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Occurrence of Molluscan Species at Village Ponds in Punjab State: An Ecological Perspective

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ABSTRACT

Freshwater ponds existing in agro-ecosystems provide habitat niches for a wide variety of animal taxa particularly macro-invertebrates. The present study was carried out to evaluate the occurrence, abundance and diversity of malacofauna in relation to water quality parameters and habitat characteristics at three selected ponds in district Ludhiana, Punjab. Two species of phylum Mollusca namely horntail snail *Macrochlamys indica* Benson, 1832 and tropical leatherback slug *Laevicaulis alte* (Ferussac, 1822) belonging to class Gastropoda were recorded. The total density of Mollusca species was 9.0, 9.0 and 3.75 individuals/m^2 at pond A, B and C respectively. Shannon Weiner Index was higher for pond A for both summer and monsoon seasons. Simpson's Diversity Index was higher for pond C in both said seasons. Correlation analysis showed positive correlation of species richness with water temperature and ambient temperature: pH and BOD had negative correlation with species richness. The presence of molluscan species in pond habitats in agricultural areas are indicative of water quality and habitat heterogeneity. Therefore it is mandatory to undertake research work to identify the prevailing biodiversity associated with pond habitats. Diversity of macro invertebrates like mollusks might be considered as one of the significant features reflecting health of village ponds.

Key words: *Agro ecosystem, Macrochlamys indica, Mollusks, Laevicaulis alte, Village ponds,*

Introduction

Ponds are defined as lentic water bodies (<2 ha in size) which are universally found and hold water for at least quarter of the year (Collinson *et al.*, 1995, Williams *et al.*, 2010) and includes both man made and naturally formed ponds (Biggs *et al.*, 2005). Pond habitats are recognized as important constituents of agricultural ecosystem worldwide; there are numerous reports of interactions existing at the aquatic-terrestrial interface. Ponds, even though occupying a small landscape are rich in species diversity and consist of sub-habitats creating numerous microhabitats on its own. In accordance, structure of macro-invertebrate communities are the outcome of interaction of physical, chemical and biological characteristics of the immediate surroundings existing at spatial and temporal scales.

Molluscans form are the second largest group of invertebrates preceding Phylum Arthropoda (Bouchet, 1992). Molluscans show diverse habitat preferences and constitute both aquatic and land communities. Freshwater pond habitats are represented by both Class Bivalvia and Class Gastropoda whereas terrestrial habitats are inhabited exclusively by Class Gastropoda only. Terrestrial gastropods account for approximately 6% of the total species recorded globally (Clark and May, 2002). Gas-

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tropoda is regarded as the largest and most prevalent class of Mollusks constituting about 75,000 species and occupy varied habitat niches in freshwater, marine and terrestrial ecosystems (Mavinkurve *et al.*, 2004).

Macro invertebrates like mollusks perform several ecosystem functions via promoting detritus feeders, macro-micro faunal interactions and energy flow to the higher trophic guilds (Wallace and Webster 1996). They enable breakdown of organic matter, nutrient recycling and become prey for a number of invertebrates like carnivorous mollusks and vertebrates like birds, herpetofauna and small mammals (Deepak *et al.*, 2010; Jimoh *et al.*, 2011). Soil invertebrates particularly malacofauna are considered as effective bio monitors of particulate pollution, residual soil pollution like heavy metals and radioactive pollution (Berger *et al.*, 1993; Godan, 1983). As molluscan communities are highly sensitive to chemical pollution therefore considered as exceptional water quality indicators for local and regional studies. The present investigation was undertaken to assess the occurrence, abundance and diversity of malacofauna in relation to water quality parameters and habitat characteristics at three selected ponds in district Ludhiana, Punjab.

Materials and Methods

Study Area

Occurrence of molluscan species was carried out at ponds in two villages namely Jhamat and Malakpur and one pond was selected from Punjab Agricultural University campus, Ludhiana. Three selected ponds in village Jhamat, village Malakpur and Punjab Agricultural University (PAU) campus at Ludhiana have been mentioned as pond A, B and C respectively. Pond A, located in the village Jhamat was surrounded by residential houses; Pond B, located at outskirts of the village Malakpur was having crop fields on three sides and residential houses on one side; Pond C was man-made and constructed for having treated water of sewage plant and surrounded by crop fields. Pond A and B being natural ponds were rain fed and receiving surface run off; they remained filled with water throughout the year. The time duration of present investigation was from March 2019 to February 2020.

Punjab Remote Sensing Centre has provided the information about vegetation cover, fallow land and pond area under water. Size of studied ponds including the Ponds A, B and C were of area 1.01 ha, 1.21 ha and 1.61 ha respectively. Area under water was maximum at pond C (1.53972 ha) followed by pond B (1.14567 ha) and pond A (0.480321ha). Habitat type comprising of vegetation was maximum at pond C followed by pond A and pond B.

Sample Collection and Observations

Observations were taken on the animals of phyla molluscan on fortnightly basis at the studied ponds. To know their abundance, sampling was done by selecting four quadrats of 1x1 m^2 each from all geographical directions. In each quadrat, number of observed individuals were counted and number of sightings per month at each pond were noted down. One or two live animals of same type were handpicked from the studied ponds and brought to laboratory for identification. Animals were narcotized in 30% ethyl alcohol and then fixed in 10% formalin and their taxonomic characteristics were recorded. Identification of species was made on the basis of morphological characters like size, body whorl, shell structure etc. as mentioned in keys given by Ramakrishna and Dey (2007). Manual of Freshwater Biota authored by Munshi *et al* (2010) was also accessed for species level identification.

Water Quality Parameters

Samples of water were taken from studied ponds and tested for various physical parameters like ambient temperature and water temperature; chemical parameters like pH, Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO) as per APHA (2012).

Statistical Analysis

The species diversity of molluscan fauna was found using two indices. Shannon -Weiner Index (Shannon and Weaver1949) and Simpson's Diversity Index (Simpson, 1949) were calculated from the data collected on population number from selected ponds in summer and monsoon months separately. Shannon wiener is calculated as per following formula

$H = -\Sigma\ pi \ln pi$

Where pi= Proportion of individuals found of species ith in the sample.

Simpson diversity index was calculated as per following formula $D = 1 - [(n-1)/(N-1)]$

n=Total number of individuals of particular spe-

cies, N= Total number of individuals of all species

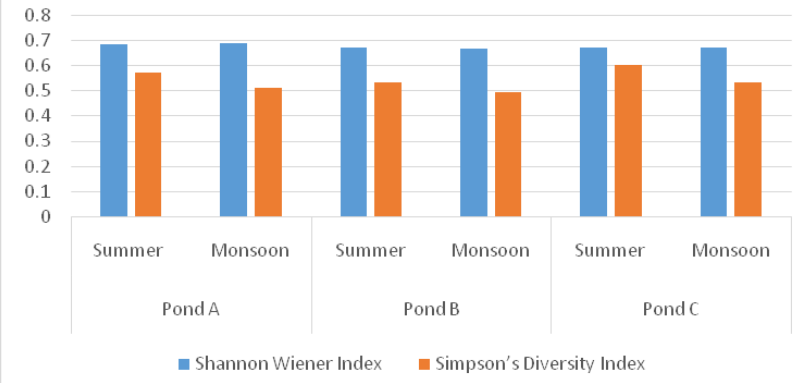
Results and Discussion

During the time of study, two species of phylum Mollusca belonging to class Gastropoda were recorded. These were identified as horntail snail *Macrochlamys indica* Benson, 1832 belonging to Family Ariophantidae and tropical leatherback slug or black slug *Laevicaulis alte* (Ferussac, 1822) belonging to Family Veronicellidae. Individuals of above mentioned species were sighted in sparse vegetation along the edges of ponds A, B and C on various occasions. In current study, a total 87 individuals of Phyla Mollusca belonging to 2 species were recorded (Fig. 2). The total density of Mollusca species was 9.0, 9.0 and 3.75 individuals/m^2 at pond A, B and C respectively. Population number per visit varied from 3-4, 3-5 and 2-3 at the pond A, B and C respectively. At pond A, population density of Mollusca species was 1.75 and 7.25 individuals/m^2 in summer and monsoon months. Frequency of sightings of molluscan species was 0.875 and 3.625 per visit in summer and monsoon months respectively. At pond B, there were noted 2.50 individuals /m^2 and 6.5 individuals/m^2 in summer and monsoon months respectively while number of individuals /visit were 1.25 and 3.25 in said months respectively. At pond C, individuals/m^2 in summer and monsoon were 1.25 and 2.50 respectively. Individuals encountered per visit were 0.625 and 1.25 in summer and monsoon respectively. Mollusks were not observed in winter months at studied ponds.

The measurements of specimens of each species collected from selected ponds had shown that the average *M. indica* length (cm) was 3.29±0.12 and 3.57±0.16 in summer and monsoon season respectively. Snail shell diameter (cm) was 1.45±0.05 in summer and 1.60±0.07 in monsoon season. Average length of *L. alte* was 4.63±0.19 cm and 5.27±0.11 cm in summer and monsoon seasons respectively.

The value of Shannon Weiner Index for summer season was highest for pond A with value of 0.683 while pond B and Pond C were having value of 0.672 each. In monsoon season, the values of Shannon Weiner Index was highest 0.688 in pond A followed by pond C having value of 0.672 and pond B with lowest value of 0.666. Simpson's Diversity Index was highest 0.60 for pond C followed by pond A having 0.57 and pond B with value of 0.533 for summer season. Similar trend was also observed for monsoon season with pond C having value of 0.533 followed by pond A with value of 0.512 and pond B with value of 0.492 (Fig. 1). Because of less habitat heterogeneity at pond B and pond C, the values of Shannon Wiener Index were identical in summer season while it was slightly different in monsoon season. In the present study, molluscan species richness was less and the factors affecting species richness were varied at studied ponds. Pond B and pond C had surface run off from crop fields which were regularly sprayed with agrochemicals; pond A was walled and had concrete protection at places and domestic waste site was at its banks.Both the species recorded in present study are invasive and have been reported as agricultural pests in nurseries and vegetable crop fields in Punjab (Kaur and Babbar 2019) and in other states (Jayashankar *et al.* 2015; Selvi *et al.* 2015). Ito *et al.* (2020) had stated that large number of factors like pesticides, weed cover-

Fig. 1. Seasonal variation in different diversity indices of the molluscan fauna at studied ponds



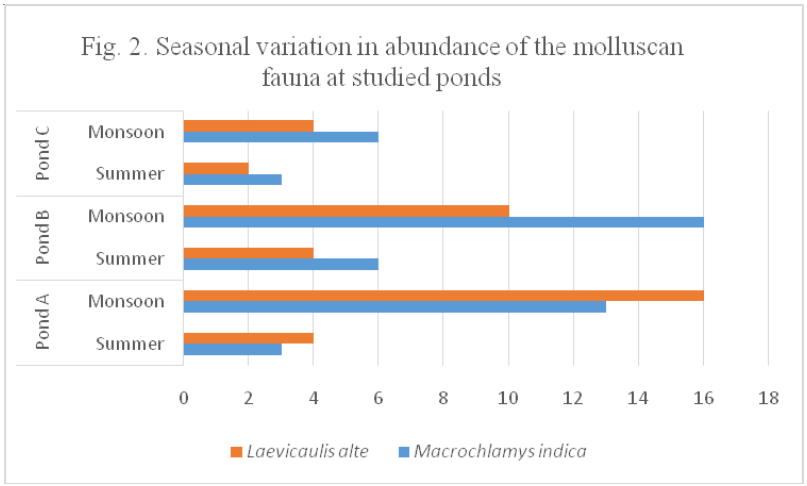
age, invasive species and concrete bank protection freshwater/irrigation ponds seemed to be acting as significant stressors on an invertebrate's richness in Japan.

Correlation analysis of water quality parameters with molluscan diversity was carried out for selected ponds. In case of Phylum Mollusca, water temperature and ambient temperature had positive correlation with species richness; values of pH, BOD had negative correlation with species richness value while area under habitat types like vegetation, pond and fallow land had no relation with species richness (Table 1).

Majority of the freshwater ponds in villages and in urban areas are facing anthropogenic threats, habitat loss, encroachments and overexploitation; it is very much evident from the elimination or severe decline in populations of sensitive molluscan species and in increased abundance of tolerant/resistant species (Kumar *et al.* 2019). Parithabhanu *et al.* (2014) reported that pond environments have existential threat due to indiscriminate discharge of pollutants and sewage in Tamil Nadu, India. Even though, it's considered tremendously testing to understand factor or factors and their interrelations determining the diversity of different animal groups in different ecosystems (Tucker *et al.* 2015). Smitha and Mustak (2017) had reported nineteen species of gastropods, out of these thirteen were terrestrial and six species were of freshwater habitat from Karnataka. They further found that soil and water properties influence their abundance and occurrence. Molluscan population fluctuations had been reported in abandoned ponds and in lotic water bodies depending upon habitat heterogeneity (Bashinskiy and Stojko, 2022). Many gastropod species have restricted migration patterns and are appropriate for assessing local or site specific evaluations of anthropogenic impacts on animal diversity. Present study has pointed out that decline in water quality of ponds and habitat features might get manifested in losses of species diversity of macro invertebrates and over-

Table 1. Correlation analysis of ambient temperature, water quality parameters and habitat types with molluscan diversity at selected ponds

	Phylum Mollusca	Average Ambient Temp	Water temp	pH	BOD (mg/l)	DO (mg/l)	Vegetation (ha)	Pond (ha)	Fallow land (ha)
Phylum Mollusca	1								
Average Ambient Temp	0.923805	1							
Water temperature	0.949779	0.937154	1						
pH	-0.75681	-0.79132	-0.61943	1					
BOD (mg/l)	-0.26462	-0.55819	-0.30779	0.456264	1				
DO (mg/l)	-0.82648	-0.61403	-0.7987	0.365377	-0.063	1			
Vegetation (ha)	0	3.60E-17	0.229729	0.404358	0.18167	-0.3173	1		
Pond (ha)	0	0	-0.22947	-0.40499	-0.18041	0.31777	-0.99999	1	
Fallow land (ha)	0	0	-0.23105	-0.40087	-0.18836	0.314686	-0.99976	0.999655	1



all animal diversity.

Assessment and quantification of the macro invertebrate diversity comprising of annelids, arthropods and mollusks in freshwater ponds in agricultural areas at several scales like seasonal, local, temporal, spatial are essential to frame freshwater conservation guidelines and their maintenance policies thereby are consequential in an enhanced understanding of the inter- relationship between invertebrate communities and the pond abiotic factors and habitat features. Such studies would help in preparing ponds specific rejuvenation /conservation plans for their management in agricultural areas.

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Conflict of interest

Authors have no conflict of interest directly or indirectly related to the work submitted for publication.

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