



Research Article

STUDIES ON THE BIODIVERSITY OF FRESHWATER ORNAMENTAL FISHES, TAMILNADU, INDIA

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ABSTRACT

Freshwater ornamental fish diversity of Tamilnadu, India was recorded during January 2012 to December (14 species), Poeciliidae and Osphronemidae (7 species), Cobitidae (6 species), Osteoglossidae (5 species), Callichthyidae and Mastacembelidae (3 species each), 2012. During the survey period, a total number of 122 ornamental fish species were identified belonging to 78 genera, 29 families and 10 orders. Cichlidae family represented maximum number of fish species (33 species) followed by the family Cyprinidae (21 species), Characidae, Doradidae, Loricariidae and Pimelodidae (2 species each) and other 17 families (1 species each). The study shows that about 43% of fish species is in not evaluated (NE), 39% fish species is in least concern (LC), 7% of fish species is in vulnerable (VU), 6% of fish species is in endangered (EN), 2% of fish species is in Lower risk (LR/cd) and being either Critically Endangered (CR), Near Threatened (NT) and Data Deficient (DD).

Key words: Diversity, *Wallago attu*, Ornamental fishes, Endangered.

INTRODUCTION

Chinese are the pioneers in ornamental fish keeping. Five hundred years ago, Chinese used a variety of containers for fish keeping such as dishes, bowls and small tanks that permitted viewing from the top for fish keeping. Evaria made of indoor tanks and pools were used by Romans to advertise fresh food fishes in restaurants that were kept alive for use or sale. Later on vivaria were modified into aquaria. With the inspiration of Philip Henry Gosse, Inventor of institutional aquarium first public aquarium was opened in Regent's Park, London on May 21, 1853. The other cities that quickly followed by London were Paris (1859), New York (1859), Boston (1859), Hamburg (1864), Berlin (1869), Brighton (1872), Washington (1873), San Francisco (1894) and India (1909).

The name aquarium was first used by the English naturalist Philip Henry Gosse in 1853. Aquarium is a container made of glass or with glass walls which permits easy and prolonged period of watching of aquatic animals, plants that inhabit in it as well as their care and breeding. A good aquarium is home for planned fish community where the shapes, size and lay out are all important. Basis of

living habitat of the animals and plants aquarium divided into three types namely freshwater, brackish and marine aquarium.

Ornamental fish keeping is emerging as one of the most popular hobbies across the world. The art of rearing and keeping fish in an aquarium is a very ancient one. It first appeared in China at the end of 800 BC with gold fish reared in glass bowl. Their simple quality of attraction, colour pattern, elegant swimming styles, hi-tech body shapes and their admirable behaviour remain as features that distinguish them from freshwater fish. Due to their colour, shape, behaviour etc. ornamental fishes are referred as the "Living Jewels". Ornamental fish keeping and its propagation rainbow revolution has become an interesting activity for many providing not only aesthetic pleasure but also financial openings.

Aquarium fish keeping has been one of the major hobbies confined mainly to the aristocratic and richer sections of the society in the developed world (Alava and Gomes, 1989). In developing countries, on the other hand, this was mainly confined to the landlords and high classes of the society. During the last four decades the number of

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aquarium hobbyists is growing slow, but steady in the industrialized countries and faster in particularly emerging economies (Tomey, 1997).

FRESHWATER ORNAMENTAL FISHES IN INDIA

India's share in ornamental fish trade is estimated to be less than 1% in the global trade. The major part of the export trade is based on wild collection. There is very good domestic market too, which is mainly based on domestically bred exotic species. The overall domestic trade in this field cross Rs. 1000 lakh and is reportedly growing at the rate of 20 percent per annum. The earning potential of this sector has hardly been understood and the same is not being exploited in a technology driven manner. Considering the relatively simple techniques involved, this activity has the potential to create substantial employment opportunities, apart from that it is possible to earn foreign exchange.

In Chennai, many farmers grow fish in their backyards and sell the stock to firms, which are engaged in the export business. Ornamental Fish culture and trade in Tamil Nadu especially at Kolathur village on the outskirts of Chennai (Red hills, Devanpattu, etc.) is famous for ornamental fish culture by small-scale producers. There are about 600 families earning their livelihood through ornamental fish culture in Kolathur and on an average each household in the village earns over Rs. 5,000 to 10,000 per month through ornamental fish farming.

This is an urgent need to develop freshwater aquaria in all possible areas to conduct research on freshwater ornamental fishes, especially to develop breeding technologies, mass production and create greater awareness about freshwater ornamental fishes and their impact on fishery development. With these ideas in mind, the present study was conducted in the freshwater ornamental fish survey of Tamilnadu, India.

MATERIALS AND METHODS

Freshwater ornamental fish survey

An extensive survey work has been carried out regarding the freshwater ornamental fish species available in the several districts of Tamilnadu during January, 2012 to December, 2012, mainly Chennai, Kanchipuram, Madurai and Coimbatore. During the visits, fish species were collected from the aqua forms, aquarium market dealers. In order to collect, data field visit was made every week, sometimes daily during the study period according to information and preference in the respective areas. In addition relevant information was also collected from various sources. The data were assembled through field survey using appropriate questionnaire (Annexure-I). The questionnaire form was filled in by interviewing the fishermen directly from the field and local fish experts and also the local people. All the collected data were analyzed and the species observed were grouped in different categories.

Different aqua forms and markets were visited and ornamental fishes were recorded. The collected fish specimens were identified following Standard taxonomic keys of Day (1989), Talwar and Jhingran (1991) and Menon (1999) were used to identify the fish species while nomenclature was based on Fishbase (<http://www.Fishbase.com>). For ascertaining conservation, status IUCN (2011) was referred. Classification was carried out on lines of Day (1989); Jayaram (1981); Nelson (1976) and Jayaram (1991), the identification of the species was done mainly on the basis of the colour pattern, specific spots or marks on the surface of the body, shape of the body, structure of various fins, etc.

RESULTS

Survey on freshwater ornamental fishes, tamilnadu

The present study was conducted in Tamilnadu main cities like Chennai, Madurai, Coimbatore, Thiruchirappalli etc. A list of 122 fish species in trade in Tamilnadu has been worked out from the data collected during the study from local experts of various aquarium forms, dealers, traders and local peoples.

During the period of study January 2012 - December 2012, frequent field surveys were conducted throughout the areas at different seasons so as to get more information on the fish species from the dealers and sellers. The information was gathered through questionnaires, personal interviews and discussions among them. The interview was conducted with the fish experts who are having the sound knowledge on fishes found in market area and used in their local language (Tamil). The questionnaire contains the details of the fish species, fish prize and threats to human.

In the study, more than thirty knowledgeable persons chosen with the assistance of local administrators and community leaders served as key informants. Each informant was visited three times in order to verify the reliability of the data obtained. The fish species were also collected during the field survey, identified and photographed. The collected fish species was assigned field book number and the field characters such as habitat, body shape, body and tail colour, fins, scales, period of breeding, occurrence and other relevant ecological features were also observed and are noted in the field book. All the collected data were assigned and prepared by using standard methods. The collected information's are arranged in the alphabetic order of the fish zoological name with the local (or) common name, order, family, genus, species and author citation.

This list includes the known Perciformes and Siluriformes are major part. The next levels Cypriniformes > Characiformes > Cyprinodontiformes > Osteoglossiformes > Synbranchiformes. The Syngnathiformes, Tetraodontiformes and Beloniformes are very least in the level. The list attempts to correlate the trade/ popular vernacular names with updated zoological nomenclature, including valid author citations. The popular

zoological synonyms have also been incorporated in the list for ease of reference. The taxonomic identification of the fish species were done with the help of Standard taxonomic keys.

The 122 fish varieties documented were belonging to 10 order, 29 families and 78 genera (Table-2). The most commonly represented families were Cichlidae, Cyprinidae and Characidae. Cichlidae represent by the highest number of species (33 species), followed by Cyprinidae (21 species) and Characidae (14 species). 2 families are represented 7 species, one family by 6 species, one family by 5 species and 2 families represent 3 species. More than 2 families represent 2 species and 18 families by 1 species.

The order Perciformes includes 10 families like Ambassidae, Channidae, Cichlidae, Datnioididae, Gobiidae, Helostomatidae, Nandidae, Osphronemidae, Pristolepididae and Pristolepididae. Followed by order Siluriformes contains 7 families like Callichthyidae, Clariidae, Doradidae, Loricariidae, Mochokidae, Pimelodidae and Pseudopimelodidae. Characiformes includes 3 families like Alestidae, Characidae and Serrasalminidae. And then Cypriniformes and Cyprinodontiformes, each have 2 families like Cobitidae, Cyprinidae and Fundulidae, Poeciliidae respectively. Then the order Osteoglossiformes has Osteoglossidae family followed by Synbranchiformes has Mastacembelidae family, Syngnathiformes has Syngnathidae family, Tetraodontiformes has Tetraodontidae family, Beloniformes has Beloniformes family.

The family Cyprinidae consists of 12 genera, followed by Characidae consists of 9 genera (Table-3). Cichlidae by 28 genera, Cobitidae by 4 genera, Osteoglossidae by 3 genera, Poeciliidae by 3 genera and Mastacembelidae, Pimelodidae, Doradidae families have 2 genera. The total 18 families like Belonidae, Alestidae, Serrasalminidae, Fundulidae, Ambassidae, Channidae, Datnioididae, Gobiidae, Helostomatidae, Nandidae, Pristolepididae, Scatophagidae, Clariidae, Mochokidae, Pseudopimelodidae, Syngnathidae, Tetraodontidae and Loricariidae have single genera of fish species.

The species are important for the variations of plants and animals. The survey revealed that the ornamental fishes have different variations in their species. There are 9 categories in the IUCN Red List namely, Ex- Extinct, EW- Extinct in the Wild, CR- Critically Endangered, EN- Endangered, VU- Vulnerable, LR/cd- Lower risk/ conservation dependent, NT- Near Threatened (includes LR/nt- Lower Risk/ near threatened), DD- Data deficient, LC-Least Concern (includes LC/lc- Lower Risk/ least concern). 122 species are documented in Tamilnadu region. Among this 1 species has critically endangered, 8 species are endangered, 9 species are vulnerable, 2 species are lower risk and 1 species has near threatened. In this data, 48 species are least concern varieties, 52 species are not evaluated and single species has data deficient (Table-4).

The surveyed fishes are ornamental. They are very attractive in body colour, shape and nature. So this fishes

are significantly traded commercially. In commercially they are graded for their colour, shape, size and beauty. They are classified Gold fishes, Angel fishes, Gourami Fishes, Barbs, Tetras, Oscars, Arowana, Discus, Cichlids, Carps, Fighters, Sharks, Catfishes, Loaches, Guppies, Mollies, Platties, Swordtails, Zebras, Dollars, Rasboras, Ramirez, Eels etc.

According to this Gold fishes like *Carassius spp.*, Guppies like *Poecilia spp.*, Platties like *Xiphophorus spp.*, Swordtails like *Xiphophorus spp.*, are recorded as mostly traded and called as potential pets. And also Angel fishes like *Pterophyllum spp.*, Gourami Fishes like *Trichopodus spp.*, *Trichopsis spp.*, *Trichogaster spp.*, *Osphronemus spp.*, *Helostoma spp.*, Barbs like *Barbonymus spp.*, *Puntius spp.*, *Pethia spp.*, Tetras like *Paracheirodon spp.*, *Gymnocorymbus spp.*, *Hemigrammus spp.*, *Hyphessobrycon spp.*, *Thayeria spp.*, *Nematobrycon spp.*, *Moenkhausia spp.*, *Aphyocharax spp.*, *Hasemania spp.*, *Phenacogrammus spp.*, were traded commonly.

DISCUSSION

Survey on freshwater ornamental fishes of Tamilnadu, India

Species may move between categories for a variety of reasons, including genuine improvement or deterioration in status, new information being available about the species that was not known at the time of previous assessment, taxonomic changes, or mistakes being made in previous assessment (eg., incorrect information used previously, misapplication of the IUCN Red List criteria, etc.).

According to the IUCN (2008) Red List of all life forms, 16,928 species are threatened globally, and of these 1275 species are fishes. There are 9 categories in the IUCN Red List namely, Ex- Extinct, EW- Extinct in the Wild, CR- Critically Endangered, EN- Endangered, VU- Vulnerable, LR/cd- Lower risk/ conservation dependent, NT- Near Threatened (includes LR/nt- Lower Risk/ near threatened), DD- Data deficient, LC-Least Concern (includes LC/lc- Lower Risk/ least concern).

During the last few years many exotic fishes are also introduced by the fishermen so that they could get a greater profit in their business without a second thought of affecting the local and indigenous fish diversity of the area. Freshwater fish are not only the most diverse group of vertebrates but they also represent and feature the greatest proportion of threatened species (Bruton, 1995; Leidy and Moyle, 1998; Duncan and Lockwood, 2001). The principal threats to freshwater fish are the deterioration or destruction of habitats, both by pollution and intense modifications (like damming, channelization and so on.) and introduction of exotic species (Moyle, 1986; Allan and Flecker, 1993). The present study will help future researchers and others for easy access of the ornamental fishes of this region and will be of great help to conservationist and aquarists.

Chaston (1983) states that in many instances the firms in fishing industry do not make real attempt to evaluate

market acceptance of the species. The participating companies merely proceed to make major investments in fishing vessels and processing facilities to exploit the new resource. Compared to the scale of costs associated with this action, a market research survey prior to such investment would represent a small increment in cost, yet yield significant information to reduce the risk of the new species not being capable of establishing itself in the marketplace against other competitive products. Market research and customer surveys indispensable before beginning any business venture, particularly fish and live fish marketing. Since any fault or incorrect decision can lead to large financial losses.

Dey and Eknath (1996) defined ornamental fishes based on their attractive colouration, peaceful nature, tiny sizes, and suitability for keeping in captivity and adaptability for living in confined spaces. Larkin *et al.*, (2001) described ornamental fishes as a composite of attributes at different levels.

Common attributes of the ornamental fishes were chosen as variables in order to compare indigenous and exotic fishes. Eight variables considered for the study were evolved based on the factor analysis, which had sorted out the factors that motivated ornamental fish purchase and further discussions with marketers and experts on ornamental fishes. The variables chosen included colour, survival, attractiveness, status, availability in aquarium shop, awareness, suitability as aquarium fish and variety. Respondents were asked to rate each variable on a seven point Semantic rating scale bounded at each end by polar adjectives or phrases. Semantic differential scales are used widely to describe the set of beliefs that comprise a person's image of an organization or brand. The procedure is also insightful for comparing the images of competing brands, stores or services (Aaker *et al.*, 1997).

Earlier studies on ornamental fish trade noted that the industry is fraught with several constraints. Sane (2005) listed the non availability of breeding stock, lack of scientific training on breeding techniques, feeding and health care, inadequate transport facilities and poor marketing strategies which affect the ornamental export from India. The study therefore aimed at identifying the major constraints faced by the marketers of Tamilnadu and the exporters of the metropolitan cities in indigenous ornamental fish marketing. An effort was made to understand the constraints faced by marketers of Tamilnadu and marketers of metropolitan cities separately.

Brichard (1980) added that the richest fishing grounds and the most perfect collecting and conditioning facilities of ornamental fishes would be seriously hampered by inadequate air connection with the markets. In the ornamental fish trade where speed and safety are essential features, the lack of proper transportation to markets abroad, placed poor prospects on African countries in developing substantial exports of ornamental fishes. The two flights which carried the largest number of ornamental fish consignments from India were, Luftansa and Singapore airlines, rather than the Indian airlines or air India.

Lack of market information was an important aspect to be taken care of to improve the ornamental fish exports. According to Rao (2000), marketing information is the basic input for the organisations to become adaptable to changes in the external environment. He added that, marketing information relating to supply and demand positions in various traditional markets, changes in regulations, competitive positions and market expectations are required by the exporters to orient their organisations towards the requirements of the external environment. Olivier (2001) pointed out that, better communication is required between all parties involved in the trade which can then improve transparency, and ensure more general awareness of the problem in the sector and find ways to resolve them.

Language problem formed an important constraint for majority of the marketers from Tamilnadu. Hence many established and experienced traders in Tamilnadu who had all facilities such as storage area, access to collectors experience and the willingness to expand their business had to restrain from taking up the export of indigenous ornamental fishes of Tamilnadu (Sane, 2005). But in Chennai the aquarium fish dealers and sellers are in Laxmipuram, Vinayapuram, Ponniamman medu, Red hills in these areas nearly 1000 farms are there. Hatcheries are mainly found in Ponneri, Thenampet, Uthukottai nearly rearing farms are there. Now farms are introduced in Thambaram, Madurai and Thanjur. MPEDA (The Marine Products Export Development Authority) is a central government scheme, it give donation upto 15 lakhs to the aquarium dealers and sellers.

Fossa (2001) mentions that although the topic of genetically modified aquarium fish first made its appearance almost a decade ago, it has only been within the last couple of years that it has been begun causing a stir within the industry circle. Today genetically modified Zebra danios (*Brachy danio rerio*) have hit the spot light.

Two genetically modified strains have been developed within the Department of Biological Science of the National University of Singapore. One a fluorescent green strain contains a gene (Green Fluorescent Protein or GFP) from Jelly fish, *Aequorea victoria*, while a fluorescent red or pink stain, contains a gene (Red fluorescent protein or RFP) for Sea anemone species, *Discosoma* sp. Jonathan *et al.*, (2005) adds that, in Taiwan, fluorescent greenish yellow Medakas (*Oryzias latipes*) will be ready for their launch in the international aquatic sector. Gong *et al.* (2001) attempted to use the transgenic technology to develop novel varieties of ornamental fish by transferring a jellyfish green fluorescent protein (GFP) gene by using the zebrafish (*Danio rerio*) as a research model. Dawes *et al.* (2000) raises concern of the subject of alien invasive species that has been gaining momentum stated it as one of the hot issues in the new millennium.

The FAO code of conduct also adopts the principle that international trade in fish and fishery products should be conducted in accordance with principles, rights and

obligations as per international agreements. Several nations have become cautious of Trans boundary introductions in their concern to protect the native fauna and also to avoid the entry of exotic pathogens. India is also a signatory to a range of trade related agreements under WRO. One of the important agreements under *wro* is, application of sanitary and phyto sanitary (SPS) measures. SPS specifies that measures should be applied only to the extent necessary to protect human, animal and plant life or health.

SPS agreement uses the standards, guidelines and recommendations developed by Office International Des Epizootics (OIE) for animal health and zoonoses as the international benchmark. According to Kumar (2005) for the rapid growth of live ornamental fish industry of India, import of brood stock of different varieties is a pre requisite. As Government of India has placed ornamental fishes in the restricted item of import and enquires special import license for importing fishes and the obtaining of license and import is a Herculean task for marketers. He put forward several recommendations which need to be seriously studied for simplification of quarantine

procedures in the country. Lakra *et al.* (2006) presented a framework of strategic plan for fish quarantine in India.

Dawes (1998), (Cheong,1998; Ling and Lin, 2005) notes that on the exporting front major players, like Singapore, are likely to be presented with a growing challenge from other exporting areas, the three most likely being Malaysia, SriLanka and possibly, Israel, all of which appear to be gathering momentum.

The ornamental fish export from India started on an experimental basis in 1969, with export earnings of US \$ 0.04 million (16.4 lakhs). India had a good rapport with its traditional markets in ornamental fish export which ceased with the paradigm shift in export trend and Singapore took over the highest market share. Indian exporter's market ornamental fishes to Singapore aiming at short term benefits but they do not realize the fact that in the long run India would be losing their best markets destinations. The fact that Singapore showed a high rate of change in growth was alarming for India, as it is a re-exporting country and occupied 6th position in ornamental fish imports.

Table 1. List of freshwater ornamental fishes recorded in Tamilnadu with classification, names and their conservation status.

Order	Family	Scientific name	Common name	Author citation	IUCN
Beloniformes	Belontiidae	<i>Xenentodon cancila</i>	Needle fish/Garfish	Hamilton, 1822	Least Concern (LC)
Characiformes	Characidae	<i>Paracheirodon innesi</i>	Neon tetra	Myers, 1936	Not evaluated
		<i>Gymnocorymbus ternetzi</i>	Widow tetra	Boulenger, 1895	Not evaluated
		<i>Paracheirodon axelrodi</i>	Cardinal tetra	Schultz, 1956	Not evaluated
		<i>Hemigrammus erythrozonus</i>	Glow light tetra	Durbin, 1909	Not evaluated
		<i>Hyphessobrycon eques</i>	Serpae tetra	Steindachner, 1882	Not evaluated
		<i>Hyphessobrycon herbertaxelrodi</i>	Black neon tetra	Géry, 1961	Not evaluated
		<i>Thayeria boehlkei</i>	Hockey stick tetra	Weitzman, 1957	Not evaluated
		<i>Nematobrycon lacortei</i>	Rainbow tetra	Weitzman & Fink, 1971	Not evaluated
		<i>Moenkhausia pittieri</i>	Diamond tetra	Eigenmann, 1920	Not evaluated
		<i>Aphyocharax rathbuni</i>	Blood fin tetra	Eigenmann, 1907	Not evaluated
		<i>Hasemania nana</i>	Silver tip tetra	Lütken, 1875	Not evaluated
		<i>Paracheirodon simulans</i>	Green neon tetra	Géry, 1963	Not evaluated
		<i>Hyphessobrycon callistus</i>	Veiltail tetra	Boulenger, 1900	Not evaluated
		<i>Hemigrammus</i>	Rummy nose	Ahl, 1924	Not evaluated

		<i>rhodostomus</i>	tetra			
	Alestidae	<i>Phenacogrammus interruptus</i>	Congo tetra	Boulenger, 1899	Least Concern (LC)	
	Serrasalminidae	<i>Metynnis argenteus</i>	Dollar fishes	Ahl, 1923	Not evaluated	
Cypriniformes	Cobitidae	<i>Cobitis taenia</i>	Spined loaches	Linnaeus, 1758	Least Concern (LC)	
		<i>Botia dario</i>	Necktie loaches	Hamilton, 1822	Least Concern (LC)	
		<i>Botia striata</i>	Tiger loaches	Narayan Rao, 1920	Endangered (EN)	
		<i>Chromobotia macracanthus</i>	clown loaches	Bleeker, 1852	Not evaluated	
			<i>Botia modesta</i>	Red tail botia loaches	Bleeker, 1864	Least Concern (LC)
			<i>Pangio kuhlii</i>	Kuhli loaches	Valenciennes, 1846	Not evaluated
	Cyprinidae		<i>Carassius auratus</i>	Gold fishes	Linnaeus, 1758	Not evaluated
			<i>Puntius conchonius</i>	Rosy barb	Hamilton, 1822	Least Concern (LC)
			<i>Barbonymus schwanenfeldii</i>	Red tail tinfoil barb	Bleeker, 1854	Least Concern (LC)
			<i>Puntius vittatus</i>	Green stripe barb	Day, 1865	Least Concern (LC)
			<i>Puntius titteya</i>	Cherry barb	Deraniyagala, 1929	Lower Rick (LR/cd)
			<i>Cyprinus carpio</i>	Koi carp	Linnaeus, 1758	Least Concern (LC)
			<i>Balantiocheilos melanopterus</i>	Silver shark	Bleeker, 1850	Endangered (EN)
			<i>Epalzeorhynchus bicolor</i>	Red tail shark minnow	Smith, 1931	Critically Endangered (CR)
<i>Epalzeorhynchus frenatus</i>			Rainbow shark	Fowler, 1934	Least Concern (LC)	
<i>Rasbora hengeli</i>			Glow light rasboras	Meinken, 1956	Not evaluated	
<i>Rasbora trilineata</i>			Scissortail rasboras	Steindachner, 1870	Least Concern (LC)	
<i>Trigonostigma espei</i>			Espe's rasboras	Meinken, 1967	Least Concern (LC)	
<i>Trigonostigma heteromorpha</i>			Harlequin rasboras	Duncker, 1904	Least Concern (LC)	
<i>Rasbora daniconius</i>			Slender rasboras	Hamilton, 1822	Least Concern (LC)	
		<i>Tanichthys albonubes</i>	Mountain minnow	Lin, 1932	Data Deficient (DD)	
		<i>Puntius tetrazona</i>	Tiger barb	Bleeker, 1855	Not evaluated	
		<i>Puntius pentazona</i>	Five banded barb	Boulenger, 1894	Not evaluated	
		<i>Puntius arulius</i>	Arulius barb	Jerdon, 1849	Endangered (EN)	
		<i>Puntius nigrofasciatus</i>	Black Ruby barb	Günther, 1868	Lower Rick (LR/cd)	
		<i>Pethia phutunio</i>	Dwarf barb	Hamilton, 1822	Least Concern (LC)	
		<i>Puntius denisonii</i>	Red line torpedo barb	Day, 1865	Endangered (EN)	
Cyprinodontifo	Fundulidae	<i>Fundulus diaphanus</i>	Killi fish	Lesueur, 1817	Not evaluated	

rmes	Poeciliidae	<i>Poecilia reticulata</i>	Guppy fishes	Peters, 1859	Not evaluated		
		<i>Poecilia sphenops</i>	Molly fishes	Valenciennes, 1846	Not evaluated		
		<i>Poecilia latipinna</i>	Marble molly	Lesueur, 1821	Not evaluated		
		<i>Xiphophorus maculatus</i>	Platy fishes	Günther, 1866	Not evaluated		
		<i>Xiphophorus variatus</i>	Variatus platy	Meek, 1904	Not evaluated		
		<i>Xiphophorus hellerii</i>	Swordtail fishes	Heckel, 1848	Not evaluated		
		<i>Danio rerio</i>	Zebra fishes	Hamilton, 1822	Least Concern (LC)		
		Osteoglossifor mes	Osteoglossidae	<i>Scleropages formosus</i>	Green arowana	Müller & Schlegel, 1844	Endangered (EN)
				<i>Osteoglossum bicirrhosum</i>	Silver arowana	Cuvier, 1829	Endangered (EN)
				<i>Scleropages aureus</i>	Golden arowana	Pouyaud, Sudarto & Teugels, 2003	Endangered (EN)
<i>Osteoglossum ferreirai</i>	Black arowana			Kanazawa, 1966	Least Concern (LC)		
<i>Scleropages jardinii</i>	Pearl arowana			Saville-Kent, 1892	Not evaluated		
Perciformes	Ambassidae			<i>Parambassis ranga</i>	Indian glassy fish	Hamilton, 1822	Least Concern (LC)
	Channidae			<i>Channa orientalis</i>	Walking snakehead	Bloch & Schneider, 1801	Not evaluated
	Cichlidae	<i>Pterophyllum scalare</i>	Angel fishes	Schultze, 1823	Not evaluated		
		<i>Astronotus ocellatus</i>	Oscar fishes	Agassiz, 1831	Not evaluated		
		<i>Symphysodon discus</i>	Discus fishes	Heckel, 1840	Not evaluated		
		<i>Symphysodon aequifasciatus</i>	Coloured Discus	Pellegrin, 1904	Not evaluated		
		<i>Melanochromis auratus</i>	Golden cichlid	Boulenger, 1897	Least Concern (LC)		
		<i>Cyphotilapia frontosa</i>	Frontosa cichlid	Boulenger, 1906	Least Concern (LC)		
		<i>Heterotilapia buttkoferi</i>	Zebra tilapia	Hubrecht, 1881	Least Concern (LC)		
		<i>Tropheus duboisi</i>	Duboisi cichlid	Marlier, 1959	Vulnerable (VU)		
		<i>Neolamprologus leleupi</i>	Lemon cichlid	Poll, 1956	Least Concern (LC)		
		<i>Mikrogeophagus ramirezi</i>	Butterfly ramirezi	Myers & Harry, 1948	Not evaluated		
		<i>Hemichromis bimaculatus</i>	Jewel cichlid	Gill, 1862	Least Concern (LC)		
		<i>Heros severus</i>	Banded cichlid	Heckel, 1840	Least Concern (LC)		
		<i>Pseudotropheus zebra</i>	Albino cichlid	Boulenger, 1899	Least Concern (LC)		
		<i>Thorichthys meeki</i>	Fire mouth cichlid	Brind, 1918	Not evaluated		
		<i>Sciaenochromis fryeri</i>	Electric blue cichlid	Konings, 1993	Not evaluated		

	<i>Melanochromis johannii</i>	Blue jehanni cichlid	Eccles, 1973	Vulnerable (VU)
	<i>Nimbochromis venustus</i>	Venus cichlid	Boulenger, 1908	Least Concern (LC)
	<i>Metriaclima greshakei</i>	Ice blue cichlid	Meyer & Förster, 1984	Vulnerable (VU)
	<i>Aulonocara hansbaenschi</i>	Peacock cichlid	Meyer, Riehl & Zetzsche, 1987	Vulnerable (VU)
	<i>Pseudotropheus socolofi</i>	Snow white cichlid	Johnson, 1974	Least Concern (LC)
	<i>Pseudotropheus crabro</i>	Crabro cichlid	Johnson, 1974	Least Concern (LC)
	<i>Aulonocara baenschi</i>	Blue Morph cichlid	Meyer & Riehl, 1985	Least Concern (LC)
	<i>Pseudotropheus zebra</i>	White Morph cichlid	Boulenger, 1899	Least Concern (LC)
	<i>Melanochromis auratus</i>	Auratus cichlid	Boulenger, 1897	Least Concern (LC)
	<i>Metriaclima pyrsonotos</i>	Red top cichlid	Stauffer, Bowers, Kellogg & McKaye, 1997	Vulnerable (VU)
	<i>Iodotropheus sprengerae</i>	Rusty cichlid	Oliver & Loiselle, 1972	Vulnerable (VU)
	<i>Aequidens rivulatus</i>	Green terror cichlid	Günther, 1860	Not evaluated
	<i>Amphilophus labiatus</i>	Red devil cichlid	Günther, 1864	Not evaluated
	<i>Cyrtocara moorii</i>	Dolphin cichlid	Boulenger, 1902	Least Concern (LC)
	<i>Pelvicachromis pulcher</i>	Rainbow Krib	Boulenger, 1901	Least Concern (LC)
	<i>Apistogramma ramirezi</i>	Golden ramirez	Myers & Harry, 1948	Not evaluated
	<i>Etroplus canarensis</i>	Canara Pearl spot	Day, 1877	Endangered (EN)
	<i>Rocio octofasciata</i>	Jack dempsy	Regan, 1903	Not evaluated
Datnioididae	<i>Datnioides microlepis</i>	Indonesian tiger	Bleeker, 1854	Not evaluated
Gobiidae	<i>Mugilogobius sarasinorum</i>	Sarasin's Goby fish	Boulenger, 1897	Vulnerable (VU)
Helostomatidae	<i>Helostoma temminckii</i>	Kissing gourami	Cuvier, 1829	Least Concern (LC)
Nandidae	<i>Nandus nebulosus</i>	Asian Leaf fish	Gray, 1835	Least Concern (LC)
Osphronemidae	<i>Trichopodus trichopterus</i>	Gourami	Pallas, 1770	Least Concern (LC)
	<i>Trichopsis schalleri</i>	Stripped gourami	Ladiges, 1962	Least Concern (LC)
	<i>Trichogaster lalius</i>	Dwarf gourami	Hamilton, 1822	Least Concern (LC)
	<i>Osphronemus goramy</i>	Giant gourami	Lacepède, 1801	Least Concern (LC)

		<i>Trichopodus microlepis</i>	Moon light gourami	Günther, 1861	Least Concern (LC)
		<i>Trichopodus pectoralis</i>	Snake skin gourami	Regan, 1910	Least Concern (LC)
		<i>Betta splendens</i>	Fighter fishes	Regan, 1910	Vulnerable (VU)
	Pristolepididae	<i>Pristolepis marginata</i>	Malabar Leaf fish	Jerdon, 1849	Least Concern (LC)
	Scatophagidae	<i>Scatophagus argus</i>	Scat fish	Linnaeus, 1766	Least Concern (LC)
Siluriformes	Callichthyidae	<i>Corydoras aeneus</i>	Albino catfish	Gill, 1858	Not evaluated
		<i>Corydoras paleatus</i>	Peppered catfish	Jenyns, 1842	Not evaluated
		<i>Corydoras sterbai</i>	Sterbai Cory	Knaack, 1962	Not evaluated
	Clariidae	<i>Clarias batrachus</i>	Walking catfish	Linnaeus, 1758	Least Concern (LC)
	Doradidae	<i>Agamyxis pectinifrons</i>	White barred catfish	Cope, 1870	
		<i>Platydoras armatulus</i>	Talking catfish	Valenciennes, 1840	Not evaluated
	Loricariidae	<i>Hypostomus punctatus</i>	Sucker catfish	Valenciennes, 1840	Not evaluated
		<i>Hypostomus plecostomus</i>	Sucker mouth catfish	Linnaeus, 1758	Not evaluated
	Mochokidae	<i>Synodontis eupterus</i>	Featherfin catfish	Boulenger, 1901	Least Concern (LC)
	Pimelodidae	<i>Phractocephalus hemioliopus</i>	Red tail catfish	Bloch & Schneider, 1801	Not evaluated
		<i>Pseudoplatystoma fasciatum</i>	Shovel nose catfish	Linnaeus, 1766	Not evaluated
	Pseudopimelodidae	<i>Microglanis iheringi</i>	Bumblebee catfish	Gomes, 1946	Not evaluated
Synbranchiformes	Mastacembelidae	<i>Mastacembelus erythrotaenia</i>	Fire eel	Bleeker, 1850	Least Concern (LC)
		<i>Macrornathus siamensis</i>	Peacock eel	Günther, 1861	Least Concern (LC)
		<i>Macrornathus pancalus</i>	Barred spiny eel	Hamilton, 1822	Least Concern (LC)
Syngnathiformes	Syngnathidae	<i>Microphis deocata</i>	Pipe fish	Hamilton, 1822	Near Threatened (NT)
Tetraodontiformes	Tetraodontidae	<i>Carinotetraodon travancoricus</i>	Malabar Puffer fish	Hora & Nair, 1941	Vulnerable (VU)

Table 2. Number of freshwater ornamental fishes.

Order	Family	No. of Species
Cypriniformes	Cobitidae	6
	Cyprinidae	21
Perciformes	Ambassidae	1
	Channidae	1
	Cichlidae	33
	Datnioididae	1

	Gobiidae	1
	Helostomatidae	1
	Nandidae	1
	Osphronemidae	7
	Pristolepididae	1
	Scatophagidae	1
Characiformes	Alestidae	1
	Characidae	14
	Serrasalminidae	1
Osteoglossiformes	Osteoglossidae	5
Siluriformes	Callichthyidae	3
	Clariidae	1
	Doradidae	2
	Loricariidae	2
	Mochokidae	1
	Pimelodidae	2
	Pseudopimelodidae	1
Cyprinodontiformes	Fundulidae	1
	Poeciliidae	7
Synbranchiformes	Mastacembelidae	3
Syngnathiformes	Syngnathidae	1
Tetraodontiformes	Tetraodontidae	1
Beloniformes	Beloniformes	1
	Total	122

Table 3. Number of freshwater ornamental fishes in IUCN category.

IUCN Category	No. of fishes
Critically Endangered (CR)	1
Endangered (EN)	8
Vulnerable (VU)	9
Lower Risk (LR/cd)	2
Near Threatened (NT)	1
Least Concern (LC)	48
Data Deficient (DD)	1
Not Evaluated (NE)	52

CONCLUSION

Studies on the Biodiversity of freshwater Ornamental fishes, Phylogeny of Ornamental cat fishes and Biology of *Wallago attu* are very important aspects for aquaculture practices. Not only has the cost benefited ratio, but also to fulfill the malnutrition. It creates awareness among the public that with minimum expenses. One can learn lakhs of rupees per year and also it creates good quality products in addition to unemployment problem. It paves the way for further research of Ornamental fish culture.

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REFERENCES

Aaker, D.A, Kumar, V, and Day, G.S., 1997. Marketing

- research, 6th edn., *John Wiley & Sons Inc*, New York, USA, p. 776.
- Alava, V.R, and Gomes, L.A.O., 1989. Breeding marine aquarium animals: the anemone fish. *Naga. The ICLARM Quarterly*, 12, 12-13.
- Allan, J.D., and Flecker, A.S., 1993. Biodiversity conservation in running waters. *Biosci.*, 43, 32-43.
- Brichard, P.J., 1980. Report to the government of Mozambique on the organization of the ornamental fish trade. Rome, FAO, pp. 57.
- Bruton, M.N., 1995. Have fishes had their chips? The dilemma of threatened species. *Environ. Biol. Fishes*, 43, 1-27.
- Chaston, I., 1983. Marketing in Fisheries and Aquaculture. Fishing News Books Ltd., Farnham, Surrey, UK, p. 141.
- Cheong, L., 1998. Overview of the current international trade in ornamental fish, with special reference to Singapore. *Rev. Sci. Tech. Off. Int. Epa.*, 15(2), 445-481.
- Dawes, J., 1998. International experience in ornamental marine species management. Part 1: perspectives. *Ornamental Fish Int. J.*, 26, <http://www.ornamental-fish-int.org/marinespecies1.htm>
- Dawes, C.J., Teasdale, B.W., and Friedlander, M., 2000. Cell wall structure of the agarophytes *Gracilaria tikvaiae* and *G. cornea* (Rhodophyta) and penetration by the epiphyte *Ulva lactuca* (Chlorophyta). *J. Appl. Phycol.*, 12: 567-575. doi:10.1023/A:1026501613984.
- Day, F., 1989. The Fauna of British India including Ceylon and Burma Fishes. 1: 548: 2: 509. The London, Taylor and Francis.
- Dey, M.M. and Eknath, A., 1996. Current trends in the Asian tilapia industry and the significance of genetically improved tilapia breeds. p.59-77, in: Nambiar and Singh (eds). *Sustainable Aquaculture. Proc. Infofish-Aquatech '96 Int. Conf. Aquacul.*, Kuala Lumpur, Malaysia, p. 25-27.
- Duncan, J.R. and Lockwood, J.L., 2001. Extinction in a field of bullets: a search for causes in the decline of the world's freshwater fishes. *Biol. Conser.*, 102, 97-105.
- Fossa, S.A., 2001. "Genetically modified organisms in the aquatic trade?" *Ornamental Fish Int. J.*, 39, consultado. en <http://www.glofish.com>.
- Gong, Z., Ju, B., and Wan, H., 2001. Green fluorescent protein (GFP) transgenic fish and their applications. *Genetica*, 111, 213-225.
- IUCN, 2008. http://www.iucnredlist.org/documents/2008RL_stats_table_1_v_1223294385.pdf
- IUCN, 2011. IUCN Red List of Threatened Species. IUCN, Gland, Switzerland.
- Jayaram, K.C., 1981. The freshwater fishes of India, ZSI, 1-438.
- Jayaram, K.C., 1991. Revision of the Genus *Puntius* Hamilton. Records of the Zoological Survey of India - Occasional Paper No. 135, Zoological Survey of India, Kolkata, India.
- Jonathan Z Long, Chantal S Lackan and Anna-Katerina Hadjantonakis, 2005. Genetic and spectrally distinct *in vivo* imaging: embryonic stem cells and mice with widespread expression of a monomeric red fluorescent protein. *BMC Biotechnol.*, 5, 20.
- Kumar, S., Srivastava, A. and Chakrabarti, R., 2005. Study of digestive proteinases and proteinase inhibitors of *Daphnia carinata*. *Aquaculture*, 243, 367-372. doi:10.1016/j.aquaculture.2004.10.011.
- Lakra, W.S., Rehna, A., Singh, A.K., Rathore. G., Sood, N. and Rajaswaminathan, T. (eds), 2006. Fish introductions and quarantine: Indian Scenario. A publication of NBFGR, Lucknow, India.
- Larkin, S.L., Adams, C.M., Degner, R.L., Lee, D.J. and Milon, J.W., 2001. An economic profile of Florida's Marine Life Industry. Sea Grant Technical Paper N. 113, University of Florida Gainesville, pp. 61.
- Leidy, R.A. and Moyle, P.B., 1998. Conservation status of the world's freshwater fish fauna: an overview. In: Fielder PL, Karieva PM (eds.). *Conservation Biology: for the coming decade*, 2nd edn, pp. 187-227. Chapman and Hall, New York.
- Ling, K.H. and Lin, L.Y., 2005. The status of ornamental fish industry in Singapore. *Singapore J. Pri. Ind.*, 32, 59-69.
- Menon, A.G.K., 1999. Checklist of freshwater fishes of India. Records of Zoological Survey of India, Miscellaneous Publication, Occasional Paper No., 179, 1-366.
- Moyle, P.B., 1986. Fish introductions into North America: patterns and ecological impact. In: Mooney HA, Drake JA (eds.). *Ecology of biological invasions of North America and Hawaii*. pp. 27-43. Springer-Verlag, Berlin.
- Nelson, 1976. *Fishes of the World*. 3rd Edn., John Wiley and Sons, New York, p. 416.
- Olivier, K., 2001. The ornamental fish market (No. 67). FAO/GLOBEFISH Research Programme, Rome, FAO, pp. 91.
- Rao, C.H.H., 2000. Declining demand for foodgrains in rural India: Causes and implications. *Econom. Polit.*

Weekly, 35(4), 201-206.

Sane, S.R., 2005. The export growth of ornamental fish constraints. Paper presented in the conference on Ornamental fish export, (4th April 2005, Cochin) MPEDA and INFOFISH, Cochin, 9-12.

Talwar, P.K. and Jhingran, A.G., 1991. Inland Fishes of India and adjacent countries (Volume I & II). Oxford

& IBH Publishing Co. Pvt. Ltd., New Delhi, 541, 542-1158.

Tomey, W.A., 1997. Review of developments in the world ornamental fish trade: update, trends and future prospects. Sustainable Aquaculture; Proceedings of INFOFISH-AQUATECH 96. Int. Conf. Aquaculture, Kuala Lumpur, Malaysia, INFOFISH.