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Harmozica zangezurica (Gastropoda, Pulmonata, Hygromiidae) – a cryptic species of land molluscs from southern Armenia

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ABSTRACT. Additional material collected in September 2019 made it possible to clarify the range of conchological variability of *Harmozica zangezurica* recently described from the Syunik region of Armenia, which largely overlaps with that of *Harmozica pisiformis* thus rendering impossible the reliable identification of empty shells. At the same time the stability has been proven of a diagnostic feature of *H. zangezurica* – very long vaginal appendages whose length is approximately equal to the total length of the penis and epiphallus. This character allows reliable distinguishing of *H. zangezurica* not only from the conchologically similar species *H. pisiformis*, but also from other representatives of the genus *Harmozica*. Some data on the ecology and life cycle of *H. zangezurica* were obtained.

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Harmozica zangezurica (Gastropoda, Pulmonata, Hygromiidae) – криптический вид наземных моллюсков с юга Армении

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РЕЗЮМЕ. Благодаря дополнительным материалам, собранным в сентябре 2019 г., удалось уточнить диапазон конхологической изменчивости недавно описанного из Сюникской области Армении вида *Harmozica zangezurica*, который в значительной степени перекрывается с таковым *Harmozica pisiformis*, что делает невозможным надежное определение пустых раковин. В то же время доказана стабильность такого диагностического признака *H. zangezurica,* как очень длинные вагинальные придатки, длина которых приблизительно равно суммарной длине пениса и эпифаллуса. Этот признак позволяет надежно отличить *H. zangezurica* не только от конхологически сходного вида *H. pisiformis*, но и от прочих представителей рода *Harmozica*. Также были получены некоторые данные, касающиеся экологии и жизненного цикла *H. zangezurica*.

Introduction

In May 2016, one adult specimen was found between Kapan and Shikahogh in southern Armenia, which differed from *Harmozica pisiformis* (L.Pfeiffer, 1846) widespread in the Caucasus region by very long vaginal appendages not typical for the genus *Harmozica* Lindholm, 1927, as well as by a half covered umbilicus of the shell. A similar empty shell of an immature snail was found nearby [Gural-Sverlova *et al*., 2017a, fig. 1–2]. This became the basis for the description of the new species *Harmozica zangezurica* Gural-Sverlova *et al*., 2017 [Gural-Sverlova *et al*., 2017b].

In September 2019, additional material confirming the absence of anatomically transitional forms between *H. zangezurica* and *H. pisiformis* was collected in locus typicus of the former species and in the adjacent territories. It was also found that the range of conchological variability in *H. zangezurica* is much wider that was previously assumed. Therefore the variability largely overlaps with that of *H. pisiformis* that makes reliable identification of empty shells impossible.

Material and methods

The material was collected between September 12 and 18, 2019 at the following sites (the number of anatomically examined adults of *H. zangezurica* at each of them is given in brackets):

1) between Chakaten and Shikahogh, locus typicus of *H. zangezurica*, 39°06.98’N, 46°28.16’E (2);

2) near Shikahogh, 39°06.25’N, 46°28.37’E (1);

3) between Chakaten and Shikahogh, 39°07.72’N, 46°28.25’E (3);

4) near Srashen, 39°03.88‘N, 46°30.07‘E (1);

5) between Srashen and Tsav, 39°03.68’N, 46°29.65’E (1);

6) near Tsav, 39°03.30’N, 46°28.86’E (1);

7) near the Vahanavank Monastery, 39°12.98’N, 46°20.12’E (1).

In total, 10 adults of *H. zangezurica* from 7 lo-

FIG. 1. The locations of the collecting sites of anatomically examined adults of *Harmozica zangezurica*.

РИС. 1. Расположение участков, на которых были собраны анатомически исследованные половозрелые особи *Harmozica zangezurica*.

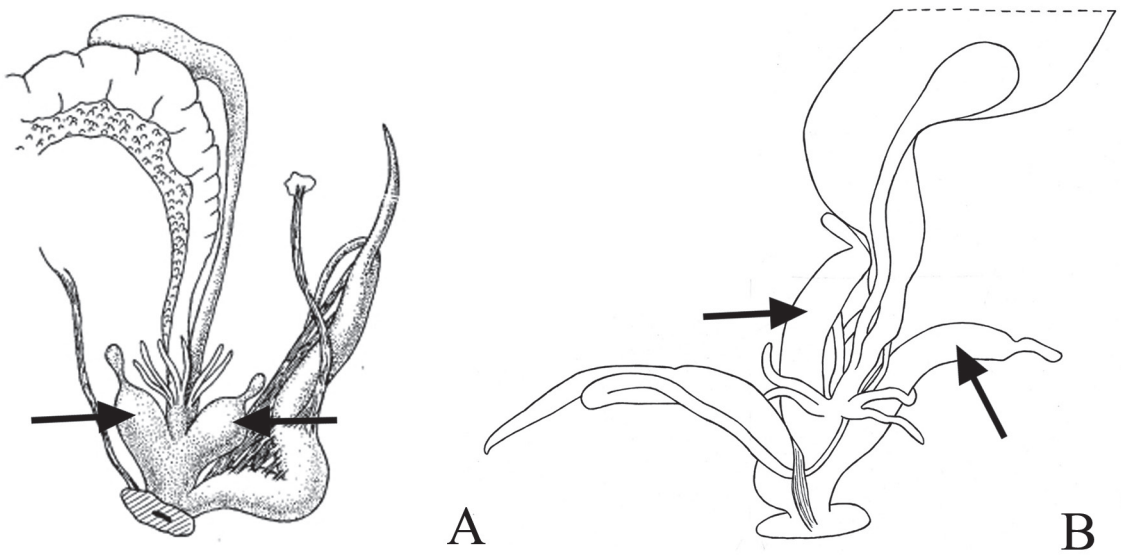

FIG. 2. The reproductive system of two conchologically similar species. **A.** *Harmozica pisiformis* after Schileyko (1978). **B**. Holotype of *H. zangezurica* after Gural-Sverlova *et al*. (2017b). Arrows indicate vaginal appendages.

РИС. 2. Половая система двух конхологически схожих видов. **A.** *Harmozica pisiformis* по Шилейко (1978). **B.** Голотип *H. zangezurica* по Gural-Sverlova *et al*. (2017b). Стрелками показаны вагинальные придатки.

calities were anatomically examined. The locations of the collecting sites are shown in Fig. 1.

The molluscs were collected, preserved, and dissected according to generally accepted methods [Schileyko, 1978]. The collected and studied material is stored in the State Museum of Natural History in Lviv.

Results and discussion

When describing *H. zangezurica*, special attention was paid to such anatomical character as vaginal appendages that are unusually long for the genus *Harmozica*, the length being approximately equal to the total length of the penis and epiphallus (Fig. 2). In other known species of the genus *Harmozica*, often referred to as *Stenomphalia* Lindholm, 1927 in the Eastern European malacological literature [Schileyko, 1978, 2005], the relative length of the vaginal appendages is 2-3 times shorter, so that they are not longer than the penis [Gural-Sverlova *et al*., 2017b]. The vaginal appendages of the genus *Hesseola* Lindholm, 1927 are similar in length, but they are located side-by-side [Schileyko, 1978, 2005], which is not observed in *H. zangezurica* [Gural-Sverlova *et al*., 2017b].

In all dissected specimens long vaginal appendages of cylindrical shape were found (Fig. 3), similar to those in the holotype of *H. zangezurica* (Fig. 2B) and very different from the relatively short saccular vaginal appendages of *H. pisiformis* (Fig. 2A). None of them had vaginal appendages of a transitional form between *H. zangezurica* and *H. pisiformis*. Thus, our study confirms the stability of this anatomical feature in *H. zangezurica*.

H. pisiformis is a variable species, however, its intraspecific variability concerns mainly conchological traits: the shape and size of the shell, the degree of expression of granular sculpture on its surface [Akramovsky, 1976; Akramovsky, Azaryan, 1964; Schileyko, 1978]. Anatomical study of different conchological forms did not show significant differences between them, including the relative size of the vaginal appendages [Akramovsky, 1976, fig. 110].

The recorded anatomical uniformity of *H. zangezurica* is accompanied by significant conchological variability, which concerns not only the shape of the shell or the width of the umbilicus, but also the degree to which the umbilicus is covered by the columellar margin of the aperture. Even among the 10 shells belonging to the anatomically studied individuals of *H. zangezurica*, various variations of this trait were observed – from completely open or only slightly covered to half-closed umbilicus (Fig. 4).

Therefore, the degree of umbilicus coverage cannot be used to differentiate *H. zangezurica* and *H. pisiformis*, as we assumed earlier [Gural-Sverlova *et al*., 2017b]. Both of these species have well-defined intraspecific conchological variability, the ranges of which overlap to a large extent. Consequently, a reliable determination of both species is obviously impossible without anatomical examination.

Little is known about the distribution of *H. zangezurica*. So far, living individuals of this species have been found in a relatively small area – between Srashen and Tsav in the southeast and Vaganavank in the northwest. The exact boundaries of its range are difficult to determine due to the above-mentioned conchological similarity with the widespread species *H. pisiformis* and a concealed lifestyle, often

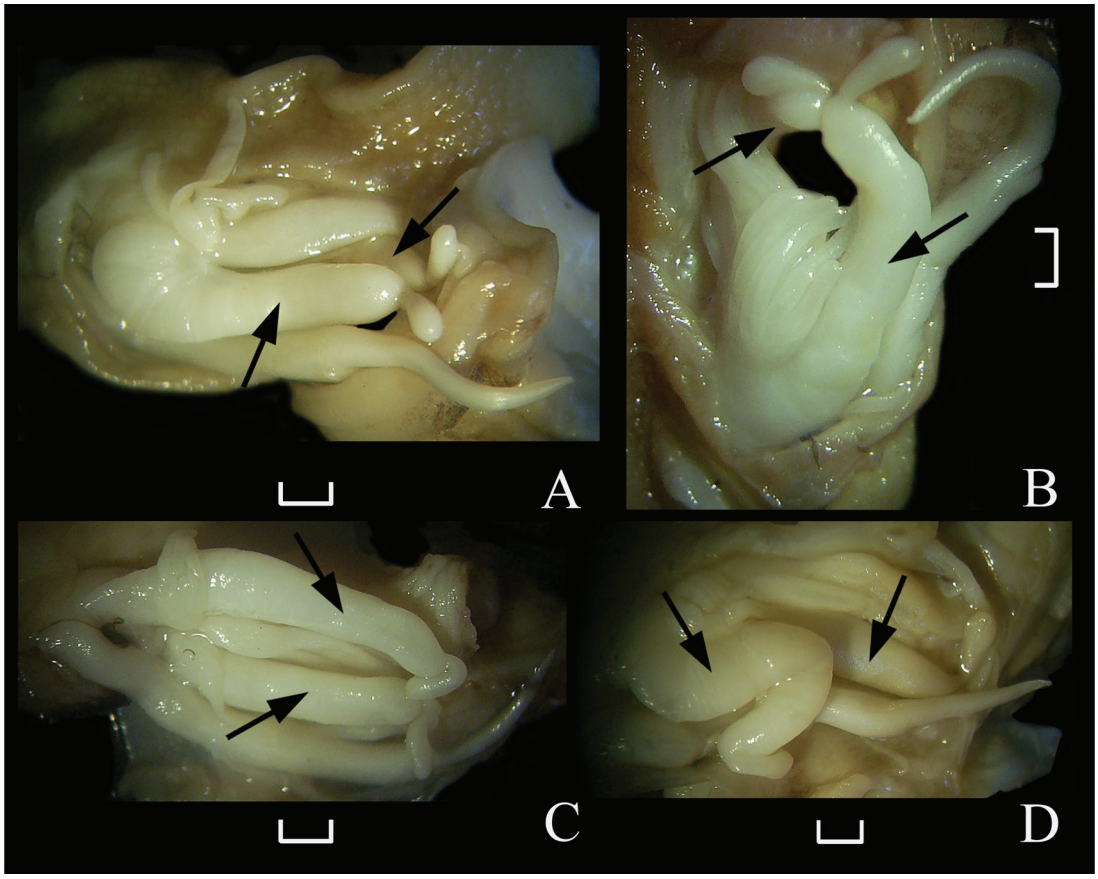

FIG. 3. Dissected specimens of *H. zangezurica* from different sites. **A.** Locus typicus (site 1). **B.** Between Srashen and Tsav (site 5). **C.** Tsav (site 6). **D.** Vaganavank (site 7). Arrows indicate vaginal appendages. Scale bars 1 mm.

РИС. 3. Вскрытые особи *H. zangezurica* с разных участков. **A.** Типовое местонахождение (участок № 1). **B.** Между Срашеном и Цавом (участок № 5). **C.** Цав (участок № 6). **D.** Ваганаванк (участок № 7). Стрелками показаны вагинальные придатки. Масштаб 1 мм.

in thickets of blackberries and other thorny shrubs. Usually it is possible to collect only empty shells, unsuitable for differentiation of *H. zangezurica* and *H. pisiformis*.

The ecology and life cycle of *H. zangezurica* also remain poorly understood. We observed adults at different seasons: in May (2016) and in September (2019). In September 2019, one egg-laying adult snail was found in the locus typicus of *H. zangezurica* (Fig. 5B). In September, immature individuals of different sizes were also found in different localities together with adults. The simultaneous presence of living specimens of different ages may indicate either that the breeding season of *H. zangezurica* is greatly extended in time, or that the life cycle of this species is more than one year.

At those sites where it was possible to anatomically confirm the presence of *H. zangezurica*, live molluscs most often stayed along forest edges, along roads, in thickets of blackberries (Fig. 5A). Even after rains, they did not rise on branches of bushes or tree trunks, but were usually under the fallen leaves. In more open and dry habitats, only empty shells have been found that could theoretically belong to both *H. zangezurica* and *H. pisiformis*.

A relatively small number of other land mollusc species (Table 1), common to the south of Armenia [Akramovsky, 1976; Gural-Sverlova *et al.,* 2017a], was collected together with *H. zangezurica.* The co-existence of *H. zangezurica* and *H. pisiformis* has not yet been recorded, although it is likely that this may be due to the difficulty of finding living individuals and the impossibility of reliable differentiation of the shells of these two species (see above).

Given the concealed lifestyle and the conchological similarity of *H. zangezurica* and *H. pisiformis*, the range of *H. zangezurica* may be much wider than is currently known. However, elucidation of its exact boundaries requires more extensive collecting and subsequent anatomical study of molluscs in southern Armenia.

The distribution of *H. pisiformis* in this area also needs to be clarified, since earlier the specimens of *H. zangezurica* could be mistaken for this species. Only limited number of anatomically verified findings of *H. pisiformis* in the Syunik region is known:

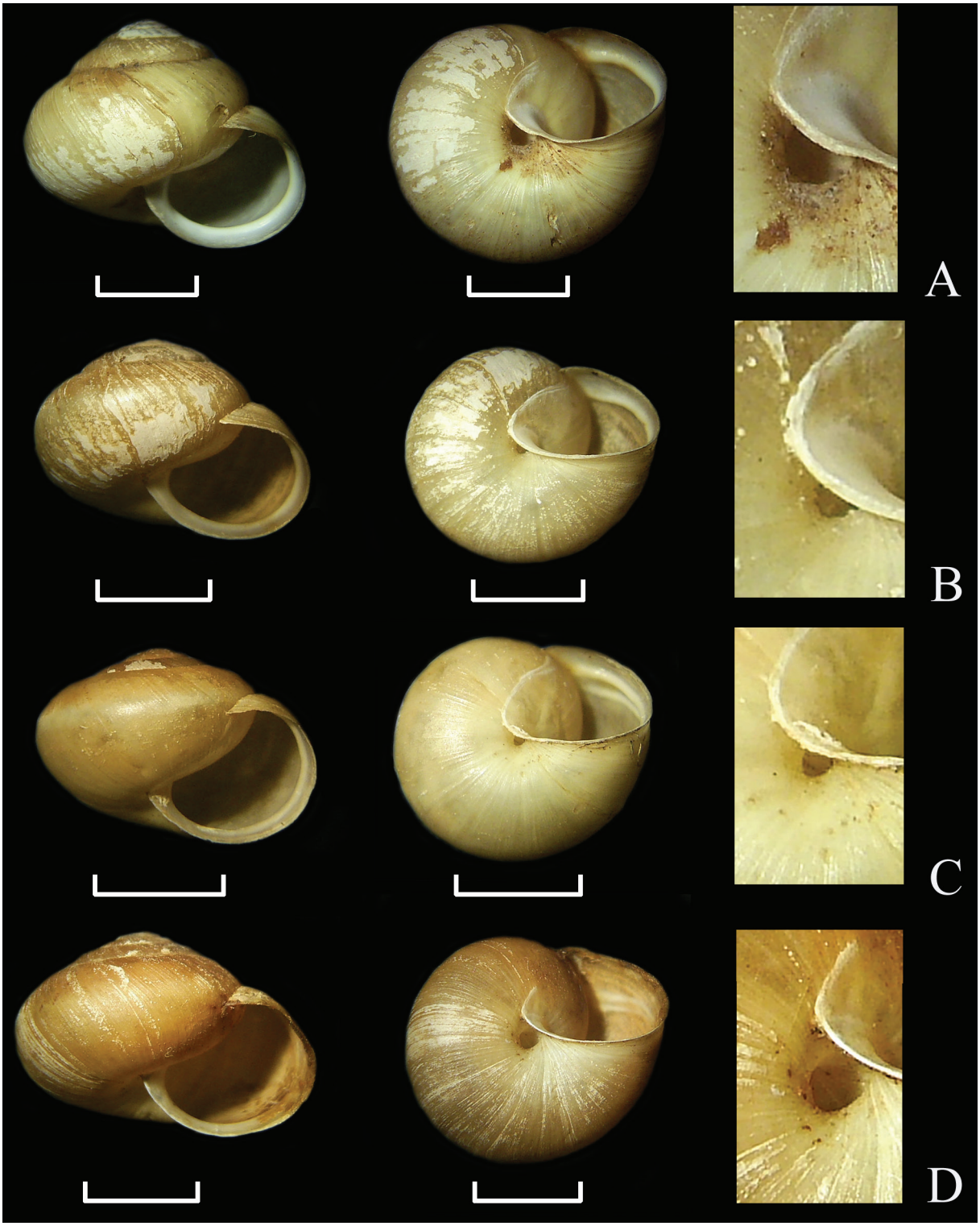

FIG. 4. The shells of anatomically verified specimens of *H. zangezurica* from different sites. **A.** Locus typicus (site 1). **B.** Shikahogh (site 2). **C.** Srashen (site 4). **D**. Vaganavank (site 7). Scale bars 5 mm.

РИС. 4. Раковины анатомически проверенных особей *H. zangezurica* с разных участков. **A.** Типовое местонахождение (участок № 1). **B.** Шикахох (участок № 2). **C.** Сраше́н (участок № 4). **D.** Ваганаванк (участок № 7). Масштаб 5 мм.

two specimens from the vicinity of Lichk collected in 1947 by N.N.Akramovsky and mentioned in the monograph of Schileyko [1978] and one individual collected by us near Harjis in May 2016 (39°29.06'N, 46°13.49'E).

Until now, *H. zangezurica* remains a little known cryptic species, the study of which is strongly hindered by its conchological similarity with *H. pisiformis* widespread in the Caucasus region. The studies carried out have confirmed a clear anatomical

FIG. 5. Habitat characteristic of *H. zangezurica* (**A**) and adult individual found during egg-laying (**B**). Both photos were taken at locus typicus.

РИС. 5. Местообитание, характерное для *H. zangezurica* (**A**), и половозрелая особь, обнаруженная во время откладки яиц (**B**). Обе фотографии сделаны в типовом местонахождении.

Table 1. Mollusc species found together with *H. zangezurica*

Таблица 1. Сопутствующие виды моллюсков, обнаруженные вместе с *H. zangezurica*

Species	Site numbers						
	1	2	3	4	5	6	7
Pomatias rivulare (Eichwald, 1829)	–	–	+	–	–	–	+
Sphyradium doliolum (Bruguière, 1792)	–	–	–	–	–	–	+
Scrobifera taurica (L.Pfeiffer, 1848)	+	–	–	–	–	–	–
Vitrea contortula (Krynicki, 1837)	–	–	–	–	–	–	+
Eopolita derbentina (O.Boettger, 1886)	+	–	–	–	–	–	+
Oxychilus subeffusus (O.Boettger, 1879)	–	–	–	–	–	+	+
Parmacella ibera Eichwald, 1841	–	–	–	–	–	–	+
Vitrina pellucida (O.F.Müller, 1774)	–	–	–	–	+	+	–
Gigantomilax brunneus (Simroth, 1901)	+	–	–	–	–	–	–
Helix lucorum Linnaeus, 1758	–	+	–	+	+	+	–
Xeropicta derbentina (Krynicki, 1836)	–	+	–	–	–	+	–

difference between these two species. However, in the future, for additional confirmation of the taxonomic independence of *H. zangezurica*, it would be desirable to carry out also comparative genetic study of *H. zangezurica* and *H. pisiformis*.

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