Bangladesh J. Zool. ***53***(1): 79-98, 2025 *Article*
ISSN: 0304-9027
eISSN: 2408-8455

COMMUNITY STRUCTURE AND INFECTION BURDEN OF HELMINTH PARASITES IN PAMA CROAKER *OTOLITHOIDES PAMA* HAMILTON, 1822 (PERCIFORMES: SCIAENIDAE) OF VATIARY COAST, CHATTOGRAM, BANGLADESH

Mahabuba Hasnath

Department of Zoology, University of Chittagong, Chittagong 4331, Bangladesh

ABSTRACT: One hundred fresh specimens of pama croaker *Otolithoides pama* Hamilton, 1822 (Perciformes: Sciaenidae) from Vatiary costal area, Chittagong, Bangladesh, were necropsied to explore the species composition, study the community structure, microhabitat preference and infection dynamics of helminth parasites. Overall, 79.0% of examined fishes were parasitized by twelve species of parasites namely, *Microcotyle spinicirrus* and *Pseudempleurosoma haywardi* (Monogenea), *Uterovesiculurus hamati*, *Phyllodistomum folium*, *Helicometrina elongata* and *Stephanostomum* sp. (Digenea), *Parachristianella trygonis* (larva) and Unidentified cestode larva (Cestoda), *Philometra protonibeae*, *Spirocamallanus notopteri* and larvae of *Contracaecum* sp. (Nematoda) and *Acanthocephalus* sp. (Acanthocephala). The present parasite community was dominated by nematodes, *Contracaecum* sp. was the core species with highest prevalence (67%) and abundance (8.82). Except the unidentified cestode larva (rare species), the rests were satellite species. Among the recovered parasites, *M. spinicirrus* (gill), *P. protonibeae* (ovary) and *Acanthocephalus* sp. (intestine) showed strict organ specificity and *Contracaecum* sp. was cosmopolitan in nature found to harbor body cavity, stomach, intestine and pyloric caeca. The females (84.91%) were found to be more susceptible to parasitic infection than male (72.34%). Stages of sexual maturity of fish had a significant influence on the prevalence, the gravid fishes were found to be 100% infected and the infection rate was lowest in the spent fishes. Significant positive correlation was observed between weight and prevalence. The association between infection site (organs) and prevalence was also significant. The intestine was the most preferred microhabitat (55.0%) while the liver, kidney, testis and swim bladder were resistant to parasitic infection.

Key words: Community structure, species composition, microhabitat preference, infection dynamics, helminth parasites, *Otolithoides pama*.

INTRODUCTION

Fish is a healthy food, easy to digest, source of vitamins, essential amino

**Author for correspondence: <mahabuba@cu.ac.bd>*
©2025 Zoological Society of Bangladesh *DOI: https://doi.org/10.3329/bjz.v53i1.82619*

acids and an excellent source of calcium, phosphorus, iodine, iron, zinc, selenium and other important minerals required for human health (Sartori and Amancio 2012, Tilami and Sampels 2018). Fishes are extensively used as the cheapest protein rich diet for humans. Fish related aquaculture activities play a major role in shaping the economic prosperity of a country like Bangladesh. To carry out a fruitful aquaculture practice, maintenance of fish health is one of prime concern as it has direct effect on the annual yield. Among the factors affecting fish health and production, parasitic infection has a major role. Like other living beings, fish can be infected by many parasites. These parasites affect host phenotypes, including changes to host morphology, behavior, and physiology (Frainer *et al.* 2018). Parasites use the fish for their shelter and food, adversely affect their biological aspects, make wound or diseases, and cause pathological damages and influence the survival of fish by reducing their size, altering the behavior of infected fish and making them vulnerable to other infections, resulting in higher mortality. Therefore, parasites can cause considerable economic losses in fish production due to mortality and tissue damage (Thomas *et al.* 2014, El Asely *et al.* 2015). They also contribute to reduction in fecundity that threaten the abundance and diversity of fish species (Paperna 1996, Adams *et al.* 1997). The ultimate damages imposed on hosts depend on parasite species, type of spoliation of host tissue, number of parasites and the health status of the host (Tavares-Dias *et al.* 1999). Beside this, most of the fishes not only serve as the host of different parasites but also serve as a carrier of many larval parasitic forms that mature and cause serious diseases in many vertebrates including man (Akter *et al.* 2007), and thus raising a great public health concern. Helminthiases transmitted by fish are limited to low-income populations, or cultures where consumption of raw, salted or smoked fish is in practiced. Approximately 56 million cases of parasite infections associated with the consumption of raw or undercooked fish or fish products but worldwide the number of people at risk, including those in developed countries, is more than half a billion (Santos and Howgate 2011, WHO 2012). In Southwest Asia alone, around 300,000 cases of infections with 1,323 deaths were recorded in 2005 (FAO 2014). So, accurate and early diagnosis and controlling steps towards these parasitic diseases are of great importance. Moreover, study of parasitic fauna of fishes is very important to understand the host-parasite relationship and the status of the aquatic environment (Lafferty 2008).

Croakers or drums, locally called Jewfish, are the largest groups of commercially important fishes exploited from Bay of Bengal, Bangladesh (Zafar *et al.* 2000, Sabbir *et al.* 2020, 2021). About 20 species of corkers under 12 genera have been reported from the marine water of Bangladesh (Fanning *et al.*

2019). *Otolithoides pama* (Hamilton, 1822), is one of the most common croakers, found in the Bay of Bengal, estuary and rivers of Bangladesh (Talwar and Jhingran 1991) and locally known as Poa fish or Pama croaker. It is a prominent bottom-dwelling carnivore, consume mainly small fish and prawn (Bhakta *et al.* 2019). This fish species is very much common in the local markets of Chittagong region and it is consumed by local marginal people in high amount due to its low price. Like other croakers this fish species also found to harbor many parasites, so there is a great chance of parasitic infection for human.

Though pama croaker is one of the popular and cheapest fish in our country, no detailed parasitic investigation has been done so far. Therefore, the present study was aimed to explore the species composition, study the community structure, microhabitat preference and infection dynamics of helminth parasites, of pama croaker *Otolithoides pama*.

MATERIAL AND METHODS

Host collection: Fresh samples of *O. pama* were collected directly from local fish markets, local fishermen and fish landing stations of Vatiary coast, Chittagong between January 2022 to June 2023. The samples were brought directly to the laboratory and autopsied as early as possible.

Parasite collection, preservation and mounting: The parasitological procedure was done by following Justine *et al.* (2012). Prior to autopsy, total length and body weight were measured using standard tools. The fishes were dissected and the body cavity was examined using magnifying glass to detect parasites that inhabits the cavities and those attached to the mesenteries or other internal organs. After then the gills, esophagus, stomach, intestine, pyloric caeca, liver, kidney, swim bladder and gonads were removed from the body and the body cavity was then rinsed with saline solution (0.85%). The gills were taken in a plastic jar containing saline water and shaken. The washed water was examined under stereo microscope. Each organ was opened, scraped slightly in some cases, and placed into separate petri dish containing saline water. Recovered parasites were fixed and preserved in 70% ethyl alcohol. The parasites were permanently mounted on slides following Cable (1977). The parasites were studied and identified using a compound microscope following Yamaguti (1941, 1958, 1961 and 1965), Arthur and Ahmed (2002) and relevant documents (Moravec and Barton 2015, Theisen *et al.* 2017).

Data analysis: The fishes were identified, classified according to gender (two groups), maturity stages of gonad (four groups), length, weight and condition factor (five groups each). Prevalence, intensity, abundance and index of infection, were calculated by following Margolis *et al.* (1982) and the condition factor was calculated followed the formula given by Pauly (1983). The parasites were graded into core species (> 60%), secondary species (40–60%), satellite species (5–40%) and rare species (<5%) (Holmes 1991). Diversity parameters like, Shannon index of species diversity, Simpson index, evenness index, index of species richness and community dominance were calculated. Statistical test included Chi – square test (X^2) and Correlation co-efficient (r) (significance level 0.05).

RESULTS AND DISCUSSION

Species composition of helminth parasites in Otolithoides pama: Twelve species of helminth parasites were recovered from one hundred (47 males and 53 females) individuals of *O. pama* namely, *Microcotyle spinicirrus*, *Pseudempleurosoma haywardi*, *Uterovesiculurus hamati*, *Phyllodistomum folium*, *Helicometrina elongata*, *Stephanostomum* sp., *Parachristianella trygonis* (larva), Unidentified cestode larva, *Contracaecum* sp. larva, *Philometra protonibeae, Spirocamallanus notopteri* and *Acanthocephalus* sp. (Table 1). Among the parasite groups, trematodes were the most diversified (4 species) followed by nematodes (3 species), monogeneans (2 species), cestodes (2 species) and acanthocephalans (1 species). Similar to this present study, a diversified helminth fauna was reported from abroad working with many Sciaenid fish other than *O. pama* (12 species from *Menticirrhus americanus* by Chaves and Luque 1999, 9 species from *Otolithes ruber* by Khosheghbal *et al.* 2017, 20 species from *Micropogonias furnieri* by Alves and Luque 2001, 12 species from *Paralonchurus brasiliensis* by Luque *et al.* 2003, 15 species from *Cynoscion guatucupa* and 14 species from *Macrodon ancylodon* by Sabas and Luque 2003, 10 species from *Ctenosciaena gracilicirrus* by Cardenas *et al.* 2012 and 15, 13, 14, 16 and 18 species from *Bairdiella chrysoura*, *C. arenarius*, *M. americanus*, *M. littoralis*, and *Umbrina coroides*, respectively by Montoya-Mendoza *et al.* 2019).

Generally, trematodes and nematodes are the most diversified parasite groups in marine fish which is also corroborate with the present study and all the above-mentioned research works. Contrary to those and present findings, Sehrin *et al.* (2023) reported only five species of helminth from three species of croaker of Bay of Bengal, Bangladesh. The carnivorous feeding habits and wide diet spectrum of croakers including pama croaker, bringing them in contact with several potential intermediate hosts of digenean trematodes, nematodes and acanthocephalans (Bell and Burt 1991, Alves and Luque 2001). Since, several helminth parasite species were reported from *O. pama* (*Gymnorhynchus* sp., *Lytocestus* sp., *Goezia* sp. and *Pallisentis* sp. by Arthur and Ahmed 2002, *Contracaecum* sp. by Naha *et al.* 2019) previously, the present study provides the first record for the occurrence of the above-mentioned helminth parasites (except *Contracaecum* sp.) in pama croaker.

Table 1. Prevalence, intensity, abundance, index of infection, dominance value and site of infection of helminth parasites in *O. pama*

Parasite group	Name of the species	No. Of Host	Infected	Prevalence %	Parasites recovered	Intensity	Abundance	Index of infection	Dominance Value (DV)	Site of infection
Monogenea	*Microcotyle spinicirrus*	100	20	20	24	1.2	0.24	4.8	1.83	Gill
	Pseudempleurosoma haywardi	100	11	11	35	3.18	0.35	3.85	2.66	Esophagus, stomach
Trematoda	*Uterovesiculurus hamati*	100	20	20	26	1.3	0.26	5.2	1.98	Body cavity, stomach, intestine
	Phyllodistomum folium	100	12	12	20	1.67	0.20	2.4	1.52	Body cavity, urinary bladder
	Helicometrina elongata	100	15	15	46	3.07	0.46	6.9	3.50	Body cavity, intestine, pyloric caeca
	Stephanostomum sp.	100	8	8	15	1.88	0.15	1.2	1.14	Stomach, intestine
Cestoda	*Parachristianella trygonis*	100	14	14	19	1.36	0.19	2.66	1.45	Stomach, intestine
	Unidentified cestode larva	100	4	4	69	17.25	0.69	2.76	5.25	Body cavity, intestine
Nematoda	*Contracaecum* sp. larva	100	67	67	882	13.16	8.82	590.94	67.12	Body cavity, stomach, intestine, pyloric caeca
	Philometra protonibeae	100	18	18	84	4.67	0.84	15.12	6.39	Gonad (ovary)
	Spirocamallanus notopteri	100	21	21	63	3.0	0.63	13.23	4.79	Body cavity, intestine
Acanthocephala	*Acanthocephalus* sp.	100	11	11	31	2.82	0.31	3.41	2.36	Intestine
Total		**100**	**79**	**79.0**	**1314**	**16.63**	**13.14**			

Community structure of helminth parasites in O. pama: The present parasite community was a moderately stable, dominating community with medium species diversity and low species richness (Table 2). The *Contracaecum* sp. was the core species and the Unidentified cestode larva found to be rare. The rests (10 species) were considered to be satellite species (Table 1). The dominance pattern of the parasite species was *Contracaecum* sp. larva > *P. protonibeae* > Unidentified cestode larva > *S. notopteri* > *H. elongata* > *P. haywardi* > *Acanthocephalus* sp. > *U. hamati* > *M. spinicirrus* > *P. folium* > *P. trygonis* (larva) > *Stephanostomum* sp. (Table 1, Figure 1). Group wise, the most and least dominant groups were Nematoda (78.31%) and Acanthocephala (2.36%), respectively. Like the present study, nematode dominated parasite fauna in Sciaenid fishes were reported by Alves and Luque (2001), Luque *et al.*

(2003), Sabas and Luque (2003). In contrast, digenean dominated parasite community also been reported by Chaves and Luque (1999) and Montoya-Mendoza *et al.* (2019). Among the nematodes, *Contracaecum* sp. was the predominant species with highest prevalence and abundance which is supported by Luque *et al.* (2003).

Table 2. Diversity parameters of the helminth parasite community in *O. pama*

Diversity parameters	Values	Criteria for Diversity parameters (Odum 1971)
Shannon Index (H)	1.37	H < 1 - Low diversity 1 > H < 3 - Medium diversity H > 3 - High diversity
Simpson Index (D)	0.46	The value of D ranges from 0 to 1 D<0.50 - Low diversity 0.50>D <0.75 - Moderate diversity D>0.75 - High diversity
Richness Index (RI)	1.53	RI < 2.5 - Low species richness 2.5 > RI < 4 - Medium species richness RI > 4 - High species richness
Evenness Index (E)	0.55	The value of E ranges from 0 to 1 E approaches 0 - Unstable species abundance distribution conditions E approaches 1 - Stable species abundance distribution conditions
Dominance Index (DI)	0.91	The value of DI ranges from 0 to 1 DI< 0.50 - No species dominates 0.50> DI <0.75 - Moderate dominance DI> 0.75 - High dominance (one or a few species dominate the community)

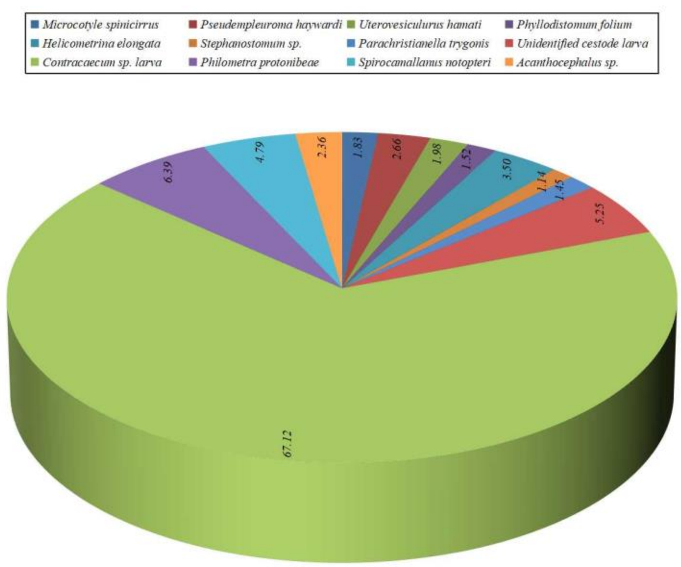

Fig. 1. Dominance pattern of the helminth parasites in *O. pama*

Microhabitat preference by helminth parasites within O. pama: Almost all the organs, e.g., body cavity, gill, esophagus, stomach, intestine, pyloric caeca, liver, kidney, urinary bladder, swim bladder and gonads (both male and female) were examined separately for occurrence of helminth parasites. Among these, intestine was the most favored microhabitat (55.0%), followed by body cavity (47.0%), stomach (20.0%) and gill (20.0%), gonad (18.0%), pyloric caeca (14.0%), urinary bladder (10.0%), and esophagus (9.0%) (Table 3, Figure 2). The prevalence, intensity, abundance and species richness (8 species) were highest in intestine probably due to being relatively nutrient rich habitat. On the other hand, liver, kidney, swim bladder and testis (male gonad) were proved to be completely unsuitable habitats for the survival of parasites. Contrary to present finding, stomach and liver (Sehrin *et al.* 2023) and body cavity (Naha *et al.* 2019) were found to be the most suitable sites for parasites, though liver was proved to be unsuitable for parasites presently.

Among the parasites, *M. spinicirrus, P. protonibeae* and *Acanthocephalus* sp. were strictly site specific, restricted only in gill, ovary (female gonad) and intestine, respectively (Table 4). The *Contracaecum* sp. was cosmopolitan in nature, found to harbor body cavity, stomach, intestine and pyloric caeca. During the present study, urinary bladder dwelling parasite, *P. folium* was recovered from body cavity, that might be the result of mishandling during the autopsy of fish. Though many other species of this genus were recovered from intestine of fish (Agrawal1966, Sarwat 2011, Rajput and Langer 2022), so, careful study should be needed.

Table 3. Organ wise prevalence, intensity and abundance of helminth parasites in *O. pama*

Site of infection (organs)	Host examined	Infected	Uninfected	Prevalence %	Parasite recovered	Intensity	Abundance	Chi - square value (p-value)
Body cavity	100	47	53	47.0	421	8.98	4.21	113.569 (0.0000)
Gill	100	20	80	20.0	24	1.20	0.24	Significant
Esophagus	100	9	91	9.00	26	2.89	0.26	
Stomach	100	20	80	20.0	68	3.40	0.68	
Intestine	100	55	45	55.0	627	11.4	6.27	
Pyloric caeca	100	14	86	14.0	47	3.36	0.47	
Gonad	100	18	82	18.0	84	4.67	0.84	
Urinary bladder	100	10	90	10.0	17	1.70	0.17	
Total	**100**	**79**	**21**	**79.0**	**1314**	**16.63**	**13.14**	

The site preference of parasites may be due to innate variance among them indicating their reaction to specific stimuli that bringing them to be confined establishment and successive migrations, influenced by some biochemical and

Table 4. Microhabitat distribution of individual parasite species in *O. pama*

Name of the species	Body cavity	Gill	Esoph agus	Stomach	Intes tine	Pyloric caeca	Gonad (ovary)	Urinary bladder	Total
Microcotyle spinicirrus	-	24	-	-	-	-	-	-	24
Pseudempleurosoma haywardi	-	-	26	9	-	-	-	-	35
Uterovesiculurus hamati	7	-	-	17	2	-	-	-	26
Phyllodistomum folium	3	-	-	-	-	-	-	17	20
Helicometrina elongata	2	-	-	-	10	34	-	-	46
Stephanostomum sp.	-	-	-	1	14	-	-	-	15
Parachristianella trygonis larva	2	-	-	-	17	-	-	-	19
Unidentified cestode larva	5	-	-	-	64	-	-	-	69
Contracaecum sp. larva	382	-	-	41	446	13	-	-	882
Philometra protonibeae	-	-	-	-	-	-	84	-	84
Spirocamallanus notopteri	20	-	-	-	43	-	-	-	63
Acanthocephalus sp.	-	-	-	-	31	-	-	-	31
Total	**421**	**24**	**26**	**68**	**627**	**47**	**84**	**17**	**1314**

physiological gradients in different organs of same host (Ulmer 1971, Holmes 1973, Evans 1977). In the present study, *M. spinicirrus* was found to occur only in gill. Previously, several microcotylid monogeneans were reported from gills of the Sciaenid fish (*Sciaenacotyle sciaenicola* in *Argyrosomus japonicus* by Hayward *et al.* 2007, *Cynoscionicola jamaicensis* in *C. guatucupa* and *M. ancylodon* by Sabas and Luque 2003, *C. pseudoheteracantha* from *C. arenarius* and *U. coroides* by Montoya-Mendoza *et al.* 2019, *C. sciaenae* in *Sciaena deliciosa* and *C. americana* in *M. ophicephalus*, *Paralonchurus peruanus*, *S. fasciata* and *Stellifer minor* by Oliva and Luque 1998). Another monogenean *P. haywardi*, reported presently from esophagus and stomach, was previously collected from the esophagus and anterior stomach of the croakers *Nibea soldado*, *O. ruber* and *Johnius amblycephalus* by Theisen *et al.* (2017) from Indonesia. Another species of this genus, *P. gibsoni* was reported by Luque *et al.* (2003) from the gill and pharynx of banded croaker. Species belonging to this genus *Pseudempleurosoma* adapted to an endo-parasitic mode of life, having different adaptation level (Yamaguti 1965), especially in the anchor apparatus, remain attached to the esophageal folds (Gerasev *et al.* 1987).

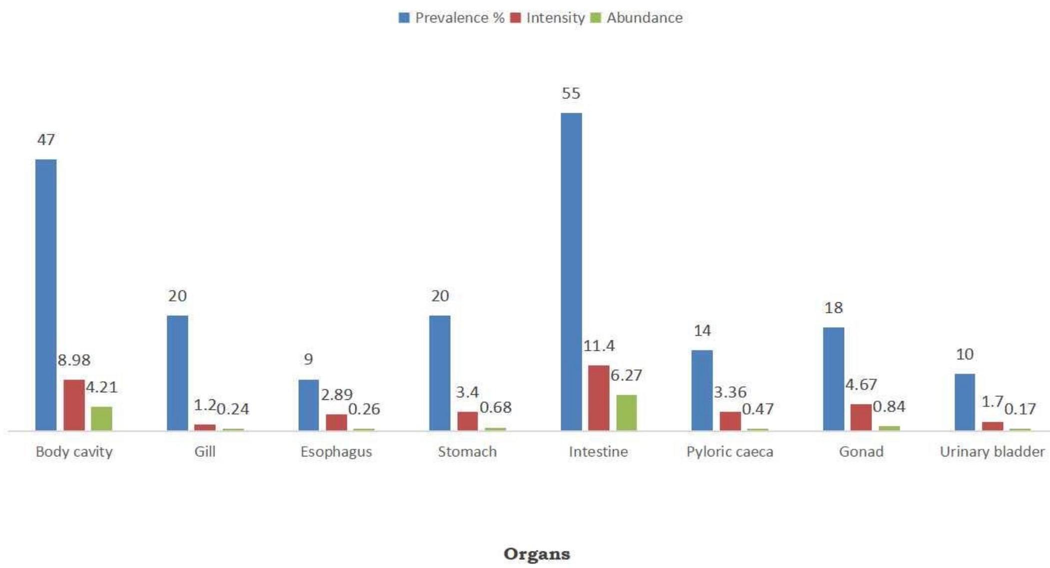

Fig. 2. Prevalence (%), intensity and abundance of helminth parasites in *O. pama* in relation to site of infection (organs)

One species of gonad infecting nematode, *P. protonibeae* was collected during the present study. Sehrin *et al.* (2023) has reported *P. cephalopholidis* in *Pennahia anea* from the coast of the Bay of Bengal, Bangladesh. The following gonad-infecting species of *Philometra* have been reported from fishes of the family Sciaenidae: *P. carolinensis* from *C. nebulosus* and *M. americanus*, and *P. floridensis* from *Sciaenops ocellatus* (Moravec *et al.* 2006, Moravec and de Buron 2009, Moravec *et al.* 2010, Moravec and de Buron 2013); *P. johnii* from *J. dussumieri* and *Johnius* sp. (Moravec and Ali 2013, Moravec and Diggles 2014); *P. otolithi* from *O. ruber* (Moravec *et al.* 2013 and 2014, Moravec and Manoharan 2013, Moravec and Ali 2014, Khosheghbal *et al.* 2017); and *P. sciaenae* from *P. argentata* (Yamaguti 1941, Moravec *et al.* 1998, Quiazon *et al.* 2008) and *P. protonibeae* from Blackspotted croaker, *P. diacanthus* (Moravec and Barton 2015).

During the present study three larval parasite species were recorded. Presence of helminth larval stages may indicate the possible intermediate trophic level of this fish and may be part of the diet of marine mammal or birds, and elasmobranch fishes (Alves and Luque 2001). Adult *Contracaecum* found in the stomach or small intestine of piscivorous birds and mammals associated with fresh, brackish and marine environments (Anderson 2000) and a wide spectrum of invertebrates and many fish species have been reported to carry larval *Contracaecum* sp. (Norris and Overstreet 1976). The larval stage of *Contracaecum* sp. is responsible for causing a severe parasitic syndrome in final host (Wharton *et al.* 1999). Normally they found in the intestinal mesentery or adhered to viscera, may travel to muscles after the host's death. Though, preference for parasitizing visceral organs limits their zoonotic potential, they may migrate into the flesh of fish if not frozen or filleted after capture. Thus, considering the potential public health importance of larval *Contracaecum* sp. special care should be given in the consumption of this fish.

Infection dynamics of helminth parasites in O. pama: The overall prevalence, intensity and abundance of helminth parasites were 79.0%, 16.63 and 13.14, respectively. Among the parasites *Contracaecum* sp. was the most prevalent species (67.0%) followed by *S. notopteri* (21.0%), *M. spinicirrus* (20.0%) and *U. hamati* (20.0%), *P. protonibeae* (18.0%), *H. elongata* (15%), *P. trygonis* larva (14.0%), *P. folium* (12.0%), *P. haywardi* (11.0%) and *Acanthocephalus* sp. (11.0%), *Stephanostomum* sp. (8.0%) and Unidentified cestode larva (4.0%) (Table 1, Figure 3). Comparatively, a higher prevalence of parasitic infection in Sciaenid fish than the present study was also reported by Alves and Luque (2001), Luque *et al.* (2003), Sabas and Luque (2003), etc. Prevalence and intensity are dependent on parasite species and their biology, host and its feeding habits, physical factors and hygiene of the water body, and presence of intermediate hosts where necessary (Shukerova *et al.* 2005, Hussen *et al.* 2012). In the present study, the females (84.91%) were found to be more vulnerable to parasitic infection than male (72.34%) though, no significant differences were observed. Both the intensity and abundance were also higher in female fish (Table 5, Figure 4A). The stages of the sexual maturity (stages of gonads) found to have significant influence on the prevalence, the prevalence was recorded 100% in ripe/gravid fishes and spent fishes have minimum infection (47.37%) (Table 6, Figure 4B). The prevalence, intensity and abundance were higher in larger (length and weight) fishes (Table 7 and 8, Figure 4C and 4D) and in fishes having 0.73-0.82 condition factor range (Table 9, Figure 4E). All the relationships between prevalence, intensity and abundance with length, weight and condition factor of fish were found insignificant positive except the significant positive relation between weight and prevalence. Having no influence of sex on parasite prevalence and abundance is a widely documented pattern (Luque *et al.* 2003, Sabas and Luque 2003, Cardenas *et al.* 2012), and interpreted as a consequence of the absence of sexual differences in some biological aspects of the fish (Luque *et al.* 1996, Alves *et al.* 2002).Again, according to Siddiqui (2014), the differences in the infection levels

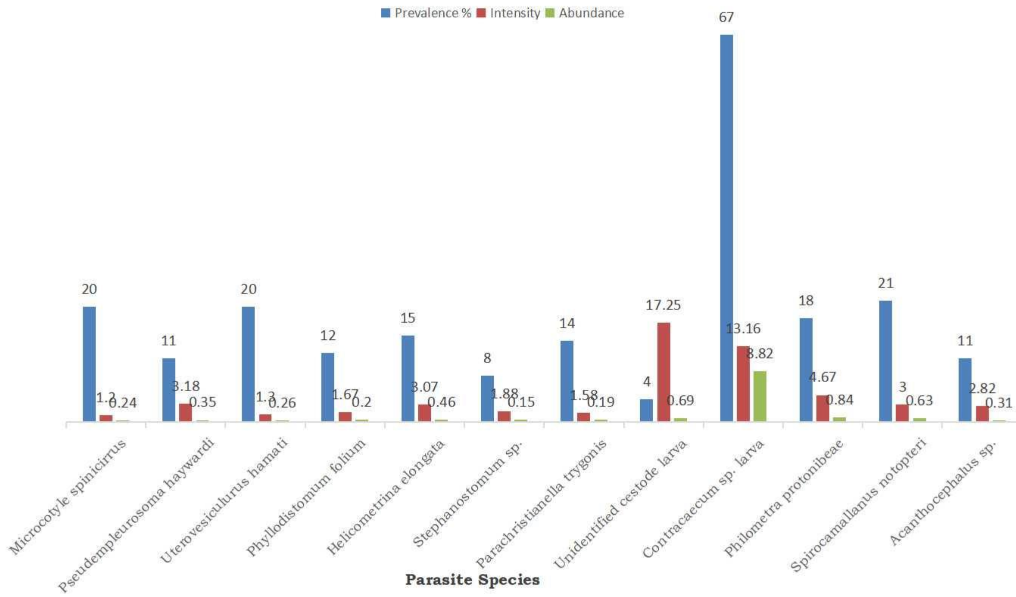

Fig.3. Prevalence (%), intensity and abundance of helminth parasites in *O. pama* in relation to parasite species

of the parasites in the female and male hosts may be due to the physiological changes in quantity and quality of steroid hormone presumably androgens of male and estrogens of female hosts. He concluded that, the differences of distribution of parasites between different sexes were not due to any one single factor, but it might be result of combination of several factors.

Table 5. Gender wise prevalence, intensity and abundance of helminth parasites in *O. pama*

Gender	Host examined	Infected	Un infected	Prevalence %	Parasite recovered	Intensity	Abundance	Chi - square value (p-value)
Male	47	34	13	72.34	437	12.85	9.30	2.371 (0.1236)
Female	53	45	8	84.91	877	19.49	16.55	Insignificant
Total	**100**	**79**	**21**	**79.0**	**1314**	**16.63**	**13.14**	

Table 6. Maturity stage wise prevalence, intensity and abundance of helminth parasites in *O. pama*

Stages of gonadal maturity	Host examined	Infected	Un infected	Prevalence %	Parasite recovered	Intensity	Abundance	Chi - square value (p-value)
Immature	18	14	4	77.78	289	20.64	16.06	17.884 (0.0000)
Mature	40	33	7	82.50	402	12.18	10.05	Significant
Ripe / Gravid	23	23	0	100.0	530	23.04	23.04	
Spent	19	9	10	47.37	93	10.33	4.89	
Total	**100**	**79**	**21**	**79.0**	**1314**	**16.63**	**13.14**	

Table 7. Length wise prevalence, intensity and abundance of helminth parasites in *O. pama*

Length group (L)	Host examined	Infected	Un infected	Prevalence (%)	Parasite recovered	Inten sity	Abundance	Correlation co-efficient (p-value)
14.1 – 18.6	35	29	6	82.86	544	18.76	15.54	L vs P = 0.6421 (0.2428) Insignificant
18.6 – 23.1	32	23	9	71.88	368	16.00	11.5	
23.1 – 27.6	24	19	5	79.17	263	13.84	10.96	L vs I = 0.1745 (0.7789) Insignificant
27.6 – 32.1	5	4	1	80.00	38	9.5	7.6	
32.1 – 36.6	4	4	0	100.0	101	25.25	25.25	L vs A = 0.3606 (0.5510) Insignificant
Total	**100**	**79**	**21**	**79.0**	**1314**	**16.63**	**13.14**	

Table 8. Body weight wise prevalence, intensity and abundance of helminth parasites in *O. pama*

Weight group (W)	Host examined	Infected	Un infected	Prevalence (%)	Parasite recovered	Intensity	Abundance	Correlation co-efficient (p-value)
25.1 – 91.0	71	56	15	78.87	1006	17.94	14.17	W vs P = 0.8892 (0.0435) Significant
91.0 – 156.9	19	14	5	73.68	151	10.79	7.95	
156. 9 – 222.8	6	5	1	83.33	56	11.2	9.33	W vs I = 0.5588 (0.3275) Insignificant
222.8 – 288.7	1	1	0	100.0	32	32.0	32.0	
288.7 – 354.6	3	3	0	100.0	69	23.0	23.0	W vs A = 0.6519 (0.2332) Insignificant
Total	**100**	**79**	**21**	**79.0**	**1314**	**16.63**	**13.14**	

Table 9. Condition factor wise prevalence, intensity and abundance of helminth parasites in *O. pama*

Condition factor (C)	Host examined	Infected	Un infected	Prevalence (%)	Parasite recovered	Inten sity	Abundance	Correlation co-efficient (p-value)
0.55 – 0.64	9	5	4	55.56	42	8.4	4.67	C vs P = 0.4394 (0.4591) Insignificant
0.64 – 0.73	40	32	8	80.00	665	20.78	16.63	
0.73 – 0.82	31	28	3	90.32	320	11.43	10.32	C vs I = 0.1557 (0.8026) Insignificant
0.82 – 0.91	14	9	5	64.29	240	26.67	17.14	
0.91 – 1.00	6	5	1	83.33	47	9.4	7.83	C vs A = 0.1976 (0.7501) Insignificant
Total	**100**	**79**	**21**	**79.0**	**1314**	**16.63**	**13.14**	

The maturity stages of the fish can potentially influence the levels of parasitism due to behavioral and physiological differences. Susceptibility to parasites is greater for some fish species during the reproductive period (Machado *et al.*2000) and the physiological state of female fish during gonad development could

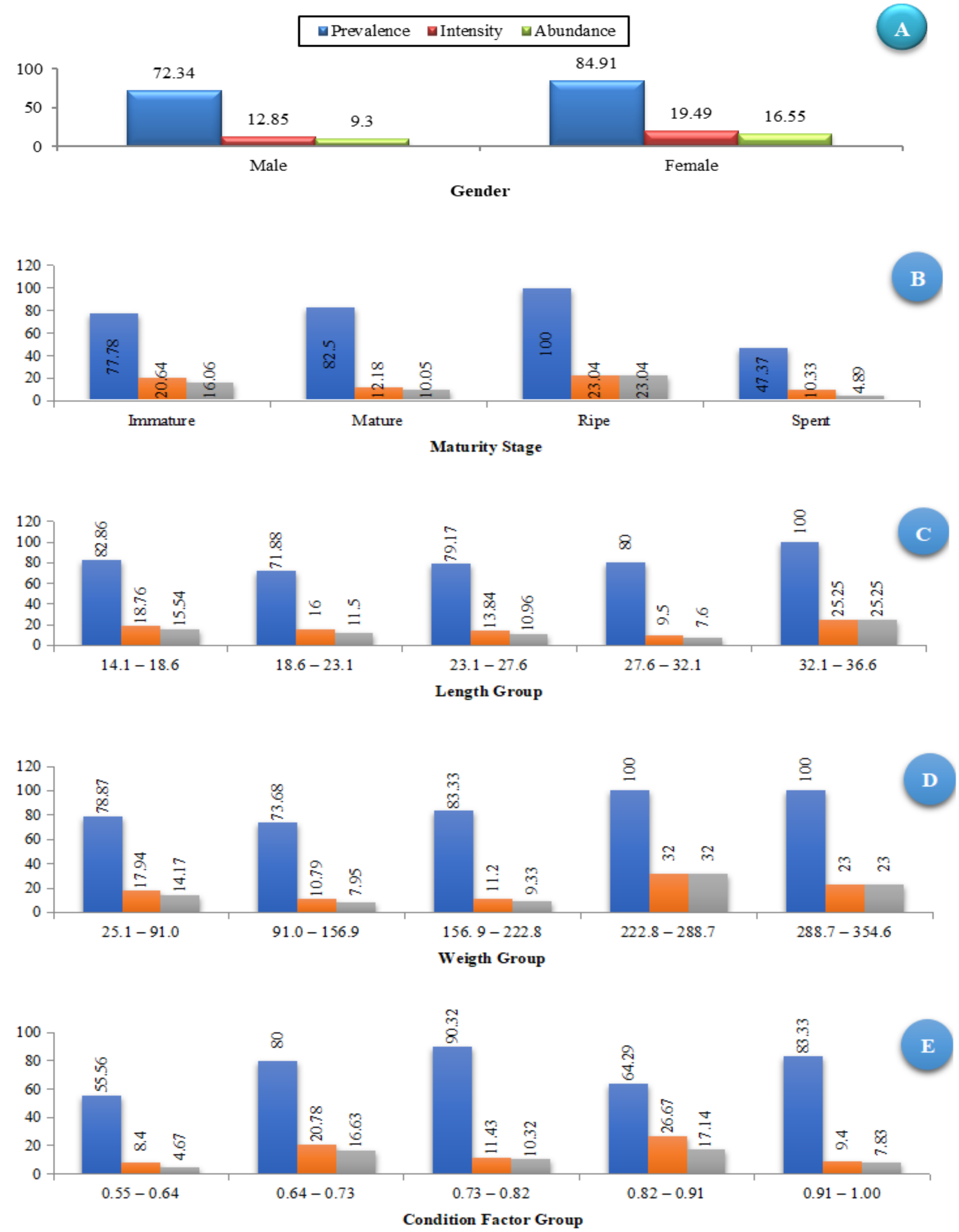

Fig. 4.. Prevalence (%), intensity and abundance of helminth parasites in *O. pama* in relation to- A. Gender, B. Maturity stages, C. Length, D. Weight, E. Condition factor

have reduced resistance to parasitic infestation (Omeji *et al.* 2011). The higher intensity in female fish may be related to their involvement in reproduction is more costly than that in males (Shukerova *et al.* 2005). In general, the length of fish is directly related to its age and body size (Shotter 1973). Parasite prevalence and intensity are positively associated with fish age (Chandler *et al.* 1995, Mohammed *et al.* 2008). The increased prevalence and intensity in larger fish might be attributed to the fact that large fish take more food and travel wider areas in searching for food for longer time of exposure to the environment and thus are more susceptible to parasitic infestation which is consistent with the report of Omeji *et al.* 2011, Naha *et al.* 2019, Sehrin *et al.* 2023) but contradicts that of Tasawar *et al.* (2007), who stated that, smaller fish have higher parasite load than large ones. Though significant correlation with length with parasite prevalence and abundance reported by Sabas and Luque (2003), the present findings regarding positive, but weak and insignificant correlation between prevalence, intensity and abundance with length, weight and condition factor of fish are in agreement with Poulin (2000) who concluded that this pattern cannot be generalized. Besides, the ontogenetical changes in the feeding behavior might have influence on parasite prevalence and abundance in the host size classes (Saad-Fares and Combes 1992).

Multiple infections were very frequent (78.48%) during the present study. Only 17 (out of 79 infected, 21.52%) showed infection with single parasite species and 18 (22.79%), 24 (30.38%), 11 (13.92%), 2 (2.53%), 6 (7.59) and 1 (1.27%) showed multiple infections with 2, 3, 4, 5, 6 and 7 parasite species, respectively. Like the present study, multiple infection was very common in Sciaenid fishes (Chaves and Lique 1999, Alves and Luque 2001, Luque *et al.* 2003, Sabas and Luque 2003, etc.). The occurrence of multiple parasite species in single host, indicates the absence of competition with respect to ecological requirements, probably because of not occupying the same niche along the microenvironment of parasites.

CONCLUSION

The present study was conducted, for the first time, to explore the total helminth fauna along with the community structure, their infection dynamics and preference for microhabitat, of a common Sciaenid fish *O. pama* which may increase the data on the biodiversity and enhances the knowledge of the helminth with regard to public health importance and sustainable fishery management, especially presence of *Contracaecum* sp. larvae and the infection in gonad (ovary) by *P. protonibeae*, respectively. However, specific morphological and molecular identification of parasites and more information about host biology are needed to improve the interpretation of these parasitological patterns, in an ecological framework incorporating pertinent environmental and biological information.

LITERATURE CITED

ADAMS, A.M., MURRELL, K.D. and CROSS, J.H. 1997. Parasites of fish and risks to public health. *Revue Scientifique et technique-office international des epizooties*. **16**(2):652-60.

AGRAWAL. P.V. 1966. Studies on some trematode parasites of freshwater fishes from Lucknow. *Annales de Parasitologie*. **44**: 217-231.

AKTER, M.A., HOSSAIN, M.D. and RAHMAN, M.R. 2007. Parasitic diseases of exotic carp in Bangladesh. *Journal of Agriculture and Rural Development.* **5**: 127-134.

ALVES, D.R. and LUQUE, J.L. 2001. Community ecology of the metazoan parasites of White Croaker, *Micropogonias furnieri* (Ostheichthyes: Sciaenidae), from the coastal zone of the State of Rio de Janeiro, Brazil. *Memórias do Instituto Oswaldo Cruz.* **96**:145-153. https://doi.org/10.1590/S0074-0276200 1000200002.

ALVES, D.R., LUQUE, J.L. and PARAGUASSÚ, A.R. 2002. Community ecology of the metazoan parasites of Pink Cuskeel, *Genypterus brasiliensis* (Ostechthyes: Ophidiidae) from the coastal zone of the State of Rio de Janeiro, Brazil. *Memórias do Instituto Oswaldo Cruz*. **97**:683-689.

ANDERSON, R.C. 2000. *Nematode parasites of vertebrates: their development and transmission.* 2nd edition. Commonwealth Agricultural Bureau International (CABI Publishing) UK, 2000. ISBN 0 85199 421. pp. 672.

ARTHUR, J.R. and AHMED, A.T. 2002. *Checklist of the parasites of fishes of Bangladesh*. Food and Agriculture. pp361.

BELL, G. and BURT, A. 1991. The comparative biology of parasite species diversity: Internal helminths of freshwater fish. *Journal of Animal Ecology*. **60**: 1047

BHAKTA, D., DAS, S.K., DAS, B. K., NAGESH, T.S. and BEHERA, S. 2019. Food and feeding habits of *Otolithoides pama* (Hamilton, 1822) occurring from Hooghly-Matlah estuary of West Bengal, India. *Regional Studies in Marine Science*. **32:** 100860. https://doi.org/10.1016/j.rsma.2019.100860.

CABLE, R.M. 1977. *An illustrated laboratory manual of parasitology*. Burges publishing company, Minneapolis USA. pp. 169.

CÁRDENAS, M.Q., FERNANDES, B.M.M., JUSTO, M.C.N., dos SANTOS, A.L. and COHEN, S.C. 2012. Helminth parasites of *Ctenosciaena gracilicirrhus* (Perciformes: Sciaenidae) from the coast of Angra dos Reis, Rio de Janeiro State, Brazil. *Revista Mexicana de Biodiversidad*. **83**: 31-35.

CHANDLER, M., CHAPMAN, L.J. and CHAPMAN, C.A. 1995. Patchiness in the abundance of metacercariae parasitizing *Poecilia gillii* (Poeciliidae) isolated in pools of an intermittent tropical stream. *Environmental Biology of Fishes.* **42**: 313–321.

CHAVES, N.N. and LUQUE, J.L. 1999. Ecology of metazoans parasites of *Menticirrhus americanus* (Osteichthyes: Sciaenidae), coast area from Rio de Janeiro State, Brazil. *Revista Brasileira de Parasitolgia Veterinária.* **8**:137-144.

EL ASELY, A.M., ABD EL-GAWAD, E.A., SOROR, E.I., AMIN, A.A. and SHAHEEN, A.A. 2015. Studies on some parasitic diseases in *Oreochromis niloticus* fish hatchery with emphasis to life stages. *Journal of Advanced Veterinary Research.* **5**:99–108.

EVANS, N.A.1977. The site preferences of two digeneans, *Asymphylodora kubanicum* and *Sphaerostoma bramae*, in the intestine of the roach. *Journal of Helmintholo*gy. **51**(3):197-204. doi: 10.1017/s0022149x00007495. PMID: 599266.

FANNING, L.P., CHOWDHURY, S.R., UDDIN, M.S. and AL-MAMUN, M.A. 2019. Marine fisheries survey reports and stock assessment. Department of Fisheries, Government of Bangladesh: Dhaka, Bangladesh.

FAO (Food and Agriculture Organization of the United Nations). 2014. Multicriteria-based ranking for risk management of food-borne parasites. *Microbiological Risk Assessment Series.* **23**. Rome. [accessed 2018 june 18] http://www.fao.org/3/a-i3649e.

FRAINER, A., MCKIE, B.G., AMUNDSEN, P.A., KNUDSEN, R. and LAFFERTY, K.D. 2018. Parasitism and the biodiversity-functioning relationship. *Trends in Ecology and Evolution.* **33**(4):260-268. doi: 10.1016/j.tree.2018.01.011.

GERASEV, P.I., GAEVSKAYA, A.V., KOVALEVA, A.A. 1987. New genera of monogeneans of the group of diplectanotrems (Ancyrocephalinae). *Parazitologicheskii Sbornik.***34**: 192–210. (In Russian, with english abstract).

HAYWARD, C.J., BOTT, N.J., ITOH, N., IWASHITA, M., OKIHIRO, M. and NOWAK, B.F. 2007. Three species of parasites emerging on the gills of mulloway, *Argyrosomus japonicus* (Temminck and Schlegel, 1843), cultured in Australia. *Aquaculture*. **265**: 27–40

HOLMES, J.C. 1973. Site selection by parasitic helminths: interspecific interactions, site segregation, and their importance to the development of helminth communities. *Canadian Journal of Zoology*. **51**(3):333-47. doi: 10.1139/z73-047. PMID: 4581918.

HOLMES, J.C. 1991. Spatial scale and important species in the analysis of communities of parasites. In: *Second international school: Parasite host environment*. Bulgarian Academy of Sciences, Sofia. **28**:1–14.

HUSSEN, A., TEFERA, M. and ASRATE, S. 2012. Gastrointestinal helminth parasites of *Clarias gariepinus* (catfish) in Lake Hawassa, Ethiopia. *Journal of Animal Science*. **6**.

JUSTINE, J.L., BRIAND, M. J. and BRAY, R.A. 2012. A quick and simple method, usable in the field, for collecting parasites in suitable condition for both morphological and molecular studies. *Parasitology Res*earch. **111**(1): 341-351.

KHOSHEGHBAL, M., PAZOOKI, J. and SHOKRI, M.R. 2017. Metazoan parasites of Otolithes ruber (Perciformes: Sciaenidae) of the Persian Gulf off Hendijan region, Iran. *Indian Journal of Geo Marine Science.* **46**(6):1175-1182.

LAFFERTY. K.D. 2008. Ecosystem consequences of fish parasites. *Journal of Fish Biology* **73**: 2083–2093 doi:10.1111/j.1095-8649.2008.02059.

LUQUE, J.L., ALVES, D.R. and RIBEIRO, R.S. 2003. Community ecology of the metazoan parasites of Banded croaker, *Paralonchurus brasiliensis* (Osteichthyes: Sciaenidae), from the coastal zone of the State of Rio de Janeiro, Brazil, *Acta Scientiarum*. *Biological Sciences*. **25**:273-278. https://doi.org/10.4025/actascibiolsci. v25i2.2009

LUQUE, J.L., AMATO, J.F.R. and TAKEMOTO, R.M. 1996. Comparative analysis of the communities of metazoan parasites of *Orthopristis ruber* and *Haemulon steindachneri* (Osteichthyes:

Haemulidae) from the southeastern Brazilian littoral: I. Structure and influence of the size and sex of hosts. *Revista Brasileira de Biologia*. **56**:279-292.

MACHADO, P.M., ALMEIDA, S.C., PAVANELLI, G.C. and TAKEMOTO, R.M. 2000. Ecological aspects of endohelminths parasitizing *Cichlamonoculus spix*, 1831 (Perciformes: Cichlidae) in the Paraná River near Porto Rico, State of Paraná, Brazil. *Comparative Parasitology*. **6**:210-217.

MARGOLIS, L., ESCH, G.W., HOLMES, J.C. and SCHOD, G.A. 1982. The use of ecological terms in parasitology. Report of an ad-hoc Committee of the American Society of Parasitologists. *Journal of Parasitology*. **68**: 131-133.

MOHAMMED, N., MAIGANDI, S.A. and HASSAN, W.A. 2008. Growth performance and economics of fish in relation to parasites. *Journal of Veterinary Science*. **7**:59-64.

MONTOYA-MENDOZA, J., SALGADO-MALDONADO, G., ÁLVAREZ-NOGUERA, LUGO-VÁZQUEZ, F., LANGO-REYNOSO, A. and LANGO-REYNOSO, F. 2019. *Communities of helminth parasites in sciaenid fish from the Alvarado Coast, Veracruz, Mexico, Southern Gulf of Mexico. Journal of Agricultural Science*. **11** (8): 65. ISSN 1916-9752.

MORAVEC, F. and ALI, A.H. 2013. *Philometra johnii* sp. nov. (Nematoda, Philometridae), a new gonad-infecting philometrid from the sin croaker *Johnius dussumieri* (Cuvier) (Perciformes, Sciaenidae) from marine waters of Iraq. *Acta Parasitologica*. **58:**263–268.

MORAVEC, F. and ALI, A.H. 2014. Additional observations on *Philometra* spp. (Nematoda: Philometridae) in marine fishes off Iraq, with the description of two new species. *Acta Parasitologica*. **87**: 259–271.

MORAVEC, F. and de BURON, I. 2009. New data on three gonad-infecting species of *Philometra* (Nematoda, Philometridae) from estuarine fishes in South Carolina, USA. *Acta Parasitologica*. **54**: 244–252.

MORAVEC, F. and de BURON, I. 2013. A synthesis of our current knowledge of philometrid nematodes, a group of increasingly important fish parasites. *Folia Parasitologica*. **60**: 81–101.

MORAVEC, F. and DIGGLES, B.K. 2014. Philometrid nematodes (Philometridae) from marine fishes off the northern coast of Australia, including three new species. *Folia Parasitologica*. **61**: 37–54.

MORAVEC, F. and MANOHARAN, J. 2013. Gonad-infecting philometrids (Nematoda: Philometridae) including four new species from marine fishes off the eastern coast of India. *Folia Parasitologica*. **60**(2): 105-122. doi: 10.14411/fp.2013.012.

MORAVEC, F. KHOSHEGHBAL, M. and PAZOOKI, J. 2013. Two philometrids (Nematoda: Philometridae) infecting the tigertooth croaker *Otolithes ruber* (Bloch & Schneider) (Teleostei: Sciaenidae) off Iran, including erection of a new genus. *Systematic Parasitology*. **86**: 33–41. doi: 10.1007/s11230-013-9430-y.

MORAVEC, F. KHOSHEGHBAL, M. and PAZOOKI, J. 2014. *Dichelyne* (*Dichelyne*) *spinigerus* sp. nov. (Nematoda: Cucullanidae) from the marine fish *Otolithes ruber* (Sciaenidae) off Iran and first description of the male of *Philometra otolithi* Moravec et Manoharan, 2013 (Nematoda: Philometridae). *Acta Parasitologica*. **59**: 229–237.

MORAVEC, F. and BARTON, D.P. 2015. Two gonad-infecting species of *Philometra* (Nematoda: Philometridae) from marine fishes off the northern coast of Australia. https://doi.org/10.1051/parasite/2015008. *Parasite*. **22**: 4

MORAVEC, F., de BURON, I. and ROUMILLAT, W.A. 2006. Two new species of *Philometra* (Nematoda: Philometridae) parasitic in the perciform fish *Cynoscion nebulosus* (Sciaenidae) in the estuaries of South Carolina, USA. *Folia Parasitologica*. **53**: 63–70.

MORAVEC, F., FAJER-AVILA, E.J. and BAKENHASTER, M. 2010. *Philometra floridensis* sp. n. (Nematoda: Philometridae) from the ovary of red drum *Sciaenops ocellatus* (Osteichthyes: Sciaenidae) off the coast of Florida, USA. *Journal of Helminthology*. **84**: 49–54.

MORAVEC, F., NAGASAWA, K. and OGAWA, K. 1998. Observations on five species of philometrid nematodes from marine fishes in Japan. *Systematic Parasitology*. **40**: 67–80

NAHA, P.R., RAHMAN, M.R., SARKER, J. and ISLAM, R.S.M. 2019. Prevalence and intensity of *Contracaecum* sp. in Jew-Fish (*Otolithoides pama*). *Scholars Journal of Agriculture and Veterinary Sciences*. **6**(7): 176-182.

NORRIS, D.E. and OVERSTREET, R.M. 1976. The public health implications of larval Thynnascaris nematodes from shellfish. *Journal of Milk and Food Technology*. **39**(1):47-54.

ODUM, E.P. 1971. *Fundamental of Ecology*. 3rd Ed. New York: Oxford University Press.

OLIVA, M.E. and LUQUE, J.L. 1998. Infracommunities of metazoan parasites in five sciaenid fishes from Peru. *Memorias do Instituto Oswaldo Cruz.* **93**: 175-180.

OMEJI, S., SOLOMON, S.G. and IDOGA, E.S. 2011. A comparative study of the common protozoan parasites of *Clarias gariepinus* from the wild and cultured environments in Benue State, Nigeria. *Journal of Parasitology Research*. doi: 10.1155/2011/916489.

PAPERNA, I. 1996. Parasites, infections and diseases of fishes in Africa: an update. FAO/CIFA *Technical*. **31**:157-170.

PAULY, D. 1983. *Some simple methods for the assessment of tropical fish stocks*. FAO Fisheries Technical Paper, FAO Rome, 234, 52.

POULIN, R. 2000. Variation in the intraspecific relationship between fish length and intensity of parasitic infection: biological and statistical causes. *Journal of Fish Biology*. **56**: 123-137.

QUIAZON, K.M.A., YOSHINAGA, T. and OGAWA, K. 2008. *Philometra sawara* sp. n. and a redescription of *Philometra sciaenae* Yamaguti, 1941 and *Philometra nemipteri* Luo, 2001 (Nematoda: Philometridae): a morphological and molecular approach. *Folia Parasitologica*. **55**: 277–290.

RAJPUT, S. and LANGER, S. 2022. Digenetic trematode parasites in two fresh water fishes *Ophiocephalus punctatus* and *Xenentodon cancila* from North west Himalayas. *Journal Parasitic Disease*. **46**(3):617-626. doi: 10.1007/s12639-022-01473-7.

SAAD-FARES, A. and COMBES, C. 1992. Abundance/host size relationships in a fish trematode community. *Journal of Helminthology*. **66**: 187-192.

SABAS, C.S.S. and LUQUE, J.L. 2003. Metazoan parasites of weakfish, *Cynoscion guatucupa* and *Macrodon ancylodon* (Osteichthyes: Sciaenidae), from the coastal zone of the State of Rio de Janeiro, Brazil. *Revista Brasileira de Parasitologia veterinária*. **12**:171-178.

SABBIR, W., HOSSAIN, M.Y., RAHMAN, M.A., HASAN, M.R., KHAN, M.N., MAWA, Z., TANJIN, S., SARMIN, M.S., RAHMAN, O., NIMA, A. and HABIB, K.A. 2020. Growth pattern of the Hooghly croaker *Panna heterolepis* (Trewavas, 1977) in the Bay of Bengal (Bangladesh) in relation to eco-climatic factors. *Egyptian Journal of Aquatic Biology and Fisheries*. **24**: 847–862.

SABBIR, W., RAHMAN, M.A., HOSSAIN, M.Y., HASAN, M.R., MAWA, Z., RAHMAN, O., TANJIN, S. and SARMIN, M.S. 2021. Stock assessment of Hooghly Croaker *Panna heterolepis* in the Bay of Bengal (Southern Bangladesh): Implications for sustainable management. *Heliyon*. **7**: e07711.

SANTOS, C.A.M.L. and HOWGATE, P. 2011. Fish borne zoonotic parasites and aquaculture: A review. *Aquaculture*. **318**(3–4): 253–261.

SARTORI, A.G. and AMANCIO, R.D. 2012. Fish nutritional relevance and consumption in Brazil. *Segur Alimen Nuture*. **19**(2):83-93. DOI: https://doi.org/10.20396/san.v19i2.8634613.

SARWAT, M.S. 2011. A new species of genus *Phyllodistomum* (Braun, 1899), (Digenea: Gorgoderidae, Looss, 1901) from freshwater fish *Mastacembelus armatus* Aurangabad (M.S.) India. *Recent Research in Science and Technology*. **3**:11–13.

SEHRIN, S., KABIR, N., SARKER, A., CHOWDHURY, M., BAKI, M.A. and AHMED, M.S. 2023. Parasite diversity and histopathological changes due to infection on three croakers (*Pennahia anea, Panna microdon* and *Johnius argentatus*) of Saint Martin's Island, Bay of Bengal. *Bioresearch Communications*. **9**(2): 1297-1304. https://doi.org/10.3329/brc.v9i2.67081.

SHOTTER, R.A. 1973. Changes in the parasite fauna of whiting *Odontogadus merlangus* L. with age and sex of host, season, and from different areas in the vicinity of the Isle of Man. *Journal of Fish Biology*. **5**: 559–573.

SHUKEROVA, S., KIRIN, D. and HANZELOVÁ, V. 2005. Endohelminth communities of the perch, *Perca fluviatilis* (Perciformes, Percidae) from Srebarna Biosphere Reserve, Bulgaria. *Helminthologia*. **47**: 99-104.

SIDDIQUI, A.A. 2014. Effects of seasons, host age, size and sex on monogenetic trematode, *Hamatopeduncularia indicus* of host fish, *Arius jella*. *Journal of Chemical, Biological and Physical Sciences*. **4**(2): 1146-1151.

TALWAR, P.K. and JHINGRAN, A.G. 1991. *Inland Fishes of India and Adjacent Countries*. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi, pp 1158.

TASAWAR, Z., UMER, K. and HAYAT, C.S. 2007. Observations on Lernaeid parasites of *Catla catla* from a fish hatchery in Muzaffargarh, Pakistan. *The Pakistan Veterinary Journal*. **27**: 17- 193.

TAVARES-DIAS, M., MARTINS, M.L. and KRONKA, S.N. 1999. Evaluation of the haematological parameters in *Piaractus mesopotamicus* Holmberg (Osteichthyes, Characidae) with *Argulus* sp. (Crustacea: Branchiura) infestation and treatment with organophosphate. *Revista Brasileira de Zoologia*. **16**: 553-555.

THEISEN, S., PALM, H.W., AL-JUFAILI, S.H. and KLEINERTZ, S. 2017. *Pseudempleurosoma haywardi* sp. nov. (Monogenea: Ancyrocephalidae (*sensu lato*) Bychowsky & Nagibina, 1968):

An endoparasite of croakers (Teleostei: Sciaenidae) from Indonesia. *Plos One* **12**(9): e0184376. https://doi.org/10.1371/journal.pone.0184376.

THOMAS, M.J., PETERSON, M.L., CHAPMAN, E.D., HEARN, A.R., SINGER, G.P., BATTLESON, R.D. and KLIMLEY, A.P. 2014. Behavior, movements, and habitat use of adult green sturgeon, *Acipenser medirostris*, in the upper Sacramento River. *Environmental Biology of Fishes*. **97**:133–146. doi: 10.1007/s10641-013-0132-8.

TILAMI, S.K. and SAMPELS, S. 2018. Nutritional value of fish: lipids, proteins, vitamins, and minerals. *Reviews in Fisheries Science and Aquaculture.* **26**(2):243-253. doi.org/10.1080/23308249.2017.1399104.

ULMER, M.J. 1971. Site-finding behavior in helminths in intermediate and definitive hosts. *Ecology and Physiology of Parasites: A Symposium*, edited by A. Murray Fallis, Toronto: University of Toronto Press, pp. 123-160. https://doi.org/10.3138/9781487595128-008.

WHARTON, D.A., HASSALL, M.L. and AALDERS, O. 1999. Anisakis (Nematoda) in some New Zealand inshore fish. *New Zealand Journal of Marine and Freshwater Research.* **33**(4):643-648.

WHO (World Health Organization). 2012. Soil-transmitted helminths. World Health Organization. http://www.who.int/intestinal.

YAMAGUTI, S. 1941. Studies on the helminth fauna of Japan. Part 33. II. Nematodes of fishes. *Japanese Journal of Zoology.* **9**:343–396.

YAMAGUTI, S. 1958. *Systema Helminthum. Volume I. The digenetic trematodes of Veterbrates*. Part I & II. New York: Interscience Publishers, pp. 1575.

YAMAGUTI, S. 1961. *Systema Helminthum. Volume III. The Nematodes of Veterbrates*. New York: Interscience Publishers, pp. 1261.

YAMAGUTI, S. 1965. New Monogenetic Trematodes from Hawaiian Fishes I. *Pacific Science.***19**(1): 55–95.

ZAFAR, M., MUSTAFA, G., AMIN, S.M.N. and HAQUE, M.A. 2000. Population dynamics of *Johnius argentatus* (Houttuyn) from the northeastern part of the Bay of Bengal, Bangladesh. *Asian Fisheries Sci*ence. **13**: 243–249.

(Manuscript received on 30 September 2024 revised on 26 December 2024)