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Factors influencing amphibian population at Cauvery river banks of Nagappattinam District, Tamil Nadu, Southern India

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Abstract

The amphibians are the most sensitive animals to environmental changes as they are in intimate contact with many components of the natural surroundings. They may signal environmental degradations earlier than most other organisms and hence serve as critical bio-indicators of the ecosystem. Most of the organisms living in water bodies which are sensitive to changes in their environment. The present study was carried out at Cauvery River banks of Nagai District from April 2010 to June 2010 with the objective to register the water quality, diversity and abundance of amphibian fauna in the old and new Cauvery regions with special reference to the physico chemical parameters. Several physicochemical or biological factors could act as stressors and adversely affect the aquatic animal growth and reproduction. Hence, regular monitoring of physicochemical and biological water quality parameters is essential to determine the status of aquatic medium with reference to aquatic animal management. Water samples were analyzed by standard procedures of APHA, 1995. The frog population was calculated as number per hectare. Statistical analyses were performed by using window based statistical packages mainly, Microsoft EXCEL, Minitab and SPSS. To understand the relationships between the frog populations with physico chemical characteristics of water was analysed through Pearson's correlation. Present survey revealed that only one species was recorded in the study area with the highest abundance in April 2010 in Cauvery River than old Cauvery River. The present study proved that, if the water quality is altered, the density of *Euphlyctis cyanophlyctis* population will also suffered a lot and it leads to imbalance in the ecosystem. This study concludes that *Euphlyctis cyanophlyctis* could be habitat specific, which could be influenced by water quality. So far as the amphibian diversity is concerned only one species of *Euphlyctis cyanophlyctis* was recorded. An overall water quality influence on amphibian density, distribution and abundance was evidenced from the present study and needs further investigation.

Key words: Amphibian Diversity, Cauvery River, Nagai District, Water quality

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INTRODUCTION

The amphibians are the most sensitive animals to environmental changes as they are in intimate contact with many components of the natural surroundings. They may signal environmental degradations earlier than most other organisms and hence serve as critical bio-indicators of the ecosystem. (Blaustein and Wake 1990; Blaustein *et al*., 1994). Amphibians have been promoted as biological indicators on the basis that their sensitive skins and use both aquatic and terrestrial habitats, makes them vulnerable to environmental change (Lips, 1998). Biologists have realized that the amphibian population, particularly those of the Anurans, are declining rapidly throughout the world and have sounded an alert through agencies such as the Declining Amphibian populations Task Force (DAPTF)

Amphibians play diverse roles in natural ecosystems, and their decline may cause other species to become threatened or may undermine aspects of ecosystem function (Whiles *et al.* 2006). Amphibian populations are declining across the globe at an alarming rate, with over 43% of species in a state of decline. Such rates of species loss are far greater than the historic background extinction rate for amphibians (McCallum 2007). As part of the global loss of species, amphibian populations are declining throughout the world (Wake, 1991; Alford and Richards, 1999; Houlahan et al., 2000; Blaustein and Kiesecker, 2002). Numerous factors, including contaminants, habitat destruction and global environmental changes are contributing to population declines in amphibians (Alford and Richards, 1999; Blaustein and Kiesecker, 2002). Water quality criteria are the important character in amphibian life cycle.

Most of the organisms living in water bodies are sensitive to any changes in their environment. Several Physicochemical or biological factors could act as

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stressors and adversely affect aquatic animal growth and reproduction (Iwama *et al*., 2000). Hence, regular monitoring of physico chemical and biological parameters is an essential to determine status of aquatic medium with reference to aquatic animal management. The widespread decline of amphibian populations and the multitude of factors causing this (Kiesecker *et al*., 2001; Green, 2003; Stuart *et al*., 2004) suggested a need to monitor amphibian population (Dodd, 2003). Since factors affecting population dynamic may have both natural and anthropogenic origins, monitoring programs are required to track changes in populations, communities, and habitat quality to better identify the causes of their changing in time (Pechmann, 2003).

Conservation strategies around the world are often made considering more conspicuous and glamorous taxa like birds and mammals, which may unnoticeably neglect smaller and less conspicuous vertebrates such as herpetofauna (Vasudevan, 2006). Only in the recent past there has been a great consciousness about extinction of herpetofauna globally (Reid, 2008).

However, in India, very few studies were evaluating the relationship between the impact of hydrological parameters and amphibian population and the responses of amphibian's population with reference to water is not investigated in detail. The present pioneer work was carried out to identify the extant population of amphibian fauna of Cauvery River banks of Nagappattinam District from April 2010 to June 2010 with the objective to register the water quality, diversity and abundance of amphibian fauna at old and new Cauvery region with special reference to the physico chemical parameters.

MATERIALS AND METHODS

Study Area

Mayiladuthurai town is located on the banks of Cauvery. From Mayiladuthurai, the river flows through several small villages before ending its journey at Kaveripoompattinam near Poombuhar. Encroachments and silt deposits on river made it to change its course at some places. Particularly the drainage channels of the river have been affected by encroachments, silt and Kattamanakku. The river Cauvery between Mayiladuthurai and Arupathy is called with two names; one area is called as Old Cauvery and at some other places is called Cauvery. The old Cauvery stretch comprising mainly drainage channels between Mayiladuthurai and Arupathy has not been desilted during the past 50 years due to encroachments. The areas chosen for the present study are Cauvery and Old Cauvery. The Cauvery River which comes from the Mettur Dam is found 200 meters away from the college, in the northern side. The old Cauvery channel runs south of the river Cauvery. The old Cauvery channel is running through the main streets of Mayiladuthurai. Domestic sewages from different regions are allowed to enter and mix with the old Cauvery water. Besides this, Oil, grease, waste pieces of wood and steel, drainage from the houses also find in old Cauvery from different areas of Mayiladuthurai.

Methods

Six sites were selected randomly from three selected areas viz, Malliyam, Moovalor and Mayiladuthurai of the Cauvery and Old Cauvery river in between Mayiladuthurai and Arupaty of Nagai District during the day hours by using Visual Encounter Survey method. The frog collection was made during morning 6.00 to 8.00 am for the entire study periods. The amphibians were identified. Water samples were collected monthly once from 6 sites of study areas. The following physico chemical variables were measured by the following methods such as Turbidity (NTU) by using Nephelometer; TDS by Gravimetric method (Trivedy and Goel, 1986): pH by using electronic pH; Electrical Conductivity **(**mhos/cm) by using Conductivity meter; BOD(mg/l) by waste water treatment methods (APHA,1995);

The frog population was calculated as number per hectare. Statistical analyses were performed by using window based statistical packages mainly, Microsoft EXCEL, Minitab (Ryan *et al*., 1992) and SPSS (Nie *et al*., 1975). Mainly parametric tests were used to test the hypotheses and they were Analysis of Variation (ANOVA), for hypothesis testing $P < 0.05$ and $P < 0.01$ were considered and the levels of significance are indicated at appropriate places. Statistical inferences are made by following Sokal and Rohlf (1995). To understand the relationships between the frog populations with water quality characteristics, the Pearson's correlation was applied.

RESULTS

The estimation of amphibian population was made in the Cauvery and Old Cauvery from April 2010 to June 2010. Only one species was found in the entire study areas for the entire study period viz., *Euphlyctis cyanophlyctis* . The density of *E. cyanophlyctis* was high during April 2010 with the value of (106.83 ± 7.36 No. / ha) and lowest in June 2010 with the value of (38.83 ± 11.51No.ha). The same trend was observed in old Cauvery as well. In old Cauvery the density of *E. cyanophlyctis* was (39.6 ± 4.84, 34.6 ± 7.97 and 16.1 ± 3.97 No. / ha.) April, May and June 2010 respectively (Table 1).

Table . 1. Population (No. / Ha) of *E. cyanophlyctis* recorded in the two riverine habitats from April 2010 to June 2010

Sl. No.	Months (2010)	E. cyanophlyctis Population (No./Ha)	
		Cauvery	Old Cauvery
1	April	106.8 ± 7.36	39.6 ± 4.84
2	May	83.8 ± 7.70	34.6 ± 7.97
3	June	38.8 ± 11.51	16.1 ± 3.97

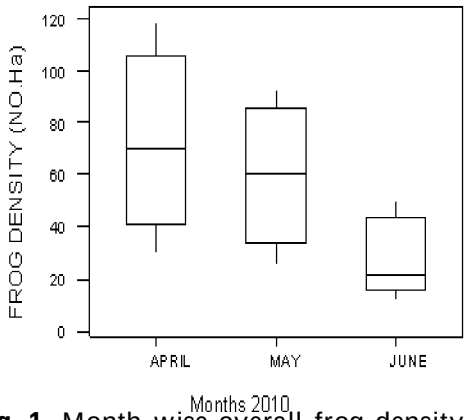

Fig. 1. Month wise overall frog density (No. / ha) recorded from April 2010 to June 2010 in both study areas.

However, the overall results of the present study indicated that the amphibian population and water chemistry features of the following characteristics such as total dissolved solids (TDS), pH, electrical conductivity (EC), biological oxygen demand (BOD) and chemical oxygen demand (COD) showed significant variations with reference to areas (P<0.001). But the characteristics such as biological oxygen demand (BOD) showed significant variations among the months (P<0.05) were observed. In contrast the water chemistry characteristics such as turbidity, total dissolved solids (TDS), pH, electrical conductivity (EC), chemical oxygen demand (COD) did not show any variations among the months whereas the turbidity did not show any variations with reference to area and months (P>0.05) (Table 3).

However, the overall month wise *E. cyanophlyctis* density was noted lower in June 2010 and higher in April 2010 in both areas (Table 2 and Fig.1). On the other hand, the overall area wise population was lower in Old Cauvery and higher in Cauvery River (Table 2 and Fig.2). The Analysis of Variance (ANOVA) revealed that both areas (F = 130.15) and months (F = 44.42) were showed significant variations with reference to the *E. cyanophlyctis* population (P<0.001) (Table 3).

The pH (r = -0.570), chemical oxygen demand (COD) (r = -0.525) were showed negative significant relationships (P<0.01). In the Old Cauvery the water chemistry characteristics pH (r = 0.527), Chemical Oxygen Demand (COD) (r = 0.57) were positive significant relationship (P<0.01) whereas negative significant relationships (P<0.01) with the frog population and water chemistry characteristics (Table 4).

Table.2. Chemical characteristic features of water recorded in the Cauvery and Old Cauvery area from April 2010 to June 2010.

Sl. No.	Water Chemistry & Population	Cauvery river			Old Cauvery		
		Months [2010]			Months [2010]		
		April (N=6)	May (N=6)	June (N=6)	April (N=6)	May (N=6)	June (N=6)
1	Turbidity(NTU)	19.1±8.01	15.0±5.48	14.1±9.17	12.5±2.74	18.3±4.08	15.0±4.47
2	Total Dissolved Solids (mg/l)	555.8±48.44	556.8±67.85	483.3±70.28	1149.0±77.4	1260.6±85.91	1251.1±123.65
3	P^H	7.1±0.08	7.2±0.11	7.4±0.17	7.7±0.15	7.7±0.14	7.5±0.08
4	Electrical Conductivity (dsm^{-1})	0.8±0.07	0.8±0.10	0.7±0.10	17±0.11	19±0.13	19±0.19
5	Biological Oxygen Demand (mg/l)	5.5±2.16	80.3±3.74	73.3±2.94	139.6±14.83	143.1±11.57	143.0±10.45
6	Chemical Oxygen Demand (mg/l)	28.6±6.92	43.1±6.11	44.5±6.28	86.3±2.66	84.8±1.72	80.6±4.55

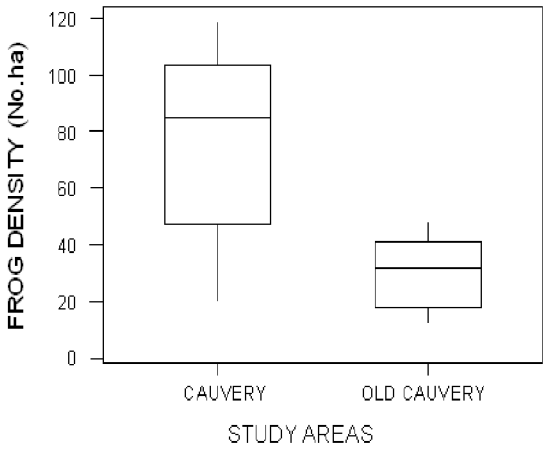

Fig. 2. Area wise overall frog density (No. / ha) recorded in the Cauvery and Old Cauvery from April 2010 to June 2010.

In both habitats, the overall results were indicated that the following water chemistry characteristics total dissolved solids (TDS) (r = -0.67), pH (r =-0.666), electrical conductivity (EC) (r = -0.67), biological oxygen demand (BOD) (r = -0.74), chemical oxygen demand (COD) (r = -0.763), with the frog population. However, the turbidity (r = 0.154) with the frog population. Apart from that among the 6 chemical characteristics features of water the pH and chemical oxygen demand (COD) showed positive significant relationships in the Old Cauvery river but in the Cauvery they had negative significant relationships when compared to the other chemical characteristics of water (P<0.01). To understand the relationships between the frog population and water chemistry characteristics the Pearson's correlation was applied and the results were given in Table 5 and 6.

Table.3. ANOVA to evaluate the impact of relationships of water chemistry with reference to the different areas i.e. Cauvery and Old Cauvery and different months studied during the entire study periods from April 2010 to June 2010.

	Source	DF	SS	MS	F	P
Turbidity	Area	1	6.25	6.25	0.16	0.7
	Months	2	26.39	13.19	0.33	0.72
	Error	32	1275	39.84		
	Total	35	1307.64			
Total Dissolved Solids	Area	1	4263537	4263537	546.6	**0**
	Months	2	20463	10231	1.31	0.28
	Error	32	249605	7800		
	Total	35	4533604			
PH	Area	1	1.48434	1.48434	51.99	**0**
	Months	2	0.00555	0.00277	0.1	0.91
	Error	32	0.91359	0.02855		
	Total	35	2.40348			
Electrical Conductivity	Area	1	10.4006	10.4006	546.7	**0**
	Months	2	0.051	0.0255	1.34	0.28
	Error	32	0.6088	0.019		
	Total	35	11.0604			
Biological Oxygen Demand	Area	1	45227	45227	321.5	**0**
	Months	2	938	469	3.33	0.05
	Error	32	4502	141		
	Total	35	50667			
Chemical Oxygen Demand	Area	1	19182.2	19182.2	444.3	**0**
	Months	2	254.4	127.2	2.95	0.07
	Error	32	1381.7	43.2		
	Total	35	20818.3			

Table. 4. Analysis of Variance of *E.cyanophlyctis* to evaluate the area and monthwise differences for the entire study periods from April to June 2010.

Source	DF	Sequential SS	Adjusted SS	Adjusted MS	F	P
Area	1	19321	19321	19321	130.15	0.001
Months	2	13189	13189	6594	44.42	0.001
Error	32	4750	4750	148		
Total	35	37260				

Table. 5. Analysis of Pearson correlation to investigate the relationships between the frog density and water chemistry characteristics in the Cauvery and Old Cauvery habitats studied during the entire study periods from April 2010 to June 2010.

S. No.	Water chemistry characteristics	Habitats		Over All (N=36)
		Cauvery (N=18)	Old Cauvery (N=18)	
1	Turbidity	0.205	-0.081	0.154
2	Total Dissolved Solids (mg/l)	0.397	-0.106	-0.67**
3	P^H	-0.570^{**}	0.527^{*}	-0.666^{**}
4	Electrical Conductivity (dsm^{-1})	0.397	-0.11	-0.67^{**}
5	Biological Oxygen Demand (mg/l)	-0.331	-0.131	-0.74^{**}
6	Chemical Oxygen Demand (mg/l)	-0.525**	0.57^{**}	-0.763^{**}

*P<0.05 **P<0.01

The present study revealed that the frog population i.e. *E. cyanophlyctis* have strong associations with the chemical characteristics features of water. The results of population estimation indicated that the Cauvery river have highest trend than that of the Old Cauvery river area.

Table.6. Pearson's Correlation to evaluate the relationships between the frog density and water chemistry studied in the study areas during the entire study periods from April 2010 to June 2010.

WATER CHEMISTRY VARIABLES	FROGDEN	TUR	TDS	pH	EC	BOD	COD
Turbidity	0.154						
Total Dissolved Solids (mg/l)	-0.67**	-0.065					
PH	-0.666**	-0.2	0.712**				
Electrical Conductivity ($ds\,m^{-1}$)	-0.67**	-0.064	1**	0.712**			
Biological Oxygen Demand (mg/l)	-0.74**	-0.078	0.919**	0.767**	0.918**		
Chemical Oxygen Demand (mg/l)	-0.763**	-0.131	0.928**	0.81**	0.928**	0.964**	

FROGDEN = Frog Density**; TUR** = Turbidly; **TDS** = Total Dissolved Solids; **EC** = Electrical Conductivity; **BOD** = Biological Oxygen Demand; **COD** = Chemical Oxygen Demand

**** = p<0.01;*= p<0.05**

DISCUSSION

The present study was carried out in two different habitats viz., Cauvery and Old Cauvery river habitats from April 2010 to June 2010, Mayiladuthurai Taluk, Nagapattinam District, Tamil Nadu. The Cauvery River is one of the important rivers in Tamil Nadu particularly in Thanjavore District, Tamil Nadu, which is the vital river and seasonally providing water sources to the lot of agricultural wetlands for various agricultural practices. Due to changes of climatic conditions and global warming, the river is facing to water scarcity every year and decreasing water flow imposes facing critical consequences and particularly in the agricultural practices especially in Cauvery deltaic regions. In fact, these temporary water bodies could support a number of species and acting as a microhabitat for certain species especially amphibians etc. (Sathish *et al*., 2010). Therefore the temporary water bodies of habitats viz., Cauvery and Old Cauvery Rivers were surveyed. The amphibian population and analyses of water chemistry characteristics were done.

However, this river is also supporting and providing the habitat for aquatic organisms like, mosquitoes, amphibians etc. and as a feeding and breeding grounds for those species (Sathish *et al*., 2010). After careful survey of both habitats, the *E. cyanophlycytis* was the only amphibian species found to be recorded for the entire study period.

The present study is indicated that the temporary water bodies are also important for aquatic organisms especially amphibian species. Where there is a temporary, natural and small size of water bodies of aquatic habitats, there are variety of species which are very often being conspicuous and therefore conservation aspects of these areas are poorly known (Grillas *et al*., 2004). Temporary ponds are habitats of critical importance for many amphibian species (Diaz-Paniagua, 1990; Griffiths, 1997; Semlitsch, 2003).

Surface water such as river, ponds and lakes can be acidified through several natural and anthropogenic process, industrial effluent and acid deposition from the atmosphere which are great concern (Sparling *et al*., 1995). According to Sparling et al. (1995) the amphibian population could influence the water and soil chemistry characteristic features. In fact our study also revealed that the pH and other water chemistry features were strongly correlated with the frog population i.e. *E. cyanophlyctis.*

In contrast, many studies well established that the water chemistry characteristics are more important for aquatic organisms. However, most of the research concerning potential declines in amphibian population has focused on the effects of habitat acidification and the subsequent lethal and sub lethal effects of low environmental pH (Horne and Dunson, 1994). But, according to Pirce (1992) who stated that there is a link between widespread declines of amphibians and acid precipitation especially due to acid rain. Furthermore, these habitats i.e. Cauvery and Old Cauvery Rivers had not much variation in the water chemistry characteristics. In fact the acidity is more viable factor, because, in amphibian during their reproductive stages i.e. early embryological stages are most sensitive to acidity (Pirce, 1992).

In the present study, the pH value was more in all the village ponds which might be due to the presence of various pesticides and fertilizers, which needs further study. Physical parameters like pH, temperature, salinity, TDS, turbidity, conductivity and DO mainly determine the water quality and the aquatic biodiversity (Chukwuka,2008). As aboitic environments influence the efficiency of physiological function of a species, these factors not only determine quality of habitat but also explain viability of population over a range of habitat components (Gururaja *et al*., 2003).

Electrical Conductivity is a parameter used in the measure of pollution which provides an estimate of the concentration of ions and salts in water samples. The higher value and the greater concentration of the pollutants reflect the electrical conductivity. Reported that the EC of water in the month of August was very low. The reduction of conductivity with time may be due to the uptake of the ions by organisms for their metabolism. It was also proved by Hanna (2004).

Dissolved oxygen is one of the most important indicators of the quality of water for aquatic life. During winter, lack of re-aeration can cause significant depletion of DO under natural conditions. There was significant differences in amphibian population in relation to do according to (Cappucio *et al.,* 2011).

Baturin *et al.* (2007) reported that the TDS measures the amount of sediments dissolved in water. High levels of TDS can harm amphibians because of their semi-permeable skin, which absorbs these sediments and can gradually kill them. The buildup of sediments reduces water clarity, which makes it difficult for amphibians to find food and hide from other predators.

Kasulo (1999) reported that most of the vertebrates found in the water hyacinth infested areas were either purely dependent upon aerial respiration like water snakes or were supplemental air breathers such as frogs and air breathing fishes like *Clarias sp.* The overall results of the present study indicated that the chemical characteristics of water closely associated with the frog population i.e. *E. cyanophlyctis.* Because most of the studies revealed that the water levels are more important as well as vital factor for the survival of aquatic organisms especially amphibians. In addition to that globally number of aquatic organisms are either under "threatened" or "endangered" category due to alteration of habitat and intensive anthropogenic pressures (Vitousek, 1994). Thus, the present study concluded that most of the physic-chemical and biological parameters in the river under study showed a monthly pattern of variations due to its local factors like release of sewage, dumping of organic debris, release of inorganic nutrients, detergents, etc, which could either directly or indirectly affect the population of frogs.

Hence it is essential that the aquatic ecosystem and neighboring areas are to be protected so as to conserve the biodiversity as well as minimizing the extinction of species. Such a vast area was covered in both areas which are one of the important aquatic habitats of this area but only one species was found for the entire study period. It seems that these habitats are degrading and therefore the species richness is declining. Moreover, the present study proved that the alteration of habitat resulted in decline in the density of *Euphlyctis cyanophlyctis* population which also caused imbalance in the ecosystem. It is also concluded that *Euphlyctis cyanophlyctis* might be habitat specific and its population influenced by water quality.

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