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Mosquito diversity in the Chilika lake area, Orissa, India

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Abstract. Twenty-two species of mosquitoes belonging to six genera *(Anopheles*, *Aedeomyia*, *Aedes*, *Armigeres*, *Culex* and *Mansonia)* were collected from eight villages in and around the Chilika lake area, Khurda and Puri Districts from 2006-2007. Greater numbers of the culicines (65.59%) were collected from the area, as compared with the anophelines (34.4%). *Mansonia indiana* and *Mansonia dives* were reported for the first time from the area. The values of the species richness (S), Shannon Index (H), and Shanon evenness (Es) between anophelines and culicines were 10, 12; 0.89, 1.85; 0.38, 0.74, respectively. Based on biostatistical analysis, the culicines were more diverse than anophelines in the study area.

INTRODUCTION

Chilika (85º20' E, 19º40' N) is the largest brackish water lake of India, and it is connected to the Bay of Bengal by a narrow 32 km long channel south to the mouth of Mahanadi River in Orissa, India. The area of the lake varies from the 1165 km^2 during the monsoon to 906 km^2 in the dry season, respectively. The highly productive lake ecosystem with its rich fishery resources sustains the livelihood of more than 0.15 million fishermen inhabiting in and around the lake. The mouth connecting the channel to the sea is close to the north eastern end of the lake. It lies in the districts of Puri, Khurda and Ganjam of the Orissa state. The villages near this area have a typical climate with an average annual maximum temperature of 39ºC and minimum of 14ºC. (Dash *et al.*, 2000). The lake and its water channels harbor a large number of faunal groups including mosquitoes. The coastal wetlands have 8 culicine species and 14 anopheline species of mosquitoes (Dash *et al.*, 2000).

In Orissa, mosquitoes play a major role as the carriers of various human and livestock diseases in the wetland ecosystems (Hussain *et al.*, 1984) and they are well adapted to survive in various habitats such as ponds, puddles, tree holes, swamps and salt marshes. The hot and humid coastal climate, wide spread paddy fields, small water pools and drains provide favorable breeding grounds for the mosquitoes. Several studies on the mosquito fauna were conducted in the coastal areas of Orissa (Fry, 1912; Covell & Singh, 1942; Nagpal & Sharma, 1983; Dash *et al.*, 2000). The anopheline vector species were more diverse than those of the culicine vectors.

Hazra & Dash (1998) reported 21 species of culicines, including the distribution of *Mansonia* species, in the coastal areas of Orissa, while Nagpal & Sharma (1983) recorded the disappearance of the notorious malaria vector, *Anopheles sundaicus* (Rodenwaldt). Environmental changes (i.e., frequent cyclones, changed agriculture practices and industrialization) have greatly affected the diversity and abundance of mosquito fauna of Chilika lake area, including the disappearance of some species (Rajgopal, 1976; Kalra, 1978; Jambulingam *et al.*, 2005). Mosquito vector diversity determines the prevalence of mosquito-borne diseases in an area. Conducive conditions for vector populations, coupled with the prevalence of pathogens, usually result in the transmission of mosquito-borne diseases (Kalluri *et al.*, 2007; Sutherst, 2004). Therefore this study aimed to determine the mosquito fauna and biodiversity using biostatistical analysis, as well as the increase of the filarial cases along the Chilika coastal areas.

MATERIALS AND METHODS

Study site

Mosquito collections for adults were collected from eight villages of 2 districts in and around the Chilika lake area namely, Cheddapader, Bidharpur, Pratap, Tota Pada (Khurda District), and Alipara, Giqala, Sipakuda, Rambharya Island (Puri District) from 2006-2007 (Figure 1). Adult mosquitoes that were resting indoor, outdoor, biting man and cattle were collected by: 1) aspirator (Hausher, Gainesville, FL, USA) both oral and mechanical, 2) spray sheet collection by spraying the room from four corner by Pyrethrum and collecting the knock down mosquito over a white cloth placed inside the room before spraying, and 3) CDC-light trap (Hausher, Gainesville, FL, USA) during dawn and dusk. Indoor collections were conducted by spraying pyrethrum with aerosol 0.6% Pyrethrin synergised with 1.4% Piperonyl butoxide to knock down the mosquitoes. Using forceps, the mosquitoes were picked up and transferred to test tubes with mesh screen cover. Outdoor resting adult mosquitoes were collected by insect sweep net from shrubs near cowsheds, paddy fields and littoral forest. The per ten

Figure 1. Map of Chilka lake areas, Orissa showing the mosquito collection localities

man-hour density (PTMHD), i.e. total number of mosquito collected by a person per hour multiplied by ten, was determined for each collected species (Service, 1976). The mosquito samples were identified using pertinent keys (Christophers, 1933; Barraud, 1934; Rao, 1984).

Data analysis:
Species diversity (H') is represented through species richness (S), Shanon index (H) and Shanon evenness (Es) (Buzas & Hayek, 1996; Hayek & Buzas, 1997, 1998), by the following formulas:

H' = Σ pilnpi.

S = Number of species.

H = pilnpi, where pi is the proportion of individuals found in the i^{th} species and ***ln*** denotes the natural logarithm.

Es = H/Hmax (value is between 0-1), where Hmax = ln(S). E = eH/S($0<E\leq 1$); e is the natural logarithm base. As for $E\leq 1$, ln(E) will be a negative number. A rank abundance curve shows the proportional abundance versus rank (with rank = 1 being the most abundant, rank = 2 being second most abundant, and so on). The PTMHD of the mosquito fauna of three coastal districts were also calculated.

Relative abundance = Proportion of species found in the *i*th species; the number found for the species and divided by the Total Number of Individuals (N).

Rank abundance = A graph of proportional abundance versus rank.

RESULTS

A total of 1994 adult mosquitoes were collected, belonging to 22 species in 6 genera: *Anopheles* (10 spp., n = 686), *Aedeomyia* (1 sp., n = 3), *Aedes* (2 spp., n = 106), *Armigeres* (2 spp., n = 480), *Culex* (1 sp., 1 sp. complex, n = 550) and *Mansonia* (4 spp., n = 166) (Table 1). The culicines (65.59%) were more dominant than the anophelines (34.40%). Table 1 also shows the calculated PTMHD values for each mosquito species from the sampled areas. *Anopheles subpictus* (46.87) had the highest PTMHD values, followed by *Armigeres subalbatus* (36.25). The number of specimens of potential malaria vector species, i.e. *Anopheles culicifacies* Giles, *Anopheles annularis* Van der Wulp, was less than 1% of total number of collected samples. The relative abundance of the anophelines was higher than the culicines. The Species Diversity (H') of the anophelines was lower than the culicines. The Shanon index of the culicines (H=1.85) showed a maximum value as its relative diversity at 74.6% (Es) of the maximal diversity Hmax = 2.48 (Table 2). The species abundance of the culicines was more diverse than anophelines as indicated by the slope of the curve where culicine was less steep than that of anopheline curve. Furthermore, the species evenness of anophelines was less than that of the culicines, and therefore the diversity of the culicines was more than anophelines (Figure 3). Two species, *Mansonia indiana* Edwards and *Mansonia dives* (Schiner) (=*Ma. longipalpis* Van der Wulp), were recorded for the first time from Chilika Lake areas.

DISCUSSION

Seven *Anopheles* species reported by Dash *et al.* (2000) were not found in the present collections, along with *An. sundaicus*. Previous studies (White & Adhikari, 1939; Covell and Singh, 1942; Nagpal & Sharma, 1983; Dash *et al.*, 2000) indicated a higher diversity of the anophelines than those of culicines in and around the Chilika lake area. In the present study, there was a higher diversity of the culicines than anophelines in the same area. The reduction of anopheline diversity in and around Chilika may be associated with the major ecological changes, including the extensive use of insecticides, modified agricultural practices, increased industrial development, natural calamities (severe cyclones, after effects of tsunami) and other factors. The population densities of the local mosquito vectors in numerous countries are affected by deforestation and subsequent land uses (Yasuoko *et al.*, 2007). A few studies have been conducted to statistically analyse the relative abundance (http://asstudents.unco.edu/faculty/radams/Ecology2006/LABS/MEASURING%20BIODIVERSITY.doc.) of mosquito species found in the studied area. In this study, results on species diversity may help in the future planning of vector control measures. Results of this study also support the reports by the Primary Health Centre (PHC) regarding the decrease of malarial cases from Chilika lake area compared with other parts of India (Sharma, 1999). Furthermore, filarial cases

Table 1. Per ten man-hour density (PTMHD) of the mosquitoes collected from in and around Chilika Lake area from 2006-2007

Serial No.	Genus	Species	No.	PTMHD
1.	*Anopheles*	*aconitus*	3	0.62
		annularis	3	0.62
		culcifacies	3	0.31
		maculatus	3	0.31
		nigerrimus	6	0.62
		splendidus	3	0.31
		subpictus	450	46.87
		theobaldi	6	0.62
		vagus	200	20.83
		varuna	3	0.31
2.	*Culex*	*quinquefasciatus*	350	36.45
		vishnui group	200	20.83
3.	*Armigeres*	*subalbatus*	348	36.25
		theobaldi	132	13.75
4.	*Mansonia*	*uniformis*	100	10.41
		annulifera	48	1.56
		indiana	15	5
		dives	3	0.31
5.	*Aedeomyia*		3	0.31
6.	*Aedes*	*albopictus*	6	0.31
		vitattus	100	10.41
7.	*Coquilettidia*	species (unidentified)	3	0.31

Table 2. Species diversity of the culicines and anophelines from the Chilika lake area

Samples	H	Es	E	S	Ln(E)	Hmax
Anophelines	0.89675159	0.38945428	0.245162627	10	-1.40583	2.302585
Culicines	1.85580583	0.7468311	0.533070913	12	-0.6291	2.484907

have been increasing in this area. This could be due to increasing diversity of the culicine vectors in and around the lake. Further surveillance, however, are needed to continuously monitor the diversity of both anopheline and culicine vectors in the area.

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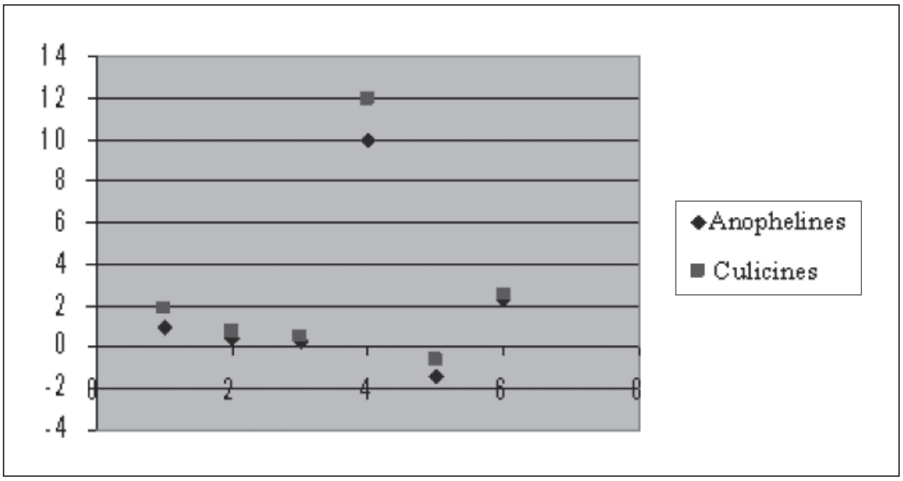

Figure 2. Species diversity of the anophelines and culicines of Chilika lake area

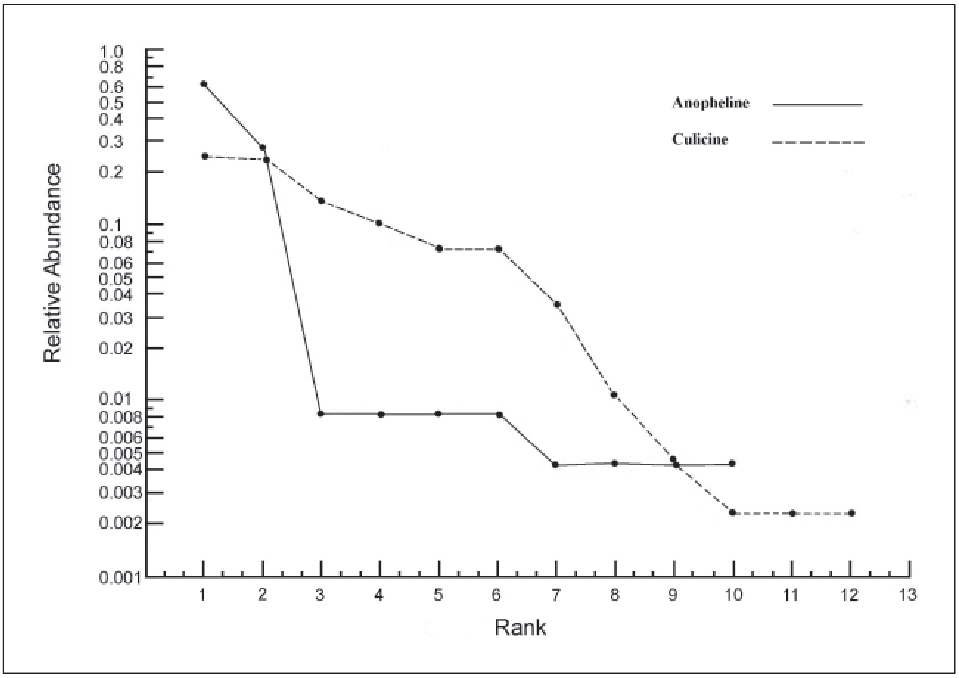

Figure 3. Rank-abundance for anophelines and culicines of Chilika lake area. Note the progressive shallower line representing culicine in comparison to the steeper anopheline curve which depicts the higher diversity of the previous one (culicines) in the Chilika lake area and it has a higher species richness (12 species)

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