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Studies on Hydrobiology in relation to Occurrence and distribution of Molluscs in Fish ponds at National Fish Seed Farm, Karnataka

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Abstract

This article deals with the distribution and variety of aquatic molluscs in relation to physico-chemical parameters of maure fed fish rearing ponds of National fish farm of Karnataka, India for the duration of April to September 2021. A total of 17 species and 14 genera belonging to 8 families of molluscans were identified. Numerical abundance of total population registered 2100±75/m^2 to 4500±155/m^2. The genus composition of molluscans during this period comprised of Filopaludina (40%), *Indo planorbis* (5%), *Lymnaea* (12%), *Campeloma* sp. (5%), Lamellidens (1%), Viviparus (5%), *Radix* sp. (5%), *Melanoides* sp (5%), Thiara (2%), *Bellamya* (12%), Margaritifera (1%), *Idiopoma* sp (2%) and *Gyraulus* sp (5%) respectively . Gastropda constitute 83.33% and Bivalve contribute 16.67% respectively *Filopaludina* species showed dominant followed by *Bellamya* and *Lymnaea* with 12%. Total aquatic molluscans showed seasonal variation being peak density in summer while, minimum in winter. Among families, Lymnaeidae consists of 5 species followed by Viviparidae with 4 species. Planorbidae, Thiaridae and Unionidae consists of 2 species each and rest of the families having 01 species each respectively. Regarding water quality, water temperature, phosphate and dissolved organic matter have significant effect on species composition and seasonal abundance.

The community of organisms residing on bottom of a water frame represent an vital element of natural food of bottom residing fishes[10]. The productiveness of benthos as an entire, is related with the fish production and numerous change strategies of water in water-soil interface. except, benthic organisms are properly signs of water first-class and eutrophication and might integrate adjustments which mirror the traits of now not simplest the sediment but also the water column[27].

In waste water ponds, sedimentation of particulate organic matter of effluent on pond bottom increases the natural content material which shape wealthy source of meals materials to benthic organisms[9]. but, because of high organic load the bottom of such ponds usually contain very low quantity of oxygen. for this reason, most effective the ones kinds of benthic fauna that can tolerate high oxygen anxiety, are typically discovered to thrive in such fish pond bottom. Fluctuation and composition of benthic macrofauna in lentic sewage-fed device have been studied by different researchers[2,5-6,12,20].

Biotic communities of an aquatic ecosystem at once meditated the circumstance of the surroundings along with the residing components. The benthic invertebrates live in or on the sediments, which on the whole rely upon the decomposition cycle for their primary meals supply. The value of benthic micro invertebrates in biological monitoring studies is properly documented[3]. Tropical species are much like temperature groups[3,17].

Seeing that, there's a developing opposition among exclusive sectors of the community for the usage of water for drinking, irrigation, industries and so on. water first-class is turning into important within the present public health set up of our civilization. With near explosion of populace and the arrival of industrialization, aquatic ecosystems were given adversely prompted with the aid of the activities of man and his livestock[22]. Human made entrophication of water bodies had turn out to be a global huge technique which can be evaluated from different angles. Of overdue interest has been paid on the deleterious results of cultural eutrophication[2].

Use of organic variables in water best tracking have been summarized via Tittizer and Kothe[25] and the biological variables are beneficial in measuring the fine of water. similarly, biological monitoring can provide resolution in area and time, as an instance, gradients inside a water frame and their evaluation with pretty easy and reasonably-priced equipments and centers. Wiederholm[26] in addition to Hellawell[8] mentioned that the benthic communities (Molluscans) in aquatic systems fulfill all of these necessities and studies to a probably extra usefulness of benthic organisms tracking as compared with other biological variables. those variables are diagnostic, and must be touchy and effortlessly interpreted. For a reasonably complete image of the fitness popularity of an aquatic eco system, a fixed of physico-chemical parameters of water and some measures of the Plankton number one producer and customer species are possibly wished.

Those are virtually no information approximately the inland water molluscans from Karnataka. To this point, 64,731 species of molluscs have been suggested from everywhere in the international, of which 31,463 species are marine, 8465 species of inland water molluscs recorded from everywhere in the global, best 277 species are represented in India. Among the latter, in all 15 species of molluscs from the inland water bodies of Dharwad (Karnataka) have been recorded.

Almost, no work on molluscan range has been carried out from fish ponds of National fish farm of Bhadravathi taluk, Karnataka. The main purpose of this study worried with the evaluation of aquatic molluscans and describing the composition and also to spotlight the effect of water quality parameters on their distribution and composition.

Study Area :

The National fish seed farm (NFSF) of Karnataka is positioned at 13° 41' N latitude and 75° 38' E longitude. This farm is situated in Bhadravathi taluk of Shivamogga district of Karnataka for fish seed production. This farm has many ponds for brood fish rearing and producing fish seeds. Some are fully earthen ponds while, few of them are bottom earthen side cement revitted ponds. In this study, 05 bottom earthen with side cement revitted ponds are used (Plate 1). The area of these ponds varied from 600-1000 m^2.

In order to study the aquatic molluscans, the bottom soil samples were collected at randomly by Ekman Grab sampler and were mixed thoroughly. The mixture was sieved and molluscans were sorted out manually and preserved in 4% formalein solution for future examination. They were confirmed by Zoological Survey of India (ZSI), Kolkata and remaining samples were confirmed as per Subba Rao[23], Taylor[24], Dey[04], Patil and Goudar[16] and APHA[1]. In each sample, organisms were counted and the abundance was calculated as number of organisms/m^2. The molluscs were identified up to species level, based on the shell characteristics[3,29] and anatomical features[13].

The physico-chemical parameters of surface water of fish ponds were monitored at monthly intervals during April–September 2020. Standard methods were followed for analysis of hydrobiological parameters[1] Water samples were collected during 8 AM to 9 AM.

Species richness index (D) was calculated as per Margalef [14] species evenness index by Pielou[18] is calculated as

$$J = \frac{H'}{L_n S}$$

where, H = Shannon Index, S = number of species. Diversity index was determined using Shannon-Weaver[21] information function, which is

$$H' = \frac{S}{i = 1}\, pi \log_2 pi$$

where, pi= proportion of abundance of species and i and s = number of species

Sample collection and Statistical analysis :

The Molluscan samples were collected with the help of fishermen from the Department of Fisheries at National fish seed farm of Karnataka and the data is compiled in the form of scientific paper. One-way ANOVA with post-hoc Tukey HSD comparison tests was carried out for water quality parameters and density of molluscans by using socscistatistics.com software.

Physico-chemical parameters of water is depicted in Figure 1 & 2. The water temperature ranged from 22 to 31°C. While, pH of the brooders ponds were alkaline in nature. Turbidity values ranged 8-17 NTU. The dissolved oxygen level varied from 4.70-6.8 mg/l and CO_2 content ranged between 4.4 and 14.4 mg/l respectively. Total alkalinity fluctuated from 96.2 to 247 mg/l. However, the DOM values varied from 4.6 to 16.85 mg/l. BOD level ranged from 0.50 to 2.8 mg/l.

Nutrients like phosphate and nitrate levels ranged from 0.08-0.58 mg/l and 0.62-8.72 mg/l respectively.

The qualitative estimation of aquatic molluscans in fish pond are presented in Table 1, Plate 2 and Figure 3. The data revealed distinct seasonal abundance and species richness in experimental water bodies. Total population registered higher numerical abundance from 2100± 75/m^2 to 4500± 155/m^2. The genus composition of molluscans during this period comprised of *Filopaludina* (40%), *Indo Planorbis* (5%), *Lymnaea* (12%), *Campeloma* sp. (5%), Lamellidens (1%), *Viviparus* (5%), *Radix* sp. (5%), *Melanoides* sp (5%), Thiara (2%), Bellamya (12%), Margaritifera (1%), *Idiopoma* sp (2%) and *Gyraulus* sp (5%) respectively. Gastropda constitute 83.33% and Bivalve contribute 16.67% respectively. Total aquatic molluscans showed unimodals pattern of seasonal variation being higher density in summer season and lower density in winter season. Among families, Lymnaeidae consists of 5 species followed by Viviparidae with 4 species. Planorbidae, Thiaridae and Unionidae consists of 2 species each and rest of the families having 01 species each.

The Shannon-Weaver index of diversity (H) values for different seasons ranged 0.365-0.385bits/ individual with annual mean value of 0.372±0.02 bits/individual. Species richness index (D) values generally maintained more or less uniform values. Species evenness index (J) values calculated from 0.04 to 0.05 with annual mean of 0.045±0.003. It has been found that H and J were positively correlated ($p<0.05$) while, D and J were negatively correlated ($p<0.05$).

Table-1. Classification and occurrence of molluscan species in fish ponds of NFF, BRP

Class	Family	Scientific Name	Pond1	Pond 2	Pond 3	Pond 4	Pond 5
Gastropoda	Planorbidae	*Gyraulus* sp.	-	-	+	+	-
		Indoplanorbis exustus	+	+	-	+	+
	Lymnaeidae	*Lymnaea luteola*	+	-	-	-	+
		Lymnaea acuminata	-	+	+	+	—
		Lymnaea stagnalis	+	+	-	-	+
		Radix luteola	+	+	-	-	-
		Radix luteola ovalis	-	+	+	-	+
	Viviparidae	*Filopaludina bengalensis*	+	+	+	+	+
		Idiopoma sp.	-	-	+	-	+
		Viviparus bengalensis	+	+	+	+	+
		Campeloma sp.	-	+	+	-	-
	Thiaridae	*Melanoides tuberculata*	-	+	+	+	-
		Thiara sp	+	-	+	+	+
	Ampullariidae	*Bellamya bengalensis*	+	+	+	+	-
	Ariophantidae	*Macrochlamys* sp.	+	+	-	-	+
Bivalve	Unionidae	*Lamellidens marginalis*	-	+	-	-	
		Lamellidens jenkinsianus			+		
	Margaritiferidae	*Margaritifera margaritifera*	-	-	+	-	-

Plate 1: Fish ponds at National fish farm of Karnataka

Bellamya bengalensis

Lamellidens marginalis

Filopaludina bengalensis

Lymnaea acuminata

Lymnaea stagnalis

Plate 2: Aquatic molluscs of fish ponds of National fish farm

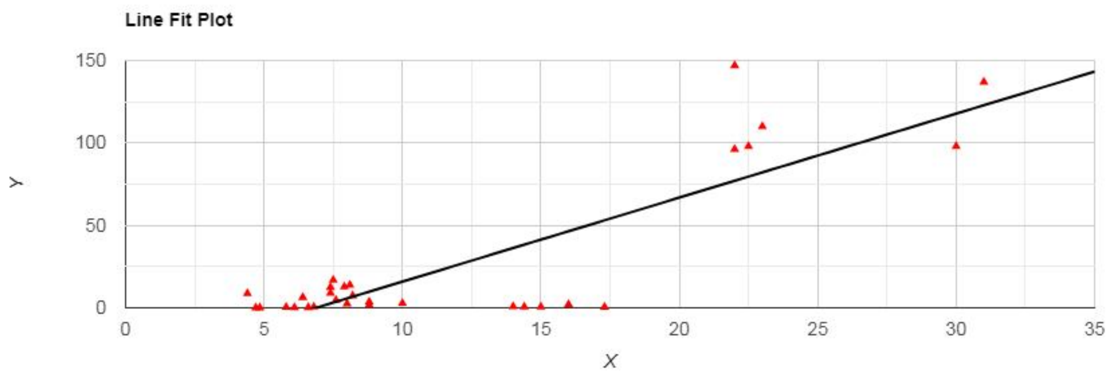

Figure 1: Line fit plot for Physico-chemical characteristics of pond waters during April –September 2020

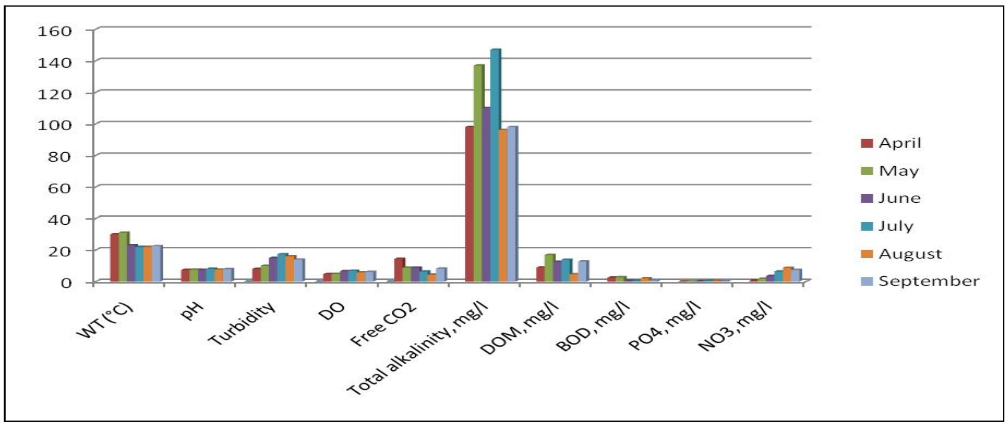

Figure 2: Mean values of physico-chemical parameters of Fish ponds (Four ponds pooled data) of National fish farm, Karnataka

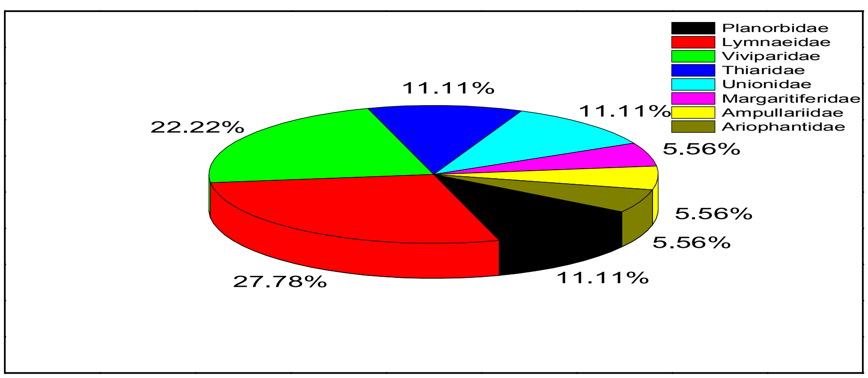

Figure 3 : Percentage occurrence of Molluscan families in Fish ponds of National fish farm, Karnataka

Table 2: One-Way ANOVA and Tukey HSD data for water quality parameters of fish ponds of NFSF, BRP

	WT & pH	Tur & DO	CO_2 & TA	DOM & BOD	PO_4 & NO_3	Total
N	12	12	12	12	12	60
$\sum X$	196.4	115.15	737.2	78.75	30.2	1157.7
Mean	16.3667	9.5958	61.4333	6.5625	2.5167	19.295
$\sum X^2$	4215.8	1346.5525	81430.24	914.5725	188.9856	88096.1506
Std.Dev.	9.5412	4.6865	57.3201	6.0134	3.2049	33.3848

Source	*SS*	*df*	*MS*	
Between-parameters	27863.0056	4	6965.7514	$F = 10.10986$
Within-parameters	37895.3235	55	689.0059	
Total	65758.3291	59		

The f-ratio value is 10.10986. The p-value is $< .00001$. The result is significant at $p < .05$.

Post Hoc Tukey HSD data :

The Tukey's HSD significant difference data procedure facilitates pairwise comparisons within ANOVA data. The F statistic tells whether there is an overall difference between sample means. Tukey's HSD test allows to determine between which of the various pairs of means - if any of them - there is a significant difference. Q value indicates a significant result. Second, it's worth bearing in mind that there is some disagreement about whether Tukey's HSD is appropriate if the F-ratio score has not reached significance.

Table-3: Post Hoc Tukey HSD data for water quality parameters of fish ponds of NFSF, BRP

Parameters wise comparisons		$HSD_{.05} = 30.2225$ $HSD_{.01} = 36.6595$	$Q_{.05} = 3.9885$ $Q_{.01} = 4.8380$
$T_1:T_2$	$M_1 = 16.37$ $M_2 = 9.60$	6.77	$Q = 0.89$ ($p = .96924$)
$T_1:T_3$	$M_1 = 16.37$ $M_3 = 61.43$	45.07	$Q = 5.95$ ($p = .00089$)
$T_1:T_4$	$M_1 = 16.37$ $M_4 = 6.56$	9.80	$Q = 1.29$ ($p = .88997$)
$T_1:T_5$	$M_1 = 16.37$ $M_5 = 2.52$	13.85	$Q = 1.83$ ($p = .69689$)
$T_2:T_3$	$M_2 = 9.60$ $M_3 = 61.43$	51.84	$Q = 6.84$ ($p = .00010$)
$T_2:T_4$	$M_2 = 9.60$ $M_4 = 6.56$	3.03	$Q = 0.40$ ($p = .99855$)
$T_2:T_5$	$M_2 = 9.60$ $M_5 = 2.52$	7.08	$Q = 0.93$ ($p = .96389$)
$T_3:T_4$	$M_3 = 61.43$ $M_4 = 6.56$	54.87	$Q = 7.24$ ($p = .00004$)
$T_3:T_5$	$M_3 = 61.43$ $M_5 = 2.52$	58.92	$Q = 7.78$ ($p = .00001$)
$T_4:T_5$	$M_4 = 6.56$ $M_5 = 2.52$	4.05	$Q = 0.53$ ($p = .99556$)

Table-4: One-Way ANOVA and Tukey HSD data for density of aquatic molluscans of fish ponds of NFSF, BRP

	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Total
N	10	10	10	10	10	50
$\sum X$	33000	35500	35980	33500	32970	170950
Mean	3300	3550	3598	3350	3297	3419
$\sum X^2$	115000000	132055000	135724400	118165000	113306900	614251300
Std.Dev.	823.2726	818.5353	834.5564	812.4038	715.294	779.4981

Source	*SS*	*df*	*MS*	
Between-treatments	830080	4	207520	$F = 0.32265$
Within-treatments	28943170	45	643181.5556	
Total	29773250	49		

The f-ratio value is 0.32265. The p-value is .86132. The result is not significant at $p < .05$.

Post Hoc Tukey HSD for density of aquatic molluscans in fish ponds of NFSF, BRP :

The Tukey's HSD (honestly significant difference) procedure facilitates pair wise comparisons within ANOVA data. The F statistic (above) tells whether there is an overall difference between sample means. Tukey's HSD test allows to determine between which of the various pairs of means - if any of them - there is a significant difference. It's worth bearing in mind that there is some disagreement about whether Tukey's HSD is appropriate if the F-ratio score has not reached significance.

Water quality and food accessibility are the significant factors prevailing the abundance and distribution of water molluscans[10,27]. Therefore, it is desirable to identify the environmental and anthropogenic factors structuring pond water community. Relatively higher temperature in summer and monsoon months enhances rate of bacterial decomposition of organic matter and results in increasing level of CO_2.

Variation of dissolved oxygen in the fish ponds are in conformity with some researchers[13,15,29]. Fish ponds showed moderate values of BOD owing to not only the amount but also the quantity of manures applied. High values of BOD may reduce the DO level during night, particularly prior to sunrise[19]. This may happened in rainy month in the water body when the sky was cloudy rich nutrients level in the pond water are responsible for higher densities of aquatic molluscans[9], Keup[11] has opined that sewage fed ecosystem often the type, concentration and quantity of wastes are not uniform, any sudden or temporary change may have a detrimental effect upon its biota. In present situation immediately after rains the aquatic molluscans populations, in general, were declined probably due to disturbances.

Table-5: Post Hoc Tukey HSD for density of aquatic molluscans in fish ponds of NFSF, BRP

Pair wise comparisons		$HSD_{.05}$ = 1019.1074 $HSD_{.01}$ = 1240.8388	$Q_{.05}$ = 4.0184 $Q_{.01}$ = 4.8927
T_1:T_2	M_1 = 3300.00 M_2 = 3550.00	250.00	Q = 0.99 (p = .95609)
T_1:T_3	M_1 = 3300.00 M_3 = 3598.00	298.00	Q = 1.18 (p = .91961)
T_1:T_4	M_1 = 3300.00 M_4 = 3350.00	50.00	Q = 0.20 (p = .99991)
T_1:T_5	M_1 = 3300.00 M_5 = 3297.00	3.00	Q = 0.01 (p = .00000)
T_2:T_3	M_2 = 3550.00 M_3 = 3598.00	48.00	Q = 0.19 (p = .99992)
T_2:T_4	M_2 = 3550.00 M_4 = 3350.00	200.00	Q = 0.79 (p = .98041)
T_2:T_5	M_2 = 3550.00 M_5 = 3297.00	253.00	Q = 1.00 (p = .95421)
T_3:T_4	M_3 = 3598.00 M_4 = 3350.00	248.00	Q = 0.98 (p = .95732)
T_3:T_5	M_3 = 3598.00 M_5 = 3297.00	301.00	Q = 1.19 (p = .91688)
T_4:T_5	M_4 = 3350.00 M_5 = 3297.00	53.00	Q = 0.21 (p = .99989)

Molluscans were found to be the most dominant group of total biota in a sewage fed lentic water body in Titagarh[5]. Chakrabarty[2] in his studies of bottom macrofauna at Rahara sewage fed fish pond, found dipteran larvae was to be the most dominant group following molluscs and oligo chaetes.

Physico-chemical parameters may have a profound effect upon both qualitative and quantitative distribution of aquatic molluscans[13,20]. In early pre-monsoon gradually increased temperature accelerate the bacterial decomposition creating suitable environment in tank bottom for growth and development of bottom dwellers. Higher aquatic gastropods populations required much DO. Thus reducing the DO level on the overlying water. The abundance of gastropodal organisms are dependent on organic matter which are main source of food materials to aquatic molluscans. Hence, abundance and distribution of molluscans are not independent on substrate.

Rich organic matter reduced the number of species but did not increase the evenness up to the mark. Although the number of tolerant or better adapted species increased, this did little increase of evenness. The species richness values indicated the relatively stable benthic community structure[14]. Variations in Shannon-Weaver values were due to variations in species composition and abundance in the study tank. Wilhm and Dorris[28] and Manna *et. al.*[13] observed high diversity value in clean water while, lower in eutrophicated water. According to their classification, the experimental lake fall high pollution category. Further, although diversity index values reflect the eutrophication status of the system but the pollution does not reach a lethal stage as to destroy all aquatic organisms.

Harish Kumar and Kiran [7] have studied the distribution and diversity of aquatic gastropods in relation to physico-chemical parameters of sewage fed Jannapura tank of India. They recorded 7 genera and 9 species of gastropods. Total aquatic gastropods showed peak density in summer while, minimum in winter season.

Aquatic molluscs have play an important roles in the food chain of studied fish ponds, but their habitats shows deterioration due to fisheries activities. Economic importance of edible gastropoda should be monitored for human usage and looked after their habitats for sustainable fisheries management. The presence of rare molluscan species indicates the significance of the fish ponds as a suitable habitat for the population of molluscs.

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