

MARINE ORNAMENTAL FISH CULTURE: MEANS FOR ECONOMIC GROWTH

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Introduction

The marine ornamental fish trade is a sunrise industry that has been expanding in recent years and has grown into a multimillion-dollar enterprise mainly due to the emergence of technologies for captive breeding of fishes, modern aquarium gadgets, setting and maintenance of miniature reef aquaria. Aquarium keeping is amongst the most popular of hobbies with millions of enthusiasts worldwide and the trade of marine ornamentals has been expanding in recent years and has grown into a multimillion-dollar enterprise. The recent emergence of modern aquarium gadgets and technologies for setting and maintenance of miniature reef aquaria made aquarium keeping much easier than previous. Since the marine ornamental trade is operated throughout the tropics, the global marine ornamental trade is estimated at US\$ 200-330 million. India is endowed with a vast resource potential of marine ornamentals distributed in the coral seas and rocky coasts with patchy coral formations. In the context of the expanding global scenario and the increasing demand for domestic trade, it appears very lucrative for India to venture into this industry. But it is a multi-stakeholder industry ranging from specimen collectors, culturists, wholesalers, transhippers, retailers, hobbyists, researchers, government resource managers and conservators, and hence involves a series of issues to be addressed and policies to be formulated for developing and expanding a sustainable trade. In recent years it has been reported that nearly 1500 species of marine ornamental fishes are traded globally and most of these are associated with coral reefs. Nearly 98% of the marine ornamental fishes marketed are wild collected from coral reefs of tropical countries such as the Philippines, Indonesia, Solomon Islands, Sri Lanka, Australia, Fiji, Maldives and Palau. This has been threatening the long-term sustainability of the trade due to the indiscriminate exploitation of coral reef areas. The three keywords in the development of marine ornamental fish trade are – collection, culture and conservation. The development of technologies for hatchery production of selected marine ornamental fishes is the only option for evolving a long-term sustainable trade without damaging the coral reef ecosystem. Even at an international level, the technologies for hatchery production of ornamental fishes are limited to a few species. The main steps in the captive production of ornamental fishes are broodstock development, breeding, live feed culture, larviculture protocols, grow-out methods, aquarium technology, diseases, packing and transportation, etc. Nearly 98% of the marine ornamental fishes marketed are wild collected from coral reefs of tropical countries. This has been threatening the long-term sustainability of the trade due to the indiscriminate exploitation of coral reef areas. The only alternative for sustainable trade is captive productions which involve broodstock development, breeding, live feed culture, larviculture, growout, aquarium technology, diseases, packing and transportation, etc. The ICAR-Central Marine Fisheries Research Institute (CMFRI) has been focusing on this vital aspect for the past few years. CMFRI is successful in developing hatchery technology for 27 species of marine ornamental fishes. The marine ornamental fish trade is low volume and high-value

industry in rural and urban areas, and hence it is very lucrative to initiate a trade purely based hatchery produced species. The setting up of a small-scale hatchery with details of economics are also included in this manuscript.

Captive breeding of marine ornamentals in India: initiatives by CMFRI

The investigations made in CMFRI have resulted in the development of hatchery technology for 27 species of marine ornamental fishes such as clownfish *Amphiprionpercula* (True percula/clown anemone fish), *A. ocellaris* (Common Clown/False clown anemonefish), *A. sandaracinos* (Yellow Skunk Clown)~ *A. frenatus* (Tomato clown), *A. clarkia* (Clark's anemone fish), *A. sebae*(Sebae clown) *A. periderarion*(Pink anemone fish) *A. ephippium* (Red saddle back anemone fish), *A.nigripes* (Lakhadweep clownfish), *Premnas biaculeatus* (Maroon clown/ Spine cheek anemone fish. The species under damsels for which technology developed under captivity included *Dascyllus trimaculatus* Three spot damsel)~ *D. aruanus*(Striped damsel)~*Pomacentrus caeruleus* (Blue damsel)~ *P. pavo* (Sapphire or Peacock Damsel)~*Neopomacentrus nemurus* (Yellow tail damsel)~ *N. filamentosus* (Filamentous tail damsel)~ *Chrysiptera cyanae* (Sapphire devil)~ *C. unimaculata*(One spot damsel), and *Chormis viridis* (Green chromis), and also dotty back *Pseudochromis dilectus* (Redhead Dottyback), purple fire goby *Nemateleotris decora* (Madhu et al., 2014)for the first time in the world and three species of marine ornamental shrimps (Madhu and Rema Madhu,2002,2006~ Madhu et al., 2006a,b,c~ Gopakumaret al., 2007~ Rema Madhu, et al., 2007~ Madhu et al., 2008, Madhu and Rema Madhu, 2014, Madhu et al.,2016), *Pseudanthias marcia* (Marcia's anthias) (Anil et al., 2018) *Dascyllus carneus* (Cloudy Damsel (Muhammed Anzeer, et al.2019) and designer clown fishes(Anikuttan et al., 2022). 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.

Entrepreneurship development

The economic viability of ornamental fish production is more lucrative when compared to other mariculture species, due to their high unit value. The complete package of practices developed for their production can be taken up as an alternative livelihood option for small and large-scale fish farmers. The transfer of technology to the public and private sector entrepreneurs who have approached the technology is being planned by imparting hands-on training through different modes under the Consultancy Processing Cell (CPC) of the CMFRI and organized training. In addition, the hatchery-produced seeds are also being sold to the farmers aquarium hobbyists and traders through the Single Window System and seed counters are in operation at marine hatcheries of CMFRI at Cochin and Mandapam. Public awareness of marine ornamental fish breeding and seed production is further enhanced through organising awareness programmes, exhibitions, student awareness camps, exhibits in marine research aquaria under the ICAR mega seed project, open house exhibitions, organized training for farmers, individual training to the farmer on request, winter and summer school, CMFRI-HRD training, NFDB training on ornamental fish culture, Public –Private Partnership(PPP) programme, backyard hatchery setting, establishing ornamental fish rearing units under SCSP Schemes, Grow out units establishes by woman self-help groups with close monitoring by CMFRI Scientist, PPP programme under AINP Ornamental fish breeding and culture and also provided consultancies for marine ornamental fish breeding and juvenile production. Established or gave guidance for setting up marine ornamental fish breeding units for private entrepreneurs at Bangalore (2 units), Delhi (One unit) Kerala (5 units), Tamil Nadu (4 units) and Calcutta (1 unit). This has resulted in the emergence of several ornamental fish trade shops all over the country. Recently the National Fisheries Development Board (NFDB) has also developed schemes to fund ornamental fish culture in the unutilized hatcheries of the prawn farmers in India.

Major steps in captive breeding

For the breeding of ornamental fishes under captive conditions, the following few important steps are to be followed apart from maintenance of high water quality, provision of suitable environmental parameters, creating suitable conditions for spawning and system for raising the larvae and juveniles.

The major aspects involved in ornamental fish culture are:

- Collection and transportation of broodstock
- In case active broodstocks are not available, pair formation and broodstock developments are to be undertaken in captive conditions
- Breeding system/ broodstock rearing setup and management
- Provision of Substrate for egg deposition
- Feed formulation and broodstock feeding and feeding schedule
- Incubation of eggs, parental care and management of parameters.
- Morphology and embryology of eggs
- Egg-hatching and larvae handling techniques
- Larval rearing
- Nursery rearing
- Growout culture
- Quarantine
- Harvest of juveniles for trade
- Packing and transportation

Allied section to subsataiate larval rearing

- Microalgae stock and mass culture (freshwater and marine)
- Zooplankton stock and mass culture (rotifers, copepod and cladoceran) for marine.
- Zooplankton stock and mass culture (rotifer, moina, daphnia and copepod) for freshwater species
- Zooplankton harvesting and handling
- Artemia cyst hatching and harvesting
- Live zooplankton bio enrichments

Setting up a small-scale hatchery

Small-scale hatcheries for marine ornamental fish are those where the capital costs and technologies are accessible for relatively low cost which focuses on broodstock development, larviculture, nursery rearing and grow-out to marketable size. The small-scale hatcheries can be easily adapted to culture a range of different species. A typical small-scale hatchery for marine ornamental fish consists of the following units and facilities.

1. Broodstock tanks
2. Larviculture tanks
3. Live feed unit

4. Nursery rearing and grow-out tanks
5. One sand filter
6. Outdoor live feed (Phyto and zooplankton) production tanks
7. Seawater and freshwater supply system.

Hatchery equipment and accessories

- (i) **Water Pump:** Two types of pumps are required for the small-scale hatchery operation. A pump of 5HP is required to pump seawater to the hatchery's sand filter tank. A separate submersible pump is required to distribute water within the hatchery system.
- (ii) **Generator:** A generator of 1 KVA is essential as a backup electricity supply for the hatchery.
- (iii) **Aeration system:** A small 100-watt air pump with at least one backup is needed.
- (iv) **Other hatchery pieces of equipment**
 - a. An ordinary microscope.
 - b. Thermometer
 - c. Salinometer
 - d. pH meter
 - e. Water analysis kit
 - f. Hand nets
 - g. Plastic wares like buckets, bins, hoses etc.

Optional

- RAS
 - Protein skimmer
 - Chiller
 - Aquarium Heater
- (v) **Manpower:** The small-scale hatchery can be managed by two full-time staff – One technician and two workers. Basic training on technical aspects is needed for day-to-day hatchery operation. Daily routine works include cleaning broodstock and larval tanks, feeding broodstock and larval tanks, harvesting microalgae, rotifers, *Artemia* etc.

Advantages of small-scale hatcheries

- Low capital inputs
- Simple construction
- Ease of operation and management
- Flexibility
- Quick economic returns.

Economic Assessment

The candidate species selected for economic analysis is the true clown *Amphiprion percula*.

Capital Investment

This component involves all the expenditure on the infrastructure and establishment of the hatchery. The items included in this component generally have a life span larger than one year and they are used to generate the future income from the hatchery. The items include

Capital Investment items	Quantum	Cost in Rupees
Temporary Shed	144m ² (12 X 12m)	1,10,000
Tanks		6,40,000
i. Broodstock	12	
ii. Larval rearing	12	
iii. Nursery and grow out	18	
iv. Microalgae (outdoor)	4	
v. Rotifer (outdoor)	3	
vi. Sand filter /Overhead tank	1	
Artemia hatching tanks (Transparent Perspex)	3	10,000
Power installation		10,000
4 HP diesel pump	1	19,000
1/2 HP submersible pump	1	6,000
Generator 2 KVA	1	30,000
Air pumps	2	40,000
PVC piping, plastic wares (water supply/aeration/drainage)		45,000
Netting, miscellaneous etc.		40,000
TOTAL COST		9,50,000

Operating expenses

This component is for the expenses that are spent during each production cycle and are essential for the routine operation of the hatchery. The items included are:

No.	Items	1st year	2nd year	3rd year
1	Broodstock fishes/Anemones	25,000	5,000	5,000
2	Feeds	12,000	12,000	12,000
3	Artemia	4,000	12,000	12,000
4	Chemicals for microalgal culture	6,000	6,000	6,000
5	Electricity	36,000	36,000	36,000
6	Diesel	24,000	24,000	24,000
7	Maintenance	12,000	18,000	18,000
8	Workers salaries(1xRs. 8000; 2xRs.5000)	2,16,000	2,16,000	2,16,000
9	Miscellaneous expenditures	12,000	12,000	12,000
	TOTAL	3,47,000	3,41,000	3,41,000

Non-operational expenses

These are related to the capital cost and investment write-off. There are two items under this component for small-scale hatcheries.

- Depreciation
- Interest on capital investment

Technical assumptions for production

It is assumed to be an indoor system located in a coastal area with access to both salt and freshwater and easy transportation access to the market. There are 12 broodstock pairs. At any time there are 10 active spawning pairs. Each pair will spawn 2 times per month. An average of 400 larvae are produced during each spawn. The survival rate of the larvae in the grow-out phase is 50%. The period from larvae to juvenile is 30 days. There is a 60% survival rate for juveniles to market size, which is saleable. The period from nursery to market size is 120 days. In a month, 240 saleable-sized fish can be produced from one pair of clown fish. Each fish can be sold at a rate of Rs.100. The sale of the fish will start from the second year onwards. The first year of operation will be the construction and set up of the building, procurement of equipment and collection and maintenance of brooders. The first spawning is expected in the eighth month of the first year. The first harvest and sale will occur in the first month of the second year.

Amount in (Rs.)			
Revenue	Year 1	Year 2	Year 3
Sale of clownfish fingerlings @ Rs.100/fingerlings(240 juveniles x10 pair x12 month =28,800 numbers 28800 x Rs 100 = Rs. 2880000)		28,80,000	28,80,000
Non-operating expenses			
a. Depreciation (20%)	1,90,000	1,90,000	1,90,000
The interest rate on capital investment @12%	78,000	78,000	78,000
Operating cost TOTAL EXPENSES	2,63,000	2,57,000	2,57,000
	5,31,000	5,25,000	5,25,000
Profit		23,55,000	23,55,000

New avenues for Aquarium and allied business

Since marine ornamental fishes are a low-volume-high-value species, the economic return is high when compared to other farming methods and it also creates other allied employment avenues such as aquarium tank designing, reef tank setting, aquarium landscaping, planted aquarium, aquarium gadgets and accessories business, aeration system, filtration system, RAS, protein skimmer, creation of artificial coral for aquaria, artificial feed, live feed, feeding gadgets and colouring additives, coral and zooanthids propagation, production of hybrid and designer marine ornamental fishes etc. Thus the opportunities offered by marine aquaria are enormous and the economic return in each sector is also high. As a result, the ornamental sector is advancing day by day and more and more entrepreneurs are emerging worldwide. Since India is endowed with a vast resource potential of marine ornamentals distributed in the coral seas and rocky coasts with patchy coral formations and the increasing demand in the domestic trade, it appears

very lucrative for India to venture into this industry. But it is a multi-stakeholder industry ranging from specimen collectors, culturists, wholesalers, transhippers, retailers, hobbyists, researchers, government resource managers and conservators, and hence involves a series of issues to be addressed and policies to be formulated for developing and expanding a sustainable trade and to open up a trade based on captive raised marine ornamental fishes.

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