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Evaluation of optimum rearing density for *Mystus cavasius* (Hamilton, 1822) larvae and fry during captive rearing in hatchery condition

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Abstract
Mystus cavasius, an important catfish is acceptable by aquaculturists as a desired candidate species for aquaculture due to high market demand. The uncertain seed availability from natural water compels for its captive production. Hence the present article communicates the optimum stocking density of larvae and fry during its hatchery production. The catfish was induced bred and seed were reared in hatchery to get the stocking material for the experiment. The larvae of 4 days old were utilised for larval density experiment. Larvae were reared for 21 days at 5, 10, 15 and 20 larvae L^{-1} to ascertain the optimum stocking density necessary for larval rearing. Similarly, the fry of 21 days old were stocked at densities of 50, 100, 200, 300 and 400 fry m^{-2} and reared for 8 week experimental period. The larval rearing at 5 larvae L^{-1} showed significantly higher ($p<0.05$) growth (23mg) and survival (79%) as compared to three other density trials. The decrease of growth and survival with the increase of density during larval rearing indicated for a low density larval rearing at initial stage. However, the density of 10 larvae L^{-1} may be accepted as this density level performs more than 50% survival to get a higher number of fry during hatchery production. The growth and survival of fry was also in descending order as the density increased. The highest (($p<0.05$) growth and survival was exhibited while stocking 50 fry m^{-2}. The study also revealed that the survival per cent was more than 90% while rearing at 100 fry m-2. Hence the present study recommends a low stocking density rearing of this catfish at larval and fry stage. The results also cautioned to adopt a maximum density level of 10 larvae L^{-1} and 100 fry m-2 to get higher number of seed, beyond which the growth and survival rate will be affected at larval and fry stage.

Keywords: *Mystus cavasius*, stocking density, larval rearing, fry rearing

Introduction

The population of many fish species from wild water is getting reduced due to climate change, habitat loss, reduction in natural recruitment, water pollution, anthropogenic activities etc. Small indigenous fish are severely affected for which many are in threatened category like *Mystus cavasius* (CAMP, 1998) [6] On the oth er hand, the small indigenous species contributes significantly to the nutritional security of the rural masses in developing countries (Mohanty *et al*., 2013) [17]. Therefore, the captive seed production of preferred species must be promoted without depending on the uncertain situation for getting seed from the natural waters. This will contribute for aquaculture diversification, nutritional contributions and the conservation of the species like *M. cavasius*. It is native to many countries of SAARC region and is found in the open water bodies of the region (Talwar & Jhingran, 1991; Roy & Hossain, 2006) [30, 23]. *M. cavasius* is a preferred food fish species and is popular among the consumers of SAARC region. The high nutritional content, few intramuscular bones and omnivorous nature (Mohanty *et al*., 2013; Chaturvedi & Saksena, 2013; Gupta, 2014; Banu *et al*., 2020) [17, 7, 12, 5] establish it as an aquaculture potential species. This catfish species can grow to a size of 60-80 g within a year, whose market price ranges from ₹300 to 400 kg^{-1} (approx. 3.5 to 5.0 US\$ kg^{-1}) in India. The successful captive rearing of *M. cavasius* larvae and fry depends on many biotic and abiotic factors. Among them, good water quality and population size during rearing are regarded as primary considerations. It is always observed that high stocking density during rearing results lower growth and survival rate during seed rearing operation. Some studies in other catfish species highlight the role of larval husbandry practices (Sahoo *et al*., 2004; Pangni *et al*., 2008; Abhilash *et al*., 2025) [24, 19, 2] and appropriate stocking density (Samad *et al*., 2005; Sahoo *et al*., 2010; Abhilash *et al*., 2026) [28, 25, 1] are essential for the successful seed production of the catfish. This type of information in *M. cavasius* is not available except few scattered information on its captive breeding and seed production (Kohinoor *et al*., 2009; Rahaman *et al*., 2013; Das *et al*., 2018; Ali *et al*., 2021) [15, 22, 9, 3]. Developing suitable technologies for offspring rearing of *M. cavasius* is essential to obtain high-quality seed for its aquaculture and to conserve the species from extinction. Hence, the present studies were undertaken to determine the optimal stocking density for larvae and fry during rearing operation to improve the growth and survival rate.

Materials and methods

Broodstock raising and breeding for stocking material

M. cavasius of 25-52 g body weight were collected from the Bhargavi River and nearby water bodies in Odisha, India. The fish were acclimatised in the Institute's indoor wet laboratory facility at the catfish hatchery. After acclimatisation, two 50 m^2 outdoor concrete tanks were stocked with 100 healthy fish in each tank. The tanks were soil-based with shelter facilities. During rearing, the fish were fed with fishmeal-based floating feed (35% crude protein; 8% crude lipid) at 2% of body weight twice daily. Fish were reared from April to September, for six months. Broods of 50-60g were used for breeding purpose during the month of July, following a standard protocol published (Sahoo *et al*., 2025b) [27].

Influence of stocking density on growth and survival of *M. cavasius* larvae

M. cavasius larvae (4 dph: 4.02 ± 0.02 mm, 0.55 ± 0.01 mg; n: 40 larvae) were randomly stocked in 12 FRP tanks (1 x 0.5 m; volume of water: 60 L) at 5, 10, 15 and 20 larvae L^{-1} of water in triplicate and provided with continuous aeration for 21 days during rearing. The initial weight of the larvae was recorded using an electronic balance (Mettler Toledo, Switzerland), and their length was measured using a microscope (Carl Zeiss Microscopy, Germany) fitted with an ocular micrometre. The *Artemia nauplii* was hatched following the procedure as mentioned earlier (Sahoo *et al*., 2025a) [26] and were fed to larvae *ad libitum* two times a day. The tank bottoms were cleaned and 60 to 70% of the water was exchanged daily to provide good aquatic environment during larval rearing. At the end of the experiment, 25 larvae were collected from each replicate tank and measured for total length (nearest 1 mm) and body weight (nearest 1 mg) to know the final length and weight increment. Mortality was recorded daily, and the dead larvae were removed immediately to prevent deterioration of water quality. The total survived larvae were counted to record the survival rate. The average value of replicates was considered as the parameter value of the treatment.

Water quality parameters were recorded for each larval rearing tank at an interval of five days following the standard procedures (APHA, 2005) [4]. The water quality parameters like water temperature, pH, dissolved oxygen, total alkalinity and total ammonia nitrogen in the larval rearing tanks were ranged between 27 to 29 °C; 7.7 to 8.1; 5.2 to 5.6 mg L^{-1}; 114 to 121 mg L^{-1} as $CaCO_3$ and 0.06 to 0.09 mg L^{-1}, respectively.

Influence of stocking density on growth and survival of *M. cavasius* fry

Rectangular ferro-cement tanks (2 x 1 m) with a water outlet facility were utilized for the rearing of fry. Tank bottoms were covered with a thin layer of soil and provided with shelters, while the feeding area was kept free of soil to prevent feed loss. One feet water was kept in the rearing tank before stocking the fry. Uniform-sized fry was collected and acclimatised for 24 h prior to stocking. The initial length and weight of 15 individual fry were recorded using a standard measuring board and an electronic balance (Mettler Toledo, Switzerland), respectively. The initial mean length and weight of 25 fry were 16.6 ± 0.023 mm and 32.58 ± 0.44 mg, respectively. Triplicate tanks were stocked at densities of 50, 100, 200, 300 and 400 fry m^{-2}. The fry was fed with crumbled feed containing 35% crude protein and 7% crude lipid twice a day. Approximately three-fourths of the tank water volume was replaced every two to three weeks. The fry rearing experiment was continued for 8 weeks. At the end of the experiment, 15 fry from each tank were randomly sampled and, their final length and weight were recorded. The total number of harvested fry was used to calculate the survival rate. Growth parameters and survival rates of larvae and fry were calculated using standard formulae as reported earlier (Ferosekhan *et al*., 2021) [11].

Water quality parameters were recorded for each tank at an interval of 20 days following the standard procedures (APHA, 2005) [4]. The recorded value for water temperature, pH, dissolved oxygen, total alkalinity and total ammonia nitrogen in fry rearing tanks were ranged between 28 to 30 °C; 7.2 to 7.8; 4.8 to 5.6 mg L^{-1}; 118 to 131 mg L^{-1} as $CaCO_3$ and 0.06 to 0.1 mg L^{-1}, respectively.

Statistical analysis

All data were expressed as mean ± standard error (SE). Percentage data, such as fertilisation rate, hatching rate, ovulation response and survival, were arcsine-transformed prior to analysis. Differences among treatments were analysed using one-way analysis of variance (ANOVA), followed by Tukey's honestly significant difference (HSD) test using IBM SPSS Statistics (Version 24.0, Armonk, NY, USA). The values were considered significant at $p<0.05$ level.

Results and discussion

Water quality of experimental rearing tank

The water quality parameters of different tanks used for rearing *M. cavasius* larvae and fry in both the experiments are reflected in materials and methods. These water quality parameters were within the permissible levels as also observed during seed rearing of different catfish in captive condition (Sahoo *et al*., 2004; 2010) [24, 25] . This could be due to the combined effect of regular cleaning of rearing tanks as well as replacing of water at short intervals during the rearing operation.

Influence of stocking density on growth and survival of *M. cavasius* larvae

Stocking density is a critical factor in fish culture influencing growth, survival, behaviour and overall health status (de Oliveira *et al*., 2012) [10]. Higher stocking densities often result in growth retardation and compromised larval health (Sahoo *et al*., 2004; Santos *et al*., 2021) [24, 29], whereas underutilisation of available culture space may lead to economic losses in commercial seed production (Wang *et al*., 2020) [31]. Therefore, optimal stocking density represents a practical balance between production efficiency and fish welfare. In the present study, the growth performance of *M. cavasius* larvae declined with increasing stocking density. The higher final body weight (22.99 ± 2.59 mg) and survival rate (79.33 ± 4.91%) were recorded at 5 larvae L^{-1}, which were significantly higher ($p>0.05$) than those observed at 15 and 20 larvae L^{-1} (Table 1). This higher growth might be due to sufficient acquisition of feed without any competition compared to the larvae reared at higher density. The increased stress levels are known to alter nutrient metabolism and increase energy expenditure, thereby affecting growth and survival (Costas *et al*., 2008) [8].

Table 1: Effect of varied stocking densities on the growth and survival of *M. cavasius* larvae in a 21-day rearing period.

Attributes	**Stocking density (larvae L^{-1})**			
	5	**10**	**15**	**20**
Initial Length (mm)^{N}	4.02 ± 0.02			
Initial weight (mg)^{N}	0.55 ± 0.01			
Final length (mm)^{n}	14.33 ± 0.52^{b}	12.43 ± 0.57^{ab}	11.37 ± 0.41^{a}	11.77 ± 0.60^{a}
Final weight (mg)^{n}	22.99 ± 2.59^{b}	16.25 ± 2.33^{ab}	10.27 ± 0.80^{a}	10.60 ± 0.79^{a}
Survival %	79.33 ± 4.91^{c}	53.67 ± 6.06^{bc}	45.33 ± 7.69^{ab}	27.33 ± 3.48^{a}

The values (Mean ± SE) in row bearing different superscripts differ significantly ($p<0.05$).
Larvae sample size (N) = 40.
Larvae sample size (n) = 25.

Larvae reared at 10 larvae L^{-1} showed no significant difference in survival (53.67 ± 6.06%) compared to those stocked at 5 larvae L^{-1}. Therefore, stocking densities up to 10 larvae L^{-1} may be considered suitable for practical seed production of *M. cavasius*, as survival remained above 50%. The optimal density observed in this study is comparable with reports in other catfish species, including 7 larvae L^{-1} in *H. brachysoma* (Sahoo *et al*., 2010) [25], 8 larvae L^{-1} in *C. macrocephalus* (Mollah, 1985) [16] and 6 larvae L^{-1} in *Chrysichthys nigrodigitatus* (Pangni *et al*., 2008) [19]. However, relatively higher optimal densities have also been reported for species such as *C. batrachus* (13 larvae L^{-1}; Sahoo *et al*., 2004) [24], *C. magur* (18 larvae L^{-1}; Rahman *et al*., 2012) [21] and *C. gariepinus* (15 larvae L^{-1}; Nwipie *et al*., 2015) [18], indicating species-specific responses to stocking density. Although cannibalistic behaviour under high stocking densities has been reported in this species (Das *et al*., 2018) [9], the reduced survival observed in the present study is more likely associated with increased competition for space and elevated physiological stress. Consistent with our earlier observations in *M. cavasius* (Sahoo *et al*., 2025a, b) [26, 27], no cannibalistic or predatory behaviour was observed among larvae or fry during the rearing period. No evidence of aggressive interactions, shooters or size-dominant individuals was noticed. Earlier studies on *M. cavasius* larval and fry rearing have also reported density-dependent mortality without attributing losses directly to cannibalism (Rahman *et al*., 2004; Hossain *et al*., 2006) [20, 13].

Influence of stocking density on growth and survival of *M. cavasius* fry

Optimal stocking density varies with life stage and species. The growth and survival performance of *M. cavasius* fry observed in the present study is presented in Table 2. Fry stocked at 50 and 100 fry m^{-2} exhibited higher individual weight gains of 1.28 g and 0.96 g, respectively, with survival exceeding 90% at these densities. In contrast, fry reared at higher stocking densities of 200, 300 and 400 fry m^{-2} showed reduced survival ranging from 57 to 77% (Table 2). These results indicate that a stocking density of 50 to 100 fry m^{-2} is suitable for achieving better fingerling production. Further increases in stocking density resulted in reduced growth and survival of *M. cavasius* fry. The decline in performance at higher densities may be attributed to increased crowding stress and unequal access to feed among individuals. The optimal stocking density observed for *M. cavasius* fry is comparatively lower than that reported for *C. batrachus* (200 fry m^{-2}; Sahoo *et al*., 2004) and *Hemibagrus wyckioides* (200 to 400 fry m^{-2}; Jiwyam & Nithikulworawong, 2014).

Table 2: The growth and survival of *M. cavasius* fry reared under varied stocking densities in captive condition for a period of eight weeks**.**

Attributes	**Stocking density (fry m^{-2})**				
	50	**100**	**200**	**300**	**400**
Initial Length (mm)^{N}	16.6 ± 0.02				
Initial weight (mg)^{N}	32.58 ± 0.44				
Final length (mm)^{n}	5.93 ± 0.06^{c}	5.20 ± 0.06^{ab}	5.59 ± 0.08^{bc}	5.25 ± 0.08^{ab}	4.91 ± 0.16^{a}
Final weight (mg)^{n}	1.31 ± 0.03^{c}	0.99 ± 0.01^{ab}	1.02 ± 0.04^{b}	0.94 ± 0.05^{ab}	0.81 ± 0.06^{a}
Survival %	95.33 ± 4.67^{b}	91.00 ± 4.93^{b}	77.00 ± 4.93^{ab}	57.23 ± 5.27^{a}	60.33 ± 4.98^{a}

The values (Mean ± SE) in row bearing different superscripts differ significantly ($p<0.05$).
Fry sample size (N) = 25.
Fry sample size (n) = 15.

Conclusion

The present study communicated the early seed rearing of *Mystus cavasius* under captive conditions. Stocking density significantly influenced larval performance, with 5 larvae L^{-1} showing maximum growth and survival, while 10 larvae L^{-1} provided comparable survival under practical conditions. Fry reared at 50 or 100 fry m^{-2} exhibited superior growth and survival relative to higher densities. These results provide practical guidance for hatchery-level seed production of *M. cavasius*.

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