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Monitoring global public health threat - surveillance of *Aedes* (*Stegomyia*) mosquitoes in new Mangalore sea port, India

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ABSTRACT: Vector surveillance and control at port of entry (PoE) is an essential activity for the implementation of International Health Regulations (IHR). The present study was undertaken in and around New Mangalore sea port. Inside the port area, a total of 13 water holding containers at 33 premises were checked and no containers were found positive for larval breeding. In the residential area, 132 water holding containers were checked in 100 houses. The breeding preference ratio was highest for earthen containers (18.8) followed by grinding stone (4.72), metal (1.72), cement tank (1.62) and plastic (0.24). The House index, Container index and Breteau index were found to be 7.0, 5.3 and 7.0% respectively. The nearness of residential colony to NMPT, consequently enhances the chances of spreading of *Aedes* mosquitoes in the port area. From the present study it is evident that inside the sea port there are ample habitats for the mosquitoes to breed and thrive in rainy season. Routine entomological surveillance is required not only to monitor the mosquito breeding in and around port area but also to prevent transportation and establishment of mosquito species in newer areas.

KEY WORDS: International health regulation, public health threat, breeding preference ratio

INTRODUCTION

Vector borne diseases pose a major public health concern today, with a number of 'old' diseases resurging in recent decades along with newly emerging infectious diseases. Mosquitoes transmit some of the world's worst life threatening and debilitating parasitic and viral diseases. Some of these were effectively controlled since few decades, but such hardwon gains are now threatened. Among the invasive mosquitoes registered all over the world, *Aedes* species are particularly frequent and grave. As several of them are potential vectors of disease, they present significant health concerns. The routes of importation and spread are often enigmatic, the ability to adapt to local environments and climates are rapid, and the biting nuisance and vector potential are both an economic and public health distress (Gubler, 2002; Smolinski *et al.,* 2003; Medlock *et al*., 2015).

Aedes mosquitoes originally found in tropical and subtropical zones carry a variety of pathogens that can be transmitted to humans. The species *Aedes aegypti* and *Ae. albopictus* are the primary vectors of alarm world wide. *Ae. aegypti* mosquito is the main vector that transmits the viruses that cause dengue, chikungunya, yellow fever and zika virus. *Ae. albopictus* is a principal urban vector for the

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transmission of dengue virus and a competent vector of 22 arboviruses, including West Nile and Yellow fever viruses (Gubler, 2003). *Aedes* mosquito is considered a highly domesticated mosquito, very adapted to living with man, preferring to rest indoors and to feed on humans during daytime hours. The *Aedes* mosquitoes generally breed in water holding containers found in and around the houses, such as those used for water storage, flower vases, mud containers, metal containers, used tires, plastic utensils and other receptacles that collect rain water (Sheela Devi *et al.*, 2012).

The incidence of vector borne diseases is increasing alarmingly due to many factors including uncontrolled urban developments that support breeding of vector mosquitoes. In India, National Vector Borne Disease Control Program (NVBDCP) reported 28,292 dengue cases and 110 deaths in 2010 from 35 states in India. In the same year, in Karnataka 2285 dengue fever (DF) cases and 7 deaths were reported. After six years, in 2017, in India the reported DF Cases rose to 1, 57,220 and 250 deaths. Karnataka, on the other hand, reported 17018 dengue fever cases and 5 deaths in 2017. There is an increase of 7.5 times DF cases in Karnataka over a span of six years. Similarly, 48176 clinically suspected chikungunya fever cases were reported in 2010 from 30 states in India and in 2017 the chikungunya fever cases in the country rose to 62268. In 2010 the clinically suspected chikungunya cases reported in Karnataka state were 8740 and 3.2 times increase ie, 31644 chikungunya cases were reported from the state in 2017.

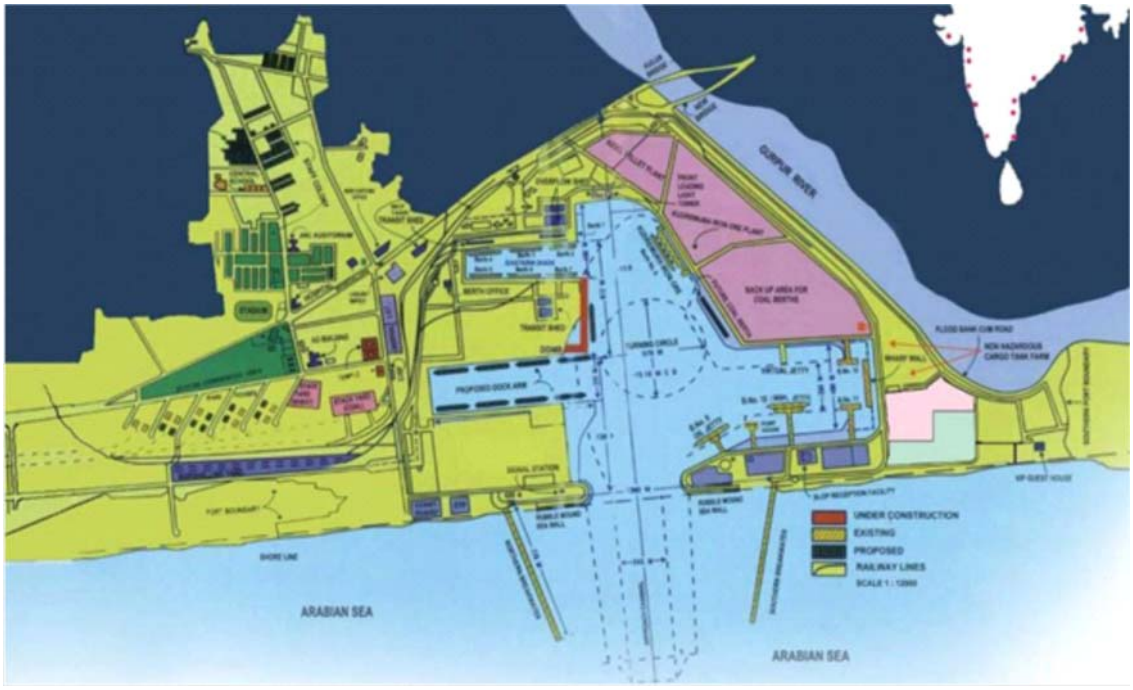
The transport of mosquitoes beyond their native range via shipping, aircraft and transport has been well documented, particularly in the expansion of *Ae. albopictus* via shipping of used tyres (Schotle and Schaffner, 2007) and the occurrence of vectors of yellow fever, dengue and malaria on aircraft (De Hart, 2003). Moreover, India shares sea route/ connection with majority of yellow fever (YF) endemic countries. This raises more concern in India to control *Aedes* mosquito breeding in seaport areas to prevent any introduction of YF virus in the country. Presence and prevalence of mosquitoes in and around ports makes this issue more rucil. Moreover, under the WHO International Health Regulation (WHO, 2016), all International airports and seaports should be kept free from all types of mosquito vectors for a distance of 400 meters around the perimeter of the ports to achieve the ultimate aim of public health security. Thus, vector surveillance and control at port of entry (PoE) has become an essential and pressing need for the implementation of International Health Regulations (IHR). Accordingly, an eco-entomological survey was undertaken to know the present scenario of entomological indices - key *Aedes* breeding habitats, behavior of vector mosquitoes, and so forth - in and around Mangalore sea port area to assess global public health threats.

MATERIALS AND METHODS

Study area:

New Mangalore Port Trust (NMPT) Area is located on the alluvial plain, and is about 10 km north of Gurupur and the Netravathi rivers. New Mangalore Port is a lagoon type harbor with a long approach channel artificially created by dredging. The coordinates of Port are Latitude 12^0 55^1 North and Longitude 74^0 48^1 East. It is deep water, all-weather port at Panambur, Mangalore in Karnataka state in India which is also the deepest inner harbor on the west coast. It is located on the west coast of India and one of 12 major ports of India; it is the only major port in the state of Karnataka (Map 1).

The port comprises three doc systems via, Eastern Doc arm, Oil Doc arm and the Western Doc arm; it has in all 15 berths. The port serves hinterland of Karnataka state and to some extent the state of Kerala. The major commodities exported through the port are iron ore concentrates and pellets, iron ore fines, manganese, granite stones, coffee, cashew and containerized cargo. The major imports of the port are crude and petroleum products, LPG, wood pulp, timber logs, finished fertilizers, liquid ammonia, phosphoric acid, other liquid chemicals and containerized cargo. The climate is governed by the monsoons. During the months June-September, the south-west (SW) monsoon occurs.



Map 1. Operational areas of New Mangalore Port

The later period is often indicated as the post-monsoon period. The average annual rainfall is 3,467 mm. The rainfall is concentrated in the SW monsoon (June to September). During this period the average rainfall is as much as 84% of the total rainfall. The temperature varies from 22^0C to 36^0C. The low temperatures occur during south west monsoon in December and January. The hottest months are from March to May. The humidity is high throughout the year.

Residential area:

To assess the *Aedes* mosquito prevalence around the port area 100 houses were randomly selected in the NMPT Staff Colony Quarters. There are 391 houses in Type I to VII which include New and Old houses. In Type A-D there are 172 houses, 100 houses are in Registered Cargo handling Workers colony, 45 houses for CISF and altogether there are 708 houses in NMPT Staff Colony. The present Entomological surveillance was done covering all the types of houses. The ecological conditions of all the house premises were closely monitored to assess the mosquitogenic and local hygiene conditions.

Entomological surveillance:

Aedes survey was done in all the operational areas of New Mangalore port and in randomly selected 100 residential houses around the port on the last week of January 2018. Present entomological surveillance for immature and adult mosquitoes was undertaken in and around NMPT. Standard entomological techniques were used for survey. Qualitative larval sampling was conducted in all permanent/ temporary aquatic habitats. Larval survey was carried out in all types of water holding containers to detect the breeding of *Aedes (Stegomyia)* mosquitoes in and around the port. All accessible larval breeding habitats like discarded tyres, mud, plastic and metal containers, cement tanks etc were inspected. The collected larvae were identified microscopically / after adult emergence as per guidelines (WHO, 1995).

The type of breeding habitats and their location were recorded on a pre designed proforma for classification. The data on larval survey were analyzed and calculated in terms of House Index (HI), Container Index (CI), Breteau index (BI) and the preferred breeding habitats of *Aedes* mosquitoes

also assessed.The dry containers seen scattered in the premises were also examined as these can act as breeding sources of *Aedes* mosquitoes during rainy days.

RESULTS AND DISCUSSION

Port area: Entomological surveillance was done at New Mangalore Port Trust (NMPT) area during 22nd to 25th January 2018. A total of 13 water holding containers at 33 premises examined revealed no containers were found positive for *Aedes* larvae (Table 1). Of the total 13 water holding containers checked, 61.54% were plastic followed by metal (30.76%) and discarded tyres (7.7%). Attempts made for the dry containers seen scattered in the premises of NMPT operational area indicated that of the total 40 dry containers noted, 80% were discarded tires followed by metal (12.5%) and plastic (7.5%) containers.

Residential area: *Aedes* surveillance undertaken in the hundred houses showed that out of the total 132 containers with water examined, 59.09% were plastic followed by cement tank (26.53%), metal (8.33%), grinding stone (3.03%), fridge (2.27%) and earthen utensils (0.76%). A total of seven water holding containers were positive for *Aedes* larvae. Of these 42.86% were cement tanks followed by earthen (14.29%), metal (14.29%), plastic (14.29%) and grinding stone (14.29%).

The house index (HI), container index (CI) and Breteau index (BI) was found to be 7.0, 5.3 and 7.0% respectively (Table 2). The larvae and adult mosquitoes collected were identified as *Aedes albopictus.* Container preference reflected by the Breeding Preference Ratio (BPR) was maximum for earthen (18.80) followed by grinding stone (4.72), metal (1.72), cement tank (1.62) and plastic (0.24) (Table 3).

An attempt made to collect adult mosquitoes in the residential colony, showed *Aedes albopictus* mosquitoes and the per man-hour density was recorded as 2.3.

International travel and transport play an important role in the spread of vector borne diseases (VBDs) all over the world. VBDs are reported in over 100 countries, and put up to 60% of the world's population at risk of infection; more than 500 million cases are reported every year (WHO, 2016). The vast development of shipping industry and expansion of port cities during the past two centuries has led to the global spread of vector mosquitoes and pathogens related to vector borne diseases.

A total of 33 premises were searched inside the sea port. Of the total 13 water holding containers seen, none of them found positive for *Aedes* larvae. Entomological surveillance undertaken in the January- February is the beginning of dry season where the temperature varies from 22^{0}C to 36^{0}C and the relative humidity ranges from 50% to70%. During the dry and hot condition maximum number of containers inside the port was without water. The nil *Aedes* positivity inside the port substantiates the dry and hot condition of the post monsoon period.

In the study on the breeding prevalence of vectors of dengue/ chikungunya and yellow fever, Sharma and Kumar (2015) could not find the breeding of *Aedes* mosquitoes inside Chennai sea port. While studying the breeding habitats of vector mosquitoes in Marmugao Port Trust (MPT), Goa, Patel *et al.* (2017) also reported a similar situation.

Of the total 40 dry containers/ sources seen inside the sea port, 32 (80%) were tyres. During monsoon the dry containers especially tires may get filled with rain water and pave for the breeding of *Aedes* mosquitoes. In order to avoid mosquito breeding either these containers are to be removed or kept properly covered. *Aedes* mosquito breeding could be noted in the present surveillance in the residential areas. Several dry containers seen scattered in the house premises intensify the breeding of *Aedes* mosquitoes in this area during monsoon season. The closeness of the residential colony to sea port enhances the chances of spreading spill over of breeding of *Aedes* mosquitoes in the port area.

The present study indicated that in residential areas around NMPT area, the Breeding Preference Ratio (BPR) was highest for earthen containers (18.8) followed by grinding stone (4.72), metal (1.72), cement tank (1.62) and plastic (0.24). A study on

Table 1: Surveillance of *Aedes m*osquitoes at operational areas of New Mangalore Port

Sl. No.	Premises	Water holding containers						Dry containers available		
		Plastic		Metal		Tyre		Plastic	Metal	Tyre
		S	P	S	P	S	P			
1	Container Yard	_	_	_	_	1	_	_	_	20
	Silver jubilee Gate(wharf)									
2	Hasan &Hajee Company	_	_	_	_	_	_	_	_	_
3	Deployment office	_	_	_	_	_	_	_	_	_
4	Amogha logistics, Amogha shipping agency	_	_	_	_	_	_	_	_	_
5	Cochin Shipping company	_	_	1	_	_	_	_	_	_
6	Indian Shipping Agency	_	_	_	_	_	_	_	_	1
7	Asprin wall & Co	_	_	_	_	_	_	_	_	_
8	Sri Ganesh shipping agency	_	_	_	_	_	_	_	1	_
9	Worldwide shipping	_	_	_	_	_	_	_	_	_
10	Export trade link agency	_	_	_	_	_	_	_	_	_
11	Konkan Marine agency	_	_	_	_	_	_	_	1	_
12	Iron or coal Berth	_	_	2	_	_	_	1	2	3
13	Yojaka Workshop	3		1	_	_	_	_	1	1
14	Berth No. I	_	_	_	_	_	_	_	_	_
15	Berth No.II	_	_	_	_	_	_	_	_	_
16	Berth No. III (Costa Classica Ship)	_	_	_	_	_	_	_	_	3
17	Berth No. IV(Passenger Lounge &Cruise Lounge)	_	_	_	_	_	_	_	_	2
18	Berth No. V	_	_	_	_	_	_	_	_	1
19	Berth No. VI	1	_	_	_	_	_	_	_	_
20	Berth No. VII-XIII	_	_	_	_	_	_	_	_	_
21	Berth No. VIII	_	_	_	_	_	_	_	_	_
22	Berth No. IX	_	_	_	_	_	_	_	_	_
23	Berth No. X	_	_	_	_	_	_	_	_	_
24	Berth No. XI	_	_	_	_	_	_	_	_	_
25	Berth No. XII	_	_	_	_	_	_	_	_	_
26	Berth No. XIII	_	_	_	_	_	_	_	_	_
27	Berth No. XIV-west	1	_	_	_	_	_	_	_	_
28	Berth No. XIV East	_	_	_	_	_	_	_	_	1
29	Berth No. XV Adani	_	_	_	_	_	_	_	_	_
30	NMPT	_	_	_	_	_	_	1	_	_
31	Port fire station area	2	_	_	_	_	_	_	_	_
32	Control room area	_	_	_	_	_	_	1	_	_
33	Oil terminal and Traffic Department area	1	_	_	_	_	_	_	_	_
	Total	8	-	4	-	1	-	3	5	32

S – Searched for *Aedes* larvae; P – Positive for *Aedes* larvae

Table 2: *Aedes* larval indices in the residential areas of New Mangalore Seaport

No of houses searched	Houses positive for *Aedes* Larvae	Total containers searched	Containers positive for *Aedes* Larvae	House/ Premise Index (HI-%)	Container Index (CI-%)	Breteau Index (BI)
100	07	132	07	07	5.3	07

Table 3: Breeding habitats of *Aedes* Mosquitoes in the Residential areas of New Mangalore Seaport

Sl No	Type of water holding containers	Searched	Positive for *Aedes* Larvae	Breeding Preference Ratio(BPR)
1	Mud pots/ Flower pots	01 (0.76)	01(14.29)	18.80
2	Metal	11 (8.33)	01 (14.29)	1.72
3	Plastic	78 (59.09)	01 (14.29)	0.24
4	Cement Tank	35 (26.53)	03 (42.86)	1.62
5	Grinding Stone	04 (3.03)	01 (14.29)	4.72
6	Fridge	03 (2.27)	0 (0)	0
	Total	132	07 (5.30)	

Figures in parentheses indicate percentage value

the entomological surveillance for the vectors of yellow fever/ dengue/ chikungunya in and around Port of Goa, Sharma *et al*. (2015) reported the earthen containers are the most preferred breeding source of *Aedes* mosquitoes in the residential area of Goa sea port. It is also noted that during dry season the inhabitants force to store water in cement tanks which enhances the chances of *Aedes* breeding. This situation necessitates further strengthening of ecology/entomology based control methods besides community awareness on local factors responsible for *Aedes* breeding.

The main intention of entomological surveillance in international airports/seaports is to maintain vector free status through appropriate vector control measures. Mosquito breeding surrounding seaport and / or International board is not just a simple local health problem; it is a serious threat to global health security. A careful invigilation of the international airports and seaports by the trained scientists/vector control personnel is recommended to prevent breeding and export of vector species. Routine entomological surveillance is required not only to monitor the mosquito breeding in and around port area but also to prevent the transportation and establishment of mosquito species in new countries, regions and continents as a result of anthropogenic transport.

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