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Short Communication

Diversity of Freshwater Gastropoda Snails Found in District Swat, Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

Mollusks a group of macroinvertebrates found in both aquatic and freshwater habitats are the oldest animals. Historically which goes back to Cambrian deposits. They have got a second rank in abundance after the more abundant arthropods taxon and are the most important invertebrates around the world whose importance may be estimated from their roles such as (i) use as a delicious food in many regions of the world (ii) key role in cosmetics and pharmaceutical industries (iii) as a pest causing serious damage to crops and (iv) an active intermediate host in the transmission of infectious agents like genus *Schistosoma, Fasciola* and *Echinostoma* etc. in mammals causing serious infections such Schistosomiasis, Fascioliasis etc. Looking to their importance, the current study was conducted in District Swat, Khyber Pakhtunkhwa, Pakistan to explore the freshwater gastropods' fauna. For this 1135 live snails' specimen were collected from various localities. Using conchological characteristics freshwater snails were identified up to species level are *Physa acuta*, Draparnaud, 1805, *Indoplanorbis exustus*, Deshayes, 1834 and *Bellamya bengalensis*, Lamark, 1882. Among the species *Physa acuta* was the more abundant species (54.18%) followed by *Indoplanorbis exustus* (26.43%) and *Bell a bengalensis* (19.38%). The Shannon-wiener and Simpsons' diversity indices shown a significant value of 1.001 and 0.599, respectively for the given region. The current study has revealed the freshwater snails' fauna for the first time from District Swat, Pakistan and also provided a key feature of the identified species.

Among the invertebrates, mollusks are the group of macroinvertebrates found in both aquatic and terrestrial habitats (Miller and Harley, 2001). The members of this taxon have an old history and can be estimated from their presence during the Cambrian deposits (Mitra and Dey, 2005). In abundance the taxon has got a second rank after the more abundant Arthropods' group and nearly 100,000 living species have been identified (Abbott, 1989; Miller and Harley, 2001; Chapman, 2009).

Molluscs are classified into various classes such as Caudofoveata, Aplacophora, Polyplacophora, Monoplacophora, Scapopoda, Bivalvia, Gastropoda and Cephalopoda. In these classes, Class gastropoda which includes snails, limpets and shell less snails (slugs) have got more importance because (i) the more abundant and diverse group containing roundabout 35,000 living species from both aquatic and terrestrial habitats, (ii) used as a delicious food in various countries in the world because of their rich nutrient profile (Miller and Harley, 2001), (iii) also a key role in cosmetics and pharmaceutical industries (Dhiman and Pant, 2021) and (iv) declared as a pests (Altaf *et al*., 2017) and (iv) some species act as intermediate hosts in the transmission of certain infections causing cercariae such as the genera *Schistosoma, Echinostoma, Fasciola, Paramphistoma, Megalodiscus* and *Gastrodiscoides* causing serious illnesses like cancer, organ failure, infertility and even death (Roberts *et al*., 2013).

In spite of their importance, these macroinvertebrates still need more attention to explore throughout the world (Qureshi *et al*., 2015) in regard of various aspects like diversity, infections transmission etc. In Pakistan, like the

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other world there is also scarcity of knowledge regarding the freshwater gastropods fauna because of the fewer number of studies which were carried out in different regions such as Punjab, Sindh, Balochistan and Khyber Pakhtunkhwa (Khan and Dastagir, 1971; Akhtar, 1978; Khatoon and Ali, 1978; Begum and Nazneen, 1992; Kakar *et al*., 2017) but no one considered District Swat in their study which need more work.

Looking to the rareness (Qureshi *et al*., 2015) as well as the favorable environmental conditions (Ahmad *et al*., 2015), the current study was conducted in District Swat, Khyber Pakhtunkhwa, Pakistan to explore the freshwater gastropods fauna which was not explored before. This is a taxonomic study which has explored the freshwater gastropods up to species taxonomic level. Furthermore, the study has also provided a diagnostic conchological features of the identified species found in the given region.

Materials and methods

The study was conducted in District Swat, Pakistan (Fig. 1). It is situated in the North of Pakistan (34.30°-35.05°N, 71.45°-72.50°E). Geographical studies revealed the possession of altitudinal variation like plain areas to a high peaks ranging from 600m-6000m above sea level form hilly as well as mountainous extremities. From these high peaks a single drainage basin (River Swat) originates which is a major source of freshwater (Ahmad *et al*., 2015). The region possesses an unusual weather profile i.e. the average recorded temperature revealed a significant fluctuation monthly wise which is 32.71°C in June falls to 0°C or below in December and January. The high precipitation in July (143.00mm) unlike the month of November and December (only 20mm). Humidity is high in August (82.58%) (Ahmad *et al*., 2015). Due to their unusual environmental condition the valley also possesses a rich flora and fauna and can be estimated from the presence forests (natural and artificial) and the agroforestry which provide a favorable condition for animal life such as terrestrial and freshwater to the life of birds (resident and migratory) (Ahmad *et al*., 2015).

Specimen collected from all the seven tehsils except Bahrain due to low water temperature Ghalegay, Guligram, Kabal, Charbagh, Khwaza Khela, Matta and Bahrain. Specimen were collected from different freshwater sources like spring water, river Swat and rice fields through a mesh as well as by handpicking (Qureshi *et al*. 2015). All the live snail specimen were brought to zoological Laboratory in ¾ filled plastic boxes (Qureshi *et al*. 2015) with constant aeration. The collection and rearing of the live specimen during transect as well as in the Laboratory was done by following the standard protocols provided by the guide entitled Guidelines and Procedures for the Malacology Collection of the Tom Ridge Environment Centre at Presque Isle Gastropoda-Snails Bivalvia-mussels (integrated taxonomic information system) with some modifications.

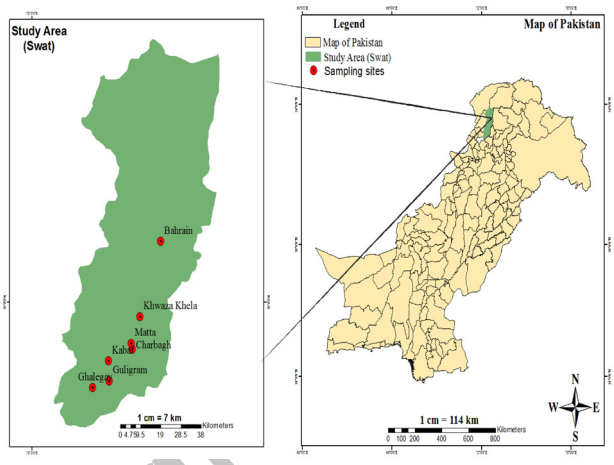

Fig. 1. Map of study area showing sampling sites.

Using the keys provided by (Neubert, 1998; Brown, 2002; Kakar *et al*., 2017) snails were identified up to species taxon. The identification was based on conchology i.e. shell height and width, no. of whorls, shell coiling (sinistral or dextral). Aperture shape and size, presence or absence of operculum, shape and texture of operculum, spire position, texture of periostracum, presence/absence of aperture lip and umbilical features (open or closed). The shell morphometry was done by Analogue Vernier caliper. Shannon-Wiener and Simpson's diversity indices were also calculated using MS Excel sheet 2013.

Results and discussion

From 1135 collected snail specimens from various localities (Table I), three freshwater snail species were identified belonging to three gastropods' families i.e. Physidae, Viviparidae and Planorbidae. The species are *Physa acuta*, Draparnaud, 1805, *Indoplanorbis exustus*, Deshayes, 1834 and *Bellamya bengalensis*, Lamarck, 1882. The species' abundance calculated during the study were 615(54.18%), 300(26.43%) and 220(19.38%) for *P. acuta, I. exustus* and *B. bengalensis*, respectively (Fig. 2) indicating *P. acuta* as the dominant species.

The environmental factors such as water pH and temperature were also recorded and the average values found were 7.00 and 26.18ºC, respectively.

Family Physidae
Genus Physa Haldeman, 1843
***Physa acuta*, Draparnaud, 1805**
(Fig. 2a, b, c)

Table I. Number of collected snail samples along with the species' distribution and richness.

S. No	Tehsils	Water temperature (°C)	*Localities*	*Physa acuta*	*Bellamya bengalensis*	*Indoplanorbis exustus*	Total collected samples
1	Babozai	27.9	Marghazar	40	00	00	240
			Guligram	40	00	50	
			Tindodag	40	40	30	
2	Barikot	28.1	Ghalegay	110	60	60	230
3	Kabal	27.5	Aligrama	20	20	00	40
4	Charbagh	24.1	Charbagh	170	00	150	320
5	Khwaza Khela	30.5	Khwaza Khela	150	20	00	170
6	Matta	26.5	Matta	45	80	10	135
Total				615	220	300	1135

Measurable features of the shell that is shell height and width are 13.31mm and 7.07mm, respectively. The species has wide distribution throughout the district. It is familiar with the name "fruit fly" of the malacology because of their very fast maturation and higher reproduction rate (Kakar *et al*., 2017).

Family Planorbidae
Genus *Indoplanorbis*, Annandale and Prashad, 1921
***Indoplanorbis exustus*, Deshayes, 1834**
(Fig. 2d, e)

Shell's height and width are 4.01mm and 10.11mm, respectively. This is a native species of Asia and is known for their role as an intermediate host for the transmission of trematode's infections, especially Asiatic schistosomiasis (Kakar *et al*., 2017).

Family Viviparidae
Genus *Bellamya*, Jousseaume, 1886
***Bellamya bengalensis*, Lamark, 1882**
(Fig. 2f, g, h)

Shell's height and width are 32.40mm and 22.47mm, respectively. The presence of color bands (striation) is one of their main diagnostic character among the other members of the same genus. In many countries throughout the world it is used as a food. It is a well-known vector for parasitic nematode of human and other animals like fishes (Farahnak and Ghobadi, 2006).

Using Shannon-Wiener and Simpson's diversity indices the diversity of gastropods were calculated for the region, which are 1.001 and 0.599, respectively (Table II) showing the significance value for diversity of gastropods in the study area. These values are less than the calculated indices found in the study of Shahrbabak *et al*. (2021), but provided a baseline for the future studies regarding the biodiversity of gastropods in the region.

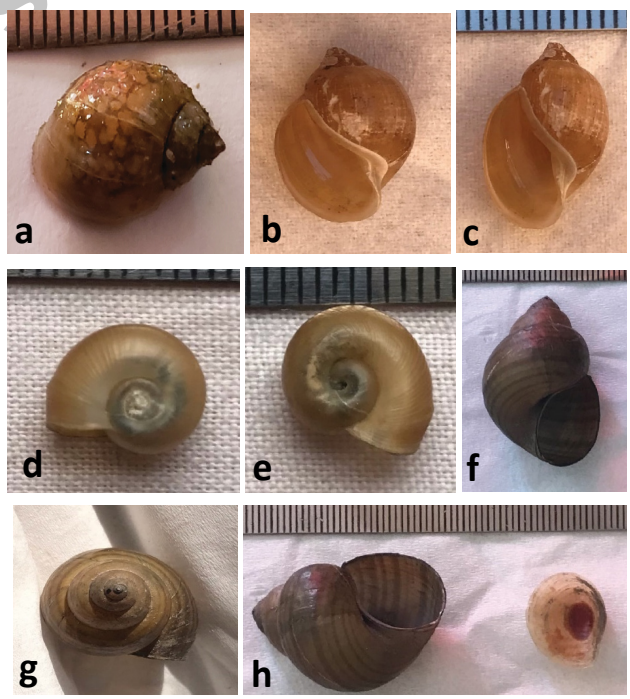

Fig. 2. *P. acuta*: a, Shell height; b, shell texture, shape of aperture and aperture lip (peristome); c, shell width. *I. exustus*: d, shell width and texture; e, umbilicus. f, shell width and umbilicus size; g, No of whorls and shell texture; h, Aperture shape and texture of operculum.

Table II. Shannon-wiener (H) and simpson (D) index values for gastropod's diversity Swat.

Name of species	No of individuals of each species (n)	pi	pi^2	In pi	pi (In pi)	n (n-1)	Σn (n-1)	N (N-1)
P. acuta	615	0.5418502	0.2936017	-0.612766	-0.332027	377610	515490	1287090
B. bengalensis	220	0.1938326	0.0375711	-1.64076	-0.318033	48180		
I. exustus	300	0.2643172	0.0698636	-1.330605	-0.351702	89700		
Total (N)	1135	1	0.4010363		-1.001762			
			H = 1.0017619				D = 0.5994919	

Among the identified species, the *P. acuta* Draparnaud, 1805 is the more prevalent and abundant species (54.18%) collected from all the sampling sites strongly supports the idea presented by Kakar *et al*. (2017) that is the *P. acuta* has high reproductive and maturation rate as compare to other gastropod species. The abundance of *I. exustus* recorded was 26.43% nearly similar to the result of Qureshi *et al*. (2015) which is 23.4%. Looking to the species richness, tehsil Babozai and Barikot are richer because all the three gastropod species were found here might be due to a little bit high water temperature (27.5°C) than the other sampling sites which is in line of the work of McCreesh and Booth (2014) i.e. snails survive well in between the range of 15°C-31°C.

The height to width ratio of the shells has calculated, they were 1.8, 1.44 and 0.39 for *P. acuta*, *B. bengalensis* and *I. exustus* respectively and have confirmed their shell shapes i.e. conical for *P. acuta* and *B. bengalensis* and plane shape for *I. exustus*. Mostly the samples were collected from the agricultural lands as compared to other water bodies supporting the idea that agro-ecosystem is rich in species than the other water bodies (Altaf *et al*., 2016).

Conflict of interest

The authors have declared no conflict of interest.

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