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Ornamental fish breeding and management and keeping aquariums is a hobby in many industrialized countries now due to its high affordability. It has also become a standard consumer product.

This commercial activity generates very high revenue even though the trading volumes are low. This sector earns good income for the rural communities in the developing countries. The organisms associated with coral reefs play a dynamic role in nourishing the ecological balance of the marine ecosystem, besides increasing the value of aquarium trade and providing livelihood to the coastal and island communities. Marine ornamental aquaculture and aquarium keeping is a flourishing industry in both developed and developing countries. The organisms include fishes and invertebrates (Fig 1 to 6), which are collected from the coral reef habitats throughout the Indo-Pacific, as well as the Red Sea and Caribbean regions. Fishes, corals including invertebrates and live-rock contribute to the bulk of the trade in terms of quantity and value. The demand for marine invertebrates such as soft corals, sea anemones, shrimps, crabs and sea lilies are increasing, as a result of the growing interest in keeping home aquaria and technological developments.

The marine ornamentals trade is worth of US\$ 693 million (including import and export) and its value is globally increasing with an average growth rate of 14% per year comprising wholesale and retail business. The tropical coral reef ecosystem spurs the aquarium trade by contributing 46,000,000 organisms representing 25,000 species with an annual trade value of US\$ 300,000,000.

However, very accurate ornamental fish industry data is difficult to obtain, as statistics vary between countries in terms of data collected, format and reliability. To justify this, the Food and Agriculture Organization (FAO) of the United Nations data indicate that, exports were worth approximately USD 330 million in 2011 with approximately 1.5 billion fish per annum, although according to INFOFISH, the figure was USD 364.9 million in 2011. FAO data also reveals, the volume of live fish export increased in value from USD 21.5 million in 1976 to USD 315 million in 2007, so it is evident that, the sector is growing.

More than two million people in the world are involved in the ornamental trade as collectors to hobbyists including government agencies, airlines, other associations etc. In general, the trade is dominated by freshwater species; however, the increasing popularity of reef aquaria has become a leading trend, since the late 1980s. Current global trade of the marine ornamental organisms from wild collections reveals ecologically unsustainable practices that require immediate policy interventions. It is estimated that, around 90% of the freshwater fishes are captive raised and remaining 10% are wild caught. However, in marine ornamentals, about 95% are harvested from natural waters, while only 5% are hatchery produced and most belongs to Pomacentridae family. The mortality of tropical organisms prior to reaching the aquarium market (25-80%) are associated to a range of factors, including poor or even destructive collection and husbandry practices, stress and poor shipping add to loss to marine ecosystems. It is difficult to estimate the long-term effects of this wild exploitation from the vulnerable and fragile reef ecosystem, which already faces the serious challenge of climate change, ocean acidification and coral bleaching.

## ICAR - NBFGR INITIATIVES ON CONSERVATION AND LIVELIHOOD PROMOTION

As a measure towards marine biodiversity conservation and promoting livelihood to the coastal and island community of the country, ICAR - National Bureau of Fish Genetic Resources (NBFGR), Lucknow has been taken initiatives and designed concepts to validate a replicable working model for harmonizing biodiversity conservation and promotion of livelihood in Lakshadweep islands. Since, the marine ornamental aquaculture is an impetus to generate employment, livelihood and earning of high foreign exchange; this will be an option to them. Culture of marine ornamental fishes, dissemination of the relevant technologies through trainings, demonstrations and hands on learning will encourage the island community to enter this venture. Running a successful ornamental business unit calls for relatively easier skills, which can be learned within few weeks time. When there is a major shift in technology and associated process or policy matters, periodic hands-on learning will improve their professional competency. A well managed rearing unit can produce quality fishes and shrimps, which fetch higher market prices and India can cater to the burgeoning global demand for marine ornamental fishes.

ICAR-NBFGR has established a Germplasm resource center for marine ornamental invertebrates is established in Agatti island, Lakshadweep, which is a new approach in the country. The exploratory surveys conducted in different pristine reef islands revealed hidden diversity with discovery of three shrimp species, which is new to Science; *Periclimenella agattii*, *Urocaridella arabianensis* and *Actinimenes koyas* and new distributional & associational records, *Thor hainanensis*, *Lysmata hochi* and *Argeiopsis inhaeae* with *Stenopus hispidus*. Besides, over 3,000 individuals of 17 species of ornamental shrimps were collected from the wild and captive raised. These fascinating ornamental shrimps exhibit myriad colors, semiotic association with other groups, behaviors and body forms, which make them attractive to the hobbyists, suggesting potential avenues for promoting marine ornamental trade in India, besides supporting the livelihood of the island communities.

The rearing technology on marine ornamental shrimps is being transferred to the islanders and two community aquaculture centers for ornamental shrimp rearing is under operational at Agatti island.

The functional target is to conserve the wild collected parents in captivity and utilize F2 generation, to help in generating supplementary income for the islanders. Mostly, such coastal communities are close to the fragile reef systems, have limited livelihood options and skills and more prone to adverse impacts of changing climates. The diversified livelihood options and supplementary income can help such communities to remain resilient and at the same time sensitive to protecting the ecosystems.

The technological interventions and innovations, validated through capacity building involving native communities will help building value chain, which will implement sharing the benefits directly through enhancing their family incomes and other social tangible benefits such as empowering woman, family health and nutrition. The interventions of mainstreaming available biological resources, with the available enabling policy will lead to scaled-up production, procedural tools for certification and traceability of the produce, as a part of the framework to protect interests of the native communities. The functional models of mainstreaming biodiversity and the lessons learnt can be shared to establish such programs with an aim of enhancing livelihood options for island and coastal communities, not only in other parts of India but, other interested nations also.

Germplasm conservation is a potential way for the documentation of marine ornamentals in coral reef region. Breeding and rearing of marine ornamentals are an only way to protect the destruction of marine bio-resources and maintain the ecological balance. Furthermore, hatchery production, adaptation and supply of marine ornamentals by the coastal and island community will be created more employment opportunities in this region and it will raise the hope of the people and their living standard. The small-scale community aquaculture centers require only a marginal investment, diminutive working area, limited water volume and very minimal manpower.

The rapid increase and great demand for fish and invertebrates of marine origin within the pet and hobby trade poses the threat of increased harvesting on natural resources. Especially, recent development of marine aquarium keeping has resulted, over exploitation of natural stock and consequent destruction of reef area. There is a report point out that, around 3002 marine ornamental species (2278 fishes and 724 invertebrates) are imported into the US between the years 2008 -2011. However, no clear details about the species are available in the trade due to the unorganized, multifaceted and fragmented supply chain. The sustainability of this growing industry has been questioned because of controversies associated with its heavy reliance on wild collections.

Conservation of biodiversity in coastal system depends on the successful resolution of developmental challenges. In general, the coastal and island communities are committed to fishing practices to generate their income for a large number of dependants in each family. Subsequently, the fishing community find themselves in a downward spiral of resource degradation and increasing poverty as overfishing happens. So, the communities lying in the coastal and island belts are exploiting the habitats of reefs for the aquarium industry as their livelihood.

India is rich in marine biodiversity and ornamental resources, which are abundant in the Gulf of Mannar and Palk Bay in Tamil Nadu, Gulf of Kutch in Gujarat, Malvan coast, in between Maharashtra and Goa, Kerala coast, in between Kovalam to Kanyakumari, and Andaman and Nicobar and Lakshadweep islands. Our waters contain 400 species of ornamental fishes belonging to 175 genera and 50 families. However, only around 100 species are found in the trade. The exploitation and trade of ornamentals caught in the wild are contributing to the economy of dependent community. Hence, it has been considered as a major conservation challenge in the biodiversity rich regions of the country.

About 500 species of invertebrates, other than coral are popular and roughly ten million of them are traded each year.

These include mollusks (gastropods, bivalves and cephalopods), echinoderms (starfish, urchins), actinarians (sea anemones), crustaceans (shrimp, crabs and lobsters) and polychaeta (feather dusters and Christmas tree worms). Of this group, cleaner shrimp of the genus *Lysmata*, boxing shrimp of the genus *Stenopus* and sea anemones of the genus *Heteractis* compose the high value non-coral invertebrates. Still there is no continuous breeding technology for this highly traded group. Continuous exploitation of these resources from reef region should be restricted and captive propagated organisms have to be introduced in the trade.

Ornamental aquaculture is usually conducted in a closed production system at a much smaller scale. Breeding of marine ornamentals not only provide an alternative supply for the market, but also provide new information on the reproductive biology and life history of the species. Marine ornamental aquaculture can be an environmental friendly way to increase the supply and helping to reduce the pressure on wild populations. Recent advances in hatchery production technology, including improvements in food for different life cycle stages will enable more species to be cultured in the controlled conditions. However, to date, successful rearing has been scientifically reported for only few species.

Since, the coastal and island community are weak in financial systems and depend on seasonal jobs and become dwellers of coral and mangrove ecosystems, there is an urgent need to develop a long-term management strategy for regular employment and routine income generation. Additionally, there is a need to conserve the marine living resources. Inadequate alternate livelihood opportunity and insufficient entrepreneurship capacity are the causes of development stagnation of the coastal and island people.

Captive propagation of some of the most collected and traded species would contribute to relieving the current pressure on coral reefs and also for ex-situ conservation of the selected species. This is important to avoid over harvesting of species that potentially disturb the ecosystem due to unauthorized anthropogenic activities. Marine aquarium trade is an excellent opportunity for community-based, conservation-focused aquaculture initiatives in the coastal and island regions. Reducing the exploitation of vulnerable marine ornamental species, aquaculture could relieve much of the conservation concern over their status in the wild. Thus, the way forward can be bio-based interventions and capacity building to the coastal and island people about community based, cluster mode ornamentals culture.

India, is a peninsular country with vast marine aquatic resources and conducive for marine ornamental aquaculture. In this milieu, the ICAR-NBFGR's integrated sustainability program on marine ornamental germplasm resource centre in Lakshadweep focusses on livelihood promotion, climate resilience and conservation of marine biodiversity.

#### SUGGESTED READINGS

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#### FIGURE LEGEND

Fig. 1. *Periclimenella agattii*

Fig. 2. *Urocaridella arabianensis* marine ornamental shrimps, discovered from Lakshadweep

Fig. 3. *Thor hainanensis*

Fig. 4. *Argeiopsis inhacae*, an ectoparasite with *Stenopus hispidus*, new distributional and associational records from Indian waters

Fig. 5. Captive propagated *Thor hainanensis*

Fig. 6. *Ancylocaris brevicarpalis*



