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ScienceDirect
Aquaculture 261 (2006) 1065–1076
Aquaculture
www.elsevier.com/locate/aqua-online

Effects of silver carp and small indigenous species on pond ecology and carp polycultures in Bangladesh

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Received 18 July 2006; received in revised form 7 September 2006; accepted 7 September 2006

Abstract

A sustainable semi-intensive pond aquaculture technology including major carp species as cash-crop and small indigenous fish species (SIS) as food for the farmers' families is being optimized in Bangladesh. The inclusion of silver carp (*Hypophthalmichthys molitrix*), a cheap large species affordable by poor farmers, is now being considered. As part of a study on the effects of this filter feeder on polycultures including the large carps rohu (*Labeo rohita*), catla (*Catla catla*) and common carp (*Cyprinus carpio*) and the SIS punti (*Puntius sophore*) and mola (*Amblypharyngodon mola*), an experiment was carried out to test the effects of silver carp and of each SIS species on the growth, survival and yield of the large and small fish and on pond ecology.

The ecology of the ponds was dominated by changes in time, strongly related to the development of a surface plankton scum at the beginning of the culture season and weather conditions. The surface scum increased decomposition processes and decreased algal development in the water body, promoted photosynthesis and ammonium release and reduced nitrification. Over those effects, the presence of silver carp in the ponds decreased algal biomass through grazing and promoted nitrification providing and resuspending particles in the water column. These effects were also produced by mola, but were evident only in the absence of silver carp. Punti stirring on the pond bottom increased nutrient flow from the sediments into the water column and promoted nitrification, but were also evident only in the absence of silver carp.

The addition of 10 silver carp over the 99 large carps stocked in the 100 m^2 fishponds did not affect punti and mola reproduction in the ponds, negatively affected rohu and catla growth and yield by about 20–25% but not their survival, did not affect common carp performance, reduced punti harvested biomass by 10%, reduced mola performance by about 50%, and silver carp's own biomass increased total yield and total income in about 20% each. The addition of 250 mola or punti to the large carp polycultures did not affect the performance of any of the large carps. The decreased income from selling the more expensive large carps was more than compensated by that obtained from silver carp, which increased total income by 13–24% as compared to the corresponding treatments without silver carp. This allows the option to the farmer of selling part of the silver carp to complete the cash income that would have been obtained from large carps only if silver carp would not be stocked, and consume the rest with the family.

Keywords: Catla; Food web; Mola; Polyculture; Punti; Rohu; Silver carp; SIS small indigenous species

1. Introduction

Freshwater aquaculture in Bangladesh has been increasing at a rate of 13% per year with a 44% contribution to the country total fish production of 2.102 million

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doi:10.1016/j.aquaculture.2006.09.010

metric tones (DoF, 2005). Polyculture of Indian major carps and Chinese carps is the main aquaculture technology practiced in the country. As part of the pond management in this culture practice, fish poisons from organic and inorganic origin have been prescribed to the pond aquaculturists to eradicate small indigenous fish species (SIS, adults size up to 15 g) from the fish ponds (Wahab et al., 2003b). Polyculture technologies focused on large carps only have deprived the members of the farming households, especially the children and women, because large carps are grown for cash crop not for family consumption. Even the large carps seldom used for family consumption often are not distributed evenly in the family, rather the male senior members consume the largest share depriving the women and children. On the other hand, small fish, which are eaten whole and constitute a rich source of vitamins and micronutrients, if available for consumption are distributed evenly among all family members. The low intake of vitamin A and other micronutrients has caused an increase in night blindness, anemia and stunted growth, which can be mitigated by providing vitamin A rich small fishes like mola (*A. mola*), calcium rich punti (*P. sophore*) and other micronutrient rich fishes (Thilsted et al., 1997).

A sustainable semi-intensive pond aquaculture technology under Bangladeshi conditions including major carp species as cash-crop and small indigenous fish species as food for the farmers' families is being developed. The first steps to optimize the cash-SIS technology were centered on the study of fish–environment relationships in several polyculture combinations, focusing on interference on the pond bottom by the bottom feeding fish (Wahab et al., 2001, 2002, 2003a; Milstein et al., 2002; Alim et al., 2004, 2005). At present the research concentrates on the intervention in the water column, through the addition of a fish with ecological and socio-economic potential advantages: silver carp (*H. molitrix*) is expected to have a strong impact on the pond ecology, because it is a very efficient filter feeder (Milstein et al., 1985a,b; Milstein, 1992), and also on the farmers' family nutrition, because it is a cheap fish that the family can afford to eat instead of selling. It is also easily accessible to the poorer section of the population because of its low market price.

In the framework of the study of the introduction of silver carp on polycultures including the Indian Major Carps rohu *L. rohita*, catla *C. catla* and common carp *C. carpio*, and the SIS species punti and mola, the objective of the herein reported experiment was to test the effects of silver carp and of each SIS species on the growth, survival and yield of the large and small fish and on pond ecology.

2. Methods

The experiment was performed at the Fisheries Field Laboratory, Bangladesh Agricultural University, Mymensingh (BAU) in 18 ponds of 100 m^2 area and 1.5 m depth each. These are experimental ponds that reflect on farm conditions, since most farm ponds are 100–800 m^2 area. Before starting the experiment, ponds were drained to eradicate all predatory fishes, embankments and slopes were repaired, and agricultural lime ($CaCO_3$) at 250 kg/ha (=2.5 kg/pond) was applied. Ponds were filled up with pumped water and fertilized with urea and triple super phosphate (TSP), each at 100 kg/ha (=1 kg/pond) to promote algal growth.

The experiment lasted 138 days and had 6 treatments in a 2×3 factorial design. The 2-level factor was with or without silver carp addition. The 3-level factor was SIS: no small fish, mola addition, and punti addition. On 1-Jul-05 each 100 m^2 pond was stocked with 33 rohu (44 g stocking weight), 33 catla (18 g) and 33 common carp (39 g). No other fish were added to the control treatment (Ctr–). Ten silver carp (37 g) and/or 250 small fish (mola of 2.7 g or punti of 2.1 g) were added to the appropriate treatments (treatments CtrS, MM–, MMS, PP– and PPS, where S and – indicate silver carp presence and absence respectively, MM indicates mola, and PP punti). Fish were weighed monthly to adjust feeding amounts. Harvesting was on 15-Nov-05. Fingerlings of the major carps were gathered from the local retailer, who collected them from rural nurseries that obtained the fertilized eggs from the nearby Government hatchery. Fingerlings of the small fish were collected from perennial ponds of the farmers, where farmers keep them together with major carps and the small fish naturally breed. Fertilizers and manure were applied at 10 days intervals, always at the same hour (10:00 AM). Fertilizers were urea and TSP (1 kg/100 m^2 pond each). Manure (6.5 kg/100 m^2 pond, wet weight) was applied wet in the four corners of each pond. Liming was repeated on 30-Jul-05 at 1 kg/100 m^2 pond, to reduce a surface plankton scum that developed in all ponds. Supplementary feed consisted of rice bran and soaked oil cake (2:1, both weighed dry, before oil cake was soaked in water), given 6 times a week at a daily rate of 3% of the large carps body weight.

Environmental sampling was carried out at 10 day intervals, 1 or 2 days after fertilization, always at around the same hour (9:00 AM). Water samples were taken in the middle of the water column. The parameters measured were temperature, transparency (Secchi disk), pH (EC 10 Portable pH meter), dissolved oxygen (digital