Population dynamics of cestode, *Circumonchobothrium shindei* (Cestoda: Pseudophyllidea Carus, 1863) in the freshwater eel, *Mastacembelus armatus* Lacépède, 1800 from River Godavari, Rajahmundry

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Abstract The freshwater eel, *Mastacembelus armatus* Lacépède, 1800 is often found infected with adults and larval plerocercoids of the cestode, *Circumonchobothrium shindei*. The population dynamics of *C. shindei* was studied in the freshwater eel, *M. armatus* during September 2005 to August 2007 from Godavari River, Rajahmundry. A total of 494 eels were examined; 184 (37.24 %) were infected with this cestode. Infection intensity ranged from 1 to 13 for *C. shindei* and their plerocercoids. *C. shindei* occupy the position of secondary species in community structure of metazoan parasites of *M. armatus*, with mean intensity, mean abundance and index of infection (2.5 ± 1.22 ; 1.1 ± 1.45 and 0.57 respectively). The present investigation deals with monthly population dynamics of *C. shindei* in *M. armatus* which summarizes percentage of prevalence, intensity, abundance and index of infection. Medium sized fish depicted more infection with this cestode and female fish illustrates comparatively higher infection rate than male fish.

Keywords *Mastacembelus armatus* · *Circumonchobothrium shindei* · Plerocercoids · Prevalence · Intensity · Abundance · Index of infection

Introduction

Fishes form an indispensable part in the ecosystem and act as valuable food items and source of income to humans. The largest spiny eel, *Mastacembelus armatus* Lacépède, 1800 is a popular indigenous aquarium fish, medicinally and commercially important food fish (Sugunan et al. 2002; Tripathi 2004). It is commonly known as zigzag eel, spiny eel, leopard spiny eel and white-spotted spiny eel and locally as “Pedda papera”, “papera”, freshwater “Baam” or “Bommidai”. They play an imperative role to meet the nutritional requirements of common people due to their great palatability and high consumer appeal in India and neighboring countries. The freshwater spiny eels of the family Mastacembelidae confine their habitat to southeast Asia and form a firm basis of several economically important fisheries in southern India. These fish also act as exceptional hosts for a diversified group of parasites like trematodes, cestodes, nematodes, acanthocephalan and crustacean parasites. Parasites are vital components of natural community affecting fish health, growth and survival (Preston and Johnson 2010). Also, European Food Safety Authority (EFSA 2010) discussed the risk assessment of parasites in fish and fishery products. *M. armatus* is often parasitized with *Circumonchobothrium shindei* and its plerocercoids. These parasites were found hanging in the intestinal lumen with their scolices attached to the intestinal villi causing severe mechanical damage. Only negligible amount of work has been carried out on this fish from various regions (Rahman et al. 1998; Kumar et al. 2007; Kadam and Dhole 2011; Fartade et al. 2011; Vankara et al. 2011; Kumar 2012). The present paper deals with the study of prevalence, mean intensity, mean abundance and index of infection of *C. shindei* from *M. armatus*.

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Table 1 Diversity parameters and distribution patterns of cestodes in *M. armatus*

Name of species	Infected fishes	Total no. of parasites	Prevalence (%)	Mean intensity	Mean abundance	Index of infection	Range	Dominance index	Mean total parasites	Location	Nature of infection	Nature of species
<i>Circumonchobothrium</i> sp.	184	536	37.24	2.5 ± 1.22	1.1 ± 1.45	0.57	1–13	0.0145	1.084	Intestine	Common	Secondary

Fig. 1 Monthly population variations of *Circumonchobothrium shindei* in *Mastacembelus armatus*: **a** prevalence, **b** mean intensity, **c** mean abundance and **d** index of infection

Materials and methods

Mastacembelus armatus ($n = 494$) were procured from the River Godavari, Rajahmundry and local fish markets in and around the river. They were brought to the laboratory for examination of parasites from August 2005 to September 2007. Fish were identified according to Jayaram (1981), Munro (1982) and Day (1994). Length, weight and sex of each fish were noted carefully and all organs were examined separately for the collection and counting of parasites. Permanent slides were prepared by conventional preservation techniques (Hiware et al. 2003; Madhavi et al. 2007). The parasites were fixed in alcohol, formaldehyde and acetic acid in 85:10:5 and stained with alum carmine. *M. armatus* measured 18–52 cm (mean = 36.42 ± 6.69 cm) in total length. The average total length of male (35.4 ± 6.59 cm, $n = 221$) and female (37.32 ± 6.64 cm,

$n = 273$) fish in the sample were not significantly different ($t = -1.0$, $p = 1.00$). Pearson's correlation coefficient r was used as an indication of the relationship between the host's length and prevalence of parasites. The effect of host sex on abundance and prevalence of parasites was tested by applying Chi square test. Different biostatistical parameters were applied for qualitative and quantitative analysis of the data. Biostatistical analysis according to 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 adopted 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).

Fig. 2 Seasonal population of *C. shindei* in *M. armatus*: **a** prevalence, **b** mean intensity, **c** mean abundance and **d** index of infection

Table 2 Correlation coefficient (r) between size and parasitic number of *C. shindei* in *M. armatus*

Sl. no.	Size groups	Class intervals	No. of parasites	Coefficient of correlation (r)
1	Group-I	18–25	7	$r = 0.29$
2	Group-II	25–32	34	
3	Group-III	32–39	195	
4	Group-IV	39–46	216	
5	Group-V	46–53	84	

Results and discussion

Of the 494 examined host species, only 184 were found to be infected with 536 (range = 1–13) *C. shindei* and their plerocercoid stages. *C. shindei* is a frequently occurring parasite in the intestine of host and occupies the position of secondary species. These parasites cause mechanical damage as well as anemia, weight loss and decreased production. *C. shindei* showed a prevalence of 37.24 %, with mean intensity, mean abundance and index of infection (2.5 ± 1.22 ; 1.1 ± 1.45 and 0.57 respectively) (Table 1). The month-wise prevalence, mean intensity, mean abundance and index of infection of *C. shindei* (including adults and larval stages) were presented graphically in Fig. 1. Prevalence of *C. shindei* for both the annual cycles was slightly irregular. During, 2005–2006 cycle, prevalence was moderate in September, drastically fell to zero in October and November, then it slightly

increased to moderate values in December and January, again it fell to lower value in February. March to August showed moderate values with many ups and downs. 2006–2007 cycle was completely different as it represents a much crisscrossed pattern. Prevalence abruptly falls from low to zero values from September to November, respectively. Then a gradual increase was observed from December and reached to the peak value in March, then an impulsive fall and rise was noted in the succeeding five months, April to August. Mean intensity in both the annual cycles show variations. 2005–2006 cycle shows a fall in the intensity from September to zero in October and November. Then a steady increase was noticed from November to January, followed by a narrow fall in February, again a rise in March and April, again a narrow fall in May and moderate values were maintained since then until August. 2006–2007 cycle was slightly different with moderate values in September and October falling abruptly to zero in November, again elevated to moderate level in December followed by a fall from January to April. A sudden raise in intensity in May followed by increase and decrease in the consecutive months was recorded. Mean abundance of *C. shindei* for both the cycles was more or less similar to the mean intensity. 2005–2006 cycle showed peak value in September, moderate values were observed from March to August and January. However, lower to zero values were observed in October to February. Higher abundance for 2006–2007 cycle was observed in May and July, lower from October to December and April and moderate in September, January to March, June and August. Index of

Table 3 Parasitization of cestode, *C. shindei* in males and females of *M. armatus* ($N_m = 221$; $N_f = 273$)

Name of the species	N_{mi}	N_{fi}	P_m	P_f	MI_m	MI_f	MA_m	MA_f
<i>Circumchobothrium</i> sp.	80	104	36.2	38.1	2.9	2.89	1.06	1.10

N_m number of males examined, N_f number of females examined, N_{mi} number of males infected, N_{fi} number of females infected, P_m and P_f prevalence of males and females respectively, MI_m and MI_f mean intensity of males and females, MA_m and MA_f mean abundance of males and females respectively

infection for 2005–2006 and 2006–2007 cycles show uniformity from September to January. The first cycle was slightly uniform with a seasonal periodicity; however the next cycle showed variability with many abrupt rise and falls. Prevalence of parasitization was high in summer followed by rainy and less in winter. However, mean intensity and mean abundance varied slightly for both annual cycles. Mean intensity and mean abundance were high in rainy followed by summer (Fig. 2). Correlation coefficient ‘ r ’ was employed to study the possible relationship between host size and total parasitic infection. The calculated values of ‘ r ’ 0.29 show a very meager positive correlation between host size and *C. shindei*. Parasitization was high in medium sized fish (Group-III and IV) and less in smaller (Group-I and II) and larger (Group-V) fishes. The studies of Llewellyn (1962), Pennycuik (1971a, b), Shotter (1973), Mc Vicar (1977), Hanek and Fernando (1978a, b), Fernandez (1985), Valtonen et al. (1990) and Roubal (1990) showed higher levels of parasitism in hosts with intermediate lengths. Fish acquire the parasites in their young phase which are then eliminated in the fish’s adult phase which might be due to ageing of parasites or immunological resistance of fish (Robert et al. 2008). Parasitization of cestodes in *M. armatus* is in harmony with the above studies as the prevalence of infection is low in small fish, abundant in medium size and then decreased in larger fishes (Table 2). Host sex is one of the biotic factors which play an important role in determining parasitization in a host. Out of the total sample of 494 *M. armatus*, 273 were females (55 %) and 221 were males (45 %). Only 110 females (40 %) and 85 males (38 %) were infected by these parasites. Based on a benchmark of 0.05 alpha, the estimated p value of 0.00 suggests that there is no statistically significant association between the parasite abundance of males and females and that the host sex has no influence on parasitization (Table 3). The studies of Lawrence (1970), Pennyquick (1971a, b), Kennedy (1975), Muzzall (1980), Belghyti et al. (1994), Machado et al. (1994), Takemoto and Pavanelli (1994), Luque et al. (1996), Takemoto and Pavanelli (2000) and De Lizama et al. (2005) indicated that host sex is not a significant factor in determining the infection rate of helminth parasites in host fishes and the present study correlate with the above studies. However, parasitization of *C. shindei* and their plerocercoids was comparatively higher in females

than males which might be due to the stress caused during reproductive periods leading into behavioural changes, thus making them more vulnerable to heavy parasitization.

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