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Correspondence

Immatures of *Aedes aegypti* in Darjeeling Himalayas - expanding geographical limits in India

Sir,

Darjeeling in West Bengal, India, is a part of the Himalayas biodiversity. Though mosquitoes are common to this region, they are restricted in their abundance in the rainy season[1,2]. Previous surveys have revealed the presence of several culicine mosquito species including *Aedes w-albus*, and the predatory mosquitoes *Toxorhynchites splendens* from this region[1], and a few other dipteran species that dominate the detritivore trophic level of the aquatic insect communities[3,4]. The mosquito larval habitats of this region include among others the cemented water storage tanks and bamboo groves[5]. Immature stages of the mosquitoes *Ae. aegypti* were noted from a temporary water pool and a few bamboo stumps in and around Darjeeling[5]. Though recorded from Gharwal region of Western Himalayas[6-9], the geographical limits of this vector were known to be restricted up to the foothills of Sikkim Himalayas[9]. In another survey[10], this species was found to have restricted distribution upto the Eastern plains of Bihar and North Bengal. However, the observation of the immature stages of *Ae. aegypti* in Darjeeling prompted us to carry out a primary survey to confirm the extension of its geographical limits in India and the Himalayas in particular.

The survey sites were the bamboo groves and temporary cemented pools in and around the Happy Valley Tea garden and Darjeeling Government College campus of Darjeeling, West Bengal, India, at an altitude of 2130m above sea level. Darjeeling receives on an average 2600 mm of rainfall during the period extending between June and October (annual average 3092 mm). The average temperature ranges between 19 – 24 °C during this period with the relative humidity above 80 per cent.

The bamboo stumps were surveyed at random for the presence of aquatic organism in selected groves of *Dendrocalamus hamiltoni* between August and September 2006. When found positive with any organisms, the detritus materials, organisms and the water content were pipetted out and placed on Tarsons® (Tarsons Products Pvt. Ltd., India) 100 ml plastic containers and brought to the laboratory of Post Graduate Department of Zoology, Darjeeling Government College, Darjeeling for identification. For the cemented temporary pools, random sampling using plankton net[11] of 200 µm mesh size attached to a iron handle was done during the same period. If found positive with mosquito larvae the sampling was continued every week, during the two month study period. The dredged material in the nets were collected in a 1000 ml glass beaker and brought to the laboratory for counting and identification[12,13] of mosquitoes and other organisms. Regular surveys at other mosquito larval habitats of this place, like, household water storage tanks, sewage drains, larger cemented water storage tanks, spring side pools, and ditches, were also carried out simultaneously, but were not found positive with the *Ae. aegypti* immatures. Data obtained on the density of *Ae. aegypti* immatures were recorded from each sites and were subjected to paired *t*-test to see the difference in the abundance in the habitats. Regression analysis was carried out on the bamboo stumps data to infer about the relationship of larval density and water content[14].

Of the 42 bamboo stumps surveyed, 21 were found to be positive with *Ae. aegypti* immatures. A total of 310 *Ae. aegypti* larvae (mean ± SE 14.76 ± 2.61) and 24 pupae (mean ± SE 1.14 ± 0.48) were collected from the 21 positive bamboo stumps, the water content in which ranged between 10 and 60 ml (mean ± S.D, 30.05 ± 17.27 ml). Among other organisms, immatures

of *Culex quinquefasciatus* Say 1826, *Lutzia vorax* Edwards 1921, *Toxorhynchites splendens* (Weidmann 1819) and immatures of chironomid midges were present in few stumps only. The immature density of *Ae. aegypti* and the water content in the stumps were positively correlated ($r = 0.892$; df = 19, $P<0.001$) with a regression equation: log (n+1) immature density (y) = 0.02 water content (x) – 0.586 ($r^2 = 0.507$; $F_{(1,19)} = 19.564$, $P<0.01$).

Of six the cemented pools, studied only one was inhabited by the immatures of *Ae. aegypti*. This pool was located in the Happy Valley tea garden, meant for the factory use, and contained immatures of *Cx. quinquefasciatus*, *Lutzia vorax* Edwards 1921, *Ae. w-albus* (Theobald 1905), *Chironomus* sp. and immatures and adults of *Rhantus sikkimensis* Regimbart, 1899, apart from *Ae. aegypti* immatures. In one sampling effort, two larvae of *Tx. splendens* were collected. In the 7 sampling days, a total of 580 larvae (mean ± SE 27.62 ± 4.64) and 117 pupae (5.57 ± 1.24) of *Ae. aegypti* were recorded from the pool (1 X 1.5 X1.5 m^3 in volume). The difference in abundance of the immatures was significantly different between the two habitats [between larval densities, pupal densities and immatures (total) $P< 0.01$].

Contrast to the distribution in the Garhwal Himalayas[6-9], *Ae. aegypti* was noted to be sporadically present in the terrains of Bihar and North Bengal[9,10]. This was associated with the lower incidence of dengue and dengue haemorrhagic fever (DHF) in North Bengal compared to other regions of West Bengal and India as a whole[10]. However, the incidence of malaria and encephalitis are common in the Dooars and adjoining parts of North Bengal[15-17]. Surveys on the mosquito fauna carried out as early as 1970 and during the mid 1990s confirmed abundance of this vector mosquito[15-17]. With the population growth and anthropogenic factors, and development in the Darjeeling Hills, mosquitoes are expected to be common with higher density and diversity. Further, Darjeeling is a well known tourist spot. Thus human migration is common, even if temporary. There may also be a possibility of transmission of dengue from the plains, apart from other relevant factors.

In recent years[1-3], several mosquito species that inhabit and co-occur with other predatory and non predatory organisms have been reported. Bamboo stumps have been newly noted mosquito larval habitat for *Ae*. *Aegypti* in this area[5]. So far the mosquito larval habitats are concerned, urban areas of Darjeeling provide plenty, in terms of quantity and quality[1]. Therefore, presence of other species of *Aedes* cannot be ruled out from this place. This mosquito was abundant in the bamboo stumps in places like Kurseong (~900m) and Rongtong (482m). Prevalence of different species of *Aedes* at a similar altitude was found to be high[6-8], but low at higher altitude in Western Himalayas. However, in contrast to the Nilgiris and Cardamom Hills (elevation up to 3000 m) in South India, where these mosquitoes are present at an altitude below 500 m[18], the Hills of Eastern Himalayas records the presence at an altitude of 2130 m. Presence of the *Aedes aegypti* in the islands of Lakshadweep has also been recorded[19]. The invasion of the high altitudes of Darjeeling Himalayas is a concern regarding the expansion of the geographical boundaries of the vector of dengue and DHF *A. aegypti* in India. Further entomological surveillance of this region is required to curtail the possibility of Dengue and DHF or other mosquito borne diseases.

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