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Occurrence of Amphibians and Reptiles at Village Ponds in Ludhiana, Punjab: Diversity, Threats and Conservation Prospects

Gurkirat Singh Sekhon, Randeep Kaur Aulakh and Tejdeep Kaur Kler

Department of Zoology, Punjab Agricultural University, Ludhiana-141 004, India
E-mail: gurkiratsekhon@gmail.com

Abstract: Amphibians and reptiles, collectively referred as herpetofauna are integral constituents of animal diversity associated with village pond habitats in agro ecosystems. Present investigation was carried out with objective to assess diversity of amphibians and reptiles in relation to water quality parameters by selecting two ponds in villages namely Jhamat and Malakpur; third selected pond was in Punjab Agricultural University (PAU) campus falling under district Ludhiana from March 2019 to February 2020. Line/point transect methods and visual encounter surveys were followed to record diversity of amphibians and reptiles. Overall, two species belonging to class Amphibia i.e. *Euphlyctis cyanophlyctis* (Schneider, 1799) and *Duttaphrynus stomaticus* (Lutken, 1864) and four species of class Reptilia i.e *Lygosoma punctate* (Gmelin, 1799), *Ptyas mucosa* (Linnaeus, 1758)*, Bungarus caeruleus* (Schneider, 1801) and *Varanus bengalensis* (Daudin, 1802) were recorded at studied ponds. Class Reptilia was indicated positive correlation with Class Amphibia. Both Amphibia and reptilia had also shown positive relation with water temperature, ambient temperature, pond area and fallow land area; whereas values of pH, BOD and DO were found to be negatively related. Land use changes due to agricultural intensification and anthropogenic factors have been altering water quality parameters thereby threating herpetofauna inhabiting freshwater pond habitats in villages. Urgent and focused conservation interventions are required to preserve village pond habitats accompanied with steps to conserve animal groups like herpetofauna in agriculture dominated Punjab State.

Keywords: Amphibians, Ecological indicators, Reptiles, Village ponds

Large portion of world's animal diversity is associated with the agro ecosystems. Agricultural landscape constitutes crop fields, pond habitats, human settlements, allied sectors like dairy farms and barren lands. Two-thirds of entire terrestrial ecosystems are composed of human modified ecosystems like agricultural landscape, human habitations and agroforestry plantations. Freshwater bodies like village bonds are characteristic features of agro ecosystems. Ponds are the abode of diverse types of animal communities which are inter related and inter dependent (Albero et al 2021, Lewis-Phillips et al 2020). Amphibians and reptiles are cold blooded, habitat specific and sensitive to environmental changes; they are considered as indicators of healthy ecosystems. Amphibians and reptiles are collectively referred to as herpetofauna constituting prey and predators components in intricate food webs existing particularly in terrestrial and specifically in agricultural ecosystems (Yadav et al 2022). Vertebrate predator populations like herpetofauna have potential as biological control agents of lower vertebrates like rodents in agro ecosystems (Twining et al 2022).

In India, a total of 421 species of amphibian under 64 genera and 16 families have been reported; 73.6% amphibian species are endemic most of these fall under rare or threatened species categories. 43 species belonging to 15 genera and 06 families have been represented in agro-ecosystems (Dinesh et al 2019). There are about 571 species of reptiles are reported in India which belong to three orders of reptiles: order Crocodylia having 3 species of crocodiles, 34 species of turtles and tortoises belonging to order Testudines and order Squamata having 231 of lizards and 303 of snakes (Aengals et al 2018). Sethy et al (2021) stated 64 species of reptiles (39 genera and 10 families) have been represented in agro-ecosystem; out of these 15 species of reptiles are endemic.

As per IUCN list of threatened species, 41% of amphibian species and 21% species of reptiles are threatened with extinctions globally (https://www.iucnredlist.org/). Wide spread declines in diversity of herpetofauna have been reported which have potential of serious repercussions on food chains via trophic guilds in agricultural habitats. Numerous workers have reported negative effects of agricultural intensification on animal communities like amphibians, reptiles and water dependent birds in ponds (Kaur et al 2018, Sidhu et al 2021). Systematic and detailed field studies are lacking on documentation of herpetofauna from agro-ecological zones of India (Dinesh et al 2021, Sethy et al 2021). Herpetofauna inhabiting village pond habitats in

agricultural areas have been less studied particularly in India specifically in agrarian state like Punjab. Inventories of Herpetofauna of pond habitats both at local and regional scales is still unexplored which is a hurdle in formulating conservation strategies. Therefore, the present study was planned to assess diversity of amphibians and reptiles in relation to water quality parameters by selecting two ponds in villages of Ludhiana district and one pond in PAU Campus, Ludhiana.

MATERIAL AND METHODS

The present study was carried out in three selected ponds (A, B, C) in villages namely Jhamat, Malakpur and sewage treatment pond of Punjab Agricultural University (PAU) campus (latitude 30° 54' 3.4740"N and longitude 75° 51' 26.1972"E) in Ludhiana district from March 2019 to February 2020. Selected habitats of ponds were surveyed on fortnightly basis following Line/Point count transect methods (Verner 1985). Pond habitat characteristics Pond A (area 1.01 ha) was located in the village surrounded by residential houses. Pond B (1.21 ha) near outskirts of the village having residential houses on one side of the pond and agricultural fields on other sides. Pond C (1.61 ha) was manmade pond unit and consisted of 4 tanks having walled boundaries formed for sewage treatment plant. Pond C was located near the botanical garden and surrounded by crop fields of PAU campus. All the studied ponds except pond C were natural ponds which remained filled throughout the year and were dependent on rainfall. Pond C remained filled with treated sewage water. Field observations on amphibians and reptiles were carried out through visual encounter survey. Identification of species was made by noting down morphological characteristics which were compared with identification keys given by Daniel (2002) in “The Book of Indian Reptiles and Amphibians” and standard reference book entitled “Snakes of India: Field Guide” authored by Whitaker and Captain (2004).

The analysis of the physico-chemical water quality parameters like water temperature, pH, biological oxygen demand (BOD) and dissolved oxygen (DO) were carried out. Temperature was recorded from Indian meteorological department website. Water temperature was recorded by using Mercury glass thermometer. pH was determined by using portable digital pH meter for the water samples. BOD and DO was analyzed at as per reference of APHA (2012). Correlation analysis was carried between Class amphibia and reptilia with physico-chemical characteristics of water and areas of selected ponds. Google maps were taken from www.google maps and land use maps were prepared by Punjab Remote Sensing Centre, Ludhiana.

RESULTS AND DISCUSSION

Two species belonging to class Amphibia i.e *Euphlyctis cyanophlyctis* (Schneider 1799) (Indian skipper frog or skittering frog) and *Duttaphrynus stomaticus* (Lutken 1864) (Indian marbled toad or Punjab toad); four species of class Reptilia i.e *Lygosoma punctate* (Gmelin 1799) (common dotted garden skink or punctuate supple skink), *Ptyas mucosa* (Linnaeus 1758), (Indian rat snake or oriental rat snake), *Bungarus caeruleus* (Schneider 1801) (Indian krait or blue krait) and *Varanus bengalensis* (Daudin 1802) (Bengal monitor or common Indian monitor) were recorded (Table1). Indian skipper frogs were often found along the edges of ponds A and B and most prevalent during the monsoon season followed by summer season. Their population was variable at both ponds A and B; highest numbers were recorded during the monsoon season and lowest during summer season. Indian marbled toad was observed in pond edges, under leaves and undergrowth at the pond B. Population number followed the same trend as that of Indian skipper frog. Herpetofauna was not found in winter months because of hibernation.

Field investigations of natural populations of amphibians have revealed correlations between population declines and vicinity to agricultural areas (Davidson et al 2002, Houlahan and Findlay 2003). In present study, amphibian species were not observed at Pond C which seemed to be because of sewage treated water and surrounded by crop fields. Water draining from intensive agricultural lands also consists of pesticides/herbicides which affect non-target organisms in the water bodied by modifying the structure and functionality of freshwater ecosystems (Vera et al 2009). At Pond A, only one species of frog namely *E. cyanophlyctis* was noted; it was having walled banks and surrounded by human habitation; anthropogenic impact might be the cause behind less diversity of amphibian taxa. One species each of frog and toad was recorded at pond B; it seemed to be due to the habitat features like large size of water body and less human disturbance was complemented by wide array of wild vegetation. Agriculture and human settlements have been proved as having negative effects on diversity of herpetofauna worldwide (Thompson et al 2016). *L. punctuate* and *V. bengalensis* were recorded at pond A. They were mostly observed hidden beneath logs, rocks, or among piles of leaves and twigs. Their population showed seasonal variation at pond A being highest during the monsoon season. At pond B, *L .punctate* and *P. mucosa* were recorded in undergrowth, dung piles and in wild vegetation along the edges. Their population showed seasonal variation which was highest during the monsoon season. The sightings of *P. mucosa* was always solitary in nature. *B.caeruleus* was

observed only at the pond C along the short wild grass during the monsoon season.

Correlation analysis of water quality parameters with diversity of amphibians and reptiles was carried out. The average ambient temperature and water temperature were strongly related to the diversity Class Amphibia at Pond A and B (Table 2). It may be inferred that increase in said parameters seem to have positive influence on the diversity of Class Amphibia. Strong positive relationship of ambient temperature and water temperature was in Class Reptilia at all studied ponds. Amphibians have been recognized indicator taxa to evaluate habitat quality and environmental stresses. pH indicted inverse relationship with Class Reptilia at selected ponds. BOD was insignificant for Class Reptilia at pond A. DO have negative correlation with Class Reptilia which could be due to species specific foraging niches as herpetofauna were having adaptations for both aquatic and terrestrial existence. Class Amphibia and Class Reptilia had positive relation with water temperature, ambient temperature, pond area and fallow land area; pH, BOD and DO was found negatively related to species richness (Fig. 1). In the current study, two species of amphibians in selected ponds are indicative of quality of fresh water habitat and healthy food webs. Four species of reptiles belonging to families namely Scincidae (1 species), Culobridae (1 species), Elapidae (1 species) and Varanidae (1 species) were documented during the present survey. All the four reptilian species observed had habitat preference of vegetation/rocks/bricks/piles of leaves which were present around the banks of ponds. The occurrence of these species seemed to be because of availability of prey, shelter and undisturbed habitat in the present study. Rapid population declines of reptiles has evoked a concern worldwide to understand the ecological roles (Lips et al 2006, Connelly et al 2011, Bohm et al 2013). Current literature has pointed out data deficient representation of reptiles in worldwide research which has been accentuated by spatial bias in monitoring work (Piccolo et al 2020).

The diversity of the herpetofauna around village ponds requires urgent attention for their habitat preservation and should include assessment of extent of anthropogenic pressures at local levels in Punjab State. Different studies have pointed out that significant stressors affecting animal diversity in freshwater ponds are overexploitation of resources, water pollution, rate of water flow, degradation of habitat and invasion by alien species (Noges et al 2015, Soni et al 2019). Regional studies have pointed that pond management efforts are vital as water quality parameters of

Table 1. Different species of class Amphibia and Reptilia observed at selected ponds

Name of species	Summer			Monsoon			Winter		
	Pond A	Pond B	Pond C	Pond A	Pond B	Pond C	Pond A	Pond B	Pond C
Euphlyctis cyanophlyctis	+	+	-	+	+	-	-	-	-
Duttaphrynus stomaticus	-	+	-	-	+	-	-	-	-
Lygosoma punctata	+	+	-	+	+	-	-	-	-
Ptyas mucosa	-	+	-	-	+	-	-	-	-
Bungarus caeruleus	-	-	-	-	-	+	-	-	-
Varanus bengalensis	+	-	-	-	-	-	-	-	-

(+) Observed, (-) not observed

Table 2. Seasonal variation in water temperature, pH, BOD and DO in selected ponds

Location	Season	Water temperature (^{O}C)	pH	BOD (mg/l)	DO (mg/l)
Pond A	Summer	22.85	7.9	2.9	4.9
	Monsoon	24.35	7.5	0.4	5.2
	Winter	14.37	8.1	2.4	6.4
Pond B	Summer	22.7	7.4	2.8	4.8
	Monsoon	24.45	7.2	2	6.0
	Winter	14.12	7.9	2.6	6.8
Pond C	Summer	24.1	7.7	3.8	4.6
	Monsoon	25.7	7.4	1.2	5.2
	Winter	18.02	9	3.2	6.0

freshwater ponds are declining (Das and Dey 2020, Nandal et al 2020). Jackson et al (2016) observed that multiple factors tend to act antagonistically, and therefore their cumulative mean effect is less than the sum of their single mean effects in freshwater ecosystems. Assessment of faunal diversity like amphibians, reptiles and birds around fresh water lake might be used as an indicator of health of environment and provide baseline data for conservation of freshwater habitats (Jagatheeswari 2016, Sugumaran and Duraimurugan 2019). The significant contribution to regional biodiversity can be made by the irrigation ponds which can potentially sustain high taxonomic richness (Declerck et al 2006, Kawano et al 2006, Chester and Robson 2013, Kim et al 2016). With the worldwide recognition for the significant role of freshwater ecosystems like ponds, lakes and wetlands; current emphasis is to conserve these water bodies both for sustenance of overall diversity and ecosystem services (Jenkins et al 2015, Johnson et al 2016, Kaur et al 2020). At present, information on effects of agricultural intensification and its practices on occurrence, diversity and populations of amphibians and reptiles at village ponds is limited and not well documented. To build up authentic data base, there is need of extensive and systematic field projects to record and identify herpetofauna in agro ecosystem. So that in future, conservation programmes may be formulated, implemented and become part of comprehensive in-vitro biodiversity preservation efforts.

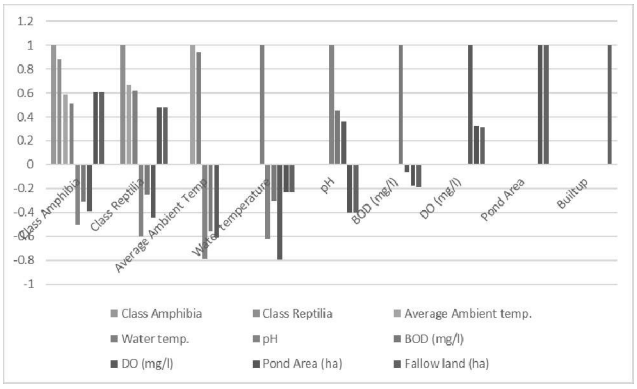

Fig. 1. Overall correlation analysis of ambient temperature, water quality parameters and habitat types with animal diversity at selected ponds

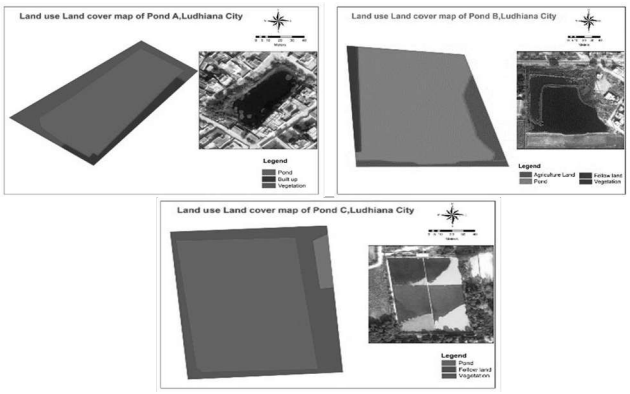

Fig. 2. Land use land cover map of Pond A, B and C in Ludhiana

CONCLUSION

Species richness of herpetofauna at selected ponds was location specific dependent on habitat features, anthropogenic stresses and water quality. Current findings indicate the need of well laid environment impact assessment programmes to recommend urgent interventions for freshwater pond habitat maintenance resulting in preservation of native herpetofauna in Punjab State.

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