Stability of Marine Ornamental Fishes in Captivity:  
A Case Study in Marine Research Aquarium of Annamalai University

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Abstract: There is an urgent need to develop marine aquaria in all possible areas to conduct research on marine ornamental fishes, especially to develop breeding technologies, mass production and create greater awareness about marine ornamental fishes and their impact on coastal area development. With these ideas in mind, the present case study was conducted in the marine aquarium of Annamalai University, Tamilnadu, India with special emphasis on Stability of marine ornamental fishes in captivity. The procedures and findings are discussed hereunder.

Key words: Marine aquarium, Ornamental fishes, Stability, Captivity

INTRODUCTION

The soothing effect of aquaria is of immense importance to relieve pressures of today’s urban life. The ornamental fish keeping is a popular hobby which is gradually replacing outdoor leisure activities and it is the second most hobby after photography [1]. The number of public aquaria displaying coral reef organisms is on the rise and the size of display tank is also steadily increasing [2]. World wide, approximately 1.5 to 2 billion people keep marine aquaria, with 6, 00,000 households in the United States alone [3,4].

Marine aquarium keeping is almost exclusively tropical in nature and is broadly divided into two major sectors based on the groups (i.e.) fish and invertebrates. Marine ornamental fishes are collected from the dynamic coral ecosystem. The fantastic shapes, brilliant colours and fascinating patterns of marine ornamental fishes have won the hearts of millions of people and hence they are aptly called “living jewels” [5]. Among freshwater ornamental fishes, around 90% are farmed and reproduced while 10% are collected from the wild, but in the case of marine ornamental fish, about 95% is collected from the wild [1].

An aquarium is an artificial tank, used for keeping aquatic organisms, plants and decorative materials for beautification. Most aquaria such as single species aquaria house numerous types of aquarium fishes but there are some species that actually grow best when either kept alone or housed with members of its own species. In the community aquaria, fish species having same requirements and size are stocked regardless of their geographical distribution. Fish has been kept in variety of receptacles including bowels, glass tanks etc. According to psychiatrists, placing aquaria with ornamental fishes in the patient’s vicinity could treat certain type of mental disorders [6].

The marine ornamental fish trade has a significant role in the economy of developed and developing countries both as a foreign exchange earner and as a source of employment. The world ornamental fish trade is about 4.5 billion US $ while India’s contribution through export is only about 0.5 million US $. The United States of America alone imports ornamental fishes worth more than 500 million US $. In Holland, 20% of the houses maintain ornamental fishes, 14 % in UK, 8 % in USA, 5 % in Germany and 4 % in Belgium and Italy [7]. Asia is the major exporting region accounting for 56% of the global exports. India has joined the lead 10 Asian exporting countries recently, contributing only 2% of the Asian export [8].

There is an urgent need to develop marine aquaria in all possible areas to conduct research on marine ornamental fishes, especially to develop breeding technologies, mass production of marine ornamental fishes and create greater awareness about marine ornamental fishes and their impact on coastal area development. With these ideas in mind, Annamalai University started the department of Marine Biology during the year 1957.

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MATERIALS AND METHODS

Considering the popularity gained from the general public, the Marine Research Aquarium built at Annamalai University, Annamalai Nagar during August, 2004 and inaugurated by the President of India Dr. A.P.J. Abdul Kalam in connection with the Platinum Jubilee function of the University.

The fascinating world of aquarium displays beautiful fishes of Indian ocean and Arabian sea which are arranged in 28 large tanks. The water for the aquarium was taken from the Vellar estuary (Lat.11°29'N; Long 79° 46' E), South East coast of India and UV filtered water was transported to the aquarium.

The total volume of water in all display tanks and the recycling system is 98,600 l. The entire aquarium building has a centralized air conditioning facility to maintain the constant water temperature of 26°C. It is one of the leading marine aquariums in South Asia.

This aquarium houses 24 numbers of rectangular concrete tanks with the size of 8 x 4 x 3'; 2 numbers with 8 x 4 x 2.5' size and 2 numbers with 8 x 4 x 2' size which are covered with ceramic tiles with front glass for viewing. Each size of tank has the capacity to hold about 2000, 1700 and 1100 l of seawater respectively. The front side is provided with 19mm thick toughened glass bent inward by 6 inch. The aquarium has a reservoir of 30,000 l capacity for storage and recycling purpose. The water from the reservoir is pumped to the overhead tank of 5000 l capacity for distribution to all the display tanks.

The water from the overhead tank is then allowed to pass through a 5 μ cartridge filter and UV filter before it reaches the display tanks. The used water from the display tanks is collected in a sedimentation tank of 5000 l capacity through gravitational flow. The water from the sedimentation tank is then pumped to the three chambered filtration systems of 5000 l capacity. Each size of tank has the capacity to hold amount of seawater which is filtered by the three filter chambers. The third one, a biological filter chamber, which is filled with bioballs of 1.25 inch diameter for the effective growth of beneficial and denitrifying bacteria. After passing through all these three filter chambers, the purified water reaches the reservoir for recirculation.

Canister filter (Eheim) is installed in each display tank with a pumping capacity of 3400 l/hr. Each canister filter is loaded with coarse fiber particle filter pad, activated carbon, bioballs and ceramic rings. In addition, all the tanks are provided with an under gravel filter bed made by acrylic sheets with two numbers of lift pump with 3400 l/hr capacity in two corners of the tanks for pumping the water from the bottom of the bed. Dead shells are also used as bed materials.

In order to have continuous movement of water in the surface of the tank to keep the DO level constant, the lift pumps and canister filters are kept on operation for 24 hrs except one hour in the morning and one hour in the late evening for feeding and tank cleaning purposes.

Six numbers of 54 watts aquarium fluorescent lightings are installed in each tank over the inner side of the tank lid. The duration of the photoperiod is 12 hrs. Biological aquarium supplement containing beneficial and denitrifying bacteria was added in the water periodically, depending up on the water condition of the tank to enrich the population of bacteria for keeping the nitrogen load of the water at constant minimum level.

Observation of Water Quality Parameters: The dissolved oxygen content of the water was regulated at 5.8 to 6.9 mg/l with the help of power heads and canister filter through water circulation. The salinity and pH were checked before loading into the sintex tanks and transported to the aquarium through lorries. The water was stored into the underground storage tank of the aquarium. The salinity, temperature and pH were maintained in the display tanks at 23-28 ‰, 26°C and 7.5-8.2 respectively.

Fishes were procured from wild caught in Mandapam (Tamilnado) and Vizhinjam (Kerala) through ornamental fish traders. The time taken for transportation of fishes from Mandapam to Chidambaram was around 11 ± 1 hrs and from Vizhinjam it was around 15 ± 1 hrs. Taking into account the health of the animals and survival during transportation, the fishes were placed in polythene bags, filled with sufficient air. After reaching the aquarium, the fishes were quarantined. The fishes retained their actual health condition and it allowed the fishes to become habituated and it also helped to reduce the stress associated with captivity. Then the fishes were transferred to the display tanks of interest.

The Marine Research Aquarium consists of community tanks and single species tanks. Community tanks are designed to accommodate more than one species. Generally they include a variety of species that do not normally occur together in nature. Using their different colours and behaviours one can add interest and entertainment value. Single species aquaria are containing only one species of fish.
New arrivals of the fishes were entered in the “Stock register” before accommodating into the display tanks, which give the details of the whole fish movements into and out of the aquarium. This overall accounting system made it possible to monitor the number of fish arrivals and departures. The data were collected as individual fishes of the family and the duration of the study was from Jan. 2005 to Dec. 2007. This data provide a specific success rate expressed in terms of the number of fishes present at the end of three year as a proportion of the total number of arrivals during this period (Table 1).

The Categorized Results Are Given Below:

- The fish families offering “easy management” (success rate greater than 50%)
- The fish families “difficult to manage” (success rate between 26 to 50%)
- The fish families with “complex management” (success rate between 0 to 25%)

The feed management is the crucial factor in the aquarium which plays a key role in maintaining the water quality. The fishes were fed once a day with various feeds such as trash fish, shrimp and bivalve meat. The excess or uneaten feed was removed daily from the tanks to avoid water spoilage.

**RESULTS**

During the study period, a total of 2,278 fishes belonging to 20 families were received. Among them, the best represented families were Pomacentridae (35.34 %), followed by Labridae (14.44 %), Chaetodontidae (11.50 %), Ostraciidae (7.68 %), Acanthuridae (4.04 %), Haemulidae (3.95 %), Scorpionidae (3.29 %), Lutjanidae (2.55 %), Balistidae (2.20 %), Carangidae (2.15 %), Siganidae (2.02 %), Pseudochromidae (1.84 %), Pomacanthidae (1.36 %), Tetraodontidae (1.36 %), Muraenidae (1.27 %), Serranidae (1.23 %), Ephippidae (1.14 %), Holocentridae (1.05 %), Scaridae (0.83 %) and Gobiidae (0.75 %) in the order of their abundance. The least represented family was Gobiidae (17 numbers only) (Table 2).

Of this total 2278 fishes, around 1246 fishes were departed from the aquarium during the study period as dead ones (615 fishes, 438 fishes and 193 fishes during the year 2005, 2006 and 2007 respectively). Among them, Pomacentridae (26.48 %), Labridae (15.97 %), Chaetodontidae (14.29 %), Ostraciidae (11.40 %), Haemulidae (5.06 %), Acanthuridae, (4.09 %), Scorpionidae (3.21 %), Lutjanidae (2.41 %), Pseudochromidae (2.25 %, Tetraodontidae (2.01 %), Balistidae (1.93 %), Siganidae (1.93 %), Carangidae (1.69 %), Pomacanthidae (1.44 %), Holocentridae (1.28 %), Muraenidae (1.12 %), Serranidae (1.04 %), Ephippidae (1.04 %), Gobiidae (0.72 %) and Scaridae (0.64 %) constituted. The contribution of each family is given in parenthesis.

A total of 949 fishes were received during the first year and the highest ‘departure’ of fishes was also recorded during the same period. The total stock size showed an upward trend, increasing from 340 fishes at the beginning of 2005 to 1372 fishes at the end of 2007.
A keen observation of “success rate” of each family stocked in the aquarium tanks showed that only 6 families were considered as “easy” to maintain. They are Pomacentridae (59 %), Scaridae (57.89 %), Carangidae (57.14 %), Serranidae (53.57 %), Balistidae (52 %) and Muraenidae (51.72 %). 12 families were “difficult” to maintain, particularly Ephippididae (50 %), Lutjanidae (48.28 %), Siganidae (47.83 %), Gobiidae (47.06 %), Scorpionidae (46.67 %), Acanthuridae (44.57 %), Pomacanthidae (41.94 %), Labridae (39.51 %), Holocentridae (33.30 %), Pseudochromidae (33.30 %), Chaetodontidae (32.06 %) and Haemulidae (30 %). Only two families namely Tetraodontidae (19.35 %) and Ostraciidae (18.86 %) were found to be “complex” to maintain.

As per the above data, the arrival and departure of ornamental fishes in marine research aquarium was positively corelated ($r = 0.963627$ $P < 0.01$, the correlation coefficient is significant at 1% level of significance) and the relation between departure and arrival of the fishes were shown in the regression graph ($R^2 = 0.928577$, departure = 0.4457 arrival + 11.53) (Fig. 2).

**DISCUSSION**

Successful marine aquarium keeping is now possible mainly due to the recent scientific advancement made on various aspects like biological filtration and also the advent of an array of aquarium gadgets. It is well known that the maintenance of marine aquarium require different
types of managements and equipments than those of fresh water aquarium. In the case of a marine aquarium, for example, Protein skimmer, Ozonizer and Denitrifier are necessary for conditioning the water quality.

Many factors need to be taken into consideration for running a successful aquarium, which include the gentle capture and safe transportation of fishes, quality diet, careful introduction of fish, monitoring health condition, change in technical/environmental factors etc.

Problems Encountered: Throughout the three year of study period, we could find out the main challenges in aquarium maintenance. During the study period, the common diseases found were ‘Exophthalmus’ or ‘Pop eye’ condition, faded pigmentation, tail and fin rot and physical injuries during handling and fighting between the fishes. The treatments given were fresh water dipping for 3 minutes with strong aeration and antibiotic treatment (Tetracycline and Chloromphenicol). These experiences have lead us to make a better success rate of late.

Among the marine ornamental fishes accommodated in the aquarium, 20 selected common families were considered for the study. A brief description about each family is also given here. Among the families, Pomacentridae is the best suited family for the aquarium life. The fishes which we found easy were Amphiprion sebae, Pomacentrus caeruleus, Dascyllus trimaculatus, Chromis viridis, Neopomacentrus nemurus, Abdufduf saxatilis etc. Pomacentrus caeruleus was also easy to handle and suitable to aquarium, but it was noticed that it loosens its colour in captivity and it may due to the absence of live feeds. The clown fish Amphiprion sebae was also suitable for the captive life and they are known for symbiotic associations with sea anemones [9-12].

The Chaetodontidae family has a group of fantastic butterfly fishes and banner fishes. Butterfly fishes are small, swift and surprisingly well patterned and bright coloured. Chaetodon auriga, Chaetodon collare, Chaetodon decussatus, Chaetodon octofasciatus, Chaetodon vagabundus, Chaetodon xanthocephalus and the banner fish, Heniochus acuminatus are the important fishes of the family. These fishes are very attractive in the aquarium but they faced a lot of threats in survival due to their feeding habit and easy infection by several diseases.

During the study period, the highest departure of fishes were recorded in first year (2005) due to diseases and poor expertise, while the departure rate decreased in the following years through due care and keen observation on fishes. Lipton, [13] reported that detection

of the health of fishes in field condition is by visual examination. It is one of the quickest, least and requires a well trained eye. Regarding complex families, they aren’t caught because of difficulties encountered in their management. This is the case with the families
Tetraodontidae and Ostraciidae, which were kept only for a limited period at the aquarium. Coming to the other families, considerable effect is needed for capturing and management to improve our results.

To reduce the mortality rate we preferred to stock juveniles, which are found to adapt better in captivity than adults as reported by Dufour [14] and Durville et al. [15]. This is very much true in the case of families Pomacentridae, Scaridae, Carangidae, Serranidae, Balistidae, Muranidae, Ephipididae and Lutjanidae. The increasing demand of juvenile fishes has resulted in over exploitation of their wild stock and consequent destruction of reef areas [16]. In addition, it is also easier to catch sub adult fishes and so they experience less stress than do captured adults, which increases success rates [2]. According to Wabnitz et al., [17] this kind of capture, which affects only new recruits, also has less impact on coral reef fish populations already present on the reef.

**CONCLUSION**

Based on the present observation, the most stabilized family under aquarium condition was identified and the fish management practices were studied. The case study of fish movements at the Annamalai University Aquarium shows 54.7 % departures as compared with the total number of arrivals over a three year period. The first year showed high mortality rate, when compared to the following years. Stress, diseases, territoriality and technical mishaps are the factors that limit the life span of fishes in captivity. The marine ornamental fish trade is sustained almost entirely by fishes collected from the coral reef habitats. The indiscriminate exploitation of coral reef areas for the collection of ornamental fishes can cause damage to the delicate coral reef ecosystem. So there is an urgent need to practice resource conservation through the development of reef-friendly aquaculture technologies as an alternative to wild collection practices and to restore degraded wild populations. The ultimate solution is the captive breeding and rearing of marine ornamental fishes and it can open up a new avenue which can lead to the supply of marine ornamental fishes from hatchery. At present there have been only a few developments in the breeding and rearing of marine fishes but it is gained momentum in aquaculturally developed countries and improved technologies are emerging in this direction. What is needed to proceed further depends on dedicated and continued research for which financial support must come in a big way from sponsoring national and international agencies. Further, these must be a ‘free hand’ for the researchers or research institutions to make use of the marine resources for rearing and reproducing purposes.

**ACKNOWLEDGEMENT**

The authors are thankful to the authorities of Annamalai University for the facilities and the Centre for Marine Living Resources and Ecology, Ministry of Earth Sciences, Kochi, for financial assistance.

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