and cotoxicity factor +43.45 and +32.76 at 48 and 72 h were high. This indicated potentiation or synergism in *entomocidus* and *berliner* combination (Table 2).

Kurstaki strain was less toxic since the mortality was only 43% in 72 h, even at a higher dose (Figure 3). When it is jointly used with *aizawai*, the mortality was 48% in the lowest dose, which was higher than in both the strains applied individually. The cotoxicity coefficient was 682.2 ± 567.6 and 151.81 ± 32.89 and the cotoxicity factor was +110.8 and +67.08 in 48 and 72 h respectively (Table 2). This suggested a synergistic action when these strains were combined. Similarly high toxicity was noticed when *aizawai* HD133 and *kurstaki* HD1 were jointly administered to *Heliothis armigera* (Hubner)[6] and *entomocidus* and *kurstaki* HD73 to *S. littoralis*[6].

The outcome of this study may be used practically for activation of mild strains or controlling the pests occupying similar ecological niche but susceptible to different strains. Joint application of strains showing synergism may be useful.

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Prospects and problems in cage culture of giant tiger shrimp in Vellar estuary

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The culture of the giant tiger shrimp *Penaeus monodon* was planned to be carried out for 90 days covering premonsoon and monsoon seasons in a cage (5 × 4 × 1 m) in Vellar estuary, feeding with a supplementary feed. Seeds (65 mm in size and weight 1.5 g) were stocked at the rate of 120,000 seeds/ha (240 seeds/20 m^2). The juvenile shrimps were fed twice a day with the pelletized feed to 10% of their body weight. The average length of the shrimps after 60 days was 127 mm and the average weight was 17.8 g having a growth rate of 1.03 mm and 0.27 g per day. The autoentrants were also collected and recorded. The culture experiment could be carried out only for 60 days after which there was an unprecedented flood lasting for 10 days in Vellar estuary due to maximum rainfall in the season, which ultimately damaged the cage, resulting in total loss of shrimps. The environmental parameters like salinity, temperature, hydrogen ion concentration and dissolved oxygen were monitored fortnightly and were found to be ranging from 0.3 to 30.0‰, 24 to 34°C, 7.5 to 8.4 and 3.6 to 5.7 ml/l respectively.

ALONG with the traditional culture practised in a few states of India, the intensive culture practices are also slowly coming up. The cage culture method is being practised in countries like Indonesia, Thailand, Japan, Malaysia, Singapore, etc. Since it is a three-dimensional culture, it gives enough room for optimum utilization of its potential.

Some pilot scale cage and pen culture studies were done in areas like Tuticorin[1,2], Kovalam[3,4], Ennore estuary[5], Kundakkal channel[6] and Killai backwaters[7,8]. Vellar estuary is one of the few estuaries in India thoroughly studied but its potential for culture practices has not been exploited so far. We used the culture of *Penaeus monodon* in a cage to study the suitability of cage culture operations of giant tiger shrimp *P. monodon* in Vellar estuary during the premonsoon and monsoon seasons and the prospects and problems involved.

A cage of the size of 5 × 4 × 1 m made of synthetic velon screen with 16 p mesh size was erected in Vellar estuary in such a position that two-thirds of the cage was kept inside the water column and the bottom of the cage about 30 cm above the bottom sediments[4]. The *P. monodon* seeds were collected from Vellar estuary using a push net having a mesh size of 1.5 mm. The seeds of almost uniform size (from tip of the rostrum to telson 65 mm length and 1.5 g in weight) were selected and acclimatized in a hapa in the estuary itself and then released into the cage after 2 or 3 days at a stocking density of 240 seeds/20 m^2 (120,000 seeds/ha).

The animals were fed at the rate of 10% of the body weight assuming a 100% survival in the cage in two instalments at dawn and dusk. The feed was formulated using the locally available ingredients such as cuttle fish (24%), fish meal (24%), prawn head waste (12%), rice bran (5%), ground nut oil cake (10%), maida (10%), tapioca flour (14%) and fish oil (10%). The amount of feed in the first 15 days of culture was about 36 g/day and after every 15 days, the amount was raised to 105 g, 218 g, 333 g and 427 g respectively depending upon the

weight increase. The gut of the sample was checked after a few hours of placing the feed on the plates, to find out whether the shrimps had fed on the feed or not. Fortnightly samplings were done to assess the growth gain in terms of increase in length and weight.

The seeds were stocked in the cage on 20 August and the harvest was scheduled on 17 November 1991 (90 days) covering premonsoon and monsoon seasons.

The salinity in the cage varied from 0.30 to 30.0‰, the temperature between 24° and 34°C and the pH between 7.5 and 8.4 throughout the culture period. The general tendency of the pH of the water was slightly alkaline. The dissolved oxygen concentration in the water varied from 3.6 to 5.7 ml/l.

During the year of the study, the area received heavy rainfall in October and November. The average rainfall during October was 46.0 mm, due to which the Vellar estuary was flooded and the salinity dropped very low, but did not damage the cage. In November the average rainfall till 13 November was 34.7 mm. The highest rainfall of 119 mm was recorded on 13 November and the resulting heavy flood damaged the cage.

The average growth attained after 60 days only of the culture period could be observed. The average length attained at the last sampling was 127 mm and the weight was 17.8 g. Therefore, the rate of growth attained was about 1.03 mm/day and the weight 0.27 g/day (Table 1). There was no total production during this study, due to the unprecedented heavy rainfall during the monsoon season resulting in devastating floods in Vellar, which damaged the cage resulting in 0% recovery of shrimps (Table 2) afterwards.

Table 1. Growth rate of *Penaeus monodon* in the cage

Number stocked	Length and weight at rearing period		Growth rate/day		
	I mon.	II mon	I mon.	II mon	Average
240/20 m^2	108	127	1 43	0.63	1 03 (in mm)
240/20 m^2	9 8	17 8	0 25	0 29	0 27 (in g)

Table 2. Summary of the experimental cage of *Penaeus monodon* (60 days)

Cage type	: Fixed
Cage size	: 5 × 4 × 1 m
Species cultured	: *Penaeus monodon*
Date of stocking	: 20 8 91
Numbers stocked	: 240
Rate of stock/ha	: 120,000
Initial average length	: 65 mm
Initial average weight	: 1 5 g
Supplementary feed	: Pelletized feed
Rate of feeding (% body weight)	: 10%
Date of last sampling	: 18 10 91
Average length observed	: 127 mm
Average weight observed	: 17 8 g
Increase in length	: 62 mm
Increase in weight	: 16 3 g

During this study the observed autoentrants were *Metapenaeus* spp., *Macrobrachium* sp. and *Acetes* sp. Among the finfishes *Ambassis* sp. formed the major portion and the other finfishes like *Periophthalmus* sp. and *Diodon* sp. were also seen.

Biotic and abiotic factors and their interrelationship determine the quality and quantity in a natural system. The growth and survival of the cultured shrimps also are influenced by these natural factors[9,10]. The cage culture was adopted due to its advantages as stocking density can be increased to several folds. Unlike the pond culture various problems such as temperature, salinity and accumulation of metabolites can be avoided here[4]. A greater growth rate of shrimps in natural water than in ponds is because there is a natural replenishment of nutrients and the metabolites are washed off from the cages due to the movement of water[10,11].

The density of population and availability of space for individuals has an impact on the growth of shrimps[4]. The growth rate of shrimps had been reportedly low due to overcrowding and lack of sufficient feed which caused an inverse relationship between stocking density and growth rate[12,13]. But the density of 12 m^2 was observed not to cause overcrowding and the problem due to insufficient feed was also not observed in the present study, since the shrimps were fed with supplementary pelletized feed in sufficient quantity.

The supplementary feed is very important to get a better growth rate in shrimp culture[3]. This study confirms that the supplementary feeding certainly enhances the growth.

The major portion of the culture period was carried out during the premonsoon season (August and September) and so the salinity of the estuary dropped gradually in the beginning of the monsoon (November). During this period the shrimps were still found to be very active and tolerated the very low salinity up to 2.5%. But when there was a sudden flood in the estuary the disaster of mortality of shrimps was experienced. Even in this situation of low salinity of 0.3%, the shrimps were surviving but were sluggish and were found to be present at the bottom of the cage. But on 13 November there was a cyclone followed by unprecedented floods and the cage got buried under lilysilt. Thus the study ended abruptly due to the natural calamity. Hence it is suggested that culture sites for cage culture should not face such problems.

In conclusion, the present study was not overly successful in terms of the final gain even though there seems to be a better growth of the shrimps. The culture of *P. monodon* could be carried out during the monsoon season as it is able to tolerate the lower salinities prevalent in the season, but has to be carried out in safer places to reduce the damages to the cage. Further, the present study indicates that the rage of monsoon is very unpredictable and it is very risky to go for cage culture in this season.

Other problems involved in cage culture are clogging, fouling and autoentry. Out of these, the first two problems could be solved through periodical cleaning of the cage wall using a brush. Similarly the problem of autoentry could be solved to a certain extent by the periodical removal of the autoentered fin and shellfishes using scoop net or hand net.

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Effect of bacterial ulcer on the haematology of *Channa punctatus* (Bloch.)

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Haemoglobin concentration and RBC count were made in control and ulcerative *Channa punctatus*. Bacterial ulcer caused an abrupt decrease in the number of erythrocytes along with reduction in the amount of haemoglobin. The loss of water from the plasma and tissue via wound proved to be anti haemopoietic and a reason behind fish death.

LIKE all animals, fishes have their full complement of disease and parasites and of abnormalities both malignant and benign. The ulcerative fish disease in epizootic form in some areas of Eastern Indian states such as Tripura, Meghalaya, Assam and West Bengal was reported in May 1988. The disease severely affected almost all districts of West Bengal[1]. Later the disease also spread to Orissa, Bihar, UP, Sikkim, Manipur and Nagaland.

Two fluorescent pseudomonads (R_1 and R_2), one aeromonad, *Aeromonas hydrophilia* (R_3) and *Micrococcus* variant (C) were isolated from the ulcer tissue of air-breathing fishes[2]. Other workers also studied the cause of ulcer and its effects on fishes[3–12].

The findings and views of earlier workers are not uniform and scanty work has been done on the haematological alterations in fishes due to ulcer. Hence, it seems necessary to study the changes in haematological parameters of fish due to ulcer on its induction.

The commonly available freshwater teleost, *Channa punctatus* was used as experimental animal, since this fish along with others was found to suffer from ulcer. Fishes were collected from ponds and swamps of Darbhanga. Care was taken to collect healthy and infected specimens. The healthy fishes were acclimatized in the laboratory aquarium for a fortnight with proper supply of fish-feed. The ulcer was induced in healthy fishes keeping a few ulcerative fishes amongst healthy ones. Blood was collected in a plastic syringe using EDTA as an anti-coagulant directly from cauda dorsalis. Haemoglobin was estimated by acid-haematin method[13]. Erythrocyte count was made by Thoma Zeiss haemocytometer[13].

The weight of healthy males was 47 ± 0.7 g. In these, the haemoglobin content was 14.99 ± 0.328 g% and the RBC count was $4.1016 \pm 0.178 \times 10^6$ mm^{-3}. The ulcerative males weighed 48.8 ± 0.55 g. The haemoglobin content and RBC count were 7.65 ± 0.221 g% and $1.8222 \pm 0.157 \times 10^6$ mm^{-3} respectively. Ulcer caused an abrupt and significant fall in the level of haemoglobin as well as in the number of erythrocytes (Table 1).

The control and ulcerative female specimens weighed 50 ± 0.65 g and 52.8 ± 0.67 g respectively. The haemoglobin content and number of RBC recorded in healthy fishes were 13.21 ± 0.203 g% and $3.7085 \pm 0.221 \times 10^6$ mm^{-3} respectively. In ulcerative females the haemoglobin content was 5.56 ± 0.296 g% and RBC count was $1.729 \pm 0.159 \times 10^6$ mm^{-3}.

Thus both haemoglobin and RBC count followed the same pattern as in the case of male specimens. The haemoglobin content and RBC count were higher in males than in females. However, the decreasing trend was similar in both the sexes.

Since the haemoglobin content of blood is directly related to the number of erythrocytes, in the present investigation the number of erythrocytes fell to a great extent. Thus, erythropaenia in the present work might be the reason behind the decrease in the concentration of haemoglobin.