CHAPTER-1

INTRODUCTION

The North Eastern Region (NER) is endowed with vast and varied aquatic resources. It is blessed with 56 notable rivers/tributaries and several small rivulets/hill-streams. The rivers Brahamaputra and Barak form the principal drainage of NE India with its numerous tributaries flowing through the different states along with the myriads of rivulets and lentic water bodies (Sarkar and Ponniah, 2000). The region with its diversified lotic and lentic water bodies are considered as the global hotspot for fish bio-diversity (Kottelat and Whitten, 1996). It harbours valuable fish garmplasm resources. Out of the total 806 fish species found in India (Talwar and Jhingran, 1991), the NER is represented by 266 fish species, belonging 114 genera under 38 families and 10 orders (Sen, 2000). In India, 288 species of exotic ornamental fishes exist of which 261 species are egg layers and 27 species are live bearers. The egg laying exotic ornamental fish species belong to 10 orders, 26 families, 123 genera and 1 sub genus, while the livebearer species are represented by 12 genera and 3 families of the order Cyprinodontiformes (Tiwari *et. al*, 2005). The NER is represented by a total of 196 species of potential ornamental fishes (Dey, 2001).

Like most of the montane state of NE region, Nagaland with an area of 16,579 sq.kms lies between 25^0 6' and 27^0 4' N latitudes and between 93^0 20' and 95^0 15' E longitudes abounds a good many rheophilic rivers and torrential hill streams besides lentic water bodies. This provides a lucrative abode of her ichthyo-diversities including ornamental fishes. A total of 149 species of Ichthyofauna belonging to 64 genera under 22 families and 6 orders are recorded from lotic, lentic and mixed habitat of the state. Out of these as many as 118 species of fishes having good export potential are identified as ornamental fishes (Ao *et.al*, 2008).

Ornamental fishes may be defined as fishes, which are reared as pets and not for consumption (Anon 2001). Ornamental fishes in general are

smaller in size, attractively coloured with majestic movement exposure in the aquarium. However, non-colourful fish will also receive ornamental status if, they exhibit peculiar body morphology, strange locomotive deportment and rare occurrences (Dey, 1984). The present day concept of ornamental fishes varies from man to man and from nation to nation. An unattractive fish for one person may be very attractive for another and a common fish in a country may be an ornamental fish in another country.

Keeping colorful fishes as pets in aquaria or garden pools is an age-old hobby. It originated in China with keeping of gold fish in glass bowl several hundred years ago (Kelly, 1987). It was during 17th century that gold fish was introduced to several countries and became popular in England and Scotland. The first public display aquarium was opened at Regent Park in England in 1853 (Swain *et.al*, 2003). Presently there are over 500 display aquaria functioning worldwide. However, the market for public aquaria of ornamental fish is less than 1% as 99% of the market is still confined to hobbyist (Bhattacharjya and Choudhury, 2004).

In India, the hobby of keeping ornamental fishes as pets is of recent origin with the opening of the Taraporevala aquarium in Mumbai in 1951. In Northeastern region, aquarium keeping as a hobby got a boost with the setting up of first aquarium shop in Guwahati around 1977 (Bhattacharjya and Choudhury, 2004). During 2002 the Department of Fisheries, Govt. of Nagaland, has set up an aquarium display unit at Dimapur.

In recent years, there has been an insatiable demand for newer unique or bizarre shaped fishes by overseas hobbyists, which may not be beautiful in the conventional sense. Presently ornamental fish keeping has emerged as the second most popular hobby next to photography (Chapman, 1997). What started as a hobby has now expanded in to a booming international trade valued at US $150 billion (Bartly 2000). India's present overall trade in ornamental fish has crossed Rs 150 million. Export of ornamental fishes from India accounted for Rs. 226.00 lakh during the year 2000 (Palanisamy, 2003). The ornamental fish trade although is growing

almost continuously, however, India's contribution to the global trade is insignificant (0.007%). Therefore it may be possible for India to capture at least 10% of the market by utilizing its vast indigenous stock of fish species and unemployed trained manpower (Vijayakumar, 2001).

In addition to the export market, the domestic demand for ornamental fishes has been estimated to be of Rs. 10.00 crore per year. The demand is increasing at the rate of 20% per year (Vijayakumar, 2001) thereby, offering enough scope for development of ornamental fish breeding and rearing on a commercial scale. Kolkata, Mumbai and Chennai have emerged as the pioneer breeding centers of India.

The U.S.A. is the largest market for ornamental fish import followed by Japan, U.K and Germany. Singapore, the world's largest exporter of ornamental fish with 30% of global supply, has already produced numerous lucrative new varieties through selective breeding. Out of the total export of ornamental fishes, freshwater fish accounts for around 90%, with almost 90% bred in captivity. The global ornamental fish trade increased from US$ 4.5 billion (1995) to US$ 7 billion today. Though India's share (US$ 0.25 million in 1997) in global trade is very less, it has been noticed that Indian ornamental fishes are of great demand in international market (Swain and Chakrabarty, 2008).

The export of indigenous ornamental fishes from the country are mainly confined to freshwater varieties and is limited to the fishes from the Northeastern states (85%) and a few bred varities of exotic species (Swain et.al, 2003). The status and export potentialities of indigenous ornamental fishes of India have been highlighted by many workers (Anon, 1982; Nopany, 1987; Shenoy, 1987; Elampasithy, 1989, 1995; Banerji, 2001; Belsesware and Naik, 2001; Ghosh *et.al*, 2002; Nair, 2001; Swain *et.al*, 2003; Bhattacharjya *et.al*, 2000; Bhattacharjya and Choudhury, 2004; Swain and Chakrabarty, 2008 and Ao *et.al*, 2008).

The paragon of pre-investment feasibility study extensively made by Dey *et.al*, (2002) on the prospect of ornamental aquaculture in NER has

revealed that, these Ornamental Fish Species (OFS) are all traded on wild caught and none venture for their culture and breeding. Therefore, the population of these valuable ichthyo-species is gradually declining due to over exploitations from their natural stock. Hence, there is enough scope and potentialities for the OFS of NER to venture into the Ornamental Fish Farming and Trade in International market.

Review of literatures

A beginner, hobbyist or entrepreneur would naturally like to know more about this beautiful ornamental fish, about its life, feeding behavior, compatibility, courtship and above all the breeding behaviour and its techniques. Notable contributions have been made by Mills (1990); Sands (1986); Kelly (1987), Nelson (1994); Riel and Baensch (1996), Vinci (1998) towards cataloging and recording the worldwide distribution of tropical freshwater ornamental fishes.

Several workers (Dey, 1973; 1975; 1982 and 1995; Sen, 2000; Nath and Dey, 1982; 2000 a, b; Das, 1989; Dey *et.al*, 2002; Bhattacharjya *et.al*, 2004 and Mahapatra, 2004) have also made valuable contribution on the fish germplasm of North East India, which have thrown light on the ornamental fish species of the region.

Fishes have remarkably wide range of biological adaptation to diverse habit. Fundamental work on fish behaviour has been a rapidly moving field. The behaviour of fishes is unique. A newly fertilized egg does not behave but an adult fish responds to its environment with repertoire of complex, adaptive behaviour pattern.

The ethological perspectives of the fishes such as ingestive and procreatic behaviour have drawn the attention of many scientific workers (Gray, 1953; Harris, 1960; Benkema, 1964; Boer, 1980; Halliday, 1983; Lauder, 1983; Wainwright and Lander. 1986; Gladstone, 1987; Houde, 1987; Bisazza *et.al*, 1989; Bells *et.al*, 1990; Mc Adam *et.al*, 1999 and Spears 2000)

Studies on the food and feeding behaviour helps in understanding and identifying the feeding ecology of the species. The feeding behaviour of fish is a species characteristic. Nikolsky (1963), categorized fishes according to their extent of variation and types of food consumed by them such as, a) Euryphagic: feeding on varieties of food. b) Stenophagic: feeding on few selected types of food and, c): Monophagic: feeding on single type of food. The food and feeding habits of cultured fishes have been studied by several workers (Fagade and Olaniyan, 1973; Ajah, *et.al,* 2006; Soyinka and Olufemi, 2008). However, report on ornamental fish culture and ingestive behaviour of the species in confined water is very fragmentary and scanty.

The mathematical relationship between length and weight of fish is an important parameter in the fishery biology (Sinha, 1981). The relationship is of significant importance in studying the growth, gonadal development, general well-being of the fish population and management of the species and their fisheries (Le Cren 1951, Shafi and Quddus 1974). The growth in weight of fish, in general, is directly proportional to the cube of its length, but sometimes values of the relationship may deviate from the cube law, either due to environmental factors or condition of fish (Le Cren, 1951; Solanki *et.al,* 2004). Pervin and Mortuza (2008) cited that, the length-weight relationship is very important for proper exploitation and management of fish species population. The economic value of fish depends upon its length weight relationship.

Ever since Harbert Spencer first enunciated the cube law in 1871, numerous workers have carried out its application to fish measurements. During earlier investigations on the applicability of the cube law to fish measurement, beginning with Hensen (1899) the constant **c** was found to fluctuate and Heincke (1908) proposed the use of this factor as an index of the well being of the fish. This factor has been variously termed as coefficient of condition, length-weight factor etc. Crozier and Hect (1914) and Hect (1916) found the cube law applicable to the fishes they investigated, but these instances appear to be exceptions rather than the rule. Fulton's findings

showed the inadequacy of the cube law in describing the length-weight relationship of fishes. In recent years a much more satisfactory way of describing the length-weight relationship of fishes has been developed through the use of more general equation : $W=cL^n$, where W= weight in grams, L=length in centimeter and **c** and **n** are two exponents. The value of **c** and the exponent **n** are determinable empirically. Such a relationship has been worked by a host of workers on different fishes, who, among others include, Walford (1932), Hile (1936), Hile and Jobes (1941), Jhingran (1952), Das and Mitra (1958), Sarma *et.al*, (1979), Baragi and James (1980), Dey (1987), Subba and Ghosh (2000), Pawar and Mane (2006) and Pervin and Mortuza (2008). Most of the above stated authors, determining the length-weight relationship of the fish they investigated, have also determined the condition factor of the fish. A great confusion appears to have arisen in describing the condition of a fish and the expression of the length-weight relationship. Hile (1936) has thrown light by elaborating upon the theme coefficient based on empirical exponents fail to reflect differences in form or relative heaviness independent of general length-weight relationship and comparable as measures of relative heaviness between fish of any length. In India, Lacey and Cretin (1905) and Treven (1952) worked on length-weight relationship of *Tor putitora* (Hamilton) for which they advanced some formulae. The formula mentioned by Lecey and Cretin is 1 ¼ length of the fish multiplied by the square of the girth in inches and divided by 1000 gives the weight of the fish in pounds. However, this approach appeared insignificant in its applicability by different workers.

The reproductive biology of freshwater ornamental fishes is a discipline of increasing importance. A perusal of literature reveals that, a great deal of scattered information is available on reproductive biology of different freshwater ornamental fishes. Notable works have been carried out by different workers. (Lowrence *et.al*, 1989; Afroze and Hossain, 1990; Bhuiyan and Parveen, 1998; Borkotoki and Dey, 2002; Dobriyal *et.al*, 2003;

Mahapatra *et.al*, 2004; Dobriyal, 2005; Mitra *et.al*, 2007; Saha *et.al*, 2009 and Bahuguna *et.al*, 2010).

On the culture and maintenance of exotic ornamental fishes, important contributions were made by Plona (1962), Anderson (1962, 1963, 1965); Kaufman (1965); Fernado and Phang (1985), Andrew (1986) and Polonski (1991).

Studies have also been made by different workers on the food, nutrition and rearing of some freshwater ornamental fishes (Basavaraja *et.al*, 1988; Tekriwal and Rao, 1990; Sinha, 2000; Belsware and Naik, 2001; Mukhopadhya, 2001; Sakthivel and Ramathilagam, 2001; Sinha *et.al*, 2001; Anna Mercy, 2001; Pandian *et.al*, 2001; Swain and Das, 2001and Swain, 2008).

In recent years focus have been drawn towards the culture and breeding of ornamental fishes. Significant contributions are made by several workers (Sinha, 1972; Dixit and Agarwal, 1974; David and Rahman, 1975; Chaco and Kuriyan, 1984; Barua and Mollah, 1987; Akteruzzaman *et.al*, 1991; Mahapatra, 1999; Abidi and Thakur, 1997; Sarkar and Ponniah, 2000; Choudhury and Biswas, 2003; Dey and Sarmah 2000, 2003; Sarmah and Dey, 2004; Sarmah, 2002, 2003; Mitra, 2004; Swain, 2008; Swain and Singh, 2008).

The success of fish culture often depends on larval rearing. Efforts were made and documented by few workers (Sane and Bhide, 1992; Das and Kalita, 2003; Swain *et.al*, 2008) on embryonic, larval development and larval rearing of some freshwater ornamental fish species of NE India as well as on some food fishes by (Moyle and Cech, 1988; Reddy and Rao, 1999; Biswas, 2002).

In recent years, increased development of ornamental fish culture has necessitated to understand the disease causing factors in an aquarium. The major diseases of ornamental fishes their preventive measures and treatment have been described by many authors (Richard, 1977; Stojkovic, 1980;

Giavenni, 1981; Gratzek, 1988; Varghese, 1988; Singh and Sreedharan, 2002; Biswas, 2002; Madhumita, 2005; Swain, 2008).

No comprehensive data base on the bionomics and breeding biology of ornamental fish species of both lotic and lentic water bodies of Nagaland are worked out so far. Information on reproductive biology, embryonic development and larval rearing is very fragmentary and inadequate. Review of literature has indicated that, no work has been done on the two rheophilic ornamental fish species viz. *Danio dangila* and *Puntius chola*.

Danio dangila is a native to fresh water rivers and streams of Southeast Asia; the name "*Danio*" comes from the Bengali name *dhani*, meaning "of the rice field", probably referring to the smallness of their size or to their being found in grassy jungles in the edges of rivers and lakes.

Puntius chola is endemic to the Western Ghats and is listed as a vulnerable species by the National Bureau of Fish Genetic Resources. It inhabits freshwater ponds, streams and small canals associated with paddy fields.

Several ornamental fishes, to name some like, *Botia dario, Puntius geliues, Hara hara, Conta conta, Badis badis, Nandus nandus, Danio dangila* and *Puntius chola* etc. caught from the wild are reportedly being exported, leading to decline in their wild stock. The present trend if allowed unabated, wild ornamental fish species may be completely wiped out from nature in days to come. In this context, captive breeding and rearing of freshwater ornamental fish species can open up a new avenue.

Objectives of the study

Realizing the importance of ornamental fishes and their export potentials in overseas market, the present investigations aimed to achieve the following objectives:

1) To collect samples of *Danio dangila* and *Puntius chola* from different natural water bodies of Nagaland and study their systematic, sexual dimorphism and sex ratio.

2) To estimate the abundance trend of the two test species in both lotic and lentic water bodies of Nagaland.

3) To study the ethology of the species especially in respect of their feeding and breeding behaviours.

4) To investigate the bionomics and breeding biology of the two test species.

5) To develop in-house breeding technology and propagation of the species for the benefit of the entrepreneurs who may be involved in ornamental fish trade.

The present investigation, therefore, will depict a clear scenario of the fish *Danio dangila* and *Puntius chola* as an ornamental fish of North Eastern India especially on the technology of captive breeding and culture with their bionomics and early life history. This in turn will lead to economic benefit for entrepreneurs and aquarists engaged in the OFS trade as well as unemployed youths.