

RESEARCH ARTICLE

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Shell and Radula Morphology of land snails in Urmia city, North-west of Iran

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Abstract

Mollusca are the second-largest phylum of invertebrates after Arthropoda and may play a role as an intermediate host for parasites. To determine the morphological features of land snails (including *Assyriella ceratomma*, *Jaminia isseliana*, *Helix lucorum* and *Euomphalia pisiformis*) from North-west of Iran (Urmia city), the specimens were collected during 2015-2017. After extraction, the radulas were stained using Mallory II and the shell morphology and teeth formula were studied.

A significant correlation was found between the mean length of radula and their body size. In addition, snails with bigger shell size, had a larger teeth size and more lateral teeth. The longest and the shortest central tooth belonged to *Helix lucorum* and *Jaminia isseliana*, respectively. The length of the central teeth in the *Helix lucorum* and *Assyriella ceratomma* differed significantly from other species. Furthermore, the shape of the central tooth in all examined snails was triangular. The lateral teeth in the *Helix lucorum* and *Assyriella ceratomma* species had one mushroom-like cusp with two short sharp cusps. The lateral teeth in *Jaminia isseliana* contained blade like cusps at the middle. *Helix lucorum* snails had more marginal teeth compared to others.

Key words: Iran, Land snails, Morphology, Radula, Shell, Urmia

INTRODUCTION

Both aquatic (freshwater and marine) and terrestrial snails belong to the Pulmonata subclass of Gastropoda, contain a variety of aquatic (freshwater and marine) snails and terrestrial snails (Morton, 1979). Despite the development of molecular biomarkers for identification of different species in recent years (Stothard & Rollinson 1996; Hebert *et al.*, 2003; Akinwale *et al.*, 2015), the morphological features, including shell and radula structure are still widely used to characterize them (Schander & Willassen, 2005). The shape of radula teeth, which composed of a long ribbon of tissue and repeated rows of teeth, is unique to a genus or species (Rumam & Thornton, 1967). Radula teeth consists of transverse rows and one central (C), one lateral (L), and one marginal teeth (M) (Mansourian, 2005). The teeth formula (Ponder & Lindberg, 1996) as well as shape, size and structure of the cusps (Kilburn, 1988; Monzon *et al.*, 1993) of radula as well as shell morphological characters are used to differentiate different snail species (Oso & Odaibo, 2018). In this current study we sought to determine the differences in the shell and radula morphology of four land snail species collected from Urmia city in North-west of Iran.



MATERIAL AND METHODS

Study area

City of Urmia (Fig. 1) is the capital of West Azarbaijan province in North-west of the country, with an area of approximately 5895 square kilometers and an altitude of about 1312 meters above sea level (longitude of 45 00' to 45 07' E and latitude of 37 29' to 37 34'N). Urmia's climate is temperate with a maximum of 34 °C in August and a minimum of 6.1 °C in January (an average of 8.9 °C). The average annual rainfall is about 370 mm, and its relative humidity sometimes can reach 50%.

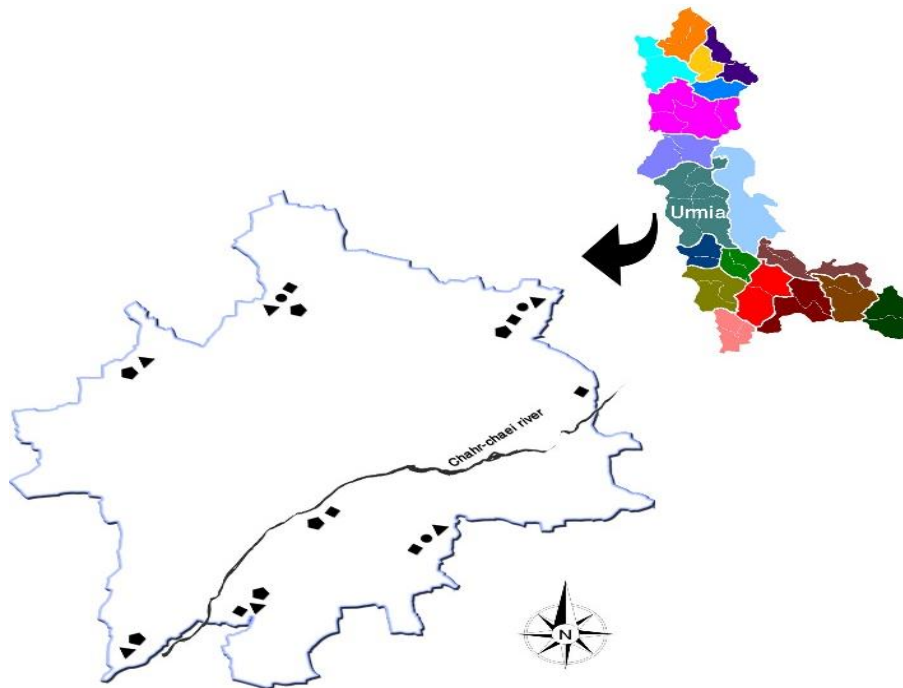


FIGURE 1. Sampling areas in Urmia, west Azerbaijan province, Iran (Trapezium: *Assyriella ceratomma*, Circle: *Jaminia isseliana*; Triangular: *Helix lucorum*; Square: *Euomphalia pisiformis*).

Collection and identification of land snails

A total of 260 snails were collected from soil and subsoil, forage, rock from different parts of Urmia during 2015 – 2017 (Fig 1). In the lab, the specimens were preserved in 70% ethanol and the length of the shells (the distance from the apex to the base of the aperture) were measured before dissection. For morphology examinations, the criteria described somewhere else were used (Burch & Van Devender, 1980; Cameron & Riley, 2008; Cameron & Redfern, 2009).

Firstly, the buccal mass was completely removed as explained previously (Kristensen, 1984) and the surrounding tissues of radulas were dissolved using 7.5% KOH for 24 hours and then stained using Mallory II solution (Mansourian, 1986). To determine the teeth configuration, radulas were mounted on slides using a mounting medium (Canada Balsam). The length of central (C), lateral (L), and marginal (M) radular teeth were measured from apical cusp to the base using an optic microscope. To determine the tooth formulas, the number of rows and the teeth within each row were counted.

Statistical analysis

The Variance (ANOVA) analysis was performed using SPSS v. 21, and the *P values* less than 0.05 were statistically considered significant.



FIGURE 2. Examined Snails: A, *Assyriella ceratomma*; B, *Jaminia isseliana*; C, *Helix lucorum*; D, *Euomphalia pisiformis*.

Results

Morphology of snails

Assyriella ceratomma (Pfeiffer, 1856) (Fig. 2A)

The discus shell large, white, matte, and hard with five whorls. The umbilicus unclear. Shell valve thick, rounded and elliptical. The shell height more than 20 mm.

Jaminia isseliana (Issel, 1865) (Fig. 2B)

A conical cylinder with seven to eight slightly twisted turns. The end twist with a white stripe on the back and slightly raised towards the aperture. Oval Aperture short, almost vertical. The edges of the aperture white and thick.

Helix lucorum (Linnaeus, 1758) (Fig. 2C)

The shell thick, spherical, compact and round. With 4.5 to 5 rounded whorls, last whorl wide. The first whorl lined with distinct spiral striae. The white background irregular with dark brown intersections stripes. Aperture small, oval-shaped with sharply upper edge.

***Euomphalia pisiformis* (Pfeiffer, 1852)** (Fig. 2D)

With discus shell. Shell color white with a brown stripe on the surface of the whorls. With 5.5 to 6 whorls. With small needle-shaped patterns on its surface. The tip sharp, and the spire equal or slightly higher than the valve. The valve rounded. The edge of the valve sharp and thin, partially turned. Shells with narrow umbilicus, partially covered by columella.

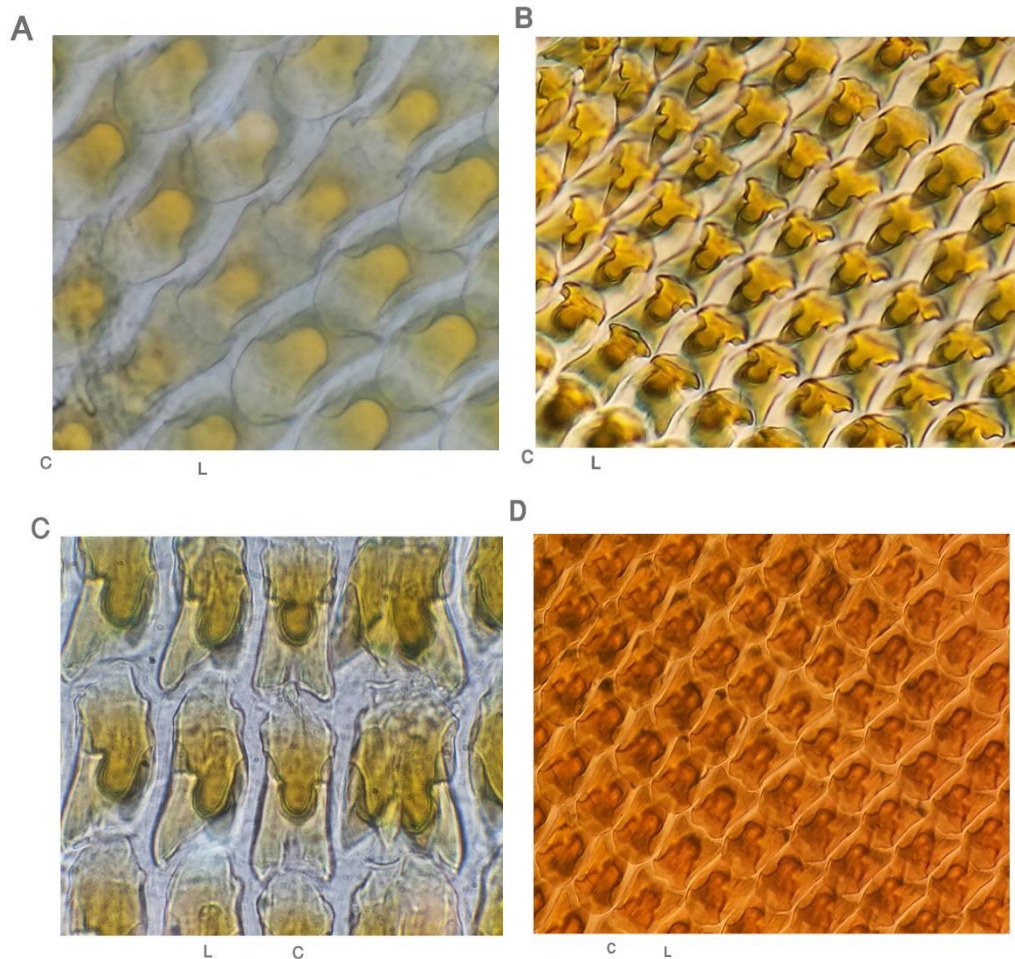


FIGURE 3. The radular central (C) and lateral (L) teeth of: A, *Assyriella ceratomma*, 100×; B, *Jamina isseliana* 100×; C, *Helix lucorum* 100×; D, *Euomphalia pisiformis* 100×. (Stained by Mallory II).

Description of radular teeth structures

The morphological differences of radula between different species are shown in Figure 3 (A–D). As shown in Table 1, the land snails with larger shell size had larger teeth size. Accordingly, the mean length of radular teeth increased with increasing of the body size in all examined specimens. The number of lateral teeth was greater in larger snails. The longest central tooth belonged to *H. lucorum* snail (33.34 ± 0.9) and the smallest was found in *J. isseliana* (15.46 ± 0.68). The length of the central teeth in *H. lucorum* and *A. ceratomma* differed significantly from other species ($p < 0.05$). There was an association between the number of teeth rows and the size of the examined snails. *H. lucorum* had the highest numbers of teeth rows (154.69 ± 4.62 ; $P < 0.05$). The number of marginal teeth was higher in *H. lucorum* snails compared to the other species. Interestingly, the teeth formula of *J. isseliana* were found to be almost the same as *E. pisiformis* (Table 1).

TABLE 1. Means and standard deviation (Mean \pm SD) for radular teeth measurements and Radula formula of Land snails in Urmia city, Iran.

Snail species	Radular teeth*						Teeth rows	Shell length	Radula Formula
	Length of Central teeth	Width of Central teeth	Length of Lateral teeth	Width of Lateral teeth	Length of Marginal teeth	Width of Marginal teeth			
<i>A. ceratomma</i>	29.64 \pm 1.86 ^b	15.93 \pm 0.45 ^b	31.87 \pm 1.66 ^a	17.99 \pm 0.42 ^b	21.82 \pm 0.92 ^a	15.43 \pm 0.51 ^a	142.08 \pm 5.60 ^{ab}	26.70 \pm 0.75 ^b	1,17,18
<i>H. lucorum</i>	33.34 \pm 0.90 ^a	17.05 \pm 0.55 ^a	33.45 \pm 1.22 ^a	21.10 \pm 0.57 ^a	22.75 \pm 1.87 ^a	14.36 \pm 0.65 ^a	154.69 \pm 4.62 ^a	39.30 \pm 0.13 ^a	1,19,24
<i>E. pisiformis</i>	15.52 \pm 0.65 ^d	7.52 \pm 0.24 ^f	15.50 \pm 0.39 ^c	8.67 \pm 0.49 ^f	9.20 \pm 0.63 ^c	8.93 \pm 0.27 ^c	107.00 \pm 1.81 ^c	13.52 \pm 0.38 ^d	1,12,15
<i>J. isseliana</i>	15.46 \pm 0.68 ^d	11.29 \pm 0.26 ^{de}	15.37 \pm 0.54 ^c	11.34 \pm 0.19 ^e	10.51 \pm 0.65 ^{bc}	10.93 \pm 0.4 ^b	107.31 \pm 5.10 ^c	7.28 \pm 0.56 ^e	1,11,15

The middle of each row of the radula (the C tooth) is almost triangular with specific cusp shape. The size of lateral teeth was the same as central teeth in all species. The L teeth in *H. lucorum* and *A. ceratomma* species had a mushroom like cusp with two short sharp cusps. The L teeth of *J. isseliana* had the blade like cusps in the middle.

DISCUSSION

Generally, study of shells in snails can provide important taxonomic information. The radular shape and size are used to differentiate the genus or species of Mollusca (Franklin *et al.*, 2007). The radula in each species of Mollusca has a unique morphology and structure (Yakhchali & Jamshidi Deillami, 2012). In several studies have been shown the importance of radula for discriminating of different species (Matthews-Cascon *et al.*, 2005; Haijirawowg *et al.*, 2008; Yakhchali & Jamshidi Deillami, 2012; Tumpeesuwan & Tumpeesuwan, 2015; Medina *et al.*, 2016).

For the first time, the current study used the morphological characteristics to differentiate different radula of land snails in Iran. Consistent with other studies, it has shown that snails with larger shell sizes had larger teeth sizes (Howe 1930; Barker, 2001; Yakhchali & Jamshidi Deilami, 2012; Yakhchali *et al.*, 2013).

The number of cusps were found to be different between species. In our study, the radula of all four land snails were tricuspid as shown previously on *Zidona dufresnei* (Medina *et al.* (2016). In our study, two cusps on outer lateral teeth of studied land snails were found, but in another study, four cusps were reported in *Pterocyclos diluvium* and *Pearsonia lamphunensis* (Tumpeesuwan & Tumpeesuwan, 2015). In addition, A pantacuspoid radula has been found in *Thais bronni* and *T. clavigera* (Fujioka, 1985). Similar to other studies, we also found that the central cusp of radular teeth is longer than the lateral cusps (Harasewych & Kantor, 1991; Harasewych & Marshall, 1995).

The median teeth of giant African land snails (Odaibo & Olayinka, 2019) and freshwater snails (Yakhchali & Jamshidi Deilami, 2012) are smaller compared to lateral and marginal teeth, but the size of the lateral and central teeth in all species were found to be the same in our study. As shown by others and in this current study, snails with larger shell size had more teeth rows (Ferreira, 1977; Ocan'a *et al.*, 2004; Yakhchali *et al.*, 2013). Snails with larger shell size also had more marginal teeth. The shell of *H. lucorum* was larger than other species and had the highest marginal teeth too, as shown by another study in *lymnaeid* snails (Yakhchali & Jamshidi Deillami, 2012).

CONCLUSION

The findings from our study demonstrates that morphological characteristics of shells and radulas were useful to differentiate different snail species.

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