Seed production and culture of marine ornamental fishes

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Introduction

The marine ornamental fish trade has been expanding in recent years and has grown into a multimillion dollar enterprise. The ornamental animals are the highest valued products that are mostly harvested from coral reef environments. The global marine ornamental trade is estimated at US$ 200-330 million. The trade is operated throughout the tropics. Philippines, Indonesia, Solomon Islands, Sri Lanka, Australia, Fiji, Maldives and Palau supplied more than 98% of the total number of marine ornamental fish exported in recent years. It is a multi-stakeholder industry ranging from specimen collectors, culturists, wholesalers, transhippers, retailers, and hobbyists to 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. It is well understood that a long term sustainable trade of marine ornamental fishes can be developed only through the development and commercialization of hatchery production technologies for the species which are in high demand in the trade.

Global scenario

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. Among the most commercially traded families of reef fishes, family Pomacentridae dominate, accounting for nearly 43% of all fish traded. The family contains about 235 species worldwide. 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%). In recent years 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 among the most commonly traded species.

Hatchery production technologies

Indiscriminate exploitation of ornamental fishes from the coral reef areas has been threatening the long term sustainability of the trade. Hence hatchery production of selected marine ornamental fishes is the only option for the development of 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 of the following species of ornamental fishes which are in high demand in the international trade.

1. Amphiprion percula - Orange clown
2. A. ocellaris - False clown
3. A.sebae - Sebae clown
4. A.nigripes - Maldive's clownfish
5. A.ephippium - Red saddleback clownfish
6. A.perideraion - Pink skunk
7. A.clarkii - Clark's anemonefish
8. Premnas biaculeatus - Maroon clown(spine cheek anemonefish)
9. Pomacentrus cearuleus - Blue damsel

10.	P.pavo	-	Peacock damsel
11.	Dascyllus trimaculatus	-	Three spot damsel
12.	Dascyllus aruanus	-	Humbug damsel
13.	Chromis viridis	-	Bluegreen damsel
14.	Neopomacentrus nemurus	-	Yellowtail damsel
15.	N.cyanomos	-	Filamentous tail damsel
16.	Chrysiptera cyanea	-	Sapphiredevil damsel

Clownfishes

Success was obtained in the seed production of eight species of clownfishes which are in good demand in the international trade of marine ornamental fishes

Amphiprion ocellaris

The spawning time was during early morning hours and the frequency of spawning ranged from 12 to 15 days. The clutch size per spawning ranged from 300 to 1000 eggs. Hatching was on the evening of 8th day of incubation and the newly hatched larvae measured from 3.2 to 4.0 mm in length. The larviculture protocols were developed and during the 15th to 17th day of hatching the larvae metamorphosed into juveniles.

Amphiprion percula

The spawning was during day time (0600 -1530 hrs) and the spawning interval ranged from 14 to 18 days. The clutch size per spawning ranged from 112-557 eggs. The hatching was on the evening of the 8th day of incubation and the length of the newly hatched larvae ranged from 1.91 to 2.02 mm.The larviculture protocols were developed and during the 19th -20th day of hatching, the larvae metamorphosed into juveniles.

Premnas biaculeatus

The broodstock was developed in 500 litre FRP tanks fitted with biological filtration and by providing special broodstock feeds. The spawning was during day time. The number of eggs per spawning ranged from 150 to 1000 numbers and the spawning interval was 15 to 20 days. Hatching occurred on the evening of the 6th day of incubation. The newly hatched larvae measured from 350 to 410 μ. Greenwater technique was employed for larval rearing and feeding protocols with enriched rotifers and newly hatched Artemia nauplii were developed. At 15 to 17th day of post hatch, the size of the juveniles ranged from 12.0 to 16 mm.

Recently success was also obtained in the breeding and seed production of five more species of clownfishes viz. Amphiprion nigripes, A. perideraion, A. frenatus, A. ephippium and A. clarkii. The breeding and seed production techniques are similar to the species mentioned above.

Damsel fishes

Broodstock development and larval rearing were achieved for six species of damselfishes viz. the three spot damsel (Dascyllus trimaculatus), striped damsel (Dascyllus aruanus), the blue damsel (Pomacentrus caeruleus), the bluegreen damsel (Chromis viridis) , the yellowtail damsel (Neopomacentrus nemurus) and the sapphire devil damsel (Chrysiptera cyanea).

Dascyllus trimaculatus

The mature fish ranged in total length from 9-10cm. The clutch size in a single spawning ranged from 12000 – 15000 eggs. The average periodicity of spawning was two weeks. The average length of newly hatched larva was 2.5mm. The green water technique with sufficient nauplii of copepods was the key factor for the success of early larval rearing. The larvae started metamorphosing from 35th day of hatching and all larvae metamorphosed by the 40th day. The just metamorphosed young one measured from 12-13mm in length. The second generation matured and spawned in the hatchery at eleven months of age.

Dascyllus aruanus

The brooders ranged in length from 7-8 cm.

The clutch size in a single spawning ranged from 8000 – 10,000. The average periodicity of spawning was two weeks. The average length of newly hatched larva was 2.4 mm. The larvae started metamorphosing from 25th day of hatching and all the larvae metamorphosed by 31st day.

Pomacentrus caeruleus

The breeders ranged in length from 7-9 cm. The clutch size in a single spawning ranged from 5000-6000 eggs. The average periodicity of spawning ranged from 3 to 12 days. The average length of the newly hatched larvae was 1.2 mm but the mouth gape was comparatively larger (around 200μ). Greenwater technique and feeding with sufficient nauplii of suitable copepods for the first ten days and thereafter with freshly hatched Artemia nauplii was the methodology followed. The larvae started metamorphosing from the 17th day and by 21st day all of them metamorphosed. The average length of just metamorphosed juvenile was 21mm.

Chromis viridis

The broodstock development of the green damsel Chromis viridis was carried out in 2 tonne FRP tanks fitted with biological filter and by feeding with special broodstock feeds. The fishes became broodstock at a total length range of 8 -9 cm. The average frequency of spawning was 5 per month with an interval of about 5 days. The egg was oval shaped and the average length was 502 μ. The total numbers of eggs per spawning ranged from 1300 -1500 eggs. Hatching occurred on the evening of the fourth day of incubation. Larvae were altricial type with no mouth opening at the time of hatching. The average length of newly hatched larva was 2.25 mm. The larvae were transferred to 5 tonne capacity round FRP tanks in which cultures of the harpacticoid copepod Euterpina acutifrons and the calanoid copepod Pseudodiaptomus serricaudatus were maintained in green water produced by adding Nannochloropsis culture. Mouth opening was formed on the second day of hatching and the gape measured around 190 μ. The larvae started feeding on copepod nauplii from the 3rd day onwards. From the 32nd day of larval rearing freshly hatched Artemia nauplii was also supplemented. Metamorphosis started from 30th day and completed by 49th day.

Neopomacentrus nemurus

The broodstock of the yellowtail damsel Neopomacentrus nemurus was developed in 2 tonne capacity FRP tanks. The average interval of spawning ranged from 4 -5 days. The length of freshly laid egg was 870 μ. The eggs hatched on the evening of the fourth day of incubation. The freshly hatched larva measured 1.8mm with a mouth gape of about 100μ. The larvae were transferred to 5 tonne capacity FRP tanks in which mixed culture of copepods were maintained in green water produced by adding cultures of Nannochloropsis. The larvae started feeding on nauplii of copepods from the third day of hatching. From the 12th day onwards the larvae were also fed ad libitum with freshly hatched Artemia nauplii. From the 16th to 21st day of hatching the larvae metamorphosed into juveniles. The length of the just metamorphosed juvenile ranged from 10 -13 mm.

Chrysiptera cyanea

Broodstock development was done in two tonne capacity FRP tanks with biological filter and by feeding ad libitum with natural feeds. The size of broodstock fish ranged from 5 to 6.5cm. The number of eggs per spawning ranged from 2000 - 2500. The interval between successive spawnings ranged from 5 to 20 days. The eggs were either attached to the sides of the broodstock tank or on the substratum provided in the broodstock tank. The eggs were oval - shaped and measured around 1.3mm in length and 0.6 mm in width. Parental care by the male was noted. Hatching occurred on the night of the third day of incubation. The larvae were altricial type but with mouth opening at the time of hatching. The length of newly hatched larvae averaged to 2.5mm and the mouth gape around 150 μ. Larviculture was done in five tonne capacity FRP tanks by employing greenwater produced by the microalgae Nannochloropsis occulata. Different larviculture systems were experimented by varying the cell counts of greenwater and the live feeds. The cell counts of green water employed for the experiments were 1 x 104 ml-1, 1 x 105 ml-1 and 1 x 106 ml-1. Four sets of experiments were conducted by feeding with different live feeds – one set with enriched rotifer (Brachionus rotundiformis) alone, the second set by employing mixed culture of two copepods species viz. Euterpina acutifrons and Pseudodiaptomus serricaudatus, the third set by employing copepods and rotifers together as live feed and the fourth set with copepods as starter feed for the first six days followed by enriched rotifers from 7 -15 dph. The larval survival was recorded on 15th day of post-hatch. Feeding experiments with B.rotundiformis alone and those with B.rotundiformis and copepods together as live feeds were not successful. Co-culturing of the two selected species of copepods in the optimum range of cell count of greenwater gave the best survival. In this set, survival rate of larvae on 15 day post-hatch (dph) ranged from 5 to 8%. The maximum survival rate was 5-6% in the group fed with copepods as starter feed upto 6 dph followed by enriched rotifers from 7 to15 dph. It was noted that a cell count range of 1 x 105 cells ml-1 was the optimum which yielded the maximum larval survival in both these sets of experiments. After 15 dph the larvae were fed with freshly hatched Artemia nauplii and no further mortality was noted. Metamorphosis of larvae started from 24th day and all the larvae metamorphosed by 30th day.

The larviculture protocols of the other species are similar to the above.

Grow- out methods

Grow out of ornamental fishes can be effectively practised in happas installed in nearshore areas. The growth was found to be much faster. The major advantage is that the colour is much brighter in fishes grown in happas due to natural light and good exchange of water. The site for installation of happas should have at least 2 m depth of water, good dissolved oxygen content, free from industrial contaminants, low anthropogenic pollution and easy accessibility from land. A protected area is generally preferred.

Construction of floating hapa

Rectangular shaped fixed floating happa (2.5 m x 1.5 m x 1.5 m) with PVC frames (dia 1.5 inch) for supporting the net bag structure and to retain the shape are used for the grow out phases of juvenile to marketable size. Here the advantage is that it provides better water exchange and natural environment to the fishes.

Good quality HDPE net having 0.5 mm and 1 mm mesh size could be used to make the net bag. Double layered net bags are stitched in 2.5 x 1.5 x 1.5 m depending upon the design and requirement of the frame. Nylon thread is used for stitching the cages. Nylon rope (6 mm dia) is used for tying the bags and poles. All the joints are reinforced with nylon ribbon (1-1.5”). Ribbon loops are provided at regular intervals (0.5 m) both on the upper and lower margins of the hapa for tying the sinkers at the four corners with nylon rope. The top of the hapa is also covered with net frame. Two opposite corners of the top cover of the hapa is made detachable so as to enable regular feeding, growth monitoring and harvesting.

Survival of 90-95% is obtained through proper feeding with different wet feeds like boiled sardine flesh, chopped clam meat, mussel meat and formulated dry feed, two times a day ad libitum. Since the hapa was installed in the sea, fouling was a regular phenomenon and regular monitoring is advisable. Cleaning the net with coir brush has to be carried out on daily basis. Checking of the outer and inner net was also recommended on daily basis to detect any defects in nets. In addition to this, checking of mooring system twice in a week is advisable. Hapa reared marine ornamental juveniles grow faster with increased survival rate and good colouration thereby juvenile fetching better price in the market.

Feeds

For feeding marine ornamental fish CMFRI has scientifically evaluated feeds containing not less than 30 % protein, 9 % fat, 39 % carbohydrates, 7 % ash (minerals) and less than 2 % fiber. These feeds are made up of marine protein, soy protein, wheat flour, oil, vitamins, minerals, color imparting nutrients, immune promoters, an anti-oxidant, antifungal and probionts. They are sold in packets of 50 g capacity. Technology commercialization package is available for production and marketing of this product with CMFRI as knowledge partner.

Prospects of development of a trade through hatchery production

The damaging fishing methods which destroy the fragile corals and over harvesting of the species in demand are the vital problems associated with the trade. It is widely accepted that the ultimate answer to a long term sustainable trade of marine ornamental trade can be achieved only through the development of hatchery production technologies. In this context it is imperative to develop commercially viable seed production techniques of species which are in demand. It is well accepted as an environmentally sound way to increase the supply of marine ornamentals by reducing the pressure on wild population and producing juvenile and market sized fish of wide variety of fish year round. In addition hatchery produced fish are hardier and fair better in captivity and survive longer. The methodologies developed by CMFRI can be scaled up for commercial level production and a hatchery produced marine ornamental fish trade could be developed.