

Dipterous haematophagous insects occurring in Dehradun district and its adjoining areas in Uttarakhand, India

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Abstract. Haematophagous dipterans belonging to 10 genera – *Aedes* (12), *Anopheles* (14), *Armigeres* (01), *Culex* (09), *Toxorhynchites* (01), *Uranotaenia* (01), *Sergentomyia* (02), *Phlebotomus* (01), *Atylotus* (01) and *Tabanus* (03) were encountered from 12 localities under 6 blocks of Dehradun district (Uttarakhand) during January 2011 to December 2012. The Culicines (50.69%) were more dominant than the Anophelines (38.9%), Toxorhynchites (1.72%), horse flies (6.63%) and sandflies (2.01%). The following species viz., *Toxorhynchites splendens* and *Phlebotomus argentipes* have been recorded for the first time while *Aedes pseudotaeniatus* as reappeared species from the study area. Species diversity is represented through Species richness (S), Shannon index (H) and Shannon Evenness (E) among *Aedes*, *Anopheles*, *Culex*, Sandfly and Horsefly. The species richness (S) and evenness (E) were found as 12, 0.65; 14, 0.84; 09, 0.74; 3, 0.61 and 4, 0.78 respectively by *Aedes*, *Anopheles*, *Culex*, Sandfly and Horsefly. Highest Shannon index was shared by *Anopheles* (2.214) followed by *Culex* (1.639), *Aedes* (1.631), Horsefly (1.085) and Sandfly (0.672) in succeeding order.

INTRODUCTION

Haematophagous insects and other arthropods are important in terms of public health as they are remarkably adaptable to the environment and successfully co-exist with man, feeding on him and his domesticated animals. Many species are known to transmit dreadful diseases like - malaria, filariasis, Japanese Encephalitis, dengue and leishmaniasis among human and surra (Trypanosomiasis) and FMD (Foot mouth disease) of domestic and wild livestock.

Earlier records about haematophagous insects from Dehradun (Uttarakhand), India in terms of mosquitoes are shown by Thomson (1903) and Wattal *et al.* (1958). Rao *et al.* (1973) in an article on haematophagous arthropods in western Himalaya recorded as many as 78 species under 36 genera from Dehradun district, including mosquitoes, horseflies and sandflies. Till then there is

almost no record on blood sucking insects other than the mosquitoes (Bhat 1975; Jauhari *et al.*, 1992; Mahesh & Jauhari 2003; Pemola & Jauhari 2004 a,b). Later on, Pemola Devi & Jauhari (2009) undertook a preliminary survey on haematophagous insects in Dehradun district and collected 63 species under 22 different genera in 7 groups (mosquito, lice, louseflies, sandflies, fleas, bedbugs and horse flies).

Some information is also available on general studies on sand flies (Kulkarni *et al.*, 1978; Kaul 1993; Mishra *et al.*, 2012; Poche *et al.*, 2011; Sharma *et al.*, 2009; Singh & Singh 2009) and tabanids (Mitra *et al.*, 2000; Vijay Veer, 2004). Keeping in view that the records on dipterous blood sucking insects seem to be scarce considering the area of the Doon valley and during the last 3-4 years there has been drastic changes in the climate as a result of which an increase in malaria and dengue cases has been reported. Henceforth, the present study aims to

determine dipterous haematophagous fauna especially mosquitoes, sandfly and housefly with more emphasis to reappearance / disappearance / new records and biodiversity using biostatistical analysis.

MATERIALS AND METHODS

The sites selection for sampling purpose is based on the geographic division of the Dehradun Valley as 6 blocks wherein 10 different sites were selected. Besides this, 2 sites were from the adjoining areas. In each sampling site, there were fixed collection spots while random sampling was also performed. Mosquitoes were sampled using aspirator and light trap (WHO, 1975 & Archives of National Institute of Malaria Research). Sandflies were collected using sticky paper traps, CDC light traps and aspirators from outdoors as well as indoors (Archives of Vector Control Research Centre, Puducherry & Rajender Memorial Research Centre, Patna). Collection of horse fly was made using common entomological nets (Vijay Veer *et al.*, 2002). Survey application were performed from January 2011 to December 2012 and both the larval and adults forms were sampled. The identification of mosquitoes is based on adult characters using standard taxonomic keys and catalogues (Christophers, 1933; Barraud, 1934; Wattal & Kalra, 1961; Knight & Stone, 1977; Das *et al.*, 1990; Nagpal & Sharma, 1995). In certain cases, the immature forms were emerged into adults under laboratory conditions and then the species was identified. For the identification of sandflies, key of Lewis (1978) was followed while the horseflies were identified by keys and catalogues as developed by Senior White (1927) and Stone (1975), besides the checklist presented by Vijay Veer (2004) and Mitra *et al.* (2007).

Data Analysis: Species diversity is represented through Species richness (S), Shannon index (H) and Shannon Evenness (E) by the following formulae:

Species richness (S) = Total number of species

$$\text{Shannon index (H)} = \sum_{i=1}^S - (P_i * \ln P_i)$$

where:

H = the Shannon diversity index

P_i = fraction of the entire population made up of species i

S = numbers of species encountered

Σ = sum from species 1 to species S

Note: The power to which the base e ($e = 2.718281828.....$) must be raised to obtain a number is called the natural logarithm (ln) of the number.

$$\text{Shannon Evenness (E)} = H/\ln(S)$$

where:

H = Shannon diversity index

$\ln(S)$ = Natural logarithm of species richness (S)

Rank abundance curves were calculated following Danoff-Burg & Chen (2005).

RESULTS

A total of 6650 specimens of blood sucking insects belonging to 45 species under 10 genera viz., *Aedes* (S=12; n=1627), *Anopheles* (S=14; n=2589), *Armigeres* (S=01; n=842), *Culex* (S=09; n=898), *Uranotaenia* (S=01; n=04), *Toxorhynchites* (S=01; n=115), *Sergentomyia* (S=02; n=320), *Phlebotomus* (S=01; n=121), *Atylotus* (S=01; n=13) and *Tabanus* (S=03; n=121) were captured (Table 1). The diversity of mosquito in terms of number of species under the six genera was found comparatively more than the other groups of blood sucking insects. There was less population of sandflies and horseflies. The Culicines (50.69%) were more dominant than the Anophelines (38.9%), *Toxorhynchites* (1.72%), horseflies (6.63%) and sandflies (2.01%). Among the mosquitoes, the *Anopheles* (42.6%) shared highest number of specimens followed by *Aedes* (26.78%), *Culex* (14.78%), *Armigeres* (13.86%), *Toxorhynchites* (1.89%) and *Uranotaenia* (0.06%) in succeeding order.

Species diversity is represented through species richness (S), Shannon index (H) and Shannon Evenness (E) in Table 2. The species richness (S) and evenness (E) were

Table 1. List of Hematophagous dipterans collected from district Dehradun between May 2010 to April 2012

Sl. No	Common Name	Genera	Species	Abundance Rank		
1.	Mosquito	i) <i>Aedes</i>	i) <i>Ae. aegypti</i> (Linnaeus, 1762)	01		
			ii) <i>Ae. albopictus</i> (Theobald, 1908)	04		
			iii) <i>Ae. albopictus</i> (Skuse, 1894)	02		
			iv) <i>Ae. greenii</i> (Theobald, 1903)	06		
			v) <i>Ae. dissimilis</i> (Leicester, 1908)	12		
			vi) <i>Ae. gilli</i> (Barraud, 1924)	07		
			vii) <i>Ae. pseudotaeniatus</i> (Giles, 1901)	03		
			viii) <i>Ae. suffusus</i> (Edwards, 1922)	11		
			ix) <i>Ae. thomsoni</i> (Theobald, 1905)	08		
			x) <i>Ae. unilineatus</i> (Theobald, 1906)	09		
			xi) <i>Ae. vittatus</i> (Bigot, 1861)	05		
			xii) <i>Ae. w-albus</i> (Theobald, 1905)	10		
		ii) <i>Anopheles</i>	i) <i>An. gigas</i> (Giles, 1901)	13		
			ii) <i>An. nigerrimus</i> (Giles, 1900)	08		
			iii) <i>An. aconitus</i> (Doenitz, 1902)	10		
			iv) <i>An. annularis</i> (Van der Wulp, 1884)	09		
			v) <i>An. culicifacies</i> (Giles, 1901)	04		
			vi) <i>An. fluviatilis</i> (James, 1902)	06		
			vii) <i>An. jeyporiensis</i> (James, 1902)	12		
			viii) <i>An. maculatus</i> (Theobald, 1901)	01		
			ix) <i>An. minimus</i> (Theobald, 1901)	11		
			x) <i>An. pulcherrimus</i> (Theobald, 1902)	14		
			xi) <i>An. splendidus</i> (Koidzumi, 1920)	07		
			xii) <i>An. stephensi</i> (Liston, 1901)	02		
			xiii) <i>An. subpictus</i> (Grassi, 1899)	03		
			xiv) <i>An. vagus</i> (Doenitz, 1902)	05		
		iii) <i>Armigeres</i>	i) <i>Ar. durhami</i> (Edwards, 1917)			
		iv) <i>Culex</i>	i) <i>Cx. brevipalpis</i> (Giles, 1902)	08		
			ii) <i>Cx. pallidothorax</i> (Theobald, 1905)	09		
			iii) <i>Cx. quinquefasciatus</i> (Say, 1823)	01		
			iv) <i>Cx. mimeticus</i> (Noe, 1899)	02		
			v) <i>Cx. mimulus</i> (Edwards, 1915)	06		
			vi) <i>Cx. ramakrishnii</i> (Wattal & Kalra, 1965)	05		
			vii) <i>Cx. raptor</i> (Edwards, 1922)	04		
			viii) <i>Cx. vagans</i> (Weidemann, 1828)	07		
			ix) <i>Cx. vishnui</i> (Theobald, 1901)	03		
		v) <i>Toxorhynchites</i>	i) <i>T. splendens</i> (Weidemann, 1819)			
		vi) <i>Uranotaenia</i>	i) <i>U. nivipleura</i> (Leicester, 1908)			
		2.	Sandflies	i) <i>Sergentomyia</i>	i) <i>S. babu babu</i> (Annandale, 1910)	01
					ii) <i>S. bailyi</i> (Sinton, 1931)	03
			ii) <i>Phlebotomus</i>	i) <i>P. argentipes</i> (Annandale & Brunetti, 1908)		02
3.	Horseflies	i) <i>Atylotus</i>	i) <i>A. agrestis</i> (Weidemann, 1828)	04		
		ii) <i>Tabanus</i>	i) <i>T. auristriatus</i> (Ricardo, 1911)	01		
			ii) <i>T. biannularis</i> (Philip, 1960)	02		
		iii) <i>T. diversifrons</i> (Ricardo, 1911)	03			

Table 2. Species diversity of the dipterous blood sucking insects collected from the selected area during the study period

Genera /group	H (Shannon index)	E (Evenness)	S (Species richness)	N (No. of species)
<i>Aedes</i>	1.631	0.657	12	1627
<i>Anopheles</i>	2.214	0.839	14	2589
<i>Culex</i>	1.639	0.746	09	898
Sand fly	0.672	0.612	03	320
Horse fly	1.085	0.783	04	121

found as 12, 0.65; 14, 0.84; 09, 0.78; 3, 0.61 and 4, 0.78 by *Aedes*, *Anopheles*, *Culex*, sandfly and horsefly respectively. Highest Shannon index was shared by *Anopheles* (2.214) followed by *Culex* (1.639), *Aedes* (1.631), horsefly (1.085) and sandfly (0.672) in succeeding order. Almost the same trend was observed in the species evenness but with regard to species richness and number of species there was a slight change as *Culex* (09, 898) was replaced by *Aedes* (12, 1627) in the sequential order. Rank abundance curves showed the percentage of species abundance (Y-axis) versus species rank (X-axis) (Fig. 1). Species in the 1st rank being the most abundant, 2nd being the second most abundant and so on (Table 1). On comparing the rank abundance curves among the groups of mosquitoes, *Anopheles* species showed higher species richness and greater species evenness than *Culex* species followed by *Aedes* species.

Among the *Aedes* mosquito, *Aedes pseudotaeniatus* was found as reappeared species while *Toxorhynchites splendens* and *Phlebotomus argentipes* were recorded for the first time from this region. The genera i.e., *Armigeres*, *Toxorhynchites* and *Uranotaenia* shared one species each i.e., *Armigeres durhami*, *Toxorhynchites splendens* and *Uranotaenia nivipleura* respectively.

DISCUSSION

Keeping in view the diversity of dipterous haematophagous insects in the vicinity of Doon Valley, it seems that the region has been

the most neglected one (Rao *et al.*, 1973; Pemola & Jauhari, 2009) and the records seem to be quite small in number considering the larger area of the Valley. Since, the studies made from this region were limited to 1973 and thereafter a survey on haematophagous insects (mosquitoes, lice, louseflies, sandflies, fleas, bedbug and horseflies) was conducted by Pemola & Jauhari (2009) who recorded 63 species under 22 genera. Rao *et al.* (1973) and Bhat (1975) recorded 31 and 30 species of mosquitoes respectively under 4 genera. But, during the present study 38 species of mosquitoes have been recorded and that too under 6 genera. Further, the species viz., *Anopheles lindesayi*, *Aedes gubernatoris*, *Aedes pulchriventer*, *Culex bitaeniorhynchus*, *Culex pseudovishnui* and *Culex shebbearei* recorded by Rao *et al.* (1973) and Bhat (1975) have not been found in the present study. Moreover, *Tox. splendens* has been recorded for the first time from Dehradun district. In the past, Bhat (1975) recorded it from Pithoragarh district in Uttarakhand. *Aedes pseudotaeniatus* is considered as the reappeared species from Dehradun as it was recorded in the collection made by Rao *et al.* (1973) and Bhat (1975) but not in the mosquito survey conducted in the past 2 and a half decades (Jauhari *et al.*, 1992; Pemola Devi & Jauhari 2004a,b and 2009)

With regard to the status of horseflies, Rao *et al.* (1973) recorded only 2 species of *Tabanus* viz., *Tabanus trinominatus* and *Tabanus auristriatus* while Pemola & Jauhari (2008) reported only one species i.e., *T. auristriatus*. But in the present collection 3 species of *Tabanus* (*T. auristriatus*,

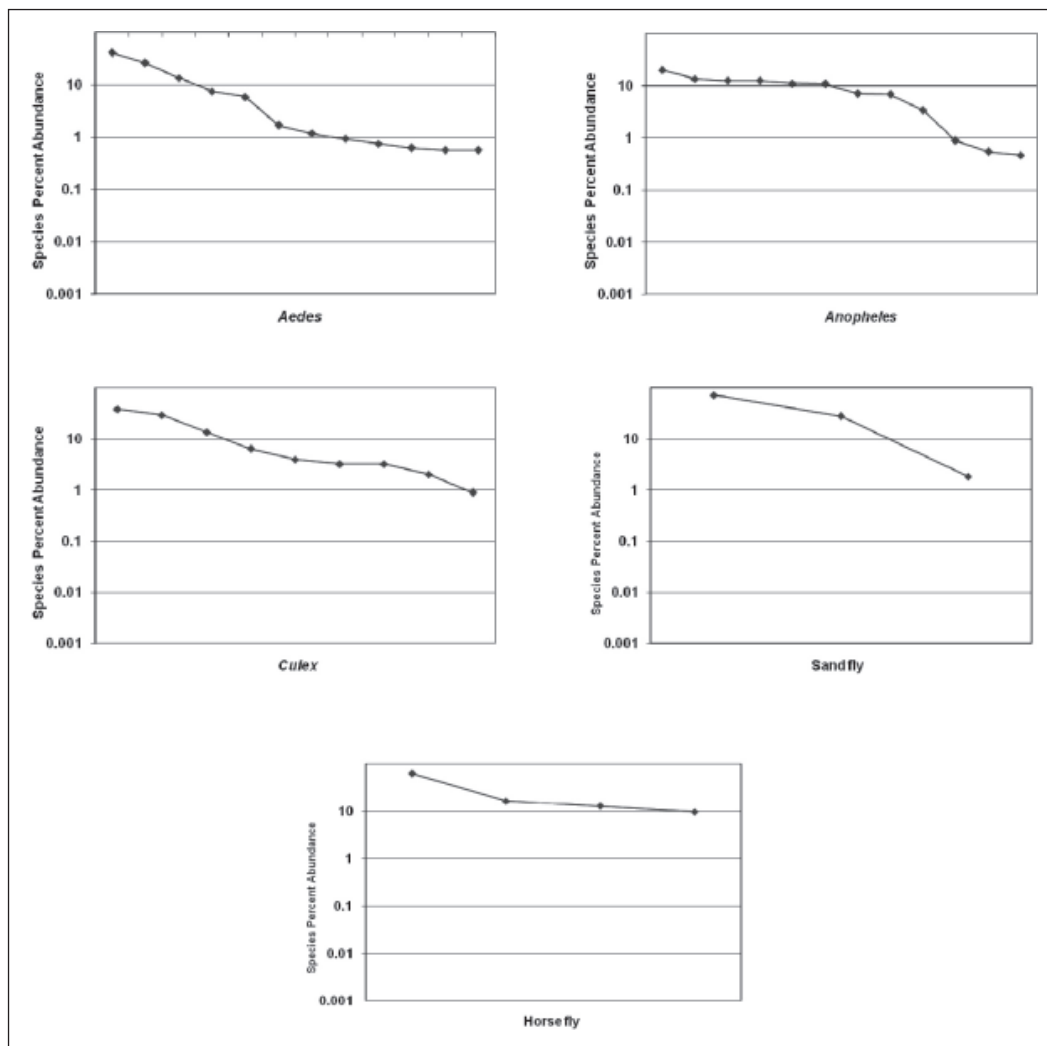


Figure 1. Rank abundance for some dipterous blood sucking insects as collected during the present study

Tabanus biannularis and *Tabanus diversifrons*) have been recorded. In this regard, our findings are in accordance with Vijay Veer (2004) who recorded 10 species including those 3 species as recorded in our studies. Rao *et al.* (1973) and Vijay Veer (2004) recorded *Atylotus agrestis* from Doon Valley, thus exhibiting a similarity with present findings. In the present collection, no specimen of *Haematopota* was recorded while Vijay Veer (2004) recorded it from Doon valley.

As far as the records of sandflies from Dehradun is concerned, Rao *et al.* (1973) recorded 3 species of *Sergentomyia* viz.,

Sergentomyia babu, *Sergentomyia bailyi* and *Sergentomyia zeylancus* from Dehradun but in the present study the former 2 species were recorded. However, in earlier studies, Pemola & Jauhari (2008) recorded only one species i.e., *S. babu babu* from Doon valley. *Phlebotomus argentipes* has been recorded for the first time from Dehradun as it was not recorded in earlier studies (Rao *et al.*, 1973, Bhat, 1975, Pemola & Jauhari, 2008).

Based on the present findings, the following species of dipterous haematophagous insects viz., *Aedes aegypti*, *Aedes albopictus*, *Anopheles maculatus*, *Anopheles stephensi*, *Armigeres durhami*, *Culex*

quinquefasciatus and *Sergentomyia babu bubu* are common from their occurrence point of view and confined to most parts of the valley. This may be due to the fact that there could be certain climatic conditions, which establish their adaptability best suited for growth and development. It can also be mentioned here that in the present study more emphasis has been given on biodiversity index of haematophagous dipterans but due to lack of information on species diversity a proper discussion cannot be accomplished. Further, there is a need to monitor the diversity of possible vector species infecting human and their livestock.

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