Ornamental Fish

Breeding, Farming and Trade

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Resource Analysis, Trade Potential and Conservation Management of Marine Ornamentals of India

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Abstract

India is endowed with vast resource potential of marine ornamentals distributed in the oceanic reef areas off Lakshadweep Islands, Andaman–Nicobar Islands, coastal areas of Gulf of Kutch to Mumbai, areas of central west coast between Mumbai and Goa, certain locations off south west coast, Visakhapatnam, Gulf of Mannar and Palk Bay. More than 50 reef fish families consisting of nearly 175 genera and about 400 species of ornamental fishes are distributed in the Indian seas. In this paper, resource analysis of marine ornamentals of Indian sub-continent, their trade potential and approaches to conservation management are discussed.

Keywords: *Marine ornamental fish, trade potential, conservation management*

1. Introduction

The trade of marine ornamentals has been expanding in recent years and has grown into a multimillion dollar enterprise mainly due to the emergence of modern aquarium gadgets and technologies for setting and maintenance of miniature reef aquaria. The marine ornamentals include fishes, stony corals, soft corals, sea fans, ornamental shrimps, sowbellies, gaint clams, ornamental echinoderms and live rocks. The ornamental animals are the highest valued product that can be harvested from a coral reef. The global marine ornamental trade is estimated at US$ 200-330 million (Larkin & Degnar, 2001). The ornamental 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 the in recent years.

India is endowed with vast resource potential of marine ornamentals distributed in the coral seas and rocky coasts with patchy coral formations. The major oceanic reef areas of coral reef distribution in India are the Lakshadweep Islands and the Andaman – Nicobar groups of Islands. The other areas of coral fish distribution are the coastal areas of fringing or patch reefs of Gulf of Kutch to Mumbai, areas of central west coast between Mumbai to Goa, certain locations of south west coast (Thirumullavaram, Vizhinjam to Kanyakumari), Visakhapatnam, Gulf of

Mannar and Palk Bay. More than 50 reef fish families consisting of nearly 175 genera and about 400 species of ornamental fishes are distributed in the Indian seas.

2. Resource analysis

2.1 Family *Pomacentridae*

The clown fishes and damsel fishes are very attractive and hence they are in good demand in the marine aquarium trade. They are small hardy fishes and are typically highly coloured. The major genera of damsel fishes in our waters are *Chromis, Dascyllus, Abudefduf, Pomacentrus, Chrysiptera* and *Neopomacentrus*. The anemone fishes (clown fishes) belong to the genus *Amphiprion*. They are associated with sea anemones, since they possess mucous coating over their body by which they are resisting to stinging of sea anemone. The major species of Pomacentrids in Indian waters include *Amphiprion sebae, Amphiprion ocellaris, Amphiprion percula, Chromis viridis, Pomacentrus pavo, Pomacentrus cearuleus, Dascyllus auranus, Dascyllus trimaculaltus, Dascyllus reticulatus, Dascyllus carneus, Neopomacentrus cyanomos, Neopomacentrus nemurus, Chrysiptera unimaculata, Abudefduf vaigiensis, Abudefduf septemfasciatus* and *Abudefduf bengalensis.*

2.2 Family Labridae

There are many colourful spices of wrasses belonging to this family in the Indian rocky coasts and reef areas. A characteristic of wrasse is its swimming style, using only the pectoral fins to row itself along, but shooting suddenly ahead by body motion. The major genera of labrids available in our waters are *Gomphosus Halichoeres, Stethojulis, Thalassoma, Labroides, Cheilinus, Anampses, Coris,* and *Bodianus*. The major species include *Thalassoma lunare, Anampses caeruleopunctatus, Gomphosus caeruleus, Labroides dimidiatus, Halichoeres scapularis, Halichoeres marginatus, Stethojulis albovittata, Stethojulis strigiventer, Coris gaimardi, Coris formosa, Cheilinus undulates and Cheilinus trilobatus.*

2.3 Family *Scaridae*

Parrot fishes of this family are of striking colours. Their name comes from the heavy parrot like beak which is formed of their fused teeth. The common genera include *Scarus* and *Leptoscarus*. The major species includes *Leptoscarus vaigiensis, Scarus sordidus, Scarus psittatus, Scarus ghobban* and *Scarus scaber.*

2.4 Family *Pomacanthidae*

The marine angel fishes are known for their grace and beauty. The major genera in our water include *Pomacanthus* and *Centropyge*. The common species are *Pomacanthus* imperator, *Pomacanthus annularis, Pomacanthus semicircualtus* and *Centropyge multispinis*.

2.5 Family *Chaetodonidae*

This family includes butterfly fishes and banner fishes. Butterfly fishes are small, swift and surprisingly well patterned and bright coloured fishes which are abundantly represented in the Indian Coast. The common species in our waters include *Chaetodon collaris, Chaetodon auriga, Chaetodon lunula, Chaetodon decussates, Chaetodon vagabundus, Chaetodon meyeri* and *Chaetodon trifasciatus*. The banner fishes are represented by genus *Heniochus*. *Heniochus acuminatus* is very attractive in the aquarium. It has black and white stripes and yellow on the dorsal and tail fins.

2.6 Family *Acanthuridae*

Surgeon fishes of this family have oval body shape because of the identical rounded shapes of soft dorsal and pectoral fins. Their name is derived from the sharp knife like spine on each side of the caudal peduncle. The common genera in our water include *Acanthurus, Ctenochaetus, Zebrasoma* and *Naso*. The common species are *Ctenochaetus strigosus, Acanthurus triostegus, Acanthurus leucosternon, Acanthurus lineatus, Acanthurus nigricauda, Zebrasoma veliferum, Naso unicornis* and *Naso litturatus*.

2.7 Family *Zanclidae*

Zanclus canescens is the only species of this family. The snout is projected, tube-like and there are horn like protuberances over the eyes.

2.8 Family *Scorpaenidae*

Lion fishes of this family owe their name to the spreading pectoral and dorsal fins. It is the wild beauty in a marine aquarium. They are occasionally found in our rocky and coral seas. The common species in our waters are *Pterois volitans* and *Dendrochirus* zebra.

2.9 Family *Syngnathidae*

This family contains the sea horses and pipe fishes. In seahorses the head is bend down joining the body almost at right angle. Pipefishes are

straight. Both have tubular snout and prehensile tail. Sea horses belong to the genus *Hypocampus*. They swim in upright position, stiff but gracefully. The female lays the eggs in the brood pouch of the male.

2.10 Family *Ephippidae*

The bat fishes of this family grow very fast. When young they are most attractive, tend to lose some of their colour as they rapidly grow. The common species available along our coast are *Platax teira* and *Platax orbicularis*.

2.11 Family *Serranidae*

Groupers of this family are widely distributed in the rocky Indian coast. Many colourful species of this family are of ornamental value. The common genera include *Cephalopholis* and *Epinephelus*. The common species are *Cephalopholis argus, Epinephelus merra, Epinephelus hexagonatus and Epinephelus tauvina*.

2.12 Family *Balistidae*

The trigger fishes and file fishes belong to this family. The trigger fishes are so named because of the locking device on the dorsal fin that triggers it into a stiff, erect spine, fixing the fish in position in a crevice in coral. In filefishes the dorsal fin consists of a single long spine. The common genera in this family include *Balistapus, Rhinecanthus, Oxymonocanthus* and *Pervagor*. The major species include *Rhinecanthus aculeatus, Balistapus undulatus, Balistapus conspicillum, Oxymonocanthus longirostris* and *Pervagor melanocephalus*.

2.13 Family *Apogonidae*

The cardinal fishes of this family are small, red or brown coloured. The common genera in our waters include *Archamia, Pristiapagon, Ostorhynchus* and *Paramia*. The most common species are *Archamia fucata, Pristiapagon snyderi, Ostorhynchus savayensis* and *Paramia quinquelineata*.

2.14 Family *Tetradontidae*

It contains the puffer fishes and porcupine fishes. The puffer fishes have the ability to inflate their bodies with water and then turning upside down so that they float to the surface. The common genera found in our Indian coast include *Arothron* and *Canthigaster*. The Porcupine fishes can also inflate their body. They have long sharp spines over the body. When

inflated, the body is round and spines protrude formidably. The common genus in our coast is *Diodon*. The major species of puffer fishes and porcupine fishes in our water are *Arothron stellatus* and *Canthigaster margaritatus* and *Diodon hystrix*.

2.15 Family *Ostraciontidae*

The box fishes have hard outer cases that completely enclose their body. *Ostracion cubicus* is a common species.

2.16 Family *Holocentridae*

The squirrel fishes are brightly coloured fishes. Typically the body is red and the fins are yellow. The common genera include *Neoniphon, Holocentrus, Sargocentron and Myripristis*. The common species are *Neoniphon samara, Sargocentron diadema, Holocentrus laevis* and *Myripristis murdjan*.

2.17 Family *Antennaridae*

Frog fishes of this family are found in our coastal waters. The best known frog fish is the Sargassum fish *Hystrio hystrio*. It is seen wherever sargassum weed is found. The body is brownish yellow mottled with darker colour. The fish becomes perfectly concealed among the sargassum weed where it lives.

2.18 Family *Muraenidae*

Morey eels of this family are often attractively coloured. Many eels belonging to the genera *Gymnothorax* and *Muraena* are distributed in our reef areas and rocky coasts.

2.19 Family *Theraponidae*

The tiger fishes of this family have typically striped bodies. The three striped tiger fish *Therapon jarbua* is very common along Indian coast.

2.20 Families *Gobidae* and *Blennidae*

The gobies and blennies are attractive small bottom living fishes which are commonly found in tidal pools of rocky coast. The common genera of Gobies and Blennies in our waters include *Acentrogobius, Aspidonotus, Istiblennius* and *Salarias*.

3. Exploitation Potential

A comprehensive study on the stock size and maximum possible yield from Lakshadweep was made by Murty (2002) (Table 1 and 2). The

estimated stock sizes of the 20 families studied reveal that the damselfish are the most dominant accounting for 43.7% of the estimated total stock (137 lakhs) followed by parrotfish(15.3%), surgeonfish (13.3%), wrasses (11.0%), squirrelfish (2.5%), goatfish (1.7%), butterflyfish (1.1%), triggerfish (1%) and the remaining twelve families 10.4%.

Table 1: Estimated stock size (number) and annual yield of ornamental fishes off Lakshaweep Islands

Group	Stock size	Maximum yield
Surgeonfish	18,17,418	7,82,195
Triggerfish	1,34,171	27,271
Butterflyfish	1,47,955	1,01,802
Wrasses	15,10,673	5,36,990
Squirrelfish	3,37,636	89,369
Goatfish	2,30,943	1,21,866
Damselfish	59,92,984	54,22,447
Parrotfish	21,01,167	12,65,071
Rock cod	83,573	27,082
Lizardfish	13,469	4,226
Cardinalfish	85,637	58,006
Filefish	13,841	9,376
Sandsmelt	13,841	9,376
Boxfish	13,841	9,376
Angels	27,682	18,752
Scorpeonfish	14,449	9,787
Rabbitfish	52,147	35,332
Pufferfish	74,974	50,783
Moorish idol	29,261	19820
Total	**1,36,95,663**	**85,99,456**

Table 2: Species-wise projected annual yield of major ornamental fishes off Lakshadweep Islands

Species	Projected annual yield (Nos)
Damselfishes	
Chromis caeruleus	43,81,000
Dascyllus aruanus	2,22,000
Chromis chrysurus	1,65,000
Abudefduf lacrymatus	1,35,000
Dascyllus trimaculatus	1,02,000
Abudefduf uniocellatus	67,000
Other damselfishes	50,43,000
Parrotfishes	
Scarus psittacus	10,033,000
Scarus bataviensis	9,57,000
Scarus sordidus	34,000
Leptoscarus vaigiensis	23,000
Scarus scaber	22,700
S. ghobban	22,000
Other species	34,700
Surgeonfishes	
Acanthurus triostegus	5,69,000
Acanthurus lineatus	63,000
Ctenochaetus strigosus	37,000
Acanthurus matoides	37,000
Other species	75,300
Wrasses	
Halichoeres hortulanus	2,65,000
Stethojulis albovittata	98,000
Halichoeres scapularis	39,000
Cheilinus trilobatus	25,000
Halichioeres marginatus	17,000
Thalassoma hardwicki	16,000

Other species	76,000
Goatfishes	
Mulloidichthys samoensis	41,000
Parupeneus macronemus	39,000
Parupeneus barberinus	18,000
Mulloidichthys auriflamma	10,000
Other species	76,000
Squirrelfishes	
Neoniphon summara	39,000
Myripristis murdjan	30,000
Other species	20,000
Butterflyfishes	
Chaetodon auriga	33,000
Chaetodon trifasciatus	17,500
Heniochus acuminatus	15,000
Megaprotodon strigangulus	10,000
Other species	26,000
Moorish idol	
Zanclus canescens	20,000
Triggerfishes	
Rhinecanthus aculeatus	24,000
Angelfish	
Centropyge multispinis	24,000
Pomacanthus imperator	3,000
Filefish	
Oxymonocanthus longirostris	8,000
Amanses sandwichiensis	1,000
Rock cods	
Epinephelus merra	13,000
Epinephelus hexagonatus	7,000
Cardinalfish	
Pristiapogon snyderi	38,000

Ostorhynchus savayensis	10,000
Pufferfish	
Canthigaster margaritatus	46,000
Lionfish	
Pterois volitans	9,000
Boxfish	
Ostracion cubicus	9,000

4. Trade

4.1 Global scenario

An overview of the global trade of marine ornamentals has been given by Wabnitz et al. (2003). Based on the Global Marine Aquarium Database, the annual global trade is between 20 million to 24 million numbers for marine ornamental fish, 1 to 12 million numbers for corals and 9 to 10 million for other ornamental invertebrates. A total of 1,471 species of fish are trade globally. Most of these species are associated with coral reef, although some of them are associated with other habitats such as sea grass beds, mangrove and mud flats. More than 98% of the total number of fish exported was contributed by Philippines, Indonesia, Solomon Island, Sri Lanka, Australia, Fiji , Maldives and Palau.

4.2 Fishes

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%), *Callioymidae* (3%), *Microdesmidae* (2%), *Serranidae* (2%), *Blenidae* (2%). The topmost species include Chromis viridis (Blue green damsel), *Amphiprion ocellaris* (clown anemone fish), *Dascyllus auranus* (Stripped damsel), *Chrysiptera cyanea* (sapphire devil), *Dascyllus trimaculatus* (three-spot damsel).

4.3 Corals

According to CITES data, the global live trade rose steadily from 1997 to 1999 with 9,34,463 live pieces and 11,42,000 live pieces being traded world wide respectively in these years. Data from 1997 to 2001 show that Indonesia, Solomon Islands, and Tonga together supplying more than 95% of the live corals exports. Commonly traded genera include Acropora (Staghorn, cluster, blue tip, bush, cat's paw or bottle brush coral)

Catalaphyllia (elegance coral), *Euphyllia* (anchor or hammer coral), *Galaxea* (galaxy coral), *Goniopora* (flower pot coral) *Heliofungia* (mushroom coral) *Lobophyllia* (lobed brain coral) *Pterogyra* (bubble or grape coral), *Turbinaria* (cup coral), *Scleractinia, Favia* and *Porties.*

4.4 Soft corals and Sea fans

Global Marine Aquarium Database indicated a total of 3,86,849 species of live soft corals traded between 1988 to 2002. Indonesia is the largest exporting country for soft corals and United states is the largest importer. The most commonly traded soft corals genera are *Sarcophyton* (leather/ mushroom / toad stool coral), *Sinularia* (finger / leather / soft finger / digitate leather coral), *Xenia* (pulse coral), *Cladiella* (cauliflower / finger/ blushing / colt coral), *Clavularia* (clove polyp), Anthelia (waving hand polyp), *Lobophytum*(finger leather coral), *Nepthea* (broccoli coral), *Dendronephthya* (carnation / strawberry coral) and *Cespitulariaa* (blue xenia). Eight genera of sea fans appear in Global Marine Aquarium Database trade records, *viz., Ctenocella, Echinogorgia, Ellisella, Euplexaura, Gorgonia, Lophogorgia, Pseudopterogorgia,* and *Rumphella.* The genus *Gorgonia* is the most well known and commonly traded sea fan.

4.5 Other ornamental invertebrates

Many invertebrates other than corals are popular in aquarium trade. As per Global Marine Aquarium Database, 516 species of invertebrates are being traded for aquarium trade. The main species in the trade were *Lysmata* spp., *Heteractis* spp., *Stenopus* spp.,*Turbo* spp., *Tridacna* spp., and *Trcohus* spp. Giant clams represent an increasingly large proportion of the export of live invertebrates for aquarium trade. Belonging to the family *Tridacnidae* and composed of two genera, of *Tridacna* (7 Species) and *Hippopus* (2 species), the giant clams are the largest bivalves in the world. The more brightly coloured *Tridacna maxima, Tridacna crocia* and *Tridacna derasa* are the most popular in the marine aquarium trade. Unsustainable exploitation of giant clam species has led to the local extinctions of some species such as *Tridacna gigas* in some areas (Hestinga, et al. 1984).

4.6 Live rocks

Live rocks are pieces of coral rocks to which live specimens of invertebrates species and coralline algae are attached. Typical inhabitants of live rocks are anemones, tunicates, bryozoans, octocorals, sponges, echinoids, mollusks, sebellarids and serpulid tube worms and calcareous algae. Fiji is the world primary supplier of live rock, and data shows that in

2001 more than 800 tonnes of live rocks were harvested from its reef. It is evident that the large scale removal of live rock, the result of hundreds of years of accretion can destroy a reef habitat, undermining the structure of coral reefs and leading to increased erosion as well as reduced biodiversity.

4.7 Destructive collection practices

Since the trade is dependent upon wild collection, the destructive collection practices, the introduction of alien species, over exploitation, the lack of scientific information on many species collected and threat to extinction of target species are the major problems. Destructive collection practices such as the use of sodium cyanide may destroy the coral reef habitat by poisoning and killing non target animals, including corals. During collection, many colonies of the branched corals are also broken for easy access to capture fish which take refuge in coral colonies. Collection of live rock is considered as potentially destructive as it may lead to increase erosion and loss of important fisheries habitat.

5. Conservation and management

A critical analysis of current global trade of the marine ornamentals from wild collections reveals many ecological concerns which require policy interventions. The major aspect that should receive top most priority is for taking appropriate action to ensure that the development of the trade should not threaten the sustainability of the coral reef ecosystem. The following measures are suggested.

5.1 Regulation for collection in the wild

The destructive collection practices such as use of cyanide should be banned by legislation and enforced. Results from a recent study demonstrated that colonies of commonly traded species of corals and soft corals to varying concentrations of cyanide over different periods of time caused mortality in all corals. *Acropora*, the genus which is specifically targeted by fishers for collection of fish as they tend to hide amongst its braches is most vulnerable to cyanide exposure, showing rapid signs of stress and bleaching (Cervino et al., 2003). Another aspect of concern is the impact of exploitation on population due to selective harvesting of species which are of high demand in the trade. Here also policy intervention through legislation has to play a key role. Several countries in Asia and South America have begun to implement collection restrictions on certain ornamental fish species (Corbin and Young, 1995; Friedlander, 2001; Ogawa and Brown, 2001). 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 targeted aquarium species due to heavy collection pressure. Studies have also shown that removal of larger quantities of cleaner wrasses and cleaner shrimps which play key roles in reef health creates negative impacts on reef diversity. The third aspect of concern is the exploitation of species which are not suited for aquarium. This also needs to be avoided by legislation. The fourth aspect which demands regulations is regarding the post harvest mortality. Research on marine ornamental trade between Sri Lanka and the United Kingdom demonstrated that in mid 1980's about 50% fish died during and immediately after collection another 10% during transport and 5% in holding facilities (Wood, 1985). As a result of such mortally more fish often need to be collected for meeting the market demand. Where organisms are collected, stored and handled by adequately trained individuals and transported in suitable containers fish mortality have been very low. The post harvest conditioning facilities should include modern gadgets such as UV lighting system, protein skimmers and carbon filters.

5.2 Introduction of certification for wild collected species

Marine Aquarium Council (MAC) has developed a certification scheme that will track an animal from collector to hobbyist. Established in 1996, the goals of MAC are to develop standards for quality products and sustainable practices and a system to certify compliance with these standards, and create consumer demand for certified products. With a net work of 2600 stakeholders in more than 60 countries, it is recognized as the lead organization for developing and co-ordinating efforts to ensure that the international trade in ornamental marine organisms is sustainable. MAC certification covers both practices and products (Bunting et al., 2003). Industry operators can be certified through an evaluation for compliance with the appropriate MAC standard for the certification of practices. For certification of products MAC certified marine ornamentals must be harvested from a certified collection area and pass from are certified operations to another. MAC – certified marine organisms bear the "MAC-certified" label on the tanks and boxes in which they are kept and shipped.

5.3 Development of hatchery technologies for selected species

The ultimate answer to a long term sustainable trade of marine ornamentals can be achieved only through the development of culture technologies. 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 (Oliver, 2003). Even though techniques are available for culture of corals, according to CITES data only 0.3% of the total global trade in live coral is from mariculture. Most branching corals can be easily propagated from small trimmings clipped from a parent colony and in about a year a five to ten fold increase in biomass can be obtained. Soft coral fragments can grow to marketable size within 4-12 months and stony corals like *Acropora* within 4 – 6 months. More than 75 species corals are bred under captivity, but fast growing corals appeared to be economically profitable.

The list of marine ornamental fishes reared in captivity today contains more than 100 species. The maximum number of species reared is from the family Pomacentridae. Attempts for spawning and rearing in closed systems have proved technically challenging for most species except Pomacentrids like *Amphiprion* spp. and the existing mariculture projects have been developed on a relatively small scale. The great obstacle to successful tank breeding of ornamental reef fish is rearing larvae beyond the 6th to 8th day of development, a time typically associated with failure to initiate larval feeding.

Artificial seed production techniques are available for giant clams and hence giant clam culture has increased considerably. Now there are successful giant calm hatcheries for aquarium trade, in most tropical pacific nations and island groups. The culture of ornamental invertebrates other than giant clams and cleaner shrimps is constrained due to lack of information's on key life history characteristics.

5.4 Other management strategies

Limited access to the fishery: A licensing system, whereby collection effort is regulated through a limited number of permits being issued each year, offers a good way of monitoring the industry (Wood, 2001). The number of permits to be issued should be based on scientific studies estimating the resource base and sustainable harvest quotas, subject to review on a regular basis.

Quotas: Limiting the number of fish being exported from any source country is another way of reducing or limiting collection pressure. Quotas are only likely to be effective if based on rigorous scientific research and

implemented at species-specific level. Although relatively simple and can be easily enforced, general quotas are not advisable as they may simply encourage collectors to focus collection on the most valuable species, hence not ensuring protection of overall stock and least so of vulnerable species.

Size limits: Size limit is another useful tool in managing aquarium fisheries. The marine ornamental fish trade tends to be highly selective in favour of juveniles due to their distinctive colouration, low transport cost for exporters and optimal size to fit in a home aquarium. Young ones of some popular species are easily stressed and hence may suffer high mortality during holding and transport. Setting minimum size limits would help to ensure that stock is not unnecessarily wasted. Maximum size limits are equally important to ensure that sufficient numbers of breeding adults remain on the reef.

Marine Reserves: The creation and effective management of areas where fishing is prohibited can prove to be a valuable tool for managing aquarium fisheries. Australia has effectively implemented this strategy for collection of corals. There are no-take areas and selected collection areas. It is reported that despite collectors harvesting 40 – 50 tonnes of coral per year for twenty years, no noticeable impact on the resource has been observed (Bruckner, 2000). Marine reserves will be more successful by a community based management. By giving community members a sense of ownership of their resources, they will guard these against destructive uses.

Temporary closures: This approach is commonly used to protect species during reproductive phases to ensure that there is sufficient recruitment to sustain the population. Although not in operation specifically for the aquarium trade at present, such closed seasons could allow juvenile fish to grow to a size unsuitable for aquarium collection, thus making sure that a healthy stock of adult fish is maintained on the reefs, which would contribute to recruitment. The temporary closures are only likely to be effective if implemented at the right time and right location.

6. Indian scenario

It is evident from the global scenario of the ornamental trade, even though the trade is very lucrative and is expanding rapidly the problems involved are complex and requires appropriate management strategies. If managed properly, the aquarium industry could support long term conservation and sustainable use of coral reefs.

In India, till date no organized trade of marine ornamentals has been initiated. But it is a fact that a great deal of illegal collection of marine ornamentals is in vague in many parts of our reef ecosystem and this is a matter of great concern due to the indiscriminate nature of exploitation and eco-hostile methods of collection which damage the reef ecosystem. In addition to this, lack of knowledge on appropriate post harvest husbandry practices leads to large scale mortality of the collected animals. It is time to evolve a marine ornamental fisheries policy in the country for developing an organized trade of marine ornamentals.

In India, the Central Marine Fisheries Research Institute has been focusing on breeding and seed production of marine ornamental fishes during the past few years. One of the milestones is the recent success in the hatchery technology of clownfish and sea horse. Success was also obtained on the brood-stock development and larval rearing of seven species of damselfishes. It is felt that research on breeding and seed production of marine ornamentals has to be intensified in future years. The culture of marine ornamental fish can prove to be more economically feasible than that of marine food fish culture. This is because even though the market for ornamental fish is much smaller than that of food fish, the price per unit is far higher in the case of aquarium fish. Hence in future, hatchery reared fish will become a significant part of marine ornamental fish trade.

India is bestowed with vast marine ornamental resources in the island ecosystems of Lakshadweep and Andaman–Nicobar Islands besides many areas of mainland. It is felt that development of a marine ornamental trade entirely by culture may not be a realistic proposition in the immediate future. A wild collected trade can be initiated by strictly enforcing certain core standards for eco-friendly and long term sustainable exploitation by following guidelines similar to those developed by MAC. It is time to develop an organized marine aquarium fishery in India by formulating certain policies and management to ensure its sustainability. In the near future, India can emerge as a lead country for a sustainable marine ornamental trade by evolving suitable aquarium fisheries policies for wild collection as well as by developing culture technologies for selected species.

The establishment of an oceanarium in the country will be of much significance for education, research and conservation of the marine ornamental biodiversity. In the oceanarium, the marine flora and fauna are kept and maintained in large tanks with walk-through acrylic tunnel and in

aquarium tanks. The oceanarium can accommodate touch lagoon, reef aquaria and display of different coral reef habitats and their biodiversity. It can also undertake educative and scientific programmes on the ecology, biodiversity and conservation of marine ornamental animals.

References

Bruckner, A. 2000. New threat to coral reefs: trade in coral organisms. Issues in Science and technology Online. www.nap.edu/issues/17.1/bruckner.htm.

Bunting, B., Holthus, P, Spalding, S. 2003. The marine aquarium industry and reef conservation. In: Marine Ornamental Species- Collection, Culture and Conservation(J. Cato and C. Brown, Eds.) Iowa State Press, Ames, USA: 109-124

Cervino, J., Hayes, R., Honovich, M., Gorea, T., Johns, S. and Rubec, P. 2003. Changes in zooxanthellae diversity, morphology and miotic index in hermatypic corals and anemones exposed to cyanide. Mar. Poll. Bull. 46: 573-586.

Corbin, J. and Young, L. 1995. Growing the aquarium products Industry for Hawaii. Department of Land and Natural Resources, Aquaculture Development Programme, Hawaii: 35 p.

Friedlander, A. 2001.Essential fish habitat and the effective design of marine reserves; application for marine ornamental fishes. Aquarium science and Conservation 3: 135 – 150.

Hestinga, G., Perron, F. and Orak, O. 1984. Mass culture of giant clams (Family Tridachnidae) in Palau. Aquaculture. 39: 197-215.

Larkin, S. and Degner, R. 2001. The US wholesale market for marine ornamentals. Aquarium Sciences and Conservation 3: 13-24.

Murty, V.S. 2002. Marine Ornamental Fishes of Lakshadweep. CMFRI, Spl.Pub.72: 134pp.

Ogawa T and Brown C. 2001. Ornamental fish aquaculture and collection in Hawaii. Aquarium sciences and Conservation, 3: 151-169.

Oliver, K. 2003. World trade in ornamental species. In: Marine Ornamental Species: Collection, Culture and Conservation (J. Cato and C. Brown, Eds.): 49-63.

Wabnitz, C., Taylor, M., Green, E. and Razak, T. 2003. From Ocean to Aquarium: The global trade in Marine Ornamental Species, UNEP World Conservation Monitoring Centre, UK: 65 p.

Wood, E. 1985. Exploitation of coral reef fishes for the aquarium trade, Marine Conservation Society, Ross-on-Wye, UK: 121 p.

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