POPULATION DYNAMICS AND IMPACT OF HELMINTH PARASITES ON SOME FISHES OF RIVER GOMTI IN LUCKNOW, UTTAR PRADESH

SUMMARY OF

THESIS

SUBMITTED TO THE

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY

(A CENTRAL UNIVERSITY)

LUCKNOW

FOR THE AWARD OF DEGREE OF

Doctor of Philosophy

IN

APPLIED ANIMAL SCIENCES

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प्रज्ञा शील करुणा

ESTABLISHED 1996

DEPARTMENT OF APPLIED ANIMAL SCIENCES

SCHOOL FOR BIOSCIENCES AND BIOTECHNOLOGY

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Enrolment No. 215/11 **Year 2016**

Summary

Fish are a source of cheap but highly nutritive (protein rich) diet for the human beings. To get perfect nutrition it is necessary that fishes must be healthy and free from parasitic and other diseases. For the prevention of disease it is important to study the cause and nature of infection and disease in fish. Parasites are important group of pathogens, which occur at various stages of development in the fish.

The fishery industry plays an important role in the economy of India as, besides providing employment opportunities, it is a source of nutritional food and foreign exchange. Millions of people are employed in fishing industries and depend upon fisheries for their livelihood in various ways. In addition to those who directly catch the fishes for marketing; there are equally large number of people engaged in subsidiary industries like preservation, canning, transport, refrigeration and in the manufacture of fish products and bye-products. There are a variety of bye-products of fishes which are of great economic value, such as fish oil which is edible and used for industrial purposes (body oil), fish manure which is a very good concentrated organic manure for agricultural crop; fish meal which contain appreciable quantity of nitrogen and phosphate and is used as manure or feed for pig, cattle and poultry. Other important commercial byproduct of commercial value include: Ising glass which is a good substitute for gelatin, fish glue, leather soap, fish flour, fish sausages. Apart from these, fishes are used for ornamental purposes and forms a popular sports and game. Several species of fishes (*Puntius sophorus*, *Rasborada nicotious*, *Channa oriantalis* and *Mystus vittatus*) are known to be larvicidal in nature and are used in biological control of malaria and filarial diseases.

Thus, fishes are of immense importance not only as food, but also for their multiple commercial benefits. However, the fishes suffer from a variety of diseases, both parasitic and non-parasitic, which pose a severe constraint to fishery industry/ pisciculture. The infected/diseased fishes are short of life, weak and unable to lead a

normal life. Moreover, sometimes, the diseases make them sterile. The tumors and sores from infections/diseases also make the fish unfit for sale.

Thus, despite the fact that fish is the primary source of quality protein for humans in many parts of the world, especially in developing countries, the infection by parasites present a continual and unacceptable threat. The parasitic infections and diseases are detrimental to the well-being and economy of millions of people as well to domesticated, farmed and wild animals in all parts of the world.

Keeping these perspectives in view, the present study was undertaken to obtain quantitative data on the helminth fauna and their effects on the morphological and physiological parameters of five popular freshwater food fishes of River Gomti in Lucknow The fishes selected were *Channa punctatus, Heteropneustes fossilis, Mystus vittatus, Mastacembalus pancalus and Wallago attu* consumed by the rural population and commonly available in abundance all-round the year.

This study was broadly aimed at investigating the prevalence of helminth infection and other parameters of population dynamics viz., monthly variation, the intensity of infection, abundance of infection, effects of length, weight and sex on the burden of infection in the selected food fishes. The effects of heavy helminth infection on the haematological parameter of the fish as well as biochemical components of fish muscles infected with helminth parasites was also studied.

The present work was conducted to achieve the following objectives:

1. To study the population dynamics of helminths parasites of some common food fishes of river Gomti in Lucknow.
2. To investigate the relationships between prevalence of helminths parasites and body weight, body length and sex of the fishes.
3. To investigate the alterations in haematological parameters of the fishes infected with helminth parasites.

4. To investigate the alterations in biochemical parameters of the fishes infected with helminth parasites.

The investigations on the above objectives are briefly discussed below.

The first objective of the study dealt with the study of the population dynamics of helminth infections in the selected five common food fishes of river Gomti in Lucknow. The investigations were carried out on a total of 1491 fishes belonging to genus *Channa punctatus* (455), *Heteropneustes fossilis* (394), *Mystus vittatus* (263), *Mastacembalus pancalus* (227), *and Wallago attu* (152). These fishes were subjected to parasitic examinations and, out of the total, overall 293 fishes were found to be infected with different helminth parasites. A total of 156 out of 455 *C. punctatus*, 58 out of 394 *H. fossilis*, 36 out of 263 *M. vittatus*, 25 out of 227 *M. pancalus* and 18 out of 152 *W. attu* were found to be infected with various classes of the helminth parasites. The highest prevalence (34.28%) was observed in *C. punctatus*, followed by *H. fossilis* (14.72%), *M. vittatus*, (12.28%), *W. attu* (11.84%)and *M. pancalus* (11.01%). The parasites collected from different body parts of fishes belonged to the four major classes of helminths i.e. Cestoda, Trematoda, Nematoda and Acanthocephala. The cestode parasites were found in the intestines only in all the host fishes. Trematode parasites were collected from Liver, Stomach, Intestine, Body cavity of *C. punctatus*, Muscles of *H. fossilis*, Swim bladder of *M. vittatus*, and Oesophagus, Body cavity, Intestine, Swim Bladder, and Stomach of *M. pancalus;* and the Swim bladder of *W. attu*. Nematode parasites were collected from Intestine, Airbladder, Body cavity of *C. punctatus* and intestine of *H. fossilis*, *M. vittatus* and *W. attu*. Acanthocephalan parasites were collected from intestine of *C. punctatus* and *M. vittatus* only. Alimentary canal of the hosts was found to be the most infected with the helminth parasites, followed by Swim bladder and Body cavity.

In the present study, spanning through two years viz., 2013 and 2014, all the four major groups of helminth parasites i.e. Cestode, Trematode, Nematode and Acanthocephalan were found in *C. punctatus* and *M. vittatus* only. In *H. fossilis* and *W. attu* Cestode, Trematode and Nematode parasites were found while Acanthocephalan parasite was

not observed at all. While in *M. pancalus*, only Cestode and Trematode parasites were found while infection with Nematode and Acanthocephalan parasites was absent.

In *Channa punctatus*, the most prevalent (16.04%) parasite group was found to be the Acanthocephalan, followed by Trematode (12.08%), Nematode (4.39%) and Cestode (1.7%) groups. However, Trematode parasites were found to be most abundant (Abundance: 0.37) and least abundant parasitic group was the Cestodes (Abundance: 0.01) parasites. In *Heteropneustes fossilis*, Trematode parasites were found to be the most prevalent (9.89%) and abundant (0.52). The Trematode group was followed by Nematode (Prevalence: 2.79%; Abundance: 0.03) and Cestode (Prevalence: 2.03%; Abundance: 0.02). Acanthocephalan was not found at all in *H. fossilis*.

In *Mystus vittatus*, Trematode parasites were found to be the most prevalent (6.84%) and abundant (0.17). It was followed by Nematodes (Prevalence: 2.66%; Abundance: 0.03), Acanthocephalans (Prevalence: 2.28%; Abundance: 0.03) and Cestodes (Prevalence: 0.76%; Abundance: 0.007).

In *Mastacembalus pancalus* Trematode parasites were found to be the most prevalent (8.37%) and abundant (0.21). It was followed by Cestode parasites (Prevalence: 2.64%; Abundance: 0.02). Nematode and acanthocephalan parasites were not found at all in the fish.

In *Wallago attu*, Trematode parasites were found to be the most prevalent (4.60%) and abundant (0.11). The Trematode group was followed by Cestode (Prevalence: 3.94%; Abundance: 0.03) and Nematode (Prevalence: 3.28%; Abundance: 0.03). Acanthocephalan parasites were not found at all in *W. attu.*

The highest prevalence (3.94%) of Cestode parasites was observed in *W. attu* and least (0.75%) in *M. vittatus.* Trematode parasites were found highest (12.7%) in *C. punctatus* and least (4.60%) in *W. attu*. Nematode parasites were found maximum (4.61%) in *C. punctatus* and least (2.66%) in *M. vittatus.* It was not found at all in *M. pancalus*. Acanthocephalan parasites were found in *C. punctatus* (16.9%) and *M. vittatus* (2.28%) only. It was not found at all in *M. pancalus, H. fossilis* and *W. attu.*

Month wise prevalence of the helminth parasites in *Channa punctatus*

During 2013, the maximum prevalence i.e. 80.0% was recorded in the month of April, while the least prevalence i.e. 20.8% was recorded in the month of November. The intensity (8.0) was recorded maximum in August whereas minimum intensity (1.41) was reported in March. In the present investigation, highest density i.e. 2.0 was recorded in the month of August whereas lowest density of 0.45 was recorded in November.

During 2014, the highest percentage of helminth infection (45%) in fish was observed during the month of July and the least prevalence of the parasite (7.14%) was recorded in November. The maximum intensity of helminth parasites in fish *C. punctatus* was recorded as (4.44) in the month of July and minimum (1.33) in the month of December. The highest density of parasites (2.0) was observed in July whereas the minimum density of infection was recorded as 0.14 in the month of November.

Monthly variation of different groups of helminth parasitic infection in *Channa punctatus*

The fish *C. punctatus* were found to be heavily infected by helminth parasites belonging to the classes Cestode, Trematode, Nematode and Acanthocephalan. In the year 2013, a total of 248 helminth parasites were collected from the 102 infected fish of *C. punctatus*.

The maximum prevalence (10%) of Cestode parasites in fish *C. punctatus* was found in the month of March whereas the minimum prevalence (5%) was recorded in July. The fishes were found to be free of infection with Cestode parasites for most months of the year viz., January, February, April, May, June, August, September, October and November (Figure 5). In the months of March, July and December (maximum intensity of infection =1.0) the fish were found to be infected by the Cestode parasites only (Figure 6). In fish *C. punctatus*, the density of Cestode parasitic infection was recorded at peak (0.1) in the month of March whereas minimum density of infection i.e. (0.05) was recorded in month of July.

In case of infection by Trematodes, the maximum prevalence (45%) in fish *C. punctatus* was recorded in the month of April whereas the minimum prevalence (8.33%) was recorded in the month of November (Figure 5). The infection was not reported in the months of May and June, 2013. The maximum intensity of infection (9.75) was found in month of August whereas the minimum intensity of (1.0) was observed in the month of March (Figure 6). The density of infection with Trematode parasites was found highest (1.95) in the month of August whereas minimum density (0.12) of Trematode infection was reported in the month of November.

The prevalence of Nematode parasites in fish *C. punctatus* was recorded highest (25%) in month of July whereas minimum prevalence (4.16%) of the parasites was recorded in month of November. The infection was not reported during the months of January, February, April, May, August, and October. The maximum intensity of infection (1.0) was observed in month of March, September and December (Figure 6). The maximum density of infection (0.35) was recorded in month of June whereas the minimum density of infection (0.05) was recorded in months of March and September.

Studies on the prevalence of Acanthocephalan parasites in fish *C. punctatus*, showed that it had highest prevalence (35%) in the month of April and least (5%) in the month of August. The maximum intensity of infection (9.0) was observed in the month of December whereas minimum intensity of infection (1.0) was recorded in the months of July and August (Figure 6). The maximum density of infection (1.12) of acanthocephalan parasites was recorded in the month of December and least density of infection (0.05) was observed in the month of August.

In the year 2014, a total of 215 helminth parasites were collected from the 50 infected fish of *C. punctatus*. Overall Incidence of infection in fish with Cestode, Trematode, Nematode and Acanthocephalan parasites was found to be 1.86%, 6.51%, 3.72% and 13.0% respectively. The fish were found to be highly infected with Acanthocephalan parasites and least with Cestode parasites.

The maximum prevalence (8.3%) of Cestode parasites was recorded in the month of December whereas the minimum prevalence (5%) was recorded during the month of March, April and July (Figure 5). The infection of Cestode parasites was not reported in the months of January, February, May, June, August, September, October and November. The maximum intensity of Cestode infection (2.0) was recorded in month of April and minimum intensity of infection (1.0) was recorded in months of March, July and December (Figure 6). The maximum density of infection (0.10) was recorded in the month of April whereas the minimum density of infection (0.05) was recorded in months of March and July.

The maximum prevalence (15%) of trematode parasites in fish *C. punctatus* was recorded in the month of July and minimum (5%) in the months of February, March and April. The infection of trematode parasites in fish was not reported in the months of June, August and November (Figure 5). The maximum intensity of trematode infection (6.6) was recorded in the month of July and minimum intensity (1.0) was recorded in the months of April and September. The maximum density (1.0) of trematode infection was observed in the month of July and minimum density of infection (0.05) found during the month of April.

The prevalence of Nematode parasites in fish *C. punctatus* was recorded highest (10%) in the month of April whereas minimum prevalence of Nematode parasites (4.7%) was recorded in the month of October. The infection of Nematode parasites in fish was not reported during the months of May, July, September, November and December. The maximum intensity (2.0) of Nematode infection was recorded in the months of January, February, March and October whereas the minimum intensity of infection (1.0) was recorded during the months of June and August. The maximum density of infection (0.15) was recorded in the month of April and minimum density of infection (0.05) was recorded in the month of June.

The maximum prevalence (25%) of Acanthocephalan parasites in fish *C. punctatus* was recorded in the month of July whereas the minimum prevalence (7.1%) of parasites was found in the months of August, September and November. The maximum intensity

(4.0) of infection by Acanthocephalan parasites was recorded during the month of September whereas the minimum intensity of infection (1.0) was recorded in the month of December. The maximum density (0.95) of infection by Acanthocephalan parasites was found in the month of July and least density of infection (0.08) was observed in the month of December.

Month wise prevalence of the helminth parasites in *Heteropneustes fossilis* .

In 2013, the maximum prevalence (25%) was recorded in the month of June while the least prevalence (10%) was recorded in the months of January, April and October. The maximum intensity (6.75) was recorded in July whereas minimum intensity (1.0) was reported in the months of March, October and December. In the present investigation, the highest density (1.35) was recorded in the month of July whereas lowest density (0.10) was recorded in October.

In 2014, the highest percentage of helminth infection (33.33%) in fish was observed during the month of July and April and the least prevalence of the parasite (10.0%) was recorded in January and June. The highest intensity (6.0) and density (2.0) of helminth parasites in fish *H. fossilis* was recorded during the month of July whereas the minimum intensity (1.5) and density of infection (1.1) was recorded in the months of January and February respectively.

Monthly variation of different groups of helminth parasitic infection in *Heteropneustes fossilis*

The fish *H. fossilis* were found to be heavily infested by helminth parasites belong to class cestode, trematode and nematode.

In the year 2013, a total of 102 helminth parasites were collected from the 33 infected fish of *H. fossilis.* The fish were highly infected with trematode parasites and minimum with cestode parasites. An acanthocephalan parasite in fish was not reported in this year.

The maximum prevalence (5.2%) of cestode parasites in fish *H. fossilis* was found in the month of March whereas the minimum prevalence (4.3%) was recorded in September and October. The fishes were found to be free of infection with cestode parasites for most of the months in the year 2013 *viz.*, January, February, April, June, July, August, October and December. In the month of March, May, September and November maximum intensity of infection (1.0) with cestode parasites was recorded in the fish. The density of cestode parasitic infection was recorded highest (0.05) in the months of March and May whereas minimum density of infection (0.04) was recorded in months of September and November.

The prevalence of trematode parasites in fish *H. fossilis* was recorded highest (25%) in month of June whereas the minimum prevalence (4.3%) was recorded in months of September and November. The maximum intensity of infection (12.0) was found in month of November whereas the minimum intensity of (1.0) was observed in the month of March and October. The density of infection with trematode parasites was found highest (1.35) in the month of July whereas minimum density (0.05) of trematode infection was reported in the month of March and October.

The prevalence of nematode parasites in fish *H. fossilis* was recorded highest (10%) in the month of August whereas minimum prevalence (4.3%) of the parasites was recorded in months of September and November. The infection was not reported during the months of January, February, March, June and July. The maximum intensity of infection (2.0) was observed in month of April and May whereas the minimum intensity of (1.0) was observed in the month of August, September, October, November and December. The maximum density of infection (0.10) was recorded in months of April, May and August whereas the minimum density of infection (0.04) was recorded in months of September and November.

In the year 2014, a total of 106helminth parasites were collected from the 25 infected fish of *H. fossilis*. Overall prevalence of infection in *H. fossilis* with cestode, trematode and nematode parasites was found to be 2.3%, 10.52% and 1.75% respectively. The fishes were found to be free of infection with acanthocephalan parasites in the year

2014. The fish were found to be highly infected with trematode parasites and least with nematode parasites.

The maximum prevalence (10%) of cestode parasites was recorded in the month of February whereas the minimum prevalence (6.6%) was recorded during the months of April, August and September. The infection of cestode parasites was not reported in the months of January, March, June, July, October, November and December. The highest intensity of cestode infection (1.0) was recorded in months of February, April, and September. The maximum density of infection (0.10) was recorded in the month of February whereas the minimum density of infection (0.06) was recorded in months of April, August and September.

The prevalence of trematode parasites in *H. fossilis* was recorded highest (33.3%) in the month of July and minimum prevalence (5%) was recorded in the months of January and February. The maximum intensity of trematode infection (6.0) was recorded in the month of July and minimum intensity (2.0) was recorded in the month of January. The maximum density (2.0) of trematode infection was recorded in the month of July and minimum density of infection (0.1) observed during January.

The prevalence of nematode parasites in *H. fossilis* was recorded highest (6.6%) in the month of March whereas minimum prevalence of nematode parasites (5%) was recorded in the month of January and May. The infection of nematode parasites in fish was not reported during the months of February, April, June, July, August, September, October, November and December. The maximum intensity (2.0) of nematode infection was recorded in the month of May whereas the minimum intensity of infection (1.0) was recorded during the months of January and March. The maximum density of infection (0.50) was recorded in the month of January while minimum density of infection (0.06) was recorded in the month of March. The fishes were again found to be free of infection with acanthocephalan parasites in the 2014.

Monthly variation of total helminth parasitic infection in *Mystus vittatus.*

In 2013, the highest prevalence (30%) was recorded in the month of May while the least prevalence (5.88%) recorded in the month of August. The maximum intensity

(3.0) was recorded in August whereas minimum (1.0) was reported in months of February, June, July, and November. In the present investigation, highest density (0.6) was recorded in the month of May whereas lowest density (0.06) was observed in November.

In 2014, the highest percentage of helminth infection (27.27%) in *Mystus vittatus* was observed during the month of December and the least prevalence of the parasite (10%) was recorded in the months of March, May and October**.** The infection was not reported during the months of January, September and November. The maximum intensity and density of helminth parasites in *M. vittatus* was recorded as 4.0 and 0.40 during March and July respectively whereas the minimum intensity and density of infection was recorded as 1.0 and 0.2 in the months of December and May respectively**.**

Monthly variation of different groups of helminth parasitic infection in *Mystus vittatus*

The fish *M. vittatus* was found heavily infested by different group of helminth parasites *viz.* cestode, trematode, nematode and acanthocephalan. In the year 2013, a total of 33 helminth parasites were collected from the 19 infected fish of *M. vittatus*. The overall Incidence of infection with cestode parasites in fish *M. vittatus* was found to be 0.71%, 8.57% with trematode parasites, 2.14% with nematode and acanthocephalan parasites. It was observed that, the fish were highly infected with trematode parasites and minimum with cestode parasites.

The data of monthly variations of different groups of parasites in the year 2013 have been depicted in Table 11. The maximum prevalence (6.66%) of cestode parasites in *M. vittatus* was found in the month of July whereas the fishes were found to be free of infection with cestode parasites for most of the months in 2013 *i.e.* January, February, March, April, May, June, August, September, October November and December. In the month of July intensity of infection (1.0) with cestode parasites was recorded maximum. The highest density of cestode infection (0.06) was recorded in months of March and July.

The prevalence of trematode parasites in fish *M. vittatus* was recorded highest (20%) in May whereas the minimum prevalence (5.88%) was recorded in August. The infection was not reported in the month of June and November. The maximum intensity of infection (3.0) was found in the months of March, August and September whereas the minimum intensity (1.0) was observed in the month of February and July. The density of infection with trematode parasites was found highest (0.5) in the month of May whereas minimum density (0.06) of trematode infection was reported in the month of July.

The prevalence of nematode parasites in fish *M. vittatus* was recorded highest (12.5%) in February whereas minimum prevalence (6.25%) of the parasites was recorded in November. The infection was not reported during the months of January, March, April, August, September, October and December. The intensity of infection (1.0) was observed at peak in February, May and November. The maximum density of infection (0.12) was recorded in month of February whereas the minimum density of infection (0.06) was recorded in month of November.

In fish *M. vittatus*, the prevalence of acanthocephalan parasites was found highest (12.5%) in the months of March and June and least prevalence (6.66%) was recorded in September. The intensity of infection (1.0) was observed in the month of March, June and September. The maximum density of infection (0.10) of acanthocephalan parasites was recorded in the month of March and June and least density of infection (0.06) was observed in the month of September.

In the year 2014, a total of 30 helminth parasites were collected from the 17 infected fish of *C. punctatus*. Again, the overall Incidence of infection in fish with cestode, trematode, nematode and acanthocephalan parasites was found to be 0.81%, 4.87%, 3.25% and 2.43% respectively. The fish were found to be highly infected with trematode parasites and least with cestode parasites.

The highest prevalence (10%) of cestode parasites was recorded in the month of February. The infection of cestode parasites was not reported in the month of January, March, April, May, June, July, August, September, October November and December.

The highest intensity of cestode infection (1.0) was recorded in month of February. The density of infection (0.10) was recorded at peak in the month of February.

The prevalence of trematode parasites in fish *M. vittatus* was recorded highest (20%) in month of July and minimum (7.6%) in the month of April. The infection of trematode parasites in fish was not reported in the months of January, May, August, September and November. The maximum intensity of trematode infection (4.0) was recorded in the month of March and minimum intensity (1.0) in December. The maximum density (0.4) of trematode infection was recorded in the month of March and minimum (0.09) during the month of December.

The prevalence of nematode parasites in fish *M. vittatus* was recorded highest (9.09%) in the month of December whereas minimum prevalence of nematode parasites (6.6%) was recorded in the month of July. The infection of nematode parasites in fish was not reported during the months of January, February, March, May, August, September, October and November. The maximum intensity (2.0) of nematode infection was recorded in the month of July whereas the minimum intensity of infection (1.0) was recorded during the months of April, June and December. The maximum density of infection (0.13) was recorded in the month of July and minimum (0.07) in the month of April.

The prevalence of acanthocephalan parasites in fish *M. vittatus* was recorded highest (11.1%) in the month of August whereas the minimum prevalence (9.09%) was reported in the month of December. The maximum intensity (2.0) of infection by acanthocephalan parasites was recorded during the months of May and August whereas the minimum intensity of infection (1.0) was recorded in the month of December. The maximum density of infection (0.20) by acanthocephalan parasites was found in the months of May and August and least (0.09) was recorded in the month of December**.**

Monthly variation of total helminth parasitic infection in *Mastacembalus pancalus*

Month wise prevalence of the helminth parasites in *Mastacembalus pancalus* was also recorded in both years of the study and shown in Table 13. In 2013, the maximum prevalence (20%) was recorded in the months of April, August and December while the

least prevalence (8.33%) was recorded in the months of May and October. The infection was not reported during the months of June, September and November. The maximum intensity (4.5) was recorded in December whereas minimum intensity (0.1) was reported in the months of April and July. The highest density (0.90) was recorded in the month of December whereas lowest density (0.17) was recorded in months of July and October.

In 2014, the highest percentage of helminth infection (25%) in fish was observed in the month of April and the least prevalence (10.0%) was recorded in February and May**.** The infection of helminth parasites was not reported in the months of March, June, August and November. The maximum intensity and density of helminth parasites in *M. pancalus* was recorded as 3.67 and 0.92 during the month of April whereas the minimum percent intensity of infection (1.0) was recorded in the months in January, February and October and the minimum density of infection (1.1) observed in February**.**

Monthly variation of different groups of helminth parasitic infection in *Mastacembalus pancalus*

The fish *M. pancalus* were heavily infested by helminth parasites belong to the two classes Cestoda and Trematoda only.

In the year 2013, a total of 31 helminth parasites were collected from the 14 infected fish of *M. pancalus*. The overall Incidence of infection with cestode and trematode parasites in the fish was found to be 2.5% and 9.1% respectively. The infection of nematode parasites and acanthocephalan parasites in fish was not reported in this year. Higher infection of trematode parasites was observed in *M. pancalus.*

The maximum prevalence (10%) of cestode parasites was found in the month of April whereas the minimum prevalence (8.3%) was recorded in July. The fishes were found to be free of infection with cestode parasites for most months of the year viz. January February, May, June, August, September, October November and December. In the month of March, April and July maximum intensity of infection (1.0) with cestode

parasites was recorded**.** The density of cestode infection was recorded highest (0.10) in month of April whereas minimum density of infection (0.08) was observed in July.

The prevalence of trematode parasites was recorded highest (20%) in months of August and December whereas the minimum prevalence (8.3%) was recorded in months of May, July and October. The infection was not reported during the months of June, September and November. The maximum intensity of infection (4.5) was found in month of December whereas the minimum intensity of (1.0) was observed in the month of April and July. The density of infection with trematode parasites was found highest (0.9) in the month of December whereas minimum density (0.08) of trematode infection was reported in the month of July.

The fishes were found to be free of infection with nematode and acanthocephalan parasites in the year 2013.

In the year 2014, a total of 23 helminth parasites were collected from the 11 infected fish of *M. pancalus*. The overall incidence of infection in fish with cestode and trematode parasites was found to be 2.8% and 7.47% respectively. The fishes were found to be free of infection with nematode and acanthocephalan parasites in the year 2014 also.

The maximum prevalence (11.1%) of cestode parasites was recorded in the month of October whereas the minimum prevalence (8.3%) was recorded during April. The infection of cestode parasites was not reported in the months of February, March, May, June, July, August, September, November and December. The maximum intensity of cestode infection (1.0) was recorded in months of January, April and October. The maximum density of infection (0.11) was recorded in the month of October whereas the minimum density of infection (0.08) was recorded in April.

The maximum prevalence (16.6%) of trematode parasites in fish *M. pancalus* was recorded in April and minimum prevalence (10%) was recorded in the months of January, February and May. The infection of trematode parasites was not reported in the months of March, June, August, October and November. The maximum intensity of

trematode infection (5.0) was recorded in the month of April and minimum intensity (1.0) was recorded in the months of January, February and September. The maximum density (0.83) of trematode infection was recorded in the month of April and minimum (0.1) during the months of January and February.

M. pancalus were found to be free of infection with nematode and acanthocephalan parasites in the consecutive year 2014 also.

Monthly variation of total helminth parasitic infection in *Wallago attu.*

Monthly variations in helminth parasites was recorded in both years of the study and the results revealed that in the month of March, maximum prevalence (25%) was recorded while the least prevalence (14.28%) was recorded in the month of December. The fishes were found to be free of infection with helminth parasites for most months of the year *viz*. January, May, June, July, September and November. The maximum intensity (2.0) was recorded in April whereas minimum intensity (1.0) was reported in the months of February, March, August, October and December. In the present investigation, highest density (0.33) was recorded in the month of April whereas lowest density (0.14) was recorded in December.

In 2014, the highest percentage of helminth infection (33.33%) in fish was observed during the month of December and the least prevalence of the parasite (10.0%) was recorded in June**.** The infection was not reported during the months of January, August, September and November. The maximum intensity and density of helminth parasites in fish *W. attu* was recorded as 3.0 and 1.0 during the month of December whereas the minimum intensity of infection (1.0) was recorded in the months of April, May and July and minimum density of infection (0.17) was recorded in the months of May and July**.**

Monthly variation of different groups of helminth parasitic infection in *Wallago attu*

The fish *W. attu* were heavily infested by helminth parasites belonging to the classes Cestoda, Trematoda and Nematoda. In the year 2013, a total of 8 helminth parasites

were collected from the 7 infected fish of *W. attu*. The overall Incidence of infection with cestode, trematode and nematode parasites in *W. attu* was found to be2.85%, 4.28% and 2.85% respectively. The infection of acanthocephalan parasites in fish was not reported in this year. It was observed that, the fishes were found to be highly infected with trematode parasites.

The maximum prevalence (20%) of cestode parasites in fish *W. attu* was found in the month of February whereas the minimum prevalence (12.5%) was recorded in March. The fishes were found to be free of infection with cestode parasites for most months of the year viz., January, April, May, June, July, August, September, October November and December. In the month of February and March, intensity of infection (1.0) with cestode parasites was recorded in the fish. In fish *W. attu*, the density of cestode parasitic infection was recorded at peak (0.20) in February whereas minimum density of infection (0.12) was recorded in March.

The prevalence of trematode parasites in fish *W. attu* was recorded highest (16.6%) in months of April and October whereas the minimum prevalence (12.5%) was recorded in March. The fishes were found to be free of infection with trematode parasites for most months of the year viz., January, February May, June, July, August, September November and December. The maximum intensity of infection (2.0) was found in month of April whereas the minimum intensity (1.0) was observed in the months of March and October. The density of infection with trematode parasites was found highest (0.33) in the month of April whereas minimum density of trematode infection (0.12) was reported in March.

The prevalence of nematode parasites in fish *W. attu* was recorded highest (16.6%) in month of August whereas minimum prevalence (14.2%) of the parasites was recorded in December. The infection was not reported during the months of January, February, March, April, May, June, July, September, October and November. The highest intensity of infection (1.0) was observed in month of August and December. The maximum density of infection (0.16) was recorded in month of August whereas the

minimum density of infection (0.14) was recorded in December. The fishes were found to be free of infection with acanthocephalan parasites in the year 2013.

In the year 2014, a total of 21 helminth parasites were collected from the 11 infected fish of *W. attu*. The incidence of infection in fish with cestode, trematode and nematode parasites was found to be 4.87%, 4.87% and 3.65% respectively. The fishes were found to be free of infection with acanthocephalan parasites in this year. The fish were found to be highly infected with cestode and trematode parasites as compared to others and least infection of nematode parasites.

The maximum prevalence (20%) of cestode parasites was recorded in the month of April whereas the minimum prevalence (10%) was recorded during the February. The infection of cestode parasites was not reported in the months of January, March, May, June, August, September, October and November. The intensity of cestode infection (1.0) was recorded in months of February, April, July, and December. The maximum density of infection (0.20) was recorded in the month of April whereas the minimum density of infection (0.1) was recorded in February.

The prevalence of trematode parasites in fish *W. attu* was recorded highest (16.6%) in month of December and minimum prevalence (10%) was recorded in February. The infection of trematode parasites in fish was not reported during the months of January, April, May, June, July, August, September and November. The maximum intensity of trematode infection (5.0) was recorded in the month of December and minimum intensity (2.0) was recorded in the month of March. The maximum density (0.83) of trematode infection was recorded in the month of December and minimum density of infection (0.25) during March.

The prevalence of nematode parasites in fish *W. attu* was recorded highest (16.6%) in the month of May whereas minimum prevalence of nematode parasites (10%) was recorded in the month of June. The infection of nematode parasites in fish was not reported during the months of January, February, March, April, July, August, September, November and December. The maximum intensity (2.0) of nematode

infection was recorded in the month of June whereas the minimum intensity of infection (1.0) was recorded during the months of May and October. The maximum density of infection (0.2) was recorded in June while minimum density of infection (0.14) was recorded in October. The fishes were found to be free of infection with acanthocephalan parasites in the year 2014 also.

In the second objective of the study, investigations were made examine the relationship between prevalence of helminth parasites and the length, weight and sex of the five selected host fishes viz., *Channa punctatus, Heteropneustes fossilis, Mystus vittatus, Mastacembalus pancalus and Wallago attu* obtained from River Gomti, Lucknow. The observations on the relationships between the prevalence of helminth infection and the different morphological and sex parameters of the host fishes are briefly discussed below:

Relationship between the prevalence of helminth infection and length, weight and sex of *Channa punctatus*

The helminth infection in relation to size (length), weight and sex of host was analyzed. Out of 455 *Channa punctatus* examined, 156 were found to be infected by the helminthic parasites. Overall 34.28% of the fish were found to be infected with the helminth parasites which belonged to the groups Trematoda, Cestoda, Nematoda and Acanthocephala. The fishes were grouped according to their length into two class viz., class I (7 – 11.9 cm) and class II (12 – 16.9 cm) and examined for their parasitic load. The results are shown in Table 1, and Figure 1. In class I (7 - 11.9 cm) a total of 254 fishes were examined out of which 82 fishes were found to be infected with the helminthic parasites. The overall prevalence was observed to be 32.28% in the fishes with this range of length. In class II (12 – 16.9 cm) a total of 201 fishes were examined, out of which 74 fishes were found to be infected, showing an overall prevalence of 36.81%. Although a higher prevalence of infection was observed in fishes of Class II. The fishes were also grouped into different classes according to their weight viz., classes I (15 – 29.9g), class II (30 – 44.9g), class III (45 – 59.9 g), class IV (60 – 74.9g), class V (75 – 89.9 g) and class VI (90 – 104.9 g) and subsequently examined for

parasitic load. The results are shown in Table 2, figure 2. In class I (15 - 29.9 g) a total of 164 fishes were examined out of which, 39 fishes were found to be infected (Prevalence=23.78%). In class II (30 - 44.9 g) a total of 133 fishes were examined out of which 49 fishes were found to be infected (Prevalence=36.84%). In class III (45 – 59.9 g) a total of 87 fishes were examined, out of which 24 fishes were found to be infected (Prevalence= 27.58%). In class IV (60 – 74.9 g) a total of 39 fishes were examined, out of which 26 fishes were found to be infected (Prevalence =66.66%). In class V (75 – 89.9 g) only 27 fishes were examined, out of which 15 fishes were found to be infected with an overall prevalence of 55.55%. In class VI (90 – 104.9 g) there were only 5 fishes, out of which 3 fishes were found to be infected. The overall prevalence of infection in this Class VI was observed as 60.00%. The relation between prevalence of infection in *Channa punctatus* in relation to the sex of the host was also determined and the results are shown in Table 3, Figure 3. A total of 266 male fishes were examined, out of which 71 fishes were found to be infected (overall prevalence was (26.69 %). A total of 189 female fishes were examined out of which 85 fishes were found to be infected, depicting an overall prevalence of infection of 44.97%.

Relationship between the prevalence of helminth infection and length, weight and sex of *Heteropneustes fossilis*

The helminthic infection load in relation to size (length), weight and sex of host fish *Heteropneustes fossilis* was analyzed. A total of 394 fishes were examined, out of which, only 58 were found to be infected by the helminthic parasites. The prevalence of infection was observed to be 14.72%. The helminthes parasites isolated from this fish species belonged to classes Trematoda, Cestoda and Nematoda. Acanthocephalan parasites were not observed in any member of this species during the period of study. The fishes (non - infected and infected) were grouped in two classes according to their lengths viz., class I (10 – 14.9 cm) and class II (15 – 19.9 cm) and examined for parasitic infection. In class I, a total of 293 fishes were examined, out of which 42 fishes were found to be infected with the helminthes parasites. The overall prevalence was observed as14.33%. In class II (15 – 19.9 cm) a total of 101 fishes were examined, out of which 16 fishes were found to be infected giving an overall prevalence of

15.84%. A little higher prevalence of helminthes infection was found in the fishes of Class II. The *H. fossilis* fishes (non - infected and infected) were grouped into different classes according to their weight viz., class I (15 – 34.9g), class II (35 – 54.9g), class III (55 – 74.9 g), class IV (75 – 94.9g), class V (95 – 114.9 g) and class VI (115 – 134.9 g) and examined for their parasitic load. In class I (15 - 34.9 g) a total of 222 fishes were examined, out of which 30 fishes were found to be infected (Prevalence=13.51%). In class II (35 - 54.9 g) a total of 125 fishes were examined out of which 19 fishes were found to be infected (Prevalence=15.20 %). In class III (55 – 74.9 g) a total of 11 fishes were examined out of which 3 fishes were found to be infected (Prevalence= 27.27 %). In class IV (75 – 94.9 g) a total of 8 fishes were examined and were not found to be infected with any helminthic parasite. In class V (95 – 114.9 g) only 18 fishes were examined, out of which 4 fishes were found to be infected, with an overall prevalence of 22.22%. In class VI (115 – 134.9 g) only 10 fishes were examined out of which 2 fishes were found to be infected (overall prevalence of infection was observed as 20.00%.The relation between prevalence of infection and sex of *H. fossilis* was also studied in which, out of a total of 233 male fishes examined, 30 were found to be infected by helminthes. The overall prevalence was found to be 12.87 %. In the same study, a total of 161 female fishes were examined out of which 28 fishes were found to be infected, with an overall prevalence of infection of 17.39 %.

Relationship between the prevalence of helminth infection and length, weight and sex of *Mystus vittatus*

Studies on the relationship between the prevalence of helminthic infection and size (length), weight and sex of host fish *Mystus vittatus* was analyzed, and out of a total of 263 fish examined, 36 were found to be infected by the helminth parasites with an overall prevalence of 13.68%. The helminth parasites isolated belonged to the classes Trematoda, Cestoda, Nematoda and Acanthocephala. The fishes were grouped into two classes in accordance to their length viz., class I (5 – 9.9 cm) and class II (10 – 14.9 cm) and examined for their parasitic load. In class I (5- 9.9 cm) a total of 251 fishes were examined out of which 34 fishes were found to be infected with the helminth parasites. The overall prevalence observed was 13.54% in the fishes with this range of length. In

class II (10 – 14.9 cm) a total of 12 fishes were examined, out of which 02 fishes were found to be infected with an overall prevalence of 16.66%. Higher prevalence of infection was found in Class II. The fishes were also grouped into different classes according to their weight viz., class I (15 – 24.9g), class II (25 – 34.9g), class III (35 – 44.9 g) and examined for the status of infection by the helminthes parasites. In class I (15 - 24.9 g), a total of 114 fishes were examined, out of which, 18 fishes were found to be infected (Prevalence=15.78%). In class II (25 - 34.9 g), a total of 137 fishes were examined and out of these 16 fishes were found to be infected (Prevalence= 12.40 %). In class III (35 –44 .9 g) a total of 12 fishes were examined out of which 02 fishes were found to be infected (Prevalence= 16.66 %). Prevalence of infection in *M. vittatus* was also studied according to the sex of the host. Out of a total of 152 male fishes examined, 17 fishes were found to be infected, with the overall prevalence of 11.18 %. Whereas, out of a total of 111 female fishes examined, 19 were found to be infected with the helminthes parasites (prevalence of infection of 17.11%).

Relationship between the prevalence of helminth infection and length, weight and sex of *Mastacembalus pancalus*

The helminth infection load in relation to size (length), weight and sex of host fish *Mastacembalus pancalus* was studied and a total of 227 fishes were examined, out of which, 25 were found to be infected by the helminth parasites. An overall prevalence of 11.01% was observed, and the isolated helminthes parasites belonged to classes Trematoda, and Cestoda only. No nematode or acanthocephalan parasites were observed. The fishes were grouped into two classes according to their length viz., class I (10-14.9 cm) and class II (15- 19.9 cm) and examined for parasitic infection. In class I (10-14.9 cm) a total of 205 fishes were examined out of which 23 fishes were found to be infected. The overall prevalence was observed as 11.21% in the fishes with this range of length. In class II (15-19.9 cm) a total of 22 fishes were examined, out of which 02 fishes were found to be infected with an overall prevalence of 9.09%. The fishes were grouped into different classes according to their weight viz., class I (15 – 29.9gm), class II (30 – 44.9gm), class III (45 – 59.9 gm) and examined for infection by helminth parasites**.** In class I (15 - 29.9 gm), a total of 147 fishes were examined out of

which 19 fishes were found to be infected (Prevalence=12.92%); in class II (30 - 44.9 gm) a total of 65 fishes were examined out of which 4 fishes were found to be infected (Prevalence=6.15%).; and in class III (45 – 59.9 gm) a total of 15 fishes were examined out of which 02 fishes were found to be infected (Prevalence= 13.33%).The prevalence of infection in *M. pancalus* was also studied in accordance to the sex of the host fish. A total of 129 male fishes were examined, out of which 13 fishes were found to be infected by the helminth parasites. The overall prevalence of infection was found to be 10.07%. In case of the total of 98 female fishes examined, 12 were found to be infected with an overall prevalence of infection of 12.24%.

Relationship between the prevalence of helminth infection and length, weight and sex of *Wallago attu*

The helminth infection in relation to size (length), weight and sex of host fish *Wallago attu* was studied and out of a total of 152 fishes examined, 18 were found to be infected by helminth parasites. The overall prevalence of infection observed was 1.84%. Three helminth parasitic classes were identified: the Trematoda, Cestoda and Nematoda. The fishes were grouped into two classes according to their lengths viz., class I (15 – 24.9 cm) and class II (25 – 34.9 cm) and examined for infection by helminthes parasites. In the length class I (15 - 24.9cm), a total of 79 fishes were examined, out of which 07 fishes were found to be infected. The overall prevalence was 8.86%. In the length class II (25 – 34.9cm), a total of 73 fishes were examined out of which 11 fishes were found to be infected. The overall prevalence was 15.06%. Higher prevalence of infection was observed in Class II as compared to class 1. The fishes were grouped into different classes according to their weights viz., class I (38 – 97.9g), class II (98 – 157.9g), class III (158 – 217.9g) and examined for helminthes infection. In class I (38 - 97.9 g), a total of 118 fishes were examined out of which 13 fishes were found to be infected. The overall prevalence was 11.01%. In class II (98 - 157.9 g) a total of 18 fishes were examined out of which only one fish was found to be infected. The overall prevalence was 5.55% and in class III (158 – 217.9 g) a total of 16 fishes was examined out of which 04 fishes were found to be infected by the helminthes. The overall prevalence was found to be 25%. The fishes were grouped according to their sex and examined for

the infection by helminth parasites. Out of a total of 89 male fishes examined, 11 were found to be infected giving an overall prevalence of 12.35%. A total of 63 female fishes were examined in which 07 fishes were found to be bearing the helminthes infection.

The Third objective of the present study dealt with the study of the alterations in haematological parameters of the fishes infected with helminth parasites as this is one of the most reliable tools for diagnosis of disease of the fishes. Changes in the fish haematological indices are physiological indicators to changing external environments due to their close relationships with energetic (metabolic levels), respiration (haemoglobin) and defence mechanisms (leukocyte levels) in the host. The three food fishes selected for examination were those that reported higher burdens of the helminth parasites in the present study. These fishes were *Channa punctatus, Heteropneustes fossilis* and *Mystus vittatus*. The remaining two fishes, *Mastacembalus pancalus* and *Wallago attu* showed very poor infection levels and, therefore, were not considered for this study.

Changes in Blood parameters of non-infected and naturally infected *Channa punctatus* :

The total red blood corpuscle (RBC) count observed in the non-infected *Channa punctatus* was 3.51 ± 0.44× $10^6/\ mm^3$ and in the infected fish, it was 2.31 ± 0.46 × $10^6/mm^3$. Data shows that RBC value was decreased significantly ($P < 0.001$) in helminths infected fishes as compared to non-infected fishes. The total white blood corpuscle (WBC) count observed in the normal fish was 38.84 ± 4.95 × $10^6/\ mm^3$ and in the infected fish was 43.55 ± 5.00 × $10^6/\ mm^3$. The value was found to be significantly increased ($P < 0.01$) in infected fishes. The haemoglobin content observed in the normal fish was 8.55 ± 1.49 gm/dl and in the infected fish was 6.28 ± 2.26 gm/dl. The Hb concentration was found to be significantly decreased ($P< 0.001$) in infected fish in comparison to normal fish. The PCV value observed in the normal fish was 30.93 ± 3.32 % and in the infected fish was 28.93 ± 3.31%. The average value showed that this concentration was decreased in infected fish in comparison to normal fishes, however, the difference was found to be statistically insignificant ($P > 0.05$). The MCV

value observed in the non-infected fish was 88.84 ± 10.11 and 127.31 ± 12.90 in the infected fish. The difference in the MCV was found to be highly significant (P < 0.001).The mean value of MCH was recorded 43.43 ± 6.59 in infected fishes which was also found to be increased significantly (P < 0.001) when compared to non-infected fishes. The MCHC was observed in the normal fish was 35.90 ± 2.52 and in the infected fish was 33.97 ± 2.33. The observed values represent that MCHC value was decreased significantly (P <0.05) in helminth infected fishes as compared to non-infected *Channa punctatus*.

Changes in Blood parameters of non-infected and naturally infected *Heteropneustes fossilis*:

The total red blood corpuscle (RBC) count observed in the normal fish was 3.89 ± 0.28× $10^6/\ mm^3$ and in the infected fish was 2.77 ± 0.24 × $10^6/mm^3$. The value was found to be decreased significantly (P < 0.001) in infected fishes as compared to non-infected *Heteropneustes fossilis.* The total white blood corpuscle (WBC) count observed in the normal fish was 14.93 ± 2.35 × $10^6/\ mm^3$ and in the infected fish it was found to be increased to 19.89 ± 2.30 × $10^6/mm^3$ which was statistically significant (P < 0.001). The haemoglobin content observed in the normal *Heteropneustes fossilis* was 10.64± 1.73 gm/dl and in the infected fish was 8.47± 1.28 gm/dl. The mean value shows that the haemoglobin content in infected fish was significantly decreased (P < 0.001) when compared to the non-infected fish. The PCV value observed in the non-infected fish was 36.42 ±1.73 % and in the infected fish, it was 32.84 ± 1.85 %. The average value showed that the PCV was significantly decreased (P < 0.001) in infected fish in comparison to non-infected fishes. The MCV values observed in the non-infected fish was 93.62 ± 2.67 and 118.72 ± 6.67 in the infected fish. The higher MCV in the infected fish was found to be statistically significant (P < 0.001). The mean value of MCH was recorded 42.83 ± 2.46 in infected fishes which was found to be significantly increased (P < 0.001).The mean MCHC value observed in the normal fish was 35.99 ± 1.06 while in the infected fish it was 36.07 ± 0.59. However, the difference was statistically non- significant (P >0.05).

Blood parameters of non-infected / naturally infected *Mystus vittatus*:

The total red blood corpuscle (RBC) count observed in the normal fishes was 2.01 ± 0.20 × 10^6/ mm^3 and in the infected fish was 1.26 ± 0.27 × 10^6/mm^3. The difference in the mean value was found to be statistically significant (P < 0.001) when comparison was made between infected and non-infected *Mystus vittatus.* The total white blood corpuscle (WBC) count observed in the non-infected fish was 22.07 ± 1.76 × 10^6/ mm^3which was significantly highly increased (27.55 ± 1.81 × 10^6/mm^3) in the infected fish (P < 0.001). The haemoglobin content observed in the non-infected fish was 9.67±0.85 gm/dl and in the infected fish, it was 8.25± 1.38 gm/dl. The mean value shows that Hb concentration was decreased significantly (P<0.001) in infected *Mystus vittatus.* The PCV value observed in the non-infected and infected fish was 17.31 ± 1.57 % and 12.52± 1.45 % respectively. The difference in the mean value was found to be highly significant (P < 0.001) statistically. The MCV value observed in the non-infected fish was 95.10 ± 8.66 and 101.40 ± 11.45 in the infected fish. However the difference in the values was not statistically significant (P >0.05). The mean value of MCH was recorded 72.90 ± 11.90 in infected fishes. It was found that the mean value of MCH was highly increased significantly (P < 0.001) in the infected fish as compared to the non-infected fish. The MCHC value observed in the non-infected fish was 57.13 ± 2.56 and in the infected fish, 71.55 ± 4.55 which was statistically very significant (P <0.001).

The fourth objective of this study was concerned with the investigations on the alterations in the biochemical parameters of the fishes bearing high burden of helminth parasites. The helminth parasites and their cysts cause damage by depriving the hosts of digested food and by feeding on host tissues, sera, or blood, thereby degrading their nutritive value. In the body of the fish, the cysts of the helminth parasites are located in the body cavity, intestine or embedded in the muscle, while the unencysted larvae migrate under the skin and in the muscles, causing extensive inflammation and necrosis. Further encystation occurring in the viscera, namely liver, spleen, or gonads causes severe pathologic changes in the adjacent tissue. Therefore, it was considered worthwhile to examine the changes in the blood and tissue biochemical parameters with

respect to the helminth infections. The observations made during the present study are briefly outlined below.

Tissue biochemical estimations of host fishes.

The tissues from 20 infected host fishes each belonging to *Channa punctatus*, *Heteropneustes fossilis* and *Mystus vittatus* were individually subjected to biochemical studies in order to evaluate the levels of protein, glycogen and lipid during natural infection by helminthes parasites.

Tissue protein in host fishes

In *Channa punctatus* the total protein level observed in the infected fish was 105.0 ± 1.81 mg/g and in the non-infected fish, it was 115.4 ± 0.60 mg/g. The total protein level was found to be decreased significantly ($P<0.01$) in the helminthes infected fishes as compared to the non-infected fishes. In *Heteropneustes fossilis*, the total protein level observed in the infected fish was 90.1 ± 5.4 mg/g and in the non-infected fish was 96.5 ± 1.6 mg/g. The difference in total protein content in infected and non-infected *H. fossilis* was found to be statistically significant ($P<0.01$).In *Mystus vittatus* the total protein observed in the infected fish was90.1 ± 1.2 mg/gm and in the non-infected fish was 100.8 ± 5.4 mg/g. The difference in total protein content in infected and non-infected *M. vittatus* was found to be highly significant ($P < 0.001$).

Tissue glycogen in host fishes

In *Channa punctatus* the glycogen levels observed in the non-infected fish and infected fish was 2.56 ±0.01mg/gm and 1.29 ± 0.39 mg/g respectively. The average values showed that the glycogen level was very significantly decreased in the infected fish ($P < 0.001$).In *Heteropneustes fossilis* the glycogen level observed in the infected fish was much lower (2.1 ± 1.5 mg/g) as compared to the levels in the non-infected fish (3.5 ± 1.6 mg/g). The difference in glycogen levels in the two groups was highly significant ($P < 0.001$).In *Mystus vittatus* the mean value of glycogen was recorded 2.8 ± 0.12 mg/g in infected fishes and 4.7 ± 0.12 mg/gm in non-infected fish, and the decreased levels in

the infected fish was statistically significant (P < 0.001) when compared to the non-infected fish.

Tissue total lipids in host fishes

In *Channa punctatus,* the observed level of total lipids in the infected fish (9.8 ± 0.13 mg/g) was significantly (P <0.001) lower than in the non-infected fish (12.6 ± 0.09 mg/g). In *Heteropneustes fossilis* the total lipids observed in the non-infected fish was 11.0 ± 0.18 mg/g and in the infected fish, it was 9.8 ± 0.73 mg/g. The decrease in the tissue total lipid content in the infected fishes was found to be significant (P<0.01), In *Mystus vittatus* the total lipid value observed in the non-infected fish was 29.5 ± 1.0mg/g and in the infected fish was 27.3 ± 0.78 mg/g. The average value showed that this level was decreased significantly (P < 0.001) in the infected fish.

Blood biochemical estimations in host fishes.

The blood sera of 20 naturally infected host fishes was subjected to biochemical study in order to evaluate the protein and glucose levels in the naturally infected *Channa punctatus, Heteropneustes fossilis* and *Mystus vittatus* as. These fishes were selected as they showed higher burden of helminthes parasites during the study period.

Serum total proteins in the host fishes

In *Channa punctatus* the serum total protein was estimated as 4.25 ± 0.38mg/dl and 3.07 ± 0.36mg/dl for non-infected fishes and infected fishes respectively. In *Heteropneustes fossilis*, the serum total protein content in non-infected fishes was higher (4.26 ± 0.80mg/dl), while in the infected fishes it was 3.15 ± 1.01mg/dl. In *Mystus vittatus*, the serum total protein content in non-infected fishes is 4.64 ± 0.98mg/dl and in infected fish it was estimated at 3.10 ± 0.67mg/dl. The results showed that, in all the fishes examined, the total protein content in serum was found to be significantly decreased (P<0.001) in the infected fishes as compared to the non-infected ones.

Serum glucose in host fishes

In *Channa punctatus* the serum glucose levels observed in the non-infected and infected fishes was 57.92 ± 4.48mg/dl and 72.99 ± 7.91mg/dl respectively. In *Heteropneustes fossilis*, the blood glucose level observed in the infected fishes (126.34 ± 16.71mg/dl) was found to be significantly increased ($P<0.01$) when compared to non-infected fishes (105.78 ± 31.27mg/dl). Similarly, in *Mystus vittatus* the blood glucose level observed in the infected fishes (120.58 ± 16.33mg/dl) was found to be significantly increased ($P<0.001$) when compared to non-infected fishes (85.72 ± 14.33mg/dl). The results shows that the glucose content was increased significantly ($P < 0.001$) in the helminth infected fishes when compared to non-infected healthy fishes.