Research Article

Dengue Vector Surveillance in and around Mormugao Port Trust (MPT) – Goa, India

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Abstract

As per the International Health Regulations, it is a moral responsibility on national governments to keep international seaports/airports and peripheral areas up to 400 meters free of vector mosquitoes in its adult and immature stages and the mosquito vectors of other diseases of epidemiological significance. In view of seriousness of the problem, the present study was undertaken in and around Mormugao Port Trust (MPT), Goa (India), to see the prevalence of *Aedes* mosquito. This study was undertaken in the month of February and December 2016. Inside the port, no larval breeding was detected except in December survey, and 3.85 Breteau Index (BI) was recorded. In Headland Sada (residential colony), breeding was detected with 6.0 and 10.0 BI in February and December 2016 respectively. Similarly, in Jetty village high larval breeding was searched with 9.8 and 8.0 BI in February and December, respectively. In the residential colony, plastic containers used for storing water acted as the main source of larval breeding. These plastic containers were used to store water for long time and maintaining *Aedes* breeding in adverse condition throughout the year. According to breeding preference ratio (BPR), cement tank showed the highest (4.37) BPR in the month of February while in December BPR was highest for iron drum (27.7) followed by water-storing plastic container (1.14). These residential colonies are in close vicinity of the seaport. Local factors play an important role in the propagation and prevalence of *Aedes* mosquito. Routine entomological surveillance is required to monitor the vector prevalence in the residential colonies around the seaport. Baseline surveillance data should be collected regularly to monitor vector prevalence and destroy the breeding sites in and around the seaport.

Keywords: *Aedes albopictus*, Dengue, Breeding preference ratio, Goa, India

Introduction

Vector-borne diseases are reported in over 100 countries, and 60% of the world's population is at risk of infection; more than 500 million cases are reported each year.[1] Mosquitoes are considered as one of the most dangerous creatures on the planet because of their ability to spread deadly diseases. Mosquito-vectored diseases include protozoan disease, i.e., malaria, and blood-dwelling nematode disease, i.e., filarial disease, and viruses such as dengue, encephalitis and yellow fever. Dengue is a serious arboviral disease of the Americas, Asia and Africa. Although it has low mortality, dengue has become more serious, both in frequency and mortality. In recent years, the rate of introduction of invasive mosquito

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species to new geographic locations has increased rapidly in step with increased international travel and trade and this has had adverse consequences for public health.[2-5]

In recent years, *A. aegypti* (Linnaeus) and *A. albopictus* (Skuse) are the vectors of dengue, Yellow fever and Zika virus. Yellow fever, which has a 400-year history, at present, occurs only in tropical areas of Africa and the Americas and is transmitted by *Aedes* mosquitoes. The Zika virus is an RNA Flavivirus, transmitted primarily by the *A. aegypti* mosquito.[6] It is endemic to parts of Africa and Asia, but in recent months, cases have been discovered across South, Central, and North America, where the disease was previously unknown. All these disease-causing viruses spread to humans through the bite of an infected *A. aegypti* or *A. albopictus* mosquito and it is a growing public health threat to both industrialized and developing nations worldwide.

Aedes mosquito is considered a highly domesticated mosquito; highly adapted to living with man, preferring to rest indoors and to feed on humans during daylight hours in an unobtrusive and often undetected manner. The adult female mosquitoes prefer to lay eggs in artificial water containers commonly found in urban areas of tropics and subtropics. Containers commonly found in and around the home, such as those used for water storage, flower vases, old tyres, buckets and various plastic containers, and other receptacles that collect rainwater are some of the examples. The life cycle of this mosquito is closely associated with human activities and larval habitats are increasing rapidly in urban areas.

This mosquito, originally of Asian origin, has established itself in America and Africa too in the last three decades. More worryingly, it is also establishing in Europe, Albania, France, Italy, Belgium, Switzerland, Greece, Spain, Serbia, Netherlands, Bosnia, and Germany reporting invasions. The transport of mosquitoes beyond their native range via shipping, aircraft and transport has been well documented, particularly the expansion of *A. albopictus* via shipping of used tyres,[7,8] and the occurrence of vectors for yellow fever, dengue and malaria on aircraft.[9] As a result of rapid transport of *Aedes* mosquitoes, dengue has become one of the fastest-growing mosquito-borne diseases in the world with about 20,000 deaths every year. Since there is no curative treatment for dengue, targeted environmental and ecosystem management is increasingly relevant. Presence and prevalence of mosquitoes in and around ports makes the issues more sensitive. Moreover, under the WHO International Health Regulation,[10,11] all international airports and seaports should be kept free from all types of mosquito vector for a distance of 400 meters around the perimeter of the ports to enhance national, regional and global public health security. In this scenario, vector surveillance and control at port of entry (PoE) has become an essential and pressing issue for the implementation of the IHR. Under this surveillance, the areas surrounding the seaports were thoroughly scanned for the presence of any favorable hot-spots for mosquito breeding.

Study Area

Non-Residential Area

Seaport Area

Mormugao Port Trust (MPT), Goa, is one of the oldest ports on the west coast of India with an open-type harbor protected by a breakwater and a mole built from the outer end of the breakwater and running parallel to the quay. The harbor is also protected from the South-West monsoon as it has been constructed on the leeward side of Mormugao Headland. It has been relentlessly serving the nation in its economic development for over a century. The port was declared a major port on 02.12.1963. This port is the premier iron ore exporting port of India with an annual throughput of around 50.02 million tons of traffic. Though ore is the predominant cargo, there has been a steady increase in liquid bulk and general cargo traffic ever since its joining the ranks of the major ports of India. The remaining traffic consists of cargoes like fertilizer, bauxite, containerized cargo, steel slabs, granite, wheat, maize, etc. During the financial year 2012-13, the port handled a traffic of 17.69 million tons which is 3 percent of the total traffic of 545.79 million tons handled by the entire twelve major ports of India. This port exported a quantity of 7.42 million tons of iron ore in 2012-13 mainly to China, Japan and European countries.

After a relatively cool January, weather starts to get warmer in Goa in February with temperature between 20°C to 27°C, while temperatures continue to cool down in Goa, in December, when both the average highs and average lows fall equally. At this time of the year, the average temperature begins at 27.5°C, created by highs of 33°C during the daytime and lows of 22°C after dark. This drops down to 25.5°C by the end of the month, created by highs of 31°C during the daytime and lows of 20°C after dark.

Materials and Methods

Area for the entomological surveillance was divided into three parts (i) inside port, (ii) outside port, and (iii) residential colony. A survey was undertaken twice a year in the month of February and December 2016.

Port Area

The coordinates of Mormugao port are latitude 15° 25’ North and longitude 73° 47’ East. Mormugao Port Trust (MPT), one of the oldest ports on the west coast of India, is one amongst the 12 major ports of the country. The

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Mormugao harbor is also a major attraction for tourists coming to the Vasco da Gama city. So, this port of Goa has enough possibilities to transport not only mosquito vector but also vectors of other diseases of public health importance.

Residential Area

To assess the *Aedes* mosquito prevalence around port area, 50 houses were selected in two residential colonies for entomological surveillance. Following colonies were visited: (i). Headland Sada, (ii). Jetty village.

Present entomological surveillance for immature and adult mosquitoes was undertaken in and around MTP, Goa. Standard entomological techniques were used for survey. Qualitative larval sampling was conducted in all permanent/temporary aquatic habitats. The breeding prevalence of *Aedes* mosquito was detected in diverse breeding containers. All accessible larval breeding habitats like discarded tyres, metal drums, plastic drums, other metal containers, plastic buckets, flower pots, mud pots, cement tanks, and other plastic containers were inspected. All live larvae were collected and brought back to the laboratory, where they were reared until adult emergence. Adult mosquitoes that emerged from the reared larvae were identified to assess the breeding potential. The data on larval survey were analyzed and calculated in terms of different indices like container index (CI) (percentage of water-holding containers infested with larvae or pupae), house index (HI) (percentage of houses infested with larvae and/or pupae), Breteau index (BI) (number of positive containers per 100 houses inspected) as per the WHO procedure (WHO, 1975).[12]

Results

Port Area

In February 2016, total containers checked were 253 inside port and 53 outside port in the 53 and 13 premises respectively, and no container was found positive for larvae, while in the month of December 2016, total 113 containers at 26 premises inside port area and 12 containers at 4 premises of outside port area were checked and larval breeding was detected only inside port area with 3.85 premises index (PI) and 0.88 (CI).

Residential Area

Surveillance was also undertaken in the residential colonies outside MPT, viz., Headland Sada and Jetty village. In the Headland Sada, 149 containers in the month of February were checked and larval breeding was detected in two houses with 2.01 CI and 6.0 BI and in the Jetty village high larval breeding was detected in 10 houses with 10.8 (CI) and 9.8 (BI). In the month of December, in the Headland Sada colony, larval breeding was noted in 5 houses and CI and BI was recorded as 3.6 and 10 respectively while in Jetty village 104 containers were checked and four containers were found positive for *Aedes* breeding with 8.0 (HI) and BI (Table 1).

Table 1.Entomological surveillance of *Aedes aegypti* mosquitoes in and around Mormugao Port Trust (MPT), Goa

Port Area	Premises/House			Container			Index	
	Searched	Found Positive	HI	Searched	Found Positive	CI	Breteau	Pupal
February 2016 (Port Area)								
Inside	53	-	-	253	-	-	-	-
Outside	13	-	-	53	-	-	-	-
December 2016 (Port Area)								
Inside	26	1	3.85	113	01	0.88	3.85	-
Outside	4	-	-	12	-	-	-	-
February 2016 (Residential Colonies)								
Head Land Sada	50	2	4	149	2	2.01	6	-
Jetty Village	50	10	20.0	102	11	10.8	9.8	-
December 2016 (Residential Colonies)								
Head Land Sada	50	4	8	137	5	3.6	10	4
Jetty Village	50	4	8	104	4	3.8	8	-

Current surveillance was undertaken twice a year, in the month of February 2016, out of 557 containers searched, 58.2 percent were plastic containers used for storing water followed by unused plastic (16.2 percent) containers. Total 84.6 percent plastic storing containers were positive for *A. aegypti* followed by plastic unused containers (15.4 per cent). Similarly, in the month of December 2016, 49.5 percent plastic storage containers were checked followed by plastic unused (25.9 percent) and water-holding solid waste (17.8 percent) and plastic storage container was the

prime source of larval breeding with 70.0 percent positivity rate (Fig. 1). Container preference reflected by the breeding preference ratio (BPR) was also calculated which was highest for the cemented tank (4.37) followed by plastic storage containers (1.06) in the month of February 2016, while in December 2016 BPR was highest for iron drum (27.7) followed by plastic storage (1.14) and plastic unused containers (0.39) (Table 2). The plastic storage containers were used for holding water for daily use. Attempt was also made to collect adult mosquitoes in the residential colonies. *A. aegypti* and *C. quinquefasciatus* were collected using hand catch method and per-man-hour density (PMHD) was recorded as 1 and 2 respectively against both the species. While using total catch method density was recorded as 4.8 per room density (PRD).

Type of Breeding

Table 2.Breeding Preference Ratio (BPR) of *Aedes aegypti* in Different Artificial Breeding Habitats in and around Mormugao Port Trust (MPT), Goa

Habitat	February					December				
	A	X %	B	Y %	BPR (Y/X)	A	X %	B	Y %	BPR (Y/X)
Plastic storage	217	86.5	11	91.7	1.06	164	68.0	7	77.7	1.17
Plastic unused	29	11.6	-	-	-	68	28.2	1	11.1	0.39
Cemented tank	5	1.9	1	8.3	4.37	-	-	-	-	-
Syntax tank	-	-	-	-	-	3	1.2	-	-	-
Planted pot	-	-	-	-	-	5	2.1	-	-	-
Iron drum	-	-	-	-	-	1	0.4	1	11.1	27.75

A – No. of containers with water. B – No. of containers with larvae.

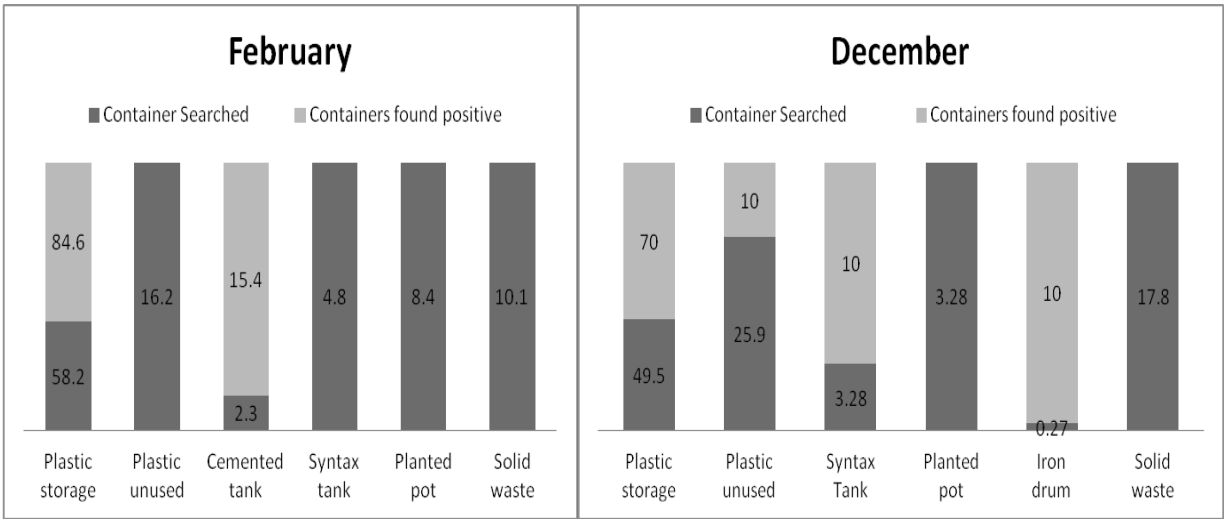

Figure 1.Percentage-wise Container Positivity Found during Entomological Survey in Mormugao Port Trust (MPT), Goa

Discussion

International travel and transport is playing an important role in the rapid spread of vector-borne diseases all over the world. Development of the shipping industry and expansion of port cities during the past two centuries has led to the global spread of reservoirs (*A. aegypti* and *A. albopictus*) and pathogens related to vector-borne diseases. In view of the expansion of *Aedes* mosquito via shipping of used tyres,[7,8] tyres were given special attention during surveillance. During the current surveillance, no tyre was found positive for *Aedes* larvae. In the residential colonies, high larval indices and adult density of *Aedes* mosquitoes were recorded. In headland Sada, BI was recorded as 6.0 and 10.0 in the month of February and December respectively. Similarly, in Jetty village 9.8 and 8.0 BI was recorded in February and December. Adult mosquito was also collected from residential colonies with 4.8 PMHD. These residential colonies are very much close to the seaport and mosquito can move to port area very easily. The presence of *Aedes* mosquito makes the area vulnerable for transmission of vector and vector-borne diseases. As far as preference of container for *Aedes* breeding is concerned, plastic containers were the prime sources of larval breeding. These plastic containers were mostly blue-colored drums used for daily use. Water

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supply in this area was irregular and local inhabitants were storing water in large plastic containers for long time which enhances the chances of *Aedes* breeding. This situation necessitated further strengthening of ecology/ entomology-based control methods besides community awareness on the basis of local factors responsible for *Aedes* breeding. Earlier in India, similar findings were observed at international airports and seaports of Kolkata,[13] Chennai,[14] Thiruvananthapuram, Kerala[15] and Bangalore, Calicut, Chennai, Cochin, Thiruvananthapuram and Vishakapatnam.[16] Regular mosquito surveillance should be done to establish baseline knowledge of the ports that can be used during subsequent surveys. This kind of entomological surveillance can help to identify particular habitat types at seaports and airports which are known to support mosquitoes and which could be targeted during further surveys or in the case of the need for vector mosquito control.

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Conflict of Interest: None

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