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Effect of Zooplankton Population and Abundance on Fish Production under Two Integrated Fish Livestock Farming Systems in Tropical Climate

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ABSTRACT: *The zooplankton population in the two integrated systems i.e. the duck-fish and chicken-fish integrated farming was analysed in terms of density, species composition, and seasonal abundance. Very high zooplankton density was recorded in both the integrated ponds, almost during the entire study period. A total of 22 and 25 species were recorded from duck-fish and chicken-fish integrated ponds, respectively. The total fish production recorded from the ponds was also high. The study suggests that integrated farming systems support large population of natural fish food organisms which results in high growth rate and overall production of fish.*

INTRODUCTION

The zooplankton are minute animals belonging to second/third trophic level. Fresh water zooplankton are of utmost significance in aquaculture, as they form important source of food for most fish species (Mageed and Sonsawa 2002). Management practices have been evolved to produce the desired level of zooplankton under nursery and grow out phases of fish rearing. They are a valuable source of protein, amino acids, lipids, fatty acids and minerals for fish. The significance of zooplankton is further increased in the integrated farming systems, where no supplementary feed is provided to the fishes and fish growth depends primarily on natural fish food organisms, particularly the zooplankton. The zooplankton population has been widely investigated in fresh water ecosystems and under extensive/semi-intensive farming systems. Integration of livestock with fish farming produces altogether different characteristics (Singh and Sharma 1998). The daily input of the excreta, wastes and spillover feed of birds might produce alterations in the zooplankton community and thus effect the growth rate and production of fish. The findings are reported in the paper.

MATERIAL AND METHODS

The present investigation was carried out for a period of 12 months at College of Fisheries, Pantnagar, in two completely integrated, fish-duck and fish-chicken farming ponds (0.056 ha ad 0.036 ha, respectively). High growth variety of broiler chicken (Bab Cock) and egg laying exotic variety of duck (Khaki Campbell) were used for integration with fish. The ducks and chicken were raised in wooden houses made-up of split bamboo, erected directly over the ponds. Both the ponds were stocked under poly-culture farming system of Indian major carps (*Labeo rohita, Catla Catla* and *Cirrhinus mrigala*) and exotic carps (*Cyprinus carpio, Hypophthalmichthys molitrix and Ctenopharyngodon idella*). The stocking proportion of different fish species is given in fig. 1. The stocking density of fish in both the ponds was 10,000 fingerlings/ha, while the stocking density of ducks and chicken was kept as 700 and 500 no. /ha, respectively. No fertilizer or manure was added in the integrated ponds; artificial feeding of fish was also not resorted to. Both ponds were managed as per standard farm management practices.

Standard methods (APHA 1985) were used for the analysis of various physico-chemical the parameters.

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For the zooplankton community analysis, fifty liters of water was filtered, from different places in each pond, through plankton net made of bolting silk cloth no. 25. The collected sample was centrifuged for 15 minutes and concentrated samples were preserved in formol. The following equation was used to enumerate the zooplankton density (Welch 1948).

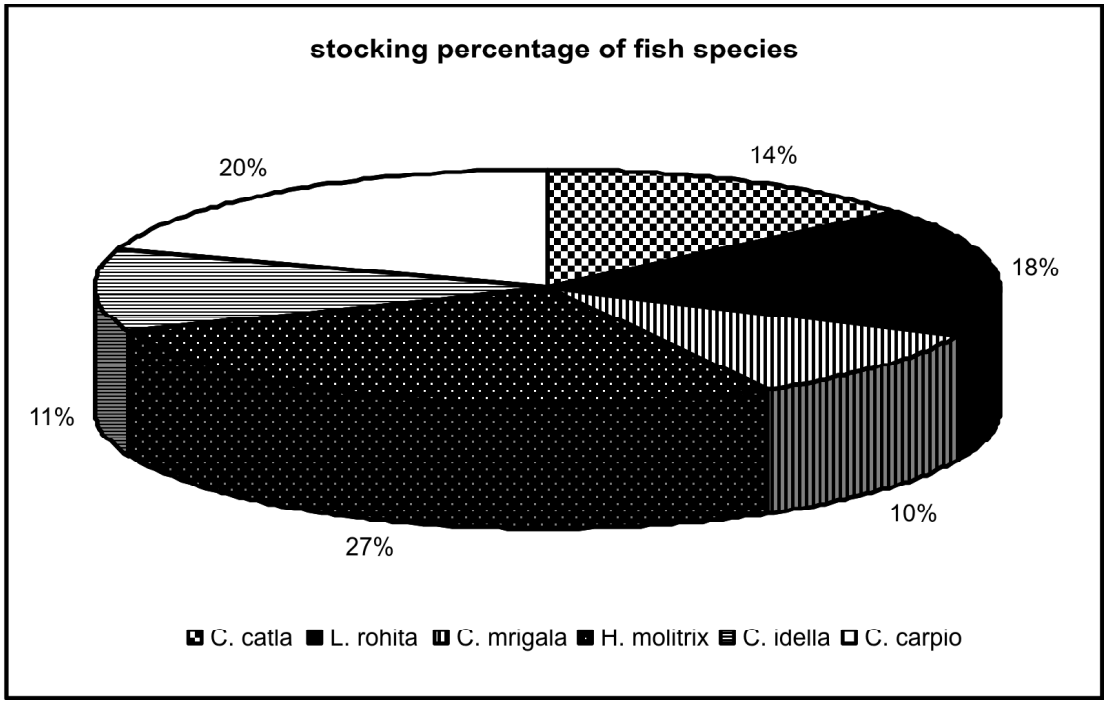

Figure 1: Stocking proportion of different species in duck-fish and chicken-fish ponds.

$$N = \frac{(a \times 1000)c}{1}$$

where, N = density (ind/l)
a = mean number of zooplankton per counting unit of 1 mm^2
l = volume of water filtered in litres.
c = volume of concentrate

RESULTS AND DISCUSSION

The important physico-chemical parameters were analysed regularly during the study period. Table 1. summarizes the mean annual range of the different parameters.

A critical analysis of the water quality reveals highly conducive conditions for the growth and survival of zooplankton and fish. Majority of physic-chemical variables are in favourable range**.** Both the ponds are rich in nutrients for sustaining large populations of zooplankton.

Table 1
Annual range of certain important physico-chemical parameters of pond water during the study period

Parameter	*Duck fish pond*	*Chicken-fish pond*
Water temperature (^{0}C)	16.0-32.5	16.0-32.5
Secchi transparency (cm)	23.5-40.0	18.0-26.5
pH	7.0-7.6	7.0-7.8
Dissolved oxygen (mg/l)	4.8-6.4	4.6-6.2
Free CO_2 (mg/l)	8.6-18.0	4.0-12.0
Alkalinity (mg/l)	165-210	80-220
NH_3 – N (mg/l)	0.05-0.5	0.04-0.6
NO_3 – N (mg/l)	0.04-0.50	0.11-0.56
PO_4 - P (mg/l)	0.04-0.30	0.04-0.35

Total zooplankton population

The total population density of zooplankton varied between 150.4 and 493.0 ind/l in duck-fish pond, while in chicken-fish pond it ranged from 172.0 to 756 ind/l (Fig. 2). The lowest and highest population was recorded in July and January, respectively in both the ponds. The zooplankton population in both the ponds remained low during the monsoon season, increasing during the pre-winter season and attained peak values in January. The zooplankton communities of the two ponds under present study were similar in terms of species composition and resemble to the tropical water bodies. Both the pond supported luxurious population of zooplankton High zooplankton density

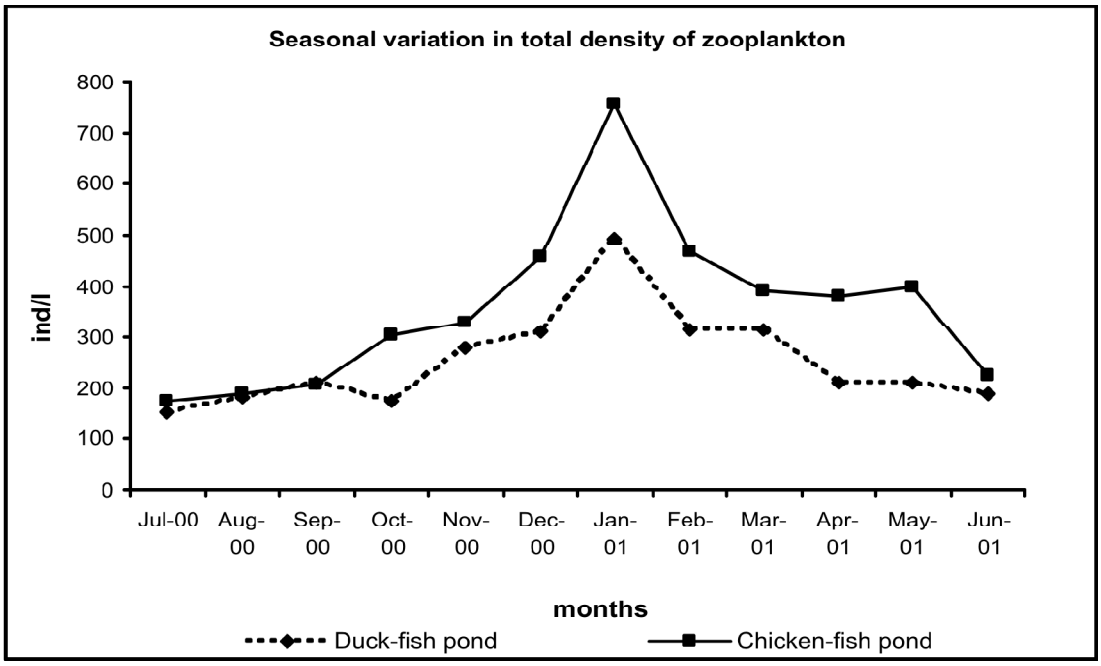

Figure 2: Seasonal variation in total density of zooplankton in duck-fish and chicken-fish ponds.

in integrated fish- cum-duck farming has also been reported by Chauhan *et al.* (1998), Kumar *et al.* (2012).

Species composition

A total of 27 species were identified from both the integrated farming ponds. 17 species belonged to rotifera, 8 to cladocera while the copepoda was represented by only 2 species (Table 2).

Among the rotifers, the species belonging to genus *Brachionus* were the most common and dominant in both ponds with a total of 8 species. It is important to note that *Brachionus spp* are commonly found in nutrient rich or heavily fertilized waters and are nutrient tolerant (Singh et al. 1997, Rahman and Hussain 2008).

Group-wise density

In terms of number, rotifera was the most dominant group in both the ponds. The total density of rotifers ranged from 13.6 to 206.7 ind/l in duck-fish pond and from 30.0 to 274.8 ind/l in chicken fish pond. Sharma *et.al.* (2001) also reported a mean rotifer population of 34% in a fish-poultry pond.

Copepoda formed the second most dominant group in the duck-fish pond with population density varying between 19.3 and 127.9 ind/l; cladocera being the third dominant group, had a contribution ranging from 0.0 to 227.2 ind/l. On the other hand, cladocera was the second most dominant group in chicken pond with population density ranging between 0.0 and

Table 2
List of zooplankton species recorded from duck-fish and chicken-fish integrated ponds.

Name of species	*Duck–fish pond*	*Chicken –fish pond*
Brachionus bidentata	+	+
B. calyciflorus	+	+
B. plicatilis	+	+
B. caudatus	+	+
B. angularis	+	+
B. quadridentatus	+	-
B. falcatus	+	+
B. diversicornis	+	+
B. havanensis	-	+
Philodina sp.	+	+
Polyarthra multiappendiculata	+	+
Notholca sp.	+	+
Asplanchna brightwelli	+	+
Filinia longiseta	+	+
Keratella tropica	+	+
Keratella procurva	-	+
Epiphanes sp.	+	+
Daphnia magna	+	+
D. pulex	+	-
D. lumholtzi	-	+
Bosminopsis sp.	+	+
Moina micrura	+	+
Alona sp.	-	+
Chydorus sphericus	-	+
Scapholeberis kingi	+	+
Mesocyclops hyalinus	+	+
Diaptomus sp.	+	+

+present, -absent

408.6 ind/l, followed by copepoda with population varying between 38.9 in May and 143.1 ind/l..

Crustaceans are the most important component of the zooplankton community in the present study, with mean annual percent contribution of 49.55 and 45.64 in duck and chicken ponds, respectively. Singh and Sharma (1998) reported annual population of 35.5 and 45.5% of cladocerans and copepods, respectively in a pond manured with poultry excreta.

Fish Production

Under duck-fish rearing, a gross fish production of 6154 kg/ha/yr was obtained at 700 no./ha stocking density of ducks. *C.carpio*, with a production of 37.1% was the largest contributor, followed by silver carp (25.9%). Chand et. al. also reported high fish production in duck fish integrated system with stocking density of ducks @400/ha.The details are given in table 3.1.

Table 3.1
Fish Production details in duck pond

Details	*Fish Species*					
	Catla	*Rohu*	*Mrigal*	*S. Carp*	*G. Carp*	*C. Carp*
Nos. stocked	100	126	70	200	75	140
Nos. harvested	86	108	58	180	66	124
Survival %	86	85.7	82.8	90	88	88.4
Initial average weight (g)	36.7	7.2	3.4	51.0	5.0	74.5
Final average weight (g)	230	225	245	520	614	451
Total weight harvest (kg)	29.65	22.920	13.500	88.819	60.690	127.200
]						

Details	*Duck-fish pond*
Area of pond	0.0557 ha
Stocking density	10000 fingerlings / ha700 ducks / ha
Production per pond / y	342.779 kg fish/y
Gross production / ha/y	6154 kg fish

In chicken fish integrated pond, gross fish production of 4483.2 was obtained (Table 3.2). Silver carp contributed maximum to the total fish production (25%). Common carp, mrigala, grass carp, rohu and catla contributed 21.14, 18.28, 13.29, 13.09 and 9.16%, respectively.

Table 3.2
Fish Production details in chicken-fish pond

Details	*Fish Species*					
	Catla	*Rohu*	*Mrigal*	*S. Carp*	*G. Carp*	*C. Carp*
Nos. stocked	56	106	120	90	48	78
Nos. harvested	43	95	107	79	36	65
Survival %	76.78	89.6	89.1	81.8	75	83.3
Initial average weight (g)	41.6	6.4	4.2	11.8	4.0	70.5
Final average weight (g)	200	106	157	220	225	298
Total weight harvest (kg)	13.81	19.7	27.5	37.67	20.015	31.9

Details	*Chicken–fish pond*
Area of pond	0.0336 ha
Stocking density	12000 fingerlings / ha500 chicken / ha
Production in pond	150.638 kg
Gross production / ha/yr	4483.2 kg fish / ha / yr

CONCLUSION

In light of the above it can be concluded that nutrient rich integrated fish livestock farming systems produce large populations of zooplankton and are sustainable in terms of food availability to the fish cultured. The quality of the zooplankton produced is also good and suitable for fish growth. As a result the growth of fish and the total fish production is higher as compared to the ponds without livestock integration, even without any kind of fertilization and supplementary feeding.

Table 3.3
Fish Production details in control pond

Details	*Fish Species*					
	Catla	*Rohu*	*Mrigal*	*S. Carp*	*G. Carp*	*C. Carp*
Nos. stocked	40	80	40	120	40	80
Nos. harvested	36	75	35	105	35	75
Survival %	90.0	93.8	87.5	87.5	87.5	93.8
Initial average weight (g)	40.5	10.2	9.5	21.2	90.0	40.8
Final average weight (g)	215	140	155	350	451	430
Total weight harvest (kg)	15.5	21.0	10.8	79.8	37.7	64.5

Details	Control pond
Area of pond	0.05 ha
Stocking density	8000 fingerlings / ha
Production per pond	223.3 kg
Gross production / ha/yr	4466.0

Fish grow rapidly in tropical waters and if natural fish food i.e. plankton, produced due to nutrient rich wastes, replaces the need for expensive supplementary feed, the cost of production could be minimized.

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