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Diversity of Anurans and their Habitat Preference in Temporary Water Pools of a Rock Mining Area at Steel City Durgapur, East India

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Abstract: The present study deals with the study on the anuran diversity and their habitat choice based on limno-chemical factors in the two temporary water pools of a rock mining area in the industrial city Durgapur, East India. Two temporary water pools and a perennial water body were chosen randomly as study sites. Population count was done weekly by hand capture and net capture methods between August 2013 and July 2014. Water sample was taken by Grab sample method in polythene bottles and tested in the laboratory. Total 693 adult individuals were captured from which seven species were recorded of five genus representing three families. The perennial water body was found as most diverse but temporary pools were most influential in habitat preference of anurans especially during the breeding season. Among the limnological factors, dissolved oxygen and sodium content were found to be positively contributing in determining habitats of anurans.

Key words: Anuran Diversity · Habitat Preference · Limno-Chemical Factors · Relative Abundance of Anurans · Water Quality

INTRODUCTION

Temporary water pools hold biotic communities that are distinctly different from that of the permanent aquatic bodies [1]. There are several groups of animals that are found in these temporary water pools, but only some of them become specialized and developed strong adaptation capabilities to survive in these kind of environments. These faunal species are distinguished from others by their rapid short time of reproduction and fast colonization rates [2]. Since, the temporary water pools are mostly small in size and shallow and their time of flooding is also unpredictable, biodiversity in these ponds varies. There is a little overlap between species observed in temporary ponds and permanent waters, although the degree of overlap may vary in different geographic locations [3]. The most influential factor affecting biota is the desiccation of the habitat during the dry season. Species richness normally increases as the length of the flooded period in ponds increases [4]. Decline in amphibian population at large scale both globally as well as locally is a statutory factor for habitat destruction [5]. One of the factors of habitat destruction is based on the land use pattern. Diversity decreases as the nature of land use grows from the natural sites to mining and agricultural sites. Intense anthropogenic influence in an area dramatically decreases both the diversity and the population of the anurans [6]. For any species, one of the fundamental reasons for choosing a habitat is breeding. Anurans stand very precise and selective when choosing breeding habitats as they can sense the presence of predators and the host parasites in a site [7]. Temporary water pools remains dry for most of the year thus presence of predators and parasites occur less. Preferring the temporary pools for breeding sites therefore is largely accepted by the anurans [4]. Also, Shallow depth keeps the eggs and tadpoles warm. After breeding, newly hatched tadpoles are very much influenced by the abiotic factors of the habitat [8]. Studies in anurns have not much been done in the Durgapur region. The present study looked at the role of limnological factors in temporary water pools in governing the diversity of anurans and their preference of habitat at a rock mining area of Durgapur, East India.

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MATERIALS AND METHODS

The present study was conducted to understand the status and diversity of anuran species in two selected temporary water pools and a perennial water body (as a control site) in a Rock Mining area (outskirts of Komalpur village) at Durgapur, East India (Fig. 1). This area is being used as a rock mining area. The entire ground surface of this area contains sand rocks mostly with variable sizes between 0.5cm and 14cm. As the miners dig for the rocks, the empty excavated small areas are left open which in monsoon gets filled up by the rain, creating the temporary pools. The pools vary in size and shape. The entire study area was surrounded by agricultural lands. Largely, rice (*Oriza* sp) is the primary crop in these agricultural lands. During the monsoon and winter season the agricultural lands were cultivated and most of the time was inundated with water, however, in summer these agricultural lands were dry and without crops. All the temporary pools in that area were marked with an individual number and two were selected randomly based on the random number generator in MS Excel 2010 using the formula "=RAND()*(b-a)+a"; Where "a" is the smallest number and "b" is the highest. At the present study, 'a' was 1 and 'b' was 77. The generated numbers were 2.699 and 40.127. Hence, the pool marked with number 2 and 40 were selected for the present study. The nearest perennial water body from the selected temporary water pools was selected as a control study site for the present study.

Study site 1 (N23°35'33.7", E087°17'49.7") was a small man made excavated temporary pool. The elevation of the site was 100.6 meter. During monsoon period, Akashmoni (*Acacia auriculiformis*) trees were found as saplings at the site which were found dead at the beginning of the winter season. Rest of the year the site was covered only with *Wollenbergia* sp along with some grasses. No anthropogenic activities were observed during the study period at this site. Study site 2 (N23°35'33.4", E087°17'50.2"), a medium sized natural temporary pool formed in a depressed land. The elevation of the site was 100.2 meter. Distance of the second site from the first was 27 meter. The vegetation was almost as same as the first study site. In addition, *Cassia* sp was encountered here. Study site 3 (N23°36'01.4", E087°17'56.4") is a natural perennial water body. It was considered as the control site depending upon its ecological health status as per the studied results. The elevation of the site was 107.4 meter. Distance between this perennial water body and other two study sites was more than 300 meters. The vegetation around this water body was comprised of *Croton* sp, *Cassia* sp, *Zizyphus* sp, *Lantana* sp etc. Various grass species were also present along with the macrophytes like *Nymphaea* sp, *Eichhornia* sp, *Nelumbo* sp, *Ipomoea* sp etc. *Droserra burmanii*, an insectivorous plant was also found at this site throughout the year.

Anurans need breeding and non-breeding habitats to survive. Water is essential for their breeding and larval development. Among the recorded species in the study area, *Duttaphrynus* sp breeds in temporary pools and ponds, *Hoplobatrachus* sp is more of aquatic species and spends most of its time in water or wet areas. *Microhyla* sp, *Euphlyctis* sp and *Fejervarya* sp breed in agricultural and temporary pools. Thus, nature and composition of the water is an important factor for the anurans, hence, water parameters were studied to co-relate the population of the anurans with the limno-chemical parameters of the study pools. The limno-chemical water parameters were examined in the laboratory of PG Department, Conservation Biology, Durgapur Government College, India. Study sites were visited four times in every month (once every week) from August, 2013 to July, 2014 for data collection. Each study site was visited between 7:00 AM to 11:00 AM for the data collection. Dissolved oxygen (DO) and pH were measured at the study sites. Water samples were collected in one litre polythene bottles were used for the water sampling. Grab Sampling Method [9] was followed for the water sample collection. After collection the samples were immediately brought back to lab and were stored at 4°C. Conductivity was measured within 4 hours of the water collection and rest of the water parameters within 48 hours. Anurans were collected by Hand Capture method and Net Capture Method with proper care [10]. Captured individuals were identified using the standard field guide [11]. After identification the individuals were released back in the water at the same capture locations. Only the collected adult individuals were studied. Analysis of water parameters were done following the guidelines of APHA [9]. Statistical analysis were done using PAST version 2.0.Water quality was studied during monsoon and winter.

Fig. 1: Location of the study site at Durgapur, East India (August, 2013 to July, 2014)

RESULTS

During the present study, a total of seven species from five genus of three families have been found (Table 1) from the 693 encountered individuals. Among the three families observed, anurans from Dicroglossidae have been encountered mostly and Microhylidae was the least. The Shannon Weiner species diversity index was maximum in the site 3 (1.364), followed by site 2 (1.256) and site 1 (1.125) (Table 2). Also, dominance (Simpson's Dominance Index) was observed highest in site 3(0.72) followed by site 2(0.68) and site 1 (0.61). Evenness (Pielou's Evenness index) was highest in the site 2(0.88) followed by site 3(0.65) and site 1 (0.62) (Table 2).

Table 1: The list of anuran species recorded from the temporary pools in a rock mining area at Durgapur, East India (August, 2013 to July, 2014)

Species	Scientific Name	Family	Local Name
Common Indian Toad	*Duttaphrynus melanostictus*	Bufonidae	Kuno Bang
Indian Marbled Toad	*Duttaphrynus stomaticus*	Bufonidae	Kuno Bang
Indian skipper frog	*Euphlyctis cyanophlyctis*	Dicroglossidae	Churchure Bang
Cricket Frog	*Fejervarya limnocharis*	Dicroglossidae	China Bang
Jerdon's Bull Frog	*Hoplobatrachus crassus*	Dicroglossidae	Sona Bang
Indian Bull Frog	*Hoplobatrachus tigerinus*	Dicroglossidae	Sona Bang
Ornate Narrow Mouth Frog	*Microhyla ornata*	Microhylidae	Kath Bang

Table 2: Diversity indices of anuran species in three study sites (temporary pools in a rock mining area) at Durgapur, East India (August, 2013 to July, 2014)

Diversity indices	Site 1	Site 2	Site 3
Simpson's Dominance Index	0.6111	0.6843	0.7216
Shannon Weiner Index	1.125	1.256	1.364
Pielou's Evenness	0.616	0.8776	0.6518

Table 3: Dimensions of different study sites (temporary water pools in a rock mining area) for studying anuran diversity at Durgapur, East India (August, 2013 to July, 2014)

Study Sites	Seasons	Length (m)	Width (m)	Depth (m)	Volume (m^3)	Surface area (m^2)
Site 1	Monsoon	31.8	26.1	3.9	3236.9	830.0
	Winter	21.3	17.7	2.7	1017.9	377.0
	Summer	0.0	0.0	0.0	0.0	0.0
Site 2	Monsoon	131.1	65.4	2.9	24692.9	8573.9
	Winter	78.6	31.2	1.8	4414.2	2452.3
	Summer	0.0	0.0	0.0	0.0	0.0
Site 3	Monsoon	169.5	92.7	5.1	80134.5	15712.7
	Winter	143.4	72.9	4.5	47042.4	10453.9
	Summer	93.3	59.7	3.5	19383.6	5570.0

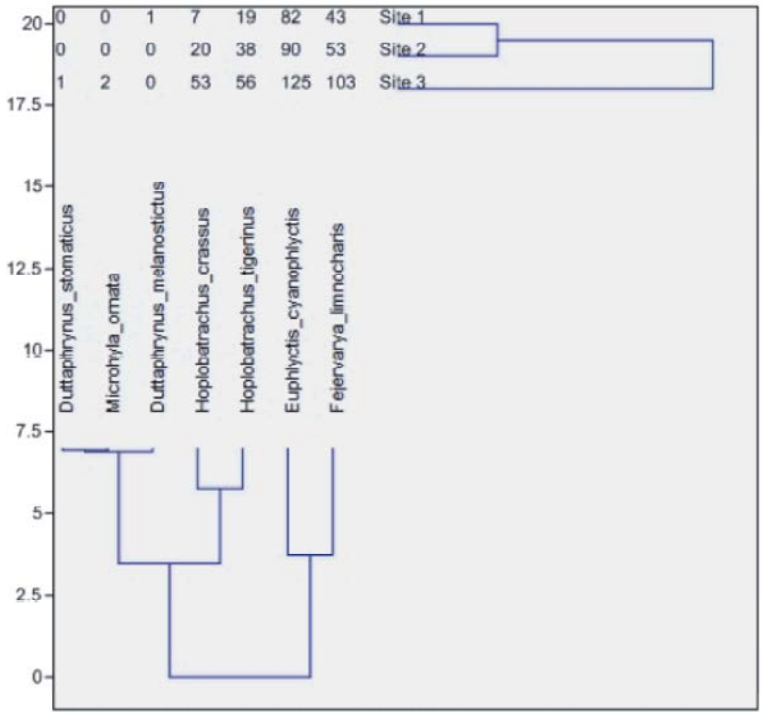

Fig. 2: Dendrogram showing the result of cluster analysis between three study sites (two temporary water pools and one perennial water body) and seven species of anurans recorded in the study sites in Durgapur, East India (August, 2013 to July, 2014)

Dendogram from the cluster analysis showed the two study sites, site 1 and site 2 are closely resembled whereas the site 3 is unique (Fig. 2). Among the anurans, *Duttaphrynus stomaticus*, *Microhyla ornata*, *Duttaphrynus melanostictus* have formed primary clusters indicating the similarity among them. *Hoplobatrachus crassus* and *H. tigerinus* has formed another primary cluster among them in the study sites. Unique to the other species, *Euphlyctis cyanophlyctis* and *Fejervarya limnocharis* are found to be close to each other in the study sites (Fig. 2).

Morphometric study of the water pools revealed that two of the study sites were temporary, namely, site 1 and site 2 whereas the site 3 was found to be perennial water body as the water remains in site 3 throughout the year. Among the three sites, site 1 had the lowest water volume and site 3 had the highest water volume during the study period (Table 3). A correlation test was performed to understand the relation between different water parameters and the anuran species found in the study area. It was found that Physico-chemical parameters of water *D. melanostictus* has co-related positively with the pH, conductivity, phosphate-phosphorus and potassium. *E. cyanophlyctis*, *F. limnocharis* and *D. stomaticus* has been found to be co-related with the dissolved oxygen and sodium positively. *H. tigerinus* and *H. crassus* has showed positive co-relation with the dissolved oxygen. *M. ornata* is not co-related with any of the water parameters.

DISCUSSION

Among the 284 recorded amphibian species from India, West Bengal holds 50 species [12]. Burdwan District has been found to hold seven species of amphibians all of which represents the order anura [13]. Specifically from Durgapur, two studies have been done describing anuran diversity [14, 12]. Current literatures showed ten species of anurans present in the Durgapur. None of the previous studies reported Indian Marbled Toad (*Duttaphrynus stomaticus*) of the family Bufonidae from Durgapur, however the present study recorded this species at site 3. Thus, the list of anurans in Durgapur is now consists of 11 species (Table 4). The individual lacking the cranial crests and three longitudinal black stripes on the arm pointed the species to be Indian Marbled Toad (*Duttaphrynus stomaticus*, Lutken 1864) [13]. It is clear that more intense study regarding the anurans in this landscape may reveal more information on ecology and diversity of anurans.

Amphibians, especially anurans are health indicators of temporary pools as their population fluctuates with the hydro-period of pools and shows the health of the ecosystem by balancing energy transfer from lower trophic levels to the uppers which also structure the biotic composition and assemblage of the entire system [15]. Anurans tend to increase in diversity in the temporary water pools but the present study shows lower diversity in the study sites. Highest species diversity was observed in the perennial water body may be due to the large surface area and maximum water volume (Table 3) and presence of macrophytes and vegetation in the water body which creates micro-habitats suitable as breeding sites [16]. Naturally depressed temporary pool, the second study site, however, was found to have the highest evenness enlightening the fact that the species were evenly distributed. Equal distribution may have been better at this site due to the presence of abundant food, less abundance of predators and other factors like the size, depth or shallowness of the water body, the water chemistry etc. whatever the reason is, site 2 have proved to be the optimum site for the recorded species as ideal habitat.

Among the seven species, five species was co-related positively with the dissolved oxygen and three species was with sodium (Table 5). Dissolved oxygen has been found previously as an important factor for the anurans [17]. High dissolved oxygen also indicates high floral growth which in turns increases the food resource for newly hatch tadpoles of anurans. The pH (5.28 ± 1) of the water bodies were lower than the average during the study period which has been found to be preferred by the anurans [18]. Lower pH affects the osmoregulation of the tadpoles which causes the tadpoles to loose sodium [19] which may be an important factor as well as a good reason for choosing habitats. Affected osmoregulation due to low pH can slow down the larval growth severely and thus are more vulnerable to predators than the adults. Also slow larval growth resulting incomplete metamorphosis before the dry period can cause the population survival into jeopardy.

During the entire study, *E. cyanophlyctis* and *F. limnocharis* has been found to be present together as a mutual group in the study sites. It can be assumed that the habitat preference for both the species are similar. Same observations were found in case of *H. crassus* and *H. tigerinus* too.

As two of the study sites were temporary and water was absent during the summer, site 3 was the only site in that area to provide habitat for the anurans.

Table 4: Checklist of Anurans in Durgapur Based on the study by Pal *et al.,* (2012), Dutta and Mukherjee *et al*., (2013) and the present study

Common Name	Scientific Name	Family	
1.	Common Indian Toad	*Duttaphrynus melanostictus*	Bufonidae
2.	Indian Marbled Toad	*Duttaphrynus stomaticus*	Bufonidae
3.	Indian Painted Frog	*Kaloula taprobanica*	Microhylidae
4.	Greater Balloon Frog	*Uperodon globulosus*	Microhylidae
5.	Ornate Narrow Mouth Frog	*Microhyla ornata*	Microhylidae
6.	Indian Skipper Frog	*Euphlyctis cyanophlyctis*	Dicroglossidae
7.	Cricket Frog	*Fejervarya limnocharis*	Dicroglossidae
8.	Jerdon's Bull Frog	*Hoplobatrachus crassus*	Dicroglossidae
9.	Indian Bull Frog	*Hoplobatrachus tigerinus*	Dicroglossidae
10.	Indian Pond Frog	*Euphlyctis hexadactylus*	Dicroglossidae
11.	Common Indian Tree Frog	*Polypedates maculatus*	Rhacophoridae

Table 5: Co-relation Table between the water parameters and the population of anurans in the studied temporary water pools at Durgapur, East India (August, 2013 to July, 2014)

	D.M	E.C	F.L	D.S	M.O	H.C	H.T
D.M	0	0.55474	0.56724	0.66667	0.66667	0.4899	0.3234
E.C	-0.64377	0	0.0125	0.11193	0.77859	0.064837	0.23134
F.L	-0.62862	0.99981	0	0.099425	0.76609	0.077338	0.24384
D.S	-0.5	0.98458	0.98783	0	0.66667	0.17676	0.34327
M.O	-0.5	-0.34082	-0.35921	-0.5	0	0.84343	0.99007
H.C	-0.71823	0.99482	0.99263	0.9617	-0.24347	0	0.1665
H.T	-0.87372	0.9347	0.92754	0.85812	0.015602	0.96599	0
pH	0.93865	-0.86817	-0.85826	-0.76799	-0.17066	-0.91413	-0.98787
Cond	0.97736	-0.79111	-0.77895	-0.67193	-0.30542	-0.8492	-0.95687
DO	-0.67193	0.9993	0.99837	0.97736	-0.30542	0.99792	0.94734
N	-0.98541	0.50413	0.48708	0.34531	0.6401	0.58933	0.77818
P	0.93947	-0.86698	-0.85703	-0.76645	-0.17302	-0.91316	-0.9875
Na	-0.3133	0.92839	0.93551	0.97908	-0.66577	0.8858	0.73568
K	0.9621	-0.82804	-0.81687	-0.7172	-0.2449	-0.88075	-0.97325

D.M- *Duttaphrynus melanostictus,* E.C- *Euphlyctis cyanophlyctis,* F.L- *Fejervarya limnocharis,* D.S- *Duttaphrynus stomaticus,* M.O- *Microhyla ornata*, H.C- *Hoplobatrachus crassus*, H.T- *Hoplobatrachus tigerinus*.

Table 6: Relative abundance of anuran species in three study sites at Durgapur, East India (August, 2013 to July, 2014)

	Monsoon			Winter			Summer		
Species Name	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
D. melanostictus	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
E. cyanophlyctis	0.063	0.091	0.040	0.052	0.039	0.027	0.003	0.000	0.113
F. limnocharis	0.033	0.026	0.032	0.027	0.046	0.025	0.001	0.004	0.092
D. stomaticus	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
M. ornata	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000
H. crassus	0.004	0.013	0.007	0.006	0.016	0.009	0.000	0.000	0.061
H. tigerinus	0.010	0.023	0.003	0.017	0.032	0.001	0.000	0.000	0.076

The volume of the pools varied dramatically and so was the diversity and abundance (Table 6) of the anurans. Site 3 contained macrophytes and long grasses which provided a suitable microhabitat for the inhabiting anuran species as well as protection from predators. During the monsoon season, the anurans were found to aggregate in the temporary pools, especially in the site 2. Site 2 was natural and bigger than the site 1 providing a better and spacious breeding ground. Site 2 also contained more vegetation than the site 1. Pools contained algae, planktons and macro-invertebrates which are preferred foods of the anurans. The temperature of the water during the winter varied between 17-18°C and most of the anurans were found not hibernating as their abundance was averagely similar as in the other seasons. During the summer, the temporary pools were dried and the anurans were found to be dispersed from their breeding sites to other perennial pools nearby.

Due to the short longevity of anurans, immediate dispersal of the juveniles is essential for the existence of the population for a long time [20]. Thus, anurans have limited spreading range. Permanent pools and their nearby area serve their only resource to stay alive during the summer in the study area. Therefore, the temporary pools in the rock mining area, proves to be an important site for the anuran breeding, as well the perennial pools for their living. Existence of anurans, hence, depends on the factors of the habitat from varying spatial scales and a combination of both temporary water pools and perennial water bodies are found to be best for anuran's survival [21]. Therefore, a long-term study in this landscape may reveal the insight information on anuran-habitat relationship and based on conservation measures can be taken to protect the anuran species.

CONCLUSION

The study suggests that the anurans prefer temporary water pools during the monsoon period for breeding rather than the perennial water body and sodium as one of the influential limno-chemical parameters during their pool choice along with other parameters like pH and dissolved oxygen. The study was carried out only in two temporary water pools with only for a single year which is a very small for sample size both spatially and temporally. Hence, an elaborate study is needed to document the actual diversity of the anurans in this rock mining landscape of East India.

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