

## Freshwater Snail Fauna of Pothwar Region, Pakistan

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**Abstract.-** The present study was aimed to identify the freshwater snail fauna inhabiting water bodies of Pothwar region, Pakistan. A total of ten freshwater snail species were identified belonging to five families viz. Planorbidae, Physidae, Viviparidae, Lymnaeidae and Thiaridae. Ten freshwater snail species were identified based on their detailed morphometric shell characteristics. They were: *Gyraulus convexiusculus* (Hutton, 1849), *Indoplanorbis exustus* (Deshayes, 1834), *Physa acuta* (Draparnaud, 1805), *Physa gyrina* (Say, 1821), *Bellamya bengalensis* (Lamarck 1822), *Lymnaea (P.) acuminata f. rufescens* (Gray, 1820), *Lymnaea (P.) luteola* (Lamarck, 1822), *Lymnaea (P.) acuminata f. chlamys* (Benson, 1836), *Lymnaea auricularia* (Linnaeus, 1758) and *Melanoides tuberculata* (Muller, 1774). The shell morphometric data of all species were taken with the help digital vernier caliper. The distribution of freshwater snails were also monitored in winter (December-February) and summer rainy (July-September) seasons. The results revealed that freshwater snails were more prevalent in summer rainy season as compared to winter season. This study provides first detailed taxonomic account of freshwater snails species commonly present in Pothwar region along with their detail shell morphometric account. Furthermore, it would provide a road map to carry out freshwater snail fauna in different region of Pakistan.

**Key word:** Freshwater snails, morphometric measurements, Pothwar region.

### INTRODUCTION

Molluscs are a part of the invertebrate microfauna of freshwater habitats throughout the world. Identification of freshwater snails is of value to zoologists, malacologists and conchologists because of their role as intermediate hosts of the larvae of a variety of trematode parasites. Some freshwater snails mostly serve as intermediate hosts to the trematode parasites, namely *Fasciola* spp. and *Schistosoma* spp. of humans and animals (Appleton, 1996). Taxonomic information on the molluscs of Pakistan has been provided by Khatoon and Ali (1978), Nazneen and Begum (1990). These studies were carried out in the Provinces of Sindh, Balochistan, Khyber Pakhtunkhwa and central Punjab. There seems to be no information on the freshwater snails of Pothwar, the northwestern part of Punjab. This paper describes the shape, size and other characteristics of the shells of 10 species of freshwater snails belonging to five families collected from some parts of the Pothwar region.

### MATERIALS AND METHODS

#### Study area

The present study on freshwater snails was conducted at different water bodies located in Rawalpindi, Islamabad, Fateh Jang, Chakwal and Attock areas of Pothwar region. The area is situated in a climatic region regarded as sub-tropical and sub-humid, latitude 30 and 34 °N and longitude 70 and 74°E (Fig. 1). The mean annual rain fall of the area is 737 mm, mean minimum temperature 0-1°C in winter and mean maximum temperature 38.5°C in summer.

#### Collection and preservation of snails

The snails were collected from different water bodies during the dry (December-February) and wet (July-September) seasons of the year 2009-2010 by applying hand scoop and hand picking methods. The snails were taken to the laboratory, washed with clean water to remove the debris and detail of fresh specimen was recorded. The specimens were put in 96% alcohol for 24 hours before removing the soft parts. The shells, deeply covered with mineral deposit and alga, were cleaned by putting them in dilute solution of oxalic acid for few minutes, before being scrubbed with a soft

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brush and washed in water in order to reveal the sculpture of shell (Mandahl-Barth, 1962; Thompson, 2004). The shells were dried at room temperature and preserved for future studies.

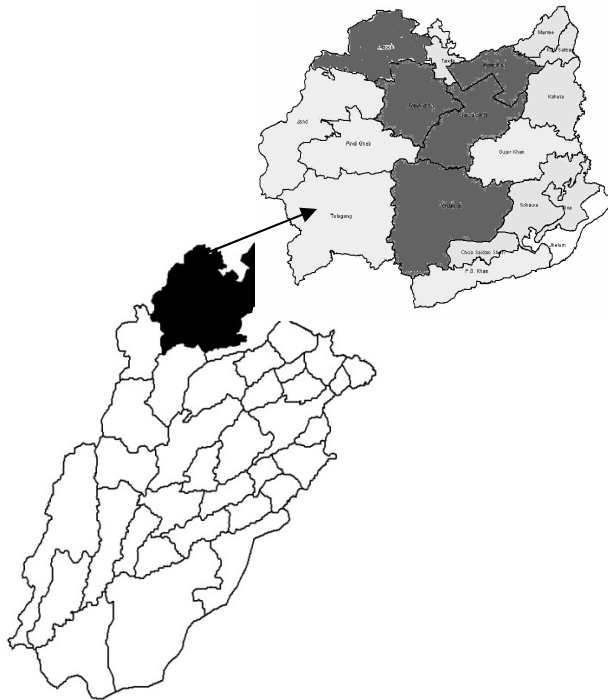


Fig.1. Map of Punjab showing Pothwar region with stations (darkly colored) from which the specimens collected.

*Morphometric data*

The morphometric measurements of the shells were taken with the help of a digital vernier caliper and measurements were taken in millimeters (mm). The height, diameter of the shell, umbilicus diameter, number of whorls, aperture size, height of spire and other morphometric parameters of shell were taken as shown in Figures 2 and 3. For the identification of freshwater snails Preston (1915), Patil and Talmale (2005) and Burdi *et al.* (2008) were followed.

**RESULTS**

The snails were more common during the wet season (July-September) than during the dry and cold months (December-February) of the year (Fig. 4). Overall 10 species of freshwater snails belonging to five families and six genera were identified and

described. The morphometric measurements of these species are given in Table I.

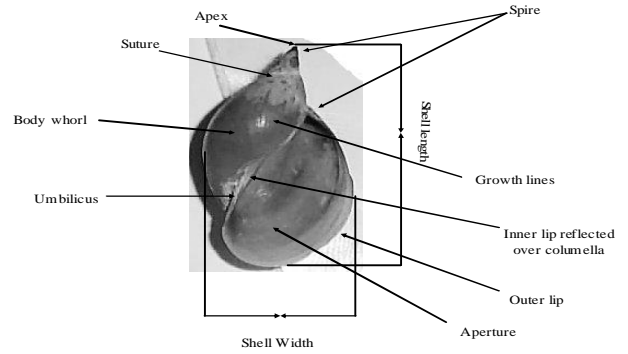


Fig.2. Morphological features of a conical shaped shell.

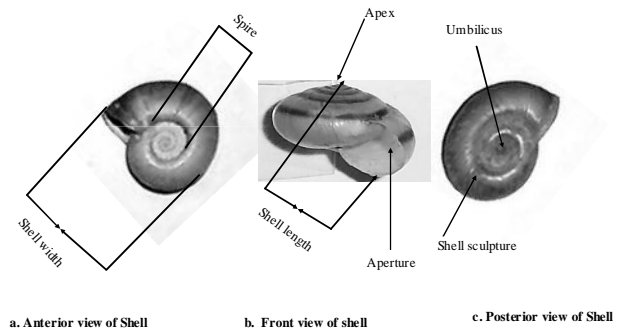


Fig. 3. Morphological features of discoidal shaped shell.

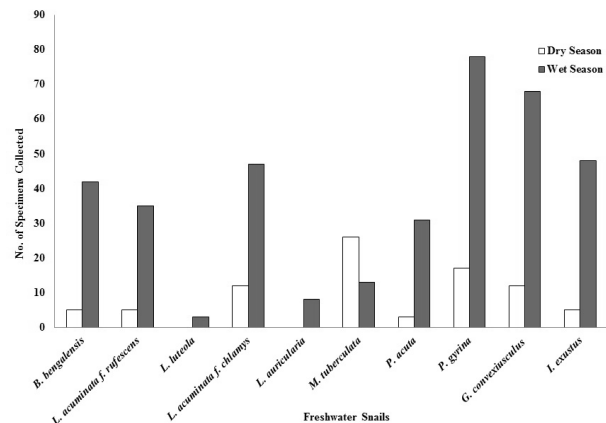


Fig.4. Specimens of different species of snails collected from different sites located in Pothwar region during the dry (December-February) and wet (July-September) seasons of the year.

**Table I.- Some linear morphometric measurements (ranges, means±SD) of the shell of freshwater snail species collected from Pothwar region.**

Shell parameters (abbreviations) Measurements(mm)	Shell height (SH)	Shell width (SW)	Aperture height/ Umbilicus diameter (AH or U)	SH/SW ratio	H/AH or SW/U ratio	Aperture width (AW)	Spire length/ Teleconch Length (SL or TL)
<i>Bellamyia bengalensis</i> (n=47)	13.63-32.60 (26.59±0.69)	10.76-20.20 (17.28±0.37)	7.90-17.59 (13.74±0.29)	1.26-1.61 (1.53±0.012)	1.61- 2.10 (1.93±0.02)	6.52-14.69 (11.89±0.27)	8.36-18.84 (15.43±0.41)
<i>Lymnaea (P.) acuminata f. rufescens</i> (n=40)	12.20-18.22 (15.24±0.32)	5.74-9.62 (7.66±0.18)	8.36-3.50 (11.05±0.25)	1.81-2.30 (1.99±0.02)	4.68-8.31 (6.24±0.20)	4.68-8.31 (6.24±0.20)	3.00-5.60 (4.36±0.09)
<i>Lymnaea (P.) luteola</i> (n=3)	14.78-14.80 (14.79±0.006)	7.32-7.35 (7.33±0.008)	10.70-10.77 (2.01±2.02)	2.01-2.02 (2.01±0.003)	1.37-1.38 (1.37±0.03)	5.33-5.71 (5.49±0.11)	4.68-4.79 (4.73±0.03)
<i>Lymnaea (P.) acuminata f. chlamys</i> (n=59)	16.03-22.97 (19.72±0.43)	8.59-12.38 (11.00±0.27)	11.67-17.50 (14.43±0.34)	1.65-1.93 (1.79±0.01)	1.31-1.42 (1.36±0.008)	7.28-11.21 (9.42±0.24)	4.83-6.37 (5.65±0.13)
<i>Lymnaea auricularia</i> (n=8)	11.43-19.81 (16.90±0.97)	6.78-11.91 (10.51±0.64)	8.67-15.84 (12.82±0.82)	1.51-1.68 (1.61±0.02)	1.25-1.47 (1.32±0.03)	6.33-10.01 (8.56±0.51)	3.51-5.57 (4.40±0.26)
<i>Melanoides tuberculata</i> (n=39)	23.27-28.12 (25.70±2.43)	7.75-8.52 (8.13±0.38)	7.81-8.06 (7.93±0.12)	3.00-3.30 (3.15±0.14)	2.98-3.48 (3.23±0.25)	3.67-4.29 (3.98±0.31)	16.03-19.59 (17.81±1.78)
<i>Physa acuta</i> (n=34)	8.10-10.06 (9.00±0.17)	4.60-5.71 (5.18±0.09)	5.83-7.42 (6.50±0.12)	1.57-1.86 (1.73±0.02)	1.29-1.54 (1.38±0.01)	..... -----	..... -----
<i>Physa gyrina</i> (n=95)	8.01-14.25 (11.81±0.62)	4.99-8.75 (7.18±0.39)	6.09-10.33 (8.51±0.44)	1.54-1.76 (1.64±0.02)	1.31-1.44 (1.38±0.01)	----- -----	----- -----
<i>Gyraulus convexiusculus</i> (n=80)	4.57-5.84 (4.99± 0.09)	8.23-13.60 (10.64±0.28)	2.68-4.55 (3.36±0.0 9)	0.38-0.57 (0.47±0.01)	2.55-3.83 (3.18±0.08)	----- -----	----- -----
<i>Indoplanorbis exustus</i> (n=53)	5.42-7.18 (6.25±0.16)	12.70-16.27 (14.14±0.36)	3.66-4.86 (4.07±0.14)	0.40-0.47 (0.44±0.01)	3.14-3.83 (3.48±0.05)	----- -----	----- -----

(.....) = These shell parameters were not taken in Planorbidae and Physaidae families.

Family *Planorbidae*

1. *Gyraulus convexiusculus* (Hutton, 1849)

Shell shape discoidal, number of whorls 3, umbilicus perforate, shell pale horn colour, glossy, depressed, dextral, whorls convex, suture well developed, last whorl expanded, periphery rounded to angulated only in last whorl, but not influencing the aperture, aperture is ovate-lunate, non-operculate, umbilicus broad, surface of the shell closely and obliquely striated.

2. *Indoplanorbis exustus* (Deshayes, 1834)

Shell shape discoidal, number of whorls 4, umbilicus perforate, shell greenish brown in colour,

finely ridged, concavely flattened on both sides, coiled sinistrally, body whorl large, aperture broad and ear shaped, non-operculate, margin of the shell are thin, umbilicus wide, sculpture with spiral striations.

Family *Physidae*

3. *Physa acuta* (Draparnaud, 1805)

Shell conical thin to medium thick, number of whorls 3, umbilicus imperforate, shell light horny yellowish, dull sometimes slightly transparent, pale shiny, shell oval shape, apex peaky, sinistral, whorls weakly convex with shallow suture, aperture very large about 3/4 of shell height and narrow at the top, whitish band on inside of outer lip, imperforate, shell surface longitudinally striated.

4. *Physa gyrina* (Say, 1821)

Shell conical thin to medium thick, number of whorls 3, umbilicus imperforate, shell light brown, smooth, translucent, apex peaky, shell sinistral and somewhat inflated, whorls with slightly impressed suture, upper whorls with reddish shade, last whorl large, aperture about 55-75 per cent of shell height, shape of shell oval to round, aperture oblique with broad white callus at parietal side.

Family *Viviparidae*

5. *Bellamya bengalensis* (Lamarck, 1822)

Shell shape globes, number of whorls 5, umbilicus rimate, shell greenish or brownish with reddish brown bands, dextral, shell is thin and ovately conical, umbilicus narrow but open, whorls convex, sutures are narrowly depressed, height of the spire equal or greater than the height of aperture, sculpture finely striated; aperture almost round and operculated, operculum spiral with concentric growth rings around nucleus, apex very peaky.

Family *Lymnaeidae*

6. *Lymnaea* (P.) *acuminata* f. *rufescens*  
(Gray, 1820)

Thin conical shell, number of whorls 4, umbilicus imperforate, shell brown in colour, dextral, thin, ovately oblong and smooth, umbilicus closed, body whorl enlarged, angular above and inflated below, sutures obliquely depressed, aperture large mango shaped pointed above and inflated below, columella twisted and oblique, shell sculpture spirally striated, apex very short, thin and pointed.

7. *Lymnaea* (*Pseudosuccinea*) *luteola* (Lamarck, 1822)

Thin conical shell, number of whorls 4, umbilicus imperforate, shell pale or brownish in colour, dextral, thin, and broadly ovate, umbilicus closed, body whorl enlarged and inflated, spire with few number of whorls, sutures are depressed,

aperture narrow and ovate, shell sculpture spirally striated, apex short and pointed.

8. *Lymnaea* (P.) *acuminata* f. *chlamys*  
(Benson, 1836)

Thin conical shell, number of whorls 5, umbilicus compressed, shell light brownish or whitish in colour, dextral, thin and oblongly ovate, body whorl enlarged and inflated, spire short and cone shaped, deeply sutured, umbilicus compressed, aperture large and ovate with twisted columella, shell sculpture smooth, glossy and spirally striated, apex pointed.

9. *Lymnaea auricularia* (Linnaeus, 1758)

Thin conical shell, number of whorls 4, umbilicus imperforate, shell light brownish in colour, dextral, thin and somewhat squarely ovate, body whorl abruptly enlarged, spire cone shaped, aperture large, very broad and ear shaped, shell sculpture spirally striated, apex sharp and pointed.

Family *Thiaridae*

10. *Melanooides tuberculata* (Muller, 1774)

Conical shell, number of whorls 7, shell light brown in colour, elongate and conical, whorl rounded, convex and gradually increasing in size downward, aperture small and ovate, operculum paucispiral, shell sculptured with reddish markings, vertical weakly curved ribs and much finer spiral striations.

## DISCUSSION

The result of present study revealed that the freshwater snail fauna was more abundant in wet season (July-September) as compared to dry season (December-February) experiencing less rainfall. The species belong to Genus *Lymnaea* and *Bellamya* were predominant during summer rainy season. The availability of these species is regulated by various physico-chemical factors viz., temperature, hardness, pH, altitude, size of water bodies, vegetation and pollution are among the significant

factors influencing the distribution and abundance of gastropods (Ollerenshaw, 1958; Yilma, 1985). The optimum habitats for snails belonging to genus *Lymnaea* were permanent water and also found in marshy areas during dry season (Ollerenshaw, 1971; Villegas, 1984). The high density of *Lymnaea* and some other freshwater snails that serve as intermediate host during wet season would have become important source of digenetic infections. Similar observation were made by Brown (1980) who had reported that summer rainy season provides optimum conditions for the availability of freshwater snails. It has been anticipated that rainy season provides environmental conditions for the propagation of freshwater snails as availability of vegetation; a good food source is increased. It has been observed that snails breed in summer rainy season attain maximum size in dry winter season. The freshwater snails biodiversity in the given water bodies is associated with type of vegetation, presence of snail predators, topography and chemical composition. Similarly acceptable freshwater quality and environmental parameters might also be considered as good biological indicators to dictate the freshwater snail biodiversity richness in a given habitat. Furthermore the population density of gastropods of each species is seasonally fluctuated.

The freshwater snail fauna of Pakistan is least known in Asia. Previously literature showed that little information is generated on the identification of freshwater snail fauna. In present study snails belonging to five families and six genera were identified on the basis of morphological characteristics in shell sculpture, color pattern, shape differences and somewhat on soft body parts. Our findings are in agreement with previously reported studies from other water bodies of Pakistan (Preston, 1915; Begum and Nazneen, 1991, 1992a, b). Lymnaeid snails are known to be distributed throughout the world. They are intermediate host of helminthes parasites which cause diseases both in man and domestic animals. Four species of *Lymnaea* were identified and ranked as secondly dominant species in the study area. Among these four species *Lymnaea acuminata chlamys* was dominant over other three Lymnaeids. In Pakistan however, the studied taxonomical status of these

Lymnaeids species is still unclear in various parts. It is to be pointed that Akhtar (1978) and Khatoon and Ali (1978) have described *Lymnaea rufescens* as a separate species instead of *Lymnaea acuminata*. However, Preston (1915), Subba Rao and Mitra (1979), Subba Rao *et al.* (1980), Goel and Srivastava (1980), Nazneen and Begum (1990) have described it as *Lymnaea acuminata*. The *Lymnaea auricularia* which was previously placed in Genus *Radix* has been characterized by having ear shaped aperture and is considered as intermediate host for many trematodes parasites especially for *Fasciola hepatica* and *Fasciola gigantica*. However, taxonomic status of the Genus *Radix* is still disputed (Bargues *et al.*, 2001 and Remigio, 2002). The *Bellamya bengalensis* also commonly known as viviparous snails is predominant in the studied areas. It has been observed in the present study the adult vivipaerid (mystery-snail) females were bearing live young ones inside its specialized marsupium mental cavity indicating the recruitment patterns in natural habitat. The identification among member of Physidae within family is very difficult. The *Physa acuta* are also synonymized under the name as *heterostropha*, *integra* and *virgata* (Dillon *et al.*, 2002; Wethington, 2004). The *Physa acuta* was first time reported in Pakistan by Begum and Nazneen (1991) whereas *Physa gyrina* was described by Khatoon and Ali (1978). The *Physa* snails are exhibiting cosmopolitan distribution pattern (Dillon *et al.*, 2002) and confined in lentic water bodies usually attached with algal mats. The pulmonate snails such as *Gyraulus convexiusculus* and *Indoplanorbis exustus* were found in the study areas where they crawled onto the water plants and into the soil in the shallow water. *Melanoides tuberculata* is medically important because this specie serve as intermediate host for the human lung fluke, *Paragonimus westermani*. This snail was first placed under Genus *Thiara* (Muller, 1774; Preston, 1915), *Nerita* (Muller, 1774), *Melania* (Annandale, 1918; Satyamurti, 1952; Tonapi and Mulherkar, 1963; Khan and Dastagir, 1971; Khatoon and Ali, 1978) and *Melanoides* (Ray, 1943; Subba Rao and Mitra, 1979).

The results from the present study clearly showed that our information of the gastropods fauna of Pakistan is incomplete. In most of the cases shells

are only used for identification as it is very hard to found fresh specimens of species all times. Therefore, need to conduct comprehensive surveillance study based on morphological characterization of freshwater snail in different agro-ecological zones of Pakistan.

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### REFERENCES

- AKHTAR, S., 1978. On a collection of freshwater molluscs from Lahore. *Biologia*, **24**: 437-447.
- ANNANDALE, N., 1918. Aquatic molluscs of the inland lake and connected waters. *Rec. Indian Mus.*, **14**: 103-182.
- APPLETON, C.C., 1996. *Freshwater molluscs of southern Africa*. University of Natal Press, Pietermaritzburg, South Africa.
- BARGUES, M.D., VIGO, M., HORAK, P., DVORAK, J., PATZNER, R.A., POINTIER, J.P., JACKIEWICZ, M., MEIER-BROOK, C. AND MAS-COMA, S., 2001. European Lymnaeidae (Mollusca: Gastropoda), intermediate hosts of trematodiasis, based on nuclear ribosomal DNA ITS-2 sequences. *Infect. Genet. Evol.*, **1**: 85-107.
- BEGUM, F. AND NAZNEEN, S., 1991. Systematic study of molluscan fauna of Layari river, Mesogastropoda (Suborder Taenioglossa). *Bangladesh J. Zool.*, **19**: 107-121.
- BEGUM, F. AND NAZNEEN, S., 1992a. Systematic study of molluscan fauna of Layari river Part-I. Archaeogastropoda (Aspidobranchia) from the Estuarine Region. *Pakistan J. scient. indust. Res.*, **35**: 10.
- BEGUM, F. AND NAZNEEN, S., 1992b. Systemic study of Molluscan fauna of Layari river, part 7: Bivalves (Paleoheterodonta). *The Philippine J. Sci.*, **121**: 121-133.
- BENSON, 1836. *Lymnaea chlamys*. *J. Asiat. Soc. Bangal*, **5**: 744.
- BROWN, D.S., 1980. *Freshwater snails of Africa and their medical importance*. Taylor and Francis Ltd., London, pp. 487.
- BURDI, G.H., BALOCH, W.A., BEGUM, F., SOOMRO, A.N. AND KHUHAWAR, M.Y., 2008. Ecological studies on freshwater gastropods (snails) of Indus river and its canals at Kotri barrage Sindh, Pakistan. *Sindh Univ. Res. J.*, **40**: 37-40.
- DESHAYES, 1834. *Planorbis exustus*. *Voy. Bell. Indes Orient., Zool.*, **3**: 417.
- DILLON, R.T., WETHINGTON, J.A.R., RHETT, J.M. AND SMITH, T.P., 2002. Populations of the European freshwater Pulmonate *Physa acuta* are not reproductively isolated from American *Physa heterostropha* or *Physa integra*. *Invertebr. Biol.*, **121**: 226-234.
- DRAPARNAUD, J.P.R., 1805. *Histoire naturelle des mollusques terrestres et fluviatiles de la France*. Ouvrage posthume. Avec XIII planches. pp 1-9.
- GOEL, H.C. AND SRIVASTAVA, C.P., 1980. Freshwater snails of Gwalior (M.P.). *J. Bombay nat. Hist. Soc.*, **77**: 215-222.
- GRAY, 1820. *Lymnaea rufescens*. In: *Sowerby's genera of shells I*. Spottiswoode and Co., London
- HUTTON, 1849. *Planorbis convexiusculus*. *J. Asiatic Soc. Bengal*, **18**: 657.
- KHAN, M.D. AND DASTAGIR, S.G., 1971. On the mollusca, gastropoda fauna of Pakistan. *Rec. Zool. Surv. Pak.*, **1**: 17-130.
- KHATOON, S. AND ALI, S.R., 1978. Freshwater mollusks of Pakistan. *Bull. hydrobiol. Res. Ser.*, **1**: 518-525.
- LAMARAK, 1822. *Lymnaea luteola*. *Hanley and Theobald, Conch. Ind.*, Pl. 70, fig. 5.
- LAMARAK, 1822. *Paludina bengalensis*. *Hist. Nat. Anim. Sans. vent.*, **6**: 74.
- LINNAEUS, 1758. *Helix auricularia*. *Syst. Nat., ed. 10*, pp.774.
- MANDAHL-BARTH, G., 1962. Key to the identification of East and Central African freshwater snails of medical and veterinary importance. *Bull. Wld. Hlth. Org.*, **27**: 135-150.
- MULLER, O.F., 1774. *Vermium terrestrium et fluviatilium*, **2-4**: 1-208.
- NAZNEEN, S. AND BEGUM, F., 1990. Systematic study of some freshwater gastropods of Sindh. *Biologia*, **36**: 1.
- OLLERENSHAW, C.B., 1958. Climate and liver fluke. *Agriculture (London)*, **65**: 231-252.
- OLLERENSHAW, C.B., 1971. Some observation on the epidemiology of fascioliasis in relation to the timing of molluscicide applications in the control of the disease. *Vet. Rec.*, **88**: 152-164.
- PATIL, S.G. AND TALMALE, S.S., 2005. A checklist of land and freshwater mollusca of Maharashtra state. *Zoos' Print J.*, **20**: 1912-1913.
- PRESTON, H.B., 1915. *The fauna of British India including Ceylon and Burma*. Taylor and Francis Publisher, London.
- RAY, H.C., 1943. Report on a collection of molluscs from

- Santal Parganas, Bihar. *J. R. Asiatic. Soc. Bengal Sci.*, **9**: 63-80.
- REMIGIO, E.A., 2002. Molecular phylogenetic relationships in the aquatic snail genus *Lymnaea*, the intermediate host of the causative agent of fascioliasis: insights from broader taxon sampling. *Parasitol. Res.*, **88**: 687-696.
- SATYAMURTI, S.T., 1952. The mollusca of Krusadai Island (in the Gulf of Manaar). Amphineura and Gastropoda. *Bull. Madras Govt. Mus. New Ser.*, **6**: 1-267.
- SAY, T., 1821. Descriptions of univalve shells of the United States. *J. Acad. Nat. Sci. Philadelphia*, **2**: 149-179.
- SUBBA RAO, N.V. AND MITRA, S.C., 1979. On land and freshwater molluscs of Pune district Maharashtra. *Rec. Zool. Surv. India*, **75**: 1-37.
- SUBBA RAO, N.V., DAS, A.K. AND MITRA, S.C., 1980. On freshwater molluscs of Andaman and Nicobar Islands. *Rec. Zool. Surv. India*, **77**: 215-245.
- THOMPSON, F.G., 2004. *The freshwater snails of Florida: a manual for identification*. University of Florida Press, Gainesville, 32611-7800.
- TONAPI, G.T. AND MULHERKAR, L., 1963. On the freshwater molluscs of Poona. *J. Bombay Nat. Hist. Soc.*, **60**: 103-120.
- VILLEGAS, L.M., 1984. *Physical-chemical study of the ecological environment snail Lymnaea viatrix in the Cajamarca valley*. (Undergraduate Thesis) Universidad Nacional de Cajamarca, Cajamarca, Peru.
- WETHINGTON, A.R., 2004. *Phylogeny, taxonomy, and evolution of reproductive isolation in Physa (Pulmonata: Physidae)*. Ph.D. dissertation, University of Alabama, Tuscaloosa.
- YILMA, J., 1985. *Study on ovine fasciolosis and other helminth parasites at Holeta*. DVM thesis, Addis Ababa University, Debre Zeit, Ethiopia, pp. 45.

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