Histopathology
It is now generally agreed that fish parasites may harm their hosts in a variety of ways. Such pathogenic relationships have been discussed by many workers.

For a long time, the importance of helminths as pathogens was not recognized and the serious damage to their fish hosts caused by them was not properly appreciated. This was perhaps largely due to the fact that common symptoms of helminthiasis are not always sufficiently spectacular to attract immediate attention. In recent years, however, there has been a gradual realization of the importance of these helminths as a factor damaging their hosts. A considerable amount of work has been done along these lines during the last two decades and useful information on the occurrence of these helminth in fishes is available.

The literature on helminths as potential pathogens of fishes is vast. The present review is an attempt to summarize the most important contributions in which cysts of trematode parasites are alleged to have had harmful effects on fishes. This aspect will probably form an important part of all future work on fish diseases.
Pathology is generally defined as the basic alterations in tissues as a result of the disease involving changes common to all tissues and organs and histopathology involves the examination of stained preparations of tissues under the microscope. General pathology and histopathology caused by metacercarial cysts have been studied. It has been seen that cysts of digenetic trematodes like *Fibricola* sp. frequently parasitize fish and because of their unique-host-parasite relationship, are responsible for causing damage to their hosts.

While considerable progress has, therefore, been made on helminths diseases of man and domestic animals the actual nature and course of similar diseases in fish have remained completely unexplored. An inevitable result of an increasing interest in fish culture as a potential source of extra food will be the need for investigations of fish diseases.

Most of the earlier workers dismissed helminths as being of little or no importance as pathogens of fish, but a number of recent text books and papers, especially those as have appeared since 1950, give greater prominence to this field of parasitology. These trematode parasites harm their hosts by causing mechanical injury or tissue
proliferation, degeneration and inflammation which may result in the atrophy of the host tissue. They deprive the fish of its food which in acute cases may result in its death. Denisov (1979) studied the pathogenic effects of *Posthodiplostomum cuticula* on silver carp. Duke (1975) studied the opthalmic pathology of fishes. Other workers who worked in this direction are: Thomas (1964); Smitherman Jr. (1964); Smitherman, R.O. (1968); Millemann and Knapp (1970); Pense and Child, Shigin (1971); Ridgway and Dailey (1972); Haffman (1973, 1975); Yoshina (1976); Crowden (1976); Grevtseva (1977) and Bose and Sinha (1979).

In the present investigations the histopathology of liver of fish host *Belone cancila* (Hamilton), infected with metacercarial cysts of *Pribicola indicus* has been studied.

**OBSERVATIONS**

**HISTOLOGY OF FISH LIVER**

The liver is encased within a fibroconnective tissue capsule. Histologically it includes exocrine pancreatic tissue that surrounds all of the portal vein and anastomosing bilaminar meshwork of hepatocytes that comprises the basic functional hepatic units. The hepatocytes are polygonal and have a distinct nucleus with densely staining chromatin margins and a prominent nucleolus. Liver sinusoids are irregularly distributed between the polygonal hepatocytes, are fewer in number and are lined by endothelial cells with prominent nuclei.
In transverse section, liver sinusoids are bordered by five to eight hepatocytes and separated by at least two hepatocytes. These vascular spaces are lined by reticuloendothelial cells that lie atop a fine network of reticular fibres. Venous blood that enters the liver via the portal vein eventually flows through these sinusoids and collects in the central veins before existing via the hepatic veins to the sinus venosus of heart. There is no lamina for the collection of bile. Bile canaliculi are formed between adjacent hepatocytes and are connected to larger bile ducts. These ducts may occur within the parenchyma or in association with the exocrine pancreas of liver. They are lined by a low cuboidal epithelium and surrounded by a thin layer of fibrous connective tissue. The smaller bile ducts become connected with the larger common bile duct before the latter emerges from the liver (Fig. 34).

**HISTOPATHOLOGY**

The effect of metacercariae upon their hosts is largely dependent on whether or not they encyst. In those species where relatively short migratory distances are covered by cercariae and encystment occurs fairly rapidly, relatively little damage to host tissues takes place. The metacercariae under such circumstances, do not feed by the ingestion of host tissue and the only effect upon the host is the stimulation of
an inflammatory response (Cheng et al., 1966a). The inflammatory responses in fish may become associated with abnormal pigmentation at the site of the metacercarial cysts. Digenean metacercaria especially those of the strigeids are often found, sometimes in very large numbers, encysted in the viscera and musculature of fish. Often they cause little obvious harm to their hosts although they may give the fish an unaesthetic appearance.

In the present studies on infected liver of freshwater fish, Belone cancila with metacercaria (encysted form) the liver does not show the diversity of pathology due to the absence of Kupffer cells in the liver sinusoids. In the present observations the parasite lesions have been observed throughout the tissue. These parasites have stimulated a wide range of responses varying from a mild inflammatory infiltrate to an extremely acute necrotizing lesions which can be fatal (Pmg.41). This acute inflammatory episode followed by encystment and fibrosis (Pmg. 41,42,43).
Hoffman and Hutcheson (1970) observed effect of digenean species, *Posthodiplostomum minimum* on centrarchid and cyprinid fish to be dangerous to their fish host, *Ichtyocotylurus erratius*, which is found encysted in the pericardial cavity, has apparently caused severe loss of condition in wild populations of coregonids in the USSR (Petrushevski and Shulman, 1961). The metacercaria of *Clinostomum marginatum*, the 'yellow grub' causes considerable damage to the viscera and musculature of many fish species (Hoffman, 1967). Most of these species have piscivorous birds as their final host. So in general our observations are almost in accord with these workers who found that these metacercaria causing severe damage to all tissues of the fish.
CONCLUSIONS

1. The liver of fishes does not show the diversity of pathology due to the absence of Kupffer cells in liver sinusoids.

2. The metacercaria of *Fibricola indicus* invades the liver sinusoides and causes severe necrotizing lesions which are followed by encystment and fibrosis.
SUMMARY

In this thesis are described twenty seven species of trematode parasites belonging to seventeen genera under thirteen families. Of these five are new to science and the rest already known. Each new species has been described and its validity in relation to already known species discussed. Keys to the species of three genera have been formulated to accommodate the new species.

With regard to already known species, their intra-specific variations have been noted. For nine species new hosts records are given.

Further histochemistry of tegument and parenchyma of two trematodes and cyst wall of metacercaria of Fibricola indicus has been made.

Histopathology of liver of Belone cancila in relation to metacercaria of F.indicus is also given.

Taxonomy

Helostomatis deroe sp.nov. from Labeo dero (Hamilton)

Acetabulum not lobed; intestinal caeca of equal length; testes equal, larger than ovary, symmetrical, opposite to each other and not lobed; ovary unlobed; genital pore median;
vitelline follicles sparsely distributed extending from the level of oesophageal bulb to the blind ends of intestinal caeca.

**Helostomatis nanagalensis** sp. nov. from *Labeo calbasu* (Hamilton)

Acetabulum not lobed; testes not lobed, obliquely placed, ovary not lobed larger than testes; genital pore median; vitelline follicles are compactly arranged extending from level of oesophageal bulb to blind end of intestinal caeca.

**Fibricola indicus** sp. nov. from *Belone cancila* (Hamilton)

This is the first record of the genus *Fibricola* from India.

Ovary bilobed, median, just behind the tribocytic organ; vitelline follicles extending up to the level of intestinal fork; ventral sucker situated at 50-52/100 of the anterior segment.

**Neobucephalopsis vachae** sp. nov. from *Eutropiichthys vacha* (Hamilton)

Tegument aspinose; testes on one side of cirrus sac; cirrus sac extends up to anterior testis; ratio between body length and cirrus sac 1:3; ovary median; uterus and vitelline follicles extend up to level of posterior aspect of rhynchus.
**Eumasenla heteropneustus** sp. nov. from *Heteropneustis fossilis* (Bloch).  
Oral sucker not funnel shaped, with double circumoral crown of spines interrupted dorsally; excretory bladder - Y-shaped; lateral prostatic diverticulum present; genital pore anterior to oral sucker.

**Bucephalopsis karvei** Dayal, 1939 from *Belone cancila* (Hamilton)  
Intraspecific variations in the size of the body and its organs have been noted cirrus sac is either half or less than half of the body length and not more than half of the body length.

**Bucephalopsis singhai** Dayal, 1948 from *Eutropiichthys vacha* (Hamilton).  
In the present specimens the two testes are not proximate and the uterus is not traversing between them.

**Bucephalopsis fusiformis** Verma, 1936 from *Eutropiichthys vacha* (Hamilton).  
Vitelline ducts meet just behind the ovary, testes almost pre-equatorial and ovary median.

**Bucephalopsis confusus** Verma, 1936 from *Eutropiichthys vacha* (Hamilton).  
A new host record is given for it.
Phyllodistomum singhiai Gupta, 1951 from Belone cancila (Hamilton).

A new host Belone cancila has been recorded for it.

Phyllodistomum srivastavaei Rai, 1964 from Mystus seenchala (Sykes).

A new host record is given for it.

Phyllodistomum tripathii Motwani and Srivastava, 1961 from Bagarius bagarius (Hamilton).

Ovary is lobed in the present specimens.

Allocreadium handiai Pande, 1937 from Channa punctatus (Bloch).

Testes are close to each other in the present specimens.

Allocreadium dollfusi Rai, 1962 from Tor putitora (Hamilton).

Ovary is spherical, cirrus sac is placed obliquely anterior to ventral sucker.

Orientocreadium indicum Pande, 1934 from Puntius sarana (Hamilton).

The maximum breadth of the body is across the post-equatorial region of the body, ovary is lateral and equatorial and testes are obliquely tandem. The cirrus sac is not close to the ventral sucker and ovary. A new host record, Puntius sarana is given for it.
Opisthorchis pedicellata Verma, 1927 from gall bladder of Bagarius bagarius (Hamilton)

Vitelline follicles are not in groups in the present specimens.

Allogomtiotremata attu (Gupta, 1953) Yamaguti, 1958 from Wallago attu (Schneider).

Receptaculum seminis is post-ovarian; vitelline follicles do not extend up to the blind ends of the intestinal caeca.

Pleurogenes attui Kakaji, 1968 from Mystus cavasius (Hamilton).

Oral sucker is smaller than the ventral sucker; intestinal caeca claviform; receptaculum seminis is extracaecal and cirrus sac stops short of antero-lateral border of ventral sucker. A new host record is given for it.

Genarchopsis dasus Gupta, 1951 from Channa punctatus (Bloch).

Testes are diagonally placed in the posterior third of body, not close to ventral sucker; vitelline glands are symmetrically placed; ovary to the right of median line and the genital bore lateral and situated at the level of the intestinal fork.

Genarchopsis lobatum Srivastava, 1933 from Channa punctatus (Bloch).

Oesophageal pouch is pear shaped, at the junction of pharynx and intestinal fork and directed antero-laterally,
testes are obliquely tandem and the Mehlis' gland complex lies close to vitelline glands. A new host record is given for it.

**Genarchopsis indicus** Gupta, 1951 from *Mystus cavasicus* (Hamilton).

Ovary is larger than testes, pharynx is oblong and Mehlis' gland complex situated between anterior lobes of the two vitelline glands. A new host has been recorded for it.

**Genarchopsis singularis** Srivastava, 1933 from *Channa punctatus* (Bloch.).

Ovary is median, testes are placed side by side and situated much behind the ventral sucker and the genital pore is at level of the intestinal fork and beneath the intestinal caecum.

**Haplorchoides seenghali** Gupta, 1953 from *Mystus seenghala* (Gykes).

Vitelline follicles extend up to the posterior end of the body receptaculum seminis lies to the right of the ovary and the genital sac is situated intercaecally.

**Eucreadium cameroni** Gupta, 1962 from *Chela bacaíla* (Hamilton).

Ovary is transversely broad, situated slightly to the right of median line, receptaculum seminis is post-ovarian and cirrus sac is quite away from the ventral sucker.
Euclinostomum srivastavai from *Channa punctatus* (Bloch).

Only variations in size of body and its organs are given.

Clinostomum gigantium Agarwal, 1959 from Liver of *Labeo rohita* (Hamilton).

It is recorded from the liver of *Labeo rohita* (Hamilton).

*Aspidogaster piscicola* Rawat, 1948 from oral cavity of *Puntius sarana* (Hamilton).

Testis is bean-shaped and situated in the middle of the ventral adhesive disc, intestinal caecum not ending with a little dilation. A new host record is given.

**Histochemistry**

Protenaceous nature of tegument in both the species *Helostomatis derce* sp.nov. and *Allocreadium dollfusi* Rai, 1962 have been observed by its positive reaction in mercury bromophenol blue stain. Mucopolysaccharides have been found in these two species.

Demonstration of SS groups in the tegument of these species was not clear as the reaction with performic acid schiff was weak.

Glycogen has been found to be absent from the tegument in these species of trematodes.
The results of Feulgen's test, methyl green-pyronin and Himes and Moriber's test confirmed the absence of nuclear material from the tegument of these trematodes.

Amount of bound carbohydrate is variable in the parenchymal spaces. The parenchymal fibres are also proteinaceous and parenchymal spaces contain glycogen and neutral polysaccharides.

Lipids are present in tegument of these species of trematodes. Lipids of parenchymal fibres are acidic in nature.

Cyst wall

Outer cyst wall is found to be rich in protein, carbohydrates. Glycogen is found to be absent in outer and inner cyst wall. No nuclear material has been observed in outer and inner cyst wall. Lipids are observed in outer and inner cyst wall and these are of acidic nature.

Histopathology

Metacercariae of *Fibricola indicus* invaded the liver sinusoides causing acute necrotizing lesions followed by encystment and fibrosis.
Abbreviations used in Figures
ABBREVIATIONS USED IN FIGURES

ACT. Acetabulum
CI. Cirrus
CS. Cirrus sac
DE. Ductus ejaculatorius
EG. Egg.
EX.P. Excretory pore
EX.VES. Excretory vesicle
FIG. Figure
GA. Genital atrium
GL. Genital lobe
GF. Genital pore
GS. Genital sucker
INT. Intestine
INT.C. Intestinal caeca
L.C. Lourier's canal
LT.T Left testis
M.GL. Mehlis' gland
MTH. Mouth
OES. Oesophagus
OES.B. Oesophageal bulb
OES.P. Oesophageal pouch
O.D. Oviduct
OCT. Cotype
O.S. Oral sucker
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>OV.</td>
<td>Ovary</td>
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<tr>
<td>PS.</td>
<td>Parenchymal space</td>
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<td>FC.</td>
<td>Parenchymal cell</td>
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<tr>
<td>PF.</td>
<td>Parenchymal fibre</td>
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<td>PH.</td>
<td>Pharynx</td>
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<td>PH.S.</td>
<td>Primary pharyngeal sacs</td>
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<td>P.P.</td>
<td>Pars prostatica</td>
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<td>PR.G.</td>
<td>Prostate gland cells</td>
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<td>PR.PH.</td>
<td>Pre-pharynx</td>
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<tr>
<td>PHY.</td>
<td>Rhynchus</td>
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<tr>
<td>R.SE.</td>
<td>Receptaculum seminis</td>
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<td>RT.T</td>
<td>Right testis</td>
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<tr>
<td>T1</td>
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<td>T2</td>
<td>Posterior testis</td>
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<td>T</td>
<td>Tegment</td>
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<td>TC</td>
<td>Tegment cell</td>
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<tr>
<td>UT</td>
<td>Uterus</td>
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<td>Vas efferens</td>
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<tr>
<td>VAS.DEF.</td>
<td>Vas deferens</td>
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<td>V.S.</td>
<td>Ventral sucker</td>
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<tr>
<td>VIT.</td>
<td>Vitellaria</td>
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<td>VIT.D.</td>
<td>Vitelline duct</td>
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<td>V.SEM.</td>
<td>Vesicula seminalis</td>
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<td>V.SEM.INT.</td>
<td>Vesicula seminalis interna</td>
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