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Note

# Short term polyculture of three cyprinid species under mid-hill conditions in Meghalaya, North-east India

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## Abstract

This study evaluated the performance of a low-input polyculture system using three cyprinid species *viz*., *Cyprinus carpio*, *Labeo gonius* and *Barbonymus gonionotus* under mid-hill conditions in Umiam, Ribhoi District, Meghalaya (900 m above mean sea level) during the post-monsoon winter period. These species were selected for mid-hill aquaculture due to their rapid growth, early maturity, simple seed production techniques and market demand. In six months, the system achieved a production yield of 1,350 kg $ha^{-1}$. *C. carpio* attained an average final weight of 207.09 g with a mean survival rate of 86.96%, while *L. gonius* and *B. gonionotus* reached average final weights of 154.48 and 189.12 g, with survival rates of 80.54% and 81.25%, respectively. Results of the study indicated that integrating the three species into polyculture systems can enhance fish production in small and seasonal village ponds in mid-hill regions.

The North-east (NE) region of India is endowed with abundant fisheries resources and it is well-suited for aquaculture and fish-based farming activities. However, the aquaculture systems adopted vary greatly depending on the topography or terrain, resource availability in any particular region as well as on the investment capabilities of the farmers. The region produces over 570 thousand tonnes of fish annually with nearly 50% coming from aquaculture (DoF, 2022). With over 95% of population being fish eaters, there remains a huge gap between supply and demand. To meet the growing demand, the region is dependent on other states *viz.* Andhra Pradesh, West Bengal, Uttar Pradesh as well as neighboring countries like Bangladesh and Myanmar to some extent for supply of fresh fish.

Aquaculture in the NE region is basically carp-based. The three Indian major carp (IMC) species Rohu (*Labeo rohita*), Catla [*Labeo* (=*Catla*) *catla*] and Mrigal (*Cirrhinus mrigala*) are widely cultured by the farmers of the region, together with three exotic carps, Silver carp (*Hypophthalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*) and Common carp (*Cyprinus carpio*). Fish seed production in the region is primarily driven by private-sector farmers, who produce seeds for about 10-12 fish species for aquaculture (Das, 2017). In addition, the state of Tripura produces seeds of *Ompok pabda* (Pabda), *Macrobrachium rosenbergii* (Giant Freshwater prawn), while Manipur and more recently Meghalaya produce seeds of the endemic medium carp *Osteobrama belangeri* (Pengba) in limited qualities (Das and Singh, 2017).

The mid altitude region, which covers a large part of NE hill states, holds immense potential for aquaculture. A period of 6-8 months per year has been identified as suitable for the growth of carp species in mid-altitude conditions (Das, 2017). However, promoting mid altitude aquaculture (400-1200 m above msl) among farmers in these hill states of the NE region presents several challenges (Das *et al.*, 2021). Aquaculture in mid-hill condition especially in tribal states, differs from aquaculture practices in low altitude plains due to various factors (Das, 2018). Relatively colder temperature, limited availability of suitable fish species, prevalence of small and seasonal ponds and resource constraints of local farmers are some of the major bottlenecks in promoting aquaculture in the region.

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Polyculture of three exotic carp species *viz.* common carp, grass carp and silver carp, is commonly practised in hill regions, as these species perform better than the Indian major carps However, the availability of grass carp and silver carp seeds remains a challenge in the hill states of NE India region. Moreover, both theese species require more than two years to attain full maturity under mid-hill climatic conditions. To address these limitations, sincere efforts have been made to diversify fish species suitable for mid-hill aquaculture in the region. Over the past few years, several fish species have been evaluated for growth and reproductive performance under mid-hill conditions in Meghalaya (Das *et al.*, 2010).

In continuation to our earlier efforts on diversification of fish species for mid-hill aquaculture (Das *et al.*, 2021), this study highlights the results of a low input polyculture system involving three fish species *viz.,* Common carp *Cyprinus carpio*, Kuria labeo *Labeo gonius* and Puthi *Barbonymus gonionotus* during the post-monsoon winter period. These three fish species were selected for evaluation due to their fast growth, early maturity, simple seed production techniques and strong market demand. Our earlier studies on two-species culture in small ponds over a period of one year yielded an average fish production of 2,550 kg ha$^{-1}$ year$^{-1}$ (Das *et al.*, 2021).

The six month long experiment was conducted at the fish farm complex of the ICAR Research Complex for North-east Hill Region (ICAR-RC NEHR), Umiam in Ribhoi District of Meghalaya at a mid hill altitude of 900 m above mean sea level (msl). The study was carried out during the post-monsoon winter period from September 2020 to March 2021. Three identical small fish ponds of 200 square meters each with an average depth of 1.5 m, were selected to evaluate the growth performance of three cyprinid fish species *viz. C. carpio*, *L. gonius* and *B. gonionotus* in a polyculture system. Fingerlings of these three species were stocked in each pond at a density of 8,000 nos. ha$^{-1}$ at a ratio of 50:30:20. The initial average lengths of *C. carpio* and *L. gonius* fingerlings were 8.96 and 5.53 cm respectively, while *B. gonionotus* had an average length of 11.88 cm. Prior to stocking of fish fingerlings, all ponds were prepared following the recommended standard package of practices (ICAR, 2006), maintaining a water depth of 1.5 m for fish culture.

The fishes were fed once daily with a supplementary feed containing 19% protein and 6.5% lipid, prepared locally using a mixture of rice polish and mustard oil cake at 5% of the body weight. Water quality parameters were monitored fortnightly and were found to be within the optimal ranges throughout the study. The water temperature was recorded daily using a digital thermometer for the entire duration of the experiment (Fig. 1).

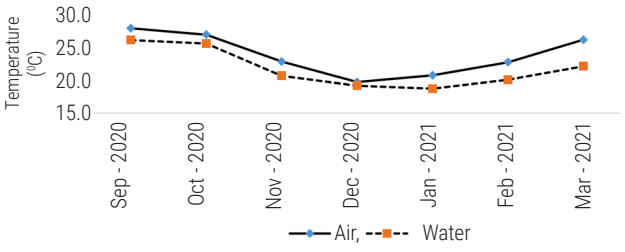


Fig.1 Monthly average air and water temperature in the experimental ponds

All the statistical analyses were performed using GraphPad Prism v10.0.2 software. The observation was considered statistically significant at a significance level of $p<0.05$.

At the end of 6 months culture period a reasonable production of 1350 kg ha$^{-1}$ was obtained from the culture system. The comparative growth in terms of length and weight of *C. carpio*, *L. gonius* and *B. gonionotus*, after rearing for six-months under pond aquaculture in mid-hill conditions are depicted in Fig. 2. *C. carpio* attained an average final weight of 207.09 g with 86.96% mean survival whereas *L. gonius* and *B. gonionotus* recorded mean survival percentage of 80.54 and 81.25 respectively with average final weight of 154.48 and 189.12 g. In the present study, the specific growth rate, SGR (% d$^{-1}$) ranged from 1.22 to 2.50 g day$^{-1}$. *L.gonius* recorded the highest SGR of 2.50 followed by *C. carpio* (1.63) and *B. gonionotus* (1.22). *Bangana dero,* an important minor carp of Manipur in NE India exhibited SGR ranging from 0.65 to 0.91 (Sobita and Basudha, 2020).

The monthly average water temperature varied from 18.7ºC in January 2020 to 26.0ºC in the month of September, 2021. Water temperature is one of the important abiotic factors influencing various physiological and growth parameters in teleost fish. The effect of temperature on SGR and survival rate of *C. carpio*), *L. gonius* and *B. gonionotus* in the treatment groups (mean±SD) are presented in Fig. 3. The results indicate a strong positive correlation between the water temperature and fish growth. In an earlier study conducted at the same location, low water temperature was found to induce stress and affect somatic growth in the teleost *Channa stewartii* (Das and Majhi, 2015), while increase in temperature resulted in varying levels of metabolic stress and growth impairment in chocolate mahseer *Neolissochilus hexagonolepis* (Majhi, *et al.*, 2013). In the present study, the improved fish growth observed during the post-monsoon winter period may be attributed to the rise in average temperature and longer warmer months likely owing to climate variability.

Similarly, Bhuyan (2003) highlighted the significant role of temperature in overall fish growth and found that *L. gonius* can be successfully cultivated under the mid-latitude conditions of Meghalaya. Additionally, the genetically improved Hungarian common carp, commonly known as Amur common carp (*Cyprinus carpio haematopterus*) also demonstrated better performance

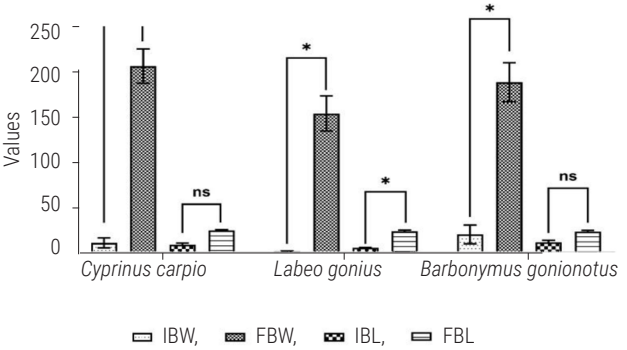


Fig. 2. Growth in terms of length and weight in *C. carpio*, *L. gonius* and *B. gonionotus* in the treatment groups (mean±SD). IBW (g fish$^{-1}$): Initial mean body weight; FBW (g fish$^{-1}$): Final mean body weight; IBL (cm): Initial mean body length; FBL (cm): Final mean body length. (Values are group means and based on average of 10 fish in n=3 replicate tanks).

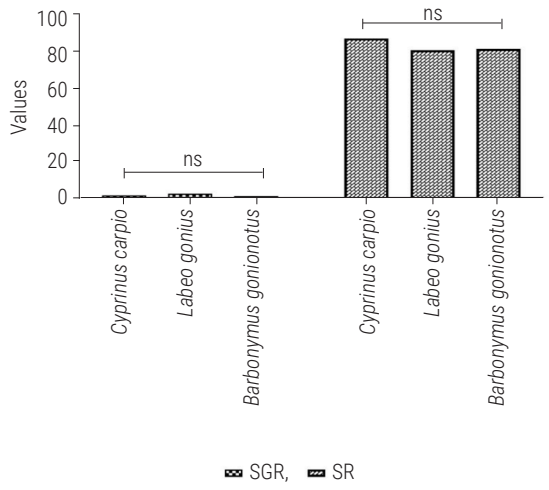


Fig. 3. Effect of temperature on specific growth rate (SGR) and survival of *C. carpio*, *L. gonius* and *B. gonionotus* in the treatment groups (mean±SD). SGR (% $d^{-1}$): Specific growth rate; SR (%): Survival rate

under similar conditions. Fish seeds with an initial average weight of 14.5 g reared under monoculture at the ICAR fish farm complex, Umiam under mid-hill conditions, attained an average weight of 794.5 g over a 13 months period (Das, 2017). Jena and Das (2011) compared the growth performance of *L. rohita, C. mrigala* and *L. gonius* in a polyculture system and found *L. gonius* to be a viable species when cultured along with major carps, with survival rates ranging from 75.5 to 79.8%. Considering the availability of seeds of these three species, their inclusion in polyculture systems is expected to enhance fish production in village-level small or seasonal ponds across the mid-hill region. Findings from the on-station trials of two species culture (Das *et al*, 2021), along with the present three-fish species polyculture system, have been disseminated to Krish Vigyan Kendras (KVKs) of North-east hill region of India. This initiative aims to demonstrate and popularise the evaluated technologies, contributing to enhanced local fish production in the hill states of the region.

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