Introduction

Fishes are the most primitive and numerous of vertebrates. More than 24000 species of fishes are found on this earth. Out of these more or less 10500 species inhabit the freshwater.

Since time immemorial, fishes are indispensable food item of human. Fishes are major source of protein diet of human all over the world, especially in south-east Asia. To meet the increasing demand of fish-proteins, fish culture has received a great attention throughout the world, especially in developed countries.

India is a country which is gifted with an abundance of all types of fishery resources. There are huge rivers and their tributaries, creeks and canals. Besides big rivers and their tributaries, creeks and canals, there are a number of ideal places for fish production such as oxbow-lakes locally known as beels and boars. Along with the natural water bodies, impounded water bodies such as ponds and canals are also found abundantly. The state of West Bengal is also a no exception. The state is highly enriched with different fishery resources resulting a substantial fish production. The state has the largest brackish water fishery resources in India. At least twenty two species of economically important fishes have been identified in the rivers of West Bengal. Beels and boars of West Bengal harbour at least twelve marketable species (Jain, 1990).

Offering wide variety of tastes as well as nutritive qualities, aqua-culture has already become a global commercial activity. This has led the intense rearing of fishes through high stocking densities, artificial feed and fertilizer use. This intensive rearing of fishes using high stocking densities, artificial feed and fertilizers has not only increased the production of fishes by many folds but also has created conditions that favour outbreak and spread of infectious diseases. As the fishes are vulnerable to various types of infectious agents, fish disease has already become a global problem causing large scale death of freshwater and marine fish, wild, cultured, sport fish and finally ornamental fishes (Trust 1986).

Fish diseases which have already been diagnosed across the world are bacterial diseases such as furunculous (Ghittino, 1972; Ferguson and McCarthy, 1978; Dalsgaard,

1994; Ford et al., 1994), vibriosis (Levin et al., 1972; Lewis, 1985; Egidius et al., 1986; Liu et al., 1994), bacterial kidney disease (Bruno and Munro, 1982; Bruno, 1986; Magnusson et al., 1994), enteric septicemia (Plumb and Sanchez, 1983; Plumb and Hilge, 1987; Kasornchandra et al., 1987; Chen and Kumlin, 1989; Morrison and Plumb, 1994), streptococcicosis (Ferguson et al., 1994; Al-Harbi, 1994), bacterial gill disease (Lumsden et al., 1994), viral diseases e.g. infectious carp dropsy or viral haemorrhagic septicemia (Schaperclaus, 1965; Ghittino et al., 1984; Trust, 1986; Meyers et al., 1992), fungal diseases (Noga et al., 1991; Kumar and Dey, 1991), metazoan and protozoan diseases (Paperna, 1980; Mishra et al., 1982; Kabata, 1985; Landsberg and Paperna, 1987) etc.

But prior to 1988 fish diseases in India had not been a menance. The diseases which were common in freshwater fishes were haemorrhagic septicemia, dropsy, ulcerative disease, columnaris disease, microsporidiasis, dactlyogyrosis, gyrodactylosis, ligulosis, argulosis and saprolegniosis (Kumar and Dey, 1992; Das and Das, 1995).

In May, 1988 Epizootic ulcerative syndrome (EUS) broke out as one of the most destructive fish diseases, India have ever experienced. The disease first appeared in some north-eastern states of India such as Tripura, Meghalaya and Assam (Das, 1988; Pal and Pradhan, 1990). In October 1988, severe out breaks of the EUS occurred in northern districts of West Bengal such as Coochbehar, Jalpaiguri, West Dinajpur, plains of Darjeeling district and Maldah (Pradhan and Pal, 1990).

Subsequently, the disease spread to some southern districts of West Bengal such as Murshidabad, Nadia and 24 Parganas and Midnapur. In 1989 the disease affected almost all the districts of West Bengal. In the same year the disease spread to some areas of other states of India such as Orissa, Bihar and Uttar Pradesh. Further it spread to almost all the states of India except Jammu and Kashmir, Punjab, Himachal Pradesh and Gujarat (Das and Das, 1993). Over 100 species of fish have been confirmed by histological diagnosis to be affected by EUS (Lilley et al., 1992). But some important culture species including tilapia, milkfish and Chinese carp have been shown to be resistant.

The name epizootic ulcerative syndrome (EUS) was adopted by the FAO consultation of experts meeting in Bangkok in 1986 (FAO, 1986). It was accepted that

the condition was primarily an infectious disease and it was a complex condition involving certainly fungal, bacterial elements and probably one or more viruses. Epizootic ulcerative syndrome was redefined at a DFID Regional Seminar in Bangkok in 1994 as a seasonal epizootic condition of freshwater and estuarine warm water fish of complex infectious etiology characterized by the presence of invasive *Aphanomyces* and necrotizing ulcerative lesions typically leading to granulomatous response (DFID 1994). The disease has been given various names, but is most commonly known as mycotic granulomatous (MG) in Japan, red spot disease (RSD) in Australia and epizootic ulcerative syndrome (EUS) in South-Asia. At present MG, RSD and EUS are considered synonymous.

Immune system of animals is the defence machinery to fight against the diseases and the immune system is a remarkably efficient defence system that has evolved into a well organized system in vertebrates to protect them from invading pathogenic micro-organisms. Fishes which lie on the base line of vertebrate evolution have developed a primitive but efficient immune system which during course of evolution reaches to its highest in mammals notably in humans. The immune system of fishes must be an effective system, because a bewildering array of infectious agents with multitudes of chemical moieties.

So along with the development of different effective treatment of different diseases, it is imperative to develop a better understanding of the immune system of fishes.

Both the innate and acquired immune system of teleost fishes appear increasingly similar to mammalian immune systems although the different evolutionary pressures teleosts have faced, may be expected to generate unique aspects of immunity. The greatest difference between the two taxa is the absence of lymph nodes and the ontogeny of leucocytes. In fish spleen, kidney (Pronephros) and thymus combinedly compensate the function of bone marrow in mammals. The spleen and kidney are the main haemopoietic organs in teleosts. In some fishes both organs function equally whereas in others any of two remains more active than the other (Catton 1951). However, in some fishes only the spleen (e.g. in Parch) or the head kidney shows activity. There are a few

reports on ontogeny of hoemopoiesis in fishes (Mahajan and Dheer, 1980; Weining, 1990).

There is evidence that the thymus plays a vital role in the ontogeny of immunologic competence (Miller, 1961; Good et al., 1962; Cooper, 1973). Studies by Beard (1994) on elasmobranch suggested that the Thymus is the source of lymphoid cells. However, there is a need for better understanding of organization of the lymphoid tissue resulting the better understanding of the functions of the lymphoid tissue. The main objectives of the present work are:

I. Histological studies of lympho-haemopoietic organs, head kidney, spleen and thymus of both healthy and EUS affected *Cirrhinus mrigala.* Electron microscopic studies of lympho-hoemopoietic organs of healthy and EUS affected *C. mrigala.*

II. Studies on blood cell profile in healthy *C. mrigala.*

III. Cytochemical studies on erythropoiesis in healthy *C. mrigala.*

IV. Studies on erythropoietic efficiency of head kidney and thymus of healthy and EUS affected *C. mrigala.*

V. Comparison of percentage of mature and immature erythrocytes in peripheral blood of healthy and EUS affected *C. mrigala.*

VI. Total counts of erythrocytes and leucocytes in peripheral blood of healthy *C. mrigala* and EUS affected *C. mrigala.*

VII. Measurement of Hb content, total erythrocyte count (TEC), total leucocyte count (TLC), differential count of three subpopulations of leucocyte in peripheral blood of healthy *C. mrigala* throughout the year.

VIII. Studies on the humoral immunity of the fish, *C. mrigala.*

IX. Count of antibody secreting "B" cells in healthy fish, *C. mrigala.*