Historical Review
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India is known for its rich fishery resources and occupies the prestigious second rank next to China, with regards to fish production from inland water bodies. But one of the major concerns nowadays is disease outbreak in ponds leading to mass mortalities and consequent economic loss. Diseases caused by parasitic agents, particularly platyhelminthes have adverse effects not only on fish health but also on environment and simultaneously on the economy. In India Trichogaster fasciatus fish is considered as highly esteemed food (Bhuiyan, 1964). It is a small carnivorous fish known to perform very important ecological role as it feeds on mosquito larvae, therefore can be recommended for the stocking tanks and ponds as an antimalarial measure (Bhatti, 1943b).

Clinostomum complanatum (Rudolphi, 1814) is a common digenetic trematode that naturally parasitizes the throat and oesophagus of piscivorous birds like Ardea coci, Egretta alba, Egretta thula etc. (Lo et al., 1981). Infective larval stage is the excysted progenetic metacercariae, which are found in several species of fish, e.g., Trichogaster fasciatus, Loricariichthys platymetapon, Hoplosternum littorale, Parauchenipterus galeatus etc. The Trichogaster fasciatus fish has very common infection of C. complanatum in Northern India. The encysted metacercariae are responsible for causing yellow grub disease in fish (Silva-Souza & Ludwig, 2005). The infection rate in Trichogaster fasciatus fishes found in Aligarh region has been reported as high as 98-100% (Siddiqui and Nizami 1982). The metacercariae degrade the quality of forage fish and is also responsible for parasitic zoonosis in India (Cameron, 1945). Literature reveals that epidemiological, morphological and biochemical aspects of Clinostomum species have been studied (Dhar and Kharoo, 1986; Abidi and Nizami, 1987; Abidi et al., 1988; Dias et al., 2003; Silva-Souza and Ludwig, 2005; Adeyemo and Agbede, 2008). The metacercariae occur in two forms i.e. excysted as well as encysted form. In India, at Aligarh region metacercariae of C. complanatum have been reported to occur in non-encysted form in a fresh water fish (Siddiqui and Nizami 1982). The infection of fish by C. complanatum metacercariae can unleash behavioural changes, disease and death on one hand, and economic loss on the other, (Eiras,1994; Vianna,2001;) the progenetic metacercariae also possess zoonotic potential (Kamo et al., 1962) infecting oral cavity of humans while eating
raw parasitized fish (Chung et al., 1995; Kitagawa et al., 2003). According to Eiras (1994) C. complanatum metacercariae can cause laryngopharyngitis and even death by asphyxia in humans. Kamo et al., (1962) reported the occurrence of anaemia in a Thailandese male whose eyes were infected by Clinostomum species. Tiewchaloem et al., (1999) and Souza and Ludwig (2005) studied the effect of parasitism on fish health. Analysis of parasite prevalence, mean intensity of infection and mean abundance were determined by Bush et al., (1997). Weight, standard length of Cichalosoma was determined and it was found that average standard length of infected individuals did not differ significantly from that of non-infected individual fish. Comparing mean Kn (condition factor) with standard value showed that infected fish has greater weight than expected (Kn>1.0) while weight of non-infected fish was equal to the expected theoretical value (Kn=1.0). The infected and non-infected individual did not differ in relation to total length and total weight. Elliot and Russert, (1949) and Vianna, 2001) detected no relation between infection by Clinostomum marginatum and condition factor of Perca flavescens. The life cycle of C. complanatum (Rudolphi 1814) described by Souza et al., (2001) revealed that mollusk Biomphalaria pregrina was the first intermediate host. Ardea cocoi and P. brasilianus are the main definitive hosts. Whole or part of life cycle of the parasite has been studied by several authors who demonstrated that it includes mollusk as its first intermediate host, fish as its second intermediate host and a fish eating bird as its definitive host (Hunter and Hunter, 1934; Cort et al.,1950; Edney, 1950; Fried et al., 1970; Lo et al., 1980, 1981, 1982; Abidi and Nizami, 1987; Larson and Oglem, 1990; Kalantan et al., 1991; Liao, 1993; Chung et al., 1998; Ludwig and Souza, 2000; Dias et al., 2001; Dias, 2002; ). Some specific mollusk species such as Radix auricularia coreana by Chung et al., 1998; Radix auricularia swinhoei by Lo et al., 1981; Heliosoma antrosum and Heliosoma complanatum by Hunter and Hunter, (1935) were considered to be as first natural intermediate host of Clinostomum complanatum. Biomphalaria glabrata was also reported as a first intermediate host of this parasite by Dias, (2002).

First human case of infection by metacercariae of Clinostomum species was reported in Korea in a 56 year old man (Chung et al., 1995) known as Clinostomum pharyngitis. Park et al., (2009) reported second human case in Korea which also occurred by the consumption of parasitised raw fish. During infection, the parasites
get attached to the surface of mucous membrane of throat and result in a clinical syndrome known as halzoun. Halzoun is a type of condition known to occur by consumption of infected improperly cooked or raw flesh and sometimes during infection the nasal discharge contain the causal organism. Kuhne et al., (1990) reported the case of nasopharyngeal linguatulosis known as halzoun syndrome in which nasal discharge of infected person contained nymphs of Linguatula serrata, which show symptoms like coughing, hoarseness, dysphagia, etc. The infection mostly occurred by the consumption of perch, Lateolabrax japonicus which is commonly eaten raw in Korea. Parasitic infections of zoonotic potential have also been reported by Yamashita, (1938); Hirai et al., (1987); Umegai et al., (1990); and Yoshimura et al., (1991). DNA segment of both Clinostomum marginatum (Rudolphi, 1819) obtained from a little egret Egretta garzetta (Linnaeus, 1766) and Clinostomum complanatum (Rudolphi 1819) obtained from great blue heron Ardea herodias (Linnaeus, 1758) were amplified, sequenced and aligned. The resulting alignment was used to develop a genetic array to differentiate between the species. The metacercariae of Clinostomum species develop in fish and is pathogenic to fingerling of cichilids (Paperna, 1996). Histopathology of Oreochromis niloticus fish tissue was studied by Adeyemo and Agbende, (2008) which was known to be infected by Clinostomum tilapiae.

Moore et al, (1984) reported that parasitic infection in Gyrodactylus fish created problems in its respiratory function of skin and gills, thus fish became dull, feeble, frequently swinging to water surface with erratic movements and died due to exhaustion. Eosinophilic dermatitis associated with C. complanatum infection observed in the fishes. Symptoms of Clinostomid infection may cause retarted growth, weight loss and pronounced exopthalmus. Malek and Mobedi, (2001) studied variation in prevalence and abundance of metacercariae of Clinostomum complanatum recovered from Capoeta capoeta gracilis. Reproductive fitness, growth rate and survival have been reported to decrease in infected fish with Clinostomum complanatum. Chopra et al., (1983) reported some biochemical aspects like Glycogen, protein, alkaline and acid phosphatase enzymes in fish. Schizothorax fish species are known to be infected by metacercariae of Diplostomum tetrai (Singh et al., 1981) infesting skin, gills, fins and operculum of the fishes which is recognized as
causal agent of black spot disease and it has been observed to damage scales and caused bulging of eyes (Van Duijn, 1956).

Morphometric analysis is mainly used for identification of fishes, but can also describe both the phenotypic variation and the similarity between the hybrid and parental species (Crossman and Buss, 1965; Cowx, 1983; Crivelli and Dupont, 1987; Bianco, 1988; Procarione et al., 1988; Kerby and Harrel, 1990; Kerby, 1993).

From the above discussions, it can be concluded that the helminthic infections are not only a menace to fish health but they also have zoonotic importance affecting human health. Review of the literature shows that most of the work related to Clinostomum species are carried out on life cycle and morphology. Little attempt has been made on biochemical aspects of this parasite. Pathophysiological and pathobiochemical studies are almost neglected. Considering the significance of fish health, human health and Indian economy, ample amount of research work is required.

In the present endeavor we have attempted to explore few pathophysiological and pathobiochemical aspects arisen due to Clinostomum complanatum infection in Trichogaster fasciatus fish.