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Marine ornamental fishes and their breeding: CMFRI initiatives

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Abstract

The marine ornamental fish trade is a sunrise industry in aquaculture and has become a growing industry worldwide. As a result the trade of marine ornamentals has been expanding in recent years and has grown into a multimillion dollar enterprise mainly due to the emergence of modern aquarium gadgets and technologies for setting and maintenance of miniature reef aquaria. Since the marine ornamental trade is operated throughout the tropics, the global marine ornamental trade is estimated at US$ 200-330 million. 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 the demand in the domestic trade, it appears very much 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. 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 indiscriminate exploitation of coral reef areas. The only alternative for the sustainable trade is the captive productions which involved broodstock development, breeding, live feed culture, larviculture, growout, aquarium technology, diseases, packing and transportation, etc. The Central

Marine Fisheries Research Institute (CMFRI) has been focusing on this vital aspect of this low volume and high value industry for the past few years.

Introduction

Marine and freshwater aquarium keeping is amongst the most popular of hobbies with millions of enthusiasts worldwide. As a result the trade of marine ornamentals has been expanding in recent years and has grown into a multimillion dollar enterprise mainly due to the emergence of modern aquarium gadgets and technologies for setting and maintenance of miniature reef aquaria. 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 in the domestic trade, it appears very much 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 Philippines, Indonesia, Solomon Islands, Sri Lanka, Australia, Fiji, Maldives and Palau. This has been threatening the long term sustainability of the trade due to indiscriminate exploitation of coral reef areas. The three key words 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 captive production of ornamental fishes are broodstock development, breeding, live feed culture, larviculture protocols, growout methods, aquarium technology, diseases, packing and transportation, etc. The 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 21 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 INDIAL: Initiatives by CMFRI

These investigations made CMFRI have resulted in the development of hatchery technology for 21 species of marine ornamental fishes such as clown fishes *Amphiprion percula*(True percula/ clown anemone fish);*A. ocellaris* (Common Clown/False clown aenemonefish); *A. sandaracinos* (Yellow Skunk Clown); *A. frenatus* (Tomato clown), *A. clarkii* (Clark's anemone fish), *A. sebae* (Sebae clown) *A. perideraion*(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 *Chormisviridis* (Green chromis), and also dotty back *Pseudochromis dilectus* (Redhead Dottyback), purple fire goby *Nemateleotris decora* for the first time in the world (Madhu and Rema Madhu,2002,2006; Madhu *et al.,* 2006a,b,c; Gopakumar*et al.,* 2007; Rema Madhu, *et al.,* 2007; Madhu *et al.,* 2008, Madhu and Rema Madhu, 2014, Madhu *et al.,*2016). 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 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 for the technology is being planned by imparting hands on training through different modes under the Consultancy Processing Cell (CPC) of the CMFRI and organized trainings.In addition, the hatchery produced seeds are also being sold to the farmers and aquarium hobbyists and traders through Single Window System and seed counters are in operationn marine hatcheries of CMFRI at Cochin and Mandapam. 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 for ornamental fish culture in the unutilized hatcheries of the prawn farmers in India.

CAPTIVE BREEDING

For the breeding of ornamental fishes under captive condition, the following few important steps are to be followed apart from maintenance of high water quality, provision of suitable environmental parameters, creating suitable condition 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 to be under taken 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 handlingtechniques
- 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

Collection and transportation of fishes

For the captive mass production of ornamental fishes, the basic requirement is to have a sufficient number of broodstocks or breeding pairs which can either be collected from the coral reef habitat or can be purchased from the pet shop depending upon the availability. In the wild, the clown fishes generally occupy in social groups cantered in a host sea anemone with a sexually active pair of adults and one to three juvenile or sub adult fish. Invariably the female was somewhat larger than the male, and showed monogamous pair formation, and these pairs are need to be collected for broodstock development and breeding programme. During transportation, the fishes and sea anemones should be kept in separate plastic transportation bags.

Quarantine

Newly acquired fish from wild as well as pet shops may carry disease and may infect valuable, healthy, broodstock. They are, therefore, kept separately in a tank or system, for three to four weeks where they are closely observed and treated with medications for possible disease outbreaks. Prior to sale also fishes should be screened and quarantined.

Pair formation

In case mated pairs are not available, the fishes having different size groups can be collected and made to pair under captive condition through pair formation for which five fishes of each sex of different size groups need to be stocked together along with single host sea anemone in a 500 L FRP tanks fitted with biological filter to reduce the aggression. The pair formation tanks need to be maintained in the hatchery where an incident light intensity of 2500 to 3000 lux was available as the sea anemones require sunlight for its better survival under laboratory condition. The fishes and anemones should be fed two times per day with wet feeds such as meat of shrimp, mussel and clam at the rate of 15% of their body weight and live feeds like Brachionus *plicatilis,* artemia nauplii and adult artemia. Environmental parameters such as temperature 26 to 29^{o} C, salinity 33 to 36 ppt, dissolved oxygen 4.6 to 6.2 ml/L and pH 8.1 to 8.9 are need to be maintained in all the rearing tanks.

Sex change and pairing

As the clownfishes are protandrous (male first) sequential hermaphrodites, a pecking order is established in which the female is dominant, the male is subordinate to the female, and all the other juveniles are subordinate to the adult male and female. Thus generally all clownfish individuals start out as males and change into females when they reach larger sizes or under situation of loss of mate. The male and female form a monogamous pair bond that lasts until one member of the pair dies. If the female dies first, the largest male rapidly changes sex into a female and the second largest or dominant juvenile becomes an active male and that pairs up with the newly transformed female. By utilizing this adaptation, pairs of clown fishes can be developed under captive condition through creating social systems. After a period of 3 to 4 months rearing in the pair formation, in each tank one pair grew ahead of others and became the spawning pair. As the newly formed pairs will be very aggressive and spending time for fleeing the other subordinates rather than reproductive activity, it is very essential to stock each breeding pairs in separate broodstock tanks.

Broodstock development and maintenance

The pairs formed through pair formation should then be transferred to separate glass aquaria for broodstock development. Depending upon the production capacity and seed demand, several pairs can be maintained for commercial hatcheries. The broodstocks need to be fed with wet feeds such as meat of green mussel, shrimp, and clam and fish egg mass, and can also be provided formulated feeds enriched with vitamins, minerals and algal powder at the rate of 10% of their body weight and supplied at an interval of every 3 hrs during day time. Apart from these, the broodstocks were also fed with enriched rotifer 800 to 1000 nos/ml and artemia nauplii (200-400 nos/ml) and adult artemia (3 to 5 nos/ml) every day. Provision of enriched live feeds which apparently improved egg quality and hatchability than the brooders fed with non-enriched live feeds.

Water quality maintenance

The maintenance of high water quality is possibly the critical factor for the breeding of marine fishes under controlled condition. As a measure for this, the sea water need to be filtered through a series of sand filters before being taken to the rearing tanks. The temperature in all the breeding tanks need to maintained between 26 to 30°C, and level of dissolved oxygen (4.8 to 6.3 ml/L), pH (8.0 to 8.9), salinity (32 to 36 ppt) and the water needs to be recirculated to ensure water movement and provided good water quality with the aid of a specially devised filter system during the period of rearing. Once in a week 25% of the water should be exchanged to avoid stress like a rapid increase in plasma cortisol concentration which will leads to Cushing's syndrome, depression of gonadal steroidogenesis, and subsequent development of gonadal atresia.

Substrate for egg deposition

In case of attached eggs a rough surfaced substrata near to the host sea anemone/ tank. It is very essential to provided suitable substratum preferably tiles or earthen pots or shells of oyster or PVC pipes for the egg deposition which will also be helpful for the transfer of deposited egg without any mechanical injury to hatching tank.

Breeding and spawning

After bloodstock rearing, each pair will start breeding within a period of 4 to 6 months rearing under captive condition if the broodstoks are provided nutritious food and provided suitable rearing conditions. Few days prior to spawning, the male selected a suitable site near to sea anemone for laying the egg and cleared algae and debris with its mouth and on the day of spawning both the parents spent considerable time for the cleaning of site which indicated that spawning may occur within few hours. Under laboratory condition, the spawning can be obtained between 0500 hrs to 1530 hrs during day time and the spawning lasted for one hr to one and a half hour. Each female lays 300 to 1000 capsule shaped eggs at every 12 to 15 days interval depending on the species of clown fish, size of fish and previous experience. Generally the egg size of clown fishes ranges between 1.5 mm to 3.0 mm in length with a width of 0.8 to 1.84 mm and adhered to the provided substratum with stalk. An average of two spawning per lunar month per pair resulting in an estimated annual fecundity of 7200 to 24000 eggs/ breeding pair/ year can be obtained under laboratory condition.

Parental care and egg morphology during incubation period.

As parental care is inevitable for hatching out of the larvae, the parents should be allowed to remain in the parental tank itself till hatching. During incubation period, both the parents carefully look after the eggs during day time and it involved two basic activities *viz*. fanning by fluttering the pectoral fins and mouthing to remove the dead or weakened eggs and dust particles. The newly spawned eggs were white to bright orange in colour for initial two days and as the embryo develop; these were turned to black on 3rd to 6th day and later turned to silvery the colour of the larvae's large eyes on 7th to 8th day of incubation. At this stage the glowing eyes of the developing larvae inside the egg capsule was clearly visible when viewed from a short distance. Male assumed nearly all responsibility of caring for the eggs and spent a higher percentage of time at the nest than the females, which increased gradually up to 70% of time as the day of hatching approached. When incubated at a water temperature range of 27 to 29^{o} C, the hatchling emerged on 8th day of incubation and peak hatching took place shortly after sunset.

Hatching and larval transfer

The eggs of clownfishes usually take from 6 to 15 days to hatch depending on the water temperature. At temperature 26 to 33 ° C the incubation period ranges from 6 to 8 days. One day prior to hatching the larvae within the eggs capsule develop a silvery colour and the glowing larval eyes can be viewed form a short distance. This is the time when one must make a decision for the mode of larval rearing. On the expected day of hatching, two hours before sunset, the eggs along with substratum were transferred from the parental tank to hatching tanks (100 L) and provided with complete darkness for accelerating the hatching. The larvae broke the egg capsule and the hatchling emerged tail first and the hatching occurred soon after sunset and the peak hatching took place between 1900 to 2030 hrs under darkness. The newly hatched larvae measured 3 to 4mm in length and each had a transparent body, large eyes, visible mouth, and a small yolk sac and remained at the bottom of the tank for a few seconds and soon after became free swimming. The larval rearing can be carried out under green water system and feeding with super small rotifer *B. rotundiformis* and newly hatched artemia nauplii. The larval period of clown fishes generally last for maximum of 20 days and then after most of the fry resembled juvenile adult fish and began to shift from partially pelagic to epibenthic and started eating minced shrimp, fish flesh, mussel meat, clam meat and formulated diets.

Methods for larval rearing

The larval rearing of clown fishes can also be carried out in three ways (i) Same tank or parental tank method, (ii)Transferring of eggs to hatching tank and subsequent larval rearing, (iii) Transferring of larvae to the larval rearing tank.

Larval feeding

The successful feeding strike is low at first feeding but rises rapidly during early development fishes. At this stage provision of suitable size and nutritionally adequate enriched feed in high density is one of the important factor for their survival as the larvae will be able to accept small size organism due to the small mouth gape, and if they do not encounter and successfully capture food before depleting their energy reserves, the larvae may starve and it will eventually lead to mortality. Moreover many of the larvae had only little quantity of yolk material and it starts feeding within few hours after hatching. As the mouth gape of clown fish larvae is between 80- 123 μ, the larvae need to be fed with live feeds measuring less than 100μ for its active feeding. All the rearing tanks need to be provided 24 hrs light up to 15 days of post hatch (DPH). During this time the larval tank must be kept very clean with the bottom siphoned off dead larvae, detritus and faeces twice a day. Water changes will also need to be performed at a rate of at least 25% per day. Feeding schedule of larvae of clownfishes can be performed in two stages: Stage 1: covered the rotifer with algae feeding phase from Day 1^{st} to 8^{th} day. Stage 2: the newly hatched artemia without any and rotifer enriched with algae feeding phase from 9^{th} to 20^{th} days. For the successful prey capture of larvae, 50-100 numbers ml^{-1}

supper small rotifer (*B. plicatilis*) having size 60 to 100 µ need to be provided after enrichment with vitamins and fatty acids.

Rearing conditions

The maintenance of high water quality is possibly the critical factor when larval rearing of clownfishes or any marine fishes is done under controlled condition. As a measure for this, the sea water needs to be filtered through a series of sand filter tanks before being taken to the larval rearing tank. However during larval rearing it was found that the period from 3^{rd} to 8^{th} day of post hatching (dph) was very critical may be due to the alteration or change in feeding (exogenous) whereas once the larvae of clownfishes completed 8 days after hatching, no further mortality was observed. Since the larvae are very delicate aeration was provided at four corners of larval rearing tanks through PVC column to maintain dissolved oxygen. During the larval rearing period, in all tanks, the environmental parameters were maintained to their optimum level with pH ranging from 8.0 to 8.2 water temperature 26 - 30° C, dissolved oxygen 5.5 - 7.8 (mg/L), salinity 33-35ppt, NH_{4+}/NH_3 and NO_2 values at 0 mg per L and NO_3 levels below 0.2 mg /L. Daily the tanks were cleaned with cotton and magnetic tank cleaner to remove the dust and slimy coating forming inside the tank and one fourth water is replaced with same amount of filtered sea water along with enriched rotifer and artemia and micro algae.

Light intensity

Head-butting syndrome was another the critical problem encountered during the larval rearing due to the immature development of the retina and subsequent hitting of larval head to the sides of the tank. In order to reduce this, two major measures have been taken that (i) all the 4 sides of the tanks were covered with black cloth or painted black to avoid reflection of the light.

ii). a low intensity light needs to be provided by hanging 2 nos. of 60 watt bulb or night lamp at a height of 15-20 cm from the surface of water level in rearing tank for 24 hours from 0 day to 20th day which enabled the larvae to detect and capture its feed and it also helped them to swim towards the surface at night rather than sinking to the bottom which otherwise show high overnight mortality.

Juvenile rearing

On 19-20 dph, the larvae became juvenile of clownfishes and shift from pelagic to epibenthic stages, and look like a miniature of adult fishes. The rate at which the young fish grow depends on the size of the rearing tank, stocking density, quality and quantity of food given and the water temperature. As the clownfish exhibit social hierarchy, dominant clownfish will grow faster and will suppress the growth of the fish below. This can largely overcome however by growing the fish up all together in a large tank with sufficient host anemones or culling the juveniles to several groups in different juvenile rearing tanks of size 250 to 1000 L capacity fitted with biological filters. At this stage, the stocking density need to be reduced to 90 -100 numbers of juveniles (size range between 8-10 mm) with single host sea anemone in glass or perspex tank- at 100 L capacity for initial 1 to 2 months rearing. During juvenile stages, the fishes show different banding pattern and growth rate, and on attaining a size of 24 to 35 mm in total length (TL), the stocking density need to be reduced to 30 to 50 number with single sea anemone in 100 L tank with 80 L bio filtered sea water until marketing. In the case of each 500 L FRP tanks, 130 to150 juveniles can be reared with 1 to 3 sea anemones.

Juvenile feeding

In the juvenile rearing, a survivability 100% were obtained through feeding with different wet feeds: mussel meat, prawn muscle, fish eggs and minced flesh of trash fish at the rate 15 to 20 % of body weight. Apart from these, artemia nauplii 10-15 numbers/ ml and rotifer (*B. plicatilis*) 50 - 55 nos. /ml were given after enrichment with brown algae (10^4 cells/ml) and green algae (10^6 cells/ml) with cod liver and fat soluble Vitamin A, D, E, K, twice a day which helped to retain the colour of fishes and provided adult artemia (2 - 4 nos/ml).

Packing and Transportation

Fishes are starved for about 2-3 days before being exported or transported. A small amount of fresh water is added to the packing water and chemicals may be added to tranquilize for longer journeys. Packing starts just prior to the transportation. Fishes are packed with oxygen and a little water either singly or multiple in double polythene bags to ensure that fish are not stranded without water. Polythene bags are packed in cardboard boxes for short journeys and for long journeys they are packed in Styrofoam boxes with some ice to keep the temperature down. Layers of paper may be inserted between plastic bags in the box to avoid catching sight of aggressive species. Packaging methods have improved considerably over the years mainly due to feedback from the customers and many exporters now guarantee almost 100% survival for most destinations provided that good connecting flights is available.

Setting up of 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

Nursery rearing and grow-out tanks

4. One sand filter
5. Outdoor live feed (Phyto and zooplankton) production tanks
6. 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 backup electricity supply for the hatchery.
(iii) Aeration system: Small 100 watt air pump with at least one backup is needed.
(iv) Other hatchery equipments
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.

(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 today 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

1. Low capital inputs
2. Simple construction
3. Ease of operation and management
4. Flexibility
5. Quick economic returns.

Economic Assessment

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

Capital Investment

This component involves all the expenditure on the infrastructure and establishmentof the hatchery. The items included in this component generally have a life span largerthan one year and they are used to generate the future income from the hatchery. Theitems nclude

Capital Investment items	**Quantum**	**Cost in Rupees**
Temporary Shed	144m2 (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 /Over head 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 andare essential for the routine operation of the hatchery. The items included are:

	Items	1st year	2nd year	3rd year
1	Broodstock fishes/Anemone	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 itemsunder this component for small-scale hatcheries.

i) Depreciation

ii) 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 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 to 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 are saleable. The period from nursery to market size is 120 days. In a month, 240 saleable sized fishes can be produced from one pair of clown fish. Each fish can be sold at a rate of Rs.100. The sale of the fishes will start from second year onwards. The first year of operationwill be construction and set up of the building, procurement of equipment and collection and maintenance of brooders. The first spawning is expected in eighth month of first year. The first harvest and sale will occur at the first month of second year.

Amount in Rs.			
	Year 1	**Year 2**	**Year 3**
Revenue			
Sale of clownfish fingerlings @ Rs.100/fingerlings(240 juveniles x 10 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
Interest rate on capital investment @12%	78,000	78,000	78,000
Operating costTOTAL 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**

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