GENERAL INTRODUCTION
INTRODUCTION

During the last fifty years enormous growth of human population has taken place all over the world, especially in the developing countries. Millions of human beings suffer from hunger and malnutrition. Although agricultural production has also increased substantially but per capita availability of food is still low and there is shortage of protein, fat and calories in diet of an average man. Nutritional problem are not peculiar to our country where food is scarce. Protein calorie malnutrition is in fact a serious disease affecting nearly half of the world population. Fish and other forms of sea food can be used to provide balance diet and reduce the protein gap. In the face of nutritional inadequacies resulting from ever increasing population of the developing countries, aquaculture holds a promise to provide a proteinaceous supplement to human diet.

Fish ranks first among the farmed animals in terms of protein yields per unit food intake. The importance of fish is not only undiminished but is on the other hand on the increase for the reason that fish happens to be one of the important sources of protein for the people and has a global market. Fish is food of an excellent nutritional value, providing high quality protein with balanced amino acid profile. It contains low fat than chicken, mutton and pork. Its fat or lipid contains less cholesterol and more polyunsaturated or highly unsaturated fatty acid. Fish as a food is less costly and its use as food will reduce heart disease in human being. Fish also contains vitamin A and D in sufficient quantities than other animal meat products. It is believed that fish eating children could be more intelligent. This is possible because of the more of highly unsaturated fatty acids which helps in the development of brain or cellular membrane.
synthesis in early part of life. It is easily digestible as compared to beef and poultry. It provides several important byproducts like fish liver oils, fish body oil, fish manure, fish silage, fish glue fish leather, fish flour, biscuits and artificial pearls, etc., and also prevents several nutritional deficiencies. Fish flesh contains all the amino acids and also provides calcium, magnesium, potassium, sodium, iodine, phosphorus and vitamins. The entire need of food for peoples can not be met from land only. The importance of fish as food has resulted in the development of fisheries as an industry in several countries and considerable progress has been achieved in the fisheries science. Fisheries sector plays a vital role in the socio-economic development of the country. In addition to being the fastest growing food production sector of the world, aquaculture activities currently employ about 9 million people (FAO 2000). Apart from generating food production, it stimulates the growth of a number of subsidiary industries for processing and production of various value added fish products so much so that the sector has been recognized as a powerful employment and income generator.

Increased fishing is dwindling our resource and hence there is a need to find an alternative means of increasing fish production. This can be achieved by aquaculture which is an important weapon in the global fight against malnutrition and poverty, particularly in the developing countries (Tacon 2001). Increase in human population along with changing perceptions of healthy food is set to increase the demand for fish. The total fish catch from the world's fishing grounds have levelled off in the last decade with the majority of wild stocks being fully exploited. The need for substantial increase in the world supply of animal protein has generated greater interests in aquaculture of finfish, shrimps and other aquatic organism. Aquaculture production seems to be
responding to the increased fish demand and have exclusively increased the world fish production. The food and agriculture organization, in its report on the world situation of fisheries and fish farming, advanced the prediction that the world production of fish, the total consumption and the food demand and consumption per capita would increase during the next three decades. It also indicated that world production of fish from capture fisheries would stagnate, whereas that from fish farming would increase. The average world consumption of fish per person could grow from 16 kg a year in 1997, to 19-20 kg by 2030, raising the total food use of fish to 150-160 million metric tones annually. Hence, there is a need to increase production of fish both fresh water and marine by applying new scientific methods and technologies in aquaculture sector. Out of 20,000 different species of the fish, only 100 species are cultured for commercial purpose.

An important prerequisite to successful aquaculture is the knowledge of the nutritional needs of the species concerned leading to the development of economical feed mixtures. Recent years have therefore seen much interest in this field. The rearing of fish at high stocking levels necessitates a detailed study of their nutritional requirement in order to produce feeds that besides being cost effective are nutritionally adequate for their growth. Hence, the economic success of the controlled production of fish depends mainly on the cost of the feed and particularly on that of protein, since protein is the major and most expensive determinant for growth (Borlongan 1991). Fish generally have higher protein requirement than terrestrial animals (Lovell 1989; Patnaik et al. 2005) and the requirement is influenced by species, age of the animal and water temperature. Fish culture in tropical climate have lower protein requirement (25-35%) than those cultured in moderate climate (30-40%). Fish fry has the higher protein requirement which declines
with the growth. Warmwater fishes have a faster specific growth rate than temperate fishes. Results of most protein requirement studies indicate that fish need relatively high (35-55%) protein for their growth (NRC 1993; Tacon & Cowey 1985; Wilson & Halver 1986; Moore et al. 1988; Tibbetts et al. 2000; Lupatsch et al. 2001; Ai et al. 2004; Mayer & Fracalossi 2004; Wanwiza et al. 2005; Sa et al. 2006). Protein requirement are always studied in aquaculture species with the aim of determining the minimum amount required to produce maximum growth. Since protein constitutes in fish culture the single most expensive item in artificial feeds, it is logical to incorporate only that much which is necessary for normal maintenance demand and growth. Any excess is considered wasteful biologically as well as economically. Decrease in protein requirement of fish with increasing size or age has been observed for several warmwater fish species (Halver 1982; Sen et al. 1978). Diet development for particular species therefore requires a precise assessment of its protein needs which determines to a large extent the overall success of its production. The pioneering work of Halver and his colleagues, working on chinook salmon with diet containing casein, gelatin and crystalline amino acid, provided the basic model for subsequent studies on the protein nutrition of a number of the fish species.

Knowledge of the protein requirement is essential for formulation of well-balanced low cost and environment friendly artificial diets because it is the principal diet component for animal growth and is the highest cost consideration in commercial feeds (Lim et al. 1979; Mai et al. 1995; Manomaitis 2001; Thompson et al. 2004; Ozorio et al. 2006, Debnath et al. 2007). It is mainly for this reason that considerable attention has
been given in the past to protein nutrition in fish (Wilson 2002; Sales et al. 2003; Luo et al. 2004; Abbas et al. 2005, Kvale et al. 2007).

Aqua-feed section of India has made tremendous development during the last two decades and annual growth rate of 10% in aquaculture is the highest among the other agriculture sectors. Significance of research and human resource development in aqua feed sector has also contributed to high growth rate in aquaculture. At present about 20 million tons of manufactured aqua feeds are being used in aquaculture sector of which major share is being used in shrimp culture. If this growth persist the feed requirement may increase many folds. Hence, more scientific understanding and interventions are required for sustainable aquaculture of our country.

This high dietary protein requirement in fish is generally attributed to preferential use of protein over carbohydrates as a dietary energy source (Cowey et al. 1975). The optimum level of protein in the diet is however, influenced by factors such as the balance of essential amino acids, protein digestibility and protein energy ratio in diet besides temperature of water, salinity, stage of growth of the fish and species and availability of natural food (Mertz 1969; Cowey & Luquet 1983; De Silva & Pereira 1985).

As far as aquaculture of Indian cultivable fish species is concerned, a number of carp species having good growth and market demand are being cultured. These species contribute to aquaculture production substantially. However, culture of air-breathing fish has also gained attention because of the growing demand for fish. The optimum level and quality of dietary protein to include in commercial catfish diets are dependent on several factors, including the balance between energy and protein in the diet, the amino acid composition of the diet, and feeding rate. Protein is needed to promote growth, while less expensive feed ingredients like corn and wheat are sufficient for providing energy. Catfish diets should be balanced to ensure that adequate levels of protein and the less-expensive energy sources are supplied in proper proportions to minimize the use of protein for energy and to maximize protein deposition. Increasing protein level in diet can lead to improved fish production especially for carnivorous fish.

Information on the basic nutritional requirement and feeding of catfishes which form a major group of commercially important fish species after carp is needed in view of recent emphasis on catfish culture in the country. Heteropneustes fossilis, the fish under study, is one of the most easily cultivable indigenous air-breathing catfishes and is of high
nutritive value. It is highly esteemed as food fish fetching a high price. It takes at least 1 year to reach marketable size.

Although dietary protein requirements of other cultivable fish species including carps have been worked out (Sen et al. 1978; Renukaradhya and Varghese 1986; Singh & Bhanot 1988; Shim et al. 1989; Khan & Jafri 1991; Webster et al. 1994; Jacinto et al. 2003; Khan et al. 2004; Lee and Sang 2005; Usman et al. 2005; Debnath et al. 2007), little information is available on the protein requirement of singhi, *H. fossilis*. Studies leading to the knowledge of optimum dietary protein requirement for this species will be a useful step in developing nutritionally adequate quality protein diets for the intensive culture of this fish. The present study was, therefore, undertaken to generate data on dietary protein requirement of two size classes of *H. fossilis* and the findings are presented in the form of this dissertation.