (Darsie & Pradhan, 1990).

The distribution of culicine species have been reported from different district of Nepal including Bhaktapur district (Sherchand*et et al.,* 2003). Along with the urbanization, human activities, changing climatic pattern and rice field ecosystem are known to be the important factor for distribution of mosquitoes in these areas (Joshi, 2004).

The earlier study conducted in Bhaktapur district by Byanju *et al*. (2012) revealed the prevalence of good number of *Cx*. *quinquefasciatus* in Thapagaun of Jaukhel and Lama tole of Nagarkot, Bhaktapur. Similarly, Shrestha (2011) reported the existence of Cx. *tritaeniorhynchus* and *Cx*. *gelidus* from Balkot Bhaktapur district. Beside this, no clear report is available regarding the distribution of *Culex* species in the district. Information available on the mosquito fauna, especially *Culex* is scanty. In view of this, a somewhat broader comprehensive view of species composition of *Culex* mosquitoes and its prevalence in the district is required to confirm the real situation of mosquito and also for developing an effective control strategy to eliminate the mosquito-borne diseases from the district. Thus the present study was carried out to study species composition of *Culex* species and its prevalence in Bhaktapur district with special emphasize in Bhelukhel, Bode and Tathali.

MATERIALS AND METHODS

Study area

Bhaktapur, the smallest district of Nepal, is situated at 27º36' to 27º44' latitude and 85º21' to 85º 32' longitudes (CBS, 2001). It is situated at west of Bagmati zone and lies about 13 km eastward of Kathmandu.

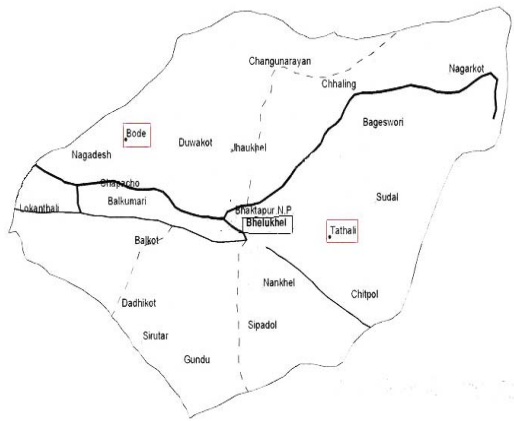

FIG.1. Map showing study sites of Bhaktapur district.

Bhaktapur is listed as a world heritage by UNESCO for its rich culture, temples and wood, metal and stone artwork and it comprises two municipality viz. Bhaktapur municipality and MadhyapurThimi municipality and sixteen VDCs namely, Bageswori, Balkot, Changunarayan, Chhaling, Chitpol, Dadhikot, Duwakot, Gundu, Jhaukhel, Kautunje, Nagarkot, Nankhel, Sipadol, Sirutar, Sudal, and Tathali. It covers an area of 119 sq km with an average population of 303,027 in the national census 2011 (CBS, 2012).

Agriculture is the primary occupation of the people. The main crops grown are rice, wheat, maize and different types of vegetable crops. Some of the farmlands are occupied by some local as well as people outside the valley for cattle farming. The climate of the district is sub-tropical cool weather with 75% annual average humidity. The temperature in general is maximum 32°C and minimum 20°C and average rainfall is 1400 mm most of which falls during June to August.

Three sites namely Bhelukheltole of Bhaktapur municipality, Bode tole of MadhyapurThimi municipality and Tathali VDC were selected as thesurvey sites to study species composition, abundance and prevalence of *Culex* mosquitoes. The sites were selected on the basis of presence of pig rearing, practices of traditional cattle shading, paddy cultivation, and presence of mosquito breeding sites.

Entomological survey

To assess the prevalence and fluctuation, mosquitoes were collected twice a month in each site throughout the month in July to December 2012. Mosquitoes were collected using dark activated rechargeable CDC light trap (Bio Quip Products, Inc. 2321 E Glaowick St. Rancho Dominguez, CA 90220, USA) fitted with double ring fine mesh collection bags, specifically, one light trap was placed outside houses within the same compound per village at dusk and was collected at dawn the next day.The light trap was fixed at about 5 ft. above the ground. The light trap was turned on overnight. Samples were collected in the morning after each night.

The screened bag from the light trap was removed and the mosquitoes were anesthetized with the help of ethyl acetate. These mosquitoes were then transported to the Tribhuvan University, Natural History Museum, Swayambhu for identification. All the sampled mosquitoes were morphologically studied and identified to the species level by using standard key by Darsie & Pradhan (1990).

Meteorological data

The relative humidity and average temperature for the period of the study was recorded by means of Thermo-hygrometer.

Data analysis

Recorded meteorological data and entomological data during the six month of study period were entered in excel and the variation in the number of *Culex* species between different study sites and month wise survey was analyzed by using two- way ANOVA table.

RESULTS

A total of 884 mosquitoes belonging to 6 genera and 21 species were collected. *Culex* species constituted 73.41% (649) of the total, of which 65.46% were recorded from Bode and 18.55% and 15.99% were recorded from Bhelukhel and Tathali respectively (fig.2).

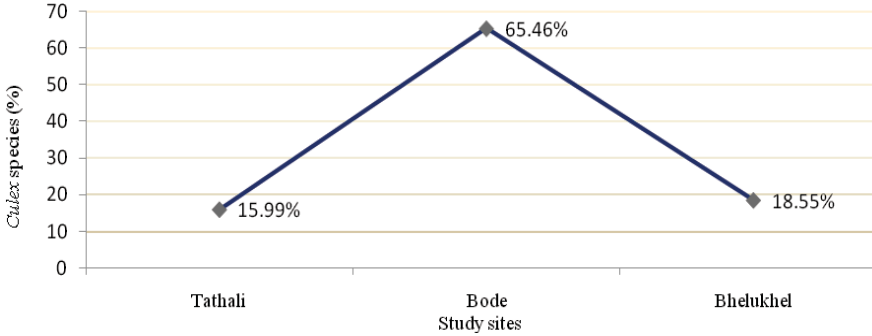

FIG.2. *Culex* **species collected during study period.**

Monthwise prevalence of *Culex* species in Bhelukhel is shown in table 1. Of the total 121 mosquitoes collected, highest population density was recorded in July (39.01%). During this month *Cx. quinquefasciatus* contributed a dominant species comprising 17.89% (22/121). *Cx. tritaeniorhynchus* recorded to be the second most abundant species constituting 6.5% (8/121). Other species *Cx. bitaeniorhynchus, Cx. vishnui and Cx.fuscocephala* constituted 4.88%, 3.25% and 3.25% of 121 respectively. Second highest density was recorded in August. During this period *Cx. bitaeniorhynchus* showed a tall peak with 6.5% (8/121). Among the all species collected, *Cx. fuscocephala* was found in every month except December, with its peak abundance in September (5.7%). No mosquito was collected in December.

TABLE 1. Monthwise percent abundance of *Culex* species in Bhelukhel.

Mosquito species	July	August	September	October	November	December
Cx. tritaeniorhynchus	6.5	1.63	1.63	0	0	0
Cx. bitaeniorhynchus	4.88	6.5	4.88	0	1.63	0
Cx. vishnui	3.25	4.1	1.63	0	0	0
Cx. pseudovishnui	0.8	3.25	3.25	0	0	0
Cx. gelidus	0	3.25	1.63	0	0.8	0
Cx. quinquefasciatus	17.89	3.25	1.63	0	1.63	0
Cx. fuscocephala	3.25	4.88	5.7	0.8	0.8	0
Cx. edwardsi	2.44	1.63	4.1	0	0	0
Cx. whitmorei	0	0	1.63	0	0.8	0
Total	39.01	28.49	26.08	0.8	5.66	0

TABLE 2. Monthwise percent abundance of *Culex* species in Bode.

	July	August	September	October	November	December
Cx.tritaeniorhynchs	1.21	4.91	1.23	0	0	0
Cx.bitaeniorhynchus	5.39	11.17	0.34	0	0	0
Cx. vishnui	1.94	14.56	0.68	0	0	0
Cx. pseudovishnui	1.94	5.8	1.17	0	0	0
Cx. gelidus	1.94	2.18	0	0	0	0
Cx.quinquefasciatus	2.7	17.48	7.7	0	0	0.2
Cx. fuscocephala	1.94	9.22	3.35	0	0.2	0
Cx. edwardsi	1.94	0	0.22	0	0	0
Cx. hutchinsoni	0.2	0.23	0	0	0	0
Total	19.2	65.55	14.69	0	0.2	0.2

Table 2 lists the month wise percent abundance of *Culex* species in Bode. The highest number of mosquitoes was collected in August. Of the total 421 *Culex* mosquitoes collected during that period comprised 17.48% *Cx. quinquefasciatus,* 14.56*% Cx. vishnui,* 11.17*% Cx. bitaeniorhynchus, 9.*22% *Cx. fuscocephala* and *4.91% Cx. tritaeniorhynchus.* The second highest numbers of mosquitoes were collected in July. *Cx. bitaeniorhynchus* was the predominant species collected during July comprising 5.39% (14/421), *Cx. tritaeniorhynchus* constituted 0.57% (5/421). Each of *Cx. vishnui*,*Cx. pseudovishnui, Cx. gelidus, Cx. quinquefasciatus*and*Cx. fuscocephala* constituted nearly 0.9% of the total 421. The numbers of mosquitoes were gradually decreased from September.

TABLE 3. Monthwise percent abundance of *Culex* species in Tathali VDC.

Mosquito species	July	August	September	October	November	December
Cx. tritaeniorhynchus	0	0.95	0	0	0	0
Cx. bitaeniorhynchus	2.86	1.9	0	3.81	0	0
Cx. vishnui	2.86	0	0	0	0	0
Cx. gelidus	0	0	0	0	1.95	0
Cx. quinquefasciatus	42.85	7.62	4.76	0.95	1.95	0
Cx. fuscocephala	12.38	3.81	0.95	0	0	0
Cx. edwardsi	5.71	0.95	0.95	0	0	0
Cx. hutchinsoni	0.95	0	0	0	0	0
Cx. whitei	1.9	0	0	0	0	0
Total	69.51	15.23	6.66	4.76	3.9	0

Monthwise percent abundance of *Culex* species in Tathali (table 3) shows that *Cx. quinquefasciatus* was the dominant species and was collected in every month of study period except December with its highest peak in July (42.85%). *Cx. fuscocephala* was the second dominant species. During July each of *Cx. vishnui* and *Cx. bitaeniorhynchus* constituted 2.86% of the total. *Cx. tritaeniorhynchus* was collected only in August and constituted 0.95% (1/105). Similarly, *Cx. gelidus* was found only in November comprising 1.95% (2/105). No specimen was collected in December.Significant variation was not observed in *Culex* species abundance in three study sites in six different months of study period.

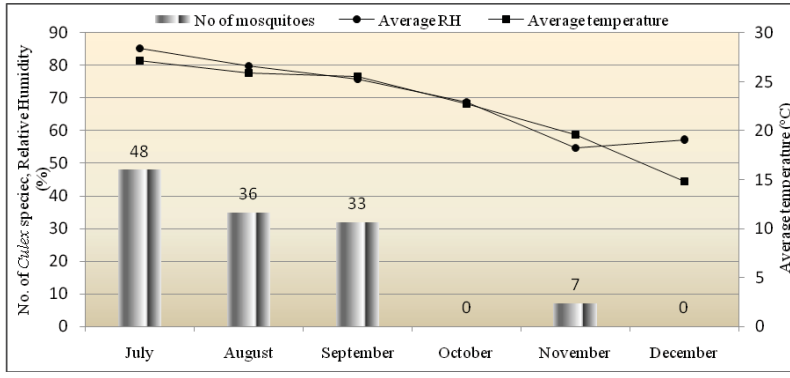

FIG. 3. *Culex* **species in relation to average temperature and relative humidity in Bhelukhel.**

A total of 48 *Culex* species were collected in July from Bhelukhel. At that time the average temperature was recorded as 27.15ºC and RH as 85.25%. In the month of October the mosquito number abruptly decreased to 0 when the average temperature and RH was recorded to be 22.73ºC and 68.83% respectively. The mosquitoes were recollected in November when the average temperature and average RH was recorded to be 19.57ºC and 54.75% respectively (fig.3).

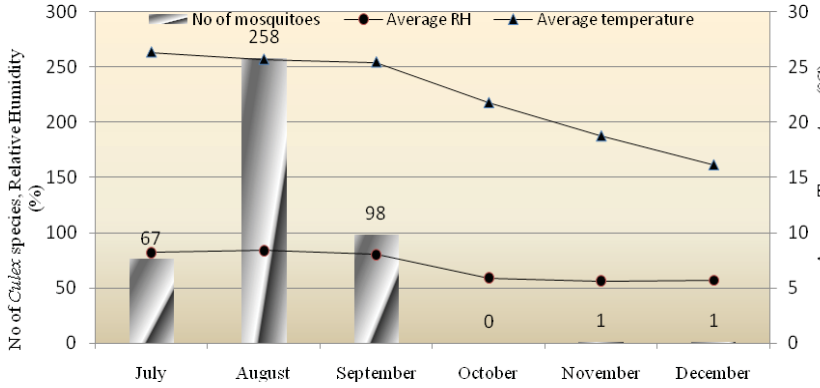

FIG. 4. *Culex* **species in relation to average temperature and relative humidity in Bode.**

The prevalence of *Culex* species in relation to average temperature and Relative Humidity in Bode (fig.4) shows that the maximum number of *Culex* species reached to 258 in August when the average temperature was recorded as 25.69ºC with average Relative Humidity 83.75%.The average temperature and average RH during October was recorded as 21.78ºC and 59.2% respectively and no mosquito was collected during this month. As shown in fig. 5, where the distribution of *Culex* species in relation to average temperature and Relative Humidity in Tathali is presented, the maximum number of 73 *Culex*species was collected in July. The average temperature at that time was recorded as 25.66°C and average Relative Humidity 86.38%. No *Culex* species was found in December when the temperature was 13.94°C and relative humidity was 56.73%.

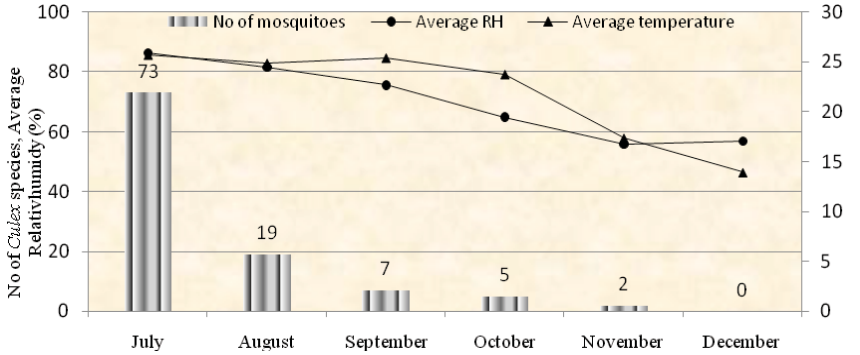

FIG. 5. *Culex* **species in relation to average temperature and relative humidity in Tathali.**

The distribution of *Culex* mosquitoes were highest in July–August (wet and rainy season) and found to be the lowest in October- December.

DISCUSSION

The study of mosquito population in Kathmandu valley revealed the similar result (Shrestha, 2011). The present study found *Cx. quinquefasciatus,* the principal vector of LF, as a dominant species. Though the species is known as poor vector of JE, few isolates of JE virus have been made from this species in India and Vietnam (Sirivanakarn, 1976). It constitutes 6.89% in Tathali, 16.75% in Bode and 3.40% in Bhelukhel. The species was found maximum in July and August. The result can be compared with a study conducted by Byanju *et al.* (2012) which reported the highest population density of *Cx. quinquefasciatus* in July and lowest in September.Neupane *et al*. (2009) reported the similar result in Chitwan district. *Cx. tritaeniorhynchus,* the principal JE vector of Nepal,whichconsisted 3.74% of the total collection was recorded in higher density from Bode in August. The species showed its tall peak during the paddy cultivation period in Kathmandu valley (Shrestha, 2011).

The study conducted in Gorakhpur, India also found rice fields contributing towards the building up of population density of JE vectors (Kanojia *et al*., 2003). House spraying with

residual insecticides, elimination of breeding sites and intermittent paddy irrigation may help in controlling larval population of *Cx. tritaeniorhynchus* (Kanojia *et al*., 2003). *Cx. gelidus* which has also been incriminated as a important JE vector in Nepal was recorded with good number from Bode (n=19) and Bhelukhel (n=16) but relatively fewer was recorded from Tathali (n=1). All three sites represent large proportion of rice cultivation and few numbers of piggeries. This species breed in habitat like cow dung pit, ground pools containing much weeds, marshy tracts etc (Gubler *et al*., 1989).

Cx. pseudovisnui, Cx. fuscocephala,Cx. bitaeniorhychus and *Cx. vishnui* was also found in appreciable density between July, August and September. These species are known to breed in large ground pools always filled with dense mass of filamentous green algae (Sirivanakarn ,1976).Other *Culex* species viz. *Cx. edwardsi, Cx. thileria, Cx. hutchinsoni, Cx. whitei* and*Cx. whitmorei* formed 10.41% of the total collected mosquitoes. Almost all individual species showed a rapid decline in the population from July to December as average temperature falls from 26.38ºC to 14.97ºC and average RH from 84.46% to 56.98%. From the statistical analysis, variable vector mosquito distribution was recorded in three study sites. Similar with the present study which showed no significant variation in *Culex*species abundance in three study sites in six different months, a study carried out in Jaukhel and Nagarkot of Bhaktapur district showed the insignificant monthwise variation of *Cx*. *quinquefasciatus* density (Byanju *et al*., 2013).

The highest number of mosquito was collected in July and August when the average temperature was recorded between 25.65ºC-26ºC with average RH 79.10%-86.69% which was similar to the study carried out by Joo & Kang (1992) who reported the highest average mosquito catch in night was July, when the temperature was between 18.6ºC-34.8ºC and the average RH 59%.-76%. Significant relation was not observed between density of *Culex* species with temperature and relative humidity. In opposite to this study, Neupane *et al*. (2009) showed positive correlation density of *Culex* with temperature.The pattern of rainfall, paddy ecosystem along with temperature and humidity affects larval breeding habit and distribution of mosquitoes (Arunanchalum *et al*., 2004; Gubler *et al*., 1989). The present study gives the information on the species composition, relative abundance and fluctuation of *Culex* species in the study area that provides the baseline data necessary for concerned health workers.Thespeciescollected from three sitesindicates the risk of area with regards to mosquito-borne diseases including JE and LF. The study shows the need of regular monitoring of mosquito in the district to find out the actual situationof mosquito and to inhibit the forthcoming disease epidemics.

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