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Container breeding preferences of *Aedes* mosquitoes in various localities of Dehradun district, Uttarakhand

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Abstract
The *Aedes* mosquito is a vector of transmitting many arboviral diseases. Knowledge of the breeding habitats of this vector is vital for implementing appropriate interventions. An entomological investigation were carried out in various localities of District Dehradun, Uttarakhand, India, during January to December 2019 with a view to study the container breeding preferences of *Aedes* mosquitoes. A total of 427 wet containers were searched in three seasons for *Aedes* larvae, out of them 67 (15.69%) containers were found positive for *Aedes* larvae. The highest number of positive containers reported was at monsoon season 30(16.13%), followed by post monsoon with 21(15.44%) and then pre-monsoon 16 (15.23%) containers. Discarded tires were the most preferred breeding habitats (28.57%)for *Aedes* mosquitoes while highest breeding preference ratio (.3.24) is for Desert coolers.

Keywords: dengue, *Aedes*, breeding preference ratio, Garhwal region

1. Introduction
Dengue is a worldwide serious public health problem spread throughout the tropical and subtropical zones. It is endemic in south-East Asia, the pacific, east and west Africa and America [1]. In India, dengue virus was first isolated in 1945 [2] and the first outbreak of Dengue hemorrhagic fever (DHF) in Calcutta occurred during 1963 [3] and subsequent DHF/ dengue shock syndrome (DSS) outbreak was documented in Delhi in 1988 [4], DF, DHF and DSS has been identified as a re-emerging disease and already reported from 35 states including union territory by the national vector borne Disease control programme (NVBDCP) [5] during the last decade. A total of 101192 dengue cases with 172 death in 2018 and 157315 dengue cases with 166 death in 2019 were reported by the NVBDCP from all sate of the country [5], in Uttarakhand state, 689 dengue cases with 3 death in 2018 and 10622 dengue cases with 8 death in 2019 were reported by NVBDCP. Dengue and DHF are posing a problem of utmost importance to the public health of the Uttarakhand state [5]

Dengue, the most common arboviral disease, is caused by four strains of dengue virus (DEN1, DEN2,DEN3 and DEN4) a member of flavivirus group in the family-flaviridae and transmitted by female *Aedes aegypti* mosquitoes [2]. Dengue virus has also been recently detected in *Ae. albopictus*, a secondary vector of dengue [6]. Now this vector has spread to rural areas also and spreading in areas which were so far free from this disease, it is due to increasing urban population, unplanned urbanization, rapid transportation, unreliable water supply and storage practices [7, 8]. Vector surveillance is an important tool to generate entomological data needed for control strategies [9].

In Uttarakhand, the first two cases of dengue were reported in Haldwani town, situated in the foot hills of the Kumaon hills in the western Himalayas, in 1996(10), various other worker who worked on various aspects of *Aedes* mosquitoes in Uttarakhand and shows that *Aedes* mosquitoes breed in artificial containers [11-13].

Knowledge of the breeding habitats of *Aedes* mosquitoes is vital for implementing appropriate interventions. Thus, this study was conducted to determine the breeding habitats and presence of *Aedes* mosquito species in the study area.

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2. Materials and Methods

2.1 Location and geography of study area
The study was conducted in Dehradun, capital of Uttarakhand state and is part of Garhwal region. Dehradun is located in the Doon valley on the foothills of the Himalayas nestled between the river Ganges on the east and river Yamuna on the west. It lies between latitudes 29°58' N and 31°2' N and longitudes 77°34'E and 78°18'E. This district consists of six tehsils-Dehradun, Chakrata, Vikashnagar, Kalsi, Tiuni and Rishikesh. The climate is humid subtropical. Summer temperature can reach up to 44 °C for a few days winter temperature are usually between 1 to 20 °C.
The area receives an average annual rainfall of 2073.3 mm. Most of the annual rainfall in the city is received during the months from June to September, July and August being rainiest.

2.2 Entomological survey
The entomological survey was carried out in the five localities of urban areas of Dehradun –Doiwala, kalsi, Raipur, Vikashnagar and city area of Dehradun, during January to December 2019. The studies were organized in urban, commercial, industrial areas as well as forested, residential, automobile and construction areas.
All peri-domestic area was observed thoroughly and the houses surveyed were selected randomly in every site. Immature were collected by dipping methods [14]. All available artificial larval habitats such as mud pots, flower pots, discarded tires, metal pots, desert coolers, plastic drums, ceramics, water tanks and thermocol and other containers in indoor and outdoor sites were searched for mosquitoes larvae.

2.3 Identification
Larvae collected from the breeding sites were identified to examine the mosquitoes with the help of stereoscopic microscope in the laboratory. *Aedes* mosquitoes species were identified with the help of pictorial identification key by Rueda [15]. Each larva observed was identified and *Aedes* larval were being chosen.

3. Results
All seven microhabitat (mud pots, flower pots, discarded tires, metal pots, plastic drums, water tanks and desert coolers) were inspected in every selected sites. A total of 427 wet containers were detected for *Aedes* larvae. A total 67(15.69%)

containers were reported positive for *Aedes* larvae. The highest number of positive containers reported was at monsoon season with 30 containers which form 44.78% of the positive containers showing high larval density followed by post monsoon with 21 containers reported positive with 31.34%. This indicates that rainfall and temperature are an important factor for the breeding of *Aedes* mosquitoes in this area. Out of seven type of containers inspected, discarded tire shows maximum [16] positivity of the larvae which forms 23.88%, followed by desert cooler 22.38% [15], mud pots 16.42 [11] and flower pot 14.92% [10]. Larval level of *Aedes* mosquitoes in water filled container in pre-monsoon, monsoon and post monsoon season were 15.23%, 16.13% and 15.44% respectively. Highest Breeding preference ratio (BPR) was 3.24,2.73 for desert cooler in post –monsoon and Monsoon season, followed by 1.97 for mud pots during pre monsoon season (Table 1).

3.1 Pre-Monsoon Survey
During Pre monsoon season, 105 wet containers were searched in selected areas of Dehradun district. The highest percentage of *Aedes* mosquitoes are found in discarded tires with 25.00 % followed by Desert cooler 31.25% and other mud pots 18.75%, while the highest breeding preference ratio (2.73) was for desert cooler followed by mud pots(1.97) and then water tanks (1.31). (Table-1).

3.2 Monsoon survey
A total of 186 containers were being searched for *Aedes* larvae, out of them 30 containers were found positive(16.13%), maximum percentage of positive containers were discarded tires (26.67%) followed by flower pots (20.00%) and desert coolers (16.67%). Breeding preference ratio was maximum for discarded tires (1.46) followed by plastic drums (1.39), flower pots (1, 16) mud pots and desert cooler (1.03) (Table-2).

3.3 Post-Monsoon survey
During post –monsoon survey, a total of 136 containers with water were searched for immature stages of *Aedes* mosquitoes. Maximum percentage of positive containers were discarded tires (28.57%), followed by Desertcooler (23.81%) and then mud pots (19.05). The highest breeding preference is of Desert coolers (3.24) followed by discarded tires (1.55) and then mud pots (1.30). (Table 3).

Table 1: Breeding Preference of *Aedes* mosquitoes in different artificial breeding habitats in Dehradun, during the pre-monsoon season

Types of breeding habitats	No of wet containers	% of wet containers (X)	No of containers with larvae	% of positive containers (Y)	BPR= Y/X
Mud pots	10	9.52	3	18.75	1.97
Flower pots	12	11.43	2	12.50	1.09
Discarded tires	25	23.81	4	25.00	1.05
Metal pots	20	19.05	0	0	0
Plastic drums	16	15.24	0	0	0
Water tanks	10	9.52	2	12.50	1.31
Desert coolers	12	11.43	5	31.25	2.73
Total	105		16		

Table 2: Breeding Preference of *Aedes* mosquitoes in different artificial breeding habitats in Dehradun, during the monsoon season

Types of breeding habitats	No of wet containers	% of wet containers (X)	No of containers with larvae	% of positive containers (Y)	BPR= Y/X
Mud pots	24	12.90	4	13.33	1.03
Flower pots	32	17.20	6	20.00	1.16
Discarded tires	34	18.28	8	26.67	1.46
Metal pots	26	13.98	2	6.67	0.48
Plastic drums	20	10.75	3	15.00	1.39
Water tanks	20	10.75	2	6.67	0.62
Desert coolers	30	16.13	5	16.67	1.03
Total	186		30		

Table 3: Breeding preference of *Aedes* mosquitoes in different artificial breeding habitats in Dehradun, during the post-monsoon season

Types of breeding habitats	No of wet containers	% of wet containers (X)	No of containers with larvae	% of positive containers (Y)	BPR= Y/X
Mud pots	20	14.71	4	19.05	1.30
Flower pots	16	11.76	2	9.52	0.81
Discarded tires	25	18.38	6	28.57	1.55
Metal pots	28	20.59	0	0	0
Plastic drums	22	16.18	2	9.52	0.59
Water tanks	15	11.03	2	9.52	0.86
Desert coolers	10	7.35	5	23.81	3.24
Total	136		21		

4. Discussion

Several communicable diseases are endemic in India. To overcome this challenge, creating awareness among the common public plays an important role in controlling them. Dengue fever is one of them. Proper vector control measures can effectively prevent the spread of dengue fever. The presence of solid wastes around the households like plastic containers, old and used tires, broken bottles etc gets flooded with water after rainy season which serves as a potential breeding site for *Aedes* mosquitoes thereby increasing the transmission of dengue fever. In this study, the most potential outdoor breeding site was discarded tires followed by desert cooler and then mud pots. This is consistent with other studies done elsewhere [16-18]. In a study on container breeding preferences of *Aedes albopictus* in urban environment in Udaipur, main breeding container is discarded tires followed by mud pots [19], similarly in Northwest Ethiopia, Ferede [20] find out that discarded tires were the most preferred breeding habitats for *Aedes* mosquitoes. This might have been because the water collected inside tires is not easily observable. Discarded tires might also be stored for longer duration and harbor mosquitoes larvae undisturbed, making them prolific breeding containers [21]. Moreover, the weather conditions inside tires, such as cool temperature, humidity and reduced light, create a suitable environment for *Aedes* mosquito breeding [22], in another study done in 2012 at Chennai, Tamil Nadu the most potential breeding sites were cement tanks, drums and discarded containers [23]. A similar result was obtained in a study done in Gampaha district of Sri Lanka where discarded containers constituted about 43.3% breeding sites [24].

In this study, other major breeding habitats was Desert cooler, similar habitats also found in Gadchiroli district of Maharastra [25]. Thus the breeding sites can be effectively reduced by simple eco-friendly control methods like solid waste management, container management and routine clean up campaigns.

5. Conclusion

The prevalence of water-holding containers allows *Aedes* mosquito larvae to breed, thereby increasing the *Aedes* mosquito population and the potential risk for arbovirus transmission. These finding might have important implications for *Aedes* mosquito control strategies, and in particular they may enable a more focused approach to vector control in which specific types of water holding containers would be targeted. Specially, the discarded tires should not be allowed to store in open spaces or must be covered to prevent rainwater from stagnating there to serve as breeding sites for mosquitoes. Therefore, it will be important to implement *mosquito* control strategies in order to prevent emergence of arboviral diseases.

6. Acknowledgements

7. References

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