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Note

Effect of stocking density on size heterogeneity and sibling cannibalism in Asian seabass *Lates calcarifer* (Bloch, 1790) larvae

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ABSTRACT

The effect of three stocking densities (4, 8, 12 no. l⁻¹) on size heterogeneity, sibling cannibalism and growth of Asian seabass larvae were studied. Fish stocked at the intermediate stocking density (8 no. l⁻¹) recorded the lowest survival (13.73 ± 0.69 %) and highest cannibalism percentage (17.71 ± 5.44 %), while the maximum survival (22.63 ± 4.13) was recorded at the lowest stocking density. Lowest growth rate (334.72 ± 68.26 %) was recorded at the lowest stocking density. Coefficient of variation and size heterogeneity showed a direct relation to stocking density. Some contrasting results observed in the present study have been attributed to the life stage and social nature of species involved.

Keywords: Cannibalism, Growth, *Lates calcarifer*, Size heterogeneity, Stocking density, Survival.

One of the major challenges faced during hatchery rearing of Asian seabass *Lates calcarifer* is size heterogeneity which is both the cause as well consequence of cannibalism (Kestemont *et al.*, 2003). A study at Van Diemen Gulf, Australia showed that cannibalism contributes up to 11% to the diet of the fish (Smith and Reay, 1981; Davis, 1985). In European seabass *Dicentrarchus labrax*, 37% fish were found to be cannibalistic accounting to 66% losses in six weeks (Katavic *et al.*, 1989). Consequences of size variation at larval stage are more drastic due to larger mouth to body size ratio permitting cannibalism on prey that are even slightly smaller (Baras, 1998). The need for more efficient early stage production has been acknowledged globally in species such as seabass due to relatively low survival rates. The present experiment was aimed at studying the effect of stocking density on growth, survival, sibling cannibalism and size heterogeneity in the Asian seabass, *L. calcarifer*.

The experiment was set up with 18 day old sea bass larvae (mean initial wt = 5.44 ± 0.016 mg; mean initial length = 7.26 ± 0.15 mm) produced in the Asian seabass hatchery, Central Institute of Brackishwater Aquaculture (ICAR), Chennai. The experiment was conducted in well aerated; indoor 5 l capacity cylindrical plastic containers. The treatments comprised three stocking densities *viz.*, 4, 8 and 12 no. l⁻¹, each tested in quadruplets. Feeding was done with *Artemia* nauplii (5 no. ml⁻¹). Water was exchanged twice daily. Mortality and cannibalism were recorded everyday. Dead fish were classified into cannibalised and non-cannibalised based on the injuries

and intactness. This along with a daily count of missing fish gave the estimate of cannibalism. Temperature, dissolved oxygen, salinity, pH, ammonia, nitrite and alkalinity recorded daily were found to range between 29-32 °C, 4.3-5.9 ppm, 28-30 ppt, 7.4-7.9, 0.02-0.12 ppm, 0.001-0.063 ppm and 149-160 ppm respectively. Final individual wet weight was measured in order to estimate growth and coefficient of variation. The parameters recorded at the end of 15 days of the experiment included survival (%), observed mortality (%), cannibalism (%), final individual standard lengths (mm), growth (%) and coefficient of variation (%). Cannibalism (%) was expressed as $100 \times \{ \text{Number of fish}_{\text{Initial}} - (\text{Number of fish}_{\text{Final}} + \text{Number of dead fish registered}) \} / \text{Number of fish}_{\text{Initial}}$. The rate of cannibalism was estimated by counting the number of missing fish expressed in proportion to the shooters (identified visually by swollen abdomens and relatively high growth increments). Growth (%) was expressed as: $100 \times (\text{Average final weight} - \text{Average initial weight}) / \text{Average initial weight}$. Coefficient of variation (%) was estimated using weight variation as (standard deviation of individual weight/mean individual weight) × 100. Size heterogeneity (weight) was estimated as final coefficient of variation/ initial coefficient of variation.

Survival ranged from 13.73% to 22.63% with the intermediate stocking density recording the lowest survival. The highest survival was recorded in the group with the lowest stocking. Cannibalism contributed to 11.19-17.71% of the total mortality. The intermediate stocking density showed highest cannibalism percentage of 17.71%.

Satisfactory growth was recorded from 334.72% in the lowest stocking density to 464.34% in the intermediate stocking density group. Coefficient of variation (%) ranged between 50.65 and 104.2% and showed a direct relation with stocking density. Size (weight) heterogeneity ranged between 2.64- 5.43 from the lowest to the highest stocking density treatment (Table 1).

Table 1. Effect of stocking density on survival, cannibalism, growth and coefficient of variation in *Lates calcarifer*

Parameters	Stocking density		
	4 no. l ⁻¹	8 no. l ⁻¹	12 no. l ⁻¹
Survival (%)	22.63 ± 4.13	13.73 ± 0.69	15.44 ± 2.23
Observed mortality (%)	66.17 ± 0.49	68.55 ± 5.67	74.66 ± 5.69
Cannibalism (%)	11.19 ± 3.89	17.71 ± 5.44	11.73 ± 3.83
Final individual weights (g)	0.0237 ± 0.004	0.0307 ± 0.006	0.0303 ± 0.004
Growth (%)	334.72 ± 68.26	464.34 ± 115.29	456.98 ± 63.65
Coefficient of variation (%)	50.65 ± 18.89	95.48 ± 15.82	104.2 ± 19.09
Size heterogeneity	2.64 ± 0.99	4.98 ± 0.83	5.44 ± 0.99

Some of the contrasting results observed in the study can be attributed to the social nature of the species and the life stage involved. Cannibalism did not show any particular trend but seems to agree with the hypothesis that at low stocking densities cannibalism is low due to lower chances of prey encounter (Baras and Jobling, 2002). Cannibalism increases with stocking densities but with further increase, cannibalism may show a reduction as the predator may get confused and display a lower efficiency to hunt prey (Baras, 1999). Similar observations were made by Pienaar (1990) in African catfish, *Clarias gariepinus*, where territoriality, agonistic behaviour and cannibalism initially increased with stocking density and later subsided after a peak (Hecht and Pienaar, 1993). Highest cannibalistic rate is reported at intermediate stocking density. The trend in cannibalism is reflected in the overall survival percentage also. The percentage of survival is highest at the lowest stocking density in agreement with the results of Kestemont *et al.* (2003) in post-larvae of European seabass. Overall, the survival percentage reported in the present study is relatively low owing to the static culture system used.

It was worth noting that in the initial stage, the chief cause of mortality was natural causes while cannibalism took a more significant role in the later stage. Once the cannibals were established, the rate of consumption observed was approximately one prey per day. Cannibals could be visually identified by swollen abdomens and the relatively fast size increments. At the end of the experiment, the number of cannibals were inversely proportional to the stocking density which may be explained by the increased potential to establish territories at lower stocking density. But the data cannot be correlated with the rate of cannibalism because the time of establishment of these

cannibals may not necessarily be the same. However, this helps to explain the results in size heterogeneity and coefficient of variation which showed a similar trend with high stocking densities displaying relatively higher size variations. The higher number of cannibals that developed at low stocking densities possibly ensured greater size uniformity at lower stocking density.

The trend in percentage of growth was observed to be opposite to the conventional observations of higher growth rates at low stocking densities. In cannibalistic species, fish stocked at low stocking densities may spend more energy in maintaining territory and aggression than for foraging (Hecht and Uys, 1997) as opposed to higher stocking densities where the fish is unable to maintain and defend territories and simultaneously gain good access to food. Kestemont *et al.* (2003) also reports slow growth rates at higher densities in post-larvae of European seabass. Hence under the given conditions, intermediate stocking densities seemed to have a positive impact on seabass post-larvae owing to the density dependent access to food.

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