INTRODUCTION

Mosquitoes are considered as nuisance pests on one hand and vectors of many dreadful diseases on the other both in rural and urban areas. In India, mosquitoes play a major role in transmission of many human diseases such as malaria, dengue, encephalitis, filariasis, and chikungunya. Approximately 400 mosquito species belonging to 19 genera are recorded in India (Dasgupta, 2000) but only mosquitoes of 4 genera i.e. Anopheles, Culex, Aedes and Mansonia are responsible for transmission of human diseases. Many pockets of the state of West Bengal, located in eastern India, are endemic foci for vector borne diseases. Siliguri town in West Bengal is approximately 125m above the sea level. Average temperature ranges from 15°C to 35°C, humidity 60% to 85% and mean rainfall is 900 mm. Siliguri is the 2nd largest municipal area following Kolkata with a population over 5 hundred thousand and is the gateway for tourists to Darjeeling and Sikkim hill resorts, and to the seven sister states of North East India. Terai area is having common international borders with Nepal, Bhutan and Bangladesh. So, the region experiences an influx and constant movement of healthy as well as diseased people from across the border and from

A COMPARISON OF THE RURAL AND URBAN MOSQUITO FAUNA OF SUBHIMALAYAN TERAI OF NORTH BENGAL

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ABSTRACT

Both the urban area of Siliguri town and its surrounding suburban and rural areas of the Terai belt showed a dominance of Culex quinquefasciatus and Armigeres subalbatus among 18 mosquito species. Occurrence of Anopheles minimus was more frequent among anophelines in urban as well as in rural sites, followed by An. barbirostris and An. varuna. All the three species were more prevalent in rural condition, with a higher incidence during rainy season. An. varuna, An. maculatus, and An. culicifacies were found in high frequency during winter in rural belt. The rainy season experience an increase in number of Aedes aegypti both in urban and rural sites. Ae. albopictus and Mansonia annulifera however could only be recorded in rural areas. Toxorhynchytes, which were greater in number in the rural areas, especially in the summer and the rainy seasons, appeared to be less adaptive to the urban water bodies, such as soak pits, nullahas and open drains those usually have a higher levels of synthetic chemicals, pollutants and effluents. Further, occurrence of six additional Anopheles species only in the rural sites supports their dependence on the less polluted conditions and the clear flowing waters prevailing in extra-urban areas of the Terai of North Bengal.

Key words: Mosquito species, urban and rural sites, Terai, North Bengal

INTRODUCTION

Mosquitoes are considered as nuisance pests on one hand and vectors of many dreadful diseases on the other both in rural and urban areas. In India, mosquitoes play a major role in transmission of many human diseases such as malaria, dengue, encephalitis, filariasis, and chikungunya. Approximately 400 mosquito species belonging to 19 genera are recorded in India (Dasgupta, 2000) but only mosquitoes of 4 genera i.e. Anopheles, Culex, Aedes and Mansonia are responsible for transmission of human diseases. Many pockets of the state of West Bengal, located in eastern India, are endemic foci for vector borne diseases. Siliguri town in West Bengal is approximately 125m above the sea level. Average temperature ranges from 15°C to 35°C, humidity 60% to 85% and mean rainfall is 900 mm. Siliguri is the 2nd largest municipal area following Kolkata with a population over 5 hundred thousand and is the gateway for tourists to Darjeeling and Sikkim hill resorts, and to the seven sister states of North East India. Terai area is having common international borders with Nepal, Bhutan and Bangladesh. So, the region experiences an influx and constant movement of healthy as well as diseased people from across the border and from

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other states of India. The outskirts of Siliguri occupy rural areas of both plains and hills covered with jungles of Sal, Teak, Gamhari, Jarul, Arjun etc. In the immediate surroundings of Siliguri urban area, tea plantations are more extensive than other agricultural crops including paddy. Annual parasitic incidence (API) of malaria has been reported to the extent of 23.02 per cent of the Terai-Dooars population in 2002 and 15.5 per cent in 2003 (Statesman News service, 3 July 2003). The number of malaria cases during 2003 was reported to be 46,987 of which malignant malaria was diagnosed positive in 19,339 patients in Jalpaiguri Dooars with death of 61 persons which was 3 times the number recorded in 2002 (Statesman News Service, 2 August 2003).

For successful implementation of vector management programme, adequate knowledge about the species composition, density and feeding behaviour is essential. Information on mosquito fauna of Himalayan Terai of eastern India is scanty (Nagpal and Sharma, 1987; Rudra and Mukhopadhyay 2010a; Rudra and Mukhopadhyay 2010b). Therefore an attempt has been made to study mosquito population with reference to the species diversity in the adjoining plains of Himalayan foothills. An analysis of the mosquito species frequenting the urban municipal area of Siliguri and its surrounding rural areas of the Terai belt of Himalaya, mainly watered by Teesta, Mahananda, Balasun, Punchnori, Lochka and Mechi rivers was done and compared based on data obtained during the first half of the opening decade (July 2002 to June 2005) of the 21st century to have a better understanding of the transmission of the diseases.

MATERIALS AND METHODS

Mosquito collection was done from eight spots covering the town of Siliguri (taking one spot from one Corporation ward) and 8 spots from 4 rural areas. The locations of 8 spots selected for mosquito collection in urban Siliguri were: Ashrampara, Hakimpura, Subhas Pally, Ghogomali, Telipara, Rail Basti, Bagra court and Pradhannagar. In rural area, within a distance of 30 km of Siliguri township, 8 spots were selected in 4 villages (2 in each village) namely Ghoshpukur, Goaltuli, Phansidewa and Gosaipur. Ten human habitations were selected and fixed in each spot of both urban and rural areas. From these habitations indoor-resting mosquitoes were captured weekly between 0600 hrs and 0800 hrs for 12 minutes. The collection was done alternately from an urban spot and a rural spot for three consecutive years from July 2002 to June 2005. A total of 4 man hours were employed in each month for collection from both the areas following the methods suggested by Holstein (1954) and the WHO (1975) and De and Chandra (1994). Mosquitoes therefore were captured altogether from 80 human habitations covering 8 spots in rural Terai as well as urban sites in all the three i.e. rainy, winter and summer seasons for three consecutive years. Statistical analysis was done using the software Origin 6.1 and windows excel versions. *Culex quinquefasciatus* and *Mansonina* mosquitoes were dissected to examine for filarial infection.

RESULTS AND DISCUSSION

Both in urban and rural belts *Aedes aegypti* occurred more in number during monsoon, *Ae. albopictus* and *Mansonina annulifera* however could only be recorded from the rural areas. Toxorhynchites, which were greater in number in the rural areas, especially in the rainy season, appeared to be less adaptive to the urban water bodies, such as soak pits, nullahas, open drains those usually have a higher levels of synthetic chemicals, pollutants and effluents. Further, non-occurrence of at least 6 *Anopheles* species in the urban conditions supported their dependence on the conditions prevailing in rural water bodies with a less polluted fresh water that may be gently flowing as stream or creek (Jhora) overshadowed with hanging branches of trees as the same flow through the green forested patches or grass and weeds growing on their sides/banks (Kettle, 1995).
Comparison of the rural and urban mosquito fauna of North Bengal

Mosquito composition in urban and rural areas based on indoor-resting collection gives an account of 1484 mosquitoes from the urban belt of Siliguri and 1785 from the rural zone adjoining Siliguri in the three year long study. During this period, a total of 9 mosquito species were found available in the human habitations from the urban area of Siliguri and as many as 18 species from its surrounding rural areas (Table I).

Table I. Comparison of the population of mosquito species (mean±SE) occurring in different seasons in urban and rural areas of North Bengal Terai.

<table>
<thead>
<tr>
<th>Species</th>
<th>Rainy Season</th>
<th>Winter Season</th>
<th>Summer Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td>Rural</td>
<td>Urban</td>
</tr>
<tr>
<td><strong>Culex quinquefasciatus</strong></td>
<td>308.67±39.99</td>
<td>261.67±20.21</td>
<td>298.67±27.00</td>
</tr>
<tr>
<td>Cx. vishnui group</td>
<td>37.33±6.37</td>
<td>41.33±22.22</td>
<td>12.00±4.00</td>
</tr>
<tr>
<td><strong>Anopheles minimus</strong></td>
<td>24.00±12.50</td>
<td>63.33±38.24</td>
<td>8.00±4.17</td>
</tr>
<tr>
<td><strong>An. subpictus</strong></td>
<td>24.33±13.88</td>
<td>8.00±8.01</td>
<td>23.33±13.89</td>
</tr>
<tr>
<td><strong>An. vagus</strong></td>
<td>16.33±9.85</td>
<td>54.00±13.13</td>
<td>3.33±3.34*</td>
</tr>
<tr>
<td><strong>An. barbipalpis</strong></td>
<td>38.67±16.73</td>
<td>39.33±12.99</td>
<td>18.67±11.64</td>
</tr>
<tr>
<td><strong>An. hyrcanus</strong></td>
<td>0.00±0.00</td>
<td>4.00±4.00</td>
<td>0.00±0.00</td>
</tr>
<tr>
<td><strong>An. annularis</strong></td>
<td>0.00±0.00*</td>
<td>57.33±14.91*</td>
<td>0.00±0.00*</td>
</tr>
<tr>
<td><strong>An. sandelicus</strong></td>
<td>0.00±0.00</td>
<td>4.00±4.00</td>
<td>0.00±0.00</td>
</tr>
<tr>
<td><strong>An. varuna</strong></td>
<td>0.00±0.00</td>
<td>0.00±0.00</td>
<td>0.00±0.00*</td>
</tr>
<tr>
<td><strong>An. maculatus</strong></td>
<td>0.00±0.00</td>
<td>53.0±3.2*</td>
<td>0.0±0.00</td>
</tr>
<tr>
<td><strong>An. culicifacies</strong></td>
<td>0.00±0.00*</td>
<td>18.67±1.20*</td>
<td>0.00±0.00*</td>
</tr>
<tr>
<td><strong>Aedes aegypti</strong></td>
<td>36.00±8.34</td>
<td>22.67±3.53</td>
<td>8.00±8.01</td>
</tr>
<tr>
<td><strong>Ae. albopictus</strong></td>
<td>0.00±0.00</td>
<td>6.67±3.53</td>
<td>0.00±0.00</td>
</tr>
<tr>
<td><strong>Mansonia indiana</strong></td>
<td>0.00±0.00*</td>
<td>39.00±7.95*</td>
<td>0.00±0.00*</td>
</tr>
<tr>
<td><strong>Mansonia annulifera</strong></td>
<td>0.00±0.00*</td>
<td>21.67±2.34*</td>
<td>0.00±0.00*</td>
</tr>
<tr>
<td><strong>Armigeres subalbatus</strong></td>
<td>61.33±9.97</td>
<td>40.33±10.35</td>
<td>90.00±28.39</td>
</tr>
<tr>
<td><strong>Toxorhynchites splendens</strong></td>
<td>6.00±6.01</td>
<td>50.67±3.72</td>
<td>4.00±4.00</td>
</tr>
</tbody>
</table>

*indicates significant difference between urban and rural populations at 5% level.
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A comparison of the occurrence of the various species of mosquitoes both in rural and urban sites showed a preponderance of *Culex quinquefasciatus* followed by a dominance of large-sized dusk-biting mosquito, *Armigeres subalbatus*. Out of total mosquitoes sampled, *Culex quinquefasciatus* comprised 65.09% in urban localities and 42.0% in rural areas. The percentage of this filarial-parasite carrying mosquito was significantly higher (P<0.05) in urban situation than that of rural belt due to high level of organically polluted water deposits in stagnant drains, cesspits, cesspools etc. It is observed that the density of this mosquito varied seasonally in different years in both the localities probably due to changing weather conditions (Fig.1). Average per man hour density during the three year of study were 40.25, 41.58, & 36.16 in urban area and 31.25, 33.2 & 28.0 in rural area, respectively. The present study further brings out that *Cx. quinquefasciatus* is a domestic pest mosquito, which dominates over other species of house-frequenting mosquitoes both in urban and rural areas. Similar observations have also been reported by Ghosh and Hati (1966), Dash et al. (1988) and Chandra and Hati (1996) and Rudra and Chandra (2000). Average infection rate of *Cx. quinquefasciatus* with *Wuchereria bancrofti* was found 3.0% in urban areas of Siliguri and 1.1% in the surrounding rural areas. *Cx. quinquefasciatus* is endophilic and highly anthropophagic.

The percentage of *Armigeres subalbatus* was significantly higher (P<0.05) in urban belt than that of rural belt. The density of this pollution-index mosquito in urban Siliguri outnumbered the population in its outskirts and rural surroundings (Fig.2). This may be due to improper maintenance of septic tanks, insufficient drainage and stagnant drains of the town. Cesspits, cesspools, septic tanks, and organically polluted logged sewers are the preferred breeding sites for both *Cx. quinquefasciatus* and *Ar. subalbatus*. The two mosquitoes were found to breed together. Possibly an unplanned urbanization, over-crowding, and deteriorating sanitary conditions both in urban and rural areas are believed to be exacerbating the density of these foul-water breeding species of mosquitoes. The density of *Ar. subalbatus* and its man-biting rate in the city of Puducherry (formally Pondicherry) was found higher than its rural surrounding during post monsoon period (Rajavel, 1975). A similar observation was also available from the expanding township of Siliguri in the present study. It was worth noting that the percentage of *Cx. vishnui* gr was significantly higher (P<0.05) in urban area of Siliguri than the rural area in question, this may probably be due to the presence of the breeding centres of *Cx. vishnui* gr. such as paddy fields and grass lands/bushes in out skirts and fringes of the town areas specially during the monsoon and post monsoon period.

*Anopheine* species captured from the urban area were only four, namely *An. minimus*, *An. subpictus*, *An. vagus* and *An. barbirostris*; whereas the number of species collected in rural areas were 10 including the 4 urban species. The other six rural species were *An. hycanus*, *An. annularis*, *An. sundaius*, *An. varuna*, *An. maculatus* and *An. culicifacies*. Average *Anopheles* population of first 4 species was higher in rural area during the starting year of survey (2002) except *An. subpictus* whose density was found higher in urban area (3.23%) in comparison to the rural field (1.23%). On an average a dominance of *An. minimus*, both in urban and rural sites were evident followed by *An. barbirostris* and *An. varuna*. These three species showed higher incidence during rainy season. In rural belt *An. varuna*, *An. maculates*, and *An. culicifascies* occurred more in winter season (Fig.3). *An. minimus* is highly anthropophilic and an endophilic one (Dutta and Mahanta, 1995). This is identified as a good vector for malaria in endemic tea estates and other pockets in Assam (Dev, 1996). *An. culicifacies* is traditionally endophilic and endophagic (Saxena et al., 1992). Total *Anopheine* percentage in consecutive three years in urban and rural areas was 10.10% & 29.63%, 8.03% & 29.74% and 16.2% & 26.31%,
Comparison of the rural and urban mosquito fauna of North Bengal

**Figure 1.** Graphical representation of occurrence of *Culex* mosquito in three seasons under Urban (U) and Rural (R) conditions.

**Figure 2.** Graphical representation of occurrence of non-anopheline mosquito in three seasons under Urban (U) and Rural (R) conditions.
respective. Although An. stephensi is the vector of urban malaria in other cities of India, it was not found in urban areas of sub-Himalayan terrain. It is known that An. minimus, An. dirus and An. fluviatilis mainly spread malaria in north-eastern states (Sharma, 1999). In another investigation, absence of An. dirus and An. fluviatilis was noted in the study area, although An. fluviatilis was collected in considerable number from the Dooars region of North Bengal, that stretches on the eastern flank of river Teesta (Rudra and Mukhopadhaya, 2010). An. varuna and An. maculatus were available in indoor-resting catches from the rural area only during the winter months. In the 1st year of survey, 12 specimens of An. sandaicus was unexpectedly collected from a rural spot in Ghoshpukur commercial check point on NH- 31, where the goods vehicles had to be detained sometime to verify their goods and documents on their way to north-eastern states and few such mosquitoes might be transported somehow through these vehicles coming from the Coastal India or Bangladesh. The same was not found again in another two years of survey. This species is generally available in the coastal belts including Andaman and Nicobar group of islands (Ruben, 2003).

*Aedes aegypti* density was 4.85%, 5.87% & 3.98% in three consecutive years of survey. The density was significantly higher in urban than that of rural areas. Dengue is closely associated with poor environmental sanitation, inferior housing and inadequate water supplies (WHO, 2003). The species being an urban domestic mosquito, it had infected more than 3000 people of urban West Bengal with dengue virus in the year 2005. *Ae. aegypti* larvae were collected from the cisterns of houses, water deposits within tyres piled in many
Comparison of the rural and urban mosquito fauna of North Bengal

places of urban localities and from unused flower tubs. *Ae. albopictus* was found only in rural habitations. Breeding sites of both *Ae. aegypti* and *Ae. albopictus* were observed mainly in tree holes and in water deposits of rejected small containers as confirmed by larval collection. The density of *Ae. aegypti* in India reaches its peak during rainy season and keeps low in hot summer (Rao, 1967; Reuben, 1970); similar population trend is also reflected in the last two years of the present study (Fig.2).

Two *Mansonina* species i.e. *Ma. indiana* and *Ma. annulifera* were available from the rural areas of the study belt. *Ma. annulifera* and *Ma. uniformis* are known as the major vectors, and *Ma. indiana* as the secondary and seasonal vector of brugian filariasis (Panicker et al., 1997). Polluted ponds with *Pistia sp.* and mixed vegetation were found to be the major potential breeding habitats for the *mansonioids*. No such mosquitoes were noticed in urban situation, probably due to absence of weeded ponds in such places. No *Mansonina* sp. was found incriminated by any filarial parasite. The density of *Toxorhynchites splendens*, was significantly higher (*P*<0.05) in rural belt than that in the urban belt, obviously due to the presence of tea gardens and dense vegetation in rural areas. The reddish brown elongated larvae of this mosquito species were collected from the tree holes and bamboo cuts. This non-biting mosquito do not harm human in any way, rather their larvae predate up on the other mosquito larvae specially *Aedes*, possibly resulting in low density of occurrence of *Ae. aegypti* in rural areas. In urban areas, these larvae could be collected from the water deposits of dumped tyres and rejected pots that speak about their urban adaptation.

The density of vectors is one of the major factors affecting the epidemiology of all the mosquito borne diseases. In the present study, malarial incidence was very high in rural area probably due to the cause of high degree of contact between man and the vector mosquitoes. Filarial disease is not so frequent in this belt as evident from scanty elephantoid patients observed throughout the study areas instead of high vector density and certain amount of infection rate. Similarly cases of dengue, Japanese Encephalitis (JE) are rare in Terai despite incidence of *Aedes* mosquitoes.

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**REFERENCES**


Dasgupta, B. 2000. Parasitology including Entomology and Acarology, pp.36-42. Books and Allied (P) Ltd, Calcutta


