

Seasonal prevalence of different species of *Culicoides* in Bangalore rural and urban districts of South India

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Abstract

Aim: The study was undertaken to know the seasonal prevalence of different species of *Culicoides* in Bangalore rural and urban districts of South India.

Materials and Methods: The flies were collected with UV-light traps (Onderstepoort Veterinary Institute. ARC. LNR ??) during rainy season (south west monsoon: June, July, August and September: North West monsoon: October, November and December), winter season (January, February) and summer season (March, April and May) in eleven different farms of cattle, buffalo, sheep and goats in Bangalore rural and urban districts.

Results: From a total of 83, 629 number of *Culicoides* midges collected, 77906 (93.16%) were female and 5723 (6.84%) were males. In rainy season a total of 48,318 (57.77%), winter season 18,592 (22.23%) and summer season 16719 (19.99%) were reported.

Conclusion: In rainy season, highest numbers of *Culicoides* were found whereas least in summer.

Keywords: biting midge, *Culicoides*, seasonal prevalence, South India.

Introduction

Culicoides is an important human and animal pest with great economic significance and a prime vector for various viruses like *Bluetongue* virus, *African horse sickness* virus, epizootic haemorrhagic disease, Akabane, Aino, Chuzan, and bovine ephemeral fever virus, Vesicular stomatitis virus, Equine Encephalitis Virus (EEV), Schmallenberg Virus, protozoa like *Haemoproteus* spp. and *Leucocytozoon* spp. and Hepatocystis, avian Trypanosomes, Plasmodium in lizard and bird malaria and filarid worms like *Onchocerca cervicalis* in horses. *Dipetalonema* spp., and *Mansonella perstans* and *Mansonella ozzardi* in humans and various filarid worms of birds, mammals [1].

Culicoides commonly known as biting midges is a nematoceros fly. It is one of the world's smallest haematophagous flies measuring from 1 to 3 mm in size. The family Ceratopogonidae to which it belongs contains 125 genera and 5,500 species. Of these genera, four are known to contain species that suck the blood of vertebrates viz. *Austroconops*, *Culicoides*, *Forcipomyia* (subgenus *Lasiohelea*), and *Leptoconops*. More than 1400 species of genus *Culicoides* have been identified worldwide of which about 96% are obligate blood feeders attacking mammals (including humans)

and birds and occur on virtually all large land masses with the exception of Antarctica and New Zealand, ranging from the tropics to the tundra and from sea level to 4000 m [2].

In India 63 species of *Culicoides* were identified morphologically and their prevalence reported by many authors from Kolkata [3, 4], Kolkata and the neighbouring areas [5], Assam and Bengal and parts of India [6], Chennai [7], Marathwada region of Maharashtra [8], Calcutta [9], Tamil Nadu [10, 11], Chittoor and Prakasam districts of Andhra Pradesh [12] and Northern Karnataka [13] region but there is a very scanty information on these midges in most parts of India including Karnataka. A detailed study was essential to know the prevalent species of *Culicoides* in Bangalore rural and urban districts.

In view of this scenario and lack of seasonal prevalence study in Karnataka, the present study was undertaken in Bangalore rural and urban districts.

Materials and Methods

The seasonal prevalence of *Culicoides* spp. was studied in eleven different farms of cattle, buffalo, sheep and goats in Bangalore rural and urban districts. The flies were collected with UV-light traps (Onderstepoort Veterinary Institute. ARC. LNR) during rainy season (southwest monsoon: June, July, August and September: North West monsoon: October, November and December), winter season (January, February) and

Table-1: Morphometric measurements of *Culicoides* species

Species	Antenal ratio	Antenal sensillar pattern	Palpal ratio	P/H ratio	Wing length (mm)	Wing width (mm)	Costal ratio	Mandible teeth	Hindtibial spine (largest spine from spur)
<i>C. imicola</i>	1.04 (1.0-1.09)	3, 12-15	2.4 (2.1-2.6)	0.87	0.93 (0.8-0.99)	0.45 (0.42-0.5)	0.54 (0.5-0.57)	13	5(I)
<i>C. oxystoma</i>	1.04 (1.0-1.13)	3, 8-10	1.99 (1.88-2.2)	0.66	1.0 (0.9-1.06)	0.46 (0.44-0.5)	0.53 (0.51-0.55)	12	4(I)
<i>C. peregrinus</i>	1.18 (1.12-1.3)	3, II-5	2.9 (2.5-3.44)	0.92	1.19 (1.06-1.26)	0.54 (0.45-0.57)	0.64 (0.62-0.67)	14	6(II)
<i>C. actoni</i>	1.1 (1.06-1.15)	3, 12-15	2.18 (2.0-2.33)	0.73	0.83 (0.78-0.87)	0.4 (0.37-0.41)	0.56 (0.54-0.56)	13	5(I)
<i>C. huffi</i>	1.36 (1.3-1.46)	3, 5, 7-10	2.0 (1.8-2.1)	0.58	0.92 (0.87-1.02)	0.44 (0.43-0.5)	0.53 (0.53-0.55)	10	4(I)
<i>C. innoxius</i>	1.1 (1.06-1.16)	3, 1I-5	2.76 (2.5-3.0)	0.8	1.18 (1.1-1.28)	0.53 (0.48-0.57)	0.68 (0.66-0.68)	19	6(II)
<i>C. anopheles</i>	0.96 (0.93-0.99)	3, 1I-15	2.2 (2.2-2.3)	0.38	1.1 (1.07-1.12)	0.54 (0.45-0.57)	0.71 (0.69-0.72)	15	4(II)
<i>C. palpifer</i>	1.0 (0.98-1.07)	3, 11-15	2.1 (2-2.25)	0.56	0.97 (0.9-1.04)	0.44 (0.42-0.48)	0.68 (0.67-0.69)	7	4(II)
<i>C. circumscriptus</i>	1.12 (1.1-1.16)	3-14	2.07 (2.0-2.1)	0.91	1.18 (1.06-1.3)	0.53 (0.5-0.57)	0.57 (0.55-0.58)	15	4(I)
<i>C. arakawae</i>	1.36 (1.32-1.42)	3-14	2.4 (2.33-2.6)	0.96	1.12 (1.03-1.23)	0.5 (0.43-0.54)	0.6 (0.58-0.62)	12	4(I)

Table-2: Season wise distribution of different species of *Culicoides*

Species	Rainy	%	Winter	%	Summer	%	Total	%
<i>C. imicola</i>	19024	39.37%	13820	74.33%	7276	43.52%	40120	47.97%
<i>C. oxystoma</i>	26613	55.08%	4030	21.68%	8723	52.17%	39366	47.07%
<i>C. actoni</i>	1549	3.21%	447	2.40%	508	3.04%	2504	2.99%
<i>C. peregrinus</i>	877	1.82%	199	1.07%	69	0.41%	1145	1.37%
<i>C. huffi</i>	53	0.11%	53	0.29%	39	0.23%	145	0.17%
<i>C. innoxius</i>	107	0.22%	0	0	23	0.14%	130	0.16%
<i>C. palpifer</i>	50	0.10%	9	0.05%	31	0.19%	90	0.11%
<i>C. anopheles</i>	30	0.06%	11	0.06%	26	0.16%	67	0.08%
<i>C. circumscriptus</i>	8	0.02%	13	0.07%	16	0.1%	37	0.04%
<i>C. arakawae</i>	7	0.01%	10	0.05%	8	0.05%	25	0.03%
Total	48318	57.77%	18592	22.23%	16719	19.99%	83629	

summer season (March, April and May). The insects were collected in the light traps, kept from 6 pm to 6 am, and positioned within close proximity of 25m where the livestock were kept at night at 1.5-2.0m above the ground level and a glass collecting beaker containing 200–300 ml of water (to which a drop of detergent was added to reduce surface tension) and was placed at the base of each trap. The collected insects were transported to the laboratory and preserved in 70% ethanol. *Ceratopogonids* were first separated from all other insects. Identification of *Culicoides* was initially based upon wing pattern and confirmed subsequently by mounting different parts of the specimen in drop of phenol-balsam mixture on microscope slides after clearing in liquefied phenol solution for 12 h [14].

Morphological identification of *Culicoides* spp. was done by using keys of [4, 9, 15-18]. The characters for morphological identification of *Culicoides* spp. included wing markings, presence and distribution of macrotrichia, lengths of flagellar segments 3-15, length of 5 palpal segments, antennal ratio & palpal ratio, distribution of antennal coeloconica, form of sensory pit on 3rd palpal segment, form of whole 3rd palpal segment, proboscis-head ratio, number & form of spermathecae, form of male genitalia, appearance of leg & thorax, number (sometime absence) of teeth of

mandible, number of hind tibial comb and largest spine among them (i.e. on third pair of legs), length of body, length and breadth of wing, costal ratio.

Results

Morphologically a total of ten different species (Table-1, Fig:1-2 showing predominant *Culicoides* spp. *C. imicola* and *C. oxystoma* respectively) of *Culicoides* were found to be prevalent in eleven different farms viz. *Culicoides imicola*, *C. oxystoma*, *C. peregrinus*, *C. actoni*, *C. anopheles*, *C. palpifer*, *C. huffi*, *C. innoxius*, *C. arakawae*, and *C. circumscriptus*. During the different seasons a total of 83, 629 *Culicoides* midges were collected, out of these 77906 were female *Culicoides* (93.16%) and 5723 were male *Culicoides* (6.84%) from different farms of rural and urban districts of Bangalore. *C. imicola* and *C. oxystoma* were found to be the most predominant species found followed by *C. actoni* and *C. peregrinus*.

In rainy season a total of 48,318 (57.77%), winter season, 18,592 (22.23%) and summer season, 16719 (19.99%) midges were collected (Table-2).

In rainy season, *C. oxystoma* was found to be the highest followed by *C. imicola*, *C. actoni*, *C. peregrinus* where as other species were found in less number. In winter, *C. imicola* was found to be highest followed by *C. oxystoma*, *C. actoni* and *C. peregrinus*.

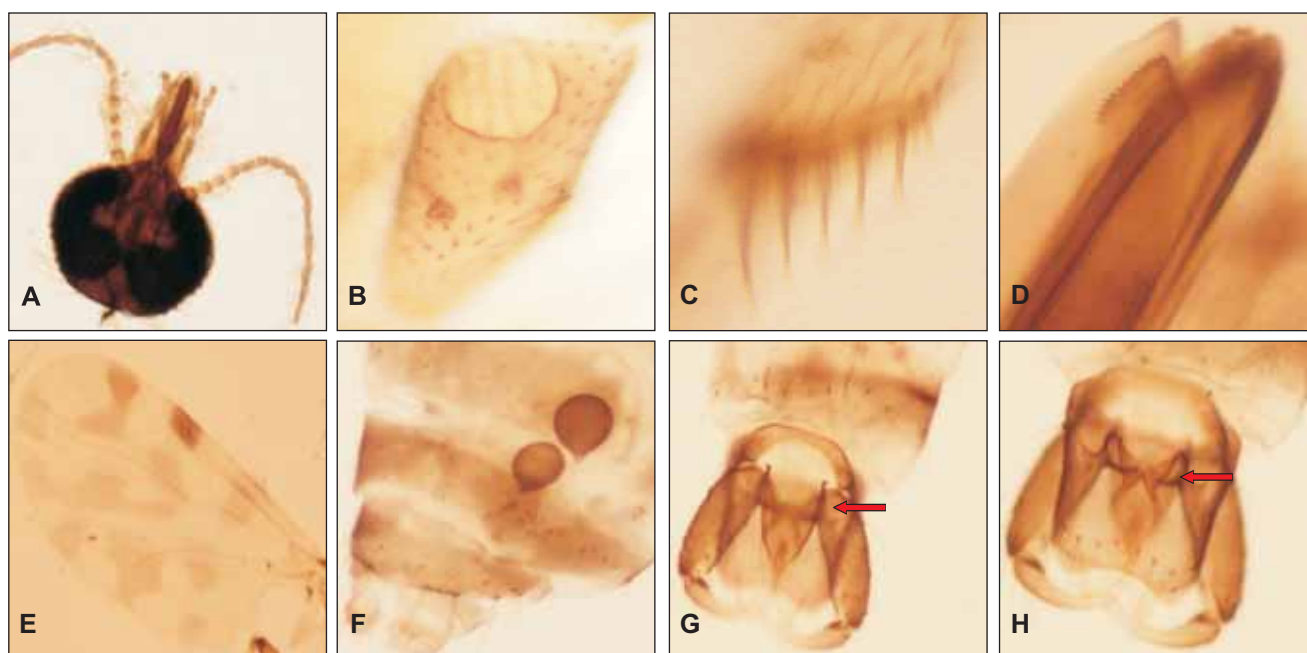


Figure-1: *C. imicola* - A. head, B. maxillary palp, C. hind tibial spine, D. mandibular teeth, E. wing, F. spermathecae, G-H. male genitalia.

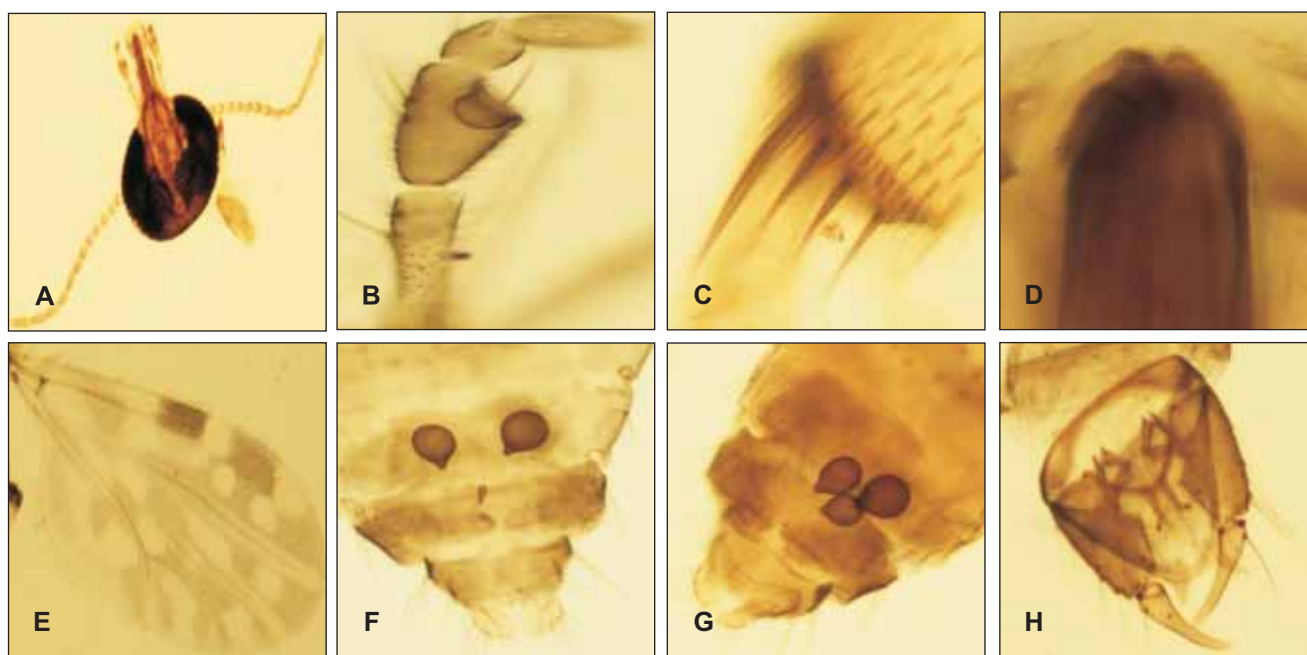


Figure-2: *C. oxystoma* - A. head, B. maxillary palp, C. hind tibial spine, D. mandibular teeth, E. wing F-G. spermathecae, H. male genitalia.

Other species were found in less number. *C. innoxius* was not found in winter season. In summer *C. oxystoma* was found to be highest in number followed by *C. imicola*, *C. actoni*, *C. peregrinus* other species were found in less number.

Discussion

The prevalence of females were more than males in the present study which is in accordance with various authors viz Satheesha *et al.* [19] Reddy and Hafeez [12], Deniz *et al.* [20], Foxi *et al.* [21] and Kim *et al.* [22] wherein females were more than males (75.7%-99.25% females) which may be because female flies are obligate blood feeders which are meant for egg

production and oviposition. Males are not blood feeders and usually die after mating.

The prevalence of 10 different species in the present study with species composition as given in Table-1, all these species were also reported by various other authors viz Wirth and Hubert [15] from South east Asia and Dasgupta [9] from Kolkata. *C. oxystoma*, *C. peregrinus*, *C. actoni*, *C. anophelis*, *C. palpifer*, *C. innoxius* by Sen and Dasgupta [4] among 31 spp., which they reported from Kolkata. *C. oxystoma*, *C. peregrinus*, *C. actoni*, *C. anophelis* were reported by Sen and Fletcher [6] from Assam and Bengal and other parts of India among 27 spp. *C. peregrinus*, *C. actoni* by Narladkar *et al.* [8] from Marathwada region of

Maharashtra. *C. imicola*, *C. oxystoma*, *C. peregrinus* were reported by Ganesh Udupa [10] from Tamil Nadu among 21 spp. *C. actoni*, *C. anophelis*, *C. innoxius*, *C. oxystoma* and *C. peregrinus* were reported by Reddy and Hafeez [12] from Chittoor and Prakasam districts of Andhra Pradesh among six spp. *C. imicola*, *C. oxystoma* by Bhoyar *et al.* [13] from Bidar and Mandakanahalli of Karnataka among 14 spp. *C. imicola*, *C. oxystoma* by Satheesha *et al.* [19] from Bidar of Karnataka among 15 spp. In all the above studies, *C. imicola*, *C. oxystoma* and *C. peregrinus* species were found to be commonly prevalent in most of the regions in India.

In the present study, *C. imicola* and *C. oxystoma* were the most predominant species which is correlated with other workers viz Ganesh Udupa [10] in Tamil Nadu, Satheesha *et al.* [19] in Bidar, Karnataka, and Bhoyar *et al.* [13] from Bidar and Mandakanahalli of Karnataka who made the same observation. Jayalakshmi [7] in Chennai and Narladkar *et al.* [8] in Marathwada of Maharashtra reported that *C. schultzei* was the most dominant spp. Reddy and Hafeez [12] reported that *C. oxystoma* was the predominant species in Chittoor and Prakasam districts of Andhra Pradesh. The variations in the occurrence of different species in different localities might be due to variations in the agro climatic and seasonal conditions in different localities/states etc [12].

In rainy season, highest number of *Culicoides* was found whereas it was least in summer this is in accordance with Narladkar *et al.* [23] who reported seasonal composition as 75.38% in rainy season, 19.75% in winter and 4.85% in summer. The above results were also found by Ilango [11] in Tamil Nadu, Reddy and Hafeez [12] in Chittoor and Prakasam districts of Andhra Pradesh, Sen and Dasgupta [4] and Dasgupta [9]. In rainy season, highest numbers of *Culicoides* were found whereas it was least in summer, this is because maximum temperature, low rainfall and high wind velocity deterred build-up of *Culicoides* and minimum temperature, high relative humidity and rainfall favoured build-up of *Culicoides* population significantly irrespective of species Nadlarkar *et al.* [23]. It can thus be concluded that rainfall plays an important influence on prevalence of *Culicoides*.

The seasonal prevalence of *Culicoides* species have been widely reported from many countries around the world. Mayo *et al.* [24] reported seasonal variation and impact of wastewater Lagoons as larval habitat on the population dynamics of *Culicoides sonorensis* at two dairy farms in Northern California. Meiswinkel *et al.* [25] reported seasonal fluctuations of *Culicoides* species in Netherlands. Diarra *et al.* [26] reported seasonal dynamics of *Culicoides* in the Niayes area of Senegal. Carvalho, L.P.C. and Silva [27] reported seasonal abundance of livestock associated *Culicoides* species in northeastern Brazil. Kim *et al.* [22] reported seasonal abundance of *Culicoides* in Northern Gyeonggi-do (Province), Korea. Kim *et al.* [28] studied the seasonal abundance of *Culicoides* spp. in

Republic of Korea. Ortega *et al.* [29] reported the seasonal abundance of biting midges, *Culicoides* spp. in central and southern Spain. Foxi *et al.* [30] reported seasonality in Sardinia (Italy). Miranda *et al.* [31] reported presence of midges in the Balearic Islands (Spain). Lysyk [32] studied seasonal abundance in Southern Alberta, Canada. In the present study, these species were not reported and these were different from seasons of present study. Breidenbaugh *et al.* [33] studied seasonal patterns of biting midges on the Parris Island Marine Corps Recruit Depot. In the present study, these species were not reported and these were different from seasons of present study. Foxi *et al.* [21] reported seasonal abundance of *Culicoides* found in northern Sardinia, Italy. The seasonal abundance patterns of the eight species of *Culicoides* were determined including *C. imicola*. In the present study *C. imicola* was found, other species did not occur, and those seasons were different from seasons of present study. Ander *et al.* [34] reported seasonal dynamics of biting midges in Sweden. Oem *et al.* [35] reported abundance of biting midge species on cattle farms in Korea. The above workers have reported seasonal abundance of *Culicoides* in different countries where they observed variation in the occurrence of different species in different season that were influenced by season. Therefore, season has a very important effect on prevalence of flies.

Conclusion

In rainy season, highest numbers of *Culicoides* were found whereas it was least in summer. In rainy season, *C. oxystoma* was found to be the highest followed by *C. imicola*, *C. actoni*, *C. peregrinus* whereas other species were found in less number. In winter, *C. imicola* was found to be highest followed by *C. oxystoma*, *C. actoni* and *C. peregrinus*. Other species were found in less number. *C. innoxius* was not found in winter season. In summer, *C. oxystoma* was found to be the highest in number followed by *C. imicola*, *C. actoni*, *C. peregrinus*. Other species were found in less number.

Authors' contributions

PED designed the study, following work was carried out by MA. PED helped in species identification. CRP and SMB helped in collection of sample. All authors participated in draft and revision of the manuscript. All authors read and approved the final manuscript.

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