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Preliminary studies on the impact of open sea cage culture of *Lates calcarifer* (Bloch) on the planktonic and benthic fauna off Cochin, Kerala

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ABSTRACT

The plankton and benthic macrofauna in relation to the open sea cage culture of *Lates calcarifer* during the period from October 2008 to March 2009 off Munambam near Cochin were studied. The cage site and a reference site were selected for simultaneous sampling. During the study, the cage culture activity was not found to influence the plankton population but there is an indication of its influence on the benthic macrofauna.

Keywords: Benthos, Cage culture, Cochin, Phytoplankton, Zooplankton

The open sea cage culture is an effective avenue to augment fish production from the sea. Countries like China, Malaysia, Thailand, Philippines, Japan and Australia have made great strides in sea cage culture. In India, open sea cage culture was launched in the sea off Visakhapatnam for the first time and successful harvesting of the fish was demonstrated in April, 2008. In Kerala, for the first time, a sea cage for rearing the Asian seabass *Lates calcarifer* was launched off Munambam, near Cochin. The cage was circular in shape with a diameter as well as depth of net portion equal to 6 m. The cage frame was made up of HDPE pipes fitted with Poly Urethene Foam (PUF). It was assumed that there would be some changes in the faunal composition of plankters and benthos associated with cage culture, as the cage would be stationary and uneaten feed and faecal matter would be available around the cage. The cage was stocked with *Lates calcarifer* in December 2008 and the fish were fed with trash fish along with growout pelleted feed @10% of body weight. The fishes were harvested in April 2009. An attempt was made to monitor the changing pattern of plankters and benthic fauna in and around the cage culture site.

Samples of phytoplankton, zooplankton and macrobenthos were collected from the cage site as well as from a reference site before and during the culture period. Simultaneous samplings from both the sites were carried out at monthly intervals prior to stocking and at fortnightly intervals after stocking. The fish cage site was located about 2 km away from the shore having a depth of 10 m (N 10° 08.162´; E 76° 08.901´) and the reference site was fixed 2 km away from the cage site towards south (N 10° 07.189´; E 76° 09.210´), having the same depth of 10 m. One litre of water sample was collected on each occasion for genus level identification of phytoplankton and their quantification in cells per litre was carried out as per Gopinathan *et al*. (1974). The zooplankton samples were collected using the method adopted by Rajagopalan *et al*. (1992) and groupwise counts of zooplankton per 100 m^3 of water were recorded. Benthos was collected using a 0.05 m^2 van Veen grab and the macrobenthos were expressed as number per m^2 (Ambika and Pillai, 1990). ANOVA tests were carried out using SPSS 10 software, to understand the variations of phytoplankton, zooplankton and macrobenthos between cage and reference sites.

Twenty two genera of phytoplankters were recorded from the study sites, comprising both the cage and reference sites. They were *Asterionella*, *Chaetoceros*, *Rhizosolenia*, *Melosira*, *Thalassiothrix*, *Biddulphia*, *Coscinodiscus*, *Ditylum*, *Thalassiosira*, *Thalassionema*, *Ceratium*, *Nitzschia*, *Surirella*, *Skeletonema*, *Navicula*, *Pleurosigma*, *Cyclotella*, *Dictyocha*, *Oscillatoria*, *Fragilaria*, *Prorocentrum* and *Peridinium*. The distribution of phytoplankton at the cage and reference sites, prior to and during the culture period is depicted in Fig. 1.

The density of phytoplankton was higher at the cage site than at the reference site before as well as during the culture period (Fig. 1). The average density of phytoplankton observed before and during the culture period at the cage site were 0.86 x 10^4 and 0.45 x 10^4 cells per litre and that at the reference site were 0.24 x 10^4 and

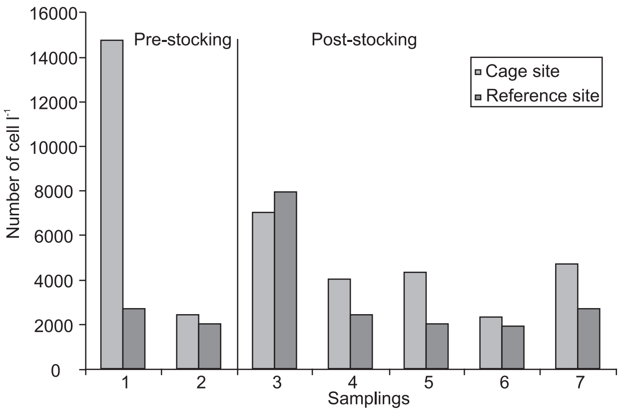

Fig. 1. Distribution of phytoplankton during the study period

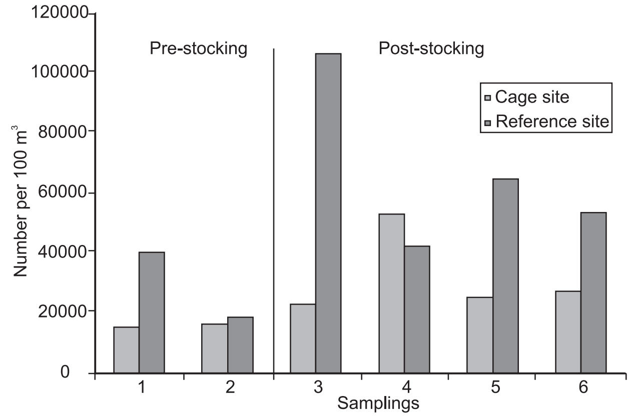

Fig. 2. Distribution of zooplankton during the study period

0.34 x 10^4 cells per litre of seawater respectively. This indicates that the phytoplankton density was always higher at the cage site which can be due to the natural characteristics of the site. Thus the cage culture activity was not found to influence the phytoplankton population in the study area during the present investigation. In October, the concentration of phytoplankton was observed to be very high at the cage site which was due to a bloom of *Chaetoceros* sp. Again, in January, an increase was recorded in the cell density at the reference site which was due to the abundance of *Rhizosolenia* sp. But during these blooms, there was not much difference in the composition of phytoplankton between the two sites. In the case of nutrients (nitrate, phosphate and silicate) in water, no significant alterations as influenced by cage culture were detected (D. Prema, personal communication). No significant variation ($p>0.05$) was observed in majority of phytoplankton genera between the cage and reference sites, before or during the culture period. Demir *et al*. (2001) while studying the influence of cage culture of trout on plankton in an Antolian dam lake, also observed no fundamental difference in the composition of phytoplankton between the two stations studied.

A total of twenty groups of zooplankters were recorded from the study area, *i.e.,* from the cage and reference sites together. They were copepods, chaetognaths, bivalve larvae, cladocerans, siphonophores, zoea stage of crab, appendicularians, fish eggs, fish larvae, prawn larvae, *Lucifer* sp., medusae, amphipods, *Creseis acicula*, gastropod larvae, polychaete larvae, foraminiferans, tintinnids, ostracods and balanid nauplii. The quantitative distribution of zooplankton at the cage culture site and at the reference site before and during the culture period are depicted in Fig. 2.

The zooplankton density was higher at the reference site than that of the cage site before as well as during the culture period. The overall mean values of zooplankton at the cage site before and after stocking the cage were 1.58 x 10^4 and 3.22 x 10^4 and the same at the reference site were 2.94 x 10^4 and 6.68 x 10^4 numbers per 100 m^3 respectively. The variation in the abundance of zooplankton in different stations might be attributed to the patchy nature of zooplankton distribution. Again, the statistical analyses of the data showed that there was no significant variation in the zooplankton population between the cage and reference sites, before or during the culture period. There was also not much variation in the composition of zooplankton among the two sites. This indicated that the zooplankton fauna in the study area was not influenced by the cage culture activity.

Six groups of benthic organisms, *viz.,* foraminiferans, bivalves, gastropods, polychaetes, copepods and amphipods were recorded from the two study sites together. After stocking fishes in the cage, the macrobenthos increased considerably at the cage site as compared to that at the reference site, but before stocking the fishes, the population was more at the reference site compared to the cage site (Fig. 3). This increase of macrobenthos at the cage culture site after stocking fishes could probably be due to the accumulation of wastes from the cage in the form of excreta of fishes and uneaten feed. The organic carbon content of the mud, studied simultaneously was also found to be less at the cage site than that of the reference site throughout the culture period, even though the reverse was true for one sampling before stocking the fish in cage (D. Prema, personal communication). It is significant to mention here that the sedimented organic matter is effectively consumed by benthos (Govindan, 2002) and that might be the reason for lower organic carbon at the cage site after stocking. Variation of macrobenthos between cage and reference sites was not significant before the cage culture period, but during the cage culture period the variation was found to be significant ($p<0.05$) in the case of total macrobenthos. The mean numbers of macrobenthos at the cage site before and during culture were 6.12 x 10^4 and 226.66 x 10^4 and those at the reference site were 316.18 x 10^4 and 3.92 x 10^4 number per m^2 respectively. This indicates that the number of macrobenthos increased tremendously after stocking while at the reference site the number of macrobenthos decreased significantly during the same period, which may be due to the influence of cage culture on the macrobenthos. While studying the influence of cage culture of trout on benthos in an Anatolian dam lake, Demir *et al*. (2001) also observed that the abundance of benthos was the highest in the cage station. As the composition of macrobenthos at both the sites did not vary much throughout the period, it is assumed that the cage culture has not influenced the composition of macrofauna in the area. Demir *et al*. (2001) while studying the influence of fish cage culture on benthos also found that the composition of benthos did not differ among stations. But, while examining the impact of a seabass (*Dicentrarchus labrax*) cage farm on macrobenthic communities in Croatia, Katavic and Antolic (1999) found that the benthic flora and fauna were quite rich and diverse, but with respect to its composition, structure and distribution, some benthic components were found clearly affected by the fish farm.

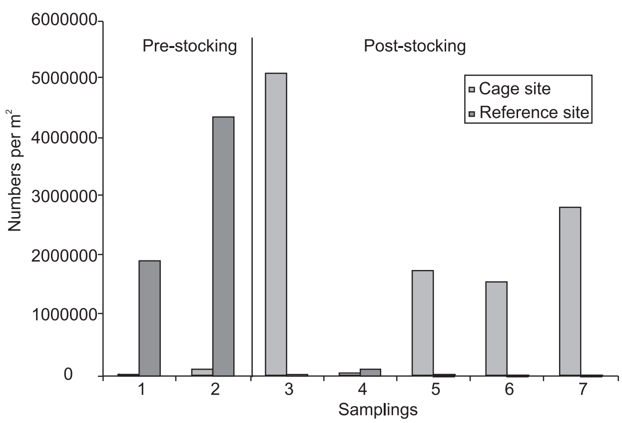

Fig. 3. Distribution of macrobenthos during the study period

The present study revealed that the cage culture activity has not influenced the production of phytoplankton and zooplankton but there is an indication of its influence on macrobenthos. As the distribution of phytoplankton and zooplankton are patchy in nature and the macrobenthos affected by the water currents, long term studies with more frequent samplings have to be attempted to arrive at reliable conclusions.

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