Note

Length-weight relationship, condition factor and cannibalism in Asian seabass *Lates calcarifer* (Bloch, 1790) reared in nursery

PREM KUMAR, M. KAILASAM, P. MAHALAKSHMI, R. V. BORICHANGAR*, G. J. VANZA*
AND C. GOPAL
*ICAR-Central Institute of Brackishwater Aquaculture, 75- Santhome High Road, R. A. Puram, Chennai - 600 028,
Tamil Nadu, India*
Soil and Water Management Research Unit, Navsari Agricultural University, Navsari - 396 450, Gujarat, India
e-mail: prem.cife@gmail.com

ABSTRACT

The length-weight relationship of Asian seabass *Lates calcarifer* (Bloch, 1790) reared in net cage hapa was studied for a period of 45 days. A total of 22,500 nos. of seabass fry (mean length 1.76 ± 0.39 cm; mean weight 0.132 ± 0.10 g) were stocked in fifteen hapas @ 1500 nos. per hapa (2x1x1m) and fed twice daily with farm made feed @ 10% of the body weight initially and reduced to 8% later on. Sampling was done at an interval of 15 days to assess the growth, survival, cannibalism and performance. On termination of the experiment, survival was 25%. Cannibalism contributed 11–51% to the total mortality. K value >1 indicated healthy condition of fish. During the entire culture period, growth was negatively allometric ($b<3$). Growth showed an increasing trend from 150.5 ± 13.4 to 732.6 ± 7.7. The study concludes that the hapa system is one of the best option for carrying out the nursery rearing of seabass.

Keywords: Condition factor, Growth, *Lates calcarifer*, Nursery rearing, Seabass, Survival

Asian seabass *Lates calcarifer* (Bloch, 1790) commonly known as bhetki or barramundi is an economically important food fish in the tropical and subtropical regions of Asia and Pacific. It is suitable for culture in marine, freshwater and brackishwater ponds and cages (Mojjada *et al.,* 2013; Ganzon-Naret, 2013). In India, potential of *L. calcarifer* farming has increased after the successful induced breeding of the species for the first time by Thirunavakkarasu *et al.* (2001). Nursery rearing is a crucial phase in *L. calcarifer* farming, to reduce cannibalism and size heterogeneity in grow-out pond. Condition factor (K) and length-weight relationship (LWR) are two important indicators in management of culture systems as they provide information on the specific conditions under which organisms are growing (Araneda *et al.*, 2008). Condition factor is a quantitative parameter estimated based on length-weight data which indicates the state of wellbeing of the fish (Hossain *et al.*, 2006). There are ample literature available on LWR and condition factor of the Asian seabass from different types of culture systems such as closed recirculatory systems (Volvich and Appelbaum, 2001), saline soil pond culture systems (Venugopal *et al*., 2003), wild collection (Rajkumar *et al.*, 2006), larval rearing in tank system (Kailasam *et al.*, 2006), tide fed pond where fishes are fed with live prey and trash fish (Biswas *et al*., 2011) and pond culture system with formulated feed (Solanki *et al.,* 2013). However, no published information is available on LWR, growth, condition factor and cannibalism

of *L. calcarifer* during nursery rearing in net-cage hapas. The present study was conducted to examine these parameters of *L. calcarifer* during nursery rearing in net-cage hapa using farm made feed.

The study was conducted in an aquaculture farm in Onjal, Navsari District, Gujarat, India for a period of 45 days. The newly excavated ponds were dried, filled with tidal water, bleached with bleaching powder (available chlorine 30%) @ 300 kg ha^{-1} and calcium carbonate @ 100 kg ha^{-1}. Further, 15 nos. of nylon net cage hapas (mesh size 1.5 mm) of size 2x1x1m were fixed in the pond. A total 22,500 nos. of seabass fry (mean length 1.76 ± 0.39 cm; mean weight 0.132 ± 0.10 g) were stocked in the hapas @1500 nos. per hapa and fed twice daily with farm made feed @ 10% of biomass initially which was later reduced to 8% and continued till the end of the experiment. Seabass nursery feed (40% protein and 8% lipid) developed by ICAR-Central Institute of Brackishwater Aquaculture (ICAR-CIBA) was steam cooked for 30 min., cooled to room temperature and mixed thoroughly with commercial vitamin and mineral mixture (1%) along with cod liver oil (0.5%), made into small balls of 5 cm dia and placed in feeding trays fixed inside the hapa. This feed was prepared fresh every day. Grading of fish based on size was performed during the 45 days of nursery rearing at an interval of 5 - 6 days. Three samplings were done at fortnightly intervals *i.e.* on 0, 15, 30 and 45 days of culture (DOC) to measure

total length (L) in cm, weight (W) in g of fish (n=150). Water samples were collected at 15 days interval for analysing physicochemical parameters such as temperature, pH, dissolved oxygen (DO), salinity, nitrite nitrogen (NO_2-N), total ammonia nitrogen (TAN) and phosphate (PO_4^{3-}) (APHA, 1989). At the end of each sampling parameters *viz*., growth rate (GR), specific growth rate (SGR), growth (%), survival rate (%), cannibalism (%), coefficient of variation (CV%), performance index (PI) and size heterogeneity (SH, weight) were estimated. The mathematical relationship between length and weight was calculated at each sampling using the conventional formula $W = aL^b$, by regression after log transformation (Pauly, 1993).

The parameters were estimated using the following formulae:

Growth rate (g days^{-1}) = (Average final weight - Average initial weight) / Culture period (days).

SGR (% day^{-1}) = [(*ln* Average final weight – *ln* Average initial weight)/Time (days) x 100].

Growth (%) = 100 × (Average final weight - Average initial weight/Average initial weight).

Survival rate (%) = (Final number of fish X 100) / Initial number of fish

Cannibalism (%) = 100 × {Initial number of fish – (Final number of fish + Number of dead fish registered)}/ Initial number of fish.

Performance index = Survival rate (%) x [Final average weight – Initial average weight)/culture period (days)]

Fulton's condition equation, K (Ricker, 1975; Chow and Sandifer, 1991) was estimated using the following equation:

$$K = W/L^3 \text{ X } 100$$

where, W is weight of fish (g) and L is total length (cm).

One way analysis of variance (ANOVA) was performed using SPSS for windows version 17.0 to compare all the variables during different DOC.

Water quality parameters of the pond recorded during the culture period were within the optimum range for brackishwater aquaculture (DO 5.2 - 5.8 ppm; pH 7.8 - 8.5; NO_2-N 0.03 - 0.04 ppm; temperature 28 - 30^{0}C) as reported by Bhowmik *et al.* (1992) and Chakraborti *et al.* (2002). TAN and PO_4^{3-} showed significantly increasing trend as culture progressed and the values ranged from 0.007 to 0.012 ppm. The increase in TAN and PO_4^{3-} might be due to the degradation of left out feed and accumulation of faecal matter. Growth (%) showed increasing trend from 150.5±13.4 to 732.6±7.7 till 45 DOC (Table 1). Survival % decreased with progress in rearing period and it was 25±0.9 at the end of experiment (Table 1). Cannibals were visually identified by swollen abdomen and relatively fast size increments as described by Sukumaran *et al.,* (2011). In European seabass *Dicentrachus labrax*, 37% fish were found to be cannibalistic (Katavic *et al.,* 1989) and in Asian seabass *L. calcarifer,* 17.7% of fish were reported to be cannibalistic (Sukumaran *et al.,* 2011). In the present study, we noticed 11-51% cannibalism which increased as the culture progressed. It was also noticed that mortality during the initial stages was mainly due to natural causes and stress while cannibalism took a more significant role in the later stage. Condition factor (K) is used to compare the wellbeing of the fish and can be useful for proper management of culture system as it gives indication of favourable/stress factors in the system (Biswas *et al.,* 2011). In the present study, condition factor did not show any significant difference as culture progressed and was more than one (Table 1) which, could be attributed to favourable culture conditions prevailed during the study. Parameters of the length-weight relationship and coefficient of correlation (R^2) are shown in Table 2. Lower R^2 value revealed that the linearity is less in 30 DOC group than the other groups. Comparison of regression coefficient *b* of *L. calcarifer* from the wild and different culture systems is compared in Table 3. In the present study, *b* value ranged from 2.46 to 3.04 and the maximum was during 15 DOC. The overall *b* value was 2.46 which is less than the values reported earlier for *L. calcarifer* (Table 3). Castillo-Vargasmachuca *et al.* (2007) reported higher value of *b* (3.14) for similar

Table 1. Growth parameters of *L. calcarifer* during 45 DOC in pond based hapa nursery

Parameters	DOC			
	0	15	30	45
GR	0.00	0.36^{ab}±0.01	0.46^b±0.01	1.07^c±0.01
SGR	0.00	0.44^b±0.34	0.51^b±0.01	0.83^c±0.01
Growth %	0.00	150.48^a±13.40	238.64^b±1.88	732.59^c±7.7
S%	100	77.66^d±1.45	42.81^c±1.91	24.89^b±0.89
Cannibalism%	0.00	11.11^a±0.56	34.01^b±1.98	51.16^c±0.45
PI	0.00	1.26^b±0.66	0.46^a±008	0.56^b±0.01
K	1.90^b±0.05	1.90^b±0.05	1.82^b±0.04	1.83^b±0.02

Values are expressed as mean ± SE (n=150), Values in the rows under each category with different superscript differ significantly (p<0.05)
GR - Growth rate, SGR - Specific growth rate, S % - Survival %, PI - Performance index, K - Condition factor

Table 2. Length-weight relationship, regression coefficient (*b*) and coefficient of correlation (R^2) during different DOC of *L. calcarifer* in pond based hapa nursery

Parameters	DOC			
	0	15	30	45
W= aL^b	W=1.71L$^{3.04}$	W=1.71L$^{2.94}$	W=1.46L$^{2.55}$	W=1.51L$^{2.46}$
R^2	0.804	0.920	0.729	0.941
b	3.04	2.94	2.55	2.46
Overall W= aL^b	W=1.53L$^{2.46}$;	b=2.46;	R^2= 0.951	

Table 3. Comparison of length-weight regression coefficient '*b*' of *L. calcarifer*

Authors	Rearing system	b
Solanki *et al.* (2013)	Pond (formulated feed)	2.89
Biswas *et al.* (2011)	Pond (trash fish fed)	2.93
	Pond (live feeds)	2.87
Venugopal *et al.* (2003)	Pond (mash feeds)	4.87
Volvich and Appelbaum (2001)	Indoor recirculatory system	3.03
Rodgers (1996)	Tank	2.83
Patnaik and Jena (1976)	Wild caught	2.91
Rajkumar *et al.* (2006)	Wild caught	2.66
Present study	Hapa (farm made feed)	2.46

type of carnivorous fish, *Lutjanus guttatus* reared in floating grow-out cages for 153 days. In the present study, initially positive allometric (*b* >3) growth were noticed which later turned to negative allometry (*b*<3). The data generated from the present work indicates the healthy condition (K>1) and negative allometric growth (*b*<3) in the fishes during nursery rearing in hapas.

Acknowledgements

References

APHA 1989. *Standard methods for the examination of water and waste water*, 17th edn. American Public Health Association, Washington D. C., USA, p. 10-203.

Araneda, M., Perez, P. E. and Gasca-Leyva, E. 2008. White shrimp *Penaeus vannamei* culture in freshwater at three densities: condition state based on length and weight. *Aquaculture*, 283: 13-18.

Bhowmik, M. L., Chakraborti, R. K., Mandal, S. K. and Ghosh, P. K. 1992. Growth of *Penaeus monodon* (Fabricius) under variable stocking densities. *Environ. Ecol.*, 10: 825-82.

Biswas. G., Thirunavukkarasu, A. R., Sundaray, J. K. and Kailasam, M. 2011. Culture of Asian Seabass *Lates calcarifer* (Bloch) in brackishwater tide-fed ponds: growth and condition factor based on length and weight under two feeding systems. *Indian J. Fish.,* 58 (2): 53-57.

Castillo-Vargasmachuca, S., Ponce-Palafox, J. T., Chavez Ortíz, E. and Arredondo-Figueroa, J. L. 2007. Effect of the initial stocking body weight on growth of spotted rose snapper *Lutjanus guttatus* (Steindachner, 1869) in marine floating cages. *Revista de Biología Marinay Oceanografía*, 42: 261-267.

Chakraborti, R. K., Sundaray, J. K. and Ghoshal, T. K. 2002. Production of *Penaeus monodon* in the tide fed ponds of Sunderbans. *Indian J. Fish.*, 49: 419-426.

Chow, S. and Sandifer, P. A. 1991. Differences in growth, morphometric traits and male sexual maturity among Pacific white shrimp, *Peneaus vannamei*, from different commercial hatcheries. *Aquaculture,* 92: 165-179.

Ganzon-Naret, E. S. 2013. Growth response and feed intake of *Lates calcarifer* to four different dietary protein levels with green pea (*Pisum sativum*) under controlled laboratory condition. *ABAH Bioflux*, 5(2): 137-144.

Hossain, M. Y., Ahmed, Z. F., Leunda, P. M., Jasmine, S., Oscoz, J., Miranda, R. and Ohtomi, J. 2006. Condition, length-weight and length-length relationships of the Asian striped catfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the Mathabhanga River, south-western Bangladesh. *J. Appl. Ichthyol.*, 22: 304-307.

Kailasam, M., Thirunavukkarasu, A. R., Sundaray, J. K., Mathew Abraham, Sarada, C., Subburaj, R., Thiagarajan, G. and Karaiyan, K. 2006. Daily growth and length-weight relationship of *Lates calcarifer* (Bloch) larvae during hatchery rearing. *Indian J. Fish*., 53: 487-491.

Kataviæ, I., Jug-dujakoviæ, J. and Glamuzina, B. 1989. Cannibalism as a factor affecting the survival of intensively cultured bass (*Dicentrarchus labrax*) fingerlings. *Aquaculture*, 77(2-3): 135-143.

Mojjada, S. K., Dash, B., Pattnaik, P., Anbarasu, M. and Joseph, I. 2013. Effect of stocking density on growth and survival of hatchery reared fry of Asian seabass, *Lates calcarifer* (Bloch) under captive conditions. *Indian J. Fish.,* 60(1): 71-75.

Patnaik, S. and Jena**,** S. 1976. Some aspects of biology of *Lates calcarifer* (Bloch) from Chilka Lake. *Indian J. Fish.,* 23(1&2): 65-71.

Pauly, D. 1993. *Editorial, Fish byte. NAGA, ICLARM Q.*, 16: 26 pp.

Rajkumar, M., Antony, P. J. and Trillers, J. P. 2006. Length-weight relationship of Asian seabass (*Lates calcarifer* Bloch, 1790) from Pichavaram mangrove waters, south-east coast of India. *Asian Fish. Sci.*, 19: 177-183.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. *Fish. Res. Board Canada Bull.*, 191: 203-233.

Rodgers, L. 1996. Feeds, feeders and feeding practices for the nursing of barramundi fry. *Barramundi farming information package. Introductory information for prospective barramundi farmers.* Freshwater Fisheries and Aquaculture Centre, Walkamin, Australia, p. 65-71.

Solanki, H. G., Prem Kumar, Bhatt, J. H., Pillai, S. M., Patil, R. G. and Arasu, A. R. T. 2013. Length-weight relationship of Asian seabass *Lates calcarifer* Bloch, 1790 reared in pond. *Indian J. Fish.,* 60(3): 131-133.

Sukumaran, K., Arasu, A. R.T., Kailasam, M., Sundaray, J. K., Subbura, R. and Thiagrajan, G. 2011. Effect of stocking density on size heterogeneity and sibling cannibalism in Asian seabass *Lates calcarifer* (Bloch, 1790) larvae. *Indian J. Fish.* 58(3): 145-147, 2011.

Thirunavukkarasu, A. R., Kailasam, M., Kishore Chandra, P., Shiranee, P., Mathew Abraham, Charles, A. V. K. and Subburaj, R. 2001. Captive broodstock development and breeding of seabass *Lates calcarifer* (Bloch) in India. In: Menon, N. G. and Pillai, P. P. (Eds.), *Perspectives in mariculture*. The Marine Biological Association of India, Kochi, p. 111-124.

Venugopal, G., Syama Dayal, J., Muralimohan, K., Ramireddi, P., Ahamad Ali, S., Thirunavakkarasu, A. R. and Sarada, C. 2003. Length-weight relationship in the Asian Seabass *Lates calcarifer* (Bloch) under culture condition. *Indian J. Fish.* 30: 61-64.

Volvich, L. and Appelbaum, S. 2001. Length to weight relationship of seabass *Lates calcarifer* (Bloch) reared in a closed recirculating system. *Israeli J. Aquacult., Bamidgeh,* 53: 158-163.