Biofouling problems in open sea cage farming of marine fishes

Biswajit Dash1, Madhumita Das1, Ritesh Ranjan2 and Shubhadeep Ghosh3

Focal Points at a Glance: *In this contribution, the authors deal with measures for preventing biofouling of cages and ensuring related environment management.*

Open sea cage culture has emerged as a potential marine farming system to support the Indian marine fish production and it has opened a new avenue for entrepreneurship. Sea cages are relatively productive and they support high stocking densities. While undertaking the sea cage culture experiments of Asian seabass, *Lates calcarifer*, in Andhra Pradesh and Odisha, several physical and biological problems are encountered which need close attention, and biofouling is one of the major problems (Fig.1,2) among them. Biofouling occurs as a result of settlement, attachment and growth of sedentary and semi-sedentary organisms on nets of cages placed in Sea. They clog the nets and restrict water exchange. Cage culture requires frequent net exchanges because of biofouling. Therefore role of biofoulers is of importance in open sea cage farming in Indian context (Fig.3).

Fig.1 Cage farm at Antarvedi, East Godavari, Andhra Pradesh

Fig. 2 Cage culture at Balasore, Odisha

Fig.3 Biofouling in nets used for open sea cage culture

Fig. 4 Biofoulers attachment in the outer net of the cage

In the marine environment, competition for living space is intense and all surfaces, living or innate, are susceptible to fouling. Basically, biofouling starts with the formation of a bio-chemical conditioning film on to which different micro-organisms colonise. Due to attachment and accumulation of water borne organisms to a surface in contact with water for a period of time, such colonisation affects the crop and its structure. Depending upon the location and the material used for making the cage, deposition on it may vary, but basically it contains diverse assemblage of organisms like algae, sponges, hydroids, polychaetes, molluscs, ascidians and bryozoans (Fig.4). These marine organisms interact among

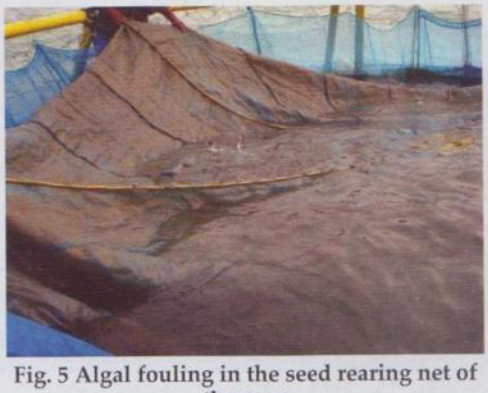

Fig. 5 Algal fouling in the seed rearing net of the cage

Fig. 6 Macrofouler *P. viridis* in cage frame

[1]*Sr.Technical Officer,* [2]*. Scientist,* [3]*Sr.Scienist*
Visakhapatnam RC of CMFRI, Ocean View Layout, Pandurangapuram, Visakhapatnam-530003, Andhra Pradesh

them selves and also with the surrounding environment and affect every aspect of the culture system. During the first stage, adsorption of macro-molecules of proteins takes place. Within hours, micro-organisms like bacteria, algae, protozoa and fungi start attaching and initiate the formation of biofouling which is called micro-fouling. Succession takes place and slowly macro-fouling organisms like seaweeds, barnacles, mussels, ascidians and hydroids start settling. Slowly the growth becomes dense and results in restricting water flow through the cage and cause water quality problems which in turn reduce the fish growth. The assemblage of organisms attached to open sea floating cage is different from those found on other structures and the information related to biological communities attached to cage is scarce. The encrustation rate of bio-fouling on tropical marine cages varies with mesh size and the net frame position. The settling of larval fouling organisms is species-specific in response to water flow. Nevertheless, there are no reported studies on bio-fouling on fish cages in India which is a disadvantage to the mariculture industry in that there is no flow of additional information to increasingly promote efficiency in controlling bio-fouling.

Biofouling problem in open sea cage farming

The investigations on biofouling began with fouling control in ships; and the bio-fouling in aquaculture with specific reference to open sea cage culture has drawn attention in recent years. Biofouling also occurs on the surface of living marine organisms. This aspect caused concern when polyculture of seabass along with oysters and seaweeds is carried out in open sea cages. The diversity and intensity of biofouling in open sea cage culture is very much location-specific, depending on season, geographic location and local environmental conditions. Biofouling is a major problem for aquatic culture systems with many related consequences. The most important problem in open sea cage culture is fouling on cage frames and nets. The fouling also increases the weight of the cage submerged inside water and measures for clearing the fouling organisms are needed to increase the buoyancy of cage. Biofouling reduces the efficiency of net materials, thereby increasing the load on the net and subsequently on the cage. This may result in damaging the net and allowing the fish to escape. Biofouling may eventually clog the mesh of the net walls, thereby reducing the water exchange. This will cause stress to the cultured fish due to oxygen deprivation and waste accumulation. Biofouling communities sometimes directly or indirectly compete for water resources with fish. Multifilament netting used in open sea floating cages offers an ideal substratum for the establishment of biofouling. The diameter and distances between threads also facilitate the establishment of algae and other unwanted animals within the netting strands. Biofouling is exacerbated on aquaculture cages because of the increased nutrient enrichment from wastes released as uneaten feed, fish excretion and faecal production which promote algal growth and may increase risk of damage by underwater currents and the wind action. Usually algal biofouling is frequent in the nets used for rearing of fry of seabass (Fig.5).

Preventive measures and control methods

The first step to avoid biofouling is the selection of a suitable cage material and the locality to carry out the open sea cage culture. The nature of the frame, and particularly its roughness would facilitate quick and increased attachment of submerged organisms. Steel cages can resist fouling and also will have anti-predatory functions. The need for suitable sites requires site accessing and expanding culture operations into new untapped open sea waters. Wide spectrums of chemical biocides are available in the market but their effect on the crop has to be detected. Use of bioactive compounds and acoustics for the control of biofouling may show some promise. As the fish grows in size, the mesh size of the nets should be increased to allow maximum water exchange. However, till now manual methods are being adopted in cleaning the cage frame and the inner and outer nets. The process is energy intensive and it causes incurring of huge labour charges, thereby increasing the cost of production. Bioactive compounds extracted from carapace of Horseshoe Crabs, *Trachypleus gigas* and *Carcinoscorpius rotundicauda* have also antifouling and antibacterial potentials.

Beneficial effects of biofouling

The benefits we get from biofouling organisms are usually characterised by efficient detritus accumulation and in turn enriching the grazing food chain. Considering the feeding habit, monoculture or polyculture of suitable candidate species can be recommended for periphyton-based sea cage culture. Biofouling organisms act as biofilters by extracting pollutants and pathogenic micro-organisms, precipitating suspended particles and thereby purifying the surrounding water. The ecological role of biofouling communities make them an effective instrument of environmental protection in particular, restoring perturbed ecosystems by means of artificial reefs which are colonised by foulers and accompanying organisms. Soft-bodied fouling organisms may reduce abrasion effects on caged fish and would provide supplemental foods for different cultured fishes. Microalgal fouling in cages can reduce ammonia levels because of feeding and the excretion of fish. Some specific biofouling organisms also function as an efficient biological sink for particulate organic matter released from fish cages, thus serving to transform or recycle waste nutrients into other usable forms. Biofouling may also provide protective habitat for larval fishes.

Measures for environmental management

While conducting cage culture experiments, there is a need to exchange the nets fortnightly or monthly depending upon the rate of fouling. Thus the impact of biofouling in open sea cages is staggering and there is a need to make environmental manipulations to decrease the rate of biofouling in open sea cage culture ecosystem. Green mussel, *Perna viridis* is widely distributed in tropical and subtropical Asia. It forms a good and cheap source of animal protein. It is also an important cultivable species in China and Southeast Asian countries. While conducting cage culture experiments of marine fishes in the coastal waters of Andhra Pradesh and Odisha, heavy colonisation of *Perna viridis* was observed in the frame structure and in both inner and outer nets of the cage (Fig.6). *Perna viridis* is an important macrofouler, while at the same time, it is a promising edible oyster. *Perna viridis* can be cultured along with marine fishes in open sea cages in boxes tied both in the inner ring and also in the outer ring of the cage. These green mussels act as biofilters, and thus will reduce the nutrient load from the cage and maximum biofouling will be confined to the mussel boxes. Similarly, the mussels tied in the outer ring will derive maximum nutrients flowing out from the cage, providing a better water quality inside the cage. As fouling inhibition is the most desirable way of avoiding biofouling, it is suggested for undertaking integrated open (offshore) cage culture of marine fish with green mussel *Perna viridis* in boxes tied to both the inner ring and the outer ring of the

cage for reducing biofouling and for harvesting maximum yield from the culture system.

Conclusion

Development of offshore cage culture will accelerate the promotion of marine finfish and shellfish industry. In this context, study of biofouling organisms attached to cages and their rate of accumulation is needed. The composition of marine biofouling organisms attached to open sea floating cages and the net materials during the culture period should be evaluated according to seasonal diurnal variations and also with relation to the predominant underwater current. Ecological benefits of biofouling should also be considered as part of developing appropriate prevention and control methods in this respect in open sea floating cage cultural practices. Baseline data must be generated with relation to distribution of biofouling organisms in east and west coasts of India and their effective control measures and culture of candidate species, which will facilitate propagation of open sea cage culture (stationary or floating) in India, contributing considerably to improve the livelihoods of the mankind, particularly fishers.