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Enrolling Breeding Sources of *Anopheles stephensi* (Liston) of Kolkata City, India, During Winter Season

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Abstract: ***Breeding sources of the prime malaria-bearing mosquito Anopheles stephensi of Kolkata City were enrolled during winter season (November 2013 — February 2014). In all 10788 water containers/sites in 48 high-risk malarious wards of Kolkata Municipal Corporation were checked for An. stephensi larvae, of which 720 (7%) were positive. Percentage positivity of water containers was much higher outdoors (11.4) than indoors (1.2). Sites with accumulated seepage water on rooftops of multistorey buildings were the most preferred breeding sources of An. stephensi (86.5%; 135/156). The other important categories of its larval habitats included masonry tanks, water storage tanks and uncovered overhead water tanks. Detection of An. stephensi larvae in grossly contaminated water in sumps (29.4%; 120/408) and some other containers/sites was quite startling. Findings of this study will help plan strategies for prevention of malaria in the city.***

Keywords: Anopheles stephensi, Kolkata, malaria, mother foci, seepage water, sumps, winter

Short Running Title: Breeding sources of *Anopheles stephensi* of Kolkata during winter season

1. Introduction

Malaria is an age-old public health problem in the city of Kolkata (Hati, Mukherjee, Chandra, Bhattacharya, Chatterjee, Banerjee, Biswas & Halder, 1991; Biswas, 2000). Due to increased environmental conduciveness, the disease spreads here more or less throughout the year. The incidence of malaria cases remains quite low during the dry winter season (November-February), starts rising during the summer (March-June) and reaches its highest peak during the rainy season (July-October). *Anopheles stephensi* (Liston) is the principal vector of the disease. The mosquito breeds more in rainwater containers than in chlorinated water containers (Mandal, Biswas, Banerjee, Mukherjee, Nandi & Biswas, 2011). The city's environment during the winter season becomes less conducive to the breeding of *An. stephensi*. Still its breeding occurs here. But the fact is, precise information regarding its breeding sources during the winter season is abysmally lacking. Hence a larval survey was undertaken by the vector control department of Kolkata Municipal Corporation (KMC) during November 2013 to February 2014 to enlighten this vital issue. Findings of the study are reported in this paper.

2. Methodology

During November 2013 to February 2014, all kinds of open water containers/sites in and around the buildings of schools, colleges, hospitals, under-construction buildings, office-buildings, market places, housing complexes and some other such places in 48 malaria-prone wards of KMC were inspected just once at random for mosquito larvae. Six Rapid Action Teams, comprising 10-12 trained field workers each, were detailed for this survey. The teams inspected these wards thrice a month from November 2013 to February 2014 under the supervision of 3 consultant entomologists.

Segregation of mosquito larvae as those belonging to the genus *Anopheles* was done in fields by the survey teams deliberately. Identification of the species of mosquito larvae was done by entomologists in the laboratory after bringing in samples of mosquito larvae from fields. Sometimes mosquito larvae collected in fields were reared in mosquito cages till the emergence of adults. Thus identification of mosquito larvae as those of the species *An. stephensi* was scrutinized. Number and type of water containers/sites checked indoors and outdoors and the containers found positive for the larvae of *An. stephensi* were noted down after the completion of every round of inspection.

3. Results & Discussion

Altogether 10788 water containers/sites of 10 categories were checked for mosquito larvae during November 2013 to February 2014. *An. stephensi* larvae were found in 6.8% (720) of them. Sites with accumulated seepage water (water that comes out of an overhead water tank due to leakage on its wall) — comprising 19% of the breeding containers (135/720) — were the major larval habitats of *An. stephensi* (**Table 1**). The other important categories of its breeding sources in descending order of prevalence were water storage tanks (132; 18.3%), uncovered overhead water tanks (132; 18.3%), sumps (120; 16.7%) and masonry tanks (105; 14.6%). Basement water reservoirs, plastic containers, low-lying lands with accumulated water and iron containers together comprised 13.3% (96) of the breeding containers. Surprisingly, no *An. stephensi* breeding was found in earthen pots.

Among the indoor containers, 7% of the basement water reservoirs harboured the larvae of *An. stephensi*, while among the outdoor containers, 86.5% of the seepage water-holding sites contained the wrigglers of this mosquito. Taken as a whole, 11.5% of the outdoor containers were positive for *An. stephensi* larvae. The positivity of indoor containers was just 1.3%. Clearly, the outdoor containers were more conducive to the breeding of the city's malaria vector than the indoor ones.

Going by reports, *An. stephensi* in Kolkata has become craftier than ever before. Due to excitorepellatory action of *DDT* used during the national malaria eradication programme in the late 1950s, this very mosquito has changed its resting habits. Earlier, it used to rest indoors; it now rests outdoors (Hati, Chatterjee, Biswas, Mukhopadhyay & Saha, 1988), thereby implying that killing *An. stephensi* adults by any IRS (indoor residual spray) is no longer feasible in the city of Kolkata. Besides, the mosquito has grown resistant to *DDT*, *Malathion* and *Propoxur* (Hati, 1979; Mukhopadhyay, Karmakar, Hati & Dey, 1997). Commonly used mosquito repellents too are of no use today in the city (Hati, 1997). Reports concerning increased tolerance of *An. stephensi* larvae to *Temephos* 50% EC too are now pouring in from different wards of Kolkata Municipal Corporation.

The study cited here reveals that during the dry winter season — seepage water collections, open overhead water tanks, basement water reservoirs, water storage tanks, lift-wells and abandoned water tanks and other such places act as the *mother foci* of *An. stephensi*. During the winter months, when the environment of Kolkata dries up and the number of domestic water storage containers diminishes due to lesser water storage practice among the city-people, these *mother foci* silently help *An. stephensi* survive in the city's environment, thereby helping it spread malaria among the city-dwellers.

January is the coolest month in Kolkata. The average temperature in this month remains at 19.6^{0}C, which is much higher than the minimum ambient temperature required for completion of the mosquito cycle of a malaria parasite — 14.5 to16.5^{0}C for *Plasmodium vivax* and 16.5 to 19^{0}C for *Plasmodium falciparum* (Dhiman, Pahwa & Dash, 2008). As shown in the **Table 2**, on an average 623 cases of malaria (1.2% of the average annual incidence) occurred in January during 2006-2013. The contribution of September was the highest (21.5%; 11018 cases out of 51216). During the hot summer season, the average number of malaria cases per month varied from 1081(2.1%) in March to 2832 (5.5%) in June. Temperature apart, the relative humidity (RH) in January too favours transmission of malaria in the city of Kolkata; it remains as high as 68.8% (8.8% higher than identified as the most conducive RH for the development of a malaria parasite in anopheline mosquitoes.

In our earlier study (KMC, unpublished report) — done during November 2012 to February 2013 — *An. stephensi* larvae were detected in grossly contaminated water in 31 containers (43.6%) out of the 71 searched (**Table 3**). Presence of *An. stephensi* larvae in pits, abandoned handcarts, clogged open surface drains, deserted plastic water reservoirs drums, lift-wells and sumps gives a crystal-clear indication that *An. stephensi* could procreate anywhere for its survival.

4. Conclusion

The drive against *An. stephensi* larvae in Kolkata should start right from January every year. Findings of the study will certainly help the authorities of KMC plan *An. stephensi* control strategies in a more effective manner.

5. Future Scope

Eliminating breeding sources of a malaria vector is easier when their prevalence is much less. Prior to planning strategies for destruction of the larvae of a malaria-bearing mosquito in a particular city or town, identification of the *mother foci* of the vector mosquito is essentially required. Traditional concept of mounting antivector drive during rainy season and the times thereafter for prevention and control of malaria should be discouraged everywhere around the world. Where to start? When to start? Unless we know the answers, we cannot plan strategies for malaria prevention.

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Table 1: Larval habitats of *Anopheles stephensi* in 48 malaria-prone wards of Kolkata Municipal Corporation during November 2013 to February 2014

Type of water containers/sites checked for *An. stephensi* larvae	Indoor containers			Outdoor containers		
	No. searched	No. positive	%	No. searched	No. positive	%
Seepage water-holding sites on rooftops of multi-storey buildings	0	0	0	156	135	86.5
Masonry tanks	684	18	2.6	252	87	34.5
Sumps	0	0	0	408	120	29.4
Water storage tanks at construction sites	0	0	0	888	132	14.8
Uncovered overhead water tanks	0	0	0	1392	132	9.5
Basement water reservoirs	516	36	6.9	0	0	0
Plastic containers	1957	6	0.3	1211	30	2.5
Low-lying lands	0	0	0	276	12	4.3
Iron containers	1259	4	0.3	589	8	1.3
Earthen pots	646	0	0	554	0	0
Total	5062	64	1.2	5726	656	11.4

Table 2: Malaria and climate data for Kolkata City (2006-2013)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average no of malaria cases	623	754	1081	1530	2106	2832	4670	7916	11018	10059	6759	1865	51216
Average temp (^{0}C)	19.6	23.8	28.5	30.8	31.0	30.6	29.5	29.1	29.3	29.0	25.1	21.0	27.3
Average RH (%)	68.8	63.8	61.4	68.0	72.5	79.0	82.6	83.9	82.0	77.2	70.4	69.7	73.2
Average rainfall (mm)	6.2	15.2	9.8	48.2	135.3	312.7	387.8	348.3	395.8	254.2	17.4	6.8	1838.0

Table 3: List of filthy water-holding containers/sites with *Anopheles stephensi* larvae detected in the city of Kolkata during November 2012 to February 2013 (KMC, unpublished data)

Water containers/sites checked for Anopheles stephensi larvae			*Quality of water with pH value (pH of water was measured by using pH paper)*
Type checked	*No checked*	*No positive*	
Abandoned handcarts in the premises of an office building	15	6	Filthy (8.5)
Pits by the side of a tramline	5	2	Muddy (7.8)
Battery shells at market places	11	4	Blackish and contaminated with organic matters (8.7)
Clogged open surface drains in the premises of medical colleges, hospitals, office buildings, etc	9	4	Filthy (7.9)
Deserted plastic drums inside the premises of office buildings	6	4	Blackish and contaminated with dead algae (9.0)
Lift-wells at under-construction buildings	6	3	Blackish (9.1)
Discarded plastic water reservoirs inside the premises of office buildings	7	2	Contaminated with dead leaves and other organic maters (7.6)
Water storage tanks at construction sites	9	4	Contaminated with algal bloom (8.6)
Sumps beneath one gallery of an internationally famous cricket field	2	1	Grossly contaminated with faecal matters (9.2)
Earthen vats at police stations	2	1	Contaminated with explosive materials (8.0)
Total	72	31	