MARINE ORNAMENTAL FISH SEED PRODUCTION

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INTRODUCTION

The ornamental fish trade is a multi- billion dollar industry and it is estimated that globally around 1.5 -2 million people keep aquaria. Over 46,000,000 organisms representing 2500 species are traded annually with a value exceeding US$ 300,000,000. Philippines and Indonesia supply the majority of livestock, with most specimens being consumed by the USA, Europe, and Japan (Calado *et al.,* 2017). 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%). The most traded species are the blue green damselfish (*Chromis viridis*), the clown anemone fish (*Amphiprion ocellaris*), the whitetail Dascyllus (*Dascyllus aruanus*), the sapphire devil (*Chrysiptera cyanea*) the three spot damsel (*Dascyllus trimaculatus*), *Amphiprion percula, Paracanthus lepturus, Dascyllus albisella,, Zebrasoma flavescens,* the cleaner wrass *Labroides dimidiatus,* the powder blue surgeon *Acanthurus leucosternon,* the sea goldie *Pseudanthias squamipinnis,* the fire goby *Nemeteleotris magnuifica,* and the dragonet *Synchiropus splendidus*.

The marine ornamental fish sector all over the world, is dominated by fishes/shell fishes/invertebrates caught from the wild and the share of hatchery produced fishes still continues to be at a very minimal level. 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 butterflyfish and angelfish due to heavy collection pressure. Even on a global basis, the commercial level hatchery production technologies have been evolved only for a limited number of species. 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. Moreover, hatchery produced fish are hardier and fair better in captivity and survive longer than wild caught ones. The number of captive-bred marine aquarium fish species, comes to over 250 species (Sweet, 2014). However, to date, successful commercial rearing has been scientifically reported for only a few species and around 5% of marine aquarium fish traded are commercially produced from hatchery. The main families bred for aquarium purposes are Pomacentridae, Pseudochromidae, Gobiidae, Apogonidae, Pomacanthidae and Syngnathidae (Dominguez and Botella, 2014; Calado *et. al.*2017).

The marine ornamental fishes that are most commonly bred in captivity include clown fishes and damsel fishes. The absence of sexual dimorphism, the complex patterns of sex change in certain groups and the problems of larval rearing can be considered as the major reasons for the slow progress in the culture of marine ornamental fishes.

CLOWN FISHES

Clown fishes are distributed throughout the Indo-West Pacific Region. Clown fishes continue to be the most demanded marine tropical fish and the technologies available at present on marine ornamental fish breeding are mainly centred around clown fishes. They are distinguished and taxonomically separated from damselfish by their dependence on anemones for protection. They are further distinguished from damsels by their large capsule shaped eggs and large larvae at hatch.

Species of clownfish for which hatchery technologies are developed and standardized in India is given in Table.1. Recently seed production of designer clown fishes (such as Picasso, Platinum, snowflake etc) which are the most sought after variety among clown fishes, have also been achieved at Mandapam Regional Centre of ICAR CMFRI.

Table.1: Species of clownfish for which hatchery technologies have been developed

Sl.No.	Species name	Common name
1	*Amphiprion sebae*	Sebae clownfish
2	*A.clarkii*	Clark's anemonefish /yellowtail clownfish
3	*A.percula*	Orange clownfish
4	*A.ocellaris*	Ocellaris clownfish/false percula clownfish
5	*A.frenatus*	Tomato clownfish
6	*A.perideraion*	Pink skunk clownfish
7	*A.nigripes*	Maldive anemonefish /black finned anemonefish
8	*A.ephippeum*	Red saddle anemonefish/Fire clown
9	*A.akallopsisos*	Skunk clownfish
10	*Premnas biaculeatus*	Spine cheeked anemone fish/ maroon clownfish

SEED PRODUCTION OF CLOWN FISHES

The hatchery protocols for seed production of all clown fishes are more or less similar. The clown fishes are protandrous hermaphrodites. The major components in the seed production are Brood stock development, Pair formation, Egg laying, Larval rearing and Live feed culture.

The broodstock development and pair formation is a major component for successful hatchery operation. The brood stock of the fishes has to be maintained at optimum water quality conditions (Table 2) free from pathogenic organisms in order to condition them for breeding. This is possible by providing a Recirculatory Aquaculture System (RAS) in the hatchery. The basic components include a common sump, biofilter, UV filter, Chiller, Protein skimmer, Blower, water inlet and outlet assembly for the fish tanks and lighting arrangement for the fish tanks.

The clown fishes are monogamous in nature and pair formation is a tricky part of the captive breeding technique. The clown fishes are born as males and according to social conditions prevailing in the clownfish colony they reverse the sex. There will be only one functional pair (male and female) in a colony. All the other members of the colony remain as sub-adults. In a colony, one pair of fish will grow ahead of other fish – the larger of the two will become the female and the other one will be the male. Hence in a clownfish colony, the larger fish will be the female and the next large fish will be the male. Compatible pairs have to be identified by trial and error methods and once the pair formation is complete, they can be introduced into the brood stock holding tank, such that, only one pair is kept in a tank with a host anemone for better results. Age of the fish is the most important factor determining sexual maturity. Sexually matured adult clownfish are usually 9-18 months old. Conditioning the fish is a prerequisite for spawning any fish. Conditioning is a term used to describe the utilization and manipulation of a combination of environmental factors to induce gonadal maturation and spawning. The factors may include light intensity, light duration and possibly wave length, temperature, water current, water quality, nitrogen, phosphate, ammonia, p^H, type of food, tank size and shape, aeration and habitat. All fish do not respond to the same environmental cues which trigger spawning. Under natural conditions, wild clownfish spawn most of the year, but usually not more than one spawn per month. Under optimum conditions and proper feeding, they can be induced to spawn atleast twice a month.

The quality of broodstock diets greatly influence a successful spawning. Hence suitable diets at satiation levels must be fed to the broodstock fish. Boiled and chopped mussel/clam meat and fish roe can be fed *ad libitum* twice a day. Live feeds like *Artemia* nauplii, adult *Artemia* and *Moina micrura* can also be supplemented. If brood stock fish are not properly fed, the results are directly reflected in the number of eggs laid, pigmentation of the eggs, fertilization rate, hatch rate and the quality of hatched larvae. Poor quality eggs develop slowly, hatch late and often result in significant early larval mortalities.

Table.2:Optimum water quality parameters for marine ornamental fish brood stock development

Sl.No	Parameter	Values
1	Temperature	27-28 ºC
2	Salinity	30 – 35 ppt
3	pH	7.5 - 8.5
4	Dissolved Oxygen	> 5ppm
5	Ammonia	0 ppm
6	Nitrite	0 ppm
7	Nitrate	< 25 ppm

The clown fish spawns by attaching the eggs to any substratum available in the tank. Hence, suitable substratum such as tiles or earthen pots can be placed inside the brood stock tanks. The clownfish normally spawn during forenoon. Once spawning commences, females press their body towards the substrate and slowly move in a rowing fashion using their pectoral fins. She moves in a circular path depositing a continuous spiral of eggs from the central outward. The male swims behind the female, releasing sperm over the newly deposited eggs. Spawning occurs during day time and it lasts for about one to one and half hours. Each female lays 300 to 1000 capsule shaped eggs. Generally the egg size ranges between 1.5 to 3mm in length and 0.8 to 1.8mm in width. Each egg is attached to the substratum by a stalk. During the incubation period both the parents carefully look after the eggs by fanning the eggs by their fins and removing the dead and infected eggs by mouth. After spawning the males assume a more dominant role. He intermittently fans the nest with his caudal or pectoral fins. He also cleans the eggs by gently mouthing them without removing them. Dead and fungal infected eggs are routinely removed and eaten. Substrate around the nest is also often cleaned. The male spends an average of 30-60% of its time during the day for tending the nest. Fanning the eggs is frequent on the day after spawning and diminishes considerably about mid way in the incubation period. On the day of hatch, fanning increases again. In captivity most pairs spawn a minimum of 11 months a year, regardless of the species.

The colour of the eggs will be bright orange initially which will change to black and finally to silvery colour with prominent eyes of the embryo on the 7^{th} day. The eggs hatch on the seventh day shortly after sunset at a water temperature range of 27 – 29 ^{0}C . On the expected day of hatching, 2 hours before sunset the eggs along with the substratum are transferred to hatching tanks. The larvae break their capsules and hatchlings emerge soon after sunset and peak hatching takes place between 1900 – 2000 hrs in darkness.

Larval rearing

The newly hatched larvae measures 3-4 mm in length and each has transparent body, large eyes, visible mouth and a small yolk sac. Soon after hatching the larvae are free swimming. The initial nourishment to the developing fish larvae is obtained from the egg yolk. When the yolk reserves have been completely utilized, the larval feeding capabilities are developed and hence at this stage the larval survival is entirely dependent on the availability and quality of food in sufficient quantities. The phase when yolk has just been depleted and the larvae turn to exogenous feeding for further development is the most critical stage. At this stage, suitable live feed should be available in the larval rearing tanks. For this larval rearing has to be carried out in green water (using microalgae such as *Nannochlorposis oculata, N.salina etc*) and feeding with rotifers (*Broachionus plicatilis & B rotundiformis*) initially (upto 8^{th} day after hatching) and then with *Artemia* nauplii from 9^{th} day onwards. A minimum 8-10 nos of rotifers per ml is required during rotifer feeding period and 2-3 nos nauplii per ml during *Artemia* feeding stage. The larvae metamorphose between 15-20 days. After metamorphosis the larvae can be transferred to grow out tanks with sea anemone. Mild aeration can be provided during larval rearing. The larviculture period from 3-8 dph is critical due to the change in feeding from endogenous to exogenous. After 8 dph there will not be any further mortality if proper feeding and water quality parameters are maintained. The tank bottom should be cleaned daily with atleast 25% water exchange. Sufficient green water should be added daily. Weaning with pellet feed can be started after metamorphosis. Start with suitable sized pellets along with the live feeds and slowly wean them to the pellet feed. The ICAR CMFRI has developed a marine ornamental fish feed “ **Cadalmin** ™

Varna" which gives very good colour enhancement for the fishes. Boiled and chopped mussel meat can also be used as feed. Two times feeding at satiation level is sufficient to rear them to marketable size.

DAMSEL FISHES

The damsel fishes which also belong to the Family Pomacentridae are very popular among aquarists due to their small size, bright colours, quick acclimation to captivity and interesting behaviour. The majority of species inhabit the Indo-Pacific region and about 100 species and 18 genera have been recorded from the Indian Ocean. More than 30 species belonging to the genera *Pomacentrus, Neopomacentrus, Chromis, Abudefduf* and *Chrysiptera* are commonly available from Indian coral seas. Broodstock development and larval rearing were achieved in India eight species of damselfishes (Table 3)

Table.3. Damselfishes for which hatchery production have been achieved.

Sl.no	Common name	Scientific name
1	Three spot damsel	*Dascyllus trimaculatus*
2	Striped damsel	*Dascyllus aruanus*
3	Blue damsel	*Pomacentrus caeruleus*
4	Peacock damsel	*P. pavo*
5	Bluegreen damsel	*Chromis viridis*
6	Filamentous tail damsel	*Neopomacentrus cyanomos*
7	Yellowtail damsel	*Neopomacentrus nemurus*
8	Sapphire devil damsel	*Chrysiptera cyanea*

(Gopakumar and Santhosi, 2009; Gopakumar *et al.,* 2009; Gopakumar *et al.,* 2002; Pananghat Vijayagopal *et al*., 2008)

SEED PRODUCTION OF DAMSEL FISHES

The damsel fishes exhibits protogynous hermaphroditism and they are group/harem spawners. One male can fertilise the eggs deposited by more than one female. The eggs are deposited on any hard substratum as in the case of clown fishes. Earthen pots or PVC pipes can be used as substratum for egg deposition in case of damsel fishes. The egg hatches out on 4th day. The egg size and larval size is comparatively smaller than clown fishes due to which the live feed also have to be smaller to suit the mouth size of the larvae. Hence copepod nauplii/copepodite of suitable size range and nutritional value has to be provided for first feeding of the damsel fish larvae. This is the major difference in seed production between clown fishes and damsel fishes. The mass production of suitable copepod species was a major bottleneck in the seed production of damsel fishes till very recently. However, techniques for culture of copepod species with suitable size and nutritional value have been developed by Vizhinjam Research Centre of ICAR CMFRI, which is being adopted for the seed production of damsel fishes. After the initial feeding stage with copepod nauplii or copepodites, rotifers can also be used as live feed along with green water technique. The rest of the larval rearing techniques are similar to that of clown fishes.

LIVE FEED CULTURE

Live feed culture is an integral part of marine ornamental fish seed production technique because the initial feeding of the larvae is purely on live feeds such as rotifers,copepods and artemia nauplii. To culture these zooplankton like rotifer and copepods, micro algae (phytoplankton) is necessary. Hence live feed comprises of micro algae and zooplanktons (such as rotifers, copepods and Artemia nauplii). Micro alage such as *Nannochlorposis occulata, N salina, Isochrysis galbana* etc are commonly cultured for rearing the rotifers or copepods. Rotifer species commonly used in hatcheries include *Brachionus rotundiformis* and *B plicatilis*. Copepods species widely used include *Parvocalanus, Pseudodiaptomus, Oithona, Temora turbinata* etc. Artemia cysts are readily available in the market, which can be hatched in the hatchery as per the requirement and given to the larvae when their mouth size is big enough to capture artemia nauplii.
Detailed description on all the live feed culture techniques are given in separate chapters in this book. The readers are advised to refer these chapters for more information.

Summary

The marine ornamental fish sector all over the world is dominated by fishes/shell fishes/invertebrates caught from the wild and the share of hatchery produced fishes still continues to be at a very minimal level. The ever increasing demand for ornamental fish has necessitated the development of captive breeding techniques of these fishes. The ICAR CMFRI has developed the seed production technologies for around twenty varieties of marine ornamental fishes/shell fishes. Promoting hatchery production of marine ornamental fishes would be the best option to ensure sustainable development of the sector. Eventhough collection from the wild continues to be the major contributor in the trade, it is imperative to shift gradually from the wild collection to captive breeding and seed production of marine ornamental fishes in order to ensure a sustainable development of the sector.

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