Ornamentals Kerala 2014

SOUVENIR

7TH INDIA INTERNATIONAL AQUA SHOW 2014

26-27 January 2014, Cochin, India

Department of Fisheries,
Govt. of Kerala

Ministry of Agriculture
Govt. of India

FIRMA

Ornamentals Kerala 2014

SOUVENIR

INTERNATIONAL SEMINAR
ON

ORNAMENTAL FISH BREEDING, FARMING AND TRADE

26, 27 January 2014

Organised by

Ministry of Agriculture
Govt.of India

Department of Fisheries
Govt. of Kerala

FIRMA

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7TH INDIA INTERNATIONAL AQUA SHOW 2014

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Prof. Dr. B. Madhusoodana Kurup
Chairman, Ornamentals Kerala 2014, Cochin
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OOMMEN CHANDY
Chief Minister
Kerala

MESSAGE

Ornamental fish has gained prominence in International trade and plays a significant role in the economy of developing countries like India. Both Government of India and Government of Kerala have initiated several steps to popularize ornamental fisheries. The biennial India International Aqua Show (IIAS) is one such initiative that offers a unique platform for all the stakeholders to showcase their products to the leading fish importers/exporters across the world and to facilitate business tie-ups.

I am confident that IIAS 2014 and Ornamentals Kerala will act as a catalyst for the development of ornamental fishery as a commercial and export oriented enterprise. I extend a wholehearted welcome to all delegates to participate in the India International Aqua Show 2014 and Ornamentals Kerala.

OOMMEN CHANDY

K. BABU
MINISTER FOR FISHERIES,
PORTS AND EXCISE
KERALA

MESSAGE

It gives me great pleasure to invite you to the 7th India International Aqua Show 2014. The IIAS will focus on encouraging fish breeders and entrepreneurs in the field and help them explore new markets and contacts. Ornamental fisheries sector is fast gaining importance due to the remarkable economic opportunities which it offers, the huge potential in providing employment to the people hailing especially from the rural sector and as a foreign exchange earner. I am confident that IIAS 2014 and Ornamentals Kerala will act as a platform for stake holders to join hands with international players in the field and serve as a vehicle for the expansion of ornamental fisheries sector in the state. I extend a warm welcome to all delegates to participate in the India International Aqua Show 2014 and Ornamentals Kerala.

K. BABU

PREFACE

Ornamentals Kerala 2014 – The international seminar on "Ornamental Fish Breeding, Farming and Trade organized jointly by the Department of Fisheries, Govt. of Kerala and Ministry of Agriculture, Govt. of India during 26th -28th January, 2014 at Cochin has received overwhelming response. This seminar was organised as a part of India International Aqua show 2014 scheduled to be held at Cochin during 24th -28th January, 2014. Though the global trade of ornamental fishes including accessories grossed to US$ 20 billion with an annual growth rate of 8%, the share of India is so insignificant with just around Rupees Six Crores. It is high time to share the experience on various aspects of ornamental fisheries such as technological innovations and policy issues on import of live aquarium fishes, accessories, feeds, trade and quarantine procedures among Asian countries, on a common platform for a full realization of the potential associated with this sector. It is expected that the seminar would be a great success with the participation of all stakeholders representing industry, farming, researchers, entrepreneurs, etc. We are much fortunate to have experts from Singapore, Norway, Netherlands, Indonesia, Sri Lanka and Australia who are leaders in the production and exports of ornamental fishes.

This seminar received wide support and encouragement from various organizations and the industry. This book of souvenir contains 14 scientific contributions from different parts of globe in five sessions under eight themes. It is hoped that the deliberations of this seminar will go a long way in increasing global export, introduction of new varieties in the trade, improving sustainability of wild stock especially when natural resources are facing threat of overexploitation. It is also hoped that the deliberations of this seminar will be immensely useful in adopting novel techniques for captive breeding and seed production of the native ornamental fishes, application of biotechnological tools for their value addition, examination of the policies and legislations for revision in tune with neighbouring Asian countries for tapping the full potential associated with this sector for earning higher foreign exchange and generating more employment in the country.

We wish to place on record our sincere thanks and appreciation to the members of Organizing committee, for their untiring effort in making Ornamentals Kerala 2014 a memorable event in Global ornamental fisheries Industry.

Prof. (Dr.) B. Madhusoodana Kurup
Chairman
Ornamentals Kerala 2014

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Current status and future of Indian ornamental fish industry

B. Madhusoodhana Kurup
Vice chancellor
KUFOS, Cochin

Introduction

Ornamental fish keeping is the second largest hobby in the world next to photography. With the changing mode of life styles and increasing mental tension, watching the serene beauty of fishes splashing the naturally preserved habitat of an aquarium tank is the best method of relaxation for both mind and body. It is to be noted that most of ornamental fish have much higher value than food fish, and may provide a good alternative livelihood for fishermen. Ornamental fish culture also ensures socially equitable distribution of benefits along the value chain as this activity is time bound, labour intensive and livelihood options of vulnerable sections of the society like housewives and unemployed youth (Ghosh et al., 2003). In India, especially in the major cities, it is easy to find a number of large aquaria's with great diversity of fish, both domesticated and wild caught, being sold at a reasonably higher cost. However, it is surprising to note that, expect a few species most of them are exotic in origin, predominantly South American. The ornamental fish sector plays a vital part in international fish trade contributing positively to rural development in many developing countries, with a positive impact throughout the value-chain (Monticini, 2010).

About 600 ornamental fish species have been reported worldwide from various aquatic environments. Indian waters possess a rich diversity of ornamental fish, with over 100 indigenous varieties, in addition to a similar number of exotic species that are bred in captivity. The growing interest in ornamental fish keeping has resulted in a steady growth in the ornamental fish trade, along with rapid developments in breeding techniques, display systems and accessories. An estimate carried out by Marine Products Export Development Authority of India shows that there are one million fish hobbyists in India.

Ornamental fish trade - Global scenario

The aquarium fish trade is a large, biodiverse, global industry (Tlusty et al., 2013) worth around 15–30 billion US$ (Penning et al., 2009) and involving 5300 freshwater and 1802 marine fish (Hensen et al., 2010; Rhyne et al., 2012a). The industry is growing at a rate of about 8% annually. Talking about the ornamental fishes in the world trade, 60% of the fishes are of freshwater origin, 30% marine and 10% brackish water origin. Of the freshwater fishes, 60% are wild caught fishes and the rest 40% are bred varieties. Globally there is a steady increase in the ornamental fish trade due to the enhanced popularity. The demand for ornamental fish in the industrialized nations is being met by imports, the volume of which is increasing year by year. The largest import markets for tropical fish are U.S.A, Japan and Western Europe and the individual market share are USA, Japan, Germany, UK, France, Singapore and others. 60.3% of the suppliers to these countries are Asian countries like Singapore, Malaysia, Indonesia, China, Philippines, Sri Lanka, Thailand, Taiwan, India and

others. The biggest exporter of ornamental fishes in the world is Singapore followed by Malaysia, Indonesia and Czech Republic.

Ornamental fish trade -Indian Scenario

Aquarium keeping as a hobby in India is nearly 70 years old and it began with the British who ruled India until 1947 (Ayyappan et al., 2006). The concept of entrepreneurship development through ornamental fish farming is gaining popularity (Ayyappan loc. cit.). India is bestowed with the climatic conditions ideally conducive for growth, maturation and breeding of many exotic as well as indigenous ornamental fishes. The Western Ghats in the southern peninsula and the North-Eastern Region of India are considered to be two of the 34 Biodiversity 'hotspot' areas of the world. Marine Ornamental Fishes are available in the Lakshadweep Islands, A & N Islands and in the Gulf of Mannar. In India, there are two major segments in the ornamental fish trade sector, viz. collection, rearing and export of native (wild caught) varieties and breeding, rearing and selling of exotic species. However, India's contribution to the international trade of ornamental fish is very low compared to major exporting countries. Out of more than 300 species exported from India, around 90% were sourced from the wild in the early stages of the industry.

A look into the ornamental fish trade scenario in India indicates that more emphasis is given to the exotic ornamental fishes in the domestic markets. The exotic ornamental fishes occupy all the domestic market segments in India to the tune of 70-80% and the share of indigenous ornamental fishes is about 10%. The common exotic varieties in the domestic market include gold fishes, angels, guppies, mollies, etc. The domestic market of ornamental fish in India is almost completely held by home hobbyists (99%), with only 1 % by public aquaria and research institutes. The present trend of domestic market appears to be promising with a steady growth rate in the recent times. The demand is increasing day by day since more and more entrepreneurs are attracted to this field especially to the wholesale and retail markets but the production is not coping with the demand. More than 200 species of fresh water ornamental fishes are bred in India for the domestic market. Most of the priced varieties are imported from other countries.

The marine ornamental fish market in India is still in its infancy. Now there is only domestic market for this sector, that too only in a limited and controlled way. A few entrepreneurs trained in marine fish 'keeping have recently stepped into the arena, especially in the coastal cities. But their share in the total domestic trade is negligible and also no regular supply of these fishes to the domestic trade. Lack of proper knowledge in maintaining the system including water quality maintenance is the major decelerating factor of Indian marine ornamental fish trade. India is a treasure trove of fish fauna. More than 600 freshwater fishes are reported from India. Yet, the awareness regarding the indigenous ornamental fishes and shellfishes is limited and resources have not been tapped to the optimum economic benefit. The potential of live tropical fishes in the international aquarium fish marketing arena is immense and India possesses the ability to export tank raised as well as wild caught varieties to overseas countries. At present, only about 220 species of live ornamental fishes are being exported from India. As far as the export of ornamental fishes is concerned, 85% of our total export is made up of wild caught fishes of freshwater origin, majority of which come from North Eastern region. The remaining are either tank raised bred and reared varieties of exotic species. If the resources are judiciously tapped with the application of natural resource management, the country can increase its export earnings

several fold and generate additional employment opportunities especially in the rural sector. On comparison of the resource and infrastructure available for ornamental fish trade in the country with others, it is evident that neighbouring countries like Sri Lanka, Malaysia, Thailand, etc. with very limited resources and infrastructure are far ahead of us in this sector. The important ornamental fish collection centres in India are North Eastern states. By virtue of access to international airport, Kolkata has become the major trade Centre in India.

Market diversity of Indian ornamental fish trade

Markets for Indian ornamental fishes have never been consistent, since the geographical spread of the markets has exhibited an ever changing hue. Singapore, USA, China Hong Kong SAR (Special Administrative Region), Malaysia and Japan are India's favourite top five market destinations and accounts for about 70% of total exports from India. India's favourite market destination is Singapore accounting for almost 42.85%, followed by Japan (13.88%) and Malaysia (9.97%). USA and China, Hong Kong, SAR, both accounting for 7.5% each. Others include Germany, United Arab Emirates, United Kingdom, Thailand and Netherlands.

During the year 2010-11, India Exported Ornamental Fish for 1.26 Million USD which is only about 0.3% of the Global trade. Port wise export of Ornamental fishes from India during the last 5 years is given in Table.1. Major Centers of Ornamental fish exports in India are Kolkata, Chennai, Mumbai, Kochi and Bangalore. Kolkata along with adjoining districts has become the major ornamental fish producing zones of India and a major export centre. About 90% of Indian exports are from Kolkata followed by 8% from Mumbai and 2% from Chennai. (Ghosh et al., 2003). Most of the ornamental fish activities are concentrated in 5 Indian states viz. West Bengal, Maharashtra, Karnataka, Tamil Nadu and Kerala.

Current position and scope of Ornamental Fish Diversity in North East region of India

All the North-Eastern States, namely, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, are gifted with vast aquatic resources which are harbouring diverse ornamental fishes with immense commercial importance. The ornamental fishes are diversified over 37 families, 114 genera and 10 orders. Out of the total 274 fish species reported from this region, around 250 species (91 per cent) possess ornamental value. The major species having a large number of ornamental fishes belong to the Order Cypriniformes, followed by Siluriformes and Perciformes. The native ornamental fishes can be classified on the basis of their diversified character, such as beautiful colour (e.g., *Pseudecheneis sulcatus, Tetradon cutcutia*), stripes & banding pattern (e.g., *Botia rostrata, Brachydanio rerio*), chamelionic habit (e.g., *Badis badis, Puntius shalynius*), jumping behaviour (e.g., *Esomus danricus, Chela laubuca*), charming predatory habit (e.g., C*hanna orientalis, Glossogobius giuris*), calm behaviour (e.g., *Ctenops nobilis, Nandus nandus*), transparent body (e.g., *Chanda mama, Pseudambassis b*aculis), small size (e.g., *Danio dangila, Brachydanio rerio*), hardiness (*Anabas testudineus*) and suckers (e.g., *Garra gotyla gotyla, Garra mcllendi*).

It is estimated that nearly 200 species of ornamental fishes are exported from India, out of which 85 per cent are from the North-Eastern states (Nair, 2004). The market opportunities for the local ornamental fish species are rising gradually in both domestic and international markets. The price of native ornamental fishes varied from Rs 3 to Rs 50

Table 1. ORNAMENTAL FISH PORT WISE EXPORT IN INDIA

Q: Quantity in tons, V:Value in ' Crore, $:USD(M)

Port Name		2006-07	2007-08	2008-09	2009-10	2010-11
CALCUTTA	Q:	102.550.56	9	11	10	36
	V:		1.98	2.68	2.76	3.34
	$:		0.49	0.60	0.58	0.74
CHENNAI	Q:	281.570.35	33	22	22	8
	V:		1.30	0.87	0.99	0.63
	$:		0.32	0.20	0.21	0.14
MUMBAI	Q:	110.370.08	12	17	3	3
	V:		0.46	0.58	0.55	0.66
	$:		0.12	0.13	0.12	0.15
JNP	Q:	00.000.00	0	0	0	0
	V:		0.00	0.00	0.00	0.01
	$:		0.00	0.00	0.00	0.00
MANGALORE/ICD	Q:	40.190.04	10	10	14	8
	V:		0.62	0.58	0.82	0.40
	$:		0.15	0.13	0.17	0.09
TRIVANDRUM	Q:	20.090.02	2	2	2	2
	V:		0.04	0.05	0.12	0.15
	$:		0.01	0.01	0.02	0.03
KOCHI	Q:	190.780.17	23	8	6	10
	V:		1.36	0.63	0.19	0.35
	$:		0.33	0.14	0.04	0.07
DELHI	Q:	00.000.00	0	0	0	0
	V:		0.10	0.03	0.07	0.00
	$:		0.02	0.01	0.02	0.00
CALICUT	Q:	00.000.00	0	0	0	0
	V:		0.00	0.00	0.00	0.00
	$:		0.00	0.00	0.00	0.00
BANGALORE	Q:	00.000.00	0	0	0	3
	V:		0.00	0.00	0.00	0.17
	$:		0.00	0.00	0.00	0.04
Grand Total	Q:	755.551.23	89	69	56	70
	V:		5.85	5.43	5.49	5.69
	$:		1.45	1.23	1.16	1.26

(Source-MPEDA)

per piece across the domestic market. Most of the native ornamental fish species from the North-Eastern region were highly preferred by the hobbyists across the globe (e.g., *Anabas testudineus, Botia, Danio*, etc.). Many of the highly preferred native ornamental fish species (e.g., *Balitora brucei, Botia berdmorei*, etc.) are becoming less abundant in the natural condition because of their over-exploitation or degradation of water bodies and need urgent attention for their sustainable utilization. Interestingly, due to lack of steady supply of common ornamental fishes, many new species (e.g., *Ailia coila, Anguilla bengalensis*, etc.) were emerging as ornamental fishes and the trade opportunities in these species were expanding, which was an added advantage to sustaining the agribusiness opportunity of this

industry. This category of potential ornamental fishes is a ready reference for an entrepreneur to explore the entrepreneurial opportunities.

Although North-Eastern states produce a bulk of the India's ornamental fish exports, the region still remains relatively untapped for the development of ornamental fisheries. Increasing agribusiness opportunities of these live fishes in the world market could be a matter of concern for the sustainability of this natural wealth in the long run, since the supply is entirely dependent on wild catch. In spite of being a renewable resource, indiscriminate harvesting of ornamental fishes from the natural water bodies is likely to cause serious depletion of the stock, particularly of those species which are already under the threat of extinction or endangerment. The depletion of fish diversity will reduce opportunities in the aqua-business. Enormous agribusiness opportunities can be explored in systematic collection and marketing of native ornamental fishes (wild catch) as well as rearing of exotic ornamental fish species (captive breeding) suitable in the region. Perhaps the opportunity of gainful employment underlines at all the levels of activities in the ornamental fish industry, viz. production, marketing and exports. Besides, the corporate sector must share the 'corporate social responsibility' through active participation in various conservation measures involved in the ornamental fisheries.

Marketing of Ornamental Fish in North–Eastern Region – Status and Prospects

Despite having tremendous growth potential, the ornamental fish sector in the North-Eastern states remains untapped mainly due to lack of systematic marketing, poor infrastructure (essential for transportation of vulnerable live fishes) and lack of access to market information. It was also learnt that some deliberate and biased practices were being followed by traders, such as accepting fish from selected fish farmers or collectors only. The marketing system was highly unorganized and no direct export was being done. Only a few traders collect the native ornamental fishes through local collectors and supply them to different exporters based in Kolkata, Howrah, Mumbai, Chennai, Trivandrum and Cochin. The most prevailing marketing channel of ornamental fish marketing was: collectors – unregistered small traders – wholesalers – exporters at various ports. Estimation showed that exporter enjoyed the lion's share of profit (45 per cent), followed by wholesaler (30 per cent), unorganized trader (20 per cent), and a meager share of 5 per cent was realized by the collectors (Mahapatra et al., 2006). This pattern of profit-sharing indicated that the benefit of this industry was distributed unequally, depriving the farmers or collectors heavily. This could be improved by providing pertinent training to the interested farmers on captive breeding and rearing of ornamental fishes and providing incentives and assistance to them to create basic infrastructure for a fishery unit. Since the water resources of the North-Eastern states are endowed with diverse ornamental fishes with high market value, the potential of this industry is very high. However, training on breeding of native and exotic ornamental fishes must be given to the farmers to make this business ecologically and economically sustainable in the long-run

Current positional and scope of Ornamental Fish Diversity in Western Ghats and Kerala

The Western Ghats, extending for over a length of 1600km, lying parallel to the coast hardly 50km away, form one of the magnificent escarpments of late Tertiary age. World conservation monitoring centre has identified Western Ghats as one of the important freshwater biodiversity hotspots. Western Ghats forms a major source for varieties of freshwater

fishes in India. *Puntius denisonii* (Red line torpedo fish), *Puntius arulius* (Aruli barb), *Puntius conchonius* (Rosy barb), *Puntius filamentosus* (Tiger barb), *Puntius ticto ticto* (Ticto barb), *Puntius vittatus* (Koolie barb) *Puntius fascialtus* (Melon barb), *Parambassis thomassi* (Glass fish), *Horabagrus brachysoma* and *Horabagru nigricollaris* (Yellow cat fishes) have already secured a position in the national and international markets as ornamental fishes while the rest of the species have tremendous potential for their introduction as ornamental species.

Streams of Kerala (ie., Southern and Central division of Western Ghats) have been identified as one of the few sites in the world showing exceptional biodiversity and high degree of endemism with respect to the freshwater fishes (Kurup, 2002). The water bodies of Kerala are blessed with more than 200 fish species resources. 104 species are potentially usable as ornamentals fishes with respect to attractive nature fascinating appearance and brilliant colouration, which could promote them as ornamental fishes in the domestic and international trade.Distribution of 15 species, was restricted to 2 rivers, while 6 species were recorded from 3 rivers. Thirty species were found well confined to the water bodies of Kerala only (endemic). Species such as *Puntius denisonii, Nemacheilus keralensis, Oseobrama bakeri, Chela fasciata, Hypselobarbus micropogon periyarensis, Silurus wynaddensis, Neolissochilus wynaadensis, Puntius ophicephalus*, *Garra surrendranathanii, Garra menonii* etc. are coming under this group. The diverse inland and marine water bodies of Kerala harbour rich resource of eye catchingly beautiful fishes, which can be judiciously utilized as ornamental fishes. Adorned with colourful bands and blotches, spots and colourations of the fins and body, the indigenous fishes of Kerala have started creating a niche of their own in the ornamental fish marketing scenario. The export of ornamental fishes from Kerala began only recently in the 1990s and the export is mainly concentrated on the wild caught species. The actual exporters from Kerala are only 1 or 2 and majority of the people who claimed to be exporters were actually suppliers to exporters in Chennai, Calcutta or Bombay. Indigenous ornamental fishes fetch only feeble price in Kerala where as they fetch a high price in the export markets. Products price is a major determinant of the market demand for it. Hence we can say that there is a good demand for the indigenous ornamental fishes in the export market compared to domestic market and that the indigenous varieties are more in demand internationally than the exotic varieties.

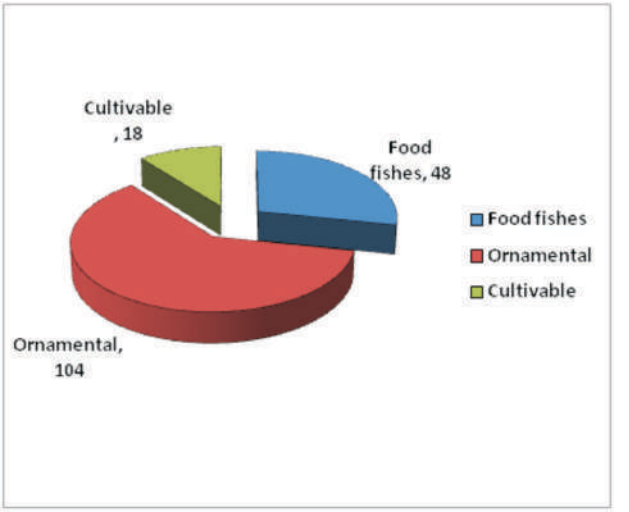

Fig 1. Details of ornamental, food fishes and cultivable freshwater fishes from Kerala

Potentials of ornamental fish culture in India

Ornamental fish culture is an excellent business opportunity in India since there is strong demand from domestic and export markets. Ornamental fisheries in India have a good potential due to enormous geographical spread, extensive species diversity, and intensive research and development efforts that are already put in by the associated institutions. Indian ornamental fish trade is mostly with

fresh water fishes (90%) of which 98 percent are cultured and two per cent are captured from wild. The rest 10 per cent of total ornamental fish trade are with marine fishes of which 98 percent are captured and two per cent from cultured. With tropical climate, Western Ghats and North Eastern Ghats are 'hot spots' or important areas identified for ornamental fish breeding and culture (Mercy et al., 2003). Chennai, Kolkata, Mumbai, and Kochi are established business sites of ornamental fish trade. Of late, Goa is also emerging as an important centre in this business. Most ornamental fish trade from these centres are of mixed type of freshwater and marine fishes. Major portion of ornamental fish export is done from Kolkata followed by Mumbai and Chennai . In Kolkata, ornamental fish farms are located in North and South 24 Parganas, Nadia, Hooghly and Howrah districts and about 2000 people are involved in this trade. However, mostly freshwater ornamental fish species are cultured here. In Tamil Nadu, Kolathur village near Chennai is famous for ornamental fish production as cottage industry. There are about 600 families involved in this activity and they earn about Rs. 5,000/month per household. In Kerala, Marine Products Export Development Authority (MPEDA) and Kerala State Cooperative Federation for Fisheries Development (Matsyafed) have provided financial assistance to more than 500 farmers belonging to 11 Districts for ornamental fish culture. The Fish Farmers Development Agency **(**FFDA) and Krishi Vigyan Kendra of Central Marine Fisheries Research Institute also provide training to the farmers in ornamental fish culture in Kerala

Breeding of indigenous Freshwater ornamental species

Central Institute of Freshwater Aquaculture (CIFA) has successfully bred and standardized the successful rearing of 16 indigenous ornamental species such as Barbs, Danios, Rasboras, Catfishes, Eels and Cichlids. Kerala University for Fishery science and Ocean studies (KUFOS) has bred Black spot barb *(Puntius filamentosus),* Melon barb *(Puntius fasciatus, Punrius melanostigma* and *Puntius pookodensis),* Mullya garra *(Garra mullya),* Malabar Danio *(Danio malabaricus).* Malabar hatchet chala *(Chela fasciata),* Batik loach *(Nemacheilus triangularis, Nemacheilus semiamatus)* and Malabar leaf fish *(Pristolepsis marginata)* and Denison Barb (*Puntius denisonni).* College of Fisheries Agartala, North East developed the breeding technology of Spotted spiny eel *(Macrognathus aculeaus),* Golden snakehead *(Chana srewartii),* Giant Danio *(Danio acquipinatus),* Blackline rasboras *(Rasbora daniconius),* Giant Gourami *(Colisa fasciata),* Dwarf Gournami *(Colisa lalia).* Day's Mystus *(Mystus bleekeri)* and Ticto barb *(Puntius ticto ticto)*

Breeding of Marine ornamental fishes

Potential marine ornamental fish species resources found in India are: Clown fish, Damsel fish, Moorish idol, Lion fish, Parrot fishes, Box fishes or trunk fishes. Marine angels, Butterfly fish, Cleaner wrasse, Cardinal fishes, Surgeon fishes, Hawk fishes, Bat fishes, Puffer fishes and Seahorses. CMFRI, Kochi and CAS-MB, Parangipettai have made some progress with following species.

CMFRI - marine ornamental fishes and invertebrates Clown fishes *(Atphiprion chrysogaster, A. sebae),* Sea horse *(Hippocampus kudu),* Star fish *(Peataceraster regulus),* Damsel fishes (*Neopomacentnrus filamentosus*, *N. nemurus, Poniacentrus caerulus),* Cuttle fish *(Sepiella inermis),* Abalone *(Haliotis varia),* Sea cucumbers *(Holothuria scabra* and *H. atra)*

CAS-MB, Annamalai University, Parangipettai- Sabae clown fish *(Amphiprion sebae),* Orange clown fish (A. *percula),* Clown anemone fish *(A. ocellaris),* Yellow tail clown fish *(A. carkii),* Spine cheek anemone fish

(Premnas biacueatus), Coral demoiselle *(Neopomacentrus nemurus),* Caerulean damsel *(Pomacentrus caeruleus),* White tail dascyllus *(Dascyllus aruanus)* and Three spot dascyllus *(D. trimaculatus)*

Government of Kerala has embarked on a structured programme to develop the ornamental fish sector through farming. Given the environmental and climatic suitability, local availability of a range of required raw materials and access to a well-developed aquaculture industry, the state has the required material pre-requisites in place to develop and expand a significant ornamental fish sector. The State of Kerala has developed a common platform of services in the form of an AQUA TECHNOLOGY PARK (ATP), the first of this kind in India, to provide operators with a ready to use onsite units for marketing and sales (both exports and domestic) of ornamental fish and satellite farms for production. A company named Kerala Aqua Ventures International Ltd. (KAVIL) has been formed with shareholders to manage the ATP. The Aqua Hub site contains a dedicated company facility having provisions for quarantine facilities and a R&D complex. The Company provides common services such as water, electricity, laboratory services, and quarantine, R&D and extension services to independently owned and managed, on site, ready-to-use fish conditioning and packing units. These sales and marketing units are linked to downstream satellite farmers and their associated homestead producers across the 14 districts of Kerala. The ATP also provides opportunities for a limited number of wild collectors of freshwater fishes and hence supports alternative livelihood opportunities. The ATP comprises satellite farms built on government and private lands. These farms have an association with homestead farms who will outgrow fish for satellite farms on a buyback scheme. The fish reared on satellite farms brought to the Aqua Hub in climate-controlled vehicles where they are reconditioned and packed for sale to national and international markets. The ATP is facilitated with the construction of CPU, containing two main sections; an external facility containing conditioning concrete tanks for conditioning incoming fish for 7-10 days and an internal packing house containing glass tanks for final quality control checks and a packing area for boxing the fish conditioned for sale. The packing facility has a climate control room to maintain the fish at around 20-22^{o}C. Each CPU is enclosed within a compound wall to enhance biosecurity and provide added security

Growing domestic market and opportunities for ornamental fishes in India

Although no definitive surveys on the domestic demand have been conducted for ornamental fish, available information suggests that the domestic market may be huge. According to Lukram (2005) the domestic ornamental fish market is worth around Rs. 500 million and the demand is increasing at 20% annually. Other reports suggest annual growth as high as 40%/yr (International Market News 27 Sep 2005), while another states the sector is worth Rs. 10 crores. This optimism can be further confirmed by encouraging shifts in the number of households and concomitant increasing wealth. Since the early 1990's the total number of households has increased by 32% with new household formation being a potential source of demand for ornamental fish (Suman Bery, 2004). The domestic sector in India, therefore, potentially offers a huge untapped market in the coming decades.

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CITES and the Ornamental Fish Trade

Svein A. Fosså
*Aquarium Trade Consultant**
President, European Pet Organization (EPO)
CITES Expert, Ornamental Fish International (OFI)
Secretary General, Norwegian Pet Trade Association (NZB)
**Akvariekonsulenten, Fladefjell 15, NO-4878 Grimstad, Norway*
Email: sfossa@online.no

Introduction

CITES – or the *'Convention on International Trade in Endangered Species of wild fauna and flora'* – is an international agreement between governments, aimed at ensuring that international trade in wild animals and plants does not threaten their survival. Through a set of regulations the convention restricts the free trade in listed species, and it is thereby of importance to all trade in wild species, including the ornamental fish industry.

CITES was drafted after a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union). The text of the Convention was finalised and agreed upon at a meeting of representatives of 80 countries on 3 March 1973. Since the founding meeting took place in Washington DC, CITES is sometimes also referred to as the Washington Convention.

States (countries) choose to become parties to CITES voluntarily, but in all practicality it is very difficult to be involved in international trade of wildlife and wildlife products without being a party. Thus, as per today, no fewer than 178 states have signed up to CITES, leaving only 15 UN member countries as non-Parties. India was the 25 country to join the convention, already in 1976.

Although CITES is legally binding on the Parties, it does not take the place of national laws. Instead, it provides a framework to be respected by each Party, and the Parties must themselves implement this into its own domestic legislation.

How CITES works

CITES works by subjecting the international trade in specimens of selected species, be it plants or animals, to certain control systems. All import, export, and re-export of a species covered by the Convention must be authorised through a licensing system. For most of the involved species, it does not matter whether the specimens are live, dead, whole or in parts, raw or processed, or even wild caught or captive bred. The control regimes and paper work involved will, unless specifically exempted, be the same.

Each Party to the Convention must designate one or more Management Authorities in charge of administering that licensing system, and one or more Scientific Authorities to advise them on the effects of trade on the status of the species.

The species covered by CITES are listed in three Appendices, according to the degree of protection they need, and dependent on which appendix a species is placed in, the restrictions applied will differ. Since the convention is all about international trade, no species should, in principle, go on CITES unless it is

known or believed to be subject to such trade, and it is perceived that this trade can negatively influence its survival. In other words, there are both biological criteria and trade criteria that need to be fulfilled for a species to be listed on CITES.

Conference of the Parties

The biological and trade criteria for listing, which are used to help determine whether a species should be included in CITES, have been agreed on by the Conference of the Parties (CoP). The CoP is the supreme decision-making body of the Convention and comprises all its member states. At each regular meeting of the CoP, Parties submit proposals based on these criteria to list (or de-list) species in CITES, which are discussed and ultimately put to a vote. The species included in CITES may be listed on three different appendices.

Not only the Parties take part in the discussion at CoPs. It is also open to NGOs such as conservation organisations, animal welfare organisations and trade associations. Trade associations that typically will attend a CoP include Ornamental Fish International, the European Pet Organisation, Ornamental Aquatic Trade Association - UK, and the Pet Industry Joint Advisory Council - USA.

In addition to the CoP, work in CITES is also done in a Standing Committee, which makes recommendations on policies, and the Animal and Plants Committees that make recommendations on science. The daily running of the convention is handled by the CITES Secretariat, located in Geneva, Switzerland.

The three appendices

Appendix I include species that are considered to be threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances, and commercial trade will normally not be accepted except of captive bred specimens from CITES certified breeding operations.

Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilisation incompatible with their survival.

Actually, the vast majority (more than 96 %) of the nearly 35.000 species of plants and animals currently covered by CITES are in Appendix II. Contrary to many people's beliefs, listing in this appendix does not mean that trade (at controlled levels) necessarily is neither harmful to the survival of the species nor illegal. The only demand for App. II species is that the trade is monitored and proven to be sustainable.

Still, an App. II listing adds much to the paper work and bureaucracy surrounding the trade, and substantially increases the risk of penalties and of shipments being confiscated even due to miniscule errors in the permits. The trade associations are therefore generally sceptical towards listings that are unlikely to have any effect on the status of the species in the wild, e.g. because all trade already is done in captive bred specimens only, or from already regulated wild collection – as sometimes is the case with species that are proposed for listing.

Appendix III contains species that are protected in at least one country, which through the listing requests other CITES Parties for assistance in controlling and monitoring the trade. Changes to Appendix III follow a distinct procedure from changes to Appendices I and II, as each Party is entitled to make unilateral amendments to it, without bringing it for the CoP. On the other hand, trade regulations are therefore also much less restrictive for species on appendix III.

Trade regulations

A specimen of any CITES-listed species may be imported into or exported (or re-exported) from a State party to the Convention only if the appropriate documents have been obtained and presented for clearance at the port of entry or exit. There is some variation on the requirements from one country to another and it is always necessary to check on the national laws that may be stricter than laid out in the Convention, but the basic conditions that apply for Appendices I and II are described below.

According to the CITES Convention, countries are allowed to make stricter regulations than those defined by the convention. The European Union has decided to implement the CITES legislation through Regulation 338/97/EC. This regulation applies to all countries of the European Union and go far beyond the original CITES Convention in many requirements. For details on CITES regulations in Europe, please see PLOEG (2012).

Even with a good knowledge of the requirements of CITES in one's own country, it is therefore of the utmost importance to check requirements in the other country before engaging in a trade operation. The following are only the general minimum requirements, as demanded by the convention.

Appendix-I specimens

An import permit issued by the Management Authority of the State of import is required. This may be issued only if the specimen is not to be used for primarily commercial purposes and if the import will be for purposes that are not detrimental to the survival of the species. In the case of a live animal or plant, the Scientific Authority must be satisfied that the proposed recipient is suitably equipped to house and care for it.

An export permit or re-export certificate issued by the Management Authority of the State of export or re-export is also required. An export permit may be issued only if the specimen was legally obtained; the trade will not be detrimental to the survival of the species; and an import permit has already been issued. A re-export certificate may be issued only if the specimen was imported in accordance with the provisions of the Convention and, in the case of a live animal or plant, if an import permit has been issued.

For captive bred specimens from CITES certified breeding operations, which are the only ones typically allowed for international commercial trade, there is a strict demand that each specimen is marked and registered. For the Dragon fish, *Scleropages formosus*, the marking is routinely done by inserting a microchip in each individual.

In the case of a live animal or plant, it must be prepared and shipped in such a way as to minimise any risk of injury, damage to health or cruel treatment.

Appendix-II specimens

An export permit or re-export certificate issued by the Management Authority of the State of export or re-export is required. An export permit may be issued only if the specimen was legally obtained and if the export will not be detrimental to the survival of the species.

A re-export certificate may be issued only if the specimen was imported in accordance with the Convention. In the case of a live animal or plant, it must be prepared and shipped to minimise any risk of injury, damage to health or cruel treatment. No import permit is needed unless required by national law.

Appendix III specimens

In the case of trade of appendix III specimens from the state(s) that have put their populations of the species onto this appendix, an export permit issued by the Management Authority of this state is required. For all other countries exporting, a certificate of origin (showing that it did not originate from the country that made the listing on appendix III) is the only demand under the convention. Some import countries (including the EU) will, however, have stricter regulations.

The species

While most people tend to think of CITES as a means to protect lions and other big cats, rhinoceroses, elephants and whales, the most interesting species from a pet trade perspective, are such commercially interesting groups as parrots (most species), stony corals (all species), sea horses (all species), the dragon fish *Scleropages formosus* and several species of tarantulas and scorpions.

Very few typical aquarium fishes are on the lists, but recent experiences with CITES suggests that we should be prepared for more to enter the appendices.

This may include the popular and high value aquarium fishes known as South-American Freshwater Stingrays, family Potamotrygonidae, which have attracted the interest of CITES already since March 2004, when they were mentioned as a possibly endangered species group at a CITES meeting in Johannesburg, South Africa.

Since then, they have been discussed at length, most notably at a CITES workshop in Geneva in April 2009 (CITES, 2009), with scientists and fisheries managers from most of the range countries in South America participating. The conclusions of the workshop was very clear, pointing out that there was no evidence of any of the stingray species being at immediate risk and that international trade seem to have very little importance in the broader picture. Habitat destruction and domestic uses were judged to be of much higher importance.

Still the workshop found good reasons for attempting to get better data on the international trade. Since none of the species

Table: 1 Species known to occur in the ornamental aquatic trade, which currently (as per January 2014) are listed on the CITES appendices.

Appendix 1
All sawfishes, family Pristidae
The sturgeon species *Acipenser brevirostrum* and *A. sturio*
Jullien's Golden Carp, *Probarbus jullieni*
Dragon fish or Asian arowana, *Scleropages formosus* (thereunder the taxon *Scleropages inscriptus*)
Mekong giant catfish, *Pangasianodon gigas*
Appendix 2
All sturgeon species, order Acipenseriformes (except *Acipenser brevirostrum* and *A. sturio*)
Congo Blind Barb, *Caecobarbus geertsii*
All seahorses, *Hippocampus* spp.
Humphead wrasse, *Cheilinus undulates*
Australian lungfish, *Neoceratodus forsteri*
All giant clams, family Tridacnidae
Queen conch, *Strombus gigas*
Blue coral, *Heliopora coerulea*
All organ-pipe corals, family Tubiporidae
All black corals, order Anthipatharia
All stony corals, order Scleractinia
All fire corals, family Milleporidae
All lace corals, family Stylasteridae

For further details on CITES, including updated lists of all covered species, see www.cites.org.

appeared to meet listing criteria for appendices I or II, it was recommended that range countries considered the listing of endemic and potentially threatened species in appendix III. This recommendation was subsequently adopted as a decision of CoP15 (March 2010), but has never been acted up on by any Party.

Interestingly, Colombia and (in part) Ecuador presented proposals to CoP16 (March 2013) to list the three species *Paratrygon aiereba, Potamotrygon motoro* and *P. schroederi*. The proposals brought nothing new in terms of evaluation of population sizes, harvest and trade, and failed to be adopted by the CoP. Colombia did, however, succeed in a principle decision on spending more CITES resources on studies on the stingrays, in order to bring up new and improved listing proposals at a later stage. They are already up on the agenda for a meeting in the CITES Animals Committee (which makes scientific recommendations) in Mexico in April/May 2014.

The selection of species in the table have been made according to the authors judgement of what may constitute trade relevant species, and the non-inclusion of any species here should NOT be taken as a guarantee that it is not listed on CITES.

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EU Fish Health Legislation: Clarifying the Confusion and Introducing Online Tools for Successful Completion of Certificates

Alex Ploeg
Secretary General, Ornamental Fish International (OFI)
Netherlands

In 1994 the ornamental fish industry in most European countries was surprised by the introduction of health certifications and border inspections. It was a wakeup call for the European ornamental fish industry to get involved in the European legislative process. It took years to find the proper contacts in Brussels and to find out how things work there and be represented. In 2004 OFI finally got access to DG SANCO, the European "ministry" of agriculture and consumer safety. At the time we were just asked to get involved in the development of the Aquaculture Directive: 2006/88. OFI was able to create a special position for ornamental fish trade to closed facilities. This directive also foresaw in new health certificates in a European model in Regulation 1251/2008. With Regulation 346/2010 an adapted model was introduced in 2010 and the most recent mode; is defined in EU Decision: 1012/2012.

Challenges

In 2007 the EU model health certificates were new to our industry and initially there was a lot of confusion. And still many operators do not fully understand that a health certificate is like a passport, a very official document. Without proper passports a human being cannot travel. If there are doubts with respect to the passport, or errors in it, access to countries is denied and people are sent back to the country of origin. The same is the case with health certificates. In general errors are not tolerated and shipments may be sent back to their origin. Even if it will kill all animals within the shipment.

Fortunately also border inspectors see ornamental aquatic animals as living organisms. In many cases, but certainly not all cases or in all countries, they allow the importer to arrange for new certificates and even temporarily accept digital copies until the new certificate arrives. In the worst cases shipments are sent back. In all cases the costs for exporter and importer increase considerably and sometimes it ends up legal fights between the two about liability. In the past we complained, often on behalf of our members, at national competent authorities, and also at governmental levels on national and EU government. Basically this was all in vain as the competent authorities' obligations are clearly described in laws. daily practice, however, in many occasions the Competent Authorities have been very cooperative to the industry. More cooperative than the Regulation allows! It is the industry itself that has to start to realize that the fact that we transport live animals does not give us the freedom to break the rules. We should also realize that times have changed. There are actual risks for economies linked to import of live animals and we must accept that.

Europe has legislation to enter all imports of animal products, and soon also for plant products, in a computer database. This way Europe can follow shipments and address eventual outbreaks of diseases quickly and efficiently. This system, Traces, requires to put all species entering Europe to be entered in the Traces database. This must be done on species level. Until 2013 this was not done properly. All aquatic animals on a certificate were entered under 'Otrapesca' (other fish). This is now no longer allowed, resulting in a lot of additional work for operators and probably additional costs. OFI is trying to withdraw this obligation as we see it as unnecessary burden.

OFI solutions

OFI has been very active these last few years. We have been active in spreading information in exporting countries, with direct contacts with competent authorities and in some cases even with the relevant ministers. OFI gave numerous presentations for exporters on the EU legislation, on specific diseases, on consequences of non-compliance etc.

Furthermore OFI has tried to solve specific problems in direct contacts with the European Commission. This has resulted in e.g. in twice a two-year delay for implementation of Epizootic Ulcerative Syndrome (EUS) legislation, and in a risk analysis with respect to EUS, and the last change in the certificate in 2012 was to needed because we managed to get EUS off the list of diseases.

We were also able to solve problems with interpretation of the legislation at the border inspector level and at CA level, in some cases even at EU level.

Now we try to address the issue in a very direct way: with assistance to exporters in filling in the certificates. The application in the OFI website provides exporters with a tool to produce health certificates in such a way that all questions are answered precisely such that it is acceptable for Competent Authorities in European Member states.

Certificate generator

Some of the main characters of the applications

- Easy understandable entry of most data and not continuing if not all data have been entered
- Automated choices where possible
- Automated striping out of texts where needed
- Production of standard certificates in proper language

The application

Signing in

OFI members have direct, free access to the application through the Members Area, left hand menu of the OFI website. Non OFI members can sign in from the home page of OFI, through the top-right menu. Then will come into a page to first sign up (receive access codes after payment of the annual application subscription fee) and with these access codes they can sign in.

Dashboard page

If you have signed in you arrive on a dashboard page. This page has a menu on top and a space for previous health certificates and also provides statistical information on how much your market share is in your own country and in the destination country. This will fill itself only if you have produced export certificates of course. The comparison is obviously only based on the shipments through this application.

Synchronization of scientific names

You will all be aware of the fact that many exporters use different names for the same species, not only different common names but also different scientific names. OFI has developed standard names for our industry. These are published in two OFI books on Standard names for Freshwater and marine aquatic organisms (book 5 and 6 in the Educational series). These books can be ordered from the OFI Secretariat. The names are also uploaded in the application. Governmental agencies seem to be very surprised that live animals are exported under wrong scientific names and we have seen several countries that already use the OFI names as a standard. Despite this, we have realized that we will not be able to convince every exporter to use the proper scientific names only. For this reason we have developed the possibility to synchronize your names with the standard names as supplied in the certificates. This way you can continue to use your own names, and still use the proper names in the certificates.

For e.g. guppies most exporters have a huge number of varieties. They all have the same scientific name: *Poecilia reticulata*. In health certificates all varieties of the same species will be added up to only one species with the combined quantity.

To synchronize go to the menu item Synchronize species list. Synchronization can take place per species or in a batch through import of an excel table with all names. In the application you can find further explanation on how to do it.

Recently we have seen a problem with filling in all scientific names into traces. To assist in this we will automatically provide the proper family name in the application.

Creating a new certificate

After synchronizing you can create your first health certificate. To create new certificates please click on the button Create Certificate. You will get into a page where the first time you have to type in all your details: the shippers details. For a second certificate these details are already provided although they can of course be changed. The fields to be filled in are understandable and fields with a * must be filled in. You cannot continue to the next screen if you did not complete all fields with a *. This applies to all screens that follow. If everything is ok you can go to the next page via the arrow at the bottom: Customers' details.

Customers' details

In this page you can select from customers' details already defined before, or click the link to create a new customer. So once you have created a customer, his details will be available for future certificates. In the menu item Customers' details you can always make changes in these details. When ready and complete, you go to the next page: Shipment details, through the right arrow at the bottom.

Shipment details

In this page you will have to enter shipment specific information. This cannot be copied from other certificates. Here you have to select e.g. what type of animals you ship (fish, crustaceans or mollusks).

Unfortunately the European Commission officially still does not allow one certificate for all three groups together. In the mean time a big majority of the EU countries do accept it and also Traces now has space for more statistical codes.

Species entry

The application demands to enter the species and does not accept just the adding of the invoice. There are two reasons for that. The first is that it is only a matter of time that the European Commission will demand this. They demand already it for all other agricultural

products and the European digital system TRACES is also fully prepared for it. Furthermore, OFI uses this system to collect data on the quantities per species transported in this industry from export country to import country. The industry is blamed from many directions that this kind of information is not available as yet. We make ourselves very vulnerable if we don't have the information in contacts with authorities in Europe.

The species can by uploaded one by one, but also as a batch by an excel sheet. The application contains a button for detailed explanation about how to do this. If everything is ok you can go to the next page via the arrow at the bottom: Guarantees.

Guarantees

The EU health certificate request guarantees for the absence of certain diseases. That is the main purpose of a health certificate. There are a few formalities that need to be confirmed. There are also disease/species specific questions. Whether you see this question depend on the species you have entered. If there is no *Cyprinus carpio* (koi) among the species, you won't see the questions on Koi Herpes Virus. If you do not ship to a country with special legislation with respect to Spring Viraemia of Carp, you won't see the questions on this topic. If you do, you will see questions about the freedom of disease of the export country/farm.

If you have filled in this page you can go on to creating the certificate and print it. In the testing period this certificate is only in English. Later on it will be available in other languages', specific for the destination.

Next step

After printing the certificate you must go to the national Competent Authority and have it signed on each page. In some countries it is arranged differently, e.g. Israel. We haven't designed a solution for that yet. If you have other practical problems, please inform the OFI secretariat.

Testing

For the moment we will test the system and access is free to everybody. After the testing period OFI members will have free access and Non-OFI members have also free access for the moment.

Advertising options

There will be opportunities for advertising at the right side of the application, in the same way as in the OFI home page, with banners of 136 x 60 pixel. This is aimed at covering the hosting costs and also for recovering the investment made by OFI. For the moment the price for this banner is set at the same price of the banner in the OFI website: 300 Euro annually, 500 Euro for 2 years and 500 Euro per year for a banner in the OFI home page and in this application together.

Understanding the breeding biology of the Asian Arowana, Scleropages formosus: Innovative approach using molecular technology

Alex Chang
Head, Group Integrated R&D Department
Quian Hu Corporation Ltd, Singapore

Introduction

Asian arowana or Dragonfish (*Scleropagesformosus*) is one of a few living members of the *Osteoglossinae*sub-familywithin the order *Osteoglossiformes* . Asian arowana is morphologically distinct from the "typical teleosts" due to its large body size and a few salient features. It is known to grow to 100 cm in total length and live up to 43 years old. The Asian arowana's laterally compressed fusiform body and a strong hypural caudal fin allow the fish to move rapidly in water and hunt for preys which renders them to be the top predator in its natural habitat and thus, plays an important ecological role. The presence of mandibular barbels at the lower jaw allows the fish to sense for preys in the tannin filled rivers of South East Asia. Asian arowana possess an anterior dorsal fin, an elongated anal fin, a lunate caudal fin and a pair of extended pectoral fins that is located near the ventral end of the operculum. The body is protected by large cosmoid scales (about 50mm in diameter for a 90cm TL adult). The terminal, superior mouth has sharp premaxillary and maxillary teeth which are located at the edges of the upper jaw and together with the pharyngeal teeth and the toothed bonytongue.They are also known as bonytongues due to the presence of large tooth plates on the tongue (basihyal) and basibranchials that bite against the roof of the mouth cavity (Parasphenoid).

Breeding biology of the Asian Arowana

Asian Arowana possess a fascinating collection of interesting characters that are important for the study of basal vertebrate breeding biology, mating behavior and mate preference. The Asian arowana differs from many other teleosts also in its large egg produced and high parental care they exhibit. Due to the fact that it is located very near to the basal groups on the phylogenetic tree of life, although not traditionally used in behavioural and genetic studies, this species provides a good model to study the evolution of mating system theories. In contrast to most other teleost breeding systems, Asian arowana probably exhibits the most extreme and unique end of high parental care where relatively few (20-80), extremely large eggs (12-15 mm in diameter) are produced and is thought to be mouth brooded by the male that will last for 40-50 days.

The most interesting and distinct difference between the Asian arowana and its related species in the *Osteoglossidae* family is the presence of natural occurring colour strains which is not found in any other species in the family. Unlike the rest of the family species member that only have one colour form, the Asian arowana possesses at least 6 known naturally occurring colour strains. These colour strains have distinct phenotypic differences

after maturation and in their natural habitat and they are isolated geographically.

It is not surprising why the species is not well studied: the long generation time, low fecundity, lack of sexual dimorphism and restriction in sample collection in the wild and most importantly, the difficulty in the culture of this fish; all make its analysis very difficult. In addition to this, conventional breeding occurs regularly only in earthen outdoor ponds and not in artificial holding tanks. As breeding in fish tanks are rare , documentation through direct observations of the temporal and spatial scope of the arowana breeding activities is almost impossible in the dense pond water. There is no documentation of artificial fertilization of this species, probably due to the large eggs and low fecundity and lack of available specimens. This lack of basic biological information of the Asian arowana becomes a bottleneck to use Asian arowana in many scientific studies; including its phylogeny, its behavioural studies, population structure and genetics, demographics and most importantly its reproductive biology. These also indirectly compel us to study the mating system using molecular tools.

Asian Arowana and CITES

The Asian arowana is one of the only four freshwater teleost that is protected under CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendix I, and the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species, it is also listed as endangered in the Endangered Species Act (ESA) and is the only teleost species under CITES appendix I that is commercially cultured in CITES-licensed farms solely for ornamental purpose. Even to this day, importation of the Asian arowana to Australia and North-America is still prohibited.

Significance of Genetic Markers in Asian Arowana Breeding Technology

The combination of classical long term field studies and the use of DNA/genetic markers could significantly improve our understanding of the breeding behaviour of the Asian arowana.Even though application of these methods in teleost are far lesser than in mammalian and avian taxa, there are still many teleost being studied but most of the species studied are commercially important food fish.Polymorphic genetic markers like microsatellite loci or Short tandem Repeats (STRs) have been shown to be excellent candidate for the study of parental care, genetic mating system, parentage analysis and kinship studies. In this 5-year study, we manage to use microsatellite genotyping to understand the breeding relationship between the brooders to construct the genetic matingplot in Asian arowana by assigning parentage to the offspring produced. We attempted to understand the phylogenetic and phylogeographic relationship and differences between the colour strains using AFLP and microsatellite genotyping as well as the genetic relativity of the different colour strains. To the best of our knowledge, no similar work has been done on the Asian arowana and for that matter,there are no detailed genetic studies of mate choice, mating system, and parental care in any primitive teleosts, particularly the *Osteoglossinae* subfamily. We hope that our work will enhance the understanding of the evolution of the breeding biology of teleost, and provide a genetic glimpse into the biology of ancient teleost using molecular tools.

Over view of the Endemic Ornamental Fishes of Sri Lanka

H.M.P. Kithsiri
National Aquatic Resources Research and Development Agency
Crow Island, Colombo 15. Sri Lanka

Introduction

Sri Lanka, a tropical island of 65,610 km^2 land area (including coastal islands) is located in the Indian Ocean to the east of the southern tip of Indian peninsular, between latitudes 5°55'- 9°51'N and longitudes 79°41'- 81°54'E. It is 440 km long from north to south, 225 km wide at the broadest part. The center of the southern half of the island is mountainous ranges from about 900 m to 2,500 m. Depending mainly on the island topography and annual rainfall pattern, Sri Lanka features two distinct climatic zones; the wet zone and the dry zone.

The natural freshwater bodies in Sri Lanka are account for about 10% of its land area of which the greater part is covered by radially draining 103 river basins and a fair number of small catchments that are mostly of <10 km^2 land area (Arumugam, 1969). Sri Lanka also blessed with non-flowing (stagnant) water bodies such as marsh, swamp, villu and etc. of these freshwater bodies, the running water bodies are very significant due to their dynamic nature and high habitat diversity. This condition is conducive to support high species richness in riverine fishes (Kortmulder et al., 1990).

Sri Lanka is rich in endemic freshwater fish species diversity. Majority of the documented fish species are known to be small (<0.5 m in total length), riverine or marsh dwellers (Fernando & Indrasena, 1969; Senanayake, 1984; Pethiyagoda, 1991). Sri Lanka does not harbour the endemic fish species adapted to live in large lacustrine water bodies (Amarasinghe et al., 2006). However, some are now inhabit the pseudo lacustrine bodies, built mainly for hydro-power generation.

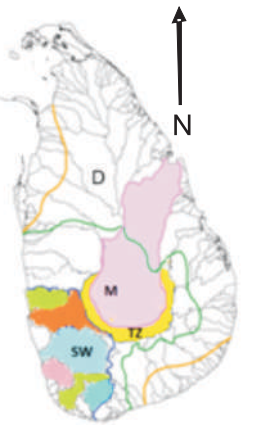


Fig. 1. The river basin map of Sri Lanka showing main ichthyofaunal provinces as suggested by Senanayake and Moyle in 1982 [key: SW-Southwest ichthyofaunal province, M-Mahaweli ichthyofaunal province, D-Dry Zone ichthyofaunal province and TZ-Transitional ichthyofaunal province].

Considering the distribution pattern of the native freshwater fish fauna in the island, Senanayake and Moyle (1982) have suggested three main ichthyfaunal provinces. They are;

(i) Southwestern ichthyofaunal province

(the river basins in southwest quarter of the island; from Attanagalu Oya to Nilwala river with the border of the second peneplain forming the boundary in the east)

(ii) Mahaweli ichthyofaunal province

(the entire catchments of the Mahaweli River covering the three peneplanis)

(iii) Dry zone ichthyofaunal province

(the first peneplain part of the lowland dry zone except the low land dry area of the Mahaweli River catchments).

In addition to these, a transitional ichthyofaunal province that covers the high elevation area of the rivers in the southern and southwestern regions has also been suggested.

Of these ichthyofuanal provinces, the highest species richness and degree of endemism is record in the Southwest ichthyofaunal province where major perennial river systems of tropical rainforests are found. The rivers and streams in the Knuckles mountain range in the Mahaweli ichthyofaunal province also very significant as it harbours rich fish species diversity with 16 endemics. The endemic fish species diversity in the Dry zone ichthyofaunal province is identical to that of first peneplain of the Mahaweli ichthyofaunal province and it shows an affinity to the fish species in the Indian peninsular. However, some fish species in this province also record either in the Southwest or Mahaweli ichthyofaunal province.

Species diversity

According to recent publications, the number of endemic freshwater fish species in Sri Lanka, varies between 50 and 52 (Shirantha, 2010; Gunasekara, 2010; MOE, 2012). With new technology explore in fish systematical studies viz. osteological, karyotype and biochemical studies, some novel fish species are being added to the checklist. The total number is therefore, varied. At present, a total of 96 indigenous freshwater fish species belonging to 20 different families are record in Sri Lanka.

Table 1 summary of the endemic fish species recorded of Sri Lanka.

Family	Number of Endemic fish species
Aplocheilidae	02
Bagridae	02
Balitoridae	02
Belontiidae	02
Channidae	02
Clariidae	01
Cobitidae	01
Cyprinidae	35
Gobiidae	02
Mastacembelidae	01
Synbranchidae	01
Total	**52**

Of these 52 (53%) are endemic whereas the remains being non-endemics. In near future this number will defiantly go up due to ongoing systematic studies on some fish specimens that have already been collected from the wild. Consequently, status and taxonomic groups of some of fish species given in the table 1 may change.

Importance, threats and conservation status

The endemic freshwater fishes of Sri Lanka are playing a vital role in aquatic ecology. Some are important to human being as a source of protein. Majority is being foreign exchange earner through aquarium fish trade and also they are of significant importance to the biodiversity in the country. The endemic fishes inhabit man-made reservoirs are also contribute to the inland fisheries whereas some species inhabit riverine habitats are important as tropical aquarium fishes especially more colourful attractive endemics.

Since there are no natural lakes in Sri Lanka most of endemic fish species occur in riverine habitats. Most of them complete their entire life cycle in riverine habitats. As such they are closely likened with annual hydrological regimes and flood patterns. Moreover, they show complicated interactions between themselves and the environments for food, spaces and spawning and etc. So that any direct human influence that works on this web of inter-relationships or large disturbance such as erosion, pollution, or climatic factors are likely to bring far-reaching or largely unpredictable effects. Presently, Sri Lanka is considered as one of the “hotspots” for freshwater fish fauna means that Sri Lanka is a biogeographic region with a significantly higher numbers of freshwater fish species which are under threat (World Conservation Monitoring Center, 2013).

The threats to the endemic freshwater fishes in Sri Lanka are mainly due to;

1. deforestation and drainage basin alteration that destroy or degrade in-stream and riparian habitats,
2. modification of river regulation; including flow modification and impoundment by dams, water extraction for irrigation and etc.
3. pollution due to waste dumping, use of agro-chemicals, effluent discharging and etc.
4. over-harvesting for tropical aquarium trade and local consumption
5. destructive fishing with plant derivative poison, explosives, drugs and etc.
6. habitat bio-resource modification such as colonization of alien invasive species

Export and breeding

The interacted or individual attribution of above factors has resulted rapid populations decline in many of endemic fish species. According to the National Red List 2012 of Sri Lanka, a total of 45 species are threatened; 20 are Critically Endangered (CR), 19 are Endangered (EN) and 05 are Vulnerable (V). Of the CR fish species, two are considered as possibly extinct in the wild. In addition to these, another 9 and 5 fish species are respectively categorized into the Data Deficiency (DD) and Near Threatened (NT) group (MOE, 2012).

Legal frame work

The freshwater fishes in Sri Lanka are basically protected under provisions of two parliament Acts; Fauna and Flora Protection Ordinance of 1938 and Fisheries and Aquatic Resources Act, No. 2 of 1996. In addition to these, there are some other Ordinances and Acts that are relate to conservation and management of the fisheries and fish fauna of Sri Lanka viz. Sri Lanka Forest Ordinance, Sri Lanka Customs Ordinance and Environment Act of Sri Lanka.

However, the rules and regulations enforce under provisions of these Ordinances and Acts are subjecting to amend from time to time for effective conservation and management of the fisheries and aquatic resources in Sri Lanka. Consequently the Act that is cited as the Fauna and Flora Protection (Amendment) Act, No. 22 has been gazette by the government of Sri Lanka in 2009 to amend rules and regulations in the Fauna and Flora Protection Ordinance of 1938. Therefore, this is the most recently revised Act which has provisions to conservation and management endemic freshwater fish fauna of Sri Lanka. Under this Act the fish species given under its scheduled VI are protected this includes 13 endemic fish species.

The Department of Wildlife Conservation (DWC) of Sri Lanka is the principal regulatory body that charge with the conservation and management of endemic freshwater fishes of Sri Lanka. The Director General of DWC is the

THE PROTECTED ENDEMIC FISH SPECIES

Family Channidae

Channa orientalis

Family Cobitidae

Lepidocephalichthys jonklaasi

Family Cyprinidae

Dawkinsia srilankensis
(cited as *Puntius srilankensis)*

Family Cyprinidae

Labeo fisheri

Family Cyprinidae

Labeo lankae
(cited as *Labeo porcellus)*

Family Cyprinidae

Rasbora wilpita

Family Cyprinidae

Pethia bandula
(cited as *Puntius bandula)*

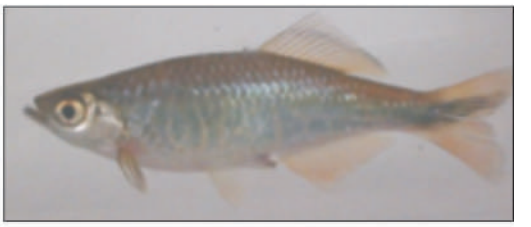
Family Cyprinidae

Systomus asoka
(cited as *Puntius asoka)*

Family Cyprinidae

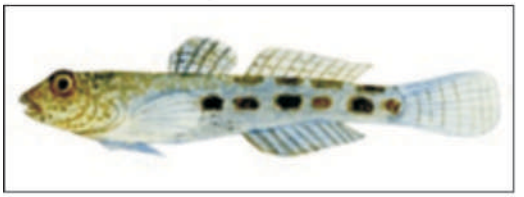
Systomus martenstyni
(cited as *Puntius martenstyni)*

Family Cyprinidae



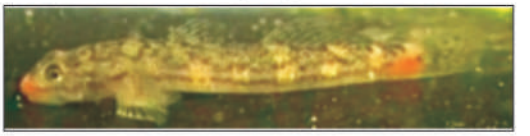
Devario pathirana

Family Gobiidae



Stiphodon martenstyni

Family Cyprinidae



Sicyopus jonklaasi

Family Mastecembelidae

Macrognathus pentopthalmus
(cited as *Macrognathus aral)*

responsible person who has rights and power to enforce the existing rules and regulation under province of the FFPO. He/she has same power to issue permits for exporting and importing any fish in live or dead form, a part or body fluid of a fish for research and other nationally important events and to issue relevant permits to carry out research and development activities on any fish species or in their habitats.

The Director General of the Department of Fisheries and Aquatic Resources of Sri Lanka (DFAR), the regulatory body of the Ministry of Fisheries and Aquatic Resources is responsible for the administration of the provinces of the Fisheries and Aquatic Resources Act, No. 2 of 1996. He/she has power to issue license and permit to trade live fish species within a permissible legal frame.

In addition the above these two regulatory bodies, other government authorities such as National Zoological Gardens, Department of National Museums, Sri Lanka Customs Department and Department of Forest Conservation have their own responsibilities and rights to protect and management of endemic freshwater fishes in Sri Lanka. The National Aquatic Resources Research and Development Agency (NARA) is the research arm affiliated to the Ministry of Fisheries and Aquatic Resources Development (MFARD) has its own mandatory to carry out related research and development activities to conserve, manage and sustainably utilize the endemic freshwater fish fauna in the island.

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Status of the Indonesian Ornamental Fish Industry

Gayatri Reksodihardjo-Lilley
LINI,Yayasan Alam Indonesia Lestari -The Indonesian Nature Foundation
BALI, Indonesia

Background

The island nation of Indonesia has a tropical climate, which passes through the equator, and lies between two oceans, that is the Indian Ocean and the Western Pacific Ocean. Indonesia is one of the countries in Southeast Asia that is influenced by two seasons – the rainy season and the dry season, and escapes the threat of typhoons. There are more than 17,000 islands, with a long coastline of more than 80,000km. It is situated in a very strategic geographical position, making Indonesia very rich in biodiversity, as well as having a variety of ecosystems, namely those of lakes, rivers, marshlands, peat swamp forests, mangroves, seagrass beds, coral reefs, and coastal and open water ecosystems. The diversity of its ecosystem provides an abundance of natural resources, which is a source of livelihoods for communities throughout Indonesia. One of the growing natural resources that is being utilized and providing significant economic value is ornamental fish, which is a product of non-consumption.

The development of the ornamental fish business in Indonesia has been rapid enough to have economically promising prospects. In a period of three years (2009 – 2011) (Table 1), the growth of Indonesia's ornamental fish trade in the world has experienced a huge increase, from US$ 11,660,000 in 2009 to US$ 19,895,702 in 2011. Based on data from the United Nations Commodity Trade Statistics Database, the value of Indonesian ornamental fish exports in 2012 amounted to US$ 21.01 million, or 8.12% of the total export value of ornamental fish across the world (US$ 258.8 million). Such increases make Indonesia the fifth biggest exporter of ornamental fish after Singapore, Spain, Japan, and Malaysia.

Singapore is higher ranking compared with Indonesia, given the country is much smaller than Indonesia. It is estimated that more than 70% of Singapore's ornamental fish exports are ornamental fish from Indonesia, which are re-exported by Singapore and recognized as fish from that country. Indonesian export destinations include Malaysia, Vietnam, Australia, Japan, European countries and North America.

Indonesian ornamental fish can be categorized into two groups – freshwater ornamental fish consisting of ornamental fish and ornamental plants, as well as marine ornamental fish, which consists of ornamental fish, coral and invertebrate animals.

Freshwater Ornamental Fish

The Indonesian government has mapped freshwater ornamental fish production areas, which are spread across 18 provinces, these are west and north Sumatera, Jambi, Jakarta, west, central amd east Java, Bali west and east Kalimantan, south, north, central, southeast Sulawesi, Maluku, Papua and west Papua. The type of ornamental fish cultivated in each

Table 1. The increased growth of Indonesia ornamental fish in global market

		2009			2010			2011
No	Country	Value (US $)	No	Country	Value (US $)	No	Country	Value (US $)
1	Singapore	60.088.000	1	Singapore	59.992.000	1	Singapore	61,858,000
2	Spain	47.059.000	2	Spain	39.313.000	2	Japan	32,005,373
3	Japan	24.067.000	3	Japan	32.101.000	3	Thailand	22,454,533
4	Malaysia	21.222.000	4	Malaysia	21.179.000	4	Czech Rep.	21,144,207
5	Thailand	18.224.000	5	Indonesia	19.766.000	5	Indonesia	19,895,702
6	Chech Rep	16.946.000	6	Thailand	18.722.000	6	Malaysia	19,534,782
7	Israel	15.656.000	7	Israel	15.223.000	7	Israel	15,859,000
8	USA	12.139.000	8	Chech Rep	15.113.000	8	USA	13,134,144
9	Indonesia	11.660.000	9	USA	13.221.000	9	Srilanka	10,082,255
10	Netherland	9.522.000	10	Belanda	9.097.000	10	Colombia	8,788,785
	Total	373.772.000		Total	332.340.000		Others	61,655,690
							TOTAL	286,362,471

Source : (UN *Comtrade*, 2010, 2011 and 2012 in MMAF 2012)

production centre are vary from area to area (Table 2 and Fig 1).

The largest centre of cultivation of ornamental fish can be found in East Java, West Java, the capital city district of Jakarta, Banten and the district of Yogyakarta. Data from the Indonesian Ministry of Marine Affairs and Fisheries showed that ornamental fish farming production in 2012 reached 938 million fish, increasing to 1.04 billion by 2013.

Table 2. Indonesia ornamental fish production centre

NU.	SPECIES	Areas
1	Arowana spp	Kalimantan, Jambi, Papua, West Java
2	Botia spp	Jambi and West Kalimantan
3	Betta spp	DKI Jakarta (West and East Jakarta), Banten, DI Jogyakarta, East Java (Kediri), Central Java (Semarang), West Java (Bogor)
4	Koi	EastJava (Blitar), D.I.Yogja (Sleman, Bantul), West Java (Cianjur, Sumedang), Central Java (Kota Semarang, Magelang)
5	Goldfish/Comet	West Java (Bogor), Central Java (Semarang, Magelang,Tulungagung)
6	Discus	East and South Jakarta
7	Tetra	West Java (Depok, Bogor)
8	Manfish	Jakarta and West Java (Bogor)
9	Black ghost	East Jakarta , West Java (Bekasi, Bogor)
10	Oscar	East Jakarta, East Java (Surabaya), Central Java

Types of Freshwater Ornamental Fish

It is estimated that there are 400 Indonesian Freshwater Ornamental Fish species of the total 1,100 species in the world. Although Indonesia is rich with many types of freshwater fish, the types that are traded both for domestic and export trade is still dominated by species that are not native to Indonesia such as koi, oscar, comet/goldfish, and guppies, among others. The types of native ornamental fish commonly traded include Arowana, Botia,

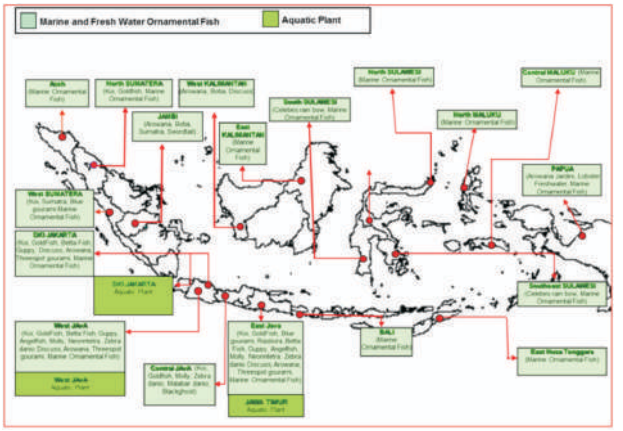

Figure 1. The distribution map of freshwater and marine ornamental fish (Source: MMAF 2012)

Rasbora and Rainbow. Native Indonesian ornamental fish species that have been cultivated are Arowana and Betta.

The Economic Outlook for Ornamental Fish

Ornamental fish cultivation activities provide economic benefits to society. As an illustration, the koi ornamental fish species is one of the superior fish that has a high price, providing livelihoods for the people on the island of Java. The centre for koi fish farming is in the town of Blitar, East Java, where more than 1,500 farmers have a total production of 167 million fish with a value of around 800 billion rupiah that are traded domestically and for export.

Other ornamental fish species, mainly goldfish, are in the region of Tulungagung in Central Java. Tulungagung annually produces no less than 55 million goldfish with a production value of 96.5 billion rupiah. The town of Kediri, the centre of *capung* fish production, produced 17 million *capung* fish in 2011 with a value of 2.5 billion rupiah.

Marine Ornamental Fish

Marine ornamental fish have beautiful colours and various shapes, and generally come from coral reef habitats. The marine ornamental fish are harvested from the coral reefs covering the reefs of Southeast Asia, the Pacific Islands, South Asian and Indian Ocean islands, Australia, Hawaii, Mexico, Florida, the Caribbean, Brazil, East Africa, and the Red Sea. The trade itself was recorded in the 1930s, with the collection on a small scale in Sri Lanka.

Globally, marine ornamental fish trade is much smaller than freshwater ornamental fish, at around 15%. This is because most freshwater ornamental fish can be farmed and most likely because the price is relatively cheaper than marine ornamental fish.

Indonesia has 18% of the world's coral reefs. With extensive coral reefs and residing on two oceans, Indonesia alone has a very high diversity of marine fish compared to other countries. Over the last 30 years, Indonesia has become a hotspot for the global marine ornamental fish collection and trade, with the industry providing an important source of income for thousands of coastal communities. In 2005, Indonesia exported 3,288,434 individual marine ornamental fish representing 997 species to the US for the marine aquarium fish trade (Rhyne *et al*., 2012).

Ornamental fish production centers are spread in 10 provinces, across major cities, including Medan, Jakarta, Surabaya, Denpasar and Makassar among others. More than 280 types of traded marine ornamental fish are caught from the wild. Compared with freshwater ornamental fish, there are very few types of marine ornamental fish that are successfully cultivated on a commercial scale, such as varius species of clownfish (*Amphiprion spp, Premnas biaculeatus*), Banggai cardinalfish (*Pterapogon kauderni*), Pinnatus batfish (*Platax pinnatus*), and blue devil damselfish (*Chrysiptera cyanea*). While other species that currently being studied including mandarin fish (*Synchiropos splendidus*).

Live coral trade

With 18% of the world's coral reefs, Indonesia is the primary source of corals for the trade, involving over 40 companies and contributing an average of 70% to the global market. Indonesia exports an average of 80 species of hardcorals, which are collected from the wild, while at least 140 species of hardcorals are available in the global marine aquarium trade (Wabnitz *et al.* 2003). The size of corals that are allowed to be collected for trade is between 5 cm to 25 cm . The trade of live corals is being regulated by the Indonesian Government, through the quota system, and to date it can only be collected from 11 Provinces. Many species of Scleractinian coral can be propagated by fragmentation, and this has been the intention of the Indonesian government to reduce the coral trade taken from the wild, and to support the coral fragmentation. Currently there are 44 species of large and small polyp corals availabe for the marine aquarium trade. In 2010, Indonesia exported 80 species, with over 1.6 million pieces of live corals from wild collection and over 420,000 pieces from mariculture (Figure 2).

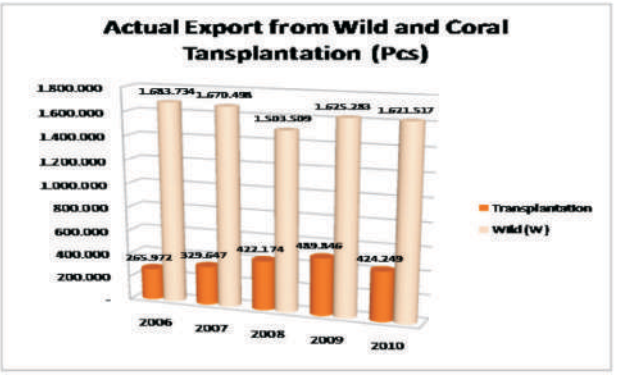

Figure 2. Export of live corals from Indonesia (2006-2010) (Indonesian MA, 2012)

Challenges

Unfortunately, destructive fishing practices such as the use of cyanide and breaking corals during collecting are still widespread throughout Indonesia. Cyanide fishing not only harm target species but also kill non-target reef fishes, corals and other invertebrates. This unsustainable resource use has led to threatened marine ecosystems and coastal areas, as well as impacting the livelihood of the communities where collection occurs. To eliminate the trade is not a long-term solution, as the ornamental fishers will continue to use the reef's natural resources. Therfore eliminating ornamental fishery will likely shift the fishermen into more environmentally destructive practices.

As with other fisheries in Indonesia, effective reef fisheries management policies arecurrently lacking, and no local or national legal framework exists to support or regulate ornamental fish collection and trade.

Yayasan Alam Indonesia Lestari (LINI – the Indonesian Nature Foundation)

started working on marine ornamentals issues in Indonesia in 2008. Although the ornamental fishery had been operating for nearly 30 years in Indonesia there were a number of problems with the business that ultimately threatened the sustainability of the trade. These included poor collection, holding and shipping methods, high stock mortalities, and unfair trade practices that hurt the livelihoods of the fish collectors on who the trade ultimately depend on.

At first, we worked with an international organisation (The Marine Aquarium Council, or MAC), which, being primarily a certification organization, sought first to define a set of standards by which the MOT practices could be measured. Then it would develop a certification program through which willing partners in the trade could adopt the new standards. The idea was that those people who adopted the standards would eventually become certified so that anyone with this

certification would be recognized as promoting 'best practices' that encouraged and supported sustainability of the MO trade with the motto "from Reef to Retail".

After the MAC stopped its operation in Indonesia in 2008, our organisation continues its work with poor coastal communities, but with more of a focus on community-based initiatives that promote the conservation of marine resources on which they depend for their livelihoods. Being among the poorest sectors of Indonesian society, it is important that these fisher communities have long-term sustainable livelihoods that give them the opportunity to drag themselves out of the poverty traps they have endured for so long. They need to be empowered to protect their own resources.

Some suggestions to improve the ornamental fish trade:

1. To increases in the prices of fish sold starting at the retailers' end of the supply chains. A survey of hobbyists' opinions on willingness to pay more showed that overall, they are willing to pay higher prices if it can be demonstrated that the fish come from well-managed areas, and have been collected in a responsible manner.
2. To Help fishers to rebuild and restore their damaged reefs to enhance their local fish stocks, and reduce the need for them to travel huge distances to collect the fish.
3. To shorten the supply chains by choosing their buyers more strategically and selectively. The intention here is to reduce stock mortality, and therefore sell more fish with less rejects, but significant financial rewards that provide incentive for the fishers to improve their practices, have yet to materialise. Prices still remain much the same as before, and once again, an increased awareness of this problem among the end buyers will help to address the issue.
4. To strengthen regulations on keeping fish in optimal health, which have been happening significantly in Indonesia, and the quarantine office is now conducting onsite checks and requires exporters' facilities to comply with biosecurity regulations. This will improve standards at the supply end.
5. To encourage exporters and importers to support more ethically- and sustainably sourced fish.
6. To promote mariculture at source, by, for example, training the fishers to catch tiny fish fry (Post Larvae) and then rearing them to a saleable size. On the down side, mariculture requires not only some basic equipment and facilities, but also a level of commitment (timekeeping, regular maintenance schedules) that the collectors still need to be taught.
7. To increase awareness of the end buyers (e.g. the aquarium keepers) on their understand of the circumstances in which the fish they buy are caught and traded, so that they can support a fair and healthy sustainable MO trade. The days of sellers relying on the ignorance of their customers should be long gone.
8. To support the development of the cyanide detection test
9. To strengthen the skills of fishers in collection, post harvest handling , and the capacity to run fishers cooperatives.

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Export Performance of Indian Ornamental Fish-Trend : An Analysis

Madhumita Mukherjee[1] & Ashis Bhuina[2]
[1] Executive Director, NFDB, Hyderabad &
Addl. Director, Directorate of Fisheries (HQ), West Bengal
[2] Assistant Fishery Officer, Directorate of Fisheries (HQ), West Bengal

At present, ornamental fish farming is the fastest growing aquaculture sector in the world with a global trade of US $ 9.0 billion per annum and a growth rate of over 8 per cent. In ornamental fish trade, freshwater ornamental fish contribute 85 per cent of the total and the rest are from marine species. More than 5,000 species of freshwater ornamental fish are traded each year, out of which 700 to 800 are most common. Approximately, 1.0 billion ornamental fish are exported annually involving more than 100 countries. The entire value of the industry inclusive of retail sales, associated materials, wages and non-exported products, was estimated to be US $ 15 billion. Though Asian countries contribute 90 per cent of the ornamental fish trade around the globe, India's share to the global trade is less than 0.01 per cent, till recently. But the ornamental fish export in India is growing at the rate of 10 per cent per annum during the last few years. At the same time, the domestic ornamental fish market in the country is also growing at 20 per cent rate per year. India is very rich in terms of ornamental fish genetic resources with more than 200 varieties of indigenous ornamental fish available in the North Eastern States and Western Ghats of the country. In addition, more than 100 species of exotic ornamental fish varieties have already been domesticated to the Indian condition and are traded to the different parts of the world.

The demand for exotic fishes is high in the international ornamental fish markets such as USA, Europe, and UK. It is noted that in the domestic market for ornamental fishes, the supply from the breeding sector does not meet the domestic demand, which points at the fact that there remains no surplus stock for export. The domestic market for ornamental fishes in India is basically a seller's market and anything bred is devoured by the market without even considering the quality of it. For an industry to improve the production level has to increase and the quality of the product also has to be enhanced.

Introduction

Ornamental Fish had occupied a significant position in global trade portfolio due its popularity amongst people with aquarium hobby. Terrestrial people want to enjoy behavior of aquatic life in aquarium. Globally there is a persistent demand for live fish for decorative, research purposes from hobbiers, educational institutes etc. Though India's share of global trade is negligible at 0.01 per centum, yet it is stated to grow at 10.5 per centum per anum. On the other side producers and exporters face a different situation comprising of idle stock, higher lead time and inventory carrying cost. Real time export data of ornamental fish (ITC code 03011000) reveals a alarming situation of declining trend during last couple of years. Marine Product Export

Development Authority (MPEDA) is assigned with the responsibility of export promotion of ornamental fish in global market and adopted few steps in this respect accordingly. Initiatives of MPEDA, has not been able to reverse the current trend of growth trajectory.

I. Ornamental Fish Global Trade Item:

I.I. Global Trade Volume:

- Annual international exports in ornamental fish are around US$250 million, with imports valued at US$300million (FAO, 2006).
- The total value of whole sale ornamental trade is estimated at close to US$1 billion, and retail trade about US$6 billion.
- The entire industry, including accessories and fish feed, is estimated to be worth more than US$14 Billion.
- Since 1985 the value of international trade in exports of ornamentals has increased at an average growth rate of approximately14%peryear.

I.II. Global Trade Scenario:

In the year 1976, 28 countries reported exports of ornamental fish. Since that year the number of exporting countries (including re-exporting) has gradually grown to 146 in 2004. And the number is still increasing. Nevertheless, there are only a few countries which are responsible for the bulk of exports. The Top 10 exporting countries have a share of no less than 69% of the total worldwide exports; the top 25 account for 93% of total exports. According to the FAO data, the worldwide export volume in US$ during this period grew from US$ 21 million in 1976 to US$ 251 million in 2004 and well over US$ 300 million in 2006. The total retail turnover in the ornamental aquatic industry consists of much more than the live fish alone. *The fish are estimated to represent approximately 15% of the total turnover in aquarium-related products*. The rest consists of fish food, aquariums, plants, lighting, filters, etc. This leads to an estimate of some US$ 15 billion and this is a substantial amount.

I.III.Number of importing countries: The number of countries which are importing ornamental fish has gradually increased from 32 in 1976 to 132 in 2001 and since then has decreased slightly to 120 in 2004. So we currently have more countries exporting ornamental fish than those importing ornamental fish. Nevertheless, in fact there are only a very few countries which are really heavily involved in this industry. The top 10 countries import more than 77% of the total import value, and the top 25 import over 95% of the total. The top 25 are mainly represented by wealthy western countries.

Although there are a large number of importing countries, the distribution of these countries is quite uniform. With 51% of the total import value, Europe is by far the largest importer in the world. Within Europe, the United Kingdom accounts for 19% of the total imports, with Germany coming in a close second (18%). France, the Netherlands, Belgium, Spain and Italy also have considerable imports. The countries in Eastern Europe have relatively low import figures.

The second largest import area is the North American continent, the USA being by far the largest player with 87% of the total imports. Many exports from South America find their way into the rest of the world through the airports of Miami and Los Angeles.On the other hand, the majority of the huge ornamental fish production industry in Florida is distributed (mostly by air freight) within the USA and is not exported.

Japan is the major player with 45% of the total imports in the third major importing Area, Asia. In fact, only Singapore, as an import-export hub, plays an important role with 23%

of the imports, putting it far behind Japan, and China with 17%, again lagging far behind Singapore, although it has enormous potential. After Japan, only import-export centre Singapore with 23% and China with 17% are significant importers. China has a huge potential for growth though. Singapore's export is more than double that of the other countries in the top 5 from 2004. In total, the market share of Singapore exports in 2004 was about 19.8 % of the world volume, which was slightly higher than the year before with 19.6%. This was the lowest market share in the period covered by the FAO statistics. In fact, this was less than half that of the top years of 1984/1985. Since the industry is growing on a global scale, the decline in market share is of course completely logical. It may be seen as a tremendous achievement that Singapore is still by far the largest exporter.

I.IV.Rapid growers and Emerging markets:

The Czech Republic and Spain are not only in the top 5 of the export countries, they also show the largest export growth. Israel was a very rapid growth country until the outbreaks of Koi Herpes Virus in 1998, which resulted in a serious drop in exports.

Emerging markets

The largest import countries in the world are of course not the countries with the largest growth of imports. As long as the total imports are low, the entrance in the market by one or two major importers can result in high growth figures, such as the import figures for Greece, Poland, Ireland, Indonesia and Iran as shown in this overview. In this list, Indonesia is the unexpected country, since it is known primarily as being an exporting country.

I.V.Declining markets.

In fact, it is only in Japan that imports have really dropped over the last decade, as we have seen in the figure above. Almost all of the other import countries have seen a steady growth or at least a stable situation.

Market share of the USA

The total market share for imports of ornamental fish into the USA dropped from its peak in the first year of the available statistics at almost 47% to only 17% in 2002 and recovered to 22% in the last year of the available statistics. Since the aquarium hobby has also grown strongly outside of the USA, for example, in Europe and Asia,

I.VI. Determining Factors of Trade:

The spring and summer seasons are very slow with hardly any sales to retailers or over-the counter sales to aquarium owners. Transports are by air-freight to the main Swedish airports or Copenhagen airport in the case of importers in the south of Sweden.

Packaging must be done right for fish to survive and arrive in good condition. The water, the plastic bags and the polystyrene boxes must all be just right for the transport to be successful.

Most of the weight of a fish transport is water, perhaps as much as 90%. In order to be able to pack more fish per litre of water and thus reduce the freight-cost per fish, exporters try to slow down the metabolism and oxygen consumption of the fish. This can be done by chemicals or by cooling the water and is practiced with varying success. It is important that the preparation of the fish and the transport is professionally done, or the importer will receive dead fish.

I.VII. Customs Tariffs and Import Regulations.

Sweden joined the European Union on 1 January 1995. From that date licensing of live fish imports is not necessary. The importer

must fill in a declaration to the Customs Authorities stating among other things, what species of fish the shipment contains, that the fish are not of endangered species according to the Washington Convention of species which could multiply in the wild in Swedish waters. Customs at the first entry point into the European Union make spot checks of aquarium fish.

Fresh water fish are duty-free while salt water fish have a duty of 7.5%. Most fish imported to Sweden are fresh water fish as salt water fish are more expensive and more difficult to keep.

I.VIII. Aquarium Plants

The combined nomenclature does not list aquarium plants under its own CN number, which makes it impossible to calculate the size of the market. Imports are estimated to be worth around SEK 4 million. There is hardly any domestic production of aquarium plants. Imports come mainly from three countries; Singapore, Denmark and the Netherlands.

Most Fish importers/ wholesalers also trade with aquarium plants, but that is not the case for all retailers. Generally speaking Swedish aquarium- owners do not fill their aquariums with much decoration but keep them relatively bare.

I.IX. Market Prospects and Business Opportunities

This is small market and there are many exporters competing for the business of a handful of importers. Trade sources do not expect an increase in the Swedish market for the foreseeable future. On the contrary, there are many new hobbies and interests competing for the time of young people, such as computer games and Internet. On the other hand, the importers are always looking for interesting new exporters of quality fish and for better prices. So, although market prospects are not particularly good, there are always opportunities, for the serious exporter who can offer quality at competitive prices, as the success of the Czech aquarium fish exporters proves.

The supply chain of exotic ornamental fish for domestic marketing includes breeders at the first step followed by wholesalers, retailers and consumer/hobbyist where as the chain for export marketing includes breeders, suppliers, exporters and consumers/hobbyist abroad. The trend towards traceability, certification and improved farm management is driving responsibilities down the market chain to the Breeders/breeding sector. Tomey (1997) pointed out that, with regards to recent developments in European legislation, tracking i.e. following a shipment from point of export to import and tracing i.e. the ability to follow the consignment all the way back to its original source, for example, a particular breeder or farm for health and welfare for all items are becoming a basic issue. Ornamental fish breeding/production has evolved from a pursuit into a sustainable livelihood alternative, comparable to agriculture or other activities of fisheries in India. Of late, this sector has been accorded wide recognition as a potent instrument for providing employment opportunities, slowing urban migrations, alleviating poverty, contributing to national income growth, and promoting equitable distribution of income and enhancing foreign exchange. In spite of the fact that India has conducive conditions for ornamental fish breeding, the production from the breeding sector is to the level of 100 Million fish per year. The ornamental fish export was to the tune of 535 Lakh (US $ 1.27 million) in 2008 (MPEDA, 2008).

II.India in Global Trade Landscape:

India share in global trade is insignificant with an amount of 0.01 per centum and remain

Table 1: Indigenous Species with Major Composition in Exports (2005-2010)

SPECIES	COMPOSITION
Tetraodon travancoricus	15.51%
Dario dario	4.81%
Puntius denisonii	3.76%
Botia striata	3.69%
Carinotetraodon imitator	1.59%
Puntius fasciatus	0.54%
Channa bleheri	0.49%
Chela dadiburjori	0.30%
Mesonoemacheilus triangularis	0.19%
Puntius terio	0.13%
Etroplus maculatus	0.12%
Puntius filamentosa	0.10%
Puntius jerdoni	0.09%
Pisodonophis boro	0.09%
Puntius narayani	0.07%
Puntius melanampyx	0.07%
Pseudosphromenus dayi	0.07%
puntius conchonius	0.05%
Barilius bakeri	0.03%
Badis assamensis	0.02%

market follower. Merchandise from India comprises of live fish both captive bred as wells as wild collection. It does not include marine species, corals, feed and other ancillaries. Predominant species of merchandise comprises of *Tetraodn travancorius* (15.51%) followed by *Dario dario* (4.81%).

II.I. Declining Trend of Export:

Time series data of value of Indian ornamental fish export during last 17 years (1996-1997 to 2012-2013) (Table 2) is taken analysis. Since, rupee denotes here is at current price, it is nominal value of currency. Nominal value of rupee is always subjected to inflationary pressure. So any simple price rise on account of inflation may contribute to sales growth. Here the real value of rupee is taken into consideration by multiplication of nominal value with GDP deflator of corresponding year. Then it is fitted with 2nd order polynomial equation to obtain a trend line.

Simple Average Growth Rate for 17 Years (1996-97 to 2012-13) period = 31.52%

Mean Annualised Growth Rate (Y2Y) = 29.05 %

Compounded Growth Rate = 11.5 %

$P_2=P_1(1 + r/100)^{17}$

$551.21 = 86.69 (1 + r/100)^{17}$

Log 86.69 = 17 log (1 + r/100)

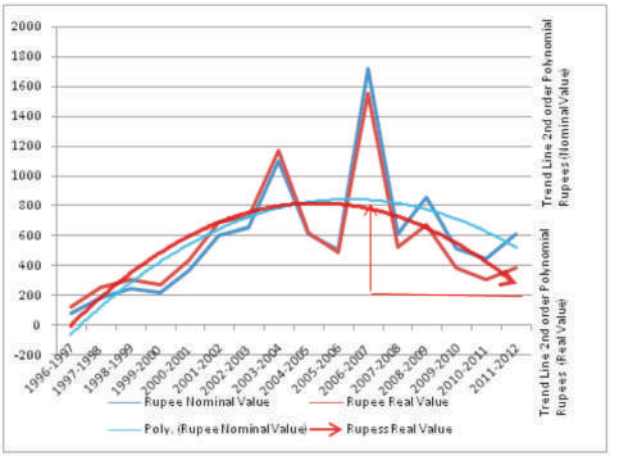
orA r = 11.5

Table 2: Value of Indian Exports in Rupee- Real and Nominal Terms.

Rs in '00,000'

Year	Values in Rs. Lacs (Nominal value)	GDP at Constant (2004-05) prices	GDP at current prices	GDP Deflator	Real value= Nominal value x GDP deflator [Constant price (2004-05=100)]	Annual Growth Rate (Y2Y) %
1996-1997	86.69	1876319	1301788	1.441339892	124.9497552	
1997-1998	187.21	1957032	1447613	1.351902644	253.0896939	115.953
1998-1999	248.47	2087828	1668739	1.251141024	310.8710103	32.723
1999-2000	226.1	2246276	1847273	1.215995596	274.9366042	-9.003
2000-2001	370.01	2342774	1991982	1.176101848	435.1694447	63.649
2001-2002	606.6	2472052	2167745	1.140379569	691.7542466	63.942
2002-2003	662.43	2570690	2338200	1.099431313	728.2962847	9.204
2003-2004	1102.79	2777813	2622216	1.059337857	1168.227196	66.476
2004-2005	619.28	2971464	2971464	1	619.28	-43.844
2005-2006	515.83	3253073	3390503	0.95946624	494.9214706	-16.705
2006-2007	1724.96	3564364	3953276	0.901622832	1555.263321	234.405
2007-2008	620.21	3896636	4582086	0.850406731	527.4307587	-64.045
2008-2009	861.71	4158676	5303566	0.784128254	675.6911578	38.938
2009-2010	523.95	4516071	6108903	0.739260551	387.3355659	-39.196
2010-2011	448.68	4937006	7266967	0.679376417	304.8226106	-14.366
2011-2012	616.25	5243582	8353495	0.627711156	386.8269997	37.347
2012-2013	551.21	1876319	1301788	1.441339892		-10.554

(Source : Export Import Data Bank; Department of Commerce)
Value of Indian Exports in Rupee- Real and Nominal TermsAnd Trendlines on 2nd Order Polynomial



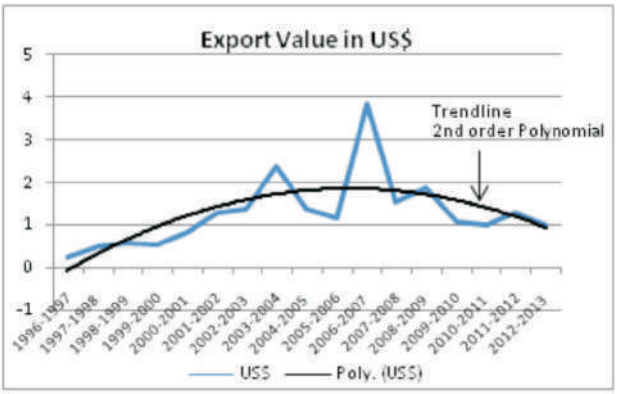
It is evident from table 2 that though value of export grew from Rs. 86.69 lacs in 1996-97 to Rs.551.21 lacs in 2012-2013 showing a modest growth rate 31.52 % on simple terms while annual compounded growth rate becomes 11.5%. Trend line of sales trajectory on second order polynomial shows that there is a clear declining trend of export value on both nominal and real terms. In fact decline commenced from the peak year in 2006-2007. The export had declined at the rate of -15.32% on an average annually during corresponding period.

II.II. Declining Value of Export in US$:

External trade volume depends upon rupee convertibility, income parity and purchase power parity. So analysis depending upon domestic currency may not depict true scenario, because of currency conversion factor. So time series data in terms of US$ is taken into consideration. This also depicts

Table 3: Value of Indian Exports in US$.

Year	Values in US$ Million
1996-1997	0.24
1997-1998	0.5
1998-1999	0.59
1999-2000	0.52
2000-2001	0.81
2001-2002	1.27
2002-2003	1.37
2003-2004	2.4
2004-2005	1.38
2005-2006	1.16
2006-2007	3.85
2007-2008	1.54
2008-2009	1.86
2009-2010	1.1
2010-2011	0.98
2011-2012	1.29
2012-2013	1.01



declining trend on 2nd order polynomial commencing from 2006-2007.

Six Sigma Analysis of Export Volume in US$.

Six Sigma Analysis

Mean (X ?) = 1.28647

Standard Deviation (σ) = 0.8461

X + σ = 2.1326

X + 2σ = 2.9787

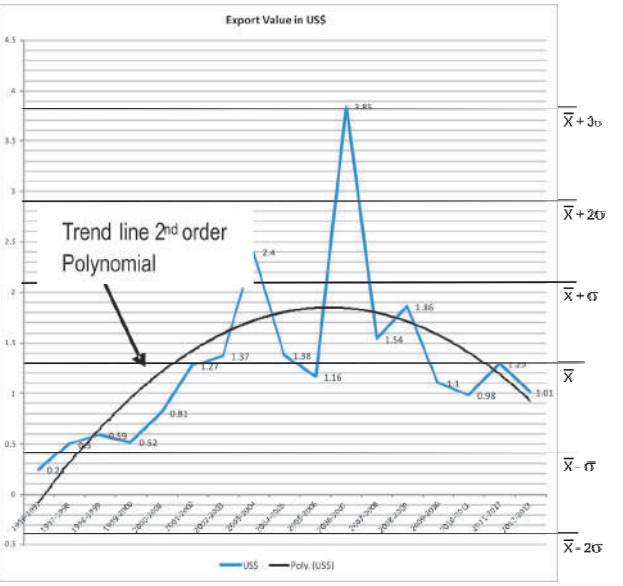
X + 3σ = 3.8248

X - σ = 0.4403

X - 2σ = -0.4058

X - 3σ = -1.2519

Six sigma analyses of the time series data reveals, predominance of data in (X ± σ) region indicates stagnation nature of data.



Trendline always confined within (X ± σ)

II.III. Stagnant Market Base:

India Exported to 78 countries during last 17 years, 1996 – 2012-2013. It is evident from the frequency distribution of table containing number of exporting years against frequency of export to a particular country, that distribution is not standard normal distribution, rather skewed. It had exported 17 years to 11 countries, 16 years to 1 country (THAILAND), 15 years to 7 countries. 2 years to 25 countries. First quartile Q_1 with (1-4) years group have total frequency of 39, while second quartile (Q_2), third quartile (Q_3) and fourth quartile (Q_4) have corresponding total frequency of 10,9,20.

This is an indicator of predominance of floating customer. Incidence of export to 25 countries only for twice during 17 years is an indicator of lack of CRM (Customer Relationship Management).

II.IV. Plateau in number of Buyer Countries:

Export market base that is number of countries of export remain stagnant since 2005-2006, since change in number of buyer countries are not substantial remaining with in $\bar{X} \pm SEx1.96$ (26 and 30). Since, expansion in export Market depends upon numbers of countries of export, remains within acceptable limits of change, it may be inferred that market base is in plateau after initial rise.

III. MPEDA-Steps taken to increase production and exports:

For Increasing Production: Provides financial assistance for establishment of ornamental fish breeding units to boost up export of ornamental fish.

MPEDA, is assigned with the responsibility of export promotion and development of

Table 4 : Frequency Distribution of Exporting Years and Exporting Countries

N (Exporting Years)	Number of Countries [Frequency(f)]			Frequency and Number of Buyer Countries
1	2			
2	25		Q1	
3	4			
4	8	39		
5	0			
6	4			
7	2		Q2	
8	3			
9	1	10		
10	2			
11	4		Q3	
12	2			
13	1	9		
14	1			
15	7		Q4	
16	1			
17	11	20		

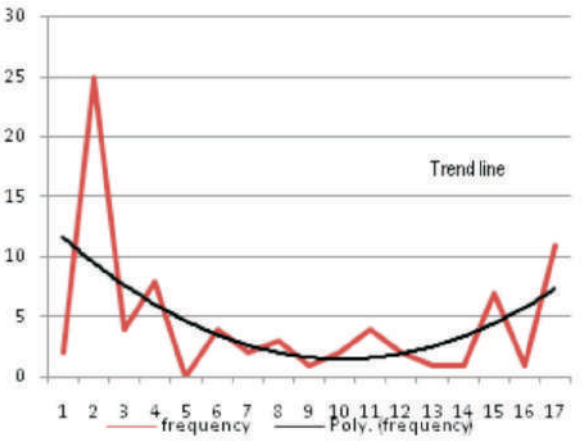
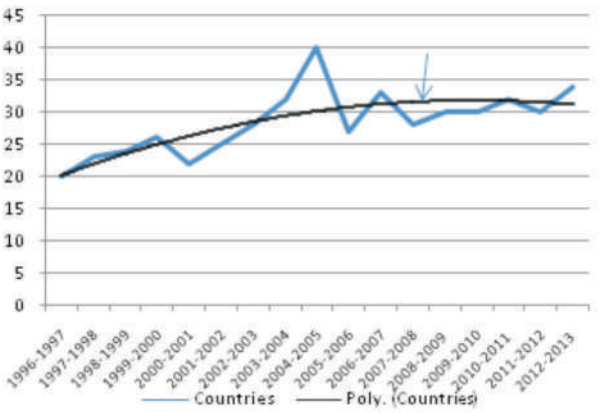


Table 5 : Frequency Distribution of Years and Buyer Countries:

Years	No. of Buyer Countries	Deviation	30?XI?26	Year wise Number of Buyer Countries
1996-1997	20	-8.471		
1997-1998	23	-5.471		
1998-1999	24	-4.471		
1999-2000	26	-2.471	Yes	
2000-2001	22	-6.471		
2001-2002	25	-3.471		
2002-2003	28	-0.471	Yes	
2003-2004	32	3.529		
2004-2005	40	11.529		
2005-2006	27	-1.471	Yes	
2006-2007	33	4.529		
2007-2008	28	-0.471	Yes	
2008-2009	30	1.529	Yes	
2009-2010	30	1.529	Yes	
2010-2011	32	3.529		
2011-2012	30	1.529	Yes	
2012-2013	34	5.529		



Mean ($\bar{X}$)		28.4705
SD (ó)		5.00147
Standard Error (SE) = $\sigma / \sqrt{n}$	1.21303	
$\bar{X}$ + SEx1.96	30.848	30
- SEx1.96	26.093	26

Since values of year 1999-2000, 2002-03, 2005-06,2007-08, 2008-09, 2009-10, 2011-12 remain within 30d"X_ie"26, change in values are likely to be data fluctuation, rather than significant change.

ornamental fish in global market as evident from the outcome budget of Ministry of commerce, Government of India (Table 7). Though positive outcome is reported against deliverables of targets, yet locus of declining trend line do not reverse. The steps adopted by MPEDA, are general and technical in nature, concerned with breeding and subsidy og FOB only. Export development strategies, as per principles of marketing management (international marketing), is not pursued, leading to low global market capitalization of Indian merchandise.

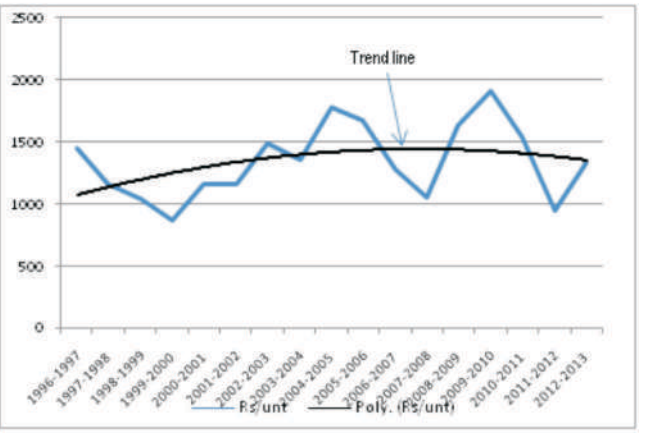
IV. Export Promotion and Development Process:

V. Analysis of Export Promotion and Development Process:

1). Trade promotion and Export Development is basically a management function requiring a holistic approach comprising of human resources management, production management, financial management, marketing management, operation management, logistic management, supply chain management

Table 6 : Year wise Price Realisation (Rupees/unit)

Year	Rs/unit	Deviation	
1996-1997	1453.869	106.4616	3
1997-1998	1162.087	-185.321	
1998-1999	1050.155	-297.253	1
1999-2000	872.903	-474.504	1
2000-2001	1157.948	-189.461	
2001-2002	1158.290	-189.117	1
2002-2003	1492.451	145.0439	4
2003-2004	1363.652	16.24475	3
2004-2005	1792.778	445.3705	4
2005-2006	1675.685	328.2781	4
2006-2007	1281.121	-66.2865	2
2007-2008	1054.770	-292.637	1
2008-2009	1634.807	287.3994	4
2009-2010	1919.069	571.662	4
2010-2011	1552.591	205.1834	4
2011-2012	950.111	-397.296	1
2012-2013	1333.636	-13.7713	2



Mean	1347.407079	Less than 1203-	1
SD	301.851994	1203 - 1347-	2
Variance	91114.62628	1347- 1490-	3
SE	73.20986203	Above 1490-	4
X + 1.96xSE	1490.898409		
X- 1.96xSE	1203.91575		

and compliance global trade regulations. Existing export development initiatives of MPEDA is technology research and development kind concerned with breeding only.

2). Export of live fish constitute 15% of aggregate global trade volume, rest being other ancillary services like feed, aquarium, aerator, plants and other elements. India's product portfolio is confined within live fish only signifying its presence in 15% of market segment.

3). India exported to 78 countries during last 17 years with inconsistent frequency.

11 countries appeared to be most consistent buyer with steady imports in all 17 years. While in 25 countries export had been made only for 2 years. Absence of repeated purchase indicates lack of CRM and appropriate follow-up.

4). Export promotion and trade development interface table indicates lack of component and sub component wise intervention.

Table 7 : Scheme wise performance of MPEDA 2009-10

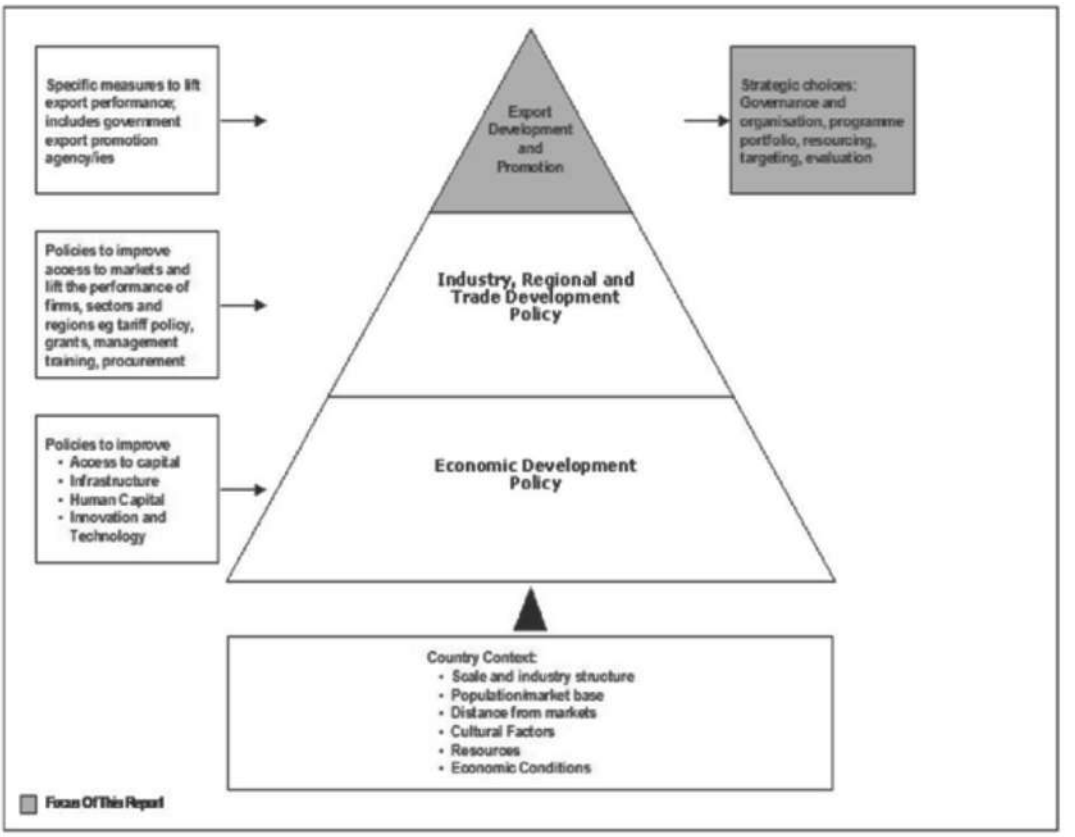
Name of Scheme Deliverables	Physical Performance/ Quantifiable		Outcome
	Target 2009-10	Achievement 01.03.2009 to 30.11.2009	01.03.2009 To 30.11.2009
MARKET PROMOTION			
Publicity	25 Nos. of various Publicity literature, brochures to be produced. Purchase of machinery/ equipments will be undertaken to upgrade the photographic studio to meet the expected standards. 60 External and 25 internal advertisements would be released in magazines/ journals to promote logo for Indian sea foods abroad. 4 sales team delegation	19 Nos. of various publicity literatures, brochures were brought out. 94 Nos. advertisements have been released in various national/ international leading fishery magazines/journals.	Disseminated information among the exporters as well as public about the schemes of MPEDA and also various products exported from India. Publicity of Indian Marine products in overseas markets.
Participation in International Fairs.	10 International + 7 Domestic Fairs. For increased acceptance of Indian seafoods in overseas markets and strengthen our existing markets and penetration into new markets, we are participating in International fairs.	MPEDA participated in 6 international fairs to get a wide acceptance to our products on overseas markets and to enable to firm up our trade relations. MPEDA also participated in 7 domestic fairs.	Increased acceptance of Indian seafoods in Overseas markets. Strengthen our existing markets and penetration into new markets. Increase in export of value added products and hence a higher export turnover.
Sea freight Assistance	Import of raw material for processing (200 containers). Promote export of specific value added products (2500 containers).		India evolving into a seafood processing hub, increased exports of value added products and increase employment opportunities.
Market Assistance 1. Developmental assistance for export of ornamental/aquarium fishes 2.Insurance scheme for workersemployed in the fishprocessing/ pre-processing units	15 (ornamental / aquarium fish) 10,000 workers for insurance scheme	6 3891	Improvement in social security, morale of workers. Exports of ornamental fish will increase.
Promotion of Ornamental Fish breeding for exports	Setting up of 56 nos. ornamental fish breeding units and marketing societies.	63 units	Increase in production and export of ornamental fish

(Source : GOVERNMENT OF INDIA , OUTCOME BUDGET ,2010-2011 ,DEPARTMENT OF COMMERCE , MINISTRY OF COMMERCE & INDUSTRY)

Table 8: OUTLAYS, QUANTIFIABLE DELIVERABLES/PHYSICAL OUTPUTS & OUTCOMES MPEDA 2011-2012

Sl. No.	Name of scheme	Objective/outcome	Quantifiable/ deliverables/ physical outputs
1	2	3	5
	Market Assistance	Development of selected items of export and for giving social and financial security for workers engaged in processing, pre-processing centres. The share of Indian exports in ornamental fish is negligible, the greatest impediments being high airfreight from India to international destinations compared with that of competing countries. To offset this disadvantage, airfreight subsidy is extended. Insurance scheme for processing/ pre-processing workers is aimed to provide a social financial security for the workers employed in fish processing plant. Market Survey to identify the strength and weakness of Indian seafood products in sophisticated markets compared to products from competing countries, to identify marketing opportunities, to explore possibilities for setting up joint ventures with established companies in these markets.	Social security /financial secutiry and improvement in morale of processing/pre-processing workers, especially women (20000 beneficiaries). Market access for Indian Ornamental fish and other products (17 neneficiaries). Identification of new marketing opportunities.
	Promotion of Ornamental Fish breeding for exports	To promote production of ornamental fish and provide infrastructure facilities for marketing, create employment generation in rural/semi urban areas.	Setting up of 56 nos. ornamental fish breeding units and market societies.

(Source : GOVERNMENT OF INDIA, OUTCOME BUDGET ,2011-2012 ,DEPARTMENT OF COMMERCE , MINISTRY OF COMMERCE & INDUSTRY)



(Source: Export Development and Promotion, Lessons from Four Benchmark Countries, the Boston Consulting Group, 2004)

Key Function and Service Options:

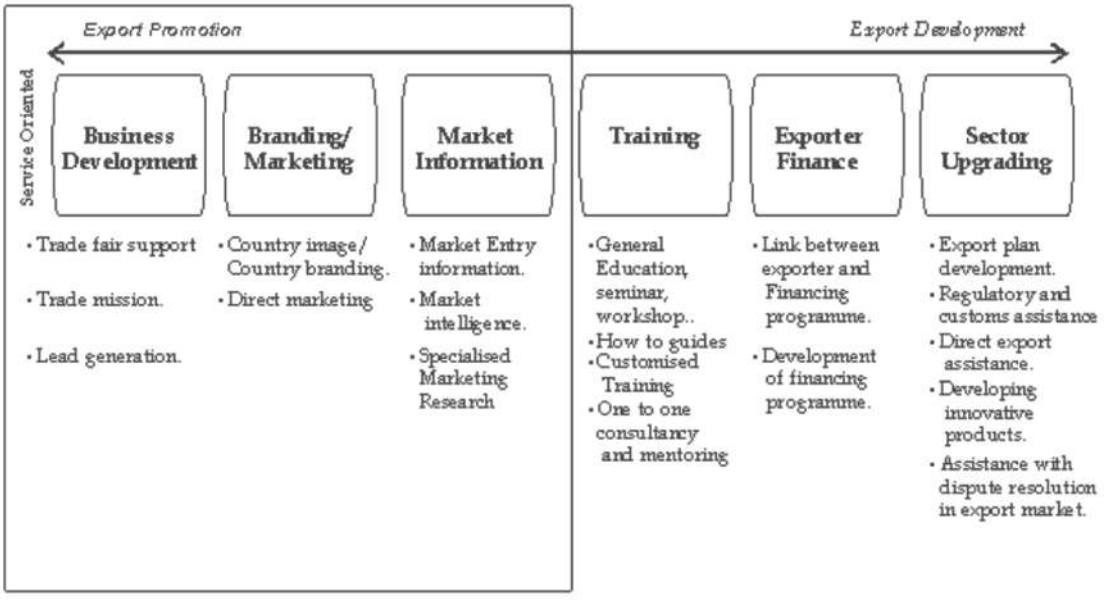


Table 9: Interface Management of MPEDA on Components and Criteria of Export Promotion and Development

Sl	Components	Criteria	Interface
I	**BUSINESS DEVELOPMENT FUNCTION**		
	Trade Fairs:		Yes
	Trade Missions:	criteria	
		a) export readiness,	No
		b) export performance,	
		c) export competence of the company executives attending the mission,	
		d) export production capacity	
		f) extent of export marketing planning.	
		Organize B2B Meetings	No
		Develop a Handbook:	Yes
		Conduct Seminar Series:	No
	Lead Generation:	a). identifying opportunities in the specific markets,	
		b) generating customized contact list of potential interested buyers	No
		c) developing business meeting agendas for visiting companies.	
II	**MARKET INFORMATION FUNCTION**		
	Market Entry Studies:	a) market potential, economic climate, market trends, and industries and business practices;	No
		b) market access conditions, specific market trends for selected export products and regulatory framework;	No
		c) transportation and distribution methods, relating to distribution channels and preferred modes of transport and shipping methods and costs.	Partly
		Integrate market information into CRM application:	No
		Develop and Disseminate Fact Sheets:	No
	Market Intelligence Reports	a) monthly bulletins, with latest updates on various topics like training, regulations	
		b) monthly and bi-annually statistical updates, with imports and export data for HS code	
		c) monthly and quarterly competitive round up, with statistical data about exports to key markets;	
		d) quarterly competitive round up analyses, including qualitative inputs in addition to the statistical data.	
		e) Alerts to inform of competition profiles, anticipated trends and market overviews, as presented in strategic publications.	No
	Specialized Reports	a) Import regulations studies, covering topics such as sanitary issues, and packaging regulations;	No
		b) Tariff studies, such as import tariffs and possible exemptions; and	No
		c) rules of origins studies.	
	Specialized Reports	a) Import regulations studies, covering topics such as sanitary issues, and packaging regulations;	No
		b) Tariff studies, such as import tariffs and possible exemptions; and	No
		c) rules of origins studies.	
III.	**OTHER FUNCTIONS**		
		Branding and Marketing	No
		Training:	Yes (Technology)
		Export Financing	No
		Sector Upgrading	No

No of Years		Countries	No of Years		Countries
All 17 years	1.	FRANCE	15 years out of 17 years	1	BAHARAIN IS
	2.	GERMANY		2	BELGIUM
	3.	HONG KONG		3	TAIWAN
	4.	JAPAN		4	CZECH REPUBLIC
	5.	MALAYSIA		5	ITALY
	6.	NEPAL		6	SRI LANKA DSR
	7.	NETHERLAND		7	SWEDEN
	8.	SINGAPORE			
	9.	U ARAB EMTS			
	10.	U K			
	11.	U S A			
16 years out of 17 years	1	THAILAND	14 years out of 17 years	1	BANGLADESH PR
13 years out of 17 years	1	KUWAIT	12 years out of 17 years	1	CHINA P RP
				2	DENMARK

Conclusion:

Ornamental fish export from India is in a stress condition at present and constraints of export need to be addressed on priority basis. Consistent decline in export in spite of persistent emphasis on technical aspects is an indicator of need for evaluation of existing plan-process-procedures. If popular marketing strategies like product diversification, market differentiation, market segmentation is strategically conceptualized then the situation will definitely alter the prospect in right perspective. Indian product is supposed to be losing export market solely because of loss of genetic purity, is an assumption based on technology gap between market leader and follower. From marketing point of view this cannot be held as a factor of constraints in a situation when 85% of global trade from India is on wild catch. Reasons of this incidence need to be analyzed with adequate market intelligence and market research. Brand positioning of Indian product with point of parity (POP) and point of difference (POD) is not resorted, if issues are properly addressed will boost the chances of India emerging as a major player in Ornamental fish export Industry.

Consulting Group, 2004)

Status of Captive Breeding of Indigenous Ornamental Fishes of Kerala

Eapen Jacob
Assistant Professor in Zoology
Govt. College, Kariavattom, University of Kerala

Different surveys and scientific studies have proved that, Kerala region of the Western Ghats has a rich biodiversity. It provides great variety of biotic types, climatic zones and remarkable endemism (Easa and Shaji, 1997). It also considered as part of one of the hot spot areas for conservation by the IUCN. Kerala has 44 rivers originating from the Western Ghats, which provide diverse freshwater habitats from the across the land strip. The freshwater habitats of Kerala harbour hundreds of beautiful fishes which can be used as potential ornamental varieties. According to FAO (Kurup, *et al.,* 2004), the identity of 175 freshwater fishes from Kerala waters are confirmed, of which 106 species can be grouped under ornamental varieties.

Scientists and hobbyists were too late to pay attention on this hidden treasure of our own land. For many years these beautiful fishes have been used as ornamentals only after wild collection. Some of the serious efforts on the development of captive production technologies were put forth by many of the major institutions after the realisation about the value of the precious bio-resources. The very first of its kind was marked by the steps taken by National Bureau of Fish Genetic Resources (NBFGR), Lucknow, who has introduced research projects for the development of captive propagation technologies of endemic freshwater ornamental fishes from both the Western Ghats and the North-Eastern Ghats under the ICAR-NATP scheme. Likewise Marine Products Development Authority (MPEDA), Cochin also funded with the similar objectives. In Kerala, College of Fisheries (presently Kerala University of Fisheries and Ocean Studies (KUFOS)) and the Regional Agricultural Research Station (RARS), Kumarakom were the focal centres of these activities. Besides a number of isolated works are being carried out on this area, most of them were as part of doctoral researches and other academic endeavours. Some of the indigenous ornamental fishes of Kerala which have been reported to be bred in captivity are listed here.

1. *Puntius denisonii*
2. *Nemacheilus triangularis*
3. *Nemacheilus semiarmatus*
4. *Puntius pookodensis*
5. *Puntius melanostigma*
6. *Rasbora daniconius*
7. *Danio malabaricus*
8. *Pristolepis marginata*
9. *Garra mullya*
10. *Garra surendranathanii*
11. *Chela fasciata*
12. *Chela dadyburjori*
13. *Horabagrus brachysoma*
14. *Etroplus suraten*sis

The College of Fisheries has succeeded in the development of captive breeding

techniques for fish species as *D. malabaricus* (Giant Danio), *R. Daniconius* (striped rasbora), *G. mullya*, *P. Melanostigma* (Wayanad barb), *P. pookodensis* (Pookode barb), *P. marginata* (Malabar sunfish), *N. Triangularis* (Koima), *N. Semiarmatus* (Koima) etc. RARS has come out successfully with the breeding technology for *E. suratensis* and *H. brachysoma*. Meanwhile the well known red torpedo barb, *P. denisonii* was bred in the College of Fisheries under an MPEDA funded scheme. *G. surendranathanii* was bred in Cochin University of Science and Technology (CUSAT).

A captive breeding programme for a freshwater fish goes through many phases, such as

1. Acclimatization to the captive environments
2. Identifying the sexes
3. Captive maturation
4. Spawning under captivity
5. Larval rearing

The application of right captive breeding technology for a species of fish depends upon a number of different factors. It includes its taxonomical position, physiological and ethological particularities along with some physical factors such as climatic or environmental conditions. Some species are found to be extremely sensitive to narrow fluctuations in environmental and other biological parameters. They need special care and monitoring throughout the procedure to attain the results.

For any captive breeding programme the first and most important step is the distinction of different sexes. In some species it will be an easy task, on the other hand, in some others, this will be almost impossible to detect the sexes. Mostly sexual segregation is accomplished by detecting special external features known as sexual dimorphic characters. The possession of these sexual dimorphic features may vary species to species. These include nuptial tubercles, serrated fin rays, genital papilla, elaborate fin spreads etc. Some cases male and female can be separated by observing the colour patterns. It can be termed as 'sexual dichromatism'. Fishes without sexual dimorphism may turn to be a big challenge on the breeder to start a captive breeding programme. In such cases he has to employ other means such as hand stripping and its ethological patterns.

As specified earlier, species-wise variations are evident in all aspects of the life history of a fish. Captive maturation means make the male and female fishes ready for spawning by ensuring perfect growth of the gonads by providing high quality feed. Studies on the feeding biology of the fish play the role here. Some fishes demands hormonal supplements along with food to attain gonadal maturity.

Easy breeding fishes spawn naturally by simple co-habitation of ripe male and female fishes in a breeding tank where its natural habitat will be simulated. In this method, the application of hormones by any means can be avoided. In the next phase fishes need hormone injections to be ovulated. They spawn their own. The next level includes fishes with extreme sensitivity. They do not lay eggs even after hormone injections. Such fishes need manual hand stripping technique to collect ovulated eggs. The collected eggs and milt are undergone fertilization by *in vitro* methods.

Fishes like *D. malabaricus* and *P. pookodensis* comes under the first category. They were bred by simple natural methods of captive breeding. A thorough understanding about the microhabitat and breeding patterns of the fish is essential to conduct a natural breeding programme. *P. Pookodensis* is a phytophil. It means presence of aquatic plants plays a positive role on the breeding of the fish.

Pristolepis marginata is a lithophil. It means, for spawning of the fish the presence of stones is an unavoidable factor.

Fishes like *G. mullya, G. Surendranathanii, P. melanostigma* and *N. triangularis* are produced by induced by more sophisticated techniques. They need hormone injections to attain oocyte final maturation. The ovulated fishes spawn themselves in the breeding tanks.

The red torpedo barb, *Puntius denisonii* was bred after elaborate procedures like captive maturation, hormone injection and in-vitro fertilization. The ovulated eggs and milt are collected by hand stripping methods. The collected milt and egg are undergone in vitro fertilization. For this collected eggs and milted are mixed under hygienic and dry conditions in laboratory. Different instruments are needed to attain maximum success.

Pristolepis marginata was bred by entirely different method because it exhibited parental care mode of reproduction (Anna Mercy *et al*., 2002). This fish exhibits parental care and nest building habits. They build nests out of pebbles (pebble nest) prior to spawning. All the activities last for days.

The propagation technology most of the indigenous fishes of Kerala are still under darkness. So it requires serious attention from the scientific world as well as the Government. A well established farm or seed production unit exclusively for indigenous ornamental fishes in Kerala has yet to come, meanwhile, a lot of them of this kind are there for exotic fishes under the support of different government agencies. So it is the need of the time to come forward with proper funding from governmental agencies to ensure captive production of indigenous ornamental fishes. It will also be helpful in the conservation of threatened species of endemic freshwater fishes of Kerala.

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Formulated ornamental fish feeds - An India perspective

Vijayagopal P. & Vijayan K. K.
MBTD, CMFRI (ICAR), Cochin
Email: vgcochin@hotmail.com

Introduction

Aquaculture nutrition involves production and use of aquatic animal feeds of the right type to meet the nutritional requirements. In general, exogenous feeding is not involved in nature because most of the nutrition is derived by aquatic animals from water. Feeding them becomes a challenge when we culture them in larger densities in confined systems. Start nutrition or larval nutrition is the first bottle neck. Live feeds both phytoplankton and zooplankton are the natural feeds. When we cannot culture them in sufficient quantity and quality our efforts are to replace them with formulated feeds. The processes involved to produce them became so sophisticated forcing us to draw techniques and technologies from not only food technology, but also from nanotechnology and pharmacology. In this article we shall attempt to present the scenario in India regarding the ornamental fish feeds which is a segment in aquatic animal feeds.

Ornamental fish nutrition

The lion's share of ornamental fish produced and traded are the ones reared in freshwater. Marine ornamental fish are more attractive and expensive. The levels of difficulties in rearing them are also high. Nutrition of these fish (both marine and freshwater ornamentals) demands several aspects which are not involved in the nutrition of food fish which are mainly grown with the objective of achieving maximum weight in minimum time. Other than meeting the macro nutrient requirements like protein and fat for their maintenance, they have a special requirement to maintain their natural color. This is by and large acquired through food. If we fail to provide them, these animals loose color which is the major factor determining the cost the fish. Therefore, ornamental fish nutrition involves meeting their basic nutrient requirements and maintenance of color. As of now, even the nutrient requirements of the majority of most traded ornamental fishes are not available in the public domain emphasizing the need for such basic studies worldwide.

In spite of this, the availability of nutritional products in various hues and attractive packaging tells us the demand for such products. Claims of incorporating various color enhancing nutrients, growth promoters, and nutrients to accelerate reproduction are all questionable due of lack of scientific evaluation or data to support such claims.

India perspective

Aquatic feed manufacture in India started with the boom in shrimp culture in 1990s. Shrimp feeds are sinking feeds and the technology involved in its manufacture is known as steam pelleting which produces a compressed pellet. All the major players came into Indian market, and operate, even after the bust of shrimp culture.

Feeds for freshwater aquaculture

Fish culture in India involves the Indian major carps and traditionally they were fed a mixture of ground nut oil cake and rice bran. It was after 2000, the benefits of feeding a floating pellet were demonstrated on farm by agencies like American Soybean Association (ASA), and a market for floating fish feeds evolved in India. With the advent of catfish farming, mainly the *Pangasius*, there came a need for floating fish feeds on a commercial scale. Gradually, floating fish feed production technology was brought into India. The technology that was brought in for the production of floating fish feeds was extrusion. Typically single screw extruders capable of producing up to 10 tons hour which are less than ten in number are in operation.

Two types of floating fish feeds are produced in these plants. One meant for catfish culture and another one for carps. The feed meant for catfish is devoid of fish meal and hence cheaper compared to the feed meant for carps containing both fish meal and fish oil. In the carp feed, oil incorporation up to 5% is possible without affecting the floating property of the feed. Another, 1-2% oil is given as an overcoat in an ordinary fat coating equipment. It should be noted that all feed produced in these extruders are above 2 mm in diameter which are meant for grow-out culture.

Feeds for mariculture

It is also relevant to note here that marine food fish farming is still at a field level demonstration stage in different locations all over the country. However, feeds for marine food fish like sea bass, groupers, cobia and pompano require floating or slow sinking feeds with more than 10 % fat. Such feeds are not produced in India because of lack of volumes in trade. The technology here is again extrusion with an add on fat coating equipment known as vacuum coating which is another form of post-pellet liquid application (PPLA) system. Such feed pellets are currently imported, due to the lack of such extrusion infrastructure in India.

Formulated feeds for aquariculture

Coming to ornamental fish feeds, they are classified as micro feeds because the particle size or diameter, in case of spheres, is less than 1.5 mm. The production technologies are several. Spray drying is used for obtaining particles ranging from 10 microns to 500 microns, drum driers and bell driers for obtaining flakes and twin-screw extrusion and spheronization for sizes above that. The complexity here is to obtain feeds with all types of buoyancies such as fully floating, slow sinking, neutrally buoyant and fully sinking feeds depending upon the organism to be fed.

Micro feeds are required to feed ornamental fish, larval fish of both ornamentals and food fish and nursery culture of food fish meant for stocking and grow out to table size or marketable size. With so many applications for such feeds, India is a country which imports the entire requirement of such feeds. When CMFRI studied the Chennai ornamental trade and market, we found that there are attempts to manufacture these feeds in India. As the traders themselves were the producers, they opine that import and trade of premium products is more lucrative than indigenously producing them.

Coming to the after effects of such a scenario, it can be said that India loses foreign exchange and produces ornamental fish, food fish fry and fingerlings at higher cost. In order to address this issue, initiating R&D efforts locally is the first step which Institutions like CMFRI under ICAR has taken up. Investment in technology is another aspect to be taken care of because, scaling up of

technologies developed by indigenous R & D can only ensure commercial scale availability of these products catering to local requirements and demands. When this value chain is complete the production of ornamental fish becomes cost effective in India, and we would be able to compete in export markets more effectively.

We feel that investment in R& D is effective at present. Investment in capital intensive technologies like twin-screw extruders is the area where we are lagging behind. This has to come through private-public-partnerships (PPP). Several agencies in Govt. and private sector should act in unison to achieve the synergy.

An Overview of Marine Ornamental Fisheries in India

***Gopakumar G. & Johnson B.**
Mandapam Regional Centre of
Central Marine Fisheries Research Institute (CMFRI),
Marine Fisheries post, Ramanathapuram District – 623 520
**Email: drggopakumar@gmail.com*

Introduction

The need for the development of organized marine ornamental fisheries in India is being highlighted since last two decades. Now it is the time to introspect and to review how these projections are translated into action. It is needed to examine some of the basic issues and concerns which are very much relevant in this regard. The initial concern is whether it is worth developing marine ornamental fisheries in India. If it is worth, the next issue is to ensure the availability of sufficient resources to develop marine ornamental fisheries. It is also needed to assess and evaluate the existing marine ornamental fisheries and the issues associated with the same in India. It is well understood that in recent years the government/ developmental agencies have been taking some steps for the development of marine ornamental fisheries. An evaluation of the impact of the same is also pertinent. In the recent past the Central Marine Fisheries Research Institute has been focusing on the hatchery production of marine ornamental fishes and technologies for more than a dozen species which are in good demand in the national and international trade have been developed. In this context, it is worth examining whether hatchery production of marine ornamental fishes will be an alternate option for sustainable marine ornamental trade. Green certification of marine ornamentals is also getting much acceptance now as a sustainable eco-friendly method of trade development. Hence it is also needed to explore the possibility of the development of a certified marine ornamental fisheries from the wild. Finally it is also essential to discuss whether the formulation of a marine ornamental fisheries policy for evolving an organized marine ornamental fisheries will be a way forward in the development of marine ornamental fisheries in India.

i) Global scenario of marine ornamental fisheries

Based on the Global Marine Aquarium Database (GMAD) the annual global trade is between 20 - 24 million numbers for marine ornamental fish, 11-12 million numbers for corals and 9-10 million for other ornamental invertebrates. A total of 1471 species of fish are traded globally. Most of these species are associated with coral reefs although a relatively high number of species are associated with other habitats such as sea grass beds, mangroves and mud flats. According to the data provided by exporters, the Philippines, Indonesia, the Solomon Islands, Sri Lanka, Australia, Fiji, Maldives and Palau, together supplied more than 98% of the total number of fish exported. GMAD trade records from importers for the years 1997-2002 showed that the United States, the United Kingdom, the Netherlands, France and Germany were the most important countries ofdestination, com-

prising 99% of all imports of marine ornamental fishes. Exporter's data revealed Taiwan, Japan and Hong Kong to be important importing areas (Collette et al., 2003).

Among the most commonly traded families of fish Pomacentridae dominate accounting for 43% of all fish traded. They are followed by species belonging to Pomacanthidae (8%), Acanthuridae (8%), Labridae (6%) Gobiidae (5%), Chaetodontidae (4%), Callionymidae (3%), Microdesmidae (2%), Serranidae (2%) and Blennidae (2%). For the years 1997-2002, the blue green damselfish (*Chromis viridis*), the clown anemone fish (*Amphiprion ocellaris*), the whitetail Dascyllus (*Dascyllus aruanus*), the sapphire devil (*Chrysiptera cyanea*) and the three spot damsel (*Dascyllus trimaculatus*) are the most commonly traded species. The top ten species together account for 36% of all fish traded from 1997 to 2002.

According to GMAD, there are 61 species of soft corals, 140 species of stony corals, eight genera of sea fans and 516 species of ornamental invertebrates are in the trade.

From the forgoing it is evident that the international trade of marine ornamentals has been expanding and has grown has multimillion dollar enterprise. It is a multi stakeholders industry ranging from specimen cultivator, culturist, wholesaler, transhipper, retailer, hobbyist to researchers, government resource manager and conservator and hence involves a series of issues to be addressed and policy to be formulated for developing and expanding a sustainable trade. In this context, it is very much lucrative to venture into the trade with appropriate policy interventions.

ii) Marine ornamental fisheries resources of India

India is endowed with vast resource potential of marine ornamentals distributed in the coral seas and rocky coasts with patchy coral formations. The major oceanic reef areas of coral reef distribution in India are the Lakshadweep Islands and the Andaman – Nicobar groups of Islands. The other areas of coral fish distribution are the coastal areas of fringing or patch reefs of Gulf of Kutch to Mumbai, areas of central west coast between Mumbai to Goa, certain locations of south west coast (Thirumullavaram, Vizhinjam to Kanyakumari), Visakhapatnam, Gulf of Mannar and Palk Bay. A total of 848 numbers of reef associated fishes are reported in Indian waters, (www.fishbase.org) out of which about 350 species are reported to be of ornamental value (www.nbfgr.res.in).

Family Pomacentridae

The clown fishes and damselfishes are very attractive and hence they are in good demand in the marine aquarium trade. They are small hardy fishes and are typically highly coloured. The major genera of damsel fishes in our waters are *Chromis, Dascyllus, Abudefduf, Pomacentrus, Chrysiptera* and *Neopomacentrus.* The anemone fishes (clown fishes) belong to the genera *Amphiprion* and *Premnas.* They are associated with sea anemones, since they possess mucous coating over their body by which they are resisting to stinging of sea anemone. Thy major species of Pomacentrids in Indian waters include *Amphiprion sebae, A. ocellaris, A. percula, Chromis viridis, Pomacentrus pavo, P. cearuleus, Dascyllus auranus, D. trimaculatus, D. reticulatus, D. carneus, Neopomacentrus cyanomos, N. nemurus, Chrysiptera unimaculata, Abudefduf vaigiensis, A. septemfasciatus* and *A. bengalensis.*

Family Labridae

There are many colourful species of wrasses belonging to this family in the Indian rocky coasts and reef areas. The characteristic of wrasse is its swimming style, using only the pectoral fins to row itself along, but shooting

suddenly ahead by body motion. The major genera of labrids available in our waters are *Gomphosus, Halichoeres, Stethojulis, Thalassoma, Labroides, Cheilinus, Anampses, Coris, and Bodianus.* The major species include *Thalassoma lunare, Anampses caerulepunctatus, Gomphosus caeruleus, Labroides dimidiatus, Halichoeres scapularis, H. marginatus, Stethojulis albovittata, S. strigiventer, Coris gaimardi, C. formosa, Cheilinus undulates* and *C. trilobatus.*

Family Scaridae

Parrotfishes of this family are of striking colours. Their name comes from the heavy parrot like beak, which is formed of their fused teeth. The common genera include *Scarus and Leptoscrus.* The major species include *Leptoscarus vaigiensis, Scarus sordidus, S. psittatus, S. ghobban* and *S. scaber.*

Family Pomacanthidae

The marine angelfishes are known for their grace and beauty. The major genera in our water include *Pomacanthus and Centropyge.* The common species are *Pomacanthus imperator, P. annularis, P. semicircualtus, Centropyge multispinis.*

Family Chaetodonidae

This family includes butterfly fishes and banner fishes. Butterfly fishes are small, swift and surprisingly well patterned and bright coloured fishes which are abundantly represented in the Indian Coast. The common species in our waters include *Chaetodon collaris, C. auriga, C. lunula, C. decussates, C. vagabundus, C. meyeri and C. trifasciatus.* The banner fishers are represented by genus *Heniochus. H. acuminatus* is very attractive in the aquarium. It has black and white stripes and yellow on the dorsal and tail fins.

Family Acanthuridae

Surgeon ishes of this family have oval body shape because of the identical rounded shapes of soft dorsal and pectoral fins. Their name is derived from the sharp knife like spine on each side of the caudal peduncle. The common genera in our water include *Acanthurus, Ctenochaetus, Zebrasoma and Naso.* The common species are *Ctenochaetus strigosus, Acanthurus triostegus, A. leucosternon, A. lineatus, A. nigricauda, Zebrasoma veliferum, Naso unicornis and N. litturatus.*

Family Zanclidae

Zanclus canescens is the only species of this family. The snout is projected, tube-like and there are horns like protuberances over the eyes.

Family Scorpaenidae

Lionfishes of this family owe their name to the spreading pectoral and dorsal fins. It is the wild beauty in a marine aquarium. They are occasionally found in our rocky and coral seas. The common species in our waters are *Pterois volitans* and *Dendrochirus zebra.*

Family Ephippidae

The bat fishes of this family grow very fast. When young they are most attractive, tend to lose some of their colour as they rapidly grow. The common species available along our coast are *Platax teira* and *P. orbicularis.*

Family Serranidae

Groupers of this family are widely distributed in the rocky Indian coast. Many colourful species of this family are of ornamental value. The common genera include *Cephalopholis* and *Epinephelus.* The common species are *Cephalopholis argus, Epinephelus merra, E. hexagonatus* and *E. tauvina.*

Family Balistidae

The triggerfishes and filefishes belong to this family. The trigger fishes are so named because of the locking device on the dorsal fin that triggers it into a stiff, erect spine, fixing the fish in position in a crevice in coral. In filefishes the dorsal fin consists of a single long spine. The common genera in this family include *Balistapus, Rhinecanthus, Oxymonocanthus and Pervagor.* The major species includes *Rhinecanthus aculeatus, Balistapus undulates, B. conspicillum, Oxymonocanthus longirostris* and *Pervagor melanocephalus.*

Family Tetradontidae

It contains the puffer fishes and porcupine fishes. The puffer fishes have the ability to inflate their bodies with water and then turning upside down so that they float to the surface. The common genera found in our Indian coast include *Arothron and Canthigaster*. The porcupine fishes can also inflate their body. They have long sharp spines over the body. When inflated, the body is round and spines protrude formidably. The common genus in our coast is *Diodon*. The major species of puffer fishes and porcupine fishes in our water are *Arothron stellatus and Canthigaster margaritatus and Diodon hystrix.*

Family Ostraciontidae

The boxfishes have hard outer cases that completely enclose their body. *Ostracion cubicus* is a common species.

Family Holocentridae

The squirrelfishes are brightly coloured fishes. Typically the body is red and the fins are yellow. The common genera include *Neoniphon, Holocentrus, Sargocentron and Myripristis.* The common species are *Neoniphon samara, Sargocentron diadema, Holocentrus laevis and Myripristis murdjan.*

Family Antennaridae

Frogfishes of this family are found in our coastal waters. The best known frog fish is the Sargassum fish *Hystrio hystrio.* It is seen wherever sargassum weed is found. The body is brownish yellow mottled with darker colour. The fish becomes perfectly concealed among the sargassum weed where it lives.

Family Muraenidae

Morey eels of this family are often attractively coloured. Many eels belonging to the genera *Gymnothorax and Muraena* are distributed in our reef areas and rocky coasts.

Family Theraponidae

The tiger fishes of this family have typically striped bodies. The three striped tiger fish *Therapon jarbua* is very common along Indian coast.

Families Gobidae and Blennidae

The gobies and blennies are attractive small bottom living fishes which are commonly found in tidal pools of rocky coast. The common genera of Gobies and Blennies in our waters include *Acentrogobius, Aspidonotus, Istiblennius and Salarias.*(Gopakumar, 2007)

It is evident that a rich biodiversity of ornamental fishes is distributed in coral reef areas. However, only scanty information is available on the exploitation potential of different species. A study done on the exploitation potential in Lakshadweep by Murty et. al. (2002) indicated that damselfish are the most dominant accounting for 43.7% of the estimated total stock (137 lakhs), followed by parrot fish (15.3%), surgeon fish (13.4%), wrasses (11 %) squirrel fish (2.5%), goat fish (1.7%), butterfly fish (1.1%) and trigger fish (1%).

iii) Existing ornamental fisheries in India

Marine ornamental fishes are caught in India either as a by-catch in gears such as traps or bottom-set gillnets or caught unscientifically in coral reef areas. Indiscriminate collection practices followed at coral reef habitats inflict damage to the ecosystem. The fisherwomen who are engaged in such practices are not aware of the eco-friendly method of collection. They also have no proper facilities for conditioning the collected fishes and consequently majority of these fishes circum to mortality in these primitive facilities. No reliable statistics of marine ornamental fishes collected and traded is available.

iv) Recent steps taken for promotion of marine ornamental fisheries

In recent years the government/developmental agencies have taken a few steps towards promotion of marine ornamental fisheries. These include the awareness programme on marine aquarium fishes and marine aquarium gadgets through aqua show events. The training programmes organized by R&D institutions has played a major role in creating awareness as well as in realizing the potential of marine ornamental fishes. The developmental agencies like NFDB, NABARD has also started financing programmes for the development of marine ornamental trade.

v) Issues Associated with Wild Collection

Destructive collection practices, the introduction of alien species, over exploitation, the lack of scientific information on many species collected and threat of extinction of target species are the major problems of the marine ornamental fish trade. Destructive fishing techniques include the use of sodium cyanide and other chemicals to stun and catch fish. Even though cyanide only stuns the fishes, high post capture mortality is recorded. It may destroy the coral reef habitat by poisoning and killing non-target animals, including corals. During collection of coral pieces for the coral trade, many more colonies may be damaged or broken than are actually harvested. Corals are also broken for easy access to capture fish. This is more common with branching species in which small species such as *Dascyllus* and *Chromis* often refuge **(Edwards &** Shepherd, 1992). Collection of live rock has been considered as potentially destructive as it may lead to increased erosion and loss of important fisheries habitat.

When exploitation is at a lower level in comparison to the resource available, there will not be any negative impact on reef fish populations. A study of the Cook Islands showed that the total catch per unit effort remained constant between 1990 and 1994 (Bertram, 1996). In Australia, due to the permit system, the current aquarium fishery is at sustainable level (Queensland Fisheries Management Authority, 1999). But Australia is a rare case as the Great Barrier Reef is the largest reef system in the world. It is well known that not all fish are equally available or equally attractive to the industry, and the most common fish need not be those favoured by the hobbyists. As a result, the effect of collection of ornamentals should be measured with respect to their potential to deplete particular species or locations. Several countries in Asia and South America have begun to implement collections restrictions of certain orna**mental fish species (Corbin &** Young, 1995; Friedlander**, 2001; Ogawa &** Brown, 2001). Although no marine species collected for the aquarium trade have been driven to global extinction, studies carried out in Sri Lanka, Kenya, the Philippines, Indonesia, Hawaii and Australia have reported localized depletion of a number of target aquarium species of fish like butterfly fish and angelfish due to heavy collection pressure (**Lubbock &**Polunin, 1975; Rubec, 198**7; Vallejo, 1997; Soegiarto & Polunin, 1982; Tissot &** Hallacher

1999). The only systematic study assessing the effects of harvesting fish for the aquarium trade on resource populations was carried out in Hawaii (Tissot, 1999). The study reported that eight of the ten species most targeted by collectors showed decline in abundance at exploited sites relative to control sites.

A larger part of the trade of ornamentals is centered on individual species. The vulnerability of the species to collection will depend on a number of life history parameters like growth, reproduction and recruitment (Harriott, 2003). Even though reef fish exhibit a wide variety of mating strategies the larvae are distributed through wave and wind driven ocean currents (Hutchings, 2002). This makes replenishment of reefs with new fish larvae highly dependent on these currents and hence the availability of fish for sustainable aquarium collection is highly variable.

The effects of fishing are significantly different for species that are hermaphroditic compared with species that do not change sex. A fishery selectively removing larger animals first will mean that animals will have to start changing sex art smaller sizes, possibly reducing the fitness of individuals and thus making hermaphroditic stocks more vulnerable to overfishing.

Trade in ornamental marine fishes is characterized by extreme selective harvesting. For many species, juveniles are preferred by aquarium fish collectors due to their distinctive coloration and ease of maintenance. Consistent harvesting of juveniles may leave only limited number of young ones to reach adult size and replenish the adult stock.

Even though most coral reef fishes have broad distribution, a few species are endemics. Some species are naturally rare, occurring only in very restricted locations or naturally occur in lower numbers, even though they may be widely distributed (Wood, 2001). Other species may be abundant at different sites, but their distribution is limited to specific habitats. The more wide spread/ or abundant a species is, the less vulnerable to exploitation. Increased rarity often implies higher prices and hence vulnerable to overexploitation.

Males of many coral reef fishes tend to be preferred due to their distinctive colouration. Selective harvesting for males of particular populations on a regular basis may lead to reproductive failure and ultimate population collapse due to heavily biased sex ratios in remaining population.

There are many factors that lead to post harvesting mortality, such as physical damage and use of chemicals during collection, poor handling practice and disease. Even when collected in an environmentally sound manner, aquarium organisms often suffer from poor handling and transport practices resulting in stress and poor health of fishes. Research on the marine ornamental trade between Sri Lanka and the UK demonstrated that in the mid 1980s about 15% of fish died during and immediately after collection, another 10% died during transit and a further 5% in holding facilities (Wood, 1985). As a result of such mortality, more fishes are required to be collected than would be necessary to meet the market demand.

vi) Status of Hatchery Production Technologies developed in India

It is well accepted that the trade developed from tank reared fish and other ornamentals is the final solution for a long term sustainable trade. The Central Marine Fisheries Research Institute (CMFRI) has been focusing on this vital aspect for the past few years. The Institute was able to develop hatchery production methods for more than a dozen species of ornamental fishes (clownfishes and damselfishes) which are in high demand in the international trade. (Gopakumar et al., 2001;

Gopakumar et al., 2002; Gopakumar & Santhosi, 2009; Gopakumar et al., 2008 , Gopakumar et al., 2009; Ignatius et al, 2001; Madhu & Rema 2002; Vijayagopal et al., 2008; Rema et al., 2007; Rema et al., 2008; Madhu et al., 2008). These methodologies developed can be scaled up for commercial level production and a hatchery produced marine ornamental fish trade could be developed in the country. It is high time that the fisheries developmental agencies should come forward with attractive schemes to popularize the technology.

Research and development in the breeding and culture of marine ornamentals is a priority area which has to be intensified in the coming years. The high unit value of ornamentals makes them more commercially viable than marine food fish culture.

vii) Development of a certified trade

Green certification is the certification given to a product to ensure its environmental and socio-economic sustainability. Certification is a procedure to assure that a product, process or service conforms to specified requirements. We have golden example of Marine Aquarium Council (MAC) which promotes marine ornamental trade through sustainable collection and conditioning methods. A glance on the objectives and the standards developed for certification will be very useful for formulating guidelines green certification of marine ornamentals.

viii) Development of a marine ornamental fisheries policy

In India, till date no organized trade of marine ornamentals has been initiated. But it is a fact that a great deal of unorganized collection of marine ornamentals is in vogue in many parts of our reef ecosystem. No data regarding the same is available and this is a matter of great concern due to the indiscriminate nature of exploitation and eco-hostile methods of collection which damage the reef ecosystem. In addition to this, lack of knowledge on appropriate post harvest husbandry practices leads to large scale mortality of the collected animals. It is time to evolve a marine ornamental fisheries policy in the country for developing an organized trade of marine ornamentals. (Gopakumar, 2007)

In developing a marine ornamental industry in India it is inevitable to formulate legislations on these issues which are of vital concern to the sustainability of the trade. It is suggested that a few number of entrepreneurs can be licensed to collect suitable species from selected areas and trained on eco-friendly collection methods and conditioning and maintaining of harvested species in healthy condition. The Central Marine Fisheries Research Institute (CMFRI) and the National Bureau of Fish Genetic Resources (NBFGR) can combine to develop a certification system on line with standards developed by the Marine Aquarium Council (MAC). The Marine Products Exports Development Authority (MPEDA) can take the lead to develop an export market for the certified varieties. The impact of exploitation has to be closely monitored by scientific agencies at periodic intervals and required management measures have to be implemented as and when required.

Conclusion

It is well understood that the marine ornamental trade is variety oriented. Even though hatchery production technologies for many marine ornamental species are emerging recent years, it can be reasonably predicted that the percentage of wild caught marine ornamental species will continue to dominate the sector on a global basis in the near future. Based on the current technologies it is neither possible nor economically viable to hatchery produce all the species required for the trade.

Hence the hatchery production of marine ornamental species can be complementary but may not be full replacement for the collection from the wild. The idea behind the establishment of GMAD and MAC is indicative of the modern trend on wild collection of marine ornamental species. It shows that the wild collection sector is important and at the same time the protection of reefs due to wild collection also is vital. It also emphasizes the accurate data base needed, the eco-friendly methods to be followed and the commitment to a certified wild caught industry for sustainable trade. The attitude towards the wild caught sector and tank reared sector of aquarium industry should be mutually supportive. In the immediate future, India can emerge as one of the major source countries for a sustainable marine ornamental trade if we appropriate steps in the light of the current global scenario by formulating appropriate policies for wild collection of species and also by commercial production of suitable species though the development of hatchery technologies.

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Biotechnological applications in ornamental fish culture with special reference to fish health

Vijayan K. K. Sanil N. K. & Pradeep M. M
Marine Biotechnology Division, Central Marine Fisheries Research Institute, Post Box No.1603, Ernakulam North P.O., Cochin-682 018

Introduction

Though India is endowed with tropical climate, abundant water resources, rich biodiversity and large manpower base, its share in global ornamental fish trade is negligible (around 500 lakhs in 2008-09 accounting for about 0.5% of world exports) and most of this comes from the export of wild-caught species. Till a few years back, ornamental fish culture has been treading the traditional track, practicing the classical breeding techniques, larviculture using live feed (infusoria, rotifers, artemia naupliietc) and further rearing using natural or traditional formulated feeds. In the case of fresh water ornamentals, breeding and culture are mostly on the traditional lines, occasionally bringing few selected imported brood stock for multiplication and trading. But in the case of marine ornamentals the situation is totally different, facilities for marine ornamental breeding are just started and the lion's share of the exports are based on wild-caught species, often to propound the issues of conservation and biodiversity losses. It is high time to infuse novelty in to this system with a sustained effort employing modern techniques in biotechnology, which would definitely improve and propel synergy and growth of aquariculture in the country.

Scope of biotechnology in aquariculture

Cultures of ornamentals differ a lot from the traditional finfish/shellfish aquaculture. In aquaculture the sole aim is faster growth and enhanced production within a shorter time frame. But in ornamental fish culture, growth is not a priority; instead the hobbyist prefers to have healthy, disease free and attractive animals having a longer lifespan. This accounts for the higher prices commanded by quality fish produced from ecologically sustainable and reliable rearing systems. Again, breeding of new/rare varieties, cross/selective breeding for developing superior traits including diverse body shape, colours etc can also enhance the demand.

The term biotechnology is not new to aquaculture as biotechnological innovations and interventions have already made their mark in the sector. The entire spectrum of aquaculture, right from brood stock selection, breeding, larval rearing, nutrition, bioremediation and health management, to post harvest processing and bioprospecting have benefited from it. The spin offs from aquaculture biotechnology have started spilling over to the field of ornamentals also. In ornamental aquaculture, biotechnology holds tremendous potential in the areas of brood stock selection, breeding, nutrition, formulated feeds, health and transgenics.

Breeding and larval rearing

Biotechnology techniques have contributed much in the development of synthetic hormones which have simplified and changed

the face of the induced breeding programmes. Recently, productions of recombinant fish gonadotropins were also achieved successfully in gold fish. Similarly is the development of polyploid animals and unisex /sterile populations. Feed biotechnology by itself is an area that has made an impact in ornamental fish culture. Right from larval rearing to grow-out systems, lot of advances have been brought into this area. The biotechnological advancements made it possible to modify/fortify/enrich the traditional live feed used for larval rearing with numerous feed additives including enzymes, microalgae, colour enhancement products and probiotics. Biotechnological techniques are widely used for mass micro-algal production & their integration into feeds as probiotics for improving the immunity/natural resistance. Loss of the attractive, natural colouration in the aquarium tanks is one of the major problems in ornamental fish fed with formulated feeds for prolonged periods. The isolation and incorporation of carotenoids/ coloring agents derived from natural sources into the feed formulations can definitely enhance the color of the fish, making them more attractive. Use of functional feeds such as micro feeds, brood-stock feeds and high-health feeds to enhance colour, health and brood-stock quality is finding a place in the quality and value addition of ornamentals.

Fish Transgenics

For the past two decades, transgenic technologies have been widely used in biotechnology. In aquaculture, the term transgenics has always been frowned upon. The first transgenic fish with human *growth hormone* (*GH*) cDNA has been produced in 1980s. The technology was successfully demonstrated and dramatic enhancement of growth rate was obtained in laboratory trials in many cultured species such as salmon. Besides the increase in yield, other benefits like reduced production time and thereby lower market price could have benefitted the consumers. But, the technology which was expected to create fast growing strains suitable for aquaculture was never adopted successfully in aquaculture for various reasons, the most important ones being the apprehension towards consuming genetically modified organisms, and ecology related concerns, safety aspects of transgenic food fish and even now the issue remains mired in controversies.

But the same transgenic technology has opened up new vistas in the area of ornamentals. Successful demonstration of the *GFP* (*green fluorescent protein*) and its expression in homologous tissue specific promoters by several researchers during the nineties led to the creation of the *GFP* transgenic fish, which was a turning point in the development of ornamentals flashing fluorescent colours. The past few years have witnessed the isolation and characterization of several tissue-specific promoters from zebra fish and their use to develop dozens of stable GFP transgenic lines with green fluorescence. Later different colouring lines such as BFP (blue florescent protein), RFP (red fluorescent transgenic protein) and YFP (yellow fluorescent protein) were also developed. Subsequent to the demonstration of novel varieties of colourful ornamental fish by use of transgenic technology through the introduction of fluorescent protein genes into their genome, 'GloFish', a patented and trademarked genetically modified (GM) fluorescent fish was made available commercially in the US market. Further, other technologies for the introduction of genes for Anti-Freeze Proteins in ornamentals to increase their cold tolerance, to produce cold tolerant transgenic fishes, which can be produced and maintained even in extremely cold conditions, would open up new possibilities and new markets.

Health and disease management

Diseases caused by parasites, bacteria, fungi and virus have always remained as one

of the major constraints for the development of aquaculture, including the ornamentals. Usually ornamentals are bulk produced mostly in the tropics and transported across the globe as per the requirements. As we know, pathogens does not recognize international boundaries and these trans-boundary movements of ornamental fish stocks across the globe can definitely aid in the spread of exotic pathogens along with them. Aquatic pathogens, once they enter the aquatic rearing systems are very difficult to eradicate. This emphasizes the importance of quarantine, health certification and regular screening for the presence of harmful and notified pathogens.

Among the screening/diagnostic methods, most of the traditional methods viz. microscopy, histopathology, electron microscopy, microbiological methods and cell culture are time consuming and have less specificity and sensitivity to perform large scale screening. Hence due consideration should be given while selecting the right diagnostic methods to be followed and pathogen detection methods need to be fast, robust yet sensitive, and capable of detecting a high degree of heterogeneity. Notified pathogens like the Koi Herpes Virus (KHV) which has the potential to wipe out ornamental & carp farming have been reported from many of our neighbouring countries. Considering the trans-boundary movements of ornamentals and the existing 'grey markets' for these, routine screening for theses pathogens are essential. Molecular diagnostic techniques having high specificity and sensitivity can be successfully used in the country for the screening and surveillance for such pathogens.

Biotechnological approaches using molecular diagnostic methods, such as the gene probes, polymerase chain reaction (PCR), real time PCR etc have enabled rapid detection, identification and quantification of aquatic pathogens which helps in the successful health management. Isothermal amplification techniques like loop mediated isothermal amplification (LAMP), Nucleic acid sequence based amplification (NASBA) which is used to amplify RNA sequences are a new development, also being used for disease diagnosis in ornamental fishes. In this regard, creation of expertise and suitable facilities in novel DNA based diagnostics in the country is imperative.

Probiotics

According to the World Health Organization, probiotics is "live micro-organisms which, when administered in adequate amounts, confer a health beneût on the host". In the ornamental fishes these microorganisms include natural gut micro flora of the fishes like lactic acid bacteria (LAB), bifid bacteria, certain yeasts and bacilli. Biotechnologies have helped to identify potential probiotic microorganisms, to characterize them in the laboratory, to evaluate and mass culture them to use them as live probiotic or as inactivated microbial products (MPs). Presently many probiotic products under different commercial brands, mostly imported, along with a few indigenous ones are available in the Indian market.

Immunostimulants

Immunostimulants are substances that stimulate the immune system by inducing activation or increasing activity of any of its components. In contrast to vaccines, immunostimulants enhances the innate and non-specific immunity of the host. In aquaculture, the role and potential of the immunostimulants are recognized for long, and recently they have also found their place in the ornamental fish rearing, as a proactive and alternative approach. It can be delivered by injection, bath or oral routes the latter being effortless for mass administration. The best known immunostimulants are components of bacterial cell walls such as lipopolysaccharides and glucans but the synthetic compounds,

polysaccharide, vitamins, animal and plant extracts also serves the purpose.

Vaccines

Unlike immunostimulants, vaccines trigger specific immune responses in the host. They are mostly administered against pathogens of viral origin as no other treatment is possible in the control of viral diseases. Vaccines are available and can be used for many diseases of other pathogenic origin as well. Traditionally, less virulent or inactivated forms of the pathogens are used as vaccines. With the intervention of biotechnology, it is now possible to identify the specific receptor molecule of the pathogen which is recognized by the host immediately followed by the pathogenic invasion; this interaction subsequently triggers the host immune response. This specific pathogenic receptor can be isolated, characterized and mass produced in the laboratory by gene cloning and recombinant DNA technology which is an inevitable part of biotechnology. Using these technologies, it is now possible to design and synthesize the whole pathogenic receptor, subunit/DNA vaccines and synthetic peptides in the laboratory which can be used as effective vaccines.

Development of specific pathogen free (SPF) and specific pathogen resistant (SPR) stock

Developments of specific pathogen free brood stocks have already been achieved successfully in aquaculture of crustaceans and fin fishes. There is a huge scope and potential for this technology to be propagated in ornamental fish culture as well. The specific target can be achieved by the selection of specific pathogen free individuals and their selective breeding. Also through biotechnology, fish strain with disease resistance and the genetic/molecular reasons behind this disease resistance can be explored Once the gene responsible for this character is found out, efforts could be made to raise populations of the fish with increased expression of the character either by gene activation/knockout/ RNA interference technologies.

Conclusion

The tools of biotechnology have opened up entirely new paths for the development of aquariculture. India, in spite of its huge resources and opportunities hasn't fully realized the importance of this promising sector. The demand for tropical ornamental fishes are ever increasing and there is a huge gap between the demand and supply in this sector. The major hurdle towards the prosperity of this sector is the lack of awareness about the technological advancements and proven solutions to overcome the constraints. Proper use of biotechnological tools can provide a lot of insights in to the common issues faced by aquariculturists and promises novel solutions. This will result in the production of quality fish and better profitability for the aquariculturists, making this emerging sector a sustainable and profitable livelihood enterprise in India.

Colour enhancement in ornamental fish

Ahilan B.
Professor, Department of Inland Aquaculture
Fisheries College & Research Institute
Tamil Nadu Fisheries University
Thoothukudi – 628 00

Introduction

Ornamental fish production is an important component of the aquaculture industry. The FAO statistics indicated that the world export of ornamental fish steadily rose from US $ 160.7 million since 1999 to a peak of US $ 282.6 million in 2006. Most of the world's supplies of ornamental fishes are from Asian countries. Singapore is the largest exporter of ornamental fish contributing 21.70 per cent followed by Spain, Czech Rep and Malaysia during 2006 (Dey, 2008). USA is the world's largest single market for ornamental fishes and imported US $ 48.40 million worth of fish in 2006, followed by UK (US $ 30.80 million) and Japan (US $ 27.20 million). Ornamental fish production is the fourth largest sector in USA after catfish, trout and salmon.

The ornamental fish trade is a foreign exchange earner, besides being a source of employment. It has a significant role in the economy of developed and developing countries. The entire ornamental fish industry including accessories and feed are estimated to be worth of more than 14 billion US $ (Thomas, 2008).

Ornamental fishes are the world's most popular pets and fish keeping happens to be a popular hobby next only to photography. The fantastic shapes and brilliant colours of ornamental fishes won the heart of millions of people; hence, they can be aptly called as "Living Jewels". Most of the ornamental fishes are sourced from the developing countries in the tropical and subtropical regions, which contributed 60 – 65 per cent of the supply. With more than 120 countries involved in the ornamental fish trade and there are about 1,800 species of ornamental fish in the market of which over 1000 varieties are from freshwater origin, 90 per cent of the fresh water fishes are farmed while 10 per cent are collected from wild.

India is a tropical country and its contribution to global ornamental fish trade is negligible (Rs.5.7 crores, 0.5 per cent of international trade in 2005-06). A large number of freshwater ornamental fishes belong to family Cyprinidae from India are known to the world. Eight hundred and six species inhabit in freshwaters of India, out of which 196 species are considered as ornamental. At present, more than 50 per cent of ornamental fishes are exported from North-eastern region of India.

India is gifted with rich resources of water bodies and have 1, 64,153 km of rivers and canals, 19 million ha reservoirs, 2.0 million ha tanks and ponds, 1.5 million ha beels and oxbow lakes and 1.4 million ha brackish water. Also, it is bestowed with ideal climatic condition conducive for better growth, maturation and breeding of ornamental fishes.

The freshwater species dominating in the market are mainly from the families of Poecilidae, Characidae, Cyprinidae and

Cichlidae. The trade in freshwater ornamental fish tends to grow more rapidly with special emphasis on coldwater fishes such as goldfish and koi carp.

Ornamental fishes are found to occupy a remarkable position in the international trade. The cost of ornamental fishes depends on its colour and appearance. Brightly coloured and attractive fishes always fetch high hence in the market.

Colouration in Fishes

Attractive colouration is a determining factor for the commercial value of ornamental fish. Pigments in the skin are responsible for coloration of fish. Carotenoids are the primary source of pigmentation in the skin of fishes. The yellow, red and blue colours are caused by various carotenoids or carotenoid protein complexes. But the fish are unable to synthesize carotenoids though they are able to modify them. So fish must get the carotenoids from their diet.

Fish in a natural environment meet their carotenoid requirements by ingesting aquatic plants (which synthesize carotenoids) or through the aquatic food chain. Many carotenoids have been identified in the aquatic environment. The most usually common are lutein and zeaxanthin (yellow and deep orange) found in aquatic plants and animals and astaxanthin (red) found in crustaceans. Fish that are grown or held in confinement where natural food is limited or absent and artificial feed is the only source they may not have optimum colour.

Ornamental fish are usually grown in closed culture systems. Management convenience is the claimed advantage of this practice. The fish must be fed on commercial feeds. Feeds made from traditional ingredients are naturally or nutritionally sufficient but unless a satisfactory pigment source is added the fish will grow well but will lack adequate colouration.

Colouration is controlled by the endocrine and nervous system, but dietary sources of pigments also play a role in determining colour in fishes. The endocrine and nervous system both influence colouration in fish. The pituitary gland secretes hormones that direct the production and storage of pigments throughout the life of a fish and particularly as maturity is reached.

Pigment production and storage often increases at the onset of maturity. Many species use colour to provide amylase and attract mate. Fish of the family cichlidae are particularly. The automatic nervous system directs rapid colour changes in response to stimuli such as a predator or an aggressive tank mate.

Purpose of colour

The colour, a fish display is multi purposeful i.e. It can be involved in :

1. Communication
2. Identification
3. Camouflage
4. Defense
5. Mimicry

Colour enhancer

Colour enhancers are a natural pigments which when fed in the diet enhane the colour of fish flesh or skin. Carotinoids are the colour pigments responsible for enhancing skin colour some of which include alpha carotene, beta carotene, astaxanthin and canthaxanthin. Colour enhancers are used widely in the salmon and trout industry where they are used to enhance the pink in flesh.

Specialized pigment containing cells called chromatophores are located beneath the scales. These cells are branched, permitting pigment granules to the near or away from the

surface and aggregated or dispersed. These cells are the reason for the variable and sometimes rapid changes in fish colour. Additionally, colourless purine crystals are contained in specialized chromatophores called iridophores. The iridophores are responsible for the silver green, particularly of small pelagic fish.

Carotenoid pigments

Carotenoids and carotenoid – containing extracts have been widely used as colourants in food for centuries. The colouration may be induced by direct addition to the foodstuff or indirectly by feeding to animals. Nowadays, the caroteniod containing plant materials are being used to enhance the colouration in food fishes as well as aquarium fishes. Carotenoids are a family of over 600 natural lipid-soluble pigments that are produced in the micro algae, phytoplankton and higher plants. They also produce compounds such as essential fatty acid steroids, vitamin A, D, E and K (Goodwin, 1984; Davis, 1985). Some fish species such as Koi and various crustaceans have the enzymatic mechanisms to convert carotenoids into other forms as well such as astaxanthin – some fish / animals don't. Astaxanthin is the optional carotenoids for the proper pigmentation of the red / pink colours in aquaculture. Crustacean and other aquatic animals are unable to produce astaxanthin *de novo* naturally (Britton et al., 1995).

Pigments are characterized by their colours. Carotenoid pigments are red and orange. Xanthophylls are yellow. Melanin pigments are black and brown. Phycocyanin is the blue pigment derived from blue-green algae. Cells containing yellow pigments overlying these containing blue pigments can produce green hues. Fish are capable of producing some pigments, but others must be supplied in the diet. Black and brown pigments are produced in cells called melanocytes. Fish are incapable of producing carotenoid and xanthophylls pigments. Therefore, these must be supplied in the diet.

Source and types of carotenoid pigments

Natural sources of pigments are available in the diets of most fish. Colour enhancing diets may contain additional natural pigments to enhance colours of ornamental fishes. The types of carotenoid pigments include Betacarotene, Lutein, Taraxanthin, Astaxanthin, Tunaxanthin, Zeaxanthin, Alpha-beta doradexanthin.

The major sources of carotenoid pigments are *Chlorella vulgaris*, *Haematococcus plurialis*, *Spirrlina* sp, Shrimp head meal, marigold, paprika, carrot, pumpkin, capsicum, wheat, corn, alfalfa, krill extract, cray fish and red yeast (*Phaffia rhodozyma*).

The carotenoid pigments found in most marine and a few freshwater invertebrates is astaxanthin. This pigment gives the characteristic colour to the flesh of salmon and is available in the diet of aquarium shrimp and krill meals and salmon (fish) meal used as sourcer of protein in some feeds. Pure astaxanthin or canthaxanthin (synthetic astaxanthin) may also be added to fish feed to enhance red and orange colouration. These carotenoid pigments are often added to feeds for farm raised salmon and trout to give fillets a desirable red colour.

Xanthophylls (yellow pigments) are found in corn gluten meal and dried egg that may be added to the diet to enhance yellows. The ground petals of marigold flowers have also been used as a source of xanthophylls. The blue-green algae spirulina is a such source of phycocyanin and may be added to a diet to enhance blue colouration. The expense of supplementary pigments often limits the amount used in trophical fish feeds.

Testosterone also plays a role in enhancing the colour of fishes. Testosterone supplied in the diet likely allows a premature storage and expression of pigments in the chromatophores. Fish that offers exhibit drab juvenile colouration may then show full adult colouration.

Carotenoids in plants

The natural extracts first used were those of carrot, palm oil saffron, tomato and paparika (Britton, 1996). The powdered, dried plant materials and extracts of them have been used for many years. Generally green leaves contain large amount of carotenoid. Carotenoids are often considered to be plant pigments alone but also occur widely in bacteria, fungi, algae and in animals. Goodwin (1980) provided extensive details about the distribution about carotenoids in plants and animals.

In plants, the carotenoids occur universally in the chloroplast of green tissues, but their colour is masked by the chlorophylls. The leaves of virtually cell species contain the same main carotenoids, that is β-carotine (usually 25-30% of the total), lutein (around 45%), violaxanthin (15%) and neoxanthin (15%) (Britton,1996). Small amount of -carotene, cryptoxanthin, zeaxanthin, antheraxanthin and lutein 5, 6 epoxide are also frequently present (Cogdwell, 1988). Carotenoids are also widely distributed in non-photosynthetic tissues of plants and are responsible for the yellow, orange and red colour of many flowers and fruit. They are usually located in chromoplasts (Goodwin, 1980). Natural extracts of some flower such as marigold (*Tagetes erecta*) contain large amount of lutein and are used for colouration.

Total carotenoid content varied from species to species. Chandersekar et al. (1999) reported, the carotenoid content in amaranthus, coriander and mint and the levels were found to be 37,400 g/100 g, 15,077 g/100 g and 8,305 g/g respectively in raw form. They used spectrophotometry and high performance liquid chromatography for the analysis. Kowsalya et al. (2001) reported that the total carotenoid content of these were 29.064 mg/100 g, 36.720 mg/100 g and 29.057 mg/100 g respectively on the basis of dry weight (sun dried).

Amaranths are hardy, wild, uncultivated, fast growing cereal – like plants. The growth habits vary from horizontal to erect and branched to un branched; their leaves and stems are of many shades of green and seeds was from black to white. Amaranth is one of the few double duty plants which can supply tasty leafy vegetables, as well as grains of high nutritional quality. The leaves of all 50-60 species of amaranths are edible (Singhal & Kulkarni, 1988).

Pigmentation on food fishes

The sole feeding of a formulated feed which contains 2 per cent of an oil extracted from the meal of the antartic krill *Euphausia superba* to yellow tail *Seriola quinqueradiata* induced poor dark green colour at the back and sides unlike the natural one of iridescent blue-green (Fujita et al., 1983).

Inoue et al. (1988) observed that the oil which is extracted from cray fish carapace with soy oil, enhanced pink colour pigment deposition in rainbow trout *Salmo garidneri*. The pigmentation of cultured red sea bream *Pagrus major* with the antartic krill is known to be attained by feeding any of the frozen krill, krill meal and oil extracted from meal (Fujita et al., 1983).

Kamata et al. (1990) used the flower (*Adonis aestivalis*) and its extract as pigment source for rainbow trout at the level of 100 mg pigment/100 g diet. The pigmentation of the flesh of cultured coho salmon *Oncorhynchus kisutchi* was examined on a practical scale by feeding diets supplemented mainly with antartic krill and littoral mysid both of which are rich

in a red carotenoid astaxanthin (Mori et al., 1990).

Pigmentation of cultured sweet smelt fed diets supplemented with a blue green algae *Spirulina maxima* was carried-out by Mori et al. (1987). He reported that spirulina enhanced the pigment deposition in sweet smelt. Tveranger (1986) observed the effect of pigment content in brood stock diet on subsequent fertilization rate, survival and growth rate of rainbow trout offspring by using 10 per cent krill meal as a source of pigmentation.

The effect of supplementing trout diet with astaxanthin rich micro algae *Haematococcus pluvialis* was studied by Sommer et al. (1991). He concluded that the total carotenoid levels were significantly higher.

Metusalach et al. (1996) carried out a study on deposition and metabolism of dietary canthoxanthin in different organs of arctic charr (*Salvelinus alpinus* L). The result showed that fish flesh was the major tissue for storing carotenoids followed by skin, liver and gonad. Nickell and Bromage (1998) studied the efficiency of pigmentation, the variation and development of fillet colour in rainbow trout fed with astaxanthin enriched diets at different stages of fry development and for different periods of time.

The effect of water temperature on pigmentation of rainbow trout was investigated by feeding a test diet with astaxanthin. The carotenoid content of fish was more at 15^0C than at 5^0C but no significant temperature effects on the carotenoid concentration in the skin, liver and gut were observed by Kyeon and Storebakken (1991). Flesh pigmentation was measured against a colour fan in chinook salmon (*Oncorhychus tshacoytscha*) by using carotenoid as a pigment source (McCallum et al., 1987).

The retention of carotenoids in the rainbow trout was significantly different for the two carotenoid sources (retention of astaxanthin 11.4 per cent, canthaxanthin 7.1 per cent) (Storebakken & Chouhert, 1991).

Torrisen (1986) reported that astaxanthin was observed more in the flesh than canthaxanthin. The trout fed with canthaxanthin tended to accumulate more carotenoids in the skin as metabolites (Bjerkeng et al., 1990). The wet diet resulted in a lower pigmentation than the dry diet in salmon (Storebakken et al., 1986).

Skin of fish fed with astaxanthin mainly contained astaxanthin esters and skin of fish fed with canthaxanthin contained reductive metabolites of canthaxanthin (Bjerkeng et al., 1992). Marron or fresh water cray fish *Cherax tenuimanus* fed on the algal slurry (Microalgae, *Dunaliella salina*) had elevated levels of total carotenoid and -carotene level (Sommer et al., 1991). Boonyaratpalin and Unprasest (1989) tested four pigments such as spirulina, marigold petal meal, shrimp head meal and turmeric on red tilapia, *Oryochromis niloticus*. The results showed single red, golden flame, flame and orange colouration respectively.

Choubert Jr. (1979) reported that the incorporation of spirulina algae in rainbow trout causes a yellow – trout pigmentation. The retention co-efficient decreased as the pigment dose in the diet increased (Choubert et al., 1989). Ibraham et al. (1984) investigated the pigment enhancement in cultured red sea bream using antartic krill. Oil extraction from antartic krill was used as colour enhancing ingredients in diet (Arai et al., 1987).

Pigmentation on ornamental fishes

Colouration is the determining factor in ornamental trade. Natu Rose (*Haematococcus pluvialis*) is a safe natural source of astaxanthin derived from a unique strain of the microalgae. It has been extensively tested and has demonstrated exceptional pigmentation in Koi and other tropical fishes (Ronneberg et al., 1979). Marine ornamental fish obtains

carotenoids by feeding upon algae, coral or prey that has accumulated these pigments (Fox.D. Biochromy, 1979). The red varieties of goldfish, stores significant quantities of astaxanthin in the skin, which can also be increased by inclusion of an artificial diet (Fox.D. Biochromy, 1979).

Ako et al. (1999) observed a colour enhancement in fresh water red velvet sword-tail (*Xiphophorus helleri*), rainbow fish (*Pseudomugil turcatus*) and Topaz cichlids (*Cichlasoma myrnae*) by using diets containing *spirulina platensis* (1.5 – 2 per cent) and 1 per cent *Haematococus pluvialis*.

Tanaka *et al.* (1976) observed enhanced level of carotenoid in goldfish when fed with astaxanthin as a pigment source from crab waste. Hata and Hata (1976) have reported that in the Dutch lionhead goldfish, zeaxanthin was easily oxidized to astaxanthin, and -carotenoid was also metabolized to astaxanthin.

Bitzer (1963) found out that paprika not only enhanced the colour of the fish, but also increased hatchability. The basic synthesis of carotenoids is carried-out in algae which are transferred to fish via. crustaceans and insects (Brinchmann, 1967).

Sherief and Mathew (1996) observed colour enhancement in goldfish using different ingredients such as carrot meal, beetroot meal and red grape skin meal. Lovell (1992) has shown that the ornamental fish, tiger barb (*Barbus tetrazona*) and cherry barb (*B. titteya*) required carotenoids in their diet for sufficient colour development. Tsushima *et al.* (1998) observed that paprika was effective for pigmentation in goldfish and its effect was increased remarkably in the sunlight.

Peimin et al. (1999) revealed that spirulina induced the growth and body colour of crucian carp. Phromkunthong (1988) reported that the addition of 10 per cent spirulina was highly effective in producing deeper colouration in fancy carp. Matsuno et al. (1980) suggested that the zeaxanthin might be metabolized to rhodoxanthin *in vivo* and the amount of astaxanthin in the integument of the test group whose diet contained zeaxanthin increased to eight times that of the control.

Ahilan and Jeyaseelan (2001) observed the colour enhancement in juvenile goldfish using shrimp head meal, dried drumstick leaves, dried curry leaves and turmeric powder. The carotenoid supplemented bitterlings had shown deep colouration (Kim et al., 1999). Fey and Meyers (1980) reported the enhancement of colour in male gourami when fed with carotenoid as a pigment source.

Ahilan and Jegan (2008) observed colour enhancement in goldfish fed with botanical additives viz., coriander, mint and amaranth leaves.

Sherief and Mathew, they have done a research on gold fish by using different colour ingredients mixed with feed. They reported that, carotene mixed feed (carrot meal) shows higher colour development with reference to carotenoid content compared to other sources (beet root meal as a source of betalaine and red grape skin as a source of anthocyanin).

Lovell (1992) has shown that the ornamental fishes, tiger barb (*Barbus tetrazone*) and cherry barb (*Barbus titteya*) require carotenoids in their diet for sufficient colour development to be marketable. He has shown that the carotenoids leutein and capaxanthin, from natural products which are used in commercial poultry feeds, can satisfactorily produce the commercially desirable yellow to deep red colours in these ornamental fish.

Colour enhancement of ornamental fish

The colour of ornamental fish may be enhanced by following methods.

1. Dyeing
2. Painting
3. Feeds with hormone
4. Feeds with pigments

Dyeing

Dyeing colorless fish has recently become popular. The fish are immersed in water containing dye and the immersion and handling may lead to disease problem.

Painting

The practice of painting essentially colourless fish has become widespread. The neon coloured paint is non-toxic but the handling and painting, coupled with shipping stress often invites disease problems. These fish often contract ich (*Icthyophthirius multifilis*) and fungal infection. The paint is shed in times and the fish returns to being colourless which may be more disturbing to some one paying a premium for painted fish.

Feeds with hormone

Hormones may be used to enhance fish colouration by causing a false early maturity. Testosterone supplied in the diet likely allows a premature storage and expression of pigments in the chromatophores. Fish that often exhibit drap juvenile colouration may then show full adult colouration. Fish treated with hormones often become all male, sterile and require a continuous dietary supply of hormones to maintain coloration.

Feeds with pigments

Carotinoids are the group of over 600 natural lipid soluable pigments that are primarily produced with in phytoplankton, algae and plants. This pigments are responsible for the broad variety of colours in nature. Most notable are brilliant yellow, orange and red colours of fruits, leaves and aquatic animals. Among all of the numerous classes of natural colours, the carotinoids are the most wide spread and structurally divers pigmenting agents. Although plants algae and some fungal and bacterial species synthesize carotenoids, animals can not produce them de novo.

Spirulina, marigold meal, alfalfa, krill and other curious products are often included in the diet as colour enhancers. Synthetic colour enhancers provide a guaranteed content of specific carotinoids but do not offer the wide range of specific carotinoids found in the natural products.

Conclusion

The use of carotinoids as pigments in aquaculture is well documented, and it appears their broader functions include a role as an antioxidant, pro vitamin A activity, immune enhancement, hormones, reproduction, growth, maturation and photoprotection. Carotenoids cannot introduce new colours in lipophores which are not coded for genetically i.e. an orange fish can not be made red by feeding excessive quantity of colour enhancers. In conclusion, good skin quality can only be achieved by feeding a high quality balanced diet while maintaining an optimum water quality environment. A good quality colour enhancing diet will contain a wide range of quality colour enhancer and improve the colouration on a healthy fish while not adversely affecting white areas. Water quality may also play a support role in determining the colour of ornamental fish. Degraded water quality increase stress on capture fish and may dull fish colours. A high quality biological filter and routine at least be weekly water changes will peroside an enshrinements enabling fish displaying their highest colours.

Feeding a varied diet rich in sources of pigments along with good water quality will thus ensure the fish to develop good colours.

Biodiversity of freshwater ornamental fishes of Kerala and scope for expanding fisheries and trade

Bijukumar A.
Department of Aquatic Biology and Fisheries, University of Kerala, Thiruvananthapuram, 695 581, India
Email: bijupuzhayoram@gmail.com

Introduction

Though freshwater makes up makes up only 0.01% of the world's water and approximately 0.8 % of the Earth's surface, it supports at least 100,000 species out of approximately 1.8 million - almost 6% of all described species **(Dudgeon et al., 2006). Freshwater fishes, which represent significant fraction of freshwater biodiversity, are not uniformly distributed across the water bodies; with greater endemism of fishes, Western Ghats has been recognised as a freshwater biodiversity hotspot. Ac**cording to Dahanukar and Raghavan (**2013) there are about** 320 species of freshwater fishes (including some secondary freshwater species, which can also live in brackish water and marine habitats) in the Western Ghats, belonging to 11 orders, 35 families and 112 genera (Table 1).

The rivers originating from the Western Ghats and other freshwater ecosystems in Kerala are home to a rich diversity of freshwater fish fauna. An updated checklist of freshwater fish fauna of the Kerala given in Table 2 shows that the ornamental fish fauna of Kerala is represented by around 142 species; many freshwater fishes of Kerala are very popular in the international ornamental fish trade. Despite the fact that the water bodies in the Western Ghats are under multifarious pressures, 16 fish species have been described from this region since 2011, many of which may be classified as 'ornamental'. A checklist of threatened freshwater fish fauna of Kerala by Raghavan et al. (2013) document 57 species belonging to 11 families and 33 genera; the threatened fish fauna in the state include 6 species listed as 'Critically Endangered', 36 listed as 'Endangered' and 15 as 'Vulnerable'. Twenty five of these threatened species are endemic to the state of Kerala. This scenario offers challenges in managing collection of indigenous fishes from the wild and promoting trade.

Existing Scenario

Kerala has conducive climatic conditions for the development of ornamental fisheries and therefore government has identified it as a potential area for enhancing employment and export. The low production cost and higher returns with in a very short time, growing demand for fishes both from domestic and international market are the major attractions of this sector when compared to any other sector. In order to make ornamental fisheries an export oriented industry, Kerala State Cooperative Federation for Fisheries Development Ltd. (Matsyafed), State Fisheries Resource Management Society (FIRMA), and Agency for Development of Aquaculture (ADAK) have been set up by the Government of Kerala. The ornamental fish trade is promoted in the

Table 1. Diversity of freshwater fishes of the Western Ghats
(Source: Dahanukar and Raghavan**, 2013)**

Order	Family	Genera	Species
ANGUILLIFORMES	Anguillidae	1	2
	Ophichthidae	1	1
BELONIFORMES	Adrianichthyidae	1	4
	Hemiramphidae	2	4
	Belonidae	1	1
CLUPEIFORMES	Clupeidae	2	2
CYPRINIFORMES	**Alitoridae**	**3**	**10**
	Botiidae	1	1
	Cobitidae	2	5
	Cyprinidae	37	150
	Nemacheilidae	6	27
	Psilorhynchidae	1	1
CYPRINODONTIFORMES	Aplocheilidae	1	4
OSTEOGLOSSIFORMES	Notopteridae	1	1
PERCIFORMES	**Ambassidae**	**3**	**10**
	Anabantidae	1	1
	Badidae	2	2
	Channidae	1	5
	Cichlidae	1	3
	Eleotridae	2	2
	Gobiidae	5	5
	Nandidae	1	1
	Osphronemidae	1	2
	Pristolepididae	1	2
	Terapontidae	1	1
SILURIFORMES	**Bagridae**	**7**	**21**
	Clariidae	2	5
	Heteropneustidae	1	2
	Pangasiidae	1	1
	Schilbeidae	6	7
	Siluridae	3	6
	Sisoridae	4	16
	Incertae Sedis(of uncertain placement)		**1** **1**
SYNBRANCHIFORMES	Mastacembelidae	2	3
	Synbranchidae	2	6
SYNGNATHIFORMES	Syngnathidae	3	3
TETRAODONTIFORMES	Tetraodontidae	1	2
Total	**112**	**320**	

Table 2. List of freshwater ornamental fishes of Kerala

Sl. No.	Scientific name	Common name	Malayalam name*	Remarks	Conservation Status
1	**ANGUILLIFORMESAnguillidae**				
	***Anguilla bengalensis* (Gray, 1831)**	Indian mottled eel	*Pulli malinjeel*	s	LC
2	***Anguilla bicolor* McClelland, 1844**	Indonesian shortfin eel	*Karutha malinjeel*	s	LC
3	**BELONIFORMESAdrianichthyidae**				
	Oryzias carnaticus (Jerdon, 1849)	Rice fish	*Anu*	s	LC
4	*Oryzias melastigma* (McClelland, 1839)	Rice fish	*Anu*	s	LC
5	*Oryzias setnai* (Kulkarni, 1940)	Malabar Rice fish	*Anu*	s, e	LC
6	**Hemiramphidae**				
	Hyporhamphus limbatus				
	(Valenciennes, 1847)	Congaturi halfbeak	*Arachudan*	s	LC
7	*Hyporhamphus xanthopterus*		*Chemchundan*		
	(Valenciennes, 1847)	Red-tipped halfbeak	*Arachudan*	s, e	VU [D2]
8	**Belonidae***Xenentodon cancila*				
	(Hamilton, 1822)	Freshwater garfish	*Kolan*		LC
9	**CLUPEIFORMES**				
	Clupeidae				
	Dayella malabarica (Day, 1873)	Day's round herring	*Netholi*	S, e	LC
10	**CYPRINIFORMES**				
	Balitoridae				
	Balitora jalpalli Raghavan, Tharian,		*Kalnakki*		
	Ali, Jadhav & Dahanukar, 2012	Stone loach	*(general name)*	ek	NE
11	*Bhavania australis* (Jerdon, 1849)	Western Ghats Loach			LC
12	*Homaloptera menoni*				
	Shaji & Easa, 1995	Stone loach	*Velumban Kalnakki*	ek	LC
13	*Homaloptera montana* Herre, 1945	Stone loach	*Kadan Kalnakki*	e	EN
14	*Homaloptera pillaii* Indra & Rema Devi, 1981	Stone loach	*Thavidan Kalnakki*	e	LC
15	*Homaloptera santhamparaiensis*				
	Arunachalam, Johnson &				
	Rema Devi, 2002	Stone loach	*Santhampara Kalnakki*	ek	EN
16	*Homaloptera silasi* Kurup &				
	Radhakrishnan, 2011	Stone loach	*Kalnakki*	ek	NE
17	*Travancoria elongata* Pethiyagoda &				
	Kottelat, 1994	Travancore loach	*Kalpoolon*	ek	EN
18	*Travancoria jonesi* Hora, 1941	Travancore loach	*Neelan Kalpoolon*	ek	EN
19	**Cobitidae**				
	Lepidocephalichthys thermalis				
	(Valenciennes, 1846)	Common spiny loach	*Manalaron*		LC
20	*Pangio goaensis* (Tilak, 1972)	Indian coolie-loach	*Cheru Poontharakan*	e	LC
21	**Cyprinidae**				
	Amblypharyngodon melettinus				
	(Valenciennes, 1844)	Attentive carplet	*Vayambu*		LC
22	*Amblypharyngodon microlepis*				
	(Bleeker, 1853)	Indian carplet	*Vayambu*		LC

23	*Barilius bakeri* Day, 1865	Baril	*Pavukan*	e	LC
24	*Barilius bendelisis* (Hamilton, 1807)	Baril	*Pulli Pavukan*		LC
25	*Barilius canarensis* (Jerdon, 1849)	Baril	*Pavukan*	e	EN
26	*Barilius gatensis* (Valenciennes, 1844)	Malabar Baril	*Varayan pavukan*	e	LC
27	*Crossocheilus latius* (Hamilton, 1822)	Latia	*Karimpachy*		LC
28	*Crossocheilus periyarensis* Menon & Jacob, 1996	Periyar Latia	*Karimpachy*	e	EN
29	*Danio rerio* (Hamilton, 1822)	Zebra fish	*Varayan Danio*		LC
30	*Dawkinsia arulius* (Jerdon, 1849)	Arulius barb	*Aruli*	ek	EN
31	*Dawkinsia assimilis* (Jerdon, 1849)		*Kodiyan Paral*	e	VU
32	*Dawkinsia exclamatio* (Pethiyagoda & Kottelat, 2005)		*Ascharya Paral*	e	EN
33	*Dawkinsia filamentosus* (Valenciennes, 1844)	Filament barb	*Poovali Paral*	e	LC
34	*Devario aequipinnatus* (McClelland, 1839)	Giant danio	*Thuppalam kothi*		LC
35	*Devario malabaricus* (Jerdon, 1849)	Malabar danio	*Thuppalam kothi*		LC
36	*Eechathalakenda ophicephalus* (Raj, 1941)	Channa barb	*Eettilakanda*	ek	EN
37	*Esomus danricus* (Hamilton, 1822)	*Indian Flying Barb*	*Chutti Parava paral*	s	LC
38	*Esomus malabaricus* Day, 1867	*Flying Barb*	*Parava paral*	e	NE
39	*Esomus thermoicos* (Valenciennes, 1842)	*Flying Barb*	*Parava paral*		LC
40	*Garra emarginata* Kurup & Radhakrishnan, 2011	Garra	*Kallotti*	e	NE
41	*Garra gotyla stenorhynchus* (Jerdon, 1849)	Garra	*ThadiyanKallotti*	e	LC
42	*Garra hughi* Silas, 1955	Garra	*Kullan Kallotti*	ek	EN
43	*Garra mcclellandi* (Jerdon, 1849)	Garra	*Neela Kallotti*	e	LC
44	*Garra menoni Rema* Devi & Indra, 1984	Garra	*Kallotti*	ek	VU
45	*Garra mlapparaensis* Kurup & Radhakrishnan, 2011	Garra	*Kallotti*	ek	NE
46	*Garra mullya* (Sykes, 1839)	Garra	*Kallotti*		LC
47	*Garra periyarensis* Gopi, 2001	Garra	*Kallotti*	ek	VU
48	*Garra surendranathanii* Shaji, Arun & Easa, 1996	Garra	*Kallotti*	ek	EN
49	*Haludaria fasciatus* (Jerdon, 1849)	Melon barb	*Vazhakkavarayan*	e	LC
50	*Haludaria melanampyx* (Day, 1865)		*Vazhakkavarayan*	e	DD
51	*Horadandia atukorali* Deraniyagala, 1943		*Aattukananjon*		LC
52	*Horalabiosa joshuai* Silas, 1954			e	EN
53	*Gonoproktopterus curmuca* (Hamilton, 1807)	Curmuca barb	*Chempalan Kooral*	e	EN
54	*Hypselobarbus jerdoni* (Day, 1870)			e	LC
55	*Hypselobarbus kurali* Menon & Rema Devi, 1995		*Karivalan Kooral*	e	LC
56	*Hypselobarbus thomassi* (Day, 1874)		*Chempan Kooral*	e	LC
57	*Laubuca dadiburjori* Menon, 1952	Dadio	*Pullicheelan*	e	LC
58	*Laubuca fasciata* (Silas, 1958)	Malabar hatchet chela	*Pullicheelan*	e	LC
59	*Osteobrama bakeri* (Day, 1873)		*Mullan paral*	e	LC
60	*Pethia conchonius* (Hamilton, 1822)	Rosy barb	*Valepottan*		LC
61	*Pethia muvattupuzhaensis* (Beevi & Ramachandran, 2005)		*Paral*	ek	DD

62	*Pethia pookodensis* (Mercy & Jacob, 2007)	Pookot barb	*Pookotan paral*	ek	CR
63	*Pethia punctata* (Day, 1865)		*Swarnavalan Paral*	e	LC
64	*Pethia ticto* (Hamilton, 1822)	Ticto barb	*Pattaru paral*	e	LC
65	*Puntius amphibius* (Valenciennes, 1842)	Scarlet-banded barb		e	DD
66	*Puntius bimaculatus* (Bleeker, 1863) Redside barb	*Irupottu paral*		LC	
67	*Puntius chola* (Hamilton, 1822)	Swamp barb	*Paral*		LC
68	*Puntius dorsalis* (Jerdon, 1849)	Long snouted barb	*Cherumookkan paral*	e	LC
69	*Puntius madhusoodani* Kumar, Pereira & Radhakrishnan, 2012		*Paral*	e	NE
70	*Puntius mahecola* (Valenciennes, 1844)		*Paral*	e	DD
71	*Puntius melanostigma* (Day, 1878)		*Karimpully paral*	e	NE
72	*Puntius parrah* Day, 1865	Parrah barb	*Parapparal*	e	LC
73	*Puntius sophore* (Hamilton, 1822)	Spotfin swamp barb, Pool barb,	*Paral*		LC
74	*Puntius vittatus* Day, 1865	Green stripe barb	*Kaypa paral*		LC
75	*Sahyadria chalakkudiensis* (Menon, Rema Devi & Thobias, 1999)	Chalakkudy barb	*Chorakkaniyan*	e	EN
76	*Sahyadria denisonii* (Day, 1865)	Red-line Torpedo	*Chenkaniyan (“Miss Kerala in trade)*	e	EN
77	*Rasbora dandia* (Valenciennes, 1844) (Taxonomy to be confirmed)	Rasbora	*Thuppal kudiyan*		LC
78	*Salmophasia acinaces* (Valenciennes, 1844)	Silver razorbelly minnow	*Valia mathiparal*	e	LC
79	*Salmophasia balookee* (Sykes, 1839)	Razorbelly minnow	*Peru mathiparal*		LC
80	*Salmophasia boopis* (Day, 1874)	Boopis razorbelly minnow	*Velli mathiparal*	e	LC
81	*Systomus sarana* (Hamilton, 1822)	Olive barb	*Kuruva paral*		LC
82	**Nemacheilidae**				
	Acanthocobitis mooreh (Sykes, 1839)	Zipper loach	*Chathuravalan koyma*	ek	LC
83	*Indoreonectes keralensis* (Rita & Nalbant, 1978)	Loach	*Kairali koyma*	ek	VU
84	*Mesonoemacheilus guentheri* (Day, 1867)	Loach	*Pacha koyma*	e	LC
85	*Mesonoemacheilus herrei* Nalbant & Bănărescu, 1982	Loach	*Anamala koyma*	ek	CR
86	*Mesonoemacheilus menoni* (Zacharias & Minimol, 1999)	Loach	*Koyma*	ek	VU
87	*Mesonoemacheilus periyarensis* (Kurup & Radhakrishnan, 2005)	Loach	*Koyma*	ek	VU
88	*Mesonoemacheilus petrubanarescui* (Menon, 1984)	Loach	*Pachapandan koytha*	e	EN
89	*Mesonoemacheilus pulchellus* (Day, 1873)	Loach	*Sundaran koytha*	e	EN
90	*Mesonoemacheilus remadevii* Shaji, 2002	Loach	*Kunthi koytha*	ek	LC
91	*Mesonoemacheilus triangularis* (Day, 1865)	Loach	*Thavittu pandan koytha*	e	LC
92	*Nemacheilus monilis* Hora, 1921	Loach	*Pulli koyma*	e	LC
93	*Schistura denisoni* (Day, 1867)	Loach	*Varayan koyma*		LC

94	*Schistura nilgiriensis* (Menon, 1987)	Loach	*Chempan koytha*	e	LC
95	*Schistura semiarmata* (Day, 1867)	Loach	*Pullon koytha*	e	LC
96	*Schistura striata* (Day, 1867)	Loach	*Neelan koytha*	e	EN
97	**CYPRINODONTIFORMES**				
	Aplocheilidae	Green	*Nettiye ponnan,*		
	Aplocheilus blockii (Arnold, 1911)	panchax	*Manathukanni*		LC
98	*Aplocheilus lineatus*	Striped	*Nettiye ponnan,*		
	(Valenciennes, 1846)	panchax	*Manathukanni*		LC
99	**OSTEOGLOSSIFORMES**				
	Notopteridae				
	Notopterus notopterus	Asian knife fish,			
	(Pallas, 1769)	Grey featherback	*Ambattan vala*		LC
100	**PERCIFORMES**				
	Ambassidae				
	Ambassis ambassis (Lacepède, 1802)	Commersos glassy	*Arinjeen*	s	LC
101	*Parambassis dayi* (Bleeker, 1874)	Day's glassy perchlet	*Puzha arinjeen*	s	LC
102	*Parambassis thomassi* (Day, 1870)	Western Ghat glassy perchlet	*Arinjeen*	s, e	LC
103	*Parambassis ranga* (Hamilton, 1822)	Indian glassy fish	*Kunjarinjeen*	s	LC
104	**Channidae**				
	Channa diplogramma (Day, 1865)	Malabar snakehead	*Varal*	e	VU
105	*Channa gachua* (Hamilton, 1822)	Dwarf snakehead			LC
106	*Channa marulius* (Hamilton, 1822)	Giant snakehead			LC
107	*Channa striata* (Bloch, 1793)	Chevron Snakehead			LC
108	**Cichlidae**				
	Etroplus maculatus (Bloch, 1795)	Orange chromide	*Pallathi*	s	LC
109	*Etroplus suratensis* (Bloch, 1790)	Green chromide, Pearl spot	*Karimeen*	s	LC
110	**Eleotridae**				
	Eleotris fusca (Forster, 1801)	Dusky sleeper		s	LC
111	**Gobiidae**				
	Awaous grammepomus (Bleeker, 1849)	Scribbled goby	*Poolon*	s	LC
112	*Glossogobius giuris* (Hamilton, 1822)	Tank goby	*Poolon*	s	LC
113	*Sicyopterus griseus* (Day, 1877)	Clown goby	*Puzha poolon*	S, e	LC
114	**Nandidae**				
	Nandus nandus (Hamilton, 1822)	Gangetic leaf fish	*Muthukki*	s	LC
115	**Osphronemidae**				
	Pseudosphromenus cupanus	Spiketail			
	(Cuvier, 1831)	paradisefish	*Karinkana*		LC
116	*Pseudosphromenus dayi*	Brown Spike-tailed			
	(Köhler, 1908)	Paradise Fish	*Karinkana*	e	v
117	**Pristolepididae**				
	Pristolepis marginata Jerdon, 1849	Malabar catopra	*Andikkalli*	e	LC
118	*Pristolepis rubripinnis*				
	Britz, Kumar & Baby, 2012	Catopra	*Andikkalli*	e	NE
119	**Terapontidae***Terapon jarbua*				
	(Forsskål, 1775)	Tiger bass		s	LC
120	**SILURIFORMES**				
	Bagridae				
	Batasio travancoria Hora & Law, 1941	Travancore batasio		e	VU

121	*Hemibagrus punctatus* (Jerdon, 1849)		*Ettakkoori*	e	CR
122	*Horabagrus brachysoma* (Günther, 1864)	*Günther's* catfish	*Manjakkoori*	e	VU
123	*Horabagrus nigricollaris* Pethiyagoda & Kottelat, 1994	Black Collared Catfish	*Karim kazhuthan Koori*	ek	EN
124	*Mystus vittatus* (Bloch, 1794)	Asian Striped Catfish	*Manja varayan koori*		LC
125	**Clariidae**				
	Horaglanis alikunhii Babu & Nayar, 2004	Indian blind catfish	*Kurudan mushi*	ek	DD
126	*Horaglanis krishnai* Menon, 1950	Indian blind catfish	*Kurudan mushi*	ek	DD
127	*Horaglanis abdulkalami* Babu, 2012	Indian blind catfish	*Kurudan mushi*	ek	NE
128	**Schilbeidae**				
	Pseudeutropius mitchelli Günther, 1864	Malabar Patashi		ek	EN
129	**Sisoridae**				
	Pseudolaguvia austrina Radhakrishnan, Sureshkumar & Ng, 2011			e	DD
130	*Glyptothorax anamalaiensis* Silas, 1952		*Vellikkettan, Parakkoori*	ek	EN
131	*Glyptothorax annandalei* Hora, 1923		*NaduvarayanParakkoori*	e	LC
132	*Glyptothorax elankadensis* Plamoottil & Abraham, 2013		*Parakkoori*	e	NE
133	*Glyptothorax housei* Herre, 1942		*Choriyan Parakkoori*	Ek	EN
134	*Glyptothorax lonah* (Sykes, 1839)		*Ney Parakkoori*	e	LC
135	*Glyptothorax malabarensis* Gopi, 2010		*Malabar Parakkoori*	e	DD
136	*Kryptoglanis shajii* Vincent & Thomas, 2011		*Midu*	ek	NE
137	**SYNBRANCHIFORMES**				
	Mastacembelidae				
	Macrognathus aral (Bloch & Schneider, 1801)	One-stripe spiny eel	*Aarakan*		LC
138	*Macrognathus guentheri* (Day, 1865)	Malabar spiny eel		e	LC
139	*Mastacembelus armatus* (Lacepède, 1800)	The tire track eel			LC
140	**SYNGNATHIFORMES**				
	Syngnathidae	Crocodile-tooth			
	Microphis cuncalus (Hamilton, 1822)	pipefish		s	LC
141	**TETRAODONTIFORMES**				
	Tetraodontidae				
	Carinotetraodon imitator Britz & Kottelat, 1999	Dwarf Malabar Puffer		e	DD
142	*Carinotetraodon travancoricus* (Hora & Nair, 1941)	Dwarf Indian Puffer		e	VU

s = can live in brackish and marine habitats as well, e = endemic to western Ghats, ek = endemic to Kerala; CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern; DD, Data Deficient; NE, Not Evaluated.

* Vernacular names are based on Biju Kumar et al. (2014)

state by organizing international Aqua shows and seminars, ensuring participation of scientists, administrators, breeders, traders and entrepreneurs from both India and abroad. The government has also set up aqua technology park-KAVIL (Kerala Aqua Ventures International Ltd) with public private participation in order to provide a unique platform for the investment and trade opportunities for the stake holders. Currently about 200 ornamental fish trade units are functioning in the state.

In addition Marine Products Export Development Authority (MPEDA), National Fisheries Development Board (NFDB) and National Bank for Agriculture and Rural Development (NABARD) offer financial support to the farmers and researchers to promote ornamental fisheries through establishing breeding and trade units, research and development. Despite all these efforts the ornamental fish production and export from the state remains to pick up momentum. Further, awareness on indigenous fish species remains centred around few 'charismatic' species such as red line torpedo barbs, loaches and puffer fish. As such there are no commercial breeding centres in the state for indigenous ornamental species.

Contribution to trade

The ornamental fish fauna of the Western Ghats are popular among ornamental fish traders across the world and the popular groups among them include barbs, loaches, puffer fish, paradise fish, eels, cichlids and perches. Many species of barbs, paradise fishes and cichlids were bred commercially by the hobbyists and professional aquarium keepers in many parts of the world. The globalised market systems and frequency of aqua shows and awareness programmes on ornamental fishes coupled with the support of the media have helped popularising indigenous ornamental fishes. The galloping demand from the international market and the increasing support for export of the aquarium fish have provided impetus for the export of ornamental fish fauna from India.

From India over 100 species that have entered the trade from Western Ghats (Raghavan, 2010), close to two dozen are regularly exported. Sekharan (2006) had listed 319 indigenous freshwater fish species exported from India. According to Jayalal and Ramachandran (2012) 239 indigenous freshwater fish species, 92 exotic fish species and 44 ornamental shrimps have been exported from India. The variations in the number of freshwater fish species in export notwithstanding, detailed species-wise data base of export is not available as with other agricultural commodities. The exported freshwater species from India that top the list include *Barilius canarensis, Botia rostrata, Botia striata, Carinotetraodon travancoricus, Channa aurantimaculata, Danio jaintianensis, Dawkinsia arulius, Dawkinsia rohani, Devario assamensis, Etroplus canarensis, Garra hughi, Gonoproktopterus curmuca, Horabagrus brachysoma, Pethia manipurensis, Pethia shalynius, Pillaia indica, Sahyadria denisonii, Sahyadria chalakkudiensis, Schismatorhynchos nukta,* and *Tor khudree* (Raghavan et al., 2013) (Figs. 1-12). Among these 9 species occur in the rivers of Kerala. The reported aquarium fish trade exports from India were worth in excess of 1.6 million US$ for the 7 year period from 2005 to 2012 and the export included more than 1.5 million freshwater fish (30% of total) belonging to 30 threatened species (Raghavan et al., 2013). Over 300,000 specimens of 'Red Lined Torpedo Barbs' (*Sahyadria denisonii, Sahyadria chalakkudiensis*), which are now classified as 'Endangered', were also traded to seven countries during 2005 to 2012. These reports often questions the sustainability of ornamental fish trade based on wild caught specimens, which is not primarily based on the involvement of local communities neither does it sustain the local economy, as in many south American countries.

Fig. 1. *Barilius canarensis*

Fig. 2. *Botia striata*

Fig. 3. *Dawkinsia arulius*

Fig. 4. *Etroplus canarensis*

Fig. 5. *Garra hughi*

Fig. 6. *Gonoproktopterus curmuca*

Fig. 7. ***Horabagrus brachysoma***

Fig. 10. ***Sahyadria denisonii - Lipstick form***

Fig. 8. ***Sahyadria denisonii***

Fig. 11. ***Sahyadria chalakkudiensis***

Fig. 9. ***Sahyadria denisonii - Veil tail form***

Fig. 12. ***Carinotetraodon travancoricus***

Scope for promotion of fisheries

The major issues that limit the domestic development of ornamental fish culture in Kerala are: (i) dependence on wild caught indigenous fish for export, (ii) lack of professional breeders and infrastructure, (iii) failure in transfer of technologies from the lab to the farmers, (iv) failure to captive breed indigenous species with good demand in international market, (v) lack of innovation among fish breeders to develop new varieties, (vi) inadequacy of present level of technical and extension support especially on disease management and advanced training, (vii) imperfections in the domestic market channels of ornamental fish culture and lack of confidence among the fish breeders to breed indigenous species.

On a global scale approximately 90% of freshwater fish traded in the hobbyist industry are captively cultured (Tlusty, 2002). No country can rely fully on wild caught fish for sustaining trade over a longer period of time. As the many species exported in higher volumes from Kerala are also threatened, culture of ornamental fish should be recognized as a feasible alternative to a wild harvest of specimens. Many collecting localities currently limit either the number of fish or the number of species taken, or both. While research and academic institutions in India have succeeded in standardising the technologies for captive breeding of indigenous marine ornamental fish, there are not many examples in freshwater forms. Many of the captive breeding technologies developed for freshwater fish are not commercially viable to meet the burgeoning demand from the international market. The transfer of technology for mass production and partnership of local communities and professional breeders would ensure supply of selected species of ornamental fishes. However, the demand for indigenous freshwater ornamental fish could not be met by aquaculture alone (eg. absence of technologies for commercial breeding of indigenous loaches), and therefore appropriate policies are needed to ensure sustainable harvest of resources. Assessments of stock status and ecological impacts of over exploitation are important for the management of any fishery. Limited distribution and unique biological characteristics of freshwater fishes of the Western Ghats may render them especially vulnerable to overexploitation, increasing the need for assessment and management. One starting point for assessment and management is to focus on ecosystem status in relation to the ornamental fishery as a whole, rather than on individual stock status.

The demand for freshwater ornamental fish in the international market is met by a larger network of professional fish breeders, especially in the Southeast Asia and Europe. General training offered for farmers/hobbyists/self-help groups would not be sufficient to boost up trade. Though knowledge and skill for breeding, marketing and packaging can be acquired through extensive training programmes, they require continuous learning in the business for a long period. New entrepreneurs may require collaborations in some of the critical operations for their easy entry into the market. Those persons who have succeeded in breeding ornamental fish and have passion to pursue ornamental fish culture as a career should be given training by international experts and should have the opportunities to visit facilities abroad to realise the latest trends in the sector. There should also be more model training/demonstration units at each district, a few high tech professional farms and network markets under co-operative societies to ensure selling of fish produced. There should also be separate strategies for meeting the demand for domestic and international markets.

Non-availability of quality broodstock from certified hatcheries, lack of infrastructure

facilities and high freight charges are other important constraints in this sector (Parvathi Rani et al., 2013). Lack of appropriate information in terms of breeding, brood stock management, rearing, grow-out, harvesting, limited technical expertise, disease diagnostics and improper knowledge about the financial aspects such as investments, risks and uncertainties involved are the other constraints that needs to be addressed in order to have a sustainable growth of the industry (Ghosh et al., 2010). Need for innovation and production of improved and new varieties through selective breeding may help in trade. For example, the endemic fish of the Western Ghats *Sahyadria denisonii* is now bred in large quantities in Southeast Asia and supplied to India, besides the modified varieties such as 'lipstick form' and 'veil-tail form'! (Figs. 9, 10).

The higher mortality levels currently recorded in ornamental fish trade could be significantly reduced by shortening the supply chain and using codes of best practices for the collection, shipping, and acclimatization of ornamental fish species. The breeding and shipping technology for majority of the indigenous freshwater fish remains to be perfected. The continued development and wider application of aquarium fish certification has the potential to develop the trade in sustainable aquarium fish. Studies have indicated a potential for the continuing development of a green certification scheme within the aquarium fish trade. MPEDA has already proposed guidelines for green certification of ornamental fish (Silas et al., 2011). Species diversification is yet another are for promoting the trade of indigenous aquarium fishes. Higher popularity of some of the newly described indigenous species endemic to India such as *Dawkinsia rohani* in the international market is an example towards this.

The government should also consider ornamental fisheries as a thrust area for future development of fisheries and should increase investment for infrastructure development. Public-private partnerships are needed to make this sector more promising. There is also scope for investing for training on aquarium designing and aquascaping. Another area that requires special attention is beginning of industries that supply high quality aquarium gadgets. Currently the demand is met primarily through the supply from Chinese markets.

As the water bodies of Kerala are home to over 140 ornamental fish species, the chances of expanding aqua tourism could be better explored. More awareness programmes and expos at various centres would provide an opportunity to popularise the importance of ornamental fisheries and indigenous ornamental fishes. A network of aquarium hobbyists and fish lovers' fora at educational institutions would go a long way in popularising the importance of aquarium keeping. For the fishing communities, ornamental fish culture could be promoted as an alternative livelihood activity. Important celebrations such as Biological Diversity Day and World Fisheries Day could be effectively used as occasions to promote awareness on the importance of freshwater species. Popularization programmes and introduction of low cost technologies would be the primary step to promote this sector. Public aquarium is another tool to popularise the importance of biodiversity if indigenous freshwater species. Currently there are no good quality public aquarium in India that can be projected as a model for aquarium research and education.

With over 140 species of freshwater ornamental fishes, Kerala has a bright future in developing freshwater ornamental fisheries in a sustainable manner. One of the basic requirements for this is to develop a strong database on the taxonomy, systematics and stock structure of freshwater ornamental species of the state. Techniques such as DNA

barcoding could be used to precisely identify the species in trade as it offers a realm of applications linked to collection practices, regulatory control and conservation. There is also an urgency to develop national and state-level policies for ornamental fisheries. The aquarium trade can be better utilized as an opportunity to educate the public about the value of ornamental fish and other aquatic organisms and the services provided by ecosystems such as rivers.

Further research in technologies is needed in order to take pressure off wild stocks and increase the cost effectiveness of facilities. Overall it is also important to highlight the need for further research on the biology, population dynamics, recruitment and conservation importance of species involved in the ornamental fish trade, with a particular focus on rare or endemic species and species that has high demand in market. The aquaculture systems can be developed in a decentralized manner with the technical support from R and D organizations, Universities and with the involvement of local community groups.

If Kerala can capitalize on the key strengths of a strong resource base and academic expertise, alleviate the major weaknesses, avoid significant challenges and take advantage of the promising opportunities through sustainable management of resources and professional ornamental fish culture, the ornamental fisheries could be developed into a promising enterprise in future.

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Ornamental fish farming, an alternative livelihood security for rural women

Swain S. K., *Sahu P., Baliarsingh B. K., Babita Patro, Sahoo S. K., Meher P. K., Rajesh N., Dash P. C., Khairnar S. O., Chinmayee Sethy & Jayasankar P.
Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar-751002
**Department of Fisheries, Odisha*

Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar is one of the premiere research institutes of ICAR with a mandate to provide livelihood support to the farmers through R & D in respective fields. The knowledge dissemination through capacity building programmes to the farmers and demonstration in the field have helped many farmers of different geographical location in the country for their livelihood improvement through adoption of improved technologies. 30 production units under public private partnership mode are established under NAIP for the livelihood support to the farmers in the state of Odisha. During the period 2011 -14, 4.8 lakhs of ornamental fishes were marketed on average per year generating an average income of Rs 7065 per farmer per year under SHG mode in the adopted clusters of Mayurbhanj, Keonjhar and Sambalpur districts of Odisha under NAIP. 24 Self Help Groups including 18 women SHGs and 6 individual units are involved in the breeding and culture of ornamental fishes. Apart from NAIP, ornamental fish breeding and culture was adopted by the farmers through motivational and awareness programmes in different regions. Ornamental fish villages were developed under cluster approach in Deogarh district of Odisha. 77 farmers including 70% women are involved in breeding and culture of ornamental fish by constructing cement tanks in their backyard in the villages. The technology is able to generate Rs7000-8000 average income in 2 cycles (8 months) along with employment generation for the farmers. A hub at Barkote is established for the easy trading of the fishes produced by the farmers. More than 75 rural women of SHGs from backward communities were trained at Khargpur block-1, Midnapur district and in CIFA, Bhubaneswar during year 2002 & 03 in collaboration with district administration of Kharagpur. The farmers have developed 4 production units in SHG mode covering 40 women at their backyard after the training and at present the net income from each unit is around Rs. 60000.00 per annum. Technical guidance and knowledge has been disseminated to the State of West Bengal officials through various training programmes and visit to the farmers site to solve farmer's problem in breeding and water quality management. Technological aid has been provided to the farm women and farmers of North Bengal through BCKV, Cooch Behar. Focus was given to the farmers of Amtala and periphery villages of West Bengal by collaboration with the Science Association of Bengal, Kolkata through different on farm training programmes thereby a significant improvement in livelihood has occurred among the farmers and entrepreneurs. Since last eight years (2004-2012) five demonstration units(hatcheries) at various locations of Meghalaya, Nagaland, Arunchal Pradesh, Mizoram and Assam were established to popularise income generation through ornamental fish farming in the region.

Key words- Ornamental fish, livelihood security, adoption, SHG, demonstration

The ornamental fish is a promising sector within aquaculture which is envisaged to be full of opportunities in terms of the growth, income generation and employment to the large number of skilled, educated and unemployed across country side. In recent time, the sector has shown a faster growth upon concentrated efforts of the farmers, entrepreneurs and the researchers to take up the ornamental fish as means of their business and livelihoods. Though the sector has an enormous potential in the field of breeding, rearing and trading of ornamental fish, aquarium plants and accessories but at present, a fraction of the domestic and international potential is harvested. The sector encompasses a large number of stakeholders like farmers, breeders, traders, vendors, transporters and exporters.

Being beautiful aquatic animals, a beginner, be he/she a hobbyist or an entrepreneur, would like to know more about the farming practices of these fish. Therefore people are entering into this lucrative business of culturing and breeding these fishes. As a result many ancillaries and also pet shops are coming up in cities. The concept of developing backyard ornamental fish farming is gaining popularity day-by-day for income generation. Low investment and high return with minimal labour and less land makes the business more farmers friendly. It has been observed that in rural areas, more women are involved in production of ornamental fishes by utilizing their leisure time.

Indian export and domestic trade- Compared to other Asian countries, the Indian ornamental fish sector is very negligible but vibrant, with potential for tremendous growth and large scale gainful employment generation. The export of ornamental fishes from the country at present is mainly confined to freshwater varieties and is limited to fishes collected from nature, predominantly in the North Eastern states and the Western Ghats (85%) and a few bred varieties of exotic species (15%). The country exported INR 50 million worth of ornamental fish during 2006-07. Among ornamental fish suppliers of Asia, during the year 2008, India ranked 10th and about 1% of the fish supplied. The country possesses vast resources in terms of natural water bodies and species diversity and we have a potential to enhance the level of export to about US $ 30 million, i.e. about Rs. 100 crore every year. The present value is increasing rapidly because of involvement of ICAR Institutes, State Agricultural Universities, State fisheries Departments, and other institutions through regular popularizing programmes. More than 100 species are traded in domestic market among which 35-40 species of fresh water fish dominate the market.

A step towards for livelihood support for rural women-

For the popularization of the ornamental fish culture technology and increasing production in the state, different strategies are adopted for diversified geographic zones. In the remote rural and tribal areas, after awareness building and motivational programmes undertaken, the interested farmers are provided with support for the installation of hatcheries for income generation through production. In the past few years, due to implementation of National Agricultural Innovation Project (NAIP) in Odisha, farmers were motivated and production units were installed in their backyard. Other related critical inputs were provided free of cost to the selected farmers in the rural and tribal villages of adopted clusters. Initially the socio economic backward farmers were encouraged to implement the technology in a group by formation of Self Help Groups (SHGs) for easy technology dissemination and the division of labour had reduced the work load so that the farmers can be involved during their leisure time.

The individual farmers having capability were also encouraged to adopt the technology and FRP hatchery units (8 rectangular tanks and a circular hatchery) were provided along with other critical inputs. The technology was implemented under public private partnership (PPP) mode. Farmers had constructed a platform and few cement tanks for breeding and culture. The skill of the framers was built through training programmes and during the demonstration phase, the close observation and active participation of the farmers had helped them to learn the breeding and rearing process step by step. As the beginners, livebearers were stocked in the production tanks. The constant guidance of the scientists and senior research fellows (SRF) with active participation of farmers had brought successful breeding and rearing of the ornamental fishes in the rural and tribal villages of Odisha. The market linkages developed for the sale of fishes had earned income for the farmers. It has been observed that more and more women farmers are adopting and becoming successful in implementation. It is easier for them to put their leisure hour and earn with less labour in comparison to other field works.

Details of technology

Each unit is having two components *viz*. breeding and rearing unit. Under PPP mode , FRP tanks (9 numbers including a circular hatchery) were provided to the beneficiaries free of cost under SHG /individual mode and to involve themselves in the farming system. The groups were advised to construct equal numbers of cement tanks and a cement platform. Dual approaches are envisaged for such intervention. While in one hand, marginal farmers would be involved suitably in co-operative mode through SHGs, on the other, resourceful farmers would be encouraged for entrepreneurship development. Culture of ornamental fish in the backyards of households requires less space, skill and time, and has the potential to improve the economic condition of the household. These varieties of fishes fetch good price in the urban markets.

The technology aims at producing varieties of the small ornamental fishes in their backyard using the leisure time available to them. The common livebearers include guppy, molly, swordtail, platy and their variants. They were fed with natural food like Zooplanktons, Tubifex worms, mosquito larvae etc. supplemented with nutritious artificial feed. The mortality caused by predation/cannibalism could be checked and survival rate of these offspring was increased. 7.31 lakhs of livebearer (seeds) are produced in 29 units involving 23 SHGs including 17 women SHGs under PPP mode. Breeding of live bearing ornamental fish using perforated cage basket has successfully undertaken in ornamental fish hatcheries with an average income of Rs.7650/ farmer / 2 cycles /Yr(SHG mode). In addition to the plankton , live food, chopped earthworms, grated and boiled chicken egg albumin were used as food supplement for enhancing the nutritional status and improving the colour of ornamental fishes. Egg layers like Goldfish is successfully introduced and cultured in some of the units in the second phase of transfer of technology to the farmers. The adage of “Buy a fish … Save a family” has been introduced in local trader shop for creating awareness and more sales of fish produced by women SHG. Framer –Trader linkage has been established by inviting local traders for proper sale in local and distant towns. Each unit is able to produce 20000 livebearers in two cycles per year. Ornamental fish farming would form one of the important components especially for the clusters having proximity to the large townships and potential market.

Concept of developing ornamental fish village in Odisha

The success of Ornamental fish culture has attracted many farmers to adopt the

technology for livelihood generation. It has proven successful in achieving the objective of employment and income generation in the rural and tribal areas in a poor state like Odisha. As a mandate of Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, different capacity building programmes are undertaken in the institute for the livelihood improvement of the farmers through adoption of desired technology . It is one of the continuous responsibilities of the scientists to transfer the research findings to the field for the benefit of the farmers.

Pankajini, a girl from Landijhari village of Barkote block of Deogarh district in Odisha was one of them. During the training at CIFA, she had decided to adopt ornamental fish culture in her village for earning livelihood. She had constructed cement tanks in her village and started breeding and culture. She was the path finder for 8 other women of the village and those started breeding and culture after her constructing cemented tanks in their backyard. Constant guidance form scientist of CIFA through skill building programmes conducted in the village and active participation of the farmers had brought success for them. The success attracted other farmers of the village. The technology has not only created scope of employment but it became a source of income for unemployed youth in the village. Gradually the success attracted the farmers of other two adjacent villages Saruali and Nuagaon. At present, 77 farmers including 70% women of these villages are adopting ornamental fish culture by constructing cement tanks in their backyard. The successful farmers earn an average income of Rs 7000 to 8000 per annum. The skill building of farmers on aquarium making has helped them to augment their earning. The progress of the farmers had influenced Agricultural Technology Management Agency (ATMA) Barkote, for providing financial support for construction of tanks to the ornamental fish culture farmers in these villages. The Assistant Fishery Officer, Barkote block of Deogarh district extended full support to the farmers for implementing the technology.

A marketing hub consisting of 8 tanks has been established at Barkote for easy trading of the ornamental fishes produced in the units. The spread out was from one to many. The cluster approach of implementation has made knowledge dissemination and sharing of experience among the farmers easy. The large scale production had also attracted the traders and increased the income of the farmers through trading in large quantity. 'Buy a fish and save a family' an adage displayed at the entrance of the village has given a moral push to the buyers for purchase.

The efforts of the farmers and their success have earned a name of "ornamental fish villages" by the hobbyist and buyers, attracting many visitors now. These villages are covered under the horizontal expansion of NAIP for better support to the farmers. Selected successful farmers will be provided with 4-5 FRP tanks (500 litre) for enhancing their productive capacity in their respective units.

Women SHG involvement at Pachim Medinapore (WB)

75 rural women of SHGs from backward communities were trained by CIFA at Khargpur block-1, with two exposure visit at CIFA in collaboration with district administration of Kharagpur. The farmers have developed now production units in SHG mode covering 40 women with a net income from each SHG unit of Rs. 60000.00 per annum. Besides, there are several backyard units under individual mode has come up.

Hatchery established in NE region- Several programmes related to ornamental fish are taken up to popularize and motivating the local people in the states like Meghalaya and Arunachal Pradesh, Assam and Tripura state to

start production of some of the important species. The large number of ornamental fish biodiversity is untapped at many places of NE region. CIFA regularly conducts the training programme, awareness programme to conserve and breed the important species. Four demonstration hatcheries specially designed for the breeding and rearing purposes are established at Killing, Meghalaya; State fish farm, Emchi, Itanagar, Arunachal Pradesh; Brood fish farm, Nagaland and Ecology and environment Department, Assam University, Silchar. During last 12 years the Institute also trained more than 600 people of the NE region by organizing training programme at NE region and many have been trained at CIFA, Bhubaneswar.

Documentary film for popularization -The Institute has made a documentary film on 'Ornamental fish breeding and culture' with the collaboration with SAARC Agricultural Information Centre (SAIC), Dhaka, Bangladesh for SAARC member countries. Technical support has been provided for making two documentary films by UNDP and GRAMSAT, Odisha. A comprehensive report has been prepared for UNDP for development of ornamental fish farming and trade in Orissa state. Film on CIFA Aquarium, Ornamental fish farming for rural women under NAIP, Ornamental fish village in Odisha, Sustainable livelihood improvement through aquaculture, are well appreciated by the viewers.

Linkages developed - Linkages have been made with MPEDA, NABARD and the State fisheries departments like Odisha,Sikkim, Manipur, Meghalaya, Mizoram, Arunachal Pradesh, Assam, Nagaland, Tripura, Andhra pradesh, Bihar, Chattisgarah, Madhya Pradesh, Gujarat, Tamilnadu, Kerala, Maharastra, West Bengal through various training programmes and establishing ornamental fish culture units for popularization of this technology for livelihood security. A mega scale production unit under State fisheries Department, Odisha has also come up adjacent to CIFA with the technical support of the Institute for quality seed distribution to farmers.

Development of new variety of fish "Shinning barb"- Development of a new variety of Rosy barb is one of the major achievements. A new variant of Rosy barb, *Pethia conchonius* called Shinning barb has been developed after 8 years of research through selective breeding. The pink red shining colour male and golden yellow shining female enhances the beauty compared to Indigenous and traded rosy barbs. The pure line shining barb has shown golden shining colour in young ones after a month of rearing at their dorsal side and after 4-5 months of rearing the sexual dimorphism develops with difference of colour with vibrant shining colour with luxture. A MoU is signed with Tropical Aquaculture and Farming Systems, Udaipur, Rajasthan for experimental release field trial, breeding and propagation, on 29th August, 2013 by Dr S.Ayyappan, Honourable Director General, ICAR, at NASC complex, New Delhi.

Extension publications with a concept- "Farmers first"- To provide skilled technical knowledge and to popularise the farming of ornamental fish, CIFA has published several booklets, brochures, pamplets, electronic publications in form of CD's, in many Indian languages for distribution. A book on "ornamental fish farming" has been published by Indian Council of Agricultural Research to popularise this sector.

Development of Biotope based aquarium at CIFA: A biotope based public aquarium has been established at Institute campus for education, research and conservation of indigenous ornamental fish diversity besides many commercial fish species. Some of the displayed aquaria are biotope based, where few natural aquatic inhabitants like fishes and plants are displayed with an ecosystem

concept. Fishes are kept in such habitat that they spawn and provide parental care to the eggs and new-borns. While simulating our imagination, few aquatic exotic habitats like Amazon River, South American cichlid tank, Giant planted tank, Asian giant fish tank are displayed with full of aesthetic and scientific backup. It is a collection and conservation centre for live indigenous ornamental fish germ plasm and plants from different parts of the country for common public and awareness centre for safeguard and propagation. The area covered for the civil structure of the building is in 332 sq m, in premises of 2000 sq m, having the provision of 54 freshwater and marine aquaria of different sizes with 30 freshwater Indian, 60 exotic, 15 marine and few brackish water species. The world of freshwater and marine ornamental fishes exhibited at the aquarium provides the visitors an opportunity to see the most diverse form and colours and above all different habits and habitat. There is a lot of scope to develop ornamental fish production in India for providing employment to a weaker section of people for livelihood security and development of captive breeding research has to be given top priority not only to conserve the ruins but also for domestic and export trade.

Human resource development- CIFA is playing major role for conducting research and training programmes on freshwater ornamental fish breeding and culture in the country by conducting more than 90 national level training programmes both in and off-campus for more than 3500 participants from all over the country. About 20000 people have exposed to this subject and several demonstration programmes conducted in the country during last decade.

SALIENT ASPECTS OF SUCCESSFUL PRODUCTION OF ORNAMENTAL FISH

"The success of any entrepreneurs depends upon the project planning, site selection, successful layout and design of the breeding or rearing unit. Once the unit is established in any site and later on found uneconomical due to unavailability of certain important facilities such as water and power. Beautification will be difficult. Therefore, proper planning is required. At present the variety of commercial enterprises producing ornamental fishes is varied and diverse as the species produced. The degree of intensification and species farmed depends on following aspects.

- Training on the subject is a prerequisite before starting an ornamental fish unit.
- The minimum land requirement is 500-1000 square feet area for a small scale farming practice, whereas 1 acre and more for large scale farming in which few earthen ponds are to be excavated for some species such as koi carps, gourami, and barbs.
- Site selection is one of the main criteria where the farmer should select a cool environment for the culture and breeding.
- Breeding and rearing unit should be made near a constant supply of clear water source and with electricity.
- In cold climates farming is too expensive as the water has to be kept warm to culture tropical fish. The tropical climates favour the production rate because of year round breeding, probability as successful rearing and better growth. So the entrepreneur has to select the species accordingly.
- The selection of candidate species depends also on the water quality of that area. Because there are species which prefers either soft water or hard water for breeding at the same time. There are species that are tolerant to a wide range of water conditions. For example all the live bearers prefer hard water- alkaline. Egg layers such as goldfish, gourami,

danio, catfish, rosy barb and fighter etc. can tolerate wide range of water condition. Species such as angel, discus, tetras, oscar and loach prefers soft - acidic water. Therefore, water quality need to be checked.

- In certain areas, some species are difficult to breed, where there is a severe problem of water quality due to physico-chemical factors. Therefore, site selection for establishing ornamental fish farms is important.
- Biofiltration unit is a prerequisite for smooth functioning of an ornamental fish culture and breeding unit.
- The brood stock selected for breeding should be of superior quality, so that good quality fish seed could be produced. If brood stocks are not available in an area, one can think of rearing healthy smaller fish in to brood stock.
- Brood stocks can be allowed to breed for not more than two years. Fresh stocks from different source may be added in every two years to the selected parent stocks to improve the breeding efficiency and produce healthy offspring.
- The small fish breeder should concentrate preferably on one species so that it helps the breeder to develop expertise on the particular species and good quality fishes can be produced as per the market demand.
- The availability of agro-based byproducts facilitates the preparation of pelleted diet for the fish. For preparing a pelleted diet, a mini pelletiser may be a requirement.
- The breeding and rearing unit may be established preferably nearer to an airport/railway station, bus stand etc. for easy transportation for export and domestic market
- The breeders should develop market relations with pet/ retail shops, potential farmers, vendors dealing with ornamental fish, marketing network, etc. to facilitate the process of selling/procuring new brood stocks.
- A committed entrepreneur should always ensure regular contact with the recent research developments in the field and attend training and exposure visits.
- All new incoming fishes should be quarantined from resident stock. Movement of fishes should be restricted from a suspected or unknown disease status area.
- Few quarantine tanks are required little away from the unit so that proper observations can be made on heath aspects.
- If any abnormal behaviour is observed in any culture tanks then the fishes needs to be isolated immediately. If mass mortality occurs, express opinion has to be sought as the lead fish as well as equipments water be dispersed.

Optimum physico - chemical parameters required for fishes

The water quality is very crucial for the culture and breeding of fishes in captivity. Breeding and culture depends upon different parameters of water quality to be maintained for optimum production. The temperature level should be maintained within 24- 28^{o} C. 75-120 ppm as calcium carbonate alkalinity level of water is ideal with pH level between7.0 - 8.5. The carbon dioxide level in water must be maintained at less than 5 ppm and hardness between 60-100 ppm as calcium carbonate. 4.0-6.0 ppm of dissolved oxygen level is required for culture of the fishes. To avoid hazards of ammonia toxicity in water free ammonia level should be less than 0.05 ppm

and ionized ammonia level in between less than 0.1- 0.4 ppm range.

Two types of production systems exist in any aqua-farming practice. First type is production through breeding and larval rearing up to 2-3 months. The second type is culture/ farming to produce fish from larvae to marketable size. The farmer may go for any one of the above production system for better result. Accordingly, the farmer or entrepreneur has to decide to take up the breeding/culture or both as per his skilled technical manpower. However, the small scale farmer in a back yard dealing with small fishes like live-bearers may not come in the above categories.

Economics of backyard unit exist in ornamental fish village

Table 1. Economics of live-bearers in Barkote block

1. a) Fixed Capital	Amount (Rs.)
Breeding and rearing (Concrete) 5 nos (3' x 2' x 2') @ Rs. 1000/ tank with a low cost shade facility	5000
Sub-total	5000
b) Recurring Expenditure (for one year)	
Brood fish- livebearers (one variety) (60 female: 20 male @ Rs. 5.00/pc.)	400
Feed 15 kg/year @ Rs. 30/kg (farm made)	450
Hand net & plankton net	300
Miscellaneous (perforated plastic breeding basket, bucket, mug, medicine etc.)	450
Sub-total	1600
Total	6600
3. Gross Income	
Sale of 3500 nos. fish @ Rs.4/pc (two cycle/8 months)	14000
4. Annual net income	
(Gross income- Expenditure)=	
Rs. 14000-6600	**7400**

Cost benefit analysis

The above table indicates about the production-income scenario of the backyard units managed by individual farmers in the adopted villages. The farmer is able to earn Rs7400 in two cycles of successful production through 60 additional man-days of labour. The average income per man day is around Rs 125.00.The farmer can go up to three production cycles in a year since breeding slows down in winter. This will further enhance the income of the farmer. However the backyard units are popular in the under developed regions like rural and tribal areas where farmers are beginners and having less capacity for investment. The technology provides ample scope for better variety of large scale production in future for the farmers gaining experience and expertise during the process of implementation through demonstration. The large scale production from breeding and rearing in more tanks brings out the economies of scale and income is enhanced by more survival of larval production due to mastering upon the breeding technologies as well as reduction of expenditures through standardization of over-all hatchery procedure.

The cost benefit analysis indicates that the initial investment on fixed cost and part of recurring cost can be arranged from the financial institutions through different financial schemes available for small farmers and entrepreneurs and the farmer can reach breakeven within a period of three years. As the sale goes on (after the completion of first cycle of production) the income will flow which can be circulated for repayment of loan as well as return for the entrepreneur. The model generates an approximate annual return of Rs 5,16,700 and it may vary in exigencies like incidence of disease, natural calamities etc. The entrepreneur can avoid / reduce such happenings by adopting precautionary steps

Table 2. Economics of ornamental fish unit for small scale entrepreneurs

1. Investment	Amount (Rs)
1. a. Fixed Capital	
Land required 1 ha	Own land /Rent
Shed with electrical supply (4000 sq. ft.)	4,00,000
Concrete breeding tanks (6' x 3' x 2') 24 nos @ Rs. 2500/tank)	60,000
Concrete rearing tank (8'x4'x2') @ Rs. 4000/tank; 30 nos.)	1,20,000
Concrete brood stock tank (6'x3'x2') @Rs. 2500/tank; 40nos.)	1,00,000
Concrete larval tank (3' x 2 x1') @Rs.1000/tank; 20 nos.)	20,000
Pump, overhead tank and water supply facility	1,50,000
Air blower and other aeration systems	1,50,000
Sub-total	10,00,000
b. Recurring expenditure	
Brood fish (6000 female, 2000 male @ Rs. 5.00 /pc for each livebearer (potential reproductive period two years)	40000
Feed (600 kg/year @ Rs. 40/kg)	24,000
Nets and other materials	25,000
Wages for labourer (@ Rs. 3000/month x3 nos)	1,08,000
Miscellaneous	25,000
Sub-total	2,22,000
2. Total Expenditure	
Recurring expenditure	2,22,000
Depreciation (10% of capital cost)	1,00,000
Interest on capital cost (12%)	1,20,000
Interest on recurring expenditure (12% for half yearly)	13,300
Total	4,55,300
3. Gross Income	
Fish sale (for 6,48,000 nos. @ Rs 1.50/piece) (Considering 90% survival from 7,20,000 seed produced from 4000 females in 3 times in a year)	9,72,000
4. Net Income (Gross income-Total expenditure)	5,16,700
5. Monthly income	**43058**

and proper care of the fishes. The standardization of overall hatchery procedures will bring more benefit and reduce the cost with the acquisition of skill and experience of the farmer.

Economics of any successful enterprise require lot of dedication, hard work, sincerity and timely marketing of the produce. Similarly in ornamental fish, the success depends on the investment, species selection, demand, and proper marketing. However, the above economics, mentioned in tables are not suitable for every place as the climatic conditions and other factor varies. Therefore, it is always advisable to make a proper viable project prior to establishing any ornamental fish breeding unit with due consultation.

Considering the proven success of involvement of women in development of backyard enterprise in farming of ornamental fish in different parts of the country, it is necessary that due encouragement is given for creation of women self help groups for such enterprise. It may be interesting to note that, Malaysia with similar climatic condition like that of ours has been able to grow the industry only with small backyard units at individual levels. Thus, development of ornament fish farming in any region, not necessarily requires very large-scale enterprises, but a few successful clusters of backyard units in different regions. In this regard special packages may be provided to these self help groups and unemployed youths or ex-service men for establishment of such enterprise.

Acknowledgement

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Corals in aquarium

Sunilkumar P.
Kerala University of Fisheries and Ocean Studies (KUFOS)
Panangad, Kochi

Introduction

Raising corals I n aquariums takes a little more care and understanding than most marine fishes. A thorough understanding on the physical, chemical and biological requirements of corals is required to achieve success. Lighting, water chemistry, water motion, and temperature are the primary factors of concern in maintaining living corals in aquarium. Biological factors include coral aggression, disease and competition from algae. **Corals, comprising members of the classes Anthozoa and Hydrozoa, are highly diverse and numerous species with varying requirements for successful husbandry.**

Common types of corals used in aquarium

1. Polyps

Mushrooms and zooanthids are polyps appropriate for both beginners and experienced reef keepers. Polyps are well-suited to beginners and so diverse that longtime reef keepers appreciate them as well. Polyps are small soft corals that can tolerate some fluctuations in lighting and water quality. They require strong water flow and enjoy phytoplankton and occasional meaty food applications. Polyps grow quickly under favorable conditions. Examples are button polyps (*Palythoa caribaeorum*), mat polyps (*Zoanthus pulchellus*), green star polyps (*Pachyclavularia* spp.) and mushroom polyps (Corallimorpharians).

2. Toadstool Corals

Toadstool corals grow quickly and tolerate some variation in water quality. Toadstool corals (*Sarcophyton* spp.) are large, fast-growing corals that also tolerate a forgiving range of water and lighting parameters. Toadstools require moderate to high lighting and water flow. While white toadstool corals are not aggressive, if they begin dying and are not removed from the tank in time, their toxins could poison other corals in the system. Yellow toadstool corals are a more delicate variety of Sarcophyton. They require the same lighting and water flow parameters as the white variety but will perish within days if they come into contact with the oils on human skin. Toadstool corals require phytoplankton feedings once a week but seldom accept meaty foods.

3. Open Brain Corals

Open brain corals are hardy stony corals that tolerate a variety of lighting conditions. Open brain corals (*Trachyphyllia* spp.) are hardy, large-polyp stony corals. Open brains have hard skeletons covered with brightly-colored tissue that fluoresces under actinic lighting. When they feed, open brains demonstrate gluttonous appetites; numerous tentacles emerge from the colorful tissue to grab meaty chunks of food. Open brain corals do not tolerate nipping or picking from aquarium co-inhabitants. Brain corals occur naturally in reef lagoon habitats that have milder currents and less light. Consequently, brains have low

to moderate lighting and water flow needs in the aquarium environment. Large-polyp stony corals such as brain corals require weekly dosing of a calcium supplement to support stony skeleton growth.

4. Acropora Corals

Advanced reef keepers maintain pristine habitats for their Acropora corals. Acroporas are rewarding because of their diversity and quick rate of growth. Colonies of Acropora require high water flow and lighting levels. Like most other stony corals, Acropora require phytoplankton feedings as well as weekly mineral and nutrient supplementation. Examples of *Acroporas* suitable for reef aquariums include staghorn corals (*Acropora formosa*) and bushy *Acropora* (*Acropora austera*).

Conditions required for setting of corals:

1. Water flow: Strong water flow is needed for feeding and to keep the coral free of algal growth. Ideally, the flow should be perpendicular to the plane of the coral, reversing (alternating) and laminar.

2.Temperature

It is best to maintain the aquarium temperature similar to those on coral reefs, around 21°-27°C. Higher temperatures often occur during summer months and when refrigeration systems malfunction. Temperatures of 32°-35°C over a one-day period can cause corals to bleach. However, most corals will recover as the temperature is reduced by chillers.

3. Placement: Place these corals a safe distance from aggressive corals and fast growing soft corals that might overgrow them. Note that some gorgonians can grow quite large (up to a meter in height).

4. Coral Lighting - All aquarium corals are placed in appropriate lighting depending upon their needs. For low light corals, they are placed under Power Compacts. On reef aquarium corals that need extreme lighting, we use only the best Metal Halide 1000-watt, 6,700K metal halide lighting to which will awaken the sleeping polyps and color enhancing zooxanthellae. Under these conditions our corals thrive and nourish, until we send them on their way.

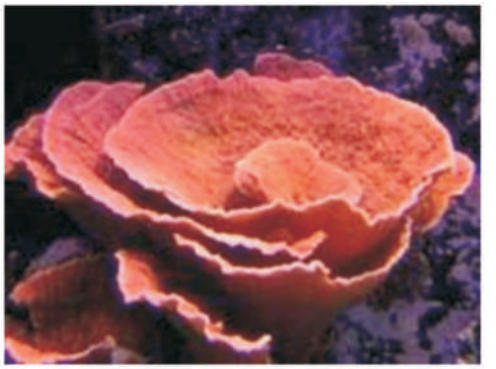
5. Picking and packaging aquarium coral - All live corals shipped out, are chosen with the most stringent quality controls followed. All corals are packaged with the utmost care, and carefully labeled to make identification easier for the beginner aquarist. We ship our corals using Fedex overnight services, and they are delivered right to your door.

6. General: The azooxanthellate members of these corals are difficult to keep and certainly not recommended for beginners. Typically, the red or orange, and many yellow colored gorgonians (with white or clear polyps) are azooxanthellate and should be avoided. Some species (the zooxanthellate species) are not quite as difficult to keep. Unfortunately, it's not always easy to identify a species, much less know if that species is one that might do well in an aquarium or not.

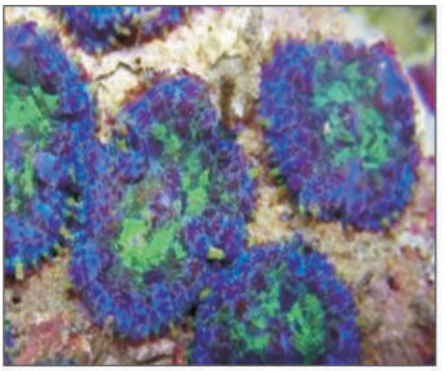
Method for setting of aquarium

- Place the aquarium away from direct sunlight.
- Rinse sand in freshwater.
- Arrange live rock in aquarium.
- Begin by placing the aquarium away from direct sunlight and drafty places.
- Arrange live rock in aquarium.
- Afterward carefully place in aquarium trying not to disrupt sand bedding.
- Add bacterial additive to start cycling.
- Make water changes about twice a week.

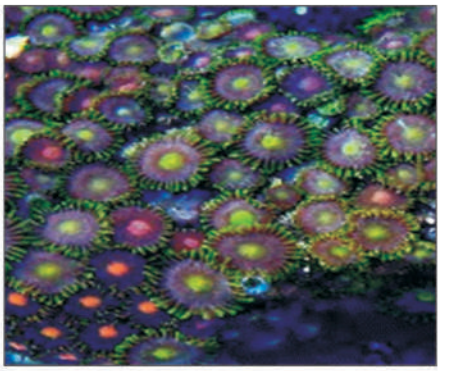
Giant green button polyps



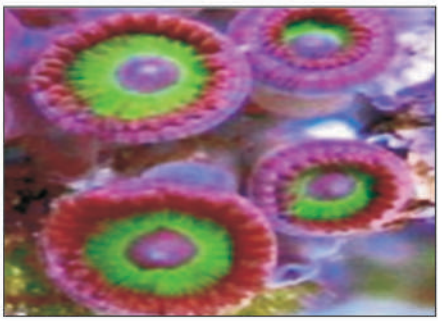
Orange Montipora Capicornus



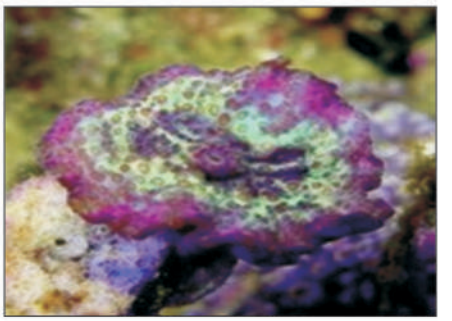
Green and blue Rhodactis Inchoata



Neon Eyed Zoanthid polyps

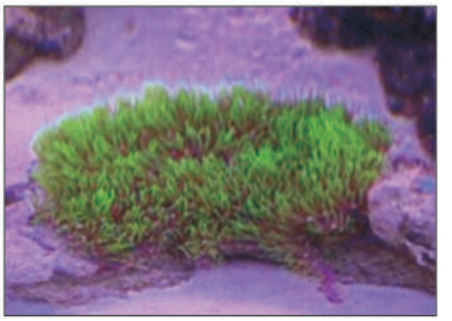


Giant green button polyp



Green cat eye Zoanthid polyp

Green star polyp with white dot centers



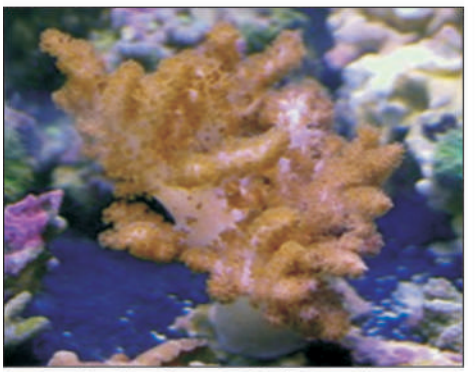
Bright metallic green star polyp

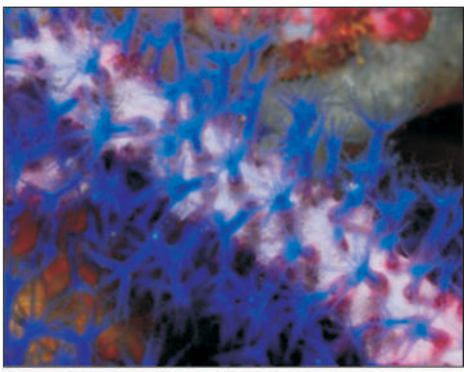

Giant cinnamon polyp


Flower Leather, *Sinularia dura*


Red actnodiscus species


Blue actinodiscus species


Cladieela sp. Colt coral


Blue polyp gorgonian coral


Purple Montipora Digitata


Yellow acropora coral

- Wait about 3 to 4 weeks to completely cycle aquarium, then make sure all parameters are acceptable.
- Add lighting and now you can add your first inhabitants to the aquarium, start by slowly and properly adding some snails and crustaceans to control waste and algae.
- Wait 2 weeks for system to adapt, then add a couple of hardy corals like yellow polyps.
- Wait two weeks and add a few hardy fish and invertebrates.

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