Parasitic infestation with reference to a new record of *Aeolosoma* spp. in *Ctenopharyngodon idella* (Valenciennes, 1844) rearing in lentic reservoirs in Pakistan

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Abstract

Fish is considered a profitable animal that provides a cheap source of proteins. Various parasites affect the fish fauna which badly affects fish tissues and stops productivity. This study explores the ectoparasites and intestinal parasites of *Ctenopharyngodon idella* from lentic reservoirs, in Pakistan. The collection of samples was done by simple hand net. The samples were examined at the University of Malakand. Out of 100 specimens, 30%(n=30) were found to be infected with ectoparasites while 60% (n=60) were have been observed with Annelids and helminths. The species-wise prevalence of ectoparasite is 30% (*Lernaea* spp.), 45% of (*Aeolosoma* spp.), and Nematode parasite showed 15% as *Rhabdochona* spp. The higher intensity was recorded for *Aeolosoma* spp. (3.0). The sex-wise prevalence of parasites was higher in female specimens. The length weight-wise prevalence of the parasite was recorded higher in fish with maximum length and high body weight compared to small size and low body weight fish. The age-wise prevalence of ectoparasite was revealed higher in adult fish and endoparasites were found higher in sub-adult fish. The season-wise prevalence of parasites was recorded higher in the summer season. This study concluded that the gastrointestinal helminth and Annelids were more prevalent than ectoparasite in lentic reservoirs.

keywords: Fish; grass carp; ectoparasites; helminth parasites; Annelids; lentic reservoirs

Introduction

The fish are classified as omnivores and predators, which feed on small fishes, aquatic and terrestrial insects, and higher plants and the demand for fish increases regularly due to the cheapest source of protein (Komatsu and Kitanishi, 2015). One of the most important herbivore fish species is grass carp (*Ctenopharyngodon idella* Valenciennes, 1844) which was introduced from the Amur River (Russia) to central Europe and Asia and successfully reared in a polyculture system. The grass carp (*C. idella*) is used as a biological control for aquatic emerged vegetation due to its herbivorous nature and the unique characteristic of such fish is reared in a lentic water system (Stevanovski *et al*., 2015). Some major factors that hardly affect the freshwater fish mainly grass carp, such as degradation of habitat, introduction of species, transferring from one region to another, insufficient water quality, harvesting, and pollution which often result in weak immunity of fish and more chances to parasites and diseases (Biu *et al*., 2014).

Fish are suffering due to many diseases in the world and the most one is parasitic (Ullah *et al*., 2022). Both types of parasites ectoparasites and endoparasites often have detrimental effects on fish tissues and often also on the health and growth of the fish (Ullah *et al*., 2024; Imam, 2010). The *C. idella* is a highly commercial fish of Pakistan that is affected by ectoparasite *Lernaea cyprinacea* (Linnaeus, 1758) commonly known as anchor worm. This harmful parasite originated in Asia and spread to different parts of the world through the transferring of fish causing a disease known as lernaeasis in freshwater fish (grass carp) and lower aquatic invertebrates. The symptoms of lernaeasis are red sores on the skin and in severe situations, this leads to secondary bacterial infection and ultimately the fish become weak and lethargic (Iqbal *et al*., 2020a). Intestinal helminths are the important pathogenic agents among various parasitic diseases of fish particularly grass carp which affect them in different ways (Hansen *et al*., 2006). Nematodes are helminth parasites present in different regions of the world and the fish are mostly utilizing these Nematodes as an intermediate host that can infect many organs of the host (Fadladdin *et al*., 2024). The one species of Nematodes *Contraceacum* sp. Which infect humans and fish and other species *Rhabdochona macrostoma*, *R. denudate*, *C. micropapillatum* and *Hepaticola petruschewkii* are found in different fish species in Southeastern, Iran (Pazooki *et al*., 2012). The life cycle of *C. multipappilatum* starts from an egg that an adult female releases and sheds into the water through the feces of the definitive host. The second stage is developed into the water body and then subsequently ingested by cyclopoid. The third stage of larvae develops inside fish when the copepod or cyclopoid is eaten by them. In the last stage, Nematode develops in the gut of the definitive host after eating Nematode-infected fish and thus finishing the successful life cycle (Huizinga, 1967). Phylum Annelida comprises to diverse group of worms that include polychaetes and oligochaetes. Polychaetes worms are generally recognizable by having many chaetae on the body called parapodia (Rouse and Pleijel 2001). The family Aeolosomatidae belong to phylum Annelida which occur mostly in freshwater habitat and reproduce agametically while, one species, *Aeolosoma singulare* reproduces by sexual reproduction which infects many aquatic organisms such as fishes and cladoceran species (Marotta *et al*., 2003). 25 species are included in Aeolosomatidae and the body is simply organized with 5mm in length. The maximum length of *A. viride* Stephenson, 1913, is 2-3mm at full development with asexually re-produces by pygidial paratomy, the *A. hemprichi* Ehrenberg 1828, is the smallest species which does not exceed 1.5-2mm (Falconi *et al*., 2006).

Relevant literature indicates that most research works were published on the parasitic assessment and biodiversity of the regional fish fauna. However, there is no data on the record of parasitofauna among grass carp in Dir Lower, Pakistan. Therefore, the present study was conducted to investigate the different species of ectoparasites and intestinal helminths among grass carp in district Dir Lower.

Materials and Methods

Study area

The present study was conducted in the district Dir Lower, the northern province of Khyber Pakhtunkhwa, Pakistan; located between 34°37' and 35°07' N and 71°310 and 72°140 E, and the geographical area of Dir Lower is 1585 km² (Khan *et al*., 2010). The overall population is almost 1,544,000 densities is about (980/km2) 2,500m2 . The district Swat is located in the East, the Malakand protected area is in the South, and district Dir (Upper) surrounds Afghanistan and Bajaur in the West. Four seasons are dominant in the study area, winter is extremely cold, whereas the summer is pleasantly warm. The winter season starts from December to March and has severe rainfall (1000-1200 mm), while the summer season starts from June to September. 06-38oC is the average temperature in winter time and 15-40oC in the hot summer season and the relative humidity ranges from 30% to 70% respectively, (Ahmad *et al*., 2021).

Fish collection and Anesthitization

The fish samples were collected through fishing net techniques and hook net from freshwater lentic reservoirs in the summer and autumn seasons in 2022. The collected fish were anesthitized with 70% ethanol in a vacuum chamber. The collected samples were transported to the Parasitology Laboratory, Department of Zoology, University of Malakand, under the bio-security protocol.

External examination

The fish host was cleaned and dried with the help of blotting paper and the debris was removed. After that keenly observed the gills, scales, caudal and anal fins, pelvic and pectoral fins with the help of magnifier glass.

Identification of fish

The collected fish samples were identified by using taxonomic keys provided by (Desia, 2003; Mirza and Sandho, 2007). Morphometric characters including total length, fork length, and total weight were determined through electric balance and scale and measuring tape for standard length.

Sex identification of fish

The sexes of fish were determined after dissection by observing the presence of testes or ovaries.

Ectoparasites collection

The parasite specimens were collected from caudal fins and scales with the help of fin forceps and fine brush and kept in bottles containing 10% formalin and then transported to the Parasitology Laboratory, Department of Zoology, University of Malakand.

Helminth Parasites collection

The fish was anesthetized and dissected longitudinally (from mouth to anus) through a scalper blade and scissor. The intestine was removed by fin forceps and kept

in a petri dish containing normal saline solution and then incising from one side to the other through a scalper blade, scissors, and forceps. The gut materials were shaken through the wooden applicator and observed with a magnifying lens. The different helminth parasites were picked up by soft brush placed in a separated closed vial (70% ethanol) and brought to the parasitology laboratory for further identification.

Processing of Endoparasites

Dehydration of Annelids was performed by ascending and descending orders by using ethanol or methanol. The placement method of parasite specimen in solution is ascending order 30>50>70>90>100% and then descending order 100>90>70>50>30% for 10 minutes each. The parasites were placed on glass slides and the formaldehyde acetic acid (FAA) solution was added to fix the parasite specimens for 1 hour. After that the specimens were taken from alcohol and placed on a glass slide with a drop of clove oil for shining and the specimens were stained with Grenacher's borax-carmine overnight. The specimens were permanently mounted with Canada balsam and the slides were sealed with glycerin. We followed the protocol of (Ohurin and Somorin, 2006). The parasites were examined in an electric compound microscope at 1st under 10X and then 40X magnification. Photographs were taken before and after staining. The parasite specimens were identified with the help of available keys provided by (Yamaguti, 1961; Gussev, 1985; Moravec, 1994).

Data Analysis

The prevalence, mean intensity, and relative density of ectoparasite and helminth parasitic infection were measured in the formula used by (Asawari *et al*., 2017).

Results

This section provides a comprehensive insight into ectoparasites, gastrointestinal helminths, and Annelids among grass carp (*C. idella*) in lentic reservoirs of district Dir Lower, Pakistan. A total of 100 suspected fishes of grass carp (*C. idella*) were collected for the exploration of ectoparasites. Thirty fish were infected with Copepoda *Lernaea* spp. (Figure 3.1) and the infestation rate was 30% in all reservoirs. The highest prevalence rate was reported in Pond 1 which is 68% and no prevalence shows in Pond 4. The P value was found statistically significant for the comparison of examined and infected fish (Table 3.1). The total number of ectoparasite obtained from thirty infected fishes were 33 and the total mean intensity was (1.1). Among all fish ponds, pond 1 shows the highest intensity (1.17), and pond 4 shows no intensity (Table 3.2). The overall relative density of ectoparasites in all ponds is (0.33) which is highest in Pond 1 (0.8) and Pond 2 (0.4), pond 3 (0.12) while pond 4 shows no relative density (Graph 3.3). In gender-wise prevalence, the female fish revealed a higher prevalence rate compared to male fish in all ponds. The intensity and relative density of ectoparasites was also higher in female hosts. The total prevalence of pond 1 (68%) was higher compared to the total prevalence of the other three ponds. In pond first, the intensity was higher (1.23) in the female host and lower in the male host (1.0) and the total intensity was (1.17). The relative density of ectoparasites in female fish was (1.06) and male is (0.4)

and the total relative density in pond 1 was (0.8) (Graph 3.4). The fish with maximum length and high body weight have higher prevalence values compared to small-size and low-weight fish in all ponds. The prevalence rate of ectoparasite in pond 1 is higher 78.57% than in the other three ponds. The intensity (1.1) and relative density (0.92) of maximum length and high body weight fish were also higher in all ponds (Table 3.3). The age-wise prevalence of ectoparasites revealed that the adult fish have a higher prevalence value of 75% compared to sub-adult fish at 55.5%. The intensity and relative density of adult fish (1.25, 0.93) was also higher than sub-adult fish (1.0, 0.55) (Graph 3.3).

Table 3.1 Overall infestation of ectoparasites (*Lernaea* spp.) on grass carps

Collection ponds/sites	**No. of hosts examined (n=100)**	**No. of host infected (n=30)**	**Infestation rate 30 %**	**P value (95% CI)**
Pond 1	25	17	68%	0.0005
Pond 2	25	10	40%	
Pond 3	25	03	12%	
Pond 4	25	00	00	

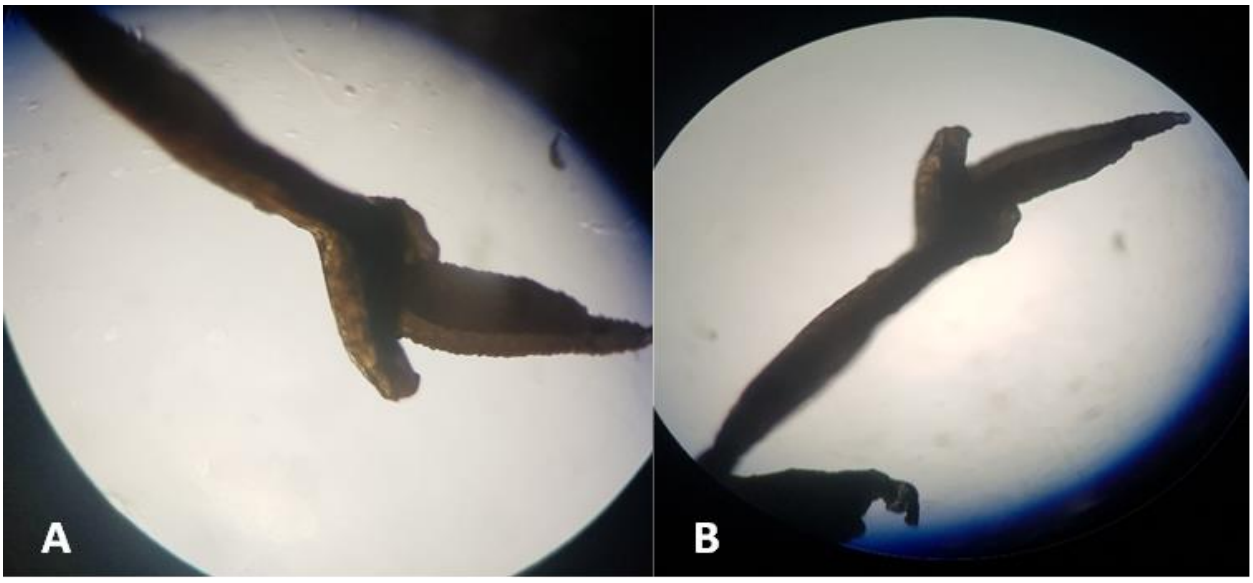
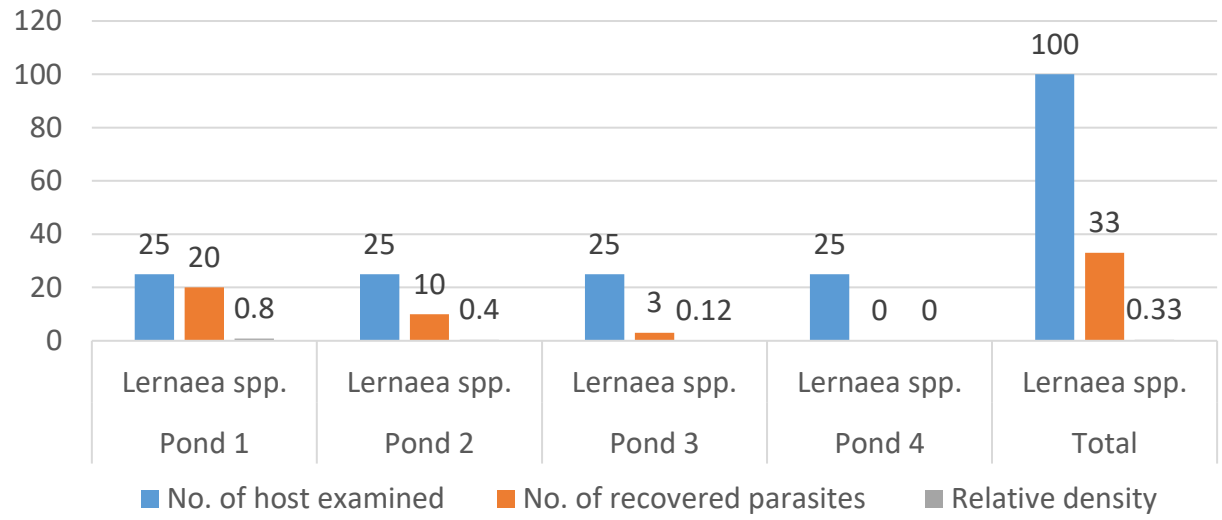


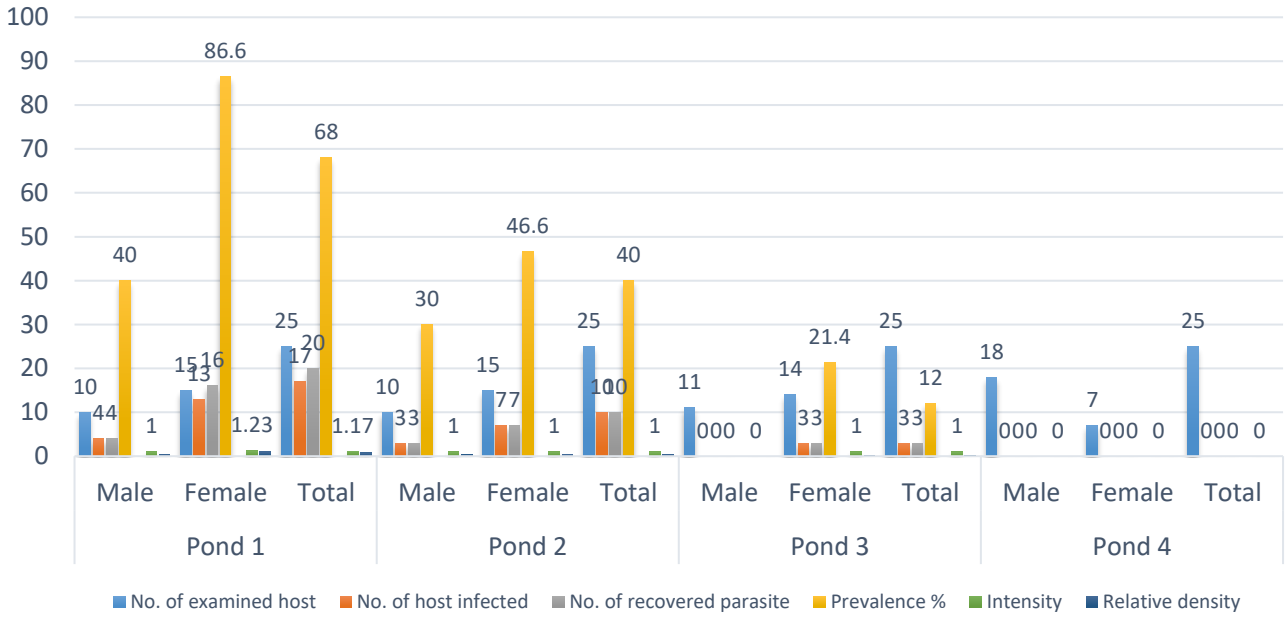
Figure 3.1: A and B Ectoparasite of Grass carp (*Lernaea* spp.) seen under a microscope

Table 3.2 Intensity of ectoparasites of grass carp (*C. idella*)

Ponds/ sites	Class	Parasites species	No. of host infected	No. of recovered parasite	Intensity
Pond 1	**Hexanauplia (Copepoda)**	*Lernaea* spp.	17	20	1.17
Pond 2		*Lernaea* spp.	10	10	1.0
Pond 3		*Lernaea* spp.	03	03	1.0
Pond 4		*Lernaea* spp.	00	00	00
Total		*Lernaea* spp.	30	33	1.1



Graph 3.1 Relative density of ectoparasites

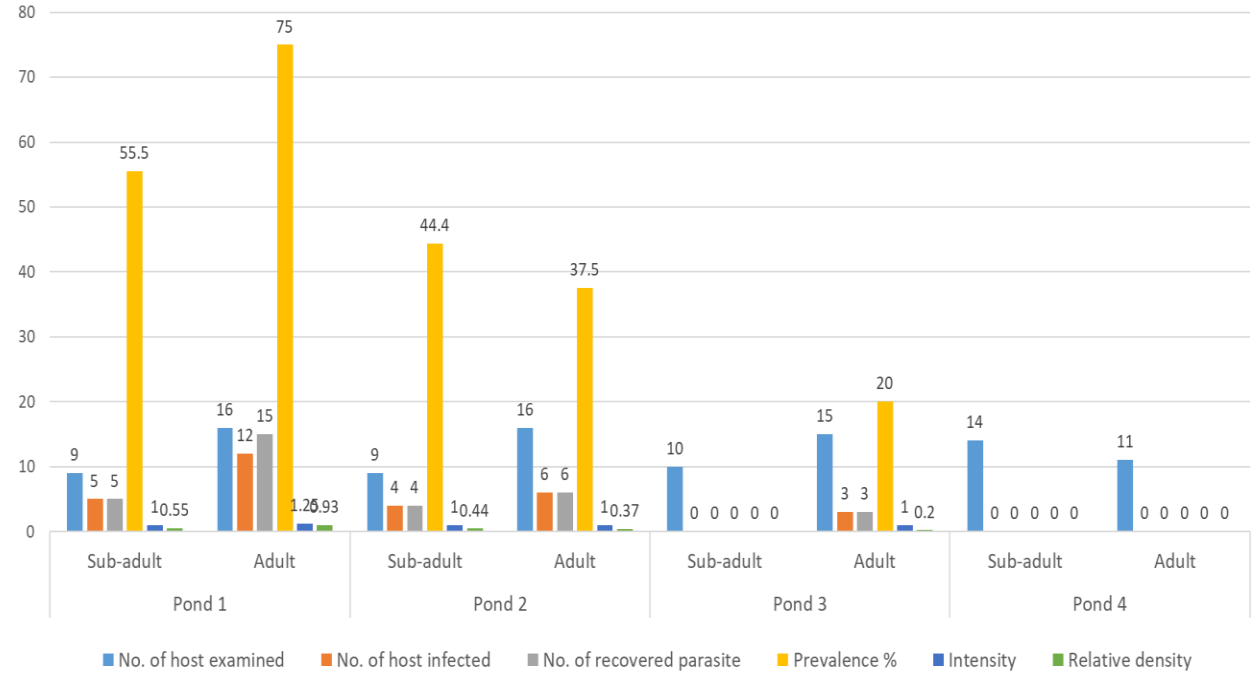


Graph 3.2 Gender-wise prevalence, intensity and relative density of ectoparasites

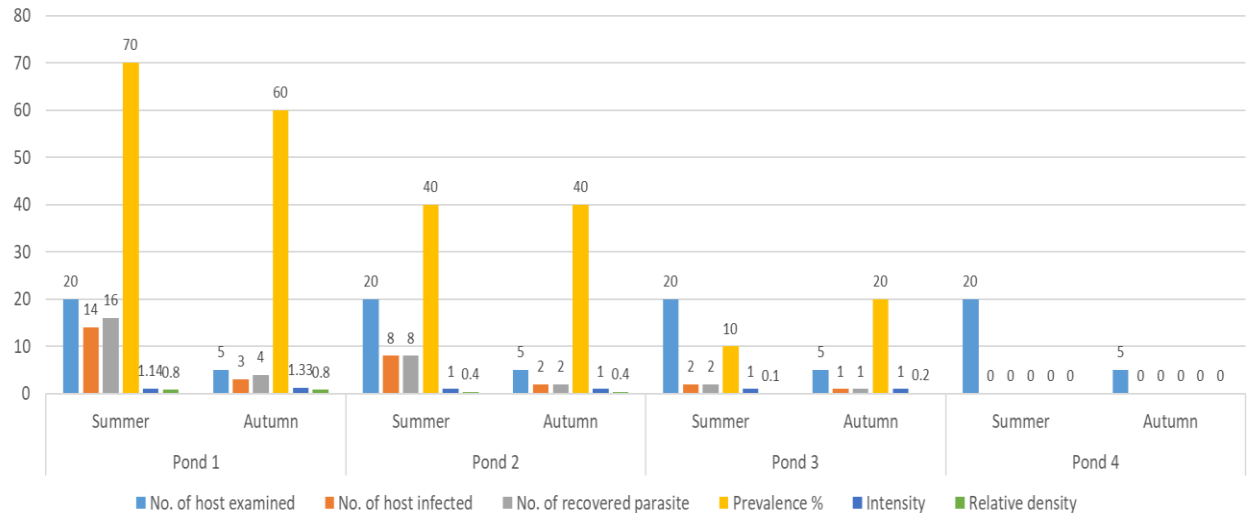
Table 3.3 Ectoparasites prevalence, intensity, and relative density according to morphometric measurement of the host

Factors	Pond 1		Pond 2		Pond 3		Pond 4	
Standard length (cm)	25-35	35.1-45	25-35	35.1-45	25-35	35.1-45	25-35	35.1-45
Body weight (g)	300-450	451-900	300-450	451-900	300-450	451-900	300-450	451-900
No. of host examine	11	14	10	15	10	15	18	07
No. of host infected	06	11	04	06	01	02	00	00
No. of recovered parasite	07	13	04	06	01	02	00	00
Prevalence %	54.54	78.57	40	40	10	13.33	00	00
Intensity	1.1	1.1	1.0	1.0	1.0	1.0	00	00
Relative density	0.63	0.92	0.4	0.4	0.1	0.13	00	00

The fish collection was done from July to October. The season-wise prevalence revealed that the summer season has a higher rate of prevalence 70% than the autumn season 20%. The highest intensity of ectoparasite was recorded in the autumn season (1.33) and the highest relative density was also higher (0.8) in the autumn season (Graph 3.4).



Graph 3.3 Age-wise prevalence, intensity and relative density of ectoparasites



Graph 3.4 Season-wise prevalence, intensity and relative density of ectoparasites

A total of 100 grass carp (*C. idella*) were collected for the investigation of gastrointestinal helminths. Sixty samples were infected with helminth parasites and Annelids. The prevalence rate of helminths and Annelids on grass carp was 60% in all ponds. The P value was noted as non-significant (P<0.05) (Table 3.4). 45% of samples were infected with *Aeolosoma* spp. (figure 3.2) which belong to class Polychaeta and phylum Annelida and 15% samples were infected with *Rhabdochona* spp. (figure 3.3) Which belong to the class Nematoda and phylum Platyhelminthes (Table 3.5). The total number of recovered parasites were 131 of which 108 were Annelids and 23 were Nematode with the total intensity being (2.18). The highest intensity was recorded in Annelids (3.0) compared to Nematode in all ponds (Table 3.6). The overall relative density recorded in all ponds is (1.31). The *Aeolosoma* spp. was the most commonly occurred having the highest relative density recorded (1.92) compared to *Rhabdochona* spp. (Graph 3.5). The female fish revealed a higher prevalence rate compared to male fish in all lentic reservoirs except pond 3 which is 63.6% in the male host and female host is 57.1%. The intensity of the Helminth parasite and Annelids was higher in female fish (3.0) compared to male fish and the relative density was also higher in female fish (2.32) in all ponds (Graph 3.6). The large-size and high body weight fish (35.1-45cm and 451-900g) were highly infected 85.71% is compared to small size and lower body weight fish (25-35cm and 300-450g). The highest intensity was shown in large-size and higher-body-weight fish (3.3) and the relative density was also found in large-size and maximum-body-weight fish (2.85) (Table 3.7). The age-wise prevalence revealed that the sub-adult fish have a higher prevalence value 88.88% than the adult fish 75% in the first pond. Furthermore, the

prevalence of parasites in the adult host is higher at 73.33% than in sub-adult fish in the other three ponds. The intensity and relative density of adult fish (3.5 and 2.62) was higher in all ponds as compared to sub-adult fish (Graph 3.7). The fish collection was done from July to October (summer and autumn). The season-wise prevalence showed that the highest infestation in ponds 1 and 3 was recorded in the summer season at 85% and 65% and pond 2 and 4 was higher in the autumn season at 80%. The highest intensity was found in the summer season (2.63) and the relative density was also shown in the summer season in all ponds (Graph 3.8).

Table 3.4 Overall infection of intestinal helminths and Annelids in grass carp

Collection ponds/sites	**No. of hosts examined (n=100)**	**No. of host infected (n=60)**	**Infestation rate 60 %**	**P value (95% CI)**
Pond 1	25	20	80%	
Pond 2	25	15	60%	
Pond 3	25	15	60%	0.5486
Pond 4	25	10	40%	

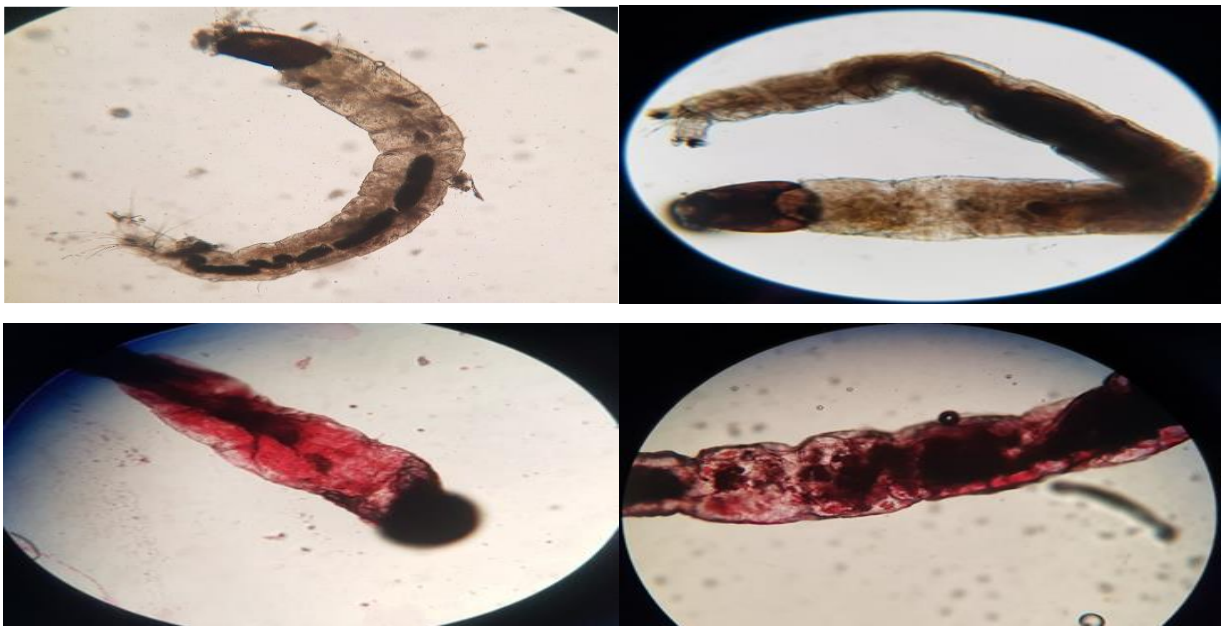


Figure 3.2: Annelids (Polychaeta: *Aeolosoma* spp.) under the microscope A and B) before staining and C and D) after staining

Figure 3.3: Helminth parasite (Nematoda; *Rhabdochona* spp.) A) Head, B) Abdomen, and C) Tail region under the microscope

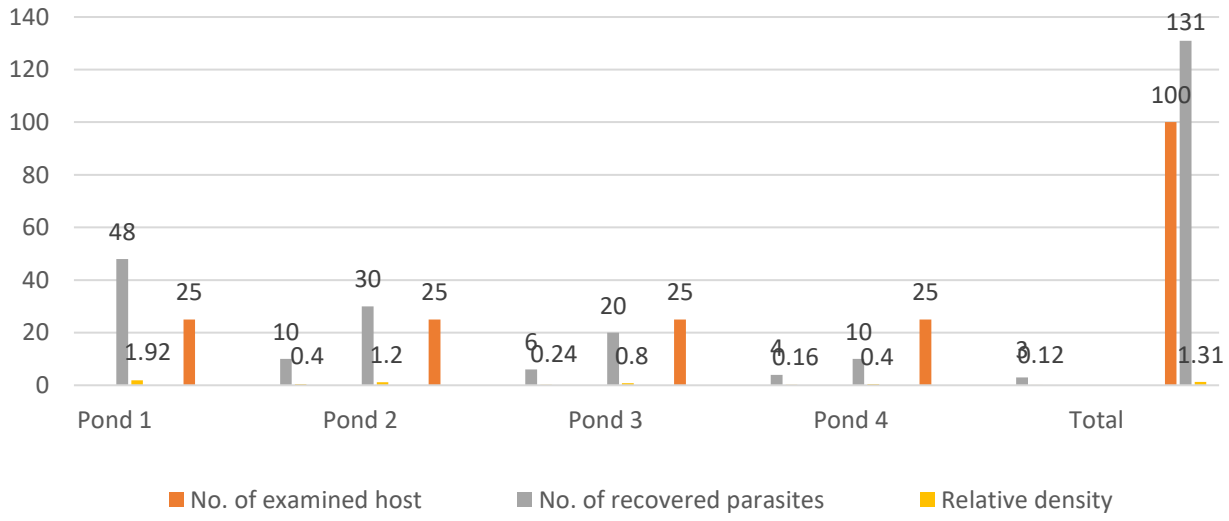
Table 3.5 Species-wise infection rate of intestinal helminths and Annelids

Class of parasites	Species	Total no. of host examined	No. of infected host	Overall infestation %
Polychaeta	*Aeolosoma* spp.	100	45	45%
Nematoda	*Rhabdochona* spp.		15	15%
Total			60	60%

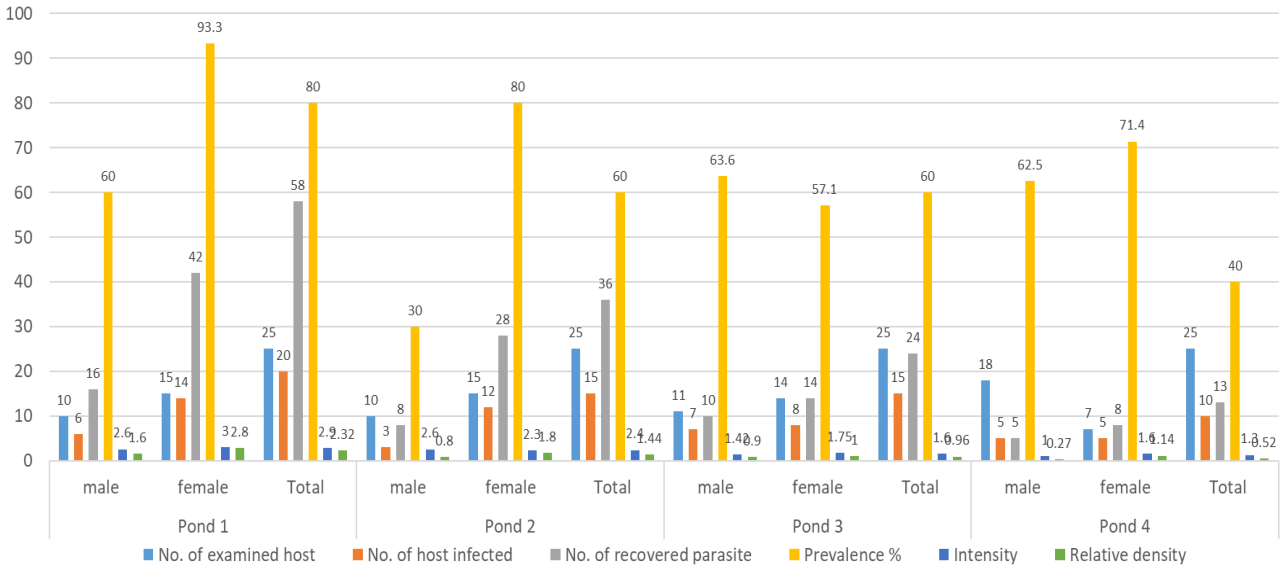
Table 3.6 Intensity of intestinal helminths and Annelids in grass carp (*C. idella*)

Ponds/sites	Class	Parasites species	No. of host infected	No. of recovered parasites	Intensity of parasites
Pond 1	**Polychaeta**	*Aeolosoma* spp.	16	48	3.0
	Nematoda	*Rhabdochona* spp.	04	10	2.5

Pond 2	**Polychaeta**	*Aeolosoma* spp.	11	30	2.81
	Nematoda	*Rhabdochona* spp.	04	06	1.5
Pond 3	**Polychaeta**	*Aeolosoma* spp.	11	20	1.81
	Nematoda	*Rhabdochona* spp.	04	04	1.0
Pond 4	**Polychaeta**	*Aeolosoma* spp.	07	10	1.42
	Nematoda	*Rhabdochona* spp.	03	03	1.0
Total			60	131	2.18



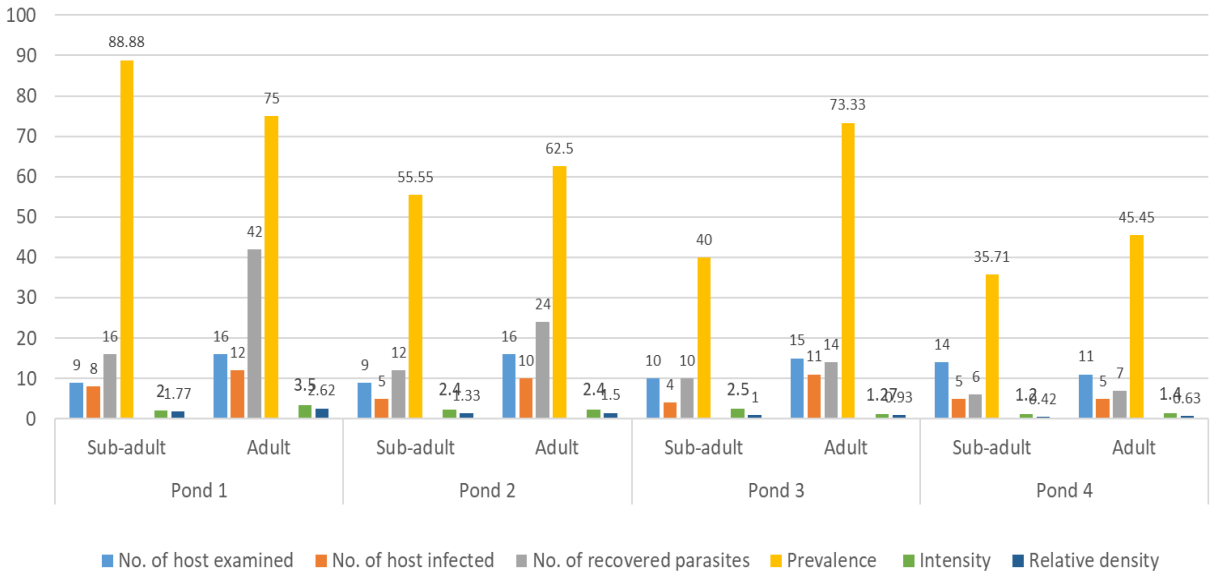
Graph 3.5 Relative density of intestinal helminths and Annelids



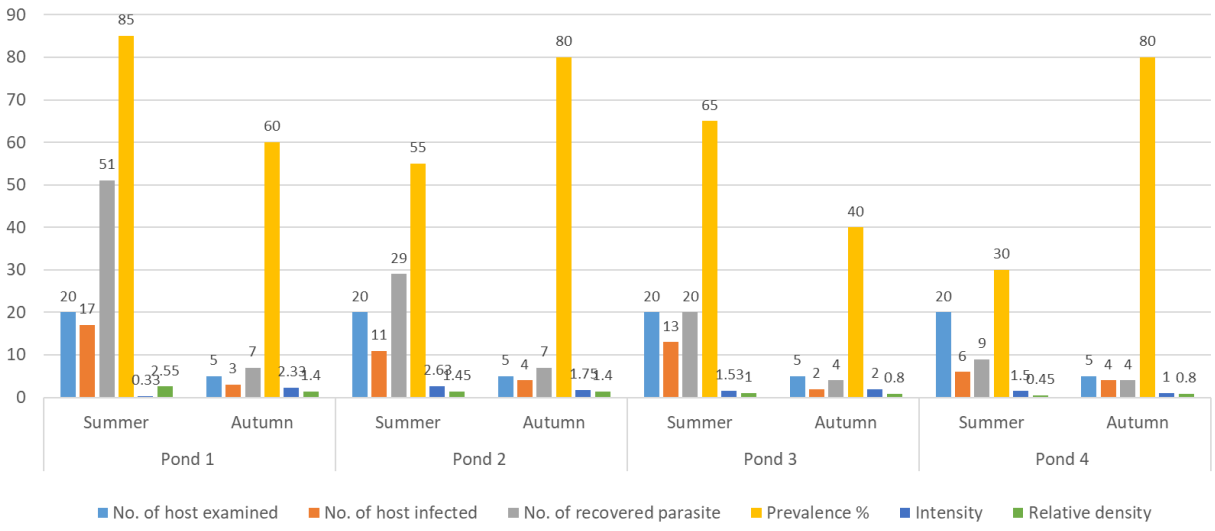
Graph 3.6 Gender-wise prevalence, intensity and relative density of intestinal helminths and Annelids

Table 3.7 Gastrointestinal helminths and Annelids prevalence, intensity, and relative density according to morphometric measurement of the host

Factors	Pond 1		Pond 2		Pond 3		Pond 4	
Standard length (cm)	25-35	35.1-45	25-35	35.1-45	25-35	35.1-45	25-35	35.1-45
Body weight (g)	300-450	451-900	300-450	451-900	300-450	451-900	300-450	451-900
No. of host examine	11	14	10	15	10	15	18	07
No. of host infected	08	12	06	09	05	10	04	06
No. of recovered parasites	18	40	10	26	07	17	05	08
Prevalence %	72.72	85.71	60	60	50	66.66	22.22	85.71
Intensity	2.2	3.3	1.6	2.8	1.4	1.7	1.2	1.3
Relative density	1.63	2.85	1.0	1.73	0.7	1.13	0.27	1.14



Graph 3.7 Age-wise prevalence, intensity and relative density of intestinal helminths and Annelids



Graph 3.8 Season-wise prevalence, intensity and relative density of intestinal helminths and Annelids

Discussions

The northern side of Pakistan, the largest population of fish under a small-holding subsistence farming system; the fish is considered a profitable animal that has good quality of white meat, and the price is high in regional and local fish markets (Ullah and Khan 2024; Muchlisin *et al*., 2015). The ectoparasites and gastrointestinal helminths are the most important agents for the diseases of fish. Overcrowding, malnutrition, the host which harbors parasites, and seasons are the major factors of fish diseases. Therefore, the present study was conducted to evaluate the ectoparasites and gastrointestinal helminths among grass carp in lentic reservoirs of Lower Dir, Pakistan.

The data was collected from four freshwater lentic reservoirs of Lower Dir, Pakistan in 2022. A total of 100 parasitic suspected grass carp were collected which includes 25 fish in each pond (Table 3.1). The overall infestation of ectoparasite from all ponds was 30%. The finding of the present work was consistent with the reported values of (Tasawar *et al*., 2009) their findings revealed the four ectoparasite species on grass carp in the Multan fish pond, the prevalence value of these parasites was (7.54%, 6.53%, 0.67%, and 0.67%). Similarly, other research work (Weijian and Pin 2004) reported the ectoparasite on grass carp in Wuhan fish pond, China. The prevalence of the parasite was more than 60%. These differences could have many factors such as overcrowding, climates of different parasites, poor sanitation system of fish, improper foods, and competition for food and place. For gastrointestinal helminths, out of 100 samples 60 were infected. The overall infection of helminth parasites and Annelids in all ponds was 60% (Table 3.4 and 3.5). Similarly, the literature (Xi *et al*., 2011) investigated 58 grass carp for helminth parasites in China. The infection rate of helminth parasites was 20.7%. However, the incidence of infection with parasites in the current study is an indication of poor hygienic conditions and uncontrolled effort regarding their health which fish (grass carp) are living in. In such despoiled conditions, the fish are directly affected by the infestation.

In the present study, only one species of ectoparasite was reported (*Lernaea* spp.) with the infestation is 30% (Table 3.1). the same study was also done by (Iqbal *et al*., 2020a) reported the ectoparasite species *L. cyprinacea* in *C. idella* and other cyprinid fishes during culture. In the present research study, there are two groups were recorded which include Annelid and Nematode. The Annelid included *Aeolosoma* spp. with a high prevalence value of 45% and Nematode included *Rhabdochona* spp. with a low infection rate of 15% (Table 3.5). The present study was compared to the report values of (Marescalchi *et al*., 2008) investigated the two species of Annelids (*A. viride* and *A. hemprichi*) in Europe, Italy, and (Aydogdu *et al*., 2011) reported the three different Nematode species which is *Contraceacum* spp., *R. denudata* and *Eustrongylides excisus*. The highest infection was recorded in *R. denudata* 86.6%.

In the recent study, the overall collected samples from all ponds (Graph 3.4) showed that the sex-wise prevalence of grass carp for ectoparasites revealed that the female fish had a high prevalence rate of 45.09% compared to male fish at 14.28%. The intensity and relative density were also higher in female fish. The current study was compared to (Asgharnia and Ghasemi 2021) who reported *D. lammelatus* in the grass carp of the

Guilan fish pond in 2018. In this study, the male carp was more highly infested than the female carp and the intensity was also higher in males as compared to female grass carp. Moreover, the sex-wise prevalence of grass carp for Helminths and Annelids revealed that the female fish had a higher rate of infection 76.47% compared to male fish 42.85% except pond 3 which males had highly infected 63.06% than females 57.01% and the relative density of female was high from male fish. The present study showed the similarity of (Omeiji *et al*., 2014) reported the Nematode sp. Female fish was more highly infected 57.5% than male 42.4%. The strong shreds of evidence show that the female grass carp is more active than the male host and confronted with the environment for food and other purposes.

The current study observed (Table 3.3) that the large size 35.1-45cm and high-body weight fish 451-900g were found more infested at 37.25% than small size 25-35cm and low body weight fish 300-450g 22.44%. The present study was compared to (Ali *et al*., 2014) who determined the ectoparasites in four culturable grass carp from nursery and hatchery, in Punjab. Results show that the maximum length and high body weight fish <500 were more infected compared to small size fish. In the present work, the large size 35.1-45cm and maximum body weight fish 451-900g were more infected by 72.54% of helminth parasites and Annelids than small size 25-35cm and lower body weight fish 300-450g 46.93% (Table 3.7). The intensity and relative density of helminth parasites including Annelids was also higher in large size and maximum body weight fish. The same study was also done by (Omeiji *et al*., 2014) reported that the large size and high-body-weight fish were more infected than the small size and lower body weight fish.
The present study revealed that the adult fish had a higher prevalence rate compared to sub-adult fish except pond 2nd which sub-adult is 44.4% and adult fish was 37.5% (Graph 3.3). The intensity was also higher in adult fish from all reservoirs. The same study (Kumar *et al*., 2018) conducted a study on ectoparasites of Indian and Chinese carp in India. The result shows that adult fish >25cm are more highly infected than smaller ones. In the present study, the adult fish have highly infected Helminth parasites including Annelids from all ponds except pond 1 which is higher in sub-adult 88.88% compared to adult fish 75% (Graph 3.7). Furthermore, the variable intensity and relative density of helminth parasites and Annelids were recorded in all lentic reservoirs. The present study was consistence with the report values of (Shakir *et al*., 2006) reported the helminth parasites in catfish, in Pakistan. The finding of this study shows that the adult samples were highly infected 39.13% and the sub-adult had a lower prevalence rate 28.85%.

The overall study showed that the different prevalence values of the parasite were reported in all ponds (Graph 3.4) and the intensity and relative density were also different in all reservoirs. Similarly, (Mortuza and Al-Misned 2015) found ectoparasites prevalence in fingerlings, in Bangladesh. The four different parasites were reported in collected fish samples. The Ciliophoran had a high infestation rate of 37.5% from October to January and the crustacean recorded a very low 5% from June to September. This study concluded that the highest infestation rate was recorded in the winter season compared to the summer season. The fish were collected from July to October (summer-

winter). The different prevalence rates of helminth parasites and Annelids were recorded from all ponds (Graph 3.8). The intensity and relative density were also different from one another in all freshwater reservoirs. (Zargar *et al*., 2012) investigated the parasitological examination of *Schizothorax niger* in 2009. The highest infestation was recorded in the summer season at 39.5% and the lowest was recorded in the winter season at 8.1%. The spreading of parasites is mostly affected by definitive hosts like piscivorous birds.

Conclusion

The following conclusions were drawn from the results of the present study. The present study showed that only one species of ectoparasite *Lernaea* spp. and two different species which include Annelids *Aeolosoma* spp. and Nematode including *Rhabdochona* spp. were recorded overall in lentic reservoirs. The *Aeolosoma* spp. 45% was found more prevalent followed by *Lernaea* spp. 30% and the *Rhabdochona* spp. 15% was found to be the least prevalent.

Data Availability

The data collected during operation of this study and analyzed through standard techniques will not be available for public concern. However, the availability can be requested by the contact with the corresponding author.

Ethical Approval

This study was conducted according to ethical guidelines for animal-related research at Hazara Univrsity Mansehra, Pakistan. This study was registered as registration No. HU-210-203224. and F.No. is /HU/ORIC/2024/1376.

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Author's Contributions

AU conducted the study and prepared first draft of the manuscript, WK Supervised the study, SA and SU done the revision critically. All the authors critically revised the manuscript and approved for publication in this journal.

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