Fishery enhancement

New approaches in fishery enhancement such as the introduction of shrimp seeds and fish seeds into the estuaries of rivers at the right time, every season, can be adopted so as to counter the depletion of the resources. Hatcheries should be set up for such fishery enhancement schemes.

Raw material marketing

Despite the fact that capacities of processing establishments in Gujarat are underutilized due to shortage of raw material, large quantities of raw material is being transported annually to other states for the processing units there. This practice should be immediately banned, to protect the interests of processors in Gujarat.

Fund generation for development

It is natural that for all of the above, there is bound to be a high cost for the Government. It is recommended that some revenue should be generated by Government, by introducing some sort of agricultural tax on fishermen and on the other areas in the fishing sector. This money would be used for development of the fishery sector.

It will be very apparent from all the above points that the situation presently is very dismal and the future will not be any better unless the suggested measures are efficiently implemented. It is not the fate of the fishermen alone that is at stake, but the whole industry would collapse unless something is done very quickly.

Marine Ornamental Fishes of Gujarat

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With the changing scenario in marine fisheries of Gujarat, there is an urgent need for diversification of fishery-related activities into new areas of resource utilization. With the catches of many high-valued fishery resources declining, the sustenance of the fishing industry and the employment generated by it are at stake. At this juncture, marine ornamental fish trade stands out as a relatively new and potential industry for generating employment and developing trade. Water scarcity and social ethics limit the popularity of fish trade, in any form, within the state. However, the success of some entrepreneurs based at Ahmedabad, Baroda and Surat in the freshwater ornamental fish trade has raised interest among others. Peninsular Saurashtra and the Gulf of Kutch is characterised by miliolite, sandstone and minor patches of coral reefs housing several species of algae, invertebrates and vertebrates which also include a wide range of marine ornamental fishes. A random survey reveals the presence of at least a dozen internationally rated groups among the observed varieties which, if promoted cautiously with appropriate breeding and hatchery technologies, can sustain an industry in ornamental fish trade. The groups of importance identified were Pomacentrids, Pomacanthids, Chaetodontids, Acanthurids, Ambassids, Apogonids, Scarids, Sparids, Lethrinids, Serranids, Balistids, Drepanids, Labrids, Tetradontids and Mullids. Three species of Pomacentrids (damselfishes), *viz*., *Chrysiptera unimaculata*, *Neopomacentrus sindensis* and *N. cyanomos* have been successfully acclimatized to aquarium rearing conditions. *N. sindensis* has successfully bred in captivity.

Key words : Marine ornamental fishes, ornamental fish trade, Gujarat

The aquarium trade is one of the most lucrative among all fishery-related activities. Freshwater aquaria are inseparable components of most households in Europe, USA and Asian countries like Japan and China. Marine ornamental fish trade has already taken deep roots in international markets. Over 1500 species of aquatic animals and plants (80% of which can be farmed or cultured) are sold worldwide for aquarium purposes. The total world retail value of the aquarium industry in 1995 was estimated to be between 4 and 15 billion $US. Marine species make up only 9% of the volume of the aquarium pet trade but due to their high value, they represent about 20% of the revenue. Importance of ornamental fishes has been discussed by Hoff (1993), Kulbicki (1988) and Letourner (1996). While freshwater aquaria and culture of freshwater ornamental fishes have already proven

to be good sources of employment and revenue generation in some Indian states like Tamil Nadu, Maharashtra, West Bengal and Kerala, marine ornamental fish trade is yet to be established as a full-fledged industry. Water scarcity and social ethics limit the popularity of fish trade, in any form, in Gujarat. However, the success of some entrepreneurs based at Ahmedabad, Baroda and Surat in the freshwater ornamental fish trade has raised interest in this area, in recent years.

With the longest coastline among the Indian maritime states and rich fishing grounds housing a highly diverse group of fishes, crustaceans and cephalopods, Gujarat has been one of the leading producers of marine fish in the country. Of late, however, the effect of increased fishing pressure on the resources with increasing demand and modernization of fishing practices have resulted in a decrease in the catches of several highly valued resources. There is an urgent need for diversifying the fishing industry of the state into other fishery-related activities to help sustain the industry and the employment generated by it. Gujarat stands relatively down in the order among Indian states, with regard to aquaculture. The aquarium trade and marine ornamental fish culture, therefore, are practically virgin fields in this state.

Patches of coral islands in the waters of Kutch and miliolite and sandstone reefs which border the coastline of peninsular Saurashtra support a wide variety of flora and fauna on which there is very little documentation. Several groups of fishes, crustaceans, molluscs, coelenterates and echinoderms live in these habitats at some stage in their life history. A preliminary survey was done to identify different species of ornamental fishes and invertebrates available along the coast of Saurashtra to provide a base-line information on resource-availability for promoting marine ornamental fish trade in Gujarat.

Materials and Methods

The reefs bordering the Saurashtra coast from Veraval to Navabundar and off Okha were surveyed (McManus *et al.*,1996) for fish diversity and abundance. Fish collection was done using gill nets, drag nets, cast nets and small hooks and lines. Handpicking was also resorted to for small fishes hiding beneath boulders. The survey was conducted from January 2001 to December 2002.

Highly valued groups like damselfishes and angelfishes were transported to the laboratory and acclimatized to aquarium conditions. Several preliminary experiments on feed preferences and breeding trials were carried out to assess their amenability to aquarium rearing, breeding and hatchery production of seed.

Results and Discussion

Several groups of high value ornamental fishes were collected from the reefs, with maximum collections during the post-monsoon months of September-

December. Larger-sized fishes, especially perches were easily collected by gill net operations. Smaller ornamental fishes like damselfishes and wrasses were best collected by small hooks and lines, boulder displacement and drag net operations in tidal pools. The major groups identified include Pomacentrids, Pomacanthids, Chaetodontids, Acanthurids, Ambassids, Apogonids, Scarids, Sparids, Lethrinids, Serranids, Balistids, Drepanids, Labrids, Tetradontids and Mullids. Forty-nine species were identified with the aid of documentation by Bapat *et al.* (1982) and Eschemeyer (1990) (Table 1).

Table 1. List of fishes collected from the reefs of Saurashtra

Family	Species	Months of availability
Acanthuridae	*Acanthurus xanthopterus*	April-June
Ambassidae	*Ambassis* spp.	Whole year
Apogonidae	*Apogon multitaeneus*	Whole year
	Apogon spp.	Whole year
Balistidae	*Abalistes stellatus*	August-October
	Odonus niger	Whole year
Bothidae	*Pseudorhombus elevatus*	Whole year
Carangidae	*Alectis indicus*	August-November
	Parastromateus niger	August-December
Chaetodontidae	*Chaetodon collaris*	April-June, November-January
	C. kleinii	April-June
	C. lunula	April-June
	Heniochus dispar	April-June
Cypriniodontidae	*Cyprinodon dispar*	Whole year
Drepanidae	*Drepane punctatus*	Whole year
Echeneidae	*Echeneis naucrates*	Whole year
Gerridae	*Gerres acinaces*	Whole year
	Gerres filamentosus	Whole year
Gobidae	*Gobiosalbo punctatus*	Whole year
Haemulidae	*Pomadasys stridens*	Whole year
Labridae	*Heliochoeres dussumieri*	Whole year
	Thalassoma labroides	Whole year
	T. lunare	Whole year
Lethrinidae	*Lethrinus rubrioperculatus*	August-October
	L. nebulosus	August-October
Lutjanidae	*Lutjanus ehrenbergii*	Whole year
	L. monostigma	Whole year
	L. vitta	Whole year
Monocanthidae	*Paramonocanthus cingalensis*	Whole year
Mugilidae	*Mugil cephalus*	August-December
Mullidae	*Upeneus vittatus*	Whole year
Pempheridae	*Pempheris mangula*	October-November
Plotosidae	*Plotosus lineatus*	October-December

Pomacanthidae	*Pomacanthus annularis*	Whole year
	P. striatus	September-January
Pomacentridae	*Abudefduf bengalensis*	Whole year
	A. sexfasciatus	Whole year
	A. sordidus	Whole year
	Chrysiptera unimaculata	December-February
	Neopomacentrus cyanomos	Whole year
	N. sindensis	Whole year
Scaridae	*Scarus russelli*	April-August; November-January
Scatophagidae	*Scatophagus argus*	Whole year
Sciaenidae	*Johnius dussumieri*	Whole year
	J. elongatus	Whole year
Serranidae	*Cephalopholis formosa*	August-October
	Epinephelus merra	August-October
Siganidae	*Siganus canaliculatus*	April-August; November-January
Sillaginidae	*Sillago sihama*	Whole year
Teraponidae	*Lagocephalus inermis*	Whole year
Crustaceans		
Alpheidae	*Alpheus strenuus*	Whole year
Palinuridae	*Panulirus homarus*	September-November
	P. polyphagus	September-November
	P. versicolor	September-November

Aquarium rearing trials showed promise in several species. Three species of damselfishes, *viz*., *Chrysiptera unimaculata*, *Neopomacentrus sindensis*, and *N. cyanomos* were found to be ideal candidates. All three species are abundantly found in the waters along the Saurashtra coast. *N. sindensis* and *N. cyanomos* are available throughout the year. Juveniles and adults collected from the reefs of Veraval were maintained in glass aquaria (2x0.67x0.67 m), FRP tanks (rectangular, cylindrical, cylindro-conical) supported by biofilters. Water quality was maintained through water exchange @ 20% every day. Sufficient artificial shelters were provided for the fishes to mimic their natural habitat. Preliminary feeding experiments were conducted to study the food preferences. The fishes were fed with shrimp meat, gastropod meat, squid meat, fish eggs, artemia, daphnia and mosquito larvae. The fishes were receptive to all these food items but maximum preference was towards shrimp meat, squid meat, fish eggs, daphnia and mosquito larvae. *N. sindensis* and *N. cyanomos* have bred under captivity. While larval rearing has not met with much success in *N. cyanomos*, results are promising in *N. sindensis*.The larvae were fed with chlorella based rotifers and protozoans. Other prospective candidates include the angelfishes such as *Pomacanthus annularis* and *P. striatus*, *Cyprinodon dispar* and *Scatophagus argus*. Of these *Cyprinodon dispar* and *Scatophagus argus* were found to be amenable to both freshwater and marine aquarium rearing. *C. dispar* has bred in both extremes of salinity. However, it is not compatible with other freshwater aquarium fishes. *S. argus*, on the other hand, is compatible with other freshwater and marine aquarium fishes. Technologies for breeding and hatchery rearing of different species of damselfishes and clownfishes have been developed in other research centres of CMFRI (Gopakumar *et al.*, 1999; Ignatius *et al.*, 1999).

There is a growing awareness among entrepreneurs in the state about the prospects of the marine aquarium trade. Attempts have already been made by three entrepreneurs based at Veraval to acclimatize reef fishes to freshwater and introduce the trade in domestic markets. However, these attempts were all based purely on harvests from the wild. Development of suitable technology packages for breeding and seed production of marine ornamental fishes and transfer of technology to the end user, is necessary for promotion of this industry. Given the right development impetus, Gujarat with its rich variety of potential ornamental fishes, can prove to be the ideal centre for marine aquarium trade in the country.

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