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Ecology of Metazoan Parasite Community of Marine Threadfin Fish, *Polydactylus sextarius* (Bloch and Schneider, 1801) from Visakhapatnam Coast, Bay of Bengal

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ABSTRACT

In this study, the structure and diversity of metazoan parasite community and their interactions with 696 *Polydactylus sextarius* 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. Of the 676 host species examined, 563 (83%) hosts were parasitized by at least one or more metazoan parasite species. A total of 5911 specimens were obtained representing 24 species comprising 2 monogenetic trematodes, 11 digenetic trematodes, 2 cestode larvae, 1 nematode, 4 Acanthocephalans, 3 copepods and 1 isopod. Endoparasites preponderate the majority of the components of the infracommunities analysed and represented 92.6% of the total parasites obtained. Larval cestodes (3515) and digeneans (1165) were the most prevalent in the parasite community of the host. Larval cestode, *Scolex pleuronectis* is the only secondary species while the remaining are satellite species being less in number. Impact of abiotic factors like temperature, water currents and biotic factors like feeding habit, diet, immunity, lifespan of host on parasitization; the relationship between host size and prevalence of infection were thoroughly investigated but the host sex was not taken into consideration due to protandrous nature of the host.

Key words: *Polydactylus sextarius*, parasite ecology, community structure, protandrous

INTRODUCTION

Marine environment is complex and provides extremely diverse habitat for a host and their parasites. Every host population within a habitat therefore acquires a characteristic array of parasites and these parasitic communities in their turn can also characterize the habitat (Dogiel *et al.*, 1962) and this concept forms the basis of modern ecological parasitology which deals with distribution and abundance of parasites in time and space (Kennedy, 1975). Ecological concepts are essential in the study of parasites to understand host-parasite relationships and their environment. In this association, parasites have to encounter different types of hazards like risks in transmission from host to host, vulnerability of free living stages in the environment, difficulty in host parasitic defensive responses offered by the host. The parasite community is influenced by the macro environment in which the host lives and the micro environment in which the parasite lives. Parasites act as bioindicators or sensitive probes (MacKenzie *et al*., 1995; Kennedy, 1997; Lafferty, 1997, 2008; Overstreet, 1997; Sures *et al*., 1997, 1999; Valtonen *et al*., 1997; Lafferty and Kuris, 1999; Sures, 2001; Ferrer-Castello *et al*., 2007; Vidal-Martinez *et al*., 2010). Parasite community ecology is a recent discipline that defines the patterns in parasite community structure, richness and diversity (Esch *et al*., 1990; Kennedy, 1995; Gudivada and Vankara, 2010; Martinez-Aquino *et al*., 2011). Marine fish parasite communities have greater species richness and abundance because of their greater vagility and wider breadth of diet when compared with their freshwater counterparts (Kennedy *et al*., 1986). Polynemids or threadfin fish represents an ideal model to assess parasite community structure from Visakhapatnam coast (17.67°'N and 83.32°'E), along the east coast of Bay of Bengal andhra Pradesh as they have anecdotal feeding habits and wide distribution. Of the available six species of Polynemid fish along this coast, *Polydactylus sextarius* (Schneider), *Polydactylus plebeius* (Broussonet) and *Eleutheronema tetradactylum* (Shaw) were of common occurrence throughout the year and *F. heptadactyla* (Cuvier), *Leptamelanosoma indicum* (Shaw) and *P. sexfilis* (Valenciennes) showed seasonal occurence. Only partial data is available on the metazoan parasites of polynemid fish and consequential work has not been performed so far in these fish (Gudivada and Vankara, 2010). Regardless of their nutritive value and accessibility as a profitable sea food to the local communities, this fish has become a highly neglected group in terms of their parasitological studies. The present study is designed to determine the structure of parasitic community and seasonal influence on metazoan parasite fauna of *P. sextarius* Bloch and Schneider, 1801 which is available at this coast throughout the year.

MATERIALS AND METHODS

Study area: The study has been designed for two successive years from July 2005 to June 2007. Total samples of 676 *P. sextarius* were analysed. Fishes were sexed, measured for its length and weight independently and all organs were carefully investigated to collect the parasites. Conventional techniques (Hiware *et al*., 2003; Madhavi *et al*., 2007) were employed for the preparation of permanent slides. *P. sextarius* measured 6-25 cm in total length. The correlation between the host's length and prevalence of parasites was evaluated by Pearson's correlation coefficient r. Berger-Parker index of dominance (Magurran, 1988) was employed to study the dominance frequencies of each parasite infracommunity. Effect of host sex on prevalence and abundance of parasites was not considered due to protandrous nature of the fish. Shannon-Weiner index (H') was employed to study the parasite species diversity. Seasonal influence on the rate of infection was calculated by a Chi-square test to depict the significance between the season and prevalence of parasite species.

RESULTS

Of the 676 fishes examined, 563 (83%) fish were frequently parasitized with one or more than one parasite species. 24 species of metazoan parasites (2 monogenetic trematodes, *Choricotyle polynemi* and *Polynemicola sextariusii* n.sp.; 11 species of Digeneans-two species were larval forms, Metacercariae of *Prosorhynchus* (553) and Didymozoid larvae (80) and the remaining 9 species are adults-*Lecithochirium polynemi, L. glandulum, Erilepturus hamatus, Aponurus laganculus, Didymozoid* sp., *Timonia cabellaria, Helicometrina nimia, Allopodocotyle argyropsi*; 2 cestode larvae-*Scolex pleuronectis* and trypanorhynchids; 1 nematode-*Camallanus cotti*; 4 Acanthocephalans-*Raorhynchus polynemi, Neoechinorhynchus topseyi, Gorgorhynchoides indicus*

Table 1: Metazoan parasites of *Polydactylus sextarius*

Name of the host	Name of the parasite	No. of parasites collected
Polydactylus sextarius	*Choricotyle polynemi* Mamaev, 1972	38
(Bloch and Schneider,1801)	*Polynemicola sextariusi* n. sp.	24
	Lecithochirium polynemi Chauhan, 1945	28
	Lecithocladium glandulum Chauhan, 1945	119
	Erilepturus hamati Yamaguti, 1934, Manter, 1947	89
	Aponurus lagunculus Looss, 1907	14
	Metacercariae of *Prosorhynchus*	553
	Didymozoid sp's	58
	Didymozoid larvae	80
	Timonia caballeroi Madhavi, 1977	112
	Opisthodiplomonorchis elongatus Madhavi, 1974	90
	Helicometrina nimia Linton, 1910	8
	Allopodocotyle argyropsi Madhavi, 1975	14
	Scolex pleuronectis Mueller, 1788	3511
	Trypanorhynchid larva	4
	Camallanus cotti Fujita, 1927	246
	Neoechinorhynchus topseyi Podder, 1937	26
	Raorhynchus polynemi Tripathi, 1959	453
	Gorgorhynchoides indicus Bhattacharya and Banerjee, 2003	54
	Serrasentis sagittifer (Linton, 1889) Linton, 1932	3
	Caligus phipsoni Bassett-Smith, 1898	254
	Caligus laticaudus Shiino, 1960	18
	Developmental stages of *Caligus polynemi* n.sp.	106
	Gnathia maxillaris Sars	9

Table 2: Frequency distribution of No. of parasitic groups per individual in *P. sextarius*

No. of parasitic groups	No. of fish infected	Frequency (%)
1	122	18.10
2	194	28.70
3	162	24.00
4	71	10.50
5	14	2.07
6	0	0.00
7	0	0.00

n = 676, Σx = 5, x = 5/676 = 0.007, Range: 1-5

and *Serrasentis sagittifer*; 3 copepods-*Caligus phipsoni*, *C. laticaudus* and Chalimus stages of *C. polynemi* n.sp. and 1 isopod, *Gnathia maxillaris*) were explored from the host (Table 1). Endoparasites prevail the majority of the components of the infracommunities and represented 92.6% of the total parasites collected which was evidenced by Berger-parker's dominance indices and mean total parasites (Table 2). The parasitic fauna of *P. sextarius* is outweighed by larval cestodes (58%) followed by digeneans, acanthocephalans, nematodes, copepods, monogeneans and isopods. 122 hosts (18.1%) were infected with single parasitic groups, 194 (28.7%) with any two parasitic groups, 162 (24%) with 3 parasitic groups and 71 (10.5%) with 4 and 14 hosts (2.07%) with 5 parasitic groups, respectively. Not even a single fish was infected with all the parasitic groups (Table 2). *Scolex pleuronectis* (3511) constitute 46.3% of the total parasites collected. Metacercariae of *Prosorhynchus* (553) outweighs the parasite fauna subsequently followed by an

Table 3: Diversity parameters of metazoan parasite communities of *P. sextarius*

Host	Sample size	Shannon's diversity index	No. of core species
P. sextarius	676	0.81±0.35	-

Table 4: No. of parasites obtained, dominance index and mean total parasites of different parasitic groups in *P. sextarius*

Parasite group	No. of parasites	Dominance index	Mean total parasites
Monogenetic trematodes	62	0.01	0.091
Digenetic trematodes	1165	0.19	1.720
Larval cestodes	3514	0.58	5.190
Nematodes	426	0.07	0.630
Acanthocephalans	536	0.09	0.790
Copepods	378	0.06	0.550
Isopods	09	0.001	0.013

acanthocephalan, *Raorhynchus polynemi* (453). A total of 5911 individual parasites were collected with 8 parasites/fish. The mean parasite diversity (Shannon's H' index) is 0.81±0.35 though the community is very rich in parasite species; the diversity index values are comparatively low (Table 3). Only two species, *Scolex pleuronectis* and *Raorhynchus polynemi* are common with a prevalence ranging between 30-50%. Six species, namely Metacercariae *Prosorhynchus*, *L. glandulum*, *Didymozoid* sp., *Caligus phipsoni*, *Chalimus* stages of *Caligus* n.sp. and *Camallanus cotti* are frequent with prevalence ranging between 10-30%. Two species namely, *Didymozoid larvae* and *Gorgorhynchoides indicus* are rare with prevalence of 4-10% and the remaining species, *P. sextarius* n.sp., *H. nimia*, *A. argyropsi*, *L. polynemi*, *A. laganculus*, *C. laticaudus*, *G. maxillaris*, *N. topseyi*, *S. sagittifer* and *Trypanorhynchid larvae* are sporadic with <4% prevalence. There was no core species in the host. *Scolex pleuronectis* was the only secondary species while the remaining 23 species are satellite species. *Scolex pleuronectis* presented the highest dominance value of 0.576 followed by Metacercariae *Prosorhynchus* (0.090) and *R. polynemi* (0.074). Mean of total parasite species of *S. pleuronectis*, Metacercariae *Prosorhynchus* and *R. polynemi* was 5.19, 0.82 and 0.67 respectively (Table 4 and 5). Prevalence of parasites was appreciably in relation to site of infection. Infections were more in intestine when compared to other locations. Mean intensity (11.2) and mean abundance (5.2) was high in *S. pleuronectis*. Host size operates as a crucial factor in determining the parasitic burden in a host. To find out the possible correlation between the host size and total parasitic infection, fishes ranging from 6-25 cm were examined and categorized into 4 groups i.e., Group 1 (6.0-10.0 cm), Group 2 (10.1-15.0 cm), Group 3 (15.1-20.0 cm) and Group 4 (20.1-25.0 cm). Overall parasitization was high in moderate fishes ranging from 10.0-20.0 cm (Group 3 and 2) but fish belonging to Group 1 and 4 showed low parasitization. Correlation coefficient 'r' was calculated for parasites encountered and the calculated values of 'r' 0.14 portray a meager positive correlation (Table 6). Host sex was not considered due to protandrous nature of the host.

Seasonal influence: Chi-square test was applied to reveal the significance in the rate of parasitization during different seasons-Rainy, winter and summer. Seasonal influence was not significant on parasitism in *P. sextarius*. The calculated value of chi-square is 1.86 for the year 2005-06, based on a standard of 0.05 alpha, the expected p-value of 0.3950 proposed that there is not a statistically considerable association between the comparison variables. For the year 2006-2007 the chi-square value is 3.23 and the expected p-value of 0.1990 implied no significant association (Table 7).

Table 5: Diversity parameters and distribution of parasitic species infecting *P. sextarius*

Parasite	Infected fish	No. of parasites	Prevalence (%)	Mean intensity	Mean abundance	D.I.	Location	Nature of infection	Nature of species
Choricotyle polynemi	27	38	4.0	1.40	0.06	0.006	Gills	Rare	Satellite
Polynemicola sextariusii n.sp.	20	24	3.0	1.20	0.04	0.004	Gills	Sporadic	Satellite
Opisthodiplomonorchis elongatus	33	90	5.0	2.70	0.13	0.014	Intestine	Rare	Satellite
Timonia caballeroi	28	112	4.1	4.00	0.17	0.018	Intestine	Rare	Satellite
Helicometrina nimia	6	8	0.9	1.30	0.01	0.001	Intestine, stomach	Sporadic	Satellite
Allopodocotyle argyropsi	12	14	1.8	1.17	0.02	0.002	Intestine	Sporadic	Satellite
Metacercariae of *Prosorhynchus*	157	553	23.2	3.50	0.80	0.090	Intestine, stomach	Frequent	Satellite
Erilepturus hamati	55	89	8.1	1.60	0.13	0.014	Stomach	Rare	Satellite
Lecithocladium glandulum	73	119	10.8	1.60	0.18	0.019	Stomach	Frequent	Satellite
Lecithochirium polynemi	20	28	3.0	1.40	0.04	0.004	Stomach	Sporadic	Satellite
Aponurus laguncuIus	8	14	1.2	1.80	0.02	0.002	Intestine	Sporadic	Satellite
Didymozoid sp's	6	58	0.9	9.70	0.09	0.009	Stomach	Frequent	Satellite
Didymozoid larvae	56	80	8.3	1.40	0.12	0.013	Stomach, gills	Rare	Satellite
Caligus phipsoni	155	254	23.0	1.60	0.38	0.041	Gills	Frequent	Satellite
Caligus laticaudus	14	18	2.1	1.30	0.03	0.002	Gills	Sporadic	Satellite
Chalimus stages	79	106	11.7	1.30	0.16	0.017	Gills	Frequent	Satellite
Gnathia maxillaries	9	9	1.3	1.00	0.01	0.001	Gills	Sporadic	Satellite
Neoechinorhynchus topseyi	18	26	2.7	1.40	0.04	0.004	Intestine	Sporadic	Satellite
Raorhynchus polynemi	210	453	31.1	2.20	0.67	0.074	Intestine	Common	Satellite
Gorgorhynchoides indicus	33	54	4.9	1.60	0.08	0.008	Intestine	Rare	Satellite
Serrasentis sagittifer	2	3	0.3	1.50	0.004	0.005	Intestine	Sporadic	Satellite
Scolex pleuronectis	313	3511	46.3	11.20	5.20	0.576	Intestine, stomach	Common	Secondary
Trypanorhynchid larvae	4	4	0.6	1.00	0.006	0.0007	Intestine	Sporadic	Satellite
Camallanus cotti	175	246	25.9	2.40	0.63	0.069	Intestine	Frequent	Satellite

No.of fish examined: 676, Common: 30-50%, Frequent: 10-30%, Rare: 4-10%, Sporadic: ≤4% Core, sp's: ≥66%, Secondary sp's: Between 66-33%, Satellite sp's: ≤33%

Table 6: Correlation of host size with the parasitization

Size groups	Class interval	No. of parasites	Coefficient of correlation (r)
1	6.0-10.0	20	0.14
2	10.1-15.0	2290	
3	15.1-20.0	3562	
4	20.1-25.0	218	

Table 7: Influence of seasons on parasitization of *P. sextarius*

Seasons	Total No. of fish examined (a)	No. of infected fish (b)	No. of parasites (c)	Prevalence (%)	Mean intensity (b/a)	Mean abundance (c/a)	Chi-square value
2005-2006							
Rainy (14°C)	110	86	876	313.6	41.0	31.9	1.86
Winter (38°C)	116	108	1048	372.2	39.4	36.1	
Summer (22°C)	113	95	1120	335.7	47.0	39.6	
2006-2007							
Rainy (16 °C)	113	87	831	305.0	38.5	29.1	3.23
Winter (39 °C)	118	108	1206	365.3	44.6	40.8	
Summer (21°C)	106	79	1009	298.3	51.0	38.2	

DISCUSSION

Both the years portrayed good resemblance in overall prevalence, mean intensity and mean abundance with negligible deviation. These variations depend on factors such as maturity and density of the host population and its stage. Temperature serves as one of the crucial factors in controlling the parasitic infections (Hedgpeth, 1957; Hopkins, 1959; Chubb, 1963; Awachie, 1966; Manter, 1966; Kennedy, 1971, 1975, 1977, 1997; Muralidhar, 1989; Rohde, 1993; Rodrigues and Saraiva, 1996; Chapman *et al.*, 2000; Turner, 2000; Wang *et al.*, 2001; Mouritsen and Poulin, 2002). Rohde (1993) had the same opinion that more infections are seen in warm seas than the colder ones. Temperature plays an important role in controlling the parasitic fauna either directly or indirectly in the present study. Though, statistically there was no significant association between the seasons and prevalence of infection but parasitization was comparatively high during winter months than in other months. The environmental circumstances of tropical waters are fairly complimentary in winter months as the waters will be warm but not ice cold and these moderate temperatures are favorable to zooplankton, invertebrate and smaller vertebrate fauna to flourish. The calmness in the sea during this season obviously naturally corresponds to the peak in feeding activities of the fish and recruitment of infection takes place after summer and reaches their climax in winter months. There is only a meager positive correlation between the host size and total parasitic infection. Pearson (1968), Dogiel (1970), Kuperman (1973), Cannon (1977), Williams and Jones (1994), Luque *et al.* (1996) and Johnson *et al.* (2004) has emphasized the impact of diet and feeding habits on the parasitic infection in the hosts. Impact of food and feeding habits of the host serve as prime causes of larval parasitic abundance as *P. sextarius* being carnivorous feed on crustaceans, molluscs, snails and shrimps which are primary intermediate hosts for the most of the digeneans and cestodes). Variations in the infection rate with age groups might be due to the less feeding capacity in younger fish and resistance or immunity in older fish which averts the novel extra parasite burdens (Lo *et al.*, 1998; Zelmer and Arai, 1998; Johnson *et al.*, 2004). Parasite life span also plays its role with number of parasites diminishing in the host with growing age. Thus, abundance of parasite population is attributed to feeding capacity of the host which is governed by biotic and abiotic factors like temperature, water currents etc. Host sex was not found to be a significant factor in determining the infection rate in helminth parasites according to Lawrence (1970), Kennedy (1975), Muzzall (1980), Belghyti *et al.* (1994) and Abdallah *et al.* (2005) and in the present study host sex is not taken into consideration due to protandrous nature of the host.

CONCLUSION

Thus from the present survey it can be said that parasite community of a host are predictable and hierarchical. The parasite diversity of a host can be attributed to its phylogeny and also to the presence of intermediate host population in that area. But the abundance of parasite population can be attributed to the vagility and feeding capacity of the host which is governed by the external ecological factors like temperature. Kennedy *et al.* (1986) and Holmes (1990) compared the intestinal helminth community diversity in a series of freshwater fish and bird hosts and found that the diversity is rich in birds than in freshwater fish. They also suggested that marine fish helminth communities should be more diverse than that of freshwater since there is greater diversity of invertebrates (possible intermediate hosts) in the sea. The present investigation is in concordance with the views of Kennedy *et al.* (1986) and Holmes (1990) suggesting that poylnemid fish operate as potential intermediate hosts with rich and diversified parasitic fauna than their freshwater counterparts.

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