Cibtech Journal of Zoology ISSN: 2319–3883 (Online)
An Online International Journal Available at http://www.cibtech.org/cjz.htm
2012 Vol. 1 (1) May-Aug 12, pp.14-32/Gudivada et al.
Research Article

POPULATION DYNAMICS OF METAZOAN PARASITES OF MARINE THREADFIN FISH, *ELEUTHERONEMA TETRADACTYLUM* (SHAW, 1804) FROM VISAKHAPATNAM COAST, BAY OF BENGAL

Mani Gudivada[1], *Anu prasanna Vankara[2] and Vijayalakshmi Chikkam[3]
[1]*Department of Zoology, Maharajah's College (Autonomous), Vizianagaram.*
[2nd]**Department of Animal Sciences, Yogi Vemana University, Kadapa- 516 003*
[3]*Department of Zoology, Andhra University, Visakhapatnam- 530 003*

ABSTRACT
Population dynamics of metazoan parasites of marine threadfin fish, *eleutheronema tetradactylum* have been studied for two consecutive years 2005-2006 and 2006-2007 from visakhapatnam (17.67°'n and 83.32°'e), in the coastal zone of bay of bengal, andhra pradesh. A total of 490 host species were examined, of which 438 hosts were found to be infected. 19 species of metazoan parasites were collected, comprising 2 monogenetic trematodes, 7 digenetic trematodes, 1 cestode larva, 1 nematode, 2 acanthocephalans and 6 copepods. The ecological parameters like prevalence, mean intensity and mean abundance were calculated to determine the abundance of parasitic species. This study was carried for both overall and groupwise parasitizations. The ectoparasites dominate the parasitic community followed by the monogenetic trematodes. Seasonal variation on parasitization, the relationship between host size and prevalence of infection were studied but the host sex was not taken into consideration due to protandrous nature of the host.

Key Words: *Eleutheronema Tetradactylum, Prevalence, Mean Intensity, Mean Abundance, Protandrous*

INTRODUCTION
Marine fish serve as definitive and/or intermediate hosts in the life cycles of many helminth parasites. Parasites affect fish health, growth, behavior, fecundity and mortality and also regulate host population dynamics and their community structure (Marcogliese, 2004). Global decline in fish parasites is driven by the removal of fish from world's oceans over the course of hundreds of years. In recent years it is recognized that parasites are a critical part of biodiversity and their loss could alter the functioning of ecosystem (Wood *et al*., 2010). Information on biology of the fish, fish diet, feeding behavior, host phylogentics and systematics is provided by using parasites as biological tags, indicators or markers (Williams *et al*., 1992, Arthur, 1997). Leaman and Kabata (1987) found that there are some limitations in the usage of parasites as biological tags like consistency of parasite distribution throughout the year, influence of temperature and other physical factors on the parasite fauna, variation in distribution of intermediate hosts, long term fluctuations in parasite abundance which are not revealed by short term studies. Keeping in view the above limitations the present study was carried out for 2 consecutive years. The Polynemidae or threadfin fishes present a good model to study parasite communities in Visakhapatnam coast as they form a closely related group with varying feeding habits, and they are widely distributed. Despite the extensive information available on the ecology and biology of polynemid fishes, population dynamics and structure of parasite communities of the Polynemid fish, *Eleutheronema tetradacylum* Shaw, 1801 remains an enigma and not much work was focused. No consequential work has been carried out on helminth parasites of *E. tetradactylum* in Visakhapatnam coast in spite of their nutritive value and availability as an economic sea food to the local communities. The present investigation was carried out to obtain the basic data on population dynamics and to gauge the influence of seasons on helminth parasite fauna of *Eleutheronema tetradactylum* Shaw, 1804 which is available at Visakhapatnam coast throughout the year.

MATERIALS AND METHODS

Study Area

For the present study, marine threadfin fishes were collected from Visakhapatnam (17.67°'N and 83.32°'E), along the east coast of Bay of Bengal, Andhra Pradesh. About six species of Polynemid fishes occur along this coast. But *P. sextarius* (Schneider), *P. plebeius* (Broussonet) and *E. tetradactylum* (Shaw) were of common occurrence throughout the year, where as *F. heptadactyla* (Cuvier), *L. indicum* (Shaw) and *P. sexfilis* (Valenciennes) occur seasonally. To minimize the inconsistent results the present study has been conducted for two consecutive years from July 2005 to June 2007. Records pertaining to the date and seasons were maintained. In the present study, a total of 490 *E. tetradactylum* Shaw, 1804 were examined of which 438 were infected. Different biostatistical parameters were applied for qualitative and quantitative analysis of the data. Biostatistical books by the Snedecor and Cochran (1967), Sundara Rao and Richard (1996), Daniel (1998) and formulae from Sokal and Rohlf (2000) were followed for statistical analysis. The ecological terminology was taken from Margolis *et al.,* (1982), Grabda-Kazubski *et al.,* (1987) and Bush *et al.,* (1997). Standard statistical computations (mean intensity, standard deviation, prevalence and abundance) were carried out using Microsoft Excel (Office 2007).

Prevalence:

Prevalence is the number of individuals of the hosts infected with particular parasite species (or) with total parasites divided by the number of hosts examined. Prevalence is expressed in terms of percentage (%).

$$\text{Prevalence (expressed in \%)} = \frac{\text{No. of individuals of a host species infected with a total parasite species x 100}}{\text{No. of hosts examined}}$$

(or)

$$\frac{\text{No. of individuals of a host infected with a particular parasite species x 100}}{\text{No. of hosts examined}}$$

*Mean Intensity***:**

Mean intensity is the average intensity of total number of individuals of particular parasite species in a sample of host species or total number of individuals of all parasites found in a sample of host species divided by the number of hosts infected with that parasite or the total number of parasites.

$$\textit{Mean intensity} = \frac{\text{Total number of individuals of all parasites in a sample of host species}}{\text{Number of hosts infected with that parasites or total number of parasites}}$$

(or)

$$\frac{\text{Total number of individuals of a particular parasite species in a sample of host species}}{\text{Number of hosts infected with that parasites or total number of parasites}}$$

Mean Abundance: Mean abundance is the total number of individuals of a particular parasite species in a sample of particular host species divided by the total number of hosts of that species examined (including both infected and uninfected hosts).

$$\text{Mean abundance} = \frac{\text{Total number of individuals of all parasites in a sample of host species}}{\text{Total number of individuals of the host s examined (infected and uninfected)}}$$

(or)

$$\frac{\text{Total number of individuals of particular parasites in a sample of host species}}{\text{Total number of individuals of the hosts examined (infected and uninfected)}}$$

To study the seasonal influence of the infection, each annual cycle is divided into three seasons: Rainy, winter and summer. A Chi-square test was calculated for testing the significance between the season and prevalence for each host species. To test the relationship between size of the host and prevalence, all hosts were categorized into 4 or 5 groups according to their length and weight. Coefficient of correlation was carried out for relation between host size and infection.

RESULTS

Total 490 host species were examined, out of which 438 hosts were found to be infected. 19 species of metazoan parasites were collected, comprising 2 monogenetic trematodes, 7 digenetic trematodes, 1 cestode larva, 1 nematode, 2 Acanthocephalans and 6 copepods (Table 1).

Table 1: Metazoan parasites of *Eleutheronema tetradactylum* Shaw, 1804.

Name of the Host	Name of the Parasite	No. of Parasites Collected
Eleutheronema tetradactylum Shaw, 1804	*Diplectanum polynemi* Tripathi, 1957	1431
	Polynemicola polynemi Unnithan, 1971	222
	Helicometrina nimia Linton, 1910	18
	Metacercariae of *Prosorhynchus*	493
	Erilepturus hamati Yamaguti, (1934) Manter, 1947	182
	Didymozoid larvae	25
	Prosorhynchus polydactyli Yamaguti, 1970	91
	Prosorhynchus eleutheronemi n.sp.	55
	Cardicola polynemi n.sp.	27
	Caligus phipsoni Bassett-Smith, 1898	397
	Parapetalus hirsutus Bassett-Smith, 1898	370
	Orbitacolax aculeatus Pillai, 1967	295
	Lernaeenicus polynemi Bassett-Smith, 1898	82
	Lernanthropus polynemi Richiardi, 1881	580
	Chalimus stages	98
	Gnathia maxillaris Sars	3
	Raorhynchus polynemi Tripathi,1959	49
	Scolex pleuronectis Mueller, 1788	228
	Camallanus cotti Fujita,1927	32

Table 2: Seasonal population dynamics of total parasites of *E.tetradactylum.*

Month	Total Fish (a)	Infected Fish (b)	Total no. of Parasites ©	Prevalence (%) (b/a)	Mean Intensity (c/b)±SD	Mean Abundance (c/a)±SD
2005-2006						
July	18	15	166	83.33	11.07±7.1	9.22±6.2
Aug	20	16	195	80	12.19±9.5	9.75±8.1
Sep	18	15	149	83.33	9.93±7.9	8.28±7
Oct	19	11	80	57.89	7.27±7.2	4.21±4.6
Nov	23	21	339	91.3	16.14±10.9	14.74±10.3
Dec	20	20	221	100	11.05±5.6	11.05±5.6
Jan	18	16	249	88.89	15.56±10.9	13.83±10.2
Feb	22	22	305	100	13.86±6.4	13.86±6.4
Mar	18	13	238	72.22	18.31±13.7	13.22±10.5
Apr	22	22	192	100	8.73±5.3	8.73±5.3
May	22	21	189	95.45	9±5.7	8.59±5.6
Jun	18	16	147	88.88	9.19±6.6	8.17±6.1
2006-2007						
July	20	17	131	85	7.71±5.1	6.55±4.5
Aug	23	20	173	86.96	8.65±5.8	7.52±5.3
Sep	23	23	101	100	4.39±2.6	4.39±2.6
Oct	22	20	113	90.91	5.65±2.9	5.14±2.7
Nov	19	19	282	100	14.84±8.2	14.84±8.2
Dec	22	22	290	100	13.18±6.7	13.18±6.7
Jan	18	13	193	72.22	14.85±12.6	10.72±9.9
Feb	18	17	216	94.44	12.71±8.6	12±8.4
Mar	20	17	179	85	10.53±8.9	8.95±8
Apr	23	23	172	100	7.48±4.1	7.48±4.1
May	22	19	180	86.36	9.47±5.3	8.18±4.8
Jun	22	20	178	90.91	8.9±5.1	8.09±4.8

Table 3: Seasonal population dynamics of *E.tetradactylum* (Monogeneans).

Month	Total Fish (a)	Infected Fish (b)	Total no of Parasites (c)	Prevalence (%)	Mean Intensity (c/b)±SD	Mean Abundance (c/a)±SD
			2005-2006			
July	18	13	81	72.2	6.2±4.9	4.5±3.8
Aug	20	6	46	30	7.7±13.6	2.3±5.1
Sep	18	7	48	38.9	6.9±9.9	2.7±4.5
Oct	19	6	35	31.6	5.8±9	1.8±3.1
Nov	23	17	185	73.9	10.9±11.1	8±9.1
Dec	20	16	92	80	5.8±4.6	4.6±4
Jan	18	7	20	38.9	2.9±3.9	1.1±1.7
Feb	22	15	74	68.2	4.9±4.6	3.4±3.5
Mar	18	13	78	72.2	6±5.5	4.3±4.4
Apr	22	15	74	68.2	4.9±4.7	3.4±3.5
May	22	15	73	68.2	4.9±4.4	3.3±3.3
Jun	18	13	56	72.2	4.3±3.5	3.1±2.7
			2006-2007			
July	20	9	40	45	4.4±5.2	2±2.5
Aug	23	14	55	60.9	3.9±4	2.4±2.7
Sep	23	6	10	26.1	1.7±2.9	0.4±0.8
Oct	22	12	34	54.6	2.8±3.4	1.6±2.2
Nov	19	17	127	89.5	7.5±8.5	6.7±8
Dec	22	17	127	77.3	7.5±7.3	5.8±6.2
Jan	18	8	75	44.4	9.4±11.9	4.2±6
Feb	18	15	105	83.3	7±6.5	5.8±5.8
Mar	20	14	95	70	6.8±7.4	4.8±5.9
Apr	23	14	54	60.9	3.9±3.6	2.4±2.4
May	22	5	15	22.7	3±5.6	0.7±1.3
Jun	22	12	54	54.6	4.5±4.7	2.5±2.8

Table 4: Seasonal population dynamics of *E.tetradactylum* (Digeneans).

Month	Total Fish (b)	Infected Fish (b)	Total no of Parasites (c)	Prevalence (%)	Mean Intensity (c/b)±SD	Mean Abundance (c/a)±SD
2005-2006						
July	18	5	15	27.8	3±4	0.8±1.7
Aug	20	8	29	40	3.6±4.8	1.5±2.1
Sep	18	3	5	16.7	1.7±3.9	0.3±0.7
Oct	19	0	0	0	0	0
Nov	23	12	42	52.2	3.5±3.7	1.8±2.1
Dec	20	8	34	40	4.3±5.6	1.7±2.5
Jan	18	14	133	77.8	9.5±9.6	7.4±8.2
Feb	22	18	126	81.8	7±7.9	5.7±7
Mar	18	0	0	0	0	0
Apr	22	8	34	36.4	4.25±6.5	1.6±2.9
May	22	8	33	36.4	4.1±6.3	1.5±2.7
Jun	18	9	35	50	3.9±5.8	1.9±3.6
2006-2007						
July	20	9	25	45	2.8±3.2	1.25±1.5
Aug	23	12	31	52.2	2.6±2.9	1.35±1.7
Sep	23	7	15	30.4	2.1±3.3	0.7±1.1
Oct	22	5	12	22.7	2.4±4.5	0.6±1.1
Nov	19	10	21	52.6	2.1±2.3	1.1±1.3
Dec	22	12	44	54.6	3.7±4.9	2±3.2
Jan	18	6	30	33.3	5±7.8	1.7±3.1
Feb	18	13	47	72.2	3.6±4.3	2.6±3.5
Mar	20	13	40	65	3.1±2.4	2±1.6
Apr	23	10	40	43.5	4±5.4	1.7±2.8
May	22	15	74	68.2	4.9±4.1	3.4±3
Jun	22	10	26	45.5	2.6±3	1.2±1.4

Table 5: Seasonal population dynamics of *E.tetradactylum* (Copepods).

Month	Total Fish (b)	Infected Fish (b)	Total no of Parasites (c)	Prevalence (%)	Mean Intensity (c/b) ±SD	Mean Abundance (c/a) ±SD
2005-2006						
July	18	15	55	83.3	3.7±2.4	3.1±2.1
Aug	20	16	90	80	5.6±3.7	4.5±3.1
Sep	18	14	71	77.8	5.1±3.7	3.9±3.1
Oct	19	11	45	57.9	4.1±4	2.4±2.5
Nov	23	18	107	78.3	5.9±4.3	4.7±3.6
Dec	20	20	90	100	4.5±1.6	4.5±1.6
Jan	18	16	94	88.9	5.9±2.9	5.2±2.6
Feb	22	21	88	95.5	4.2±2.3	4±2.3
Mar	18	13	112	72.2	8.6±7.2	6.2±5.6
Apr	22	18	82	81.8	4.6±3.2	3.7±2.8
May	22	19	82	86.4	4.3±3.3	3.7±3
Jun	18	9	54	50	6±7.1	3±4
2006-2007						
July	20	15	46	75	3.1±2.3	2.3±1.8
Aug	23	12	77	52.2	6.4±2.9	3.3±1.7
Sep	23	19	68	82.6	3.6±2.5	3±2.2
Oct	22	18	64	81.8	3.6±2.4	2.9±2.1
Nov	19	19	118	100	6.2±3.1	6.2±3.1
Dec	22	20	106	90.9	5.3±2.9	4.8±2.7
Jan	18	13	70	72.2	5.4±4	3.9±3.1
Feb	18	10	51	55.6	5.1±5.7	2.8±3.6
Mar	20	11	28	55	2.6±2.8	1.4±1.7
Apr	23	20	67	86.9	3.35±2.2	2.9±2
May	22	17	78	77.3	4.6±3.3	3.6±2.7
Jun	22	19	79	86.4	4.2±2.4	3.6±2.2

Table 6: Seasonal changes in overall prevalence, mean intensity and mean abundance of parasites in *E.tetradactylum.*

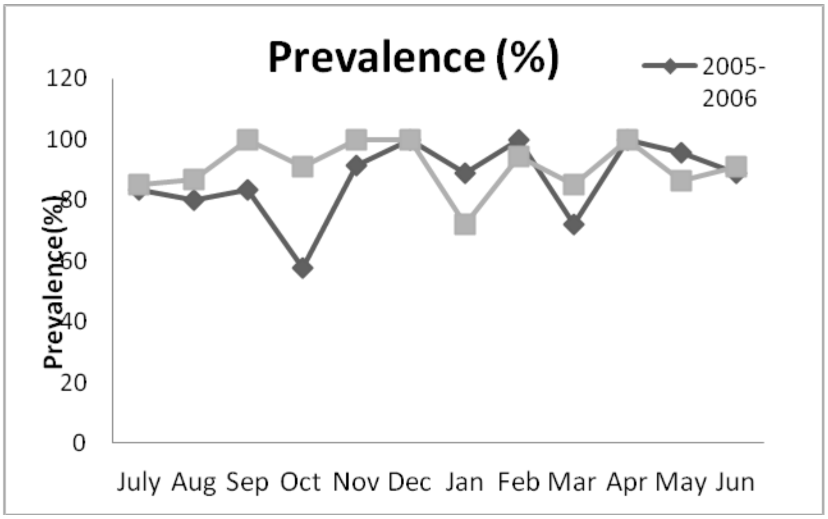
Season	No. of fish examined	No. of fish infected	No. of parasites	Prevalence%	Mean intensity	Mean abundance	Chi-square value
2005-2006							
Rainy	75	57	590	76.0	10.4	7.9	3.96
Winter	83	79	1114	95.2	14.1	13.4	
Summer	80	72	766	90.0	10.6	9.6	
2006-2007							
Rainy	88	80	518	90.9	6.5	5.9	20.08
Winter	77	71	981	92.2	13.8	12.7	
Summer	87	79	709	90.8	9.0	8.1	

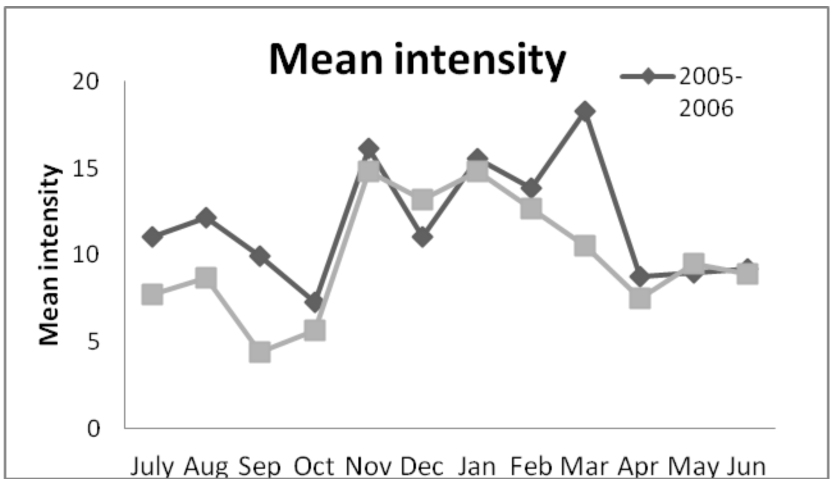
Table 7: Correlation coefficient (r) between size and parasitic number in *E. tetradactylum.*

S.No.	Size Groups	Class Interval	No. of Parasites	Coefficient of Correlation (r)
1	Group-1	13.0-20.0	372	0.17
2	Group-2	20.1-25.0	472	
3	Group-3	25.1-30.0	2140	
4	Group-4	30.1-35.0	1389	
5	Group-5	35.1-40.0	315	

Research Article

Figure 1: Seasonal population dynamics of total parasites of *E. tetradactylum*





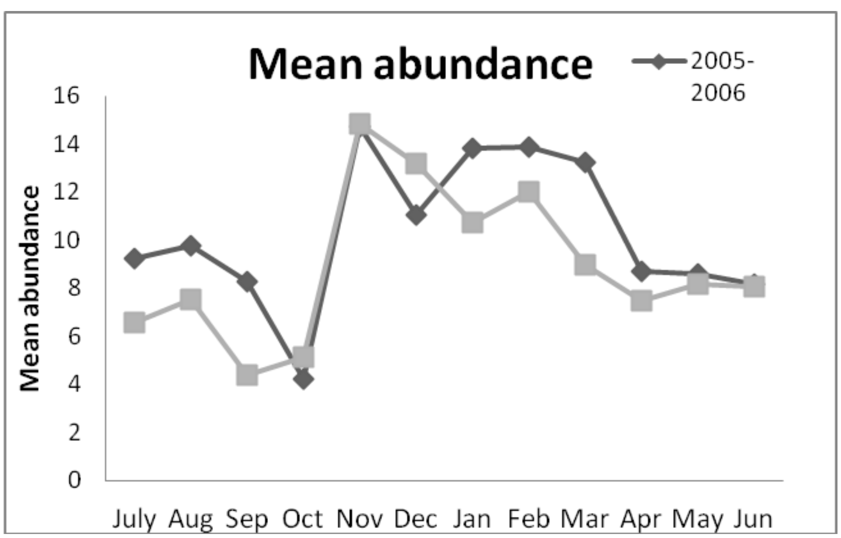


Figure 2: Seasonal population dynamics of *E. tetradactylum* (Monogeneans)

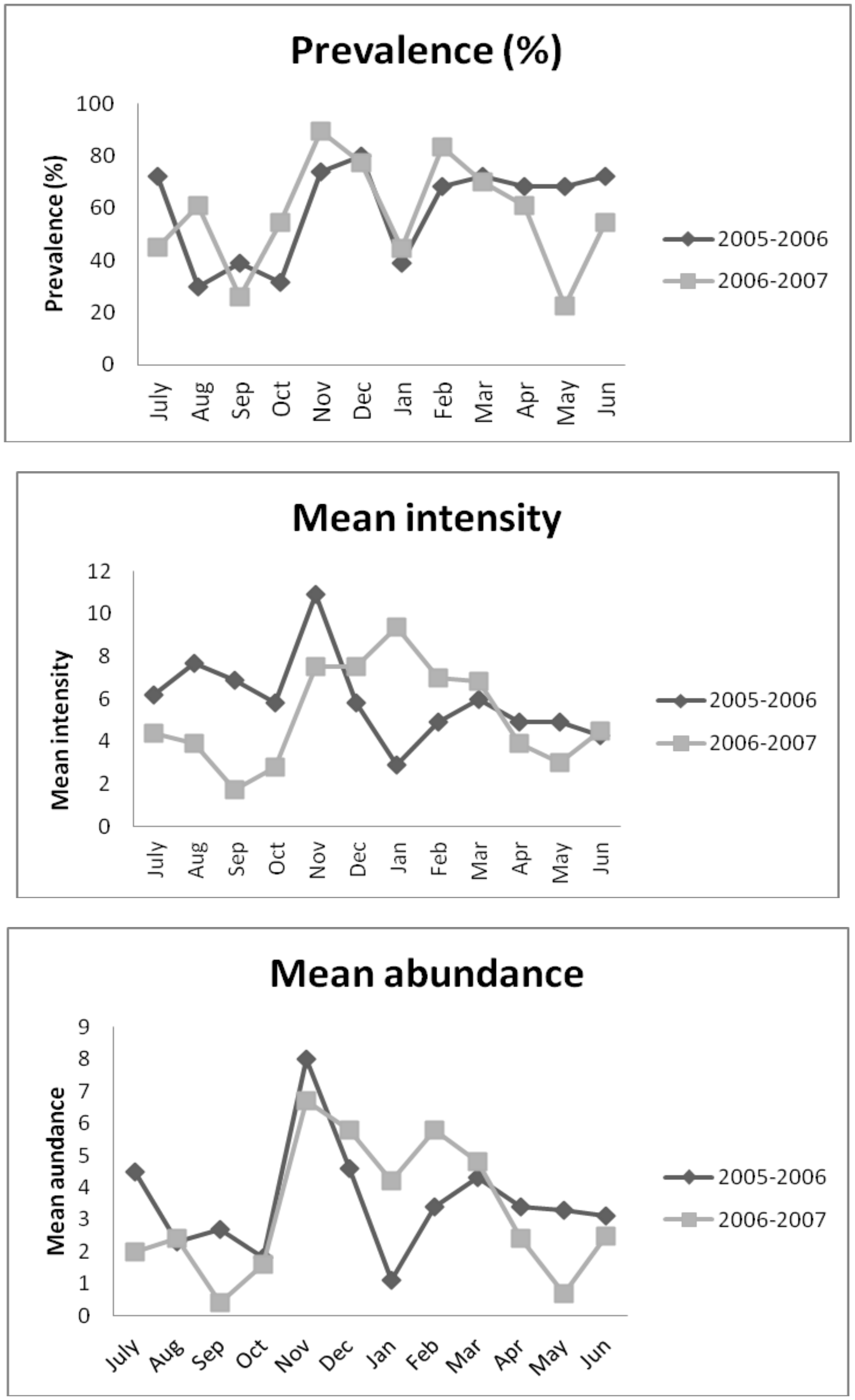


Figure 3: Seasonal population dynamics of *E. tetradactylum* (Digeneans).

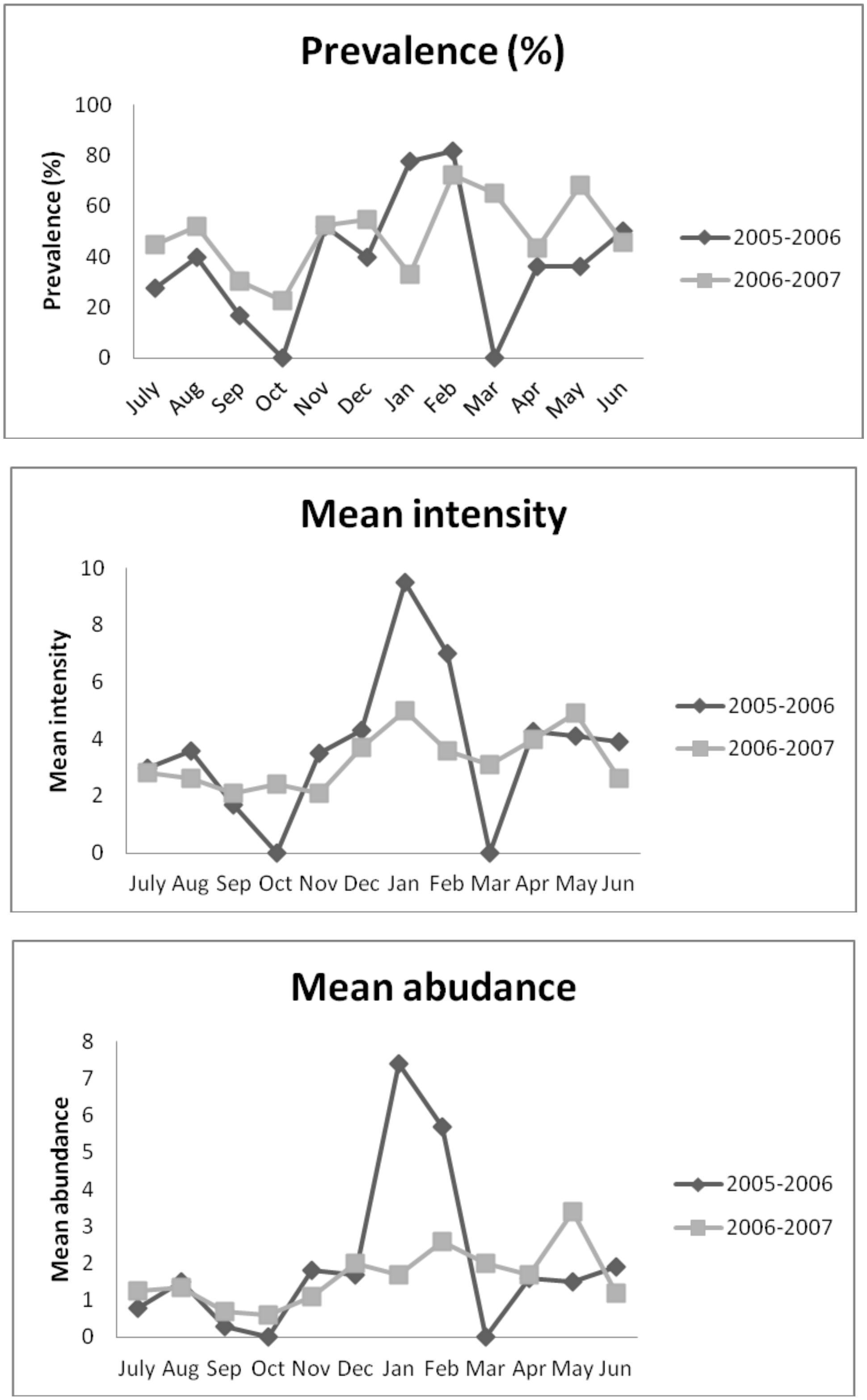
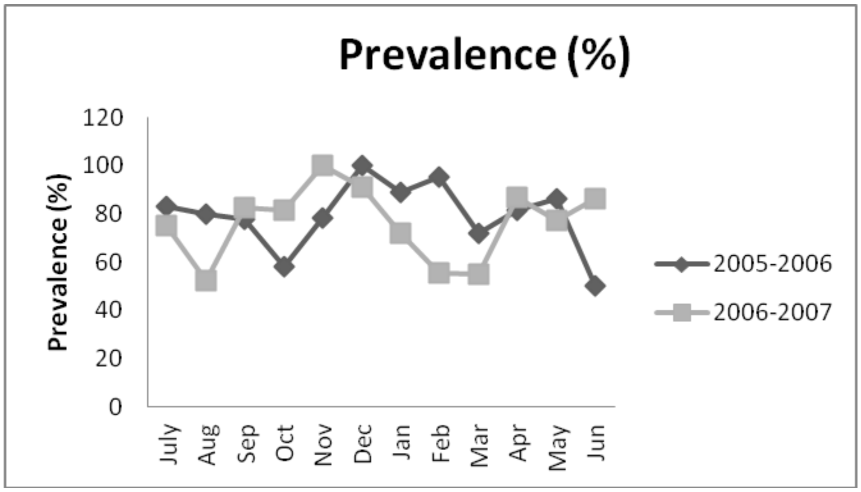
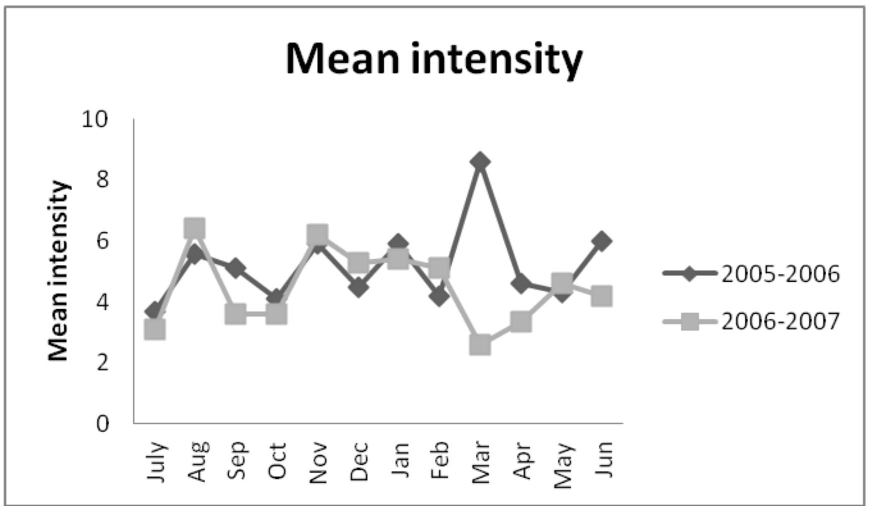


Figure 4: Seasonal population dynamics of *E. tetradactylum* (Copepods)





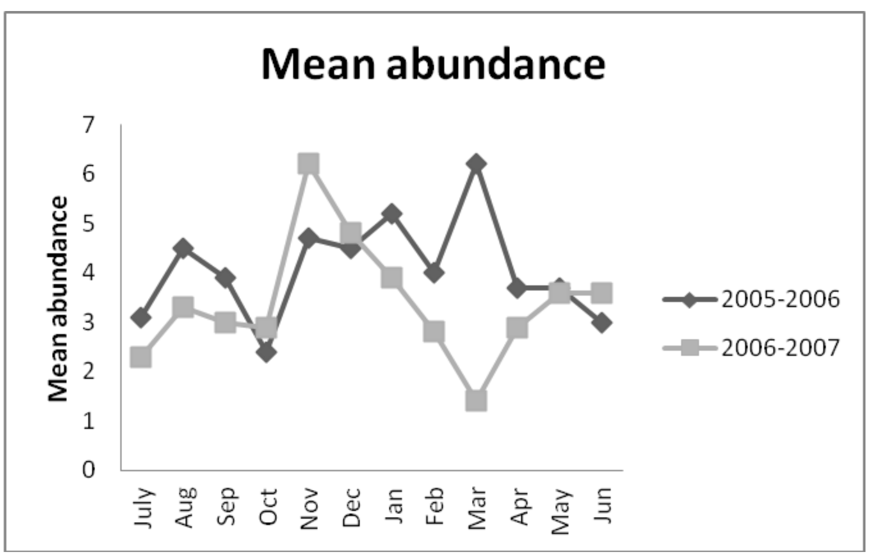
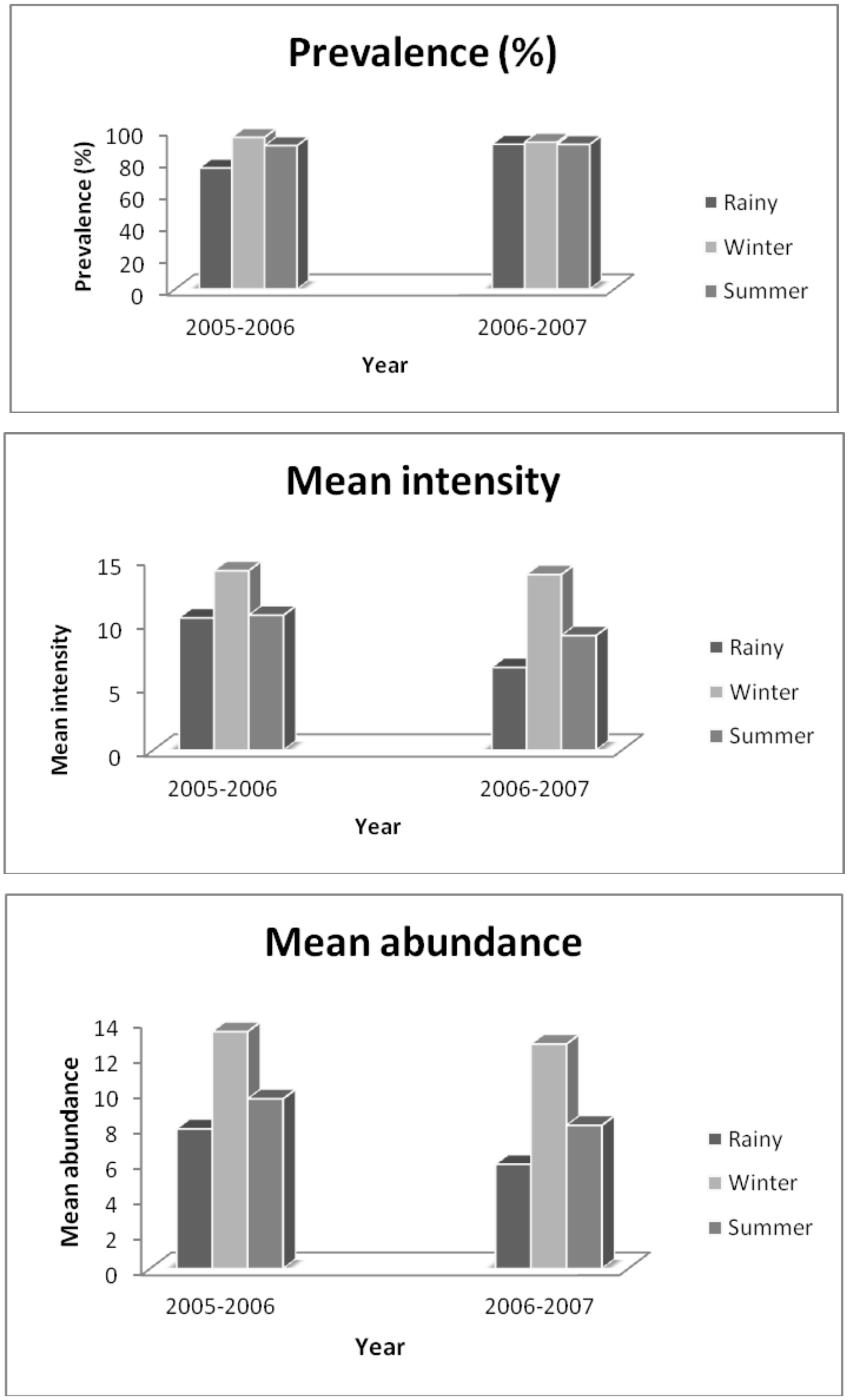


Figure 5: Seasonal changes in prevalence, mean intensity and mean abundance of infection of *E. tetradactylum*



Moderate values of prevalence were noticed throughout the 2005-06 and 2006-07 cycles. Lower values were noticed in 2005-06. Both the cycles showed a very good coherence. Mean intensity showed fluctuations during 2005-06. It was not uniform throughout the period. There were alternate ups and downs up to April. From April to June it is uniform. 2006-07 cycle, though coincides with the previous period, showed a gradual rise from September to November and fall from January to April and continued to be low during other two months. Mean abundance of both the cycles coincides with each other. In both the cycles, a gradual fall was seen from August to October and suddenly a great rise in November was observed followed by gradual decline towards June. A peak value was observed in the month of November in both the cycles.

Individual parasitic groups: Seasonal population dynamics of parasites was calculated groupwise, i.e. monogenetic trematodes, digenetic trematodes, and copepods in *E. tetradactylum*. Acanthocephalans and nematodes were not considered due their less number.

Monogenenes (Table 3 and Figure 2)

In 2005-06 high prevalence was noticed in the months of July, November and December and from February to June. Low values were noticed in August, September, October and January. 2006-07 cycle shows good lineation with the previous cycle except for the months of July, August and May. Mean intensity in both the cycles, more or less coincides from July to November. 2005-06 cycles showed high values than 2006-07 cycles. Though only 2 different genera of monogeneans obtained, they were in good numbers. A total number of 1653 parasites were collected from this fish in 2 years. Interestingly in the month of January, the highest value for 2006-07 cycles was seen whereas it is the lowest value for 2005-06 cycles. Mean abundance also shows a good fit for both the cycles except for September and May. The value rised suddenly from October to November to a peak which declined steeply in January for 2005-06 cycles, whereas it was moderate in 2006-07.

Digenes (Table 4 and Figure 3)

In 2005-06, highest prevalence was in January and February. 2006-07 cycles were slightly different from the previous year cycle. This cycle is interesting to note that in October and March the prevalence falls to zero, whereas in 2006-2007 cycle the values were moderate without lower values. In the first quarter of the 2005-06 cycles, mean intensity was moderate becoming nil in October and raised again to moderate levels in November and December. January and February showed peak levels of infection but again March showed nil infection and rising to moderate levels in the next 3 months of the cycle. This cycle shows moderate, peak and nil values. Though the second year cycle runs more or less parallel to the previous year, nil infection was not occurring and the highest infection rate was less when compared to 2005-06. Moreover, there was not much variation in the infection throughout the year. Mean abundance also shows not much deviation for 2006-07 cycle, however 2005-06 cycle showed a peak point and two nil areas in the graph. Though both lines run side by side to some extent, there was no specific peak period for 2006-07 cycles. The infection was maintained throughout the year without any break points whereas the second cycle showed January and February as peak levels.

*Nematodes***:** Nematodes were not considered for evaluation since their infection rate was less.

Acanthocephalans: Infection with acanthocephalans was very less, less than 10%, so seasonal dynamics was not estimated.

Copepods (Table 5 and Figure 4)

Infections of copepods in this fish were quite good with a total number of 1822 parasites for both the years. Overall prevalence was also almost high throughout the year in 2005-06. The highest value was recorded in December to February. Lower values were noticed in the months of October and June. The second annual cycle shows gradual rise from August to November and values are moderate throughout the year. Mean intensity during 2005-06 is alternatively up and down, with higher value in March. During 2006-07 lowest infection rate was observed in March, which is quite opposite to the first annual cycle. Overall the cycle is with moderate values with less deviation. Mean abundance was moderate during

2005-06 with the highest value in March, and the lowest in October. 2006-07 cycles showed peak abundance in November and from then onwards a gradual decline till March, and again a gradual rise in May and June was observed. There was no coherence between the two cycles.

*Seasonal Influence***:**

Chi-square test reveals the significance in the rate of parasitization during different seasons – Rainy, winter and summer. In *E. tetradactylum*, the chi-square value for 2005-06 is 3.96 and the estimated p-value of 0.138 suggests no significant association. However in 2006-2007, the chi-square value is 20.08 and the estimated p-value of 0.000 suggesting that there is a statistically significant association between two comparison variables i.e. prevalence and seasons. Histograms drawn for prevalence, mean intensity and mean abundance against the seasons for the two cycles showed that prevalence and seasons are not much associated together except for 2006-07 cycle of *E. tetradactylum* (Table 6; Figure 5). However, parasitization is high in winter in both the cycles of *E. tetradactylum* though variations seen in rainy and summer seasons are not very consistent.

Size:

An attempt has been made to find out the possible relationship between the host size and total parasitic infection. For this purpose, correlation coefficient 'r' was calculated for parasites encountered in *E. tetradactylum* ranging from 13.0 – 40.0 cm. The fishes were categorized into 5 groups (Table 7). The calculated values of 'r' 0.17 for *E. tetradactylum*, showed the positive correlation, but it is very meager. The overall parastization was high in fish belonging to Group – III and IV in *E. tetradactylum*, moderate in Group – II and less in group-I and V. Parasitization was less in younger and older fishes.

*Sex***:** Due to protandrous nature of the host – host sex changing from juvenile to hermaphrodite, then to a female with growth, sex of the host was not taken into consideration.

DISCUSSION

There was a good similarity in the overall prevalence, mean intensity and mean abundance for both the two years cycle with only a slight deviation which was not very significant. The variations depend upon some factors such as density of the host population and its stage and maturity. Many scientists insisted on the importance of temperature as one of the factors in controlling the parasitic infections (Hedgepeth 1957, Hopkins 1959, Chubb 1963, Awachie 1966, Manter 1966, Kennedy 1971, 1975, 1977a, 1977b, 1997c, Muralidhar 1989, Rohde 1993, Rodregues and Saraiva 1996, Chapman *et al*., 2000, Turner 2000, Wang *et al.*, 2001 and Mouritsen and Poulin 2002). Infections are more in warm seas than in colder ones Rohde (1993). The present study also supports the role of temperature in controlling the parasitic fauna either directly or indirectly. Statistically there is no significant association between the seasons and prevalence of infection. But parasitization was high during winter months than in other months. The environmental conditions of tropical waters are quite favorable in winter months as these waters are warm but not ice cold and the sea is calm and there may not be any disturbance during this season. At these moderate temperatures, zooplankton, invertebrate and smaller vertebrate fauna may be rich when compared to high temperature of summer months in tropical waters. Recruitment of infection may take place after summer and reach their peak in winter months. There is a meager positive correlation between the host size and total parasitic infection. The main characteristic feature of the parasite community of the *E.tetradactylum* is the strong dominance of ectoparasites (copepods and monogeneans) at quantitative levels (74%). The diversity of ectoparasites (2 species of monogenea and 7 species of copepods) almost equals to that of endoparasites. Oliva (1994), Oliva *et al*., (1996), Oliva and Luque (1998) found the dominance of ectoparasites and the scarcity of endoparasitic fauna at both qualitative and quantitative levels in fishes and they correlated this fact may be a consequence of the unstable environment due to an upwelling system, periodically affected by the El Nino Southern Oscillation phenomena. According to Rohde (1993), fishes from lower latitude harbour a richer monogenean fauna than those of higher latitudes. Studies of Carvalho *et al*., (2004) stated that both feeding sites and body size of a parasite play an important role in the distribution and abundance of ectoparasites. Since the isopods have a larger body size than copepods and feeding site is much smaller (gill chamber) than that of copepods (the whole body surface of the host), the host can have a much greater abundance of copepods than of isopods. The dominance of ectoparasitic fauna over endoparasites is clearly seen in *E. tetradactylum*. The number of parasitic species that host species supports varies widely from one host species to another and it may be influenced by a number of biotic and abiotic factors according to Holmes and Price (1986). They stated that the factors responsible for parasite assemblages in the fish may be attributed to host vagility, composition of diet, complexity of gut, host size and phylogeny. The variation in infection with age group may be because of younger fish have less capacity of feeding whereas older fish may be resistant and therefore do not allow new extra parasite burdens (Lo *et al*., 1998; Zelmer and Arai, 1998 and Johnson *et al*., 2004). The parasite life span also plays its role with number of parasites diminishing in the host with increasing age. Thus less feeding capacity, immunity and parasite life span may be the main reasons for low parasite burden in the small and old fish when compared to the medium sized fish. The present study holds good as the parasitization was high in medium sized fish and less in younger and older fishes. The present study holds good with the views of Holmes (1990) which suggests that fish as intermediate hosts have rich parasite fauna since they harbour both adults and larval helminths.

ACKNOWLEDGEMENTS
The first author is grateful to the UGC for providing financial assistance under the Fellow Improvement Programme (FIP) and the second author is thankful to Council of Scientific and Industrial Research, New Delhi for providing the financial assistance as senior research fellow.

REFERENCES
Arthur JR (1997). Recent advances in the use of parasites as biological tags for marine fish. *Diseases in Asian aquaculture* III eds 141-154.
Ayala SC and Hutching R (1974). Hemogregarines (Protozoa: Sporozoa) as zoogeographical tracers of Galapagos Island lava lizards and marine iguanas. *Herpetologica* **30** 128-132.
Awachie JBE (1966). Observations on *Cyathocephalus truncates* pallas, 1781 (Cestoda: Spathebothriidea) in its intermediate and definite hosts in a trout stream, North wales. *Journal of Helminthology* **40** 1-10.
Bush AO, Lafferty KD, Lotz JM and Shostak AW (1997). Parasitology meets ecology on its own terms. Margolis *et al.*, Revisted. *Journal of Parasitology* **83**(4) 575-583.
Cannon LRG (1977). Some ecological relationships of larval ascaridoids from south-eastern Queensland marine fishes. *International Journal for Parasitology* **7** 227-232.
Carvalho LN, Arruda R and Kleber Del-Claro (2004). Host-parasite interaction between the piranha *Pygocentrus haltereri* (Characiformes: Characidae) and isopods and branchiurans (Crustacea) in the Rio Araguaia basin, Brazil. *Neotropical Ichthyology* **2**(2) 93-98.
Chapman LJ, Lanciani CA and Chapman CA (2000). Ecology of a diplozoon parasite on the gills of the African cyprinid *Barbus neumayeri*. *African Journal of Ecology* **38**(4) 312-320.
Chubb JC (1963). On the characterization of the parasites fauna of the fish of Llyn Tegid. *Proceedings of the Zoological Society of London* **141** 609-621.
Daniel WW (1998). Biostatistics: A foundation for analysis in the health sciences (VIII Ed.), John Wiley and Sons Int., New York.
Ferrer-Castello E, Raga JA and Aznar FJ (2007). Parasites as fish population tags and pseudoreplication problems: the case of striped red mullet, *Mullus surmuletus* in the Spanish Mediterranean. *Journal of Helminthology* ***81***(2) 169-178.

Grabda – Kazubski B, Baturo-Warsza-Wska B and Pojmanska T (1987). Dynamics of parasite infestation of fish in lakes Dgal Wielki and Warnaik in connection with introduction of Phytophagous species. *Acta Parasitologica Polonica* **32** 1-28.

Hedgepeth JW (1957). Marine biogeography, In: Hedgepeth, J.W. (Ed) Treatise on marine ecology and paleoecology. *Volume of Geological Society of America* 359-382.

Holmes JC (1990). Competition, contacts and other factors restricting niches of parasitic helminths. *Annales de Parasitologie Humaine et Comparéei* **65** 69-72.

Hopkins CA (1959). Seasonal variations in the incidence and development of cestode *Proteocephalus fillicolis* (Rud, 1810) In Gasterosteus aculeatus L. I1766) *Parasitology* **49** 529-542.

Johnson MW, Nelson PA and Dick TA (2004). Structuring mechanisms of yellow perch (*Perca flavescens*) parasitic communites: host age, diet, and local factors. *Canadian Journal of Zoology* **82** 1291-1301.

Kennedy CR (1971). The effect of temperature upon the establishment and survival of the cestode *Caryophyllaeus laticeps* in Orfe, Leuciscus Indus. *Parasitology* **63** 59-66.

Kennedy CR (1975). Ecological animal parasitology. Blackwell Scientific Publications, Oxford, 163.

Kennedy CR (1977a). The regulation of fish parasite populations. In: *Regulation of Parasite Populations*. 61-109.

Kennedy CR (1977b). The biology, specificity and habit of the species of *Eubothrium* (Cestoda: Pseudophyllidea) a review and reappraisal. *Journal of Fish Biology*.

Kennedy CR (1997). Freshwater fish parasites and environmental quality: an overview and caution. *Parassitolgia* **39** 249-254.

Klassen GJ (1992). Coevolution: a history of the macroevolutionary approach to studying host-parasite associations. *Journal of Parasitology* **78** 573-587.

Kuperman BI (1973). Tapeworms of the Genus *Triaenophorus*. Parasites of Fishes. Nauka Publishers Leningrad Section, Leningrad (English translation 1981 Amerind Publishing Co. Pvt. Ltd, New Delhi).

Lafferty KD (1997). Environmental parasitology: What can parasites tell us about human impacts on the environment? *Parasitology Today* **13** 251-255.

Lafferty KD (2008). Ecosystem consequences of fish parasites. *Journal of Fish Biology* **73** 2083-2093.

Lafferty KD and Kuris AM. (1999). How environmental stress affects the impacts of parasites. *Limnology and Oceanography* **44** 925-931.

Leaman BM and Kabata Z (1987). *Neobrachiella robusta* (Wilson, 1912) (Copepoda: Lernaeopodidae) as a tag for identification of stocks of its host, *Sebastes alutus* (Gilbert, 1890) (Pisces: Teleostei). *Canadian Journal of Zoology* **65** 2579-2582.

Lo CM, Morand S and Galzin R (1998). Parasite diversity/host age and size relationship in three coral-reef fishes from French Polynesia. *International Journal for Parasitology* **28** 1695-1708.

Luque JL, Amato JFR and Takemoto, RM (1996). Comparative analysis of the communities of metazoan parasites of *Orthopristis rubber* and *Haemulon steiindachneri* (Osteichthyes: Haemulidae) from the Southeastern Brazilian littoral: I. Structure and influence of size and sex of the hosts. *Revista Brasileira de Biologia* **56** 279-292.

Manter HW (1966). Parasites of fishes as biological indicators of recent and ancient conditions. In: *Host Parasite Relationships*, edited by Mc Vauley JE, Annual Biology Colloq., Oregon state University Press **26** 59-71.

MacKenzie K, Williams HH, Williams B, McVicar AH and Siddall R (1995). Parasites as indicators of water quality and the potential use of helminth transmission in marine pollution studies. *Advances in Parasitology* **35** 85-144.

Marcogliese DJ (2004). Parasites: Small Players with Crucial Roles in the Ecological Theatre. *Ecohealth* **1**(2) 151-164.

Margolis L, Esch GW, Holmes JC, Kuris AM, Schad GA (1982). The use of ecological terms in parasitology (report of an Adhoc Committee of the American Society of Parasitologists). *Journal of Parasitology* **68** 131-137.

McClelland G and Melendy J (2007). Use of endoparasites helminths as tags in delineating stock of American plaice (*Hippoglossoides Figuressoides*) from the Southern Gulf of St. Lawerence and Cape Breton Shelf. *Fishery Bulletin* **105**(2) 180-188.

Mouritsen KN and Poulin R (2002). Parasitism, climatic oscillations and the structure of natural communities. *Oikos* **97**(3) 462-468.

Moyo, DZ (2009). Observations on the Helminth Parasites of Fish in Insukamini Dam, Zimbabwe. *Research Journal of Agriculture and Biological Sciences* **5**(5) 782-785.

Muralidhar A (1989). Seasonal variation of helminth parasites in marine fishes at East coast of India. *Indian Journal of Helminthology* **41**(1) 1-4.

Oliva ME (1994). Parasite of the Chilean jack mackeral *Trachrus symmetricus murphy*i (Pisces: Carangidae). *Memoirs Instituto Oswaldo Cruz* **89** 363-364.

Oliva ME, Castro RE and Burgos R (1996). Parasites of the flatfish, *Paralichthys adspersus* (Steindachner, 1867) (Pleuronectiformes) from northern Chile. *Memoirs Instituto Oswaldo Cruz* **91** 301-306.

Oliva ME and Luque JL (1998). Metazoan Parasite Infra communities in five sciaenids from the central Peruvian coast. *Memoirs Instituto Oswaldo Cruz* **93**(2) 175-180.

Overstreet RM (1997). Parasitological data as monitors of environmental health. *Parassitologia* **39** 169-175.

Pearson JC (1968). Observations on the morphology and life-cycle of *Paucivitellosus fragilis* Coil, Reid and Kuntz, 1965 (Trematoda: Bivesiculidae). *Parasitology* **58** 769-788.

Rodrigues AA, Saraiva A (1996). Spatial distribution and seasonality of *Pseudodactylogyrus anguillae* and *P. bini* (Monogenea) on the gills of the European eel Anguilla anguilla from Portugal. *Bull of the European Association of fish Pathologists* **63**(3) 85-88.

Rohde K (1993). "Ecology of marine parasites" An introduction to marine parasitology: Department of Zoology, Unit of New England, Armidale, NSW, 2351, Australia, CAB International ISBN, 0851 988458.

Snedecor WG and Cochran GW (1967). *Biostatistical Methods*. (IOWA State University Press) **6** 593.

Sokal RR and Rohlf FJ (2000). Biometry (3rd Ed) the principles and practice of statistics in Biological Research. W.H.Freeman and Company New York.

Sundara Rao PSS and Richard J (1996). An Introduction to Biostatistics. *A manual for students in Health Sciences* (Prentice Hall of India Pvt Ltd New Delhi).

Sures B (2001). The use of fish parasites as bioindicators of heavy metals in aquatic ecosystems: a review. *Aquatic Ecology* **35** 245-255.

Sures B, Taraschewski H and Siddall R (1997). Heavy metal concentrations in adult acanthocephalans and cestodes compared to their fish hosts and to established free-living bioindicators. *Parassitologia* **39** 213-218.

Sures B, Siddall R and Taraschewski H (1999). Parasites as accumulation indicators of heavy metal pollution. *Parasitology Today* **15** 16-21.

Timi JT (2007). Parasites as biological tags for stock discrimination in marine fish from South American Atlantic waters. *Journal of Helminthology* **81**(2) 107-111.

Turner HM (2000). Seasonality of *Alloglossoides cardicol*a (Trematoda: Macroderiodea) infection in the cray fish, *Procambarus acutus*. *South western Naturalist* **45**(1) 69-71.

Valtonen ET, Holmes JC, Koskivaara M (1997). Eutrophication, pollution and fragmentation: effects on parasite communities in roach (*Rutilus rutilus*) and perch (*Perca fluviatilis*) in four lakes in central Finland. *Canadian Journal of Fisheries and Aquatic Sciences* **54** 572-585.

Vidal-Martinez VM, Daniel P, Sures B, Purucker ST and Poulin R (2010). Can parasites really reveal environmental impact? *Cell Press* 1-8.

Wang GT, Yao WJ and Nie P (2001). Seasonal occurrence of *Dollfustrema vaneyi* (Digenea: Bucephalidae) metaceraria in the bull head cat fish *Pseudobagnus fluvidraeo* in a reservoir in china. *Diseases of Aquatic Organisms* **44**(2) 127-131.

Williams HM, Jones A, 1994. Parasitic worms of fish. Taylor and Francis, London, 563.

Williams HH, MacKenzie K and McCarthy AM (1992). Parasites as biological indicators of the population biology, migrations, diet and phylogenetics of fish. *Reviews in Fish Biology and Fisheries* **2** 144-176.

Wood CL, Lafferty KD and Micheli F (2010). Fishing out marine parasites? Impacts of fishing on rates of parasitism in the ocean. *Ecology Letters* **13**(6) 761-775.

Zelmer DA and Arai HP (1998). The contributions of host age and size to the aggregated distribution of parasites in Yellow perch (*Perca flavescens*) from, Garner Lake Alberta, Canada. *Journal of Parasitology* **84** 24-28.