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Seasonal Trend in the Abundance of Anopheline Immatures and Species Distribution in Three Districts of Andaman and Nicobar Islands

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Abstract

Andaman and Nicobar Islands are historically known for high malaria incidences. Those areas flooded during the catastrophic tsunami occurred in 2004, still remain as potential breeding habitats for anophelines, with seasonal variations. A longitudinal survey was attempted on anopheline immature abundance in four seasons of a year, in three districts of Andaman and Nicobar Islands. The abundance of anopheline immatures were higher in Nicobar district as compared to other two districts, in Pre-monsoon and Monsoon season. The result has a significant implication on the incidence of malaria in Nicobar district, where high malaria cases have been reported in recent times.

Keywords

Anophelines, Dip per density, Malaria, Nicobar, Season

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INTRODUCTION

Malaria is one of the most widespread diseases in the world, especially in South East Asian countries [1]. It is one of the most important vector-borne diseases and was endemic for a century in Andaman and Nicobar Islands. However, malaria cases were observed to be declining due to effective control activities, such as; release of larvivorous fishes, Indoor residual spray of insecticides, health education campaigns and bioenvironmental control of the principal vector, *Anopheles sundaicus*, using sluice gates [2,3].

Even though malaria is one of the major communicable disease in all the three districts of Andaman & Nicobar Islands, it was observed to be higher in Nicobar district. It was reported that *An. sundaicus* is the only incriminated vector for malaria parasites in the three districts of Andaman and Nicobar Islands, viz; South Andaman, North & Middle Andaman and Nicobar [4,5]. Though, both

Plasmodium falciparum and *P. vivax* are prevalent, the latter is dominant in these Islands.

Anopheles sundaicus are reported to breed both in freshwater as well as in brackish water habitats [2]. Out of 23 anopheline species reported from these Islands, 18 species were recorded from the two Andaman districts (both South and North & Middle Andaman) and 5 species from Nicobar district [6]. It was observed that the anopheline species diversity was higher in the two Andaman districts, even though malaria cases were negligible. There are many studies on the bionomics of the major malaria vector, *An. sundaicus* [7, 8, 9&10]. The present study focussed on the abundance of anopheline immature population in the three districts of the archipelago during the four seasons of a year.

MATERIALS AND METHODS

Study area

Andaman and Nicobar Islands are comprised of three districts, viz; South Andaman, North & Middle Andaman, and Nicobar. The Island has a tropical climate with humidity about 80% and temperature varying from 23 ^{o}C -31^{o}C. The North East monsoon sets in November, whereas South West monsoon towards the end of May. There are four seasons in this island, viz,winter (January –February), premonsoon (March- April), monsoon (May-September) and post-monsoon (October – December).

The study area consisted of 9 tehsils in the three districts. From each tehsil, three villages were selected for anopheline immature collection based on the malaria cases reported during the past five years. Annual Parasite Incidence (API) for Nicobar district during the past five years (2013 - 2017) ranged from 7.04 to 16.07, and for South Andaman and North & Middle Andaman districts the API were 0.99-0.21 and 0.57-0.18 respectively. Anopheline immatures were collected from selected villages once in three months for a period of 12 months from July 2017 to August 2018. From each village, an extensive larval survey was carried out in all the stagnant water bodies, using a long-handed dipper, with white enamel bowl at the end of the handle, having the capacity of 350 ml. A steel ladle was used to collect immatures from low volume aquatic habitats. Geographical coordinates for all larval habitats were recorded using a hand-held Global Positioning System (GPS).

The number of dips was determined by estimating the surface area of the habitats. The number of dips and mosquito immature count in each habitat was recorded. Late stages of anopheline immatures collected during the survey were brought to the laboratory for emergence, in a labelled plastic container. Larvae were fed on a mixture of dog biscuit and yeast, in a ratio of 3:1. The emerged mosquitoes were identified morphologically using standard taxonomical keys [11].

Data analysis was carried out in Microsoft excel, 2013. Analysis of variance (two-way ANOVA) for two factors (season and districts/ tehsils) was used to compare the means and to estimate the level of significance in the dip per density of anophelines immatures with respect to the 3 districts, 9 tehsils, and also among different seasons,

RESULTS

A total of 6, 615 anopheline immatures were collected from 26 different aquatic habitats, which were categorized into permanent and temporary/transient habitats. The permanent water bodies which were positive for anopheline immatures include, pond, stream margin, cement tank, creek, mangrove swamp, culvert, kutcha and pucca drain, well, dam and irrigation canal. Temporary habitats include; mud pool, rainwater collections, tyre mark, cesspool, cesspit, hoof print, puddles, plastic drum, ground pit, paddy field, ditch and ground pool.

A total of 10 anophelines were recorded from the three districts, viz, *An. sundaicus, An. vagus, An. kochi, An. pallidus, An. philippinensis, An. varuna, An. aconitus, An. jamesii, An. barbirostris* and *An. maculatus*, in different habitats (Table 1). Of the emerged mosquitoes, *Anopheles vagus* (30.8%) was the highest, followed by *An. kochi* (17.6%), *An. barbirostris* (16.0%), *An.sundaicus* (14.8) and *An. aconitus* (8.7%). Of these, *An. sundaicus, An. barbirostris, An. maculatus* and *An. kochi* alone were recorded from Nicobar district. All the 10 species were found prevalent in both South Andaman and North & Middle Andaman (Figure 1).

Table 1: Anopheline species collected in different habitats of the archipelago

SL.No.	Anopheline species	Breeding habitats												
		CP	RW	DR	MS	SM	MP	PD	FF	CT	PU	CT	WL	DT
1	*An. sundaicus*		■		■									■
2	*An. kochi*		■											
3	*An. vagus*	■					■			■				
4	*An. pallidus*							■						
5	*An. jamesii*							■						
6	*An. aconitus*							■						
7	*An. varuna*								■					
8	*An. barbirostris*			■				■		■		■	■	■
9	*An. macualtus*					■								
10	*An. dirus*			■							■			

Abbrevations used for Breeding Habitats: CP=Cesspool, RW=Rainwater Collections, DR=Drain, MS = Mangrove Swamp, SM= Stream Margin, MP= Mud pool, PD=Pond, FF= Fallow Field, PU= Puddle, CT= Cement tank, WL= Well, DT=Ditch

There were 18 common breeding habitats in the three districts which included; rainwater collections, pond, mangrove swamps, culvert, kutcha drain, pucca drain, stream margin, mangrove swamp, well, mud pool, tyre mark, cesspool, cesspit, hoof print, puddles, ground pit, ditch and ground pool. Paddy field, fallow field, irrigation canal, cement tank was not found with anopheline breeding in Nicobar. Whereas, creek was not found breeding in the two Andaman districts.

Per dip density of anophelines was estimated and compared for the three districts and 9 tehsils in four seasons (Figure 2& 3). Among the three districts, per dip density was highest in Nicobar district, especially during pre-monsoon and monsoon seasons, whereas, anopheline immature density was low in winter and post-monsoon seasons. ANOVA analysis showed that the immature density was statistically different between the three districts in four seasons ($P<0.05$, $F=13.3$). However, there was no statistical difference observed within each district in four seasons ($P=0.23$, $F=2.09$). Among 9 tehsils, the highest immature dip per density was found in Ferrargunj tehsil of South Andaman district in monsoon season and a significant difference was found between each tehsil in four seasons ($P=0.004$, $F=7.66$).

Figure 1. Anopheline faunal diversity (%) recorded

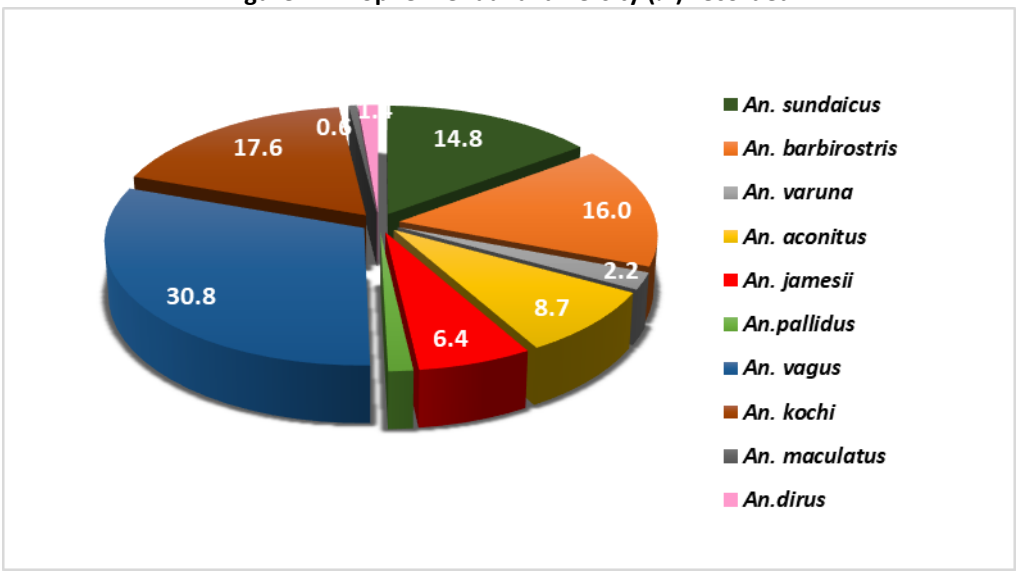


Figure 2. Seasonal variations in anopheline abundance in the three districts

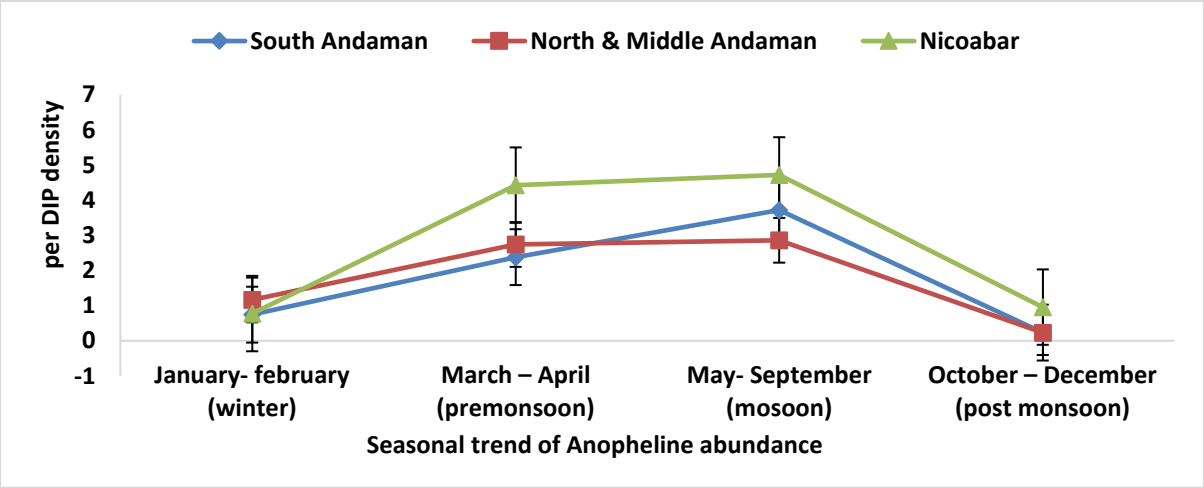
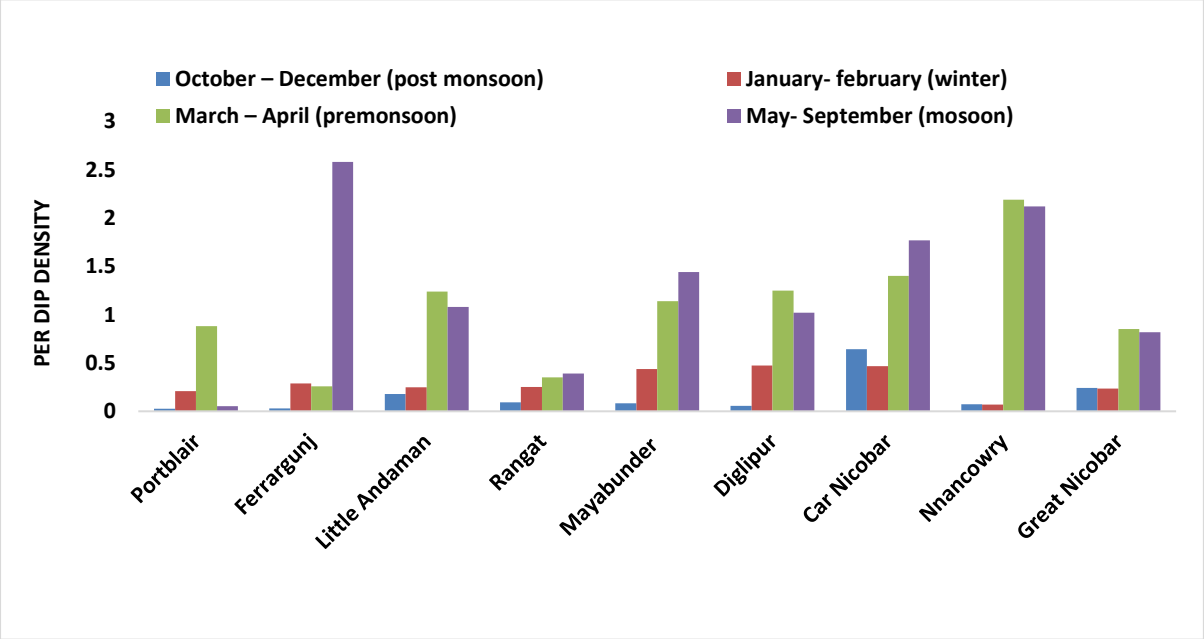


Figure 3. Per dip density of Anophelines in nine tehsils of Andaman & Nicobar Islands



DISCUSSION AND CONCLUSION

Many studies have been carried out to determine the relationship between meteorological parameters and mosquito abundance from different localities [12, 13, 14]. In a study from Thailand, it was observed that rainfall had a significant influence on mosquito immature density [16]. Similary, Sathiskumar and Vijayan [17] were reported that in three seasons such as premonsoon, monsoon and postmonsoon had the highest density of immatures than summer season in Goa, India. There are only a few studies available on mosquito composition and larval density pattern across all the three districts of Andaman and Nicobar Islands. These studies were restricted to either a tehsil or district. A total of 23 species of anophelines were recorded from all the Islands [6], however, only 10 species were obtained from this study.

The results of the present study showed that the dip per density of anophelines immatures was significantly different in different seasons. The density was high in monsoon and pre-monsoon seasons in all the districts. As Andaman gets precipitation throughout the year with variation in the quantity, there is no complete summer season.

Therefore, there were no much habitats which were completely dry, except transient water bodies such as rainwater collections, mud pool, tire mark, mudpit and hoof prints. The permanent water bodies like the pond, stream, dam were found throughout the year, and thereby mosquito breeding were also maintained in these water bodies.

In the monsoon season, the number of habitats were more than in other seasons. Low number of habitats were found in post-monsoon and winter season. Habitats with large volume of water, viz, pond, stream, and culvert were found reduced in its water volume during post-monsoon and winter season, which transformed into small, confined habitats. Climatic factors affect adult mosquito abundance by altering the quality and quantity of breeding habitats [13].

The present study could provide a picture on the effect of seasons on anopheline immature abundance in the three districts of Andaman. Even though, more number of anopheline species were collected from both the Andaman districts, the incidences of malaria was higher in Nicobar district. This data may help to strengthen vector control methods such as anti-larval operations and environmental management of breeding habitats.

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