Breeding and Rearing of Marine Ornamentals

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Introduction

The marine aquarium trade is a billion dollar business that may sustain continued growth in the coming years. In the past decade, there has been a worldwide increase in the popularity of reef tanks, which has led to an increased demand for marine ornamental organisms (Wood 2001; Green 2003). In contrast to the freshwater ornamental species, most marine organisms being marketed in the aquarium trade are collected from the wild, particularly from coral reef areas. The prevalence of destructive low-cost harvesting techniques, such as the use of cyanide and explosives, has caused dramatic and drastic impacts on the health and biodiversity of the reef ecosystems. Developing hatchery technology for marine ornamental species is therefore urgently needed to guarantee the sustainable supply for the industry while minimising the negative impacts on the natural environment (Lin et al. 2002). In the recent years, researchers, traders, collectors and hobbyists have begun a worldwide effort to minimise the growing pressure on the natural populations of marine ornamental species and to promote the sustainable use of these high-valued resources (Corbin 2001).

Although fishes and corals are still the most heavily traded ornamental marine species for the aquarium, many other organisms are also highly popular among hobbyists. The organisms receive the 'ornamental status' mainly because of their dazzling coloration and delicacy, hardiness in captivity and being 'reef safe' (do not harm other aquarium organisms) (Sprung 2001). Nevertheless, if a species presents mimetic adaptations, displays associative behaviour (particularly symbiotic associations) or performs a specific function on the reef aquarium (eating nuisance organisms), it may also be targeted by the marine ornamental hobbyists.

Presently, a percentage of commercially cultured ornamentals is limited with few fish species, mainly the clowns of the genus *Amphiprion* (Wabnitz et al. 2003; Ajith Kumar and Balasubramanian 2009; Ajith Kumar et al. 2010) and damselfishes (Gopakumar et al. 2002; Subodh Kant Setu and Ajith Kumar 2010).

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Global Status

Marine ornamental aquaculture provides employment opportunities to the rural poor and also is an earner of foreign exchange to many developing countries. It has been estimated that over 1.5 million people are engaged in this industry and over 3.5 million hobbyists constitute the trade (Dey 2010). A total of 1,471 species of fishes are traded worldwide with the best estimate of annual global trade ranging between 20 and 24 million individuals. Damselfish (Pomacentridae) make up almost half of the trade and other species such as angels (Pomacanthidae), surgeons (Acanthuridae), wrasses (Labridae), gobies (Gobiidae) and butterflyfishes (Chaetodontidae) accounting another 25–30 %. The most traded species are blue-green damselfish (*Chromis viridis*), anemonefish (*Amphiprion ocellaris*), whitetail dascyllus (*Dascyllus aruanus*), sapphire devil (*Chrysiptera cyanea*) and three-spot dascyllus (*D. trimaculatus*) (Wabnitz et al. 2003).

The international ornamental fish trade at the retail level is estimated to be more than US$ 8 billion, while the entire industry including aquarium tanks, plants, accessories, feed, medications, etc. is at US$ 20 billion. Up to 2008, more than 125 countries were involved in the ornamental fish trade, of which 15 countries exported fishes, worth more than US$ 5 billion. In Asian countries, Singapore stands first with an estimated share of 39.3 % with total exports, followed by Malaysia. The value of a fish from marine origin in the trade has increased from US$ 9 million in 2003 to reach almost US$ 29 million in 2007. The impact trend during a 10-year period (1999–2008) has shown that the imports rise from US$ 245.6 million in 1999 to US$ 349.4 million in 2008 and exports grow from US$ 167.6 million in 1999 to US$ 343.9 million in 2008 (Dey 2010).

Indian Scenario

Ornamental aquaculture is an excellent business opportunity in India, since there is a strong demand from domestic and export markets. In India, there is a good potential due to enormous geographical distribution and extensive species diversity. Our country is blessed with a wide array of marine ornamental varieties, while our contribution was only 2.5 % (US$ 3.8 million) to the total Asian ornamental fish exports. Compared to other Asian countries, the Indian ornamental fish sector is small, but exciting, with tremendous growth and large-scale gainful employment generation. At present, the ornamental fish export from India is dominated by the wild-caught species, which cater to a small portion of the global market, and we contribute the least (0.9 %) to the global market. In 2007, the marine component of the trade in India reached 48 % and the freshwater component 52 %, and the value of brackishwater fish was trifling (FAO 2009). Currently, India has also started the breeding and rearing of marine ornamental organisms, and the possibilities are more to reach greater heights, as our natural wealth of ornamentals in the Andaman and Lakshadweep islands are very high. Despite having cheap labour, quality water and sufficient manpower, India lacks the appropriate infrastructure, technology and trainings in this sector.

Captive Breeding

In the recent years, there has been an increased focus on supplying aquarium fishes through closed system culturing. Ornamental aquaculture can be an environmentally friendly way to increase the supply of such organisms, by helping to reduce the pressure on wild fish populations and producing a wide variety of species throughout the year. Furthermore, rearing aquarium fish in captivity is likely to lead the production of hardier species, which fare better in captivity and survive longer (Olivier 2003; Ogawa and Brown 2001).

To date, India has proved successful breeding only in a few species. It is hoped that much of the market demand for the more popular ornamentals such as clown, damsel and angelfish may eventually be satisfied by cultured fish, once culture technologies have been established successfully. Closing life cycles in captivity and suitable live feeds are the challenges for most of the marine species.

Hatchery Technology in Hand

Taking the facts discussed above and also in view of the growing demand on marine aquarium organisms, an attempt was made to establish the Marine Ornamental Fish Hatchery at the Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai and Agatti Island, Lakshadweep, with the financial support of the Govt. of India to develop a hatchery production technology for marine ornamental fishes and transfer the technology to the coastal and island communities of the country for their sustainable development, and this task would help in conserving the marine biodiversity. In India, the Central Marine Fisheries Research Institute is the pioneer concentrating on the ornamental aquaculture from the last two decades and succeeded with its technologies.

In recent years, many worldwide fisheries organisations are showing keen interest in breeding and rearing of marine ornamental fishes. In this context, Indian fishery organisations have successfully developed broodstocks for 13 species of clowns such as *Amphiprion ocellaris*, *A. percula*, *A. sebae*, *A. clarkii*, *A. nigripes*, *A. frenatus*, *A. akallopisos*, *A. sandaracinos*, *A. perideraion*, *A. polymnus*, *A. ephippium*, *A. thiellei* and *Premnas biaculeatus*, and the hatchery technology has been developed for ten species (Fig. 1). Annamalai University has succeeded with this, using estuarine water, a milestone work done in the aquaculture history of the country. This is an excellent effort in the ornamental aquaculture in general and clownfishes in particular, since these fishes belong to coral reefs. The university has also developed broodstock for ten different species of damselfishes, *viz. Pomacentrus caeruleus*, *P. pavo*, *Neopomacentrus cyanomos*, *Dascyllus trimaculatus*, *D. aruanus*, *D. carneus*, *D. reticulatus*, *Chromis viridis*, *Chrysiptera cyanea* and *Neoglyphidodon oxyodon*, and experimental successes in hatchery production were obtained for four species (Fig. 1).

The development of artificial culture methodologies for marine ornamental crustaceans has been focused on a limited number of shrimp species. Among them, the tropical species of the genera *Lysmata*, *Periclimenes*, *Hymenocera* and *Stenopus* have received special attention, mainly due to their growing demand in the aquarium trade (Lin et al. 2001). Recently, in India, initiatives have been taken in rearing certain species of these marine ornamental shrimps such as *Stenopus hispidus*, *Rhynchocinetes durbanensis*, *Hymenocera picta, Lysmata debelius* and *L. amboinensis* (Fig. 2) successful captive spawning was achieved, and larval rearing practices are under progress.

The cardinal fishes and dottyback (Fig. 3), which are extremely attractive in appearance, are very hardy in captivity. The cardinals exhibit an unusual mode of reproduction in that the males incubate their female partner's eggs in their mouth (Tullock 1999). They make outstanding tank companions with all fishes, coral and other marine ornamentals; hence, they become very popular in the marine ornamental trade (Michael 1996). Because of the remarkable rise in the popularity of this species, various stakeholders in the aquarium industry are keen in producing them in captivity.

Live Feeds

Phytoplankton: Microalgae

Microalgae are the floating microscopic plants which constitute the base of the food chain in an aquatic ecosystem. They are being used to produce mass quantity of rotifers and brine shrimps which serve as food for fish larval stages. The mostly used marine microalgal species *Nannochloropsis salina, Chlorella marina* and *Isochrysis galbana* were stocked using Conway - Walnes, F/2 medium and agricultural fertilisers for mass culture. The 'green water technique' is used for rearing fish

Fig. 1 Hatchery-bred clowns and damsels

Fig. 2 Broodstock developed for marine ornamental shrimps

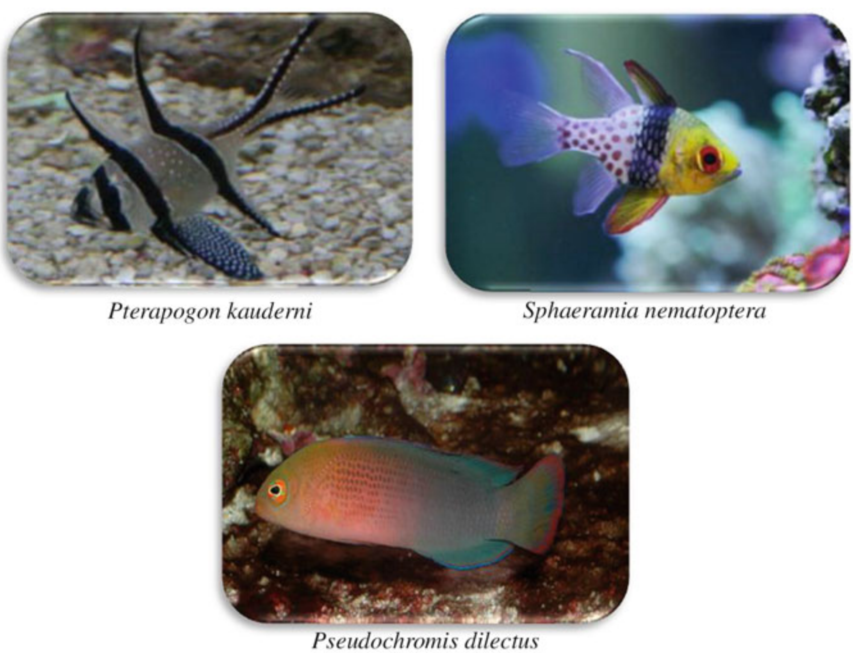

Fig. 3 Broodstock developed for other marine ornamental fishes [*Cardinals & Dotty backs*]

larvae; microalgae are directly pumped into the larval rearing tanks, where they serve as water conditioner by stabilising the water quality, nutrition of the larvae and microbial content.

Zooplankton: Rotifer

They form an excellent feed for fish larvae due to their size, active movement, ability to be cultured in high densities and high reproductive ratio. The mostly used rotifers (*Brachionus rotundiformis* and *B. plicatilis*) were stocked and mass cultured using algal mass culture, and within 5–7 days, the culture contained a maximum concentration of 50–60 nos/ml.

Artemia

Artemia cysts were purchased commercially and allowed to hatch in a cylindrical tank with transparent bottom. Vigorous aeration and an artificial light for 24 h were essential for good hatching rate, and it will be hatched out after 18–24 h.

First Feeding of Larvae

The initial nourishment to the developing larvae will be obtained from the yolk. When the yolk reserves have been completely utilised, the larval feeding capabilities are developed, and supplement food in sufficient quantities is needed. However, they have limited yolk reserves and have to resort to exogenous feeding even though they have small mouths and primitive digestive system.

Lab to Land

The hatchery technology developed by the Annamalai University and CMFRI has been transferred besides training imparted to the coastal people of the country which is considered as a significant step towards the conservation of marine biodiversity and yet another way to enhance the marine products export through hatchery-bred fishes. During the training period, various aspects such as fish handling, feeding, water quality, larval rearing, live feed culture, disease diagnosis, packing, transportation, marketing and establishment of backyard hatchery were taught. These institutes have developed different packages to suit varied interests and also published different handbooks on the breeding and rearing of clowns and damsels. In addition, the researchers are concentrating on value addition to the hatchery-bred organisms such as colour and growth enhancement, stress tolerance and disease resistance, etc.

Conclusion

In recent years, marine aquarium keeping has become a popular activity worldwide, with reef tanks being widely considered as the most challenging and spectacular display. This highly profitable industry relies almost exclusively on the wild organisms, mainly caught in the reef areas, causing destruction of the coral reefs. This current state of crisis on the coral reefs has put the marine aquarium industry 'in the line of fire'. The devastating and long-lasting effects of dynamite fishing, water quality degradation because of anthropogenic pollution and global warming are the threats that are certainly more relevant. Nevertheless, there is a current effort to advocate and enforce sustainable collection and trade of the marine ornamental species. In an attempt to minimise the industry's dependence on wild collections, research institutes and private entrepreneurs have started to address the culture of marine ornamental species. However, the lack of basic scientific knowledge on many of the targeted species by culture efforts has caused serious bottlenecks that impair commercial culture of the most highly demanded species. Despite such difficulties, the strong belief of some researchers and traders is that the captive culture is more potentially profitable commercial venture and there is a need for the sustainable development of this industry.

However, further research studies are still needed to allow the regular supply of a broader number of cultured marine ornamentals for the marine aquarium trade. The major goal of the marine ornamental aquaculture is not only to promote the coral reef conservation but to develop a sustainable alternative to all those involved in the collection and supply of these remarkable organisms to the aquarium trade.

References

Ajith Kumar TT, Balasubramanian T (2009) Broodstock development, spawning and larval rearing of the false clown fish, *Amphiprion ocellaris* in captivity using estuarine water. Curr Sci 97(10):1483–1486

Ajith Kumar TT, Sethu SK, Murugesan P, Balasubramanian T (2010) Studies on captive breeding and larval rearing of clownfish *Amphiprion sebae* (Bleeker, 1835) using estuarine water. Indian J Mar Sci 39(1):114–119

Corbin JS (2001) Marine Ornamentals'99, conference highlights and priority recommendations. In: Burgess P (ed) Marine ornamental conference, Kluwer Academic Publishers, Netherlands, Hawaii. Aqua Sci Conserv 3:3–11

Dey VK (2010) Ornamental fish trade – recent trends in Asia. In: Souvenir, ornamentals Kerala 2010. Department of Fisheries, Government of Kerala. pp 39–45

FAO (2009) Fish Stat Plus. Universal software for fishery statistical time series. Version 2.3. www.fao.org

Gopakumar G, Sreeraj G, Ajith Kumar TT, Sukumaran TN, Raju B, Unnikrishnan C, Hillary P, Benziger VP (2002) Breeding and larval rearing of three species of damsel fishes (Family: Pomacentridae). Mar Fish Inform Serv T & E Ser 171:3–5

Green E (2003) International trade in marine aquarium species: using the global marine aquarium database. In: Cato JC, Brown CL (eds) Marine ornamental species: collection, culture and conservation. Iowa State Press, Ames, pp 31–47

Lin J, Zhang D, Creswell R (2001) Aquaculture of marine ornamental shrimps: an overview. Aquaculture 2001 book of abstracts. World Aquaculture Society, Orlando, p 378

Lin J, Zhang D, Rhyne A (2002) Broodstock and larval nutrition of marine ornamental shrimp. In: Cruz-Suárez LE, Ricque-Marie D, Tapia-Salazar M, Gaxiola-Cortés MG, Simoes N (eds) Avances en Nutrición Acuícola VI. Memorias del VI Simposium Internacional de Nutrición Acuícola. 3 al 6 de Septiembre del 2002. Cancún, Quintana Roo, México, pp 589

Michael S (1996) The Banggai Cardinalfish: a newly available species that may become too popular for its own good. Aquar Fish Mag 8(8):86–87

Ogawa T, Brown C (2001) Ornamental fish aquaculture and collection in Hawaii. Aquar Sci Conserv 3 (1–3):151–169

Olivier K (2003) World trade in ornamental species. In: Cato J, Brown C (eds) Marine ornamental species: collection, culture and conservation. Iowa State Press, Ames, pp 49–63

Setu SK, Ajith Kumar TT (2010) Spawning behaviour and Embryonic development of Regal damsel fish, *Neopomacentrus cyanomus* (Bleeker, 1856). World J Fish Mar Sci 2(5):410–415

Sprung J (2001) Oceanographic series invertebrates:, a quick reference guide. Ricordea Publishing, Miami, 240 pp

Tullock J (1999) Banggai cardinalfish alert. Aquar Front. http://www.aquariumfrontiers.net/EnvironmentalAquarist/html

Wabnitz C, Taylor M, Green E, Razak T (2003) From ocean to aquarium. UNEP-WCMC, Cambridge, p 64

Wood EM (2001) Collection of coral reef fish for aquaria: global trade, conservation issues and management strategies. Marine Conservation Society, UK, 80 pp