PERSPECTIVES IN MARICULTURE

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Multi crop farming system as fish aggregating device to enhance marine production

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ABSTRACT

The results of the studies during 1995 to 2000 March using different types of cages, spat collectors and other gadgets for farming pearl oysters and mussels at Vizhinjam showed that large aggregations of edible fishes, ornamental fishes, cephalopods and other marine organisms frequently appear in the farming areas in search of substratum, shelter, food and breeding purpose. It is also observed that this system acts as a sanctuary conserving these resources by providing them breeding habitat.

The organisms collected by regular operation of different types of cages are presented in this paper describing their behaviour showing how this multi crop farming system simultaneously acts to improve resources generation and conservation.

Introduction

The Central Marine Fisheries Research Institute has initiated marine farming in India in 1972 by starting mussel farming at Vizhinjam. As the marine resource exploitation from the coastal sector has reached the threshhold level, there is an urgent need to enhance production through improved sea farming and sea ranching activities. India's marine production swings between 2.3 to 2.8 million tonnes during the past few years. Realising this there has been considerable improvement and research prioritization in marine farming activities especially in the fields of mussels, pearl oyster, edible oyster, prawn, crab, lobsters, algae etc.

The research results of the project "Development of low cost technology system for sea farming of pearls and mussels", started in 1995 at Vizhinjam, were highly encouraging (Achary *et. al.*, 1998). The studies also showed that the multi crop farming system developed using new designs of cages in the sea bottom was also acting as fish aggregating device just like the concrete modules and other structures used for developing artificial reefs in India as well as in some of the developed countries. Vik (1982) and Grove and Sonu (1983) have reviewed the Japanese artificial reef technology showing the possibilities of enhancement of marine production through the introduction of modules. It was also observed that the cages and the nylon frills used for farming were giving better results than the cement modules and the former used for multi crop farming system can be raised to the surface periodically for stocking candidate species suitable to the farming area and the operations can be regulated as a "farming cum fishing activity" using series of two-in-one trap cages. James and Lazarus (1996), Lazarus (1996), Parameswaran Pillai (1996), Raja (1996), Rajamani (1996) and Sanjiva Raj (1996) have elaborately given the details of the

artificial reefs operated in some of the localised regions in India and other countries showing the functional merits and demerits of the artificial reef system and the associated fisheries. As these reefs are permanently submerged and is launched in deeper areas it is practically difficult to monitor the biosystem from the surface. The multi crop farming system presented here shows that while the farming operation is done using a main crop like pearl oyster, mussels, lobsters, crabs, edible fishes, etc. ornamental fishes, crinoids, echinoids, bryozoans, sponges, gorgonids etc. also can be raised according to the depth and local conditions of the farming area for extracting medicines. In addition the system attract the larvae and adults of the above organisms just like the fish aggregating device (FAD) and function as a sanctuary. In short the multi crop farming system functions as a "mobile artificial reef" for farming different desirable animals and can be lifted to the surface for stocking, farming and harvest as well as simultaneously manipulating the ecosystem for induced regulation of the faunal and floral complexity.

The farming system for developing fish aggregating device

The farming system is developed as a multicrop sea bottom activity by introducing *high density stocking cages* fabricated with additional lateral pedestals to avoid the cages touching the silty bottom. A 64 cm^3 cage with four shelves could accommodate 4000 mussels or pearl oysters with normal growth. Cages with radial pedestals which are known as *satellite cages* are also designed to protect the cages and the stocked animals in any adverse circumstances. Nylon frills of 50 cm length are suspended from the lateral pedestals for attracting mussel and pearl oyster spats. As these cages are launched in the sea with the stocked animals, large aggregations of fishes and other animals are noticed around the cages. For catching the fishes, the high density cages are converted into two-in-one cages with trap mouth for fishing cum-farming of oysters using the top and bottom shelves (Achary *et. al.*, 1998). A series of all these cages could act as 'Modules' of the artificial reefs forming a new biosystem in the sea with high rate of biomass production (Fig.1).

Raft system with cages, breeding hapas and spat collector frills maintained in the Vizhinjam bay is also found to act as fish attracting

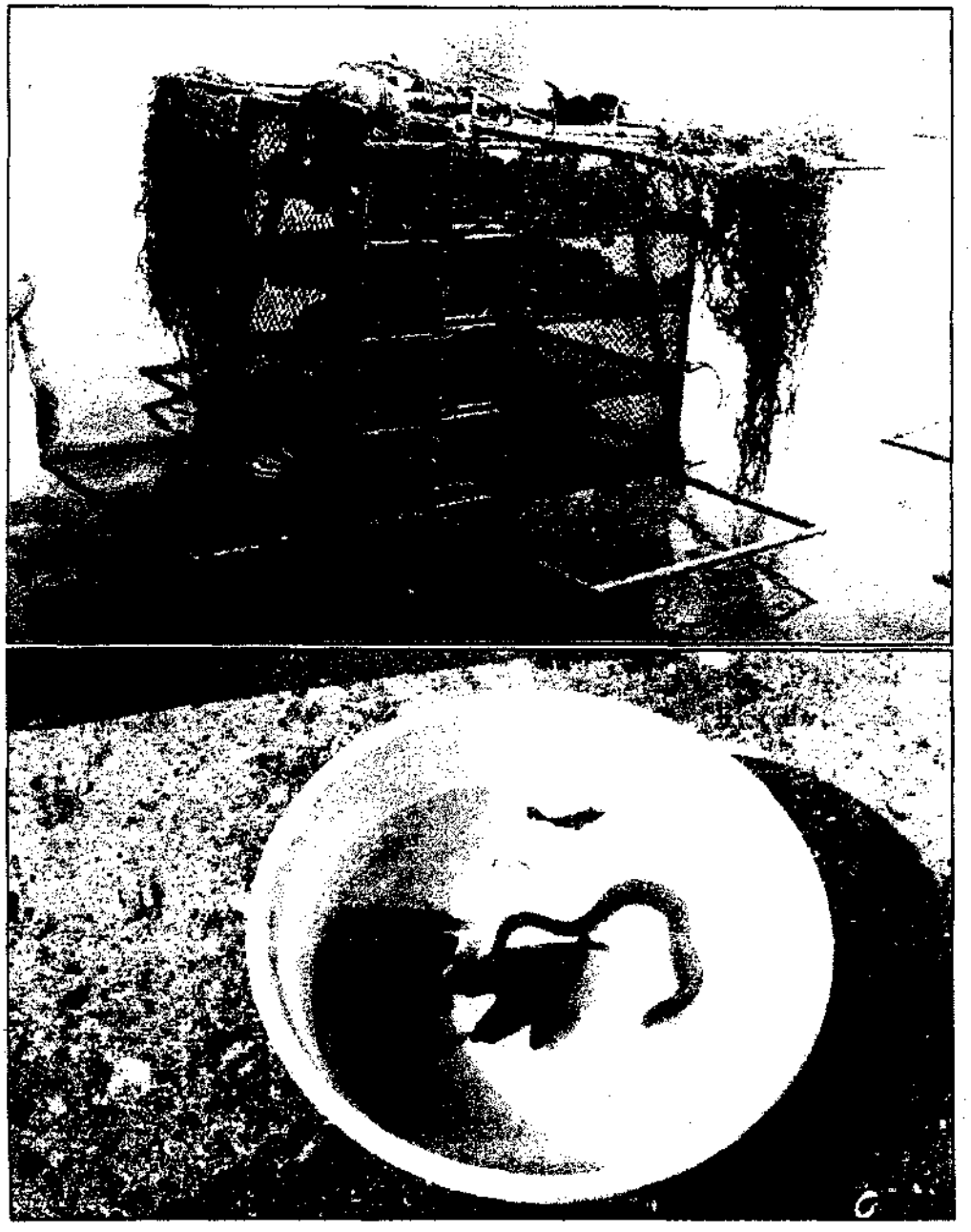

Fig. 1 (Above) : High density stocking cages with individual lid for each shelf.
Fig. 2 (Below) : Fishes caught using two-in-one trap cages (Collection from a single cage)

device while operated as a multicrop system. However since the protected bays are very much limited, along the Indian coast, sea bottom farming by using these cages are more desirable to compensate the rough sea conditions.

Fresh settlement of different sedentary and free living animals like pearl oysters, mussels, ascidians, barnacles, bryozoans, sponges, holothurians, crinoids, echinoids etc. were noticed within three months after launching the cages. Penaeid and caridian prawns, crabs, lobsters, edible fishes and ornamental fishes, cephalopods etc. were the other groups attracted by this newly developed biosystem. It is also observed during the period of study that by introducing few numbers of a particular group like pearl oyster or mussel it will be possible to raise a sizable population of these animals within two to three years and an associate faunistic complex as shown above can also be built up during this period to have a multicrop self sustaining system, which will later function as a fish aggregating device (Fig. 2).

Fishes and other marine organisms collected from multicrop farming system

During the period of studies 93 species of fishes belonging to 46 genera and 25 families were collected using the fishing-cum-farming two-in-one trap cages. In addition lobsters, crabs, cephalopods and holothurians were also regularly collected.

Fishes of the family Serranidae, Lethrinidae, Lutianidae, Mullidae, Siganidae, Pomacentridae and Acanthuridae were the common food fishes entrapped. A single trap cage could collect 0.5 to 2 kg of fishes based on the frequency of operation and the availability of fishes. Most of the fishes caught using the trap cages were belonging to the ornamental fishes which are of high export value.

Panulirus homarus and *Panulirus polyphagus* were commonly collected from the farm area. Lobsters of 100 to 180 mm were frequently trapped during November to June which could be used for subsequent farming and fattening. *Scylla oceanica* and *Scylla serrata* measuring 145 to 540 mm were collected from the interspace of cages during July and November, immediately after rains.

Loligo duvaucelli, Sepioteuthis lessoniana, Sepia pharaonis and *Sepiella inermis* use to congregate in the multicrop farming area for depositing their egg masses on the spat collectors and on the cages during October to January period. Fishermen catch them using hooks and lines, at a catch rate of 2 to 5 kg.

Holothurians of the species *Thelenota ananas* weighing 1.5 to 2 kg were occasionally caught from the trap cages.

Settlement of *Ulva* spp, *Caulerpa* spp, *Gracilaria* spp and other green and red algae in the shallow water multicrop farming system indicates the possibilities of farming these algae also along with other animals.

List of edible and ornamental fishes caught

1. Family: **Acanthuridae**

Acanthurus lineatus (Linnaeus), *A. triostegus* (Linnaeus), *A. nigricans* (Linnaeus), *A. edlongatus* (Lacepede).

2. Family: **Apogonidae**

Rhabdamia cypselurus (Weber), *Pristiapogon synderi* (Jordan and Evermann), *Ostrorhynchus nubilus* (Garman), *O.endekataenia* (Bleeker), *O. quadrifasciatus* (Cuvier), *Apogon sangiensis* (Bleeker).

3. Family: **Blennidae**

Istiblennius sp

4. Family: **Callyodontidae**

Callyodon sordidus (Forskal), *C. bataviensis* (Bleeker), *C.sexvittatus* (Ruppell), *C. scaber* (Valenciennes), *C. jordani* (Jenkins).

5. Family: **Canthigasteridae**

Canthigaster amboinensis (Bleeker), *C. cinctus* (Richardson), *C. margaritatus* (Ruppell).

6. Family: **Chaetodontidae**

Chaetodon aurige Forskal, *C. collare* Bloch, *C. melannotus* (Bloch and Schneider), *C. bennetti* Cuvier, *C.vagabundus* Linnaeus, *Heniochus acuminatus* (Linnaeus), *H. monoceros* Cuvier, *Megaprotodon strigangulus* (Gmelin)

7. Family: **Diodontidae**

Diodon hystrix (Linnaeus), *Lophodiodo calori* (Bianconi)

8. Family: **Gaterinidae**

Gaterin nigrus (Cuvier)

9. Family: **Hemirhamphidae**

Hemirhampus georgii (Valanciennes)

10. Family: **Holocentridae**

Holocentrus sammara (Forskal), *H. spinifer* (Forskal), *H. diadema* Lacepede, *Myripristis murdjan* (Forskal).

11. Family: **Labridae**

Labroides dimidiatus (Valenciennes), *Anampses caeruliopunctatus* Ruppell, *Thalassoma janseni* (Bleeker), *Initisteus pavo* (Valenciennes).

12. Family: **Lethrinidae**

Lethrinus harak (Forskal), *L. mahsena* (Forskal).

13. Family: **Lutianidae**

Lutjanus kasmira (Forskal), *L. russelli* (Bleeker)

14. Family: **Monacanthidae**

Paramonacanthus choirocephalus (Bleeker)

15. Family: **Mullidae**

Upeneus tragula Richardson, *U. vittatus* (Forskal), *Parupenius indicus* (Shaw), *P. barberinus* (Lacepede)

16. Family: **Muraenidae**

Echidna delicatula (Kaup), *E. zebra* (Shaw), *E. nebulosa* (Ahl), *E. polyzona* (Richardson), *Gymnothorax pictus* (Ahl), *G. pseudothyrsoidea* (Bleeker), *G. ruppelli* (Meclelland).

17. Family: **Ostraciontidae**

Ostracion tuberculatus Linnaeus, *O. melagris* Shaw, *Rhynchostracion nasus* (Bloch), *Lactoria cornuta* Linnaeus.

18. Family: **Pomacentridae**

Abudefduf bengalensis (Bloch), *Pomacentrus opercularis* (Gunther), *P. pavo* (Bloch), *P. melanopterus* Bleeker , *P. nigricans* (Lacepede), *Dascyllus trimaculatus* (Ruppell), *Amphiprion crysogaster* Cuvier, *Chromis caerulea*(Cuvier), *C.chrysura* (Bliss), *C.nigrurus* Smith.

19. Family: **Priacanthidae**

Priacanthus cruentatus (Lacepede)

20. Family: **Scorpaenidae**

Pterois volitans (Linnaeus), *P. antennata* Bloch, *P. radiata* Cuvier, *Scorpaenodes guamensis* (Quboy and Gaimard), *S. parvipinnis* (Garret).

21. Family: **Serranidae**

Epinephelus tauvina (Forskal), *E. hexagonatus* (Block and Sceneider), *E.merra* Block, *E. fasciatus* (Forskal) , *E. flavocaeruleus* Lacepede, *E. melanostigma* Schultz, *Cephalopolis boenack* (Bloch), *C. miniata* (Forskal), *C. pachycentron* (Valeneiennes), *Grammistes sexlineatus* (Thunberg).

22. Family: **Siganidae**

Siganus stellatus Forskal , *S. canaliculatus* (Park)

23. Family: **Sillaginidae**

Sillago sp

24. Family: **Tetrodontidae**

Tetrodon hispidus Linnaeus, *T. meleagris* Lacepede, *T. stellatus* Bloch and Schneider, *T. nigropunctatus* Bloch and Schneider

25. Family: **Zanclidae**

Zanclus cornutus

Farming of side crop and sea ranching in natural system

Many animals collected from the farm area can be cultivated further as side crops for fettening, brood stock development, sea ranching etc. in the natural system and for extraction of medicines from some of the rare organisms.

Edible and ornamental fishes

The juvenile fishes which get entrapped in cages can be stocked in

separate cages for further fattening and brood stock development. Some of the fishes belonging to the family Serranidae, Chaetodontidae and Pomacentridae are of high commercial value as brood stock and as export commodity. A regular system can be maintained in the farm area for protecting and further fattening of these fishes.

Lobsters and crabs

The experimental results at Vizhinjam indicated that by keeping separate lid for each shelf of the cage, berried lobsters and crabs can be farmed for releasing their larvae into the natural system. This will also help to grow them into commercial size while replenishing the area with the larvae released by them. As there is high competition for the export of lobsters and crabs in the live condition there is decrease in the spawning population. A large scale attempt on the fattening of the under sized lobsters and crabs to the first maturity condition in the natural system using the cages will compensate this situation.

Ascidians, bryozoans, sponges, gorgonids and other marine organisms

The system also attracts and colonizes a wide variety of organisms like sponges, anthozoans, tunicates, gorgonids, annelids, bivalves, brachiopods, echinoderms and algae. Many of them have biochemical compounds with anti viral, anti tumor and anti cancer properties. Thomas and Rani (1987) have discribed the biochemical diversity in sponges and gorgonids listing a series of compounds of medicinal value from these animals.

Marine algae

Just like stocking various animals in the high density stocking cages, different species of algae like *Ulva* spp, *Caulerpa* spp, *Gelidiella acerosa*, *Gracilaria* spp and *Hypnea muciformis* can be stocked in different shelves of the cages placed in shallow tidal areas and the out growths through the large meshes of the netting can be harvested periodically. The antibacterial and antifungal activities of marine algae have been

assessed by and projected the scope for making medicines from these algae by Padmakumar and Ayyakkannu (1997).

Discussion and conclusion

The results of the study presented here show that the multi-crop farming system using the cages function as an efficient fish aggregating device. It is also of interest that in addition to the reef dwelling fishes, other pelagic fishes also congregate in the farm area as reported by James and Lazarus (1996). As the high density stocking cages and the two-in-one cages along with the spat collectors (Nylon frills) give sufficient protection to fishes and other organisms, the biomass production in unit area is also increased considerably compared with other habitats. One of the disadvantage of the 'modules" used for the construction of *conventional artificial reefs* in India and otner developed countries is that the modules are permanently submerged in the sea and are usually in greater depths and consequently the monitoring of the system and harvesting becomes difficult after the establishment of the reef. The cages and other gadgets used for the multicrop farming system is also functioning just like the cement or other types of modules used for developing the conventional reefs and these cages (modules) can be lifted to the surface as and when required just like a "mobile artificial reef" and any desired species can be stocked and farmed at any depth of the sea and can be periodically harvested. Another important advantage is that this type of farming encourages *sea ranching in the natural system* as described elsewhere in this paper and can function as sanctuary for the conservation of desired species. Under the light of this study it is recommended that the multi-crop sea bottom farming system can be taken up at an International collaboration of the maritime countries so that a joint venture of the participating countries will help to increase the biomass of the marine eco system on a global basis and will thereby enhance the marine resource potential. However on a national basis, all the maritime states of India can be co-ordinated for a joint programme for establishing multi-

crop farming system along the Indian coast and this will help to increase the marine production and also will serve as fish aggregating devise to conserve the marine resource.

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