

**PREVALENCE OF CRUSTACEAN PARASITE (*ARGULUS* SP.)
IN FISHES FROM CULTURED ENVIRONMENTS OF PRIVATE
FISH FARM AT GADHAWA, DEUKHURI, DANG.**



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Signature ... *Anand* ...
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Prayapta Chaudhary

TU Regd. No.: 5-2-37-318-2014

TU Exam Roll No.: Zoo 731/075

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Submitted to

Central Department of Zoology
Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu

Nepal

2022

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

Date 24-Aug-2022
2022-05-08



Prayapta Chaudhary



त्रिभुवन विश्वविद्यालय
TRIBHUVAN UNIVERSITY



०१-४३३१८९६

01-4331896

Email: info@cdztu.edu.np

URL: www.cdztu.edu.np

प्राणी शास्त्र केन्द्रीय विभाग
CENTRAL DEPARTMENT OF ZOOLOGY

कीर्तिपुर, काठमाडौं, नेपाल।
Kirtipur, Kathmandu, Nepal.

पत्र संख्या :-

च.नं. Ref.No.:-

RECOMMENDATIONS

This is to recommend that the thesis entitled “Prevalence of crustacean parasite (*Argulus* sp) in fishes from cultured environments of private fish farm at Gadhwara, Deukhuri, Dang.” has been carried out by Prayapta Chaudhary for the partial fulfilment of Master’s Degree of Science in Zoology with special paper Fish Biology and Aquaculture. This is his/her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

Date. 26 Aug 2022
2079-05-10

Prof. Dr. Kumar Sapkota, PhD.

Supervisor

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu,

Nepal



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Kirtipur, Kathmandu, Nepal.

पत्र संख्या :-

च.नं. Ref.No.:-

LETTER OF APPROVAL

On the recommendation of supervisor “Prof. Dr. Kumar Sapkota” this thesis submitted by Prayapta Chaudhary entitled “Prevalence of crustacean parasite (*Argulus* sp.) in fishes from cultured environments of private fish farm at Gadhawa, Deukhuri, Dang” is approved for the examination and submitted to the Tribhuvan University in partial fulfilment of the requirements for Master’s Degree of Science in Zoology with special paper Fish Biology And Aquaculture.

Date. 26 Aug. 2022
2079-05-10

Prof. Dr. Tej Bahadur Thapa, PhD.

Head of Department

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal



त्रिभुवन विश्वविद्यालय
TRIBHUVAN UNIVERSITY



०१-४३३१८९६

01-4331896

Email: info@cdztu.edu.np

URL: www.cdztu.edu.np

प्राणी शास्त्र केन्द्रीय विभाग

CENTRAL DEPARTMENT OF ZOOLOGY

कीर्तिपुर, काठमाडौं, नेपाल।
Kirtipur, Kathmandu, Nepal.

पत्र संख्या :-

च.नं. Ref.No.:-

CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Prayapta Chaudhary entitled “Prevalence of crustacean parasite (*Argulus* sp.) in fishes from cultured environments of private fish farm at Gadhawa, Deukhuri, Dang” has been accepted as a partial fulfilment for the requirements of Master’s Degree of Science in Zoology with special paper Fish Biology and Aquaculture.

Evaluation Committee

Supervisor

Prof. Dr. Kumar Sapkota, PhD

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

Head of Department

Prof. Dr. Tej Bahadur Thapa, PhD.

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

External examiner

Internal Examiner

Date of Examination: 14 Sep 2022

2079-05-29

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ABSTRACT

This study was carried out at the private fish farm at Gangaparaspur which lies in Gadhwaha Rural Municipality Ward number 5, Deukhuri-Dang, Rapti zone, Lumbini Province, Nepal in April 2022 (Chaitra 2078). The objective of the study was the identification of crustacean parasite (*Argulus* sp) in fishes of private fish farm at Gadhwaha, Deukhuri, Dang. Altogether 1018 fish samples of four different fish species namely, Common carp (*Cyprinus carpio*), Rohu (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix*) and Mrigal (*Cirrhinus mrigala*) were examined. These host fish were divided into three groups according to length wise, smaller sized (15- 25 cm), medium sized (26-35 cm) and large sized (36-45 cm) and weight wise, small weight fish (201- 400 gm), medium sized (401- 600 gm) and large sized fish (601-800 gm). During the study time the total *Argulus* parasites recorded were 24 in 17 host fishes. Prevalence, mean intensity and abundance was analysed. Among the four different fish species, *H. molitrix* was highly prevalent species (3.2374 %) by *Argulus* parasite and least prevalence was recorded in *C. mrigala* (0.4347 %). The *Argulus* were collected from various body parts of fish, from skin, pectoral fin, chest, caudal fin and gill cover and pectoral fin region was found highly infested by *Argulus* and least in gill cover. Prevalence (0.0145 %), intensity (0.0189) and abundance (0.0182) of parasites were found to be highest in medium sized fish (weight wise). The female *H. molitrix* recorded the highest prevalence (3.0303 %), mean intensity (1.6667) and abundance (0.0505) of the *Argulus* parasite.

1. INTRODUCTION

Nepal is an agricultural country, most of the Nepalese people rely on agriculture for their living. About 66% of total population are dependent on agriculture including fish farming (census 2068 B.S.). Rearing or culturing of fish upgrades the socio-economic status of farmers directly or indirectly. The farmers are involving in capture fishery as well as in culture of different fish species or termed as aquaculture. The aquaculture is the production of aquatic organisms that provide the shares 50% of world fishery industry. In Nepal, about 200 species of fish are found, including cold water as well as warm water fisheries. Among them 190 species are indigenous and remaining are exotic fish (Sharma, 2008). The introduced exotic fish are common carp (*Cyprinus carpio*), Sliver carp

(*Hypophthalmichthys molitrix*), Bighead carp (*Aristichthys nobilis*), Grass carp (*Ctenopharyngodon idella*), Rohu (*Labeo rohita*), Catla (*Catla catla*), Naini (*Cirrhinus mrigala*) (FAO, 2016). These fish are cultured in pond as warm water fisheries mostly in Terai region of Nepal.

Cultured fish face several parasitic infections. The common parasites of fish includes the protozoa, bacteria, fungi, viruses, helminthes, crustaceans, etc. The infection of parasites in fish differs from species to species, season and differences in water sources (Rai, 1986, Das *et al.*, 2016), seasonally dependent reach peak during summer and autumn (Moller, 2012). Fish health condition and their immunity against the disease causing pathogens are greatly influenced by physio-chemical parameters (Plumb *et al.*, 1988 and Shrestha, 1994). Crustacean disease in fish is commonly caused by *Lernaea* sp. and *Argulus* sp. (Jha and Bhujel, 2012). More than 100 species of *Argulus* are distributed globally and most studied species are *Argulus foliaceus*, *A. japonicas* and *A. coregons* (Steckler and Yanong, 2012). These parasite species are infectious to fresh water fisheries.

Argulus sp. are referred as fish lice which are the members of large group of branchiuran crustaceans, causing the fish disease, Argulosis. *Argulus* sp. are dorsoventrally flattened, oval rounded body and has two compound eyes, two prominent suckers located each side of mouth (Steckler *et al.* 2012). It is the major threats to fish health causing significant morbidity and mortality in heavy infestation

(Flick and Weigertjes, 2005). They make the fish unedible by attacking fish and makes wounds or disease on their flesh (Woo, 1999). *Argulus* sp. also has been regarded to be vehicle for other fish pathogens (Avernant and Oldewage, 2001). Pectoral region is the most preferable of infestation and brood fish are most susceptible of infection due to weak physiology at breeding time (Das *et al.* 2016).

Diseased fish usually rub against hard substratum for the relief from irritation or to remove the parasites (Steckler and Yanong, 2012). The most common method of transmission is introduction of infested fish and it puncture the skin, inject a cytolytic toxin through oral sting and feed on blood. (Hoffman, 1977). There is deleterious effects on growth, survival and behavior of fish due to ectoparasite infestation (Ebrahim, *et al.* 2019). Infested fish shows retardation in growth, survival and production (Menezes *et al.* 1990, Costelo, 2006). Information on fish ectoparasites and their prevalence are crucial for planning to treat and prevent the infection in fishes.

Recently, information on prevalence of crustacean parasites in cultured fishes was scarce. Therefore, this study is design to identify the *Argulus* species and their prevalence on farmed fishes from private fish ponds in Deukhuri Dang, Western Nepal.

1.1 Research Hypothesis

- Prevalence of *Argulus* sp. is expected to be high in cultured fishes at private fish farm.
- There is significant difference in prevalence of *Argulus* sp. with fish species, size and weight.

1.2 Research Questions

- What is the prevalence rate of disease in farmed fishes?
- Is the infection of *Argulus* sp. is variant in cultured fish according to size of fish?
- In which fish species this infection is seen most?

1.3 Objectives

1.3.1 General Objective

- To investigate the prevalence of *Argulus* sp. in fishes from cultured environments of private fish farm at Gadhawa, Deukhuri, Dang, Nepal.

1.3.2 Specific Objective

- To investigate the mean intensity and abundance of *Argulus* sp. of fishes from cultured habitats.
- To know the physical and chemical properties of water during study time.

1.4 Significance of Study

Fish ectoparasite like *Argulus* sp. are reported as a big threats to the health of fish in cultured pond causing a disease, Argulosis. It has been reported that argulosis is the major cause of high mortality and less production of fish in cultured farm. Also, significant studies and research works on argulosis has yet to be carried out through the nation. So, through this study, farmers will be able to know the cause and effects of parasite in fish and also find the solutions to eradicate it. Hence, they will be able to increase their production.

2. LITERATURE REVIEW

Mofasshalin *et al.* (2012) studied the parasites of three Indian major carps (*Labeo bata*, *Labeo gonius* and *Cirrhinus reba*) in Rajshahi, Bangladesh. And found that 370 fish were infected by protozoa, monogenean, crustacean, digenea and nematode out of 480 host fish samples, the highest infestation rate was due to digenea and lowest was nematode. The study concluded that the infection and infestation rate of parasites varied with fish size and season and found high in post monsoon and in winter season.

Upadhyay *et al.* (2012) studied the parasitic incidence in a cyprinid fish *Labeo rohita* (Ham.) at river Song in Doon valley (Uttarakhand) and found that 34 fish were infested by parasites out of 144 specimens and highest prevalence was by Platyhelminthes and lowest by accanthocephalon and they recorded highest infestation in monsoon and lowest in winter season.

Kumar *et al.* (2012) studied the antiparasitic efficacy of piperine against *Argulus* sp. on *carassius auratus* in vitro and in vivo study and found that 100 percent mortality of *Argulus* was seen in piperine solution at 9.0 mg/l in 3 hours and in vivo test 100 percent antiparasitic efficacy of piperine solution was found at 9.0 mg/l in 48 hours.

Ahmad *et al.* (2012) studied the external parasite infection of common carp (*Cyprinus carpio*) and Big head (*Hypophthalmichthys nobilis*) in fish farm of Mashhad, north east Iran and found the most infected parts by ectoparasite was in skin region.

Mirzaei and Khovand (2013) studied the prevalence of *Argulus foliaceus* in ornamental fish [Goldfish (*Carassius auratus*) and Koi (*Cyprinus carpio*)] in Kerman, southeast Iran and found that the prevalence of the parasite was 6.67 percent out of 300 fish samples and higher infestation rate was in goldfish (9.5%) and lowest in koi fish (1%).

Alsarabiki *et al.* (2014) studied the parasitism of *Argulus japonicus* in cultured and wild fish of Guangdong, China with new record of three hosts and found that 712 fish were infected by *Argulus japonicus* out of 2271 fish samples and most abundant and intensive parasitic infestation was found in silver carp among other eight fish species. Abundance and intensity of parasite infection was found significantly influenced by habitat origin and size of fish.

Mikheev *et al.* (2015) reviewed the behavioural adaptation of argulid parasites (Crustacea: Branchiura) to major challenges in their life cycle and came to know that aggregation of parasites during reproduction occurs on different scales and involves in both host aggregation and parasite aggregation on host and searching for host and mates, host manipulation and host choice were the main behavioural adaptation of *Argulus* sp. which were all focused on the fish.

Monir *et al.* (2015) determined the highest prevalence of fish parasitic disease in *Labeo rohita* in winter season and lowest in *Catla catla* in summer season among three Indian major carps *L. rohita*, *C. catla* and *Cirrhinus mrigala*. It was recorded from three different districts of Bangladesh viz Mymensingh, Sylhet and Jajshah from July 2012 to June 2013. It is reported that 80 carp farms were infected among 120 carp farms.

Das *et al.* (2016) reported that *Argulus* parasite prevalence varies according to season. The investigation was done at Mymensingh region, Bangladesh in June 2010 to May 2012 from 8 different fish farm. Among 3 different seasons viz, rainy, summer and winter, rainy season had higher rate of infestation and it was found higher rate in Rohu than Catla and Mrigal where altogether 2880 fish host were examined of which 940 hosts were found to be infested.

Ebrahimi *et al.* (2017) investigated ectoparasitism on freshwater fish in West Azerbaijan, northwest of Iran from June 2015 to January 2017 and found that high prevalence of ectoparasite infestation (*Ichthyophthirius multifiliis*, *Argulus* sp. *Dactylogyrus* sp. and *Gyrodactylus* sp.) was in cyprinidae than Salmonidae among the total 280 fish samples. Rayamajhi *et al.* (2017) reported that *Argulus japonicus* as the first recorded crustacean parasites from common carp at Fisheries Research Division, Nepal Agricultural Research Council, Godawari, Lalitpur. A total of 164 specimens of *Argulus japonicus* were isolated among the 20 fish samples and 11 male and 5 female parasites were identified. It is also mentioned that the prevalence of *Argulus* parasite was reduced to 95% by feeding Duroclean treated fish with effective dose 0.3 per kg fish for 3 days regularly with 1 day off.

Alhassan *et al.* (2018) did investigation of ectoparasite in Nile Tilapia (*Oreochromis niloticus*) in cage culture at Mpakadam, Ghana and found that skin as the most infested part of the host by *Argulus* sp., *Dactyogyrus* sp., *Lernaea* sp., *Trichodina* sp. It is reported that 94 samples were infested out of 210 fish samples which was carried out

in three phases namely initial phase, intermediate and final phase and most infested parasite was intermediate phase (7.1cm – 12cm) and smaller sized fish (0.1 gm – 30 gm).

Kumar *et al.* (2018) investigated the prevalence of fish lice (*Argulus* sp.) in cultured fish farms at Uttarakhand, India and found out that maximum prevalence in Rohu and least in Grass carp among six different carp species, Catla, Rohu, Mrigala, Silver carp, Grass carp and Common carp. It is reported that 378 carp specimens were found infected among total of 2695 specimens and bigger sized fish were more infested than smaller one. Also treatment analysis were also done and had shown complete detachment of the parasite from the hosts when common salt's 3.0% solution for 5 minutes bath treatment applied. Also, the bath treatment with 0.1% solution of KMnO₄ for 5 minutes caused complete removal of the parasite from the host fishes.

Vollset *et al.* (2018) studied the parasitic sea louse infestation on wild sea trout: separating the role of fish farms and temperature and found out the attachment of fish lice on sea trout increased with the temperature when infestation pressure from fish farms was high and not in low infestation pressure and the effect of rising temperature was indirect and mediated through the infestation pressure.

Prasad *et al.* (2018) carried out a study at Fishery Development Center, Bhairahawa, Rupandehi, Nepal between pre monsoon and post monsoon in two fish species: Silver carp (*Hypophthalmichthys molitrix*) and Common carp (*Cyprinus carpio*) and resulted that among 321 fish samples 17 fish (5.3%) were infected by *Argulus* sp. The parasites were found on skin, fins and operculum. Highest prevalence were recorded from small fishes and in *H. molitrix* in pre monsoon.

Indahsari *et al.* (2019) studied the prevalence and intensity of ectoparasite of Tilapia (*Oreochromis niloticus*) in ponds with low, medium and high stocking density and found that the highest prevalence of ectoparasite was in low stocking density with total sample 180 fish tails examined.

Hunt and Cable (2020) experimented the survival and growth of the fish ectoparasite *Argulus foliaceus* impacts due to temperature, density and host species and found that *A. foliaceus* significantly affected by temperature, development, growth and survival. Parasites hatched and developed faster in higher temperature and grew faster in natural host and in lower infection densities but had very short lifespan.

3. MATERIALS AND METHOD

3.1 Study Area

Gangaparaspur lies in Gadhwara Rural Municipality ward number 5, Deukhuri-Dang, Rapti zone, Lumbini Province. It lies 40 kilometers south-east to the district headquarter Ghorahi and 23 kilometers south-west to the Lumbini Province capital Bhalubang. The owner of fish farm is Mr. Yam Raj Chaudhary. There are 6 ponds including 2 small ponds. The total area of pond is 5 hectares but water pond area is 3 hectares. It is located at an elevation of 2,300 feet (700 m) in the Mahabharat-Chure hill region and in between latitude 27.7583° N and longitude 82.5294° E. The main source of irrigation in Deukhuri (Gadhawa) region is Rapti River and other its small sub-streams. The climatic condition is sunny and warm most of the months in a year and the soil topography is sandy type. The climate and water is applicable for the culture of warm water fisheries like carp species like common, rohu, mrigal, grass, silver, bighead, etc.

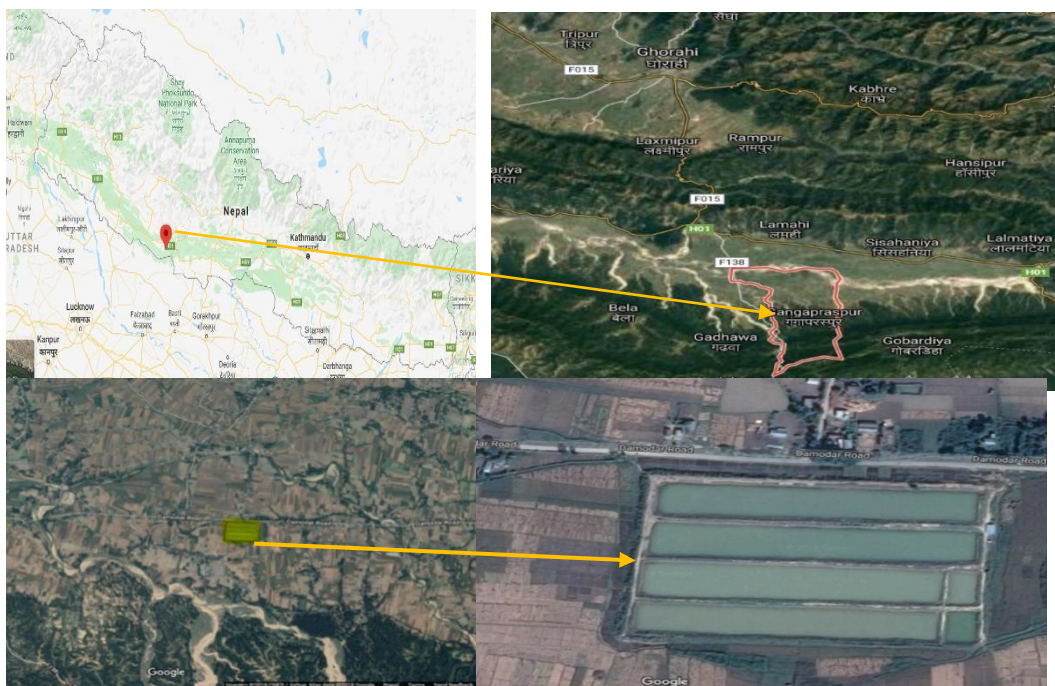


Figure 1: satellite view of study area

3.2 Fish Sampling

The fish samples were collected in April 2022 (Chaitra 2078) during the time of harvesting. The total fish sample collection and examined were 1018 fish of four different fish species; Common carp (*Cyprinus carpio*), Rohu (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix*) and Mrigal (*Cirrhinus mrigala*).

3.3 Separation of Male and Female Fish

The male and female fishes were identified on the basis of their secondary sexual characters. The adult or matured male was identified by roughness of the dorsal surface on the pectoral fin, which on the contrary was smooth in the female. The roughness in pectoral, fins was felt by touching the surface of fin close to the body. The mature male and female were also distinguished from the shape of their body, condition of the vent and secretion of milt in males. The distinguishing characters for the identification of the mature male and female fishes are explained in table.

Table 1: Characteristics Features of Male and Female Fishes

S.N	Characters	Male	Female
1	Body size and color	Body smaller and lighter; brighter colored than female	Body heavier and larger.
2	Pectoral fin and scales	Pectoral fin larger and rough; scales rough and grainy in nature	Pectoral fin smaller and smooth; scales are smooth in nature
3	Abdomen	Smooth and not bulging	Soft and bulging
4	Vent	Narrow, concave and not pink	Round, convex and pink
5	Putting pressure on abdomen (if matured fish)	On slight pressure above the vent on the abdomen milky white fluid (milt) runs out through the vent.	Pressure slight yellowish discharge or a few ova may come out through the vent.
6	Special character	Pearl organ (Nuptial tubercles) seen on the snout of common carp.	Such organ not present

3.4 Examination Procedure and Prevalence Analysis

The collected fish samples were separated according to fish species and counted total fish individually. The average length in centimeter and weight in gram of common, silver, rohu and mrigal were also measured. Then the length measured fishes were divided into three groups of different length. The *Argulus* parasite were inspected using hand lens (magnifying glass) and taken photographs by mobile phone camera. Parasites were identified using a key for parasites of freshwater fish (Bykhovskaya and Pavloskaya *et al.* 1964) and recorded, along with measurements of the standard length (cm) and weight (gm) of the whole fish. First the caudal, dorsal and anal fins were inspected, then the rest of the body surface and the gills. The *Argulus* parasite were collected from body skin, gill cover and fins. The parasite were collected by using sterile scalpel, forceps and brush from infected host fish along with mucus and kept in 70 percent spirit in a small plastic jar. Then after, drop of safranin were added into the mucus and observed under light microscope (40x magnification) in laboratory.

3.5 Estimation of Prevalence, Abundance and Mean Density

The prevalence, abundance and mean intensity were determined by following the keys of (Margalef *et al.* 1982) as follows.

- Prevalence = Number of infested host /Total number of host examined×100
- Abundance = Number of infested host/Total number of host examined
- Mean intensity = Number of parasites/Total number of infected host

3.6. Physical and Chemical Analysis of Water

The existing meteorological conditions and the chemical compositions affect the physical properties of water in any aquatic ecosystem. Different physical and chemical properties of water was analyzed during the study period after (Trivedy and Goel 1986), (Adoni 1985) and (APHA 1976). The physical and chemical properties of water are as follows;

- Temperature
- Transparency

- Hydrogen ion concentration (pH meter)
- Dissolved Oxygen (DO meter)
- Free Carbon dioxide (Titration)

3.7 Statistical Analysis

The statistical analysis was done as follows:

- The data is presented as mean.
- All the statistical analysis is performed by using excel.

4. RESULTS

The total fish sample collected was 1018 fish tails belonging to four different fish species cultured in the same pond. The different fish species samples were common carp (*Cyprinus carpio*), Rohu (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix*) and Mrigal (*Cirrhinus mrigala*) and their collection number 260, 278, 250 and 230 respectively. The numbers of infected host fish were recorded as 3, 9, 3 and 1 of *C. carpio*, *L. rohita*, *H. molitrix* and *C. mrigala* respectively. The numbers of the parasite were recovered as 4, 14, 5 and 1 from the hosts viz., *C. carpio*, *L. rohita*, *H. molitrix*, and *C. mrigala* respectively. A total of 24 parasite (*Argulus*) were found on different fish parts. The parasite were collected from skin, pectoral fin, chest, caudal fin and gill cover and predominant site of infestation was pectoral fin.

4.1 Total Average Weight and Length of Fish

The total average weight in gram and body length in centimeter of all four species fish were determined by using measuring scale and digital weighing machine. The average weight in gram and length in centimeter of *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Labeo rohita* and *Cirrhinus mrigala* were 433 and 26.5, 610 and 36.5, 630 and 35.5 and 490 and 38.5 respectively. The total average weight and length of all the four fish species were 540.75 and 34.25 respectively. (Table 2).

Table 2: Different species and number of sample collected and their average weight and length.

Species	Samples collected	Average weight (gm)	Average length (cm)
<i>Cyprinus carpio</i>	260	433	26.5
<i>thalmichthys molitrix</i>	278	610	36.5
<i>Labeo rohita</i>	250	630	35.5
<i>Cirrhinus mrigala</i>	230	490	38.5
Total	1018	540.75	34.25

4.2 Prevalence of *Argulus* Parasite in Different Parts of Fishes

The prevalence was determined in four fish species viz, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Labeo rohita* and *Cirrhinus mrigala*, from different parts; from skin, pectoral fin, chest, caudal fin and gill cover and the most infected fish species by parasite was *H. molitrix* followed by *L. rohita*, *C. carpio*, and *C. mrigala*. *H. molitrix* has the highest prevalence (3.2374 %) of parasite among all four fish species followed by *L. rohita* (1.2 %), *C. carpio* (1.1538 %) and least in *C. mrigala* (0.4347 %).

Among the various parts of fish, the pectoral region was found to be highly infested by the parasite *Argulus* followed by skin, caudal fin and chest and gill cover. The number *Argulus* in pectoral fin region, skin, caudal fin and chest and gill cover were 11, 8, 2, 2 and 1 respectively. (Table 2).

Table 3: Fish species, fish sample examined and infected, number of parasite and infested parts

Name of fish	No. of fish sample		No. of parasite	infested parts	Prevalance (%)	Mean intensity	Abundance
	Examined						
		Infected					
<i>Cyprinus carpio</i>	260	4	4	Pectoral Fin (2), chest(2)	1.1538	1.333	1.3333
<i>Hypophthalmichthys molitrix</i>	278	9	14	Pectoral fin(7), Skin(5), Caudal fin(2),	3.2374	1.5556	0.0503
<i>Labeo rohita</i>	250	3	5	Pectoral fin(2), Skin(2), Gill cover(1)	1.2	1.6667	0.02
<i>Cirrhinus mrigala</i>	230	1	1	Skin(1)	0.4347	1	0.0043
Total	1018	17	24		6.0260	5.5556	1.4080

4.3 Sex Wise Prevalence, Mean Intensity and Abundance of *Argulus* Parasite

Among four different fish species the prevalence, mean intensity and the abundance of *Argulus* parasite were determined according to sex of fish (i.e. male and female). The

results showed the female fish in *H. molitrix* had higher prevalence, mean intensity and abundance; 3.0303, 1.6667 and 0.0505 respectively and the least in *C. mrigala*. The prevalence, mean intensity and abundance in *C. mrigala* was 1.6667, 1, and 0.0167 respectively. In male too *H. molitrix* had higher prevalence, mean intensity and abundance; 3.75, 1.3333 and 0.05 respectively and *C. mrigala* had least or zero. (Table 3).

Table 4: Sex wise prevalence, mean intensity and abundance of Argulus parasite

Name of fish	Sex	No. of fish sample		No. of parasite	Prevalance %	Mean Intensity	Abundance
		Examined	infected				
<i>Cyprinus carpio</i>	Male	91	1	1	1.0989	1	0.0109
	Female	169	3	3	1.7751	1	0.0177
<i>Hypophthalmichthys molitrix</i>	Male	80	3	4	3.75	1.3333	0.05
	Female	198	6	10	3.0303	1.6667	0.0505
<i>Labeo rohita</i>	Male	85	1	1	1.1764	1	0.0117
	Female	165	2	4	1.2121	2	0.0242
<i>Cirrhinus mrigala</i>	Male	170	0	0	0	0	0
	Female	60	1	1	1.6667	1	0.0167

4.4 Physical and Chemical Properties of Water

Table 5: Physical and chemical properties of water

Parameter	Physical		Chemical		Remark
Date	Temperature (°C)	Transparency (cm secchi disk)	Dissolved oxygen Concentration (mg/l)	ion oxygen (pH)	
April 2020	28.8	14.5	7.7	6.63	Free carbon dioxide (mg/l) 8.2

4.5 Length Wise Prevalence, Mean Intensity and Abundance of Argulus Parasite

Altogether 1018 fish samples of four different species viz; of *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Labeo rohita* and *Cirrhinus mrigala* with fish tail

number of 260, 278, 250 and 230 respectively were inspected and divided length wise into three group between 15- 45 cm. Smaller 15- 25 cm, medium 26- 35 cm and larger 36-45 cm sized fishes were grouped.

In *C. carpio*, bigger sized fish of length 36-45 cm showed the higher prevalence of parasite *Argulus* (6.6667%) and least in smaller sized fish (1.1764%). (Fig. 2)

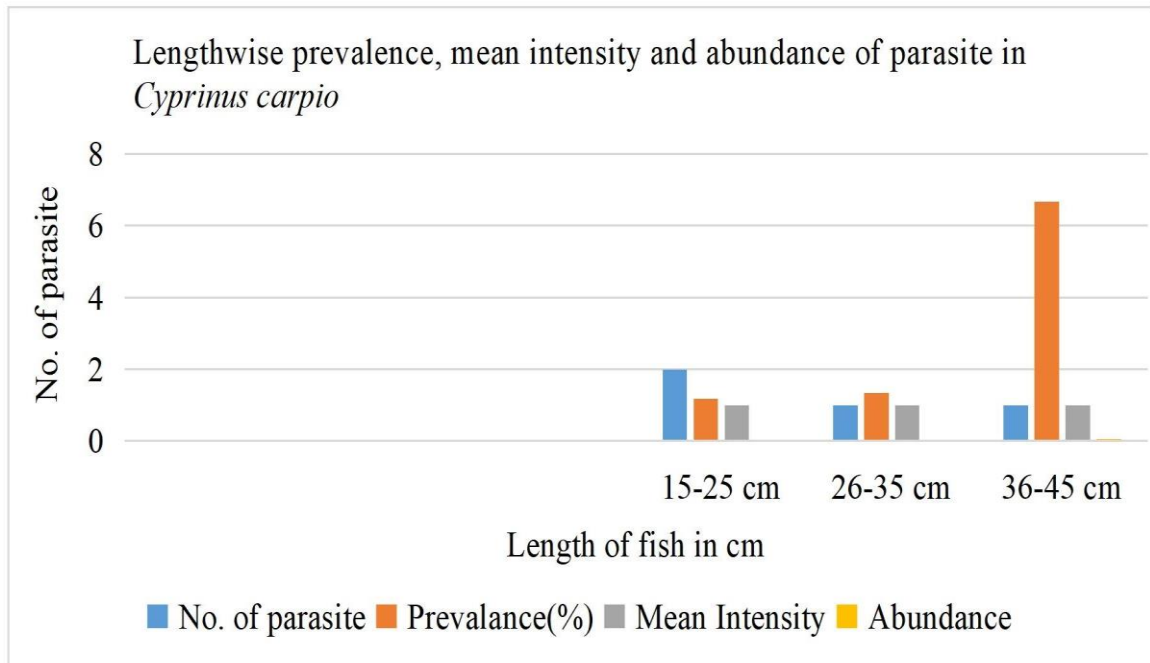


Figure 2: Lengthwise prevalence, mean intensity and abundance of parasite *Cyprinus carpio*

In *H. molitrix*, the *Argulus* prevalence, mean intensity and abundance was higher in medium sized (26-35 cm) fish; 8.5016 %, 1.6 and 0.0852 respectively and least in smaller sized (15-25 cm) fish i.e. prevalence 2.5316 %, mean intensity 1.3333 and abundance 0.0253. (Fig. 3)

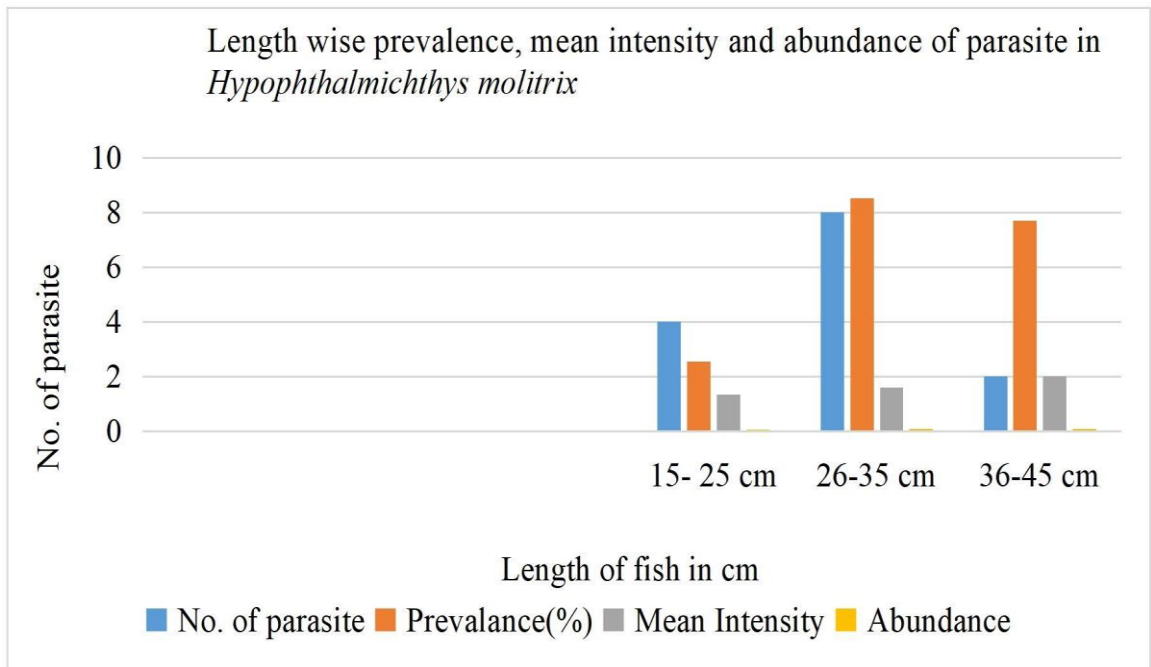


Figure 3: Length wise prevalence, mean intensity and abundance of parasite

The prevalence, mean intensity and abundance in *L. rohita* was also higher in medium sized (26-35 cm) fish; 2.5 %, 3, and 0.025 respectively and least in bigger sized (36-45 cm) fish; prevalence 1. 4285 %, mean intensity 1 and abundance 0.0142. (Fig. 4).

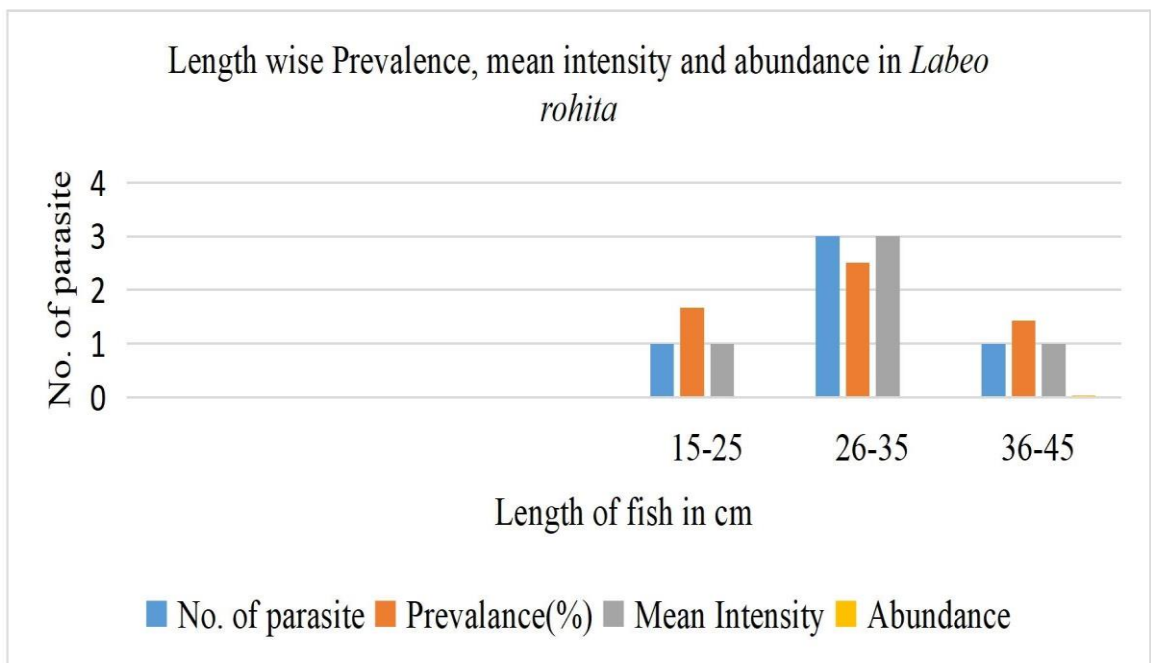


Figure 4: Length wise prevalence, mean intensity and abundance of parasite *Labeo rohita*

But in *C. mrigala*, *Argulus* parasite infection was found only in small sized fish (15-25 cm) and other higher group fish were nil. The prevalence, mean intensity and abundance was 1.0638 %, 1 and 0.0106 respectively. (Fig. 5)

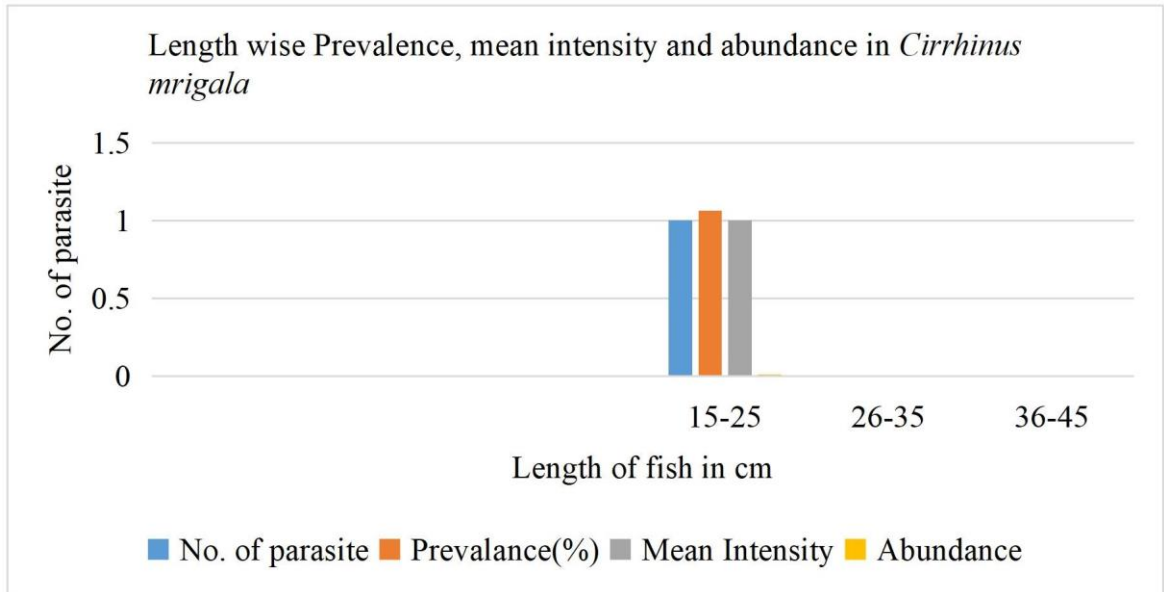


Figure 5: Length wise prevalence, mean intensity and abundance of parasite *Cirrhinus mrigala*

4.5 Weight Wise Prevalence, Mean Intensity and Abundance of *Argulus* Parasite

All the fish of four different species were weighed in gram in digital weighing machine and divided weight wise into three groups i.e. smaller sized fish 201- 400 gm, medium size 401- 600 gm and bigger size 601- 800 gm. The number of fish samples examined in small sized fish were 482 with parasite number 8 in 7 infected fish. Likewise the middle sized fish examined number were 371 with parasite number 12 in 7 infected fish. And the bigger sized fish examined number were 165 with parasite number 4 in 3 infected fish. The result showed that the highest prevalence, mean intensity and abundance was seen in medium sized fish (401- 600 gm) i.e. 1.8868 %, 0.0189 and 1.7143 respectively. The least prevalence, mean intensity and abundance was found in smaller sized fish (201- 400 gm) i.e. 1.4523 %, 0.0145 and 1.1429 respectively. (Fig. 6)

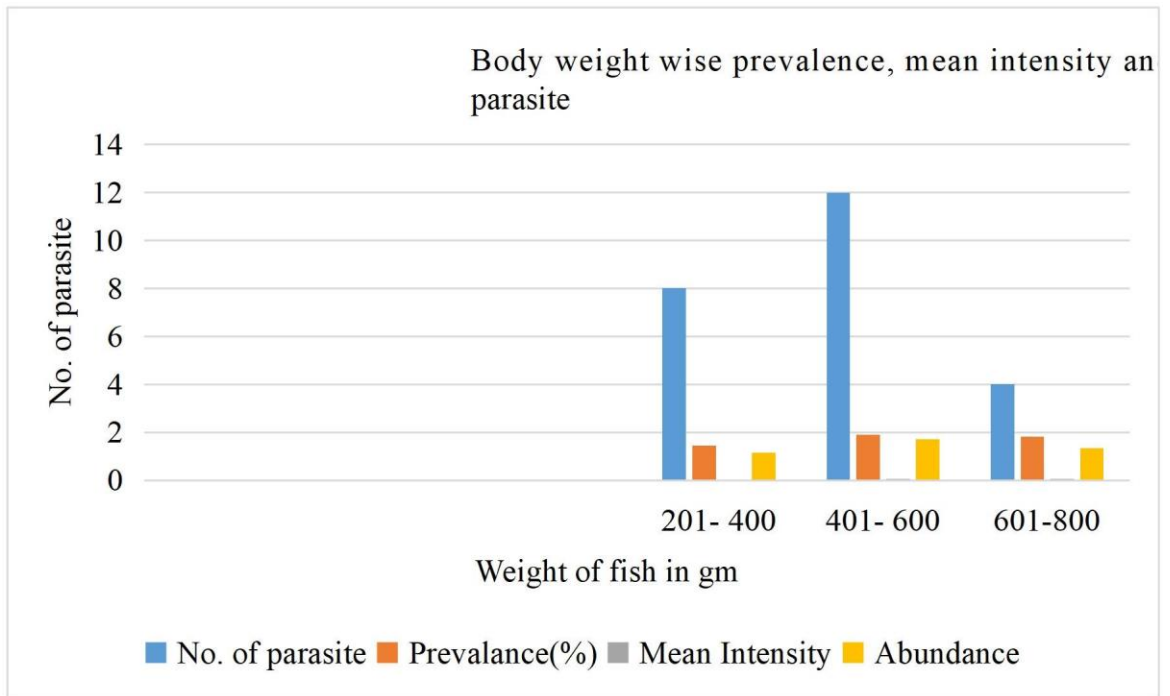


Figure 6: Body weight wise prevalence, mean intensity and abundance of parasite

5. DISCUSSION

Out of 1018 fish samples, 17 fishes were infected by *Argulus* parasite. The total number of parasite collected were 24 from different body parts of fish; pectoral fin, skin, chest, caudal fin and gill cover. According to sex, *H. molitrix* showed the more susceptible to the *Argulus* parasite as the higher number of parasite were collected from them. The prevalence, mean intensity and abundance of four fish species viz; *C. carpio*, *L. rohita*, *H. molitrix* and *C. mrigala* were examined according to the body size i.e. length in centimeter and weight in gram. The high prevalence were found in the fish of medium body size (> 25 cm and <35 cm) and least in smaller and larger body sized i.e. <25 cm and > 35 cm respectively. This result supported to the research of Jalali and Barzegar (2006), Bhuiyan *et al.* (2007), Ozan *et al.* (2008), Raisy *et al.* (2010), Upadhyay *et al.* (2011), Yakhchali *et al.* (2012) and Alom *et al.* (2019) and disagree with the result of Pojmanska and Chabros (1993) and Prasad *et al.* (2018) which reported that the high prevalence were in smaller group.

Among the four fish species the *H. molitrix* has highest prevalence of parasite in medium body size >25cm and <35 cm (8.5106%) and less in bigger size fish > 35 cm (7.6923%) and least in smaller size <25 cm (2.516%). (Fig. 2). This result supports to the research of Alsarakibi *et al* (2013) and disagree with the study of Kumar *et al.* (2018) which reported that *C. carpio* and *L. rohita* had higher prevalent by *Argulus* than other carp species. According the sex wise, the female fishes have higher prevalence than male fishes. (Table 3). This result supported to research of Alom *et al.* (2019).

In this study the *Argulus* parasite infestation was found high in pectoral fin region and this result disagree with the result of Rayamajhi *et al.* (2015) which resulted that high infestation on body surface. The parasite examination was done according to body weight in gram and found that the medium body weighed fish showed higher prevalence of 1.8868% (401- 600 gm), less in heavier and least in lighter fish; 1.4523% (601- 800 gm) and 1.8182% (201- 400 gm) respectively. (Fig. 5)

A lot of studies towards the effect of ecto-parasitic infestation in fishes have been carried out on the basis of seasonal variation and temperature fluctuation. This study was done in summer season earlier to pre- monsoon and was recorded low *Argulus*

infestation. This supported to the study of Mortuza *et al.* (2015), Alom *et al.* (2019) Das *et al.* (2016) suggested that rainy or monsoon as the possibility of maximum occurrence of parasitic infestation and minimum infestation in the winter season. Seasonal variations of argulids are influenced by temperature, dissolved oxygen concentration and water quality, size of the fish host and fish maturity. Amhed *et al.* (2009) and Kumar *et al.* (2018) suggested that ectoparasite are most susceptible in rainy season due to stocking density, water depth, temperature along with other physico-chemical parameters and management practices. During study time, the infected fish showed erratic and slow swimming, red blotches on skin, nervousness and scratch themselves (Jha, 2020, Das *et al.* 2016)

6. CONCLUSION

Branchiuran ectoparasites of the genus *Argulus* can have severe negative effects on cultured fish. Parasitic infestation can have serious problems in the field of aquaculture that effects on the growth, survival, and behaviours of fishes. The parasitic infestation rate were highest in medium sized fish followed by smaller and bigger size group. *Argulus* infestation has also been the major cause of concern and causing significant drawnacks to freshwater aquaculture in Nepal.

The present study has helped to know the status of infestation of *Argulus* spp. parasite in the cultured habitat at private fish farm. The study showed that the *Argulus* infestation in study area were low prevalence than expectation. The prevalence of *Argulus* was high in medium sized fish followed by smaller and bigger fish. This low prevalence than expectation may be due to good water quality parameters of pond, proper pond management and hygienic feeding procedures. This is possible through regular check up by the farm owner. Hence, this study gives suggestion to fish farmers to do proper pond management, hygienic and tidy feed stuffs and maintaining good water quality parameter to get rid of parasitic infestation like *Argulus* in fishes.

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PHOTOPLATES



Figure 7: Pond view of study area



Figure 8: Fish sample collection



Figure 9: Sample measurement and parasite examination



Figure 10: pH meter and DO meter

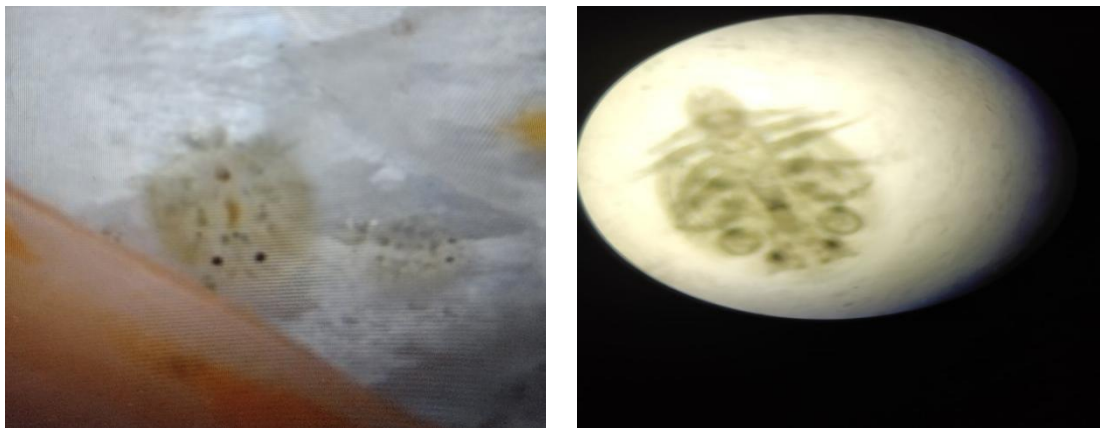


Figure 11: Argulus parasite in Silver carp and under 40X microscope