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ORIGINAL ARTICLE

CONCHOLOGICAL VARIABILITY OF TERRESTRIAL MOLLUSK *CHONDRULOPSINA FEDTSCHENKOI* (ANCEY, 1886) (GASTROPODA, PULMONATA, ENIDAE) FROM THE ZARAFSHAN RANGE, UZBEKISTAN

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ABSTRACT

The article presents the results of studying the conchological variability of the terrestrial mollusk *Chondrulopsina fedtschenkoi* (Ancey, 1886), known to occur in three regions of the Zaravshan Range (Central Asia): the Urgutsay Gorge, the vicinity of the Gissarak Reservoir and the Ingichka-Irmak Gorge. Conchological variability was determined based on statistical analysis. The climate of the three regions is different, and environmental factors have led to changes in the mollusk shell. The shells have changed in response to environmental factors, these are their adaptive traits for survival; the variability of conchological features is also reflected in the color of the shell, and the intensive development of the color of the shell in mollusks is an adaptive feature reflecting on the one hand, the adaptability of mollusks to any biotope, and on the other hand climatic and landscape conditions.

Keywords: *Chondrulopsina fedtschenkoi*, Conchological, Ecology, Shell, Variability, Zarafshan Range.

INTRODUCTION

In the malacofauna of Central Asia, in the literature encounter two groups of phenomena that correspond to the concept of "variability". First, it is conchological (phenotypic) variability, which reflects, to a greater or lesser extent, the adaptation of mollusks to specific conditions. Secondly, it is anatomical (genetic) variability, not directly related to external conditions (Schileyko, 1984). It should be noted that the nature of the variability of Central Asian terrestrial mollusks has been partially analyzed (Matyokin, 1959; Schileyko, 1984; Pazilov, 1990; Uvalieva, 1990; Schileyko and Rymzhanov, 2013; Snegin and Snegina, 2019; Pazilov and Umarov, 2020), however, the variability of conchological characters has been studied fragmentarily.

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A characteristic feature is the extreme diversity of microclimatic, soil, metrological, geochemical and plant conditions in the microlandscapes of the study region, which strongly affects the neighboring links of the genus of variability. For example, the same species *Ch. fedtschenkoi* living in two biotopes located close to each other, reflecting some factors well, may differ sharply in other characters (Pazilov, 1991). Therefore, in terrestrial mollusks in Central Asia, such a wide conchological variability is found that sometimes closely related species of the same genus were described as representatives of different genera. In connection with these, of undoubted interest is a comparative analysis of the conchological variability of terrestrial mollusks living in different populations (Schileyko, 1984; Pazilov and Azimov, 2003). *Chondrulopsina fedtschenkoi* was first introduced to Uzbekistan on the basis of specimens found in the Samarkand Region (Sysyoev and Schileyko, 2009).

The aim of this study was to investigate the interpopulation variability of quantitative and qualitative characteristics of the shell of the widespread terrestrial mollusk *Chondrulopsina fedtschenkoi* (Ancey, 1886) in Zarafshan Range.

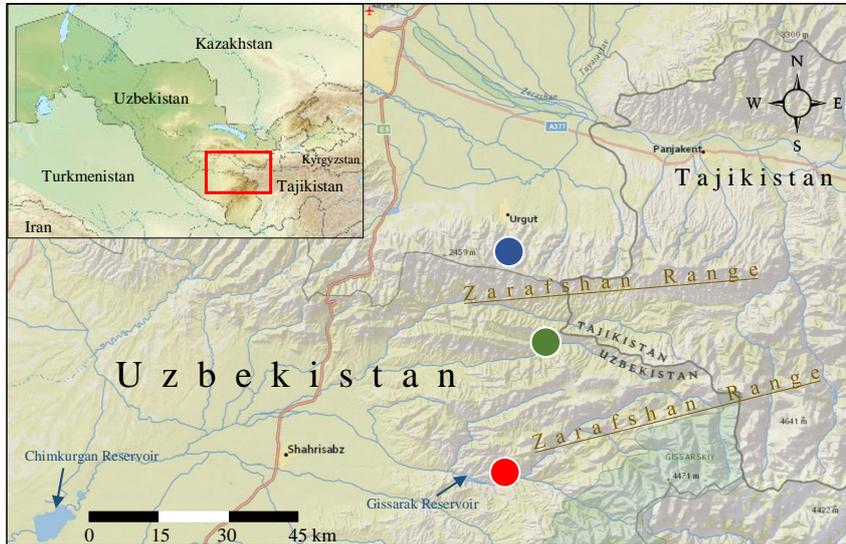
MATERIALS AND METHODS

The material for this work was collected (Map 1) on the Zarafshan Range, Urgutsoy Gorge (39°22'27.6"N 67°14'23.1"E), at an altitude of 1200–1300 m above sea level; the vicinity of the Gissarak Reservoir (39°01'58.3"N 67°13'17.7"E), at an altitude of 1500 m above sea level, and the Ingichka-Irmak Gorge (39°12'27.1"N 67°20'39.2"E), at an altitude of 1700–2000 m above sea level. A total of 750 individuals were collected. Materials were collected in May–June 2019; the reason is that mollusks are very active in mountainous areas in late spring and early summer. They can be easily found at this time.

The Pearce and Orstan (2006) method was used to collect land mollusks. Picking up mollusks in the morning is advisable, as they are active in the morning. They were collected mainly using tweezers. Collected materials are placed in special containers filled with water for 1 day. Then they will perish. The dead mollusks are stored in 45% ethyl alcohol for 4–5 days. They are then permanently stored in 75% ethyl alcohol. Anatomical studies can be performed on these materials.

Commonly accepted methods such as Schileyko (1984) and Pazilov and Azimov (2003) were used to identify molluscs up to the species level. That is, in determining the species of mollusk; the morphology of the shell was determined in the first stage and the reproductive organ in the second stage. To study the variability of conchological characters, 30 adult individuals were randomly selected from each specimen. Shell measurements were carried out according to Schileyko (1978, 1984). The following parameters were measured: shell height (SH), shell width (SW), aperture height (AH), aperture width (AW), height before last turnover (HLT).

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Map (1): Zarafshan Range, research area (Baratov *et al.*, 2002). Collection points for material: ● – Urgutsoy Gorge; ● – Ingichka-Irmak Gorge; ● – the vicinity of the Gissarak Reservoir.

During the statistical analysis of morphometric indicators for each local population, the following characteristics were calculated: arithmetic mean (\bar{X}), coefficient of variation (CV), and determinism (r^2). The methods of Terentiev and Rostova (1977); Rostova (1980) and Lakin (1990) were used for a comparative characterization of the general variability.

In order to identify the conchological variability of mollusks, the data obtained as a result of shell measurements were subjected to biometric processing and further processed using the SPSS Statistics 17.0 Microsoft Excel 7.0 application.

RESULTS AND DISCUSSION

Chondrulopsina fedtschenkoi (Ancey, 1886), Central Asian endemic species, which is locally distributed in the Fergana, Alai and Zarafshan ranges (Pazilov, 1991; Schileyko, 1984; Pazilov and Azimov, 2003).

Terrestrial mollusks are very fond of moisture, they live mainly in biotopes that are not very long in water bodies. Terrestrial mollusks move very slowly; Usually they live around a radius of 50-100 m during the season. For this reason, mollusks scattered in one gorge area cannot pass into the second gorge area. As a result, there is variability between them (Tissot, 1988; Kramarenko, 1993; Kramarenko and Popov, 1994; Pazilov *et al.*, 2014). Population variability of conchological traits of *Ch. fedtschenkoi* were studied from 3 populations of the Zarafshan Range (Urgutsoy Gorge - 39°22'27.6"N

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67°14'23.1"E; the vicinity of the Gissarak Reservoir - 39°01'58.3"N 67°13'17.7"E; Ingichka-Irmak Gorge - 39°12'27.1"N 67°20'39.2"E).

Population 1: Zarafshan Range, Urgutsoy Gorge, at an altitude of 1100–1300 m above sea level, on the stems of semishrubs (their lower part). Here there are mollusks with a cylindrical shell shape and moderately hard-walled. Whorls 7, well convex, separated by a fine suture, last whorl very slightly elevated towards aperture, always less than half height of shell, with dark brown color. Sculpture in the form of fine radial striation, mouth triangular, the places of its attachment are not close, connected by a very weak callus, on which a very weak parietal tooth; palatal tooth developed in the form of a tubercle (Pl. 1 A).

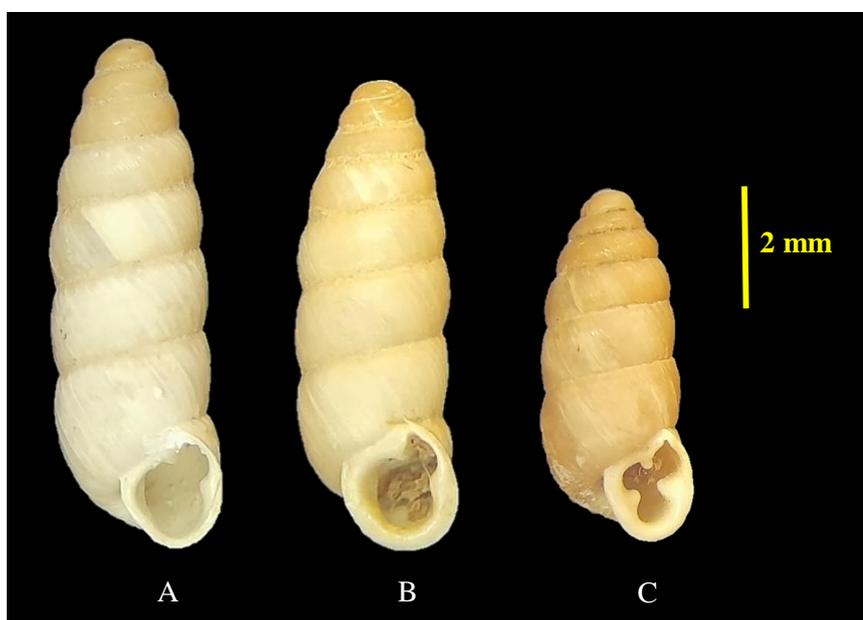


Plate (1): Variability of the shell of *Ch. fedtschenkoi*; (A) Zarafshan Range, Urgutsay Gorge; (B) Zarafshan Range, the vicinity of the Gissarak Reservoir; (C) Zarafshan Range, Ingichka-Irmak Gorge (Photo by F. U. Umarov).

Population 2: Zarafshan Range, environs of the Gissarak Reservoir, at an altitude of 1500 m above sea level, under stones, among shrubs, shell conical-cylindrical shape, hard-walled. Shell with 7 whorls and slightly convex and greyish-white color; sculpture consists of coarse radial wrinkles. Aperture oval: well-developed parietal and palatal teeth are located in the mouth, columellar teeth absent (Pl. 1 B).

Population 3: Zarafshan Range, Ingichka-Irmak Gorge, at an altitude of 1900-2500 m above sea level. Among shrubs and under stones, shells of mollusks cylindrical shape, moderately hard-walled. Whorls 7, not convex; coloration with dark brown. Sculpture in the form of a thin obscure radial striation. Aperture almost sheer, rounded-triangular, the

place of its attachment is well approximated and connected with the callus, on which a well-developed parietal tooth is located. Palatal tooth well developed than columellar one (Pl. 1 C). As can be seen from the above material, the variability of the characteristics of the shell of *Ch. fedtschenkoi* is more pronounced in color, the degree of development of elements of palatal teeth.

The variability of the shell color of terrestrial mollusks was discussed in their works by Matyokin (1959); Schileyko (1984); Uvalieva (1990) and Snegin and Snegina (2019).

According to Schileyko (1984), the development of color depends on the amount of solar energy. Long-term observations have established that the matter is not so much in the carbonate regime, however, in the amount of solar energy necessary to complete the life cycle. The following facts testify to this. In *Ch. fedtschenkoi* living in populations 1 (Urgutsoy Gorge) and 3 (Ingichka-Irmak Gorge) populations, color of shell dark brown, while in mollusks 2 (near the Gissarak Reservoir), it grayish-white.

Studies have shown that the color of the shell gradually changes from north (40°N) to south (38°N). Apparently, it depends on the time of sunshine. For example, where mollusks with dark brown shells living area, the annual number of sunshine is 2600 hours, and molluscs with grayish-white shells – 3000 hours. Thus, the more solar energy in nature, the more populations with light-colored shells. Regarding to Schileyko (1984) that the coloration from light strokes, radial motley on a dark background to absolutely white shells depends on the amount of solar energy (Matyokin, 1959; Uvalieva, 1990; Pazilov and Umarov, 2020).

Long-term observations have shown that wellhead fittings (teeth) change depending on environmental conditions. For example, in *Ch. fedtschenkoi* living in more humid conditions, where the average annual rainfall is 550-600 mm and the average monthly air temperature (April-May) is 16°C (Urgutsay Gorge), mouth teeth are very poorly developed. In the environs of the Gissarak Reservoir, where the average annual precipitation is only 300-400 mm and the average monthly air temperature (April-May) is 19.5°C, parietal teeth are poorly developed in mollusks, and palatal teeth are well developed. In mollusks living in the most arid conditions (Ingichka-Irmak Gorge), where the amount of precipitation is only 200-250 mm and the air temperature is 24-25°C, all the mouth teeth are developed to the maximum.

Based on the results, it was found that with an increase in air temperature and with a decrease in precipitation from north to south; mollusks develop intensively mouth teeth, which is very important in a dry and hot climate. According to Schileyko (1984), they serve to squeeze out mucus from the edge of the mantle and the glands of the leg, which is important for the formation of the epiphragm, which reduces the intensity of moisture evaporation from the body of the mollusk and contributes to the long-term habitation of the animal at high temperatures.

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It should be noted that in addition to the above (qualitative) variability in *Ch. fedtschenkoi*, the variability of morphometric characters was studied: shell height, shell width, aperture height, aperture width, height before last turnover, considered diagnostic and quantifiable. Variability of morphometric features of *Ch. fedtschenkoi* by population is as follows (Tab.1).

Table (1): Variability measurements of conchological features of *Ch. fedtschenkoi* by population (in mm)

Statistical indicators	SH	SW	AH	HLT
Population 1				
$\bar{X} \pm$	8.46 ± 0.14	3.68 ± 0.04	3.71 ± 0.10	3.71 ± 0.03
CV, %	3.3	2.13	6.13	1.12
r ²	0.045	0.043	0.01	0.01
Population 2				
$\bar{X} \pm$	7.76 ± 0.24	3.08 ± 0.04	2.39 ± 0.18	3.09 ± 0.07
CV, %	5.28	2.59	3.46	2.82
r ²	0.06	0.01	0.01	0.07
Population 3				
$\bar{X} \pm$	5.81 ± 0.08	2.11 ± 0.03	2.42 ± 0.03	3.12 ± 0.09
CV, %	1.45	2.23	2.86	4.11
r ²	0.34	0.04	0.2	0.28

The analysis of the tabular data showed that all the studied signs turned out to be slightly variable (1-6.31%). The variability of the studied traits was different, depending on the habitat of the mollusks. For example, in population 1, the most highly variable feature was the aperture height; the variability of this trait depends on external factors. Shell height and width can be called strongly deterministic features; their variability is consistent with other features (Diag. 1). The height of the before last turnover turned out to be the most weakly variable and weakly deterministic character.

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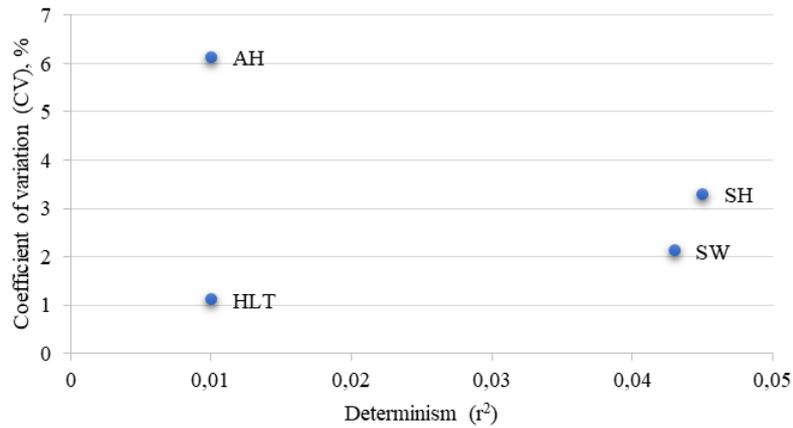


Diagram (1): Variability (CV, %) and determinism (r^2) of traits of terrestrial mollusks of 1 population.

In the population 2, variability and determinism of signs have changed compared to population 1. Here in Diagram (2), the shell width to be a weakly variable and weakly deterministic feature; aperture height very variable.

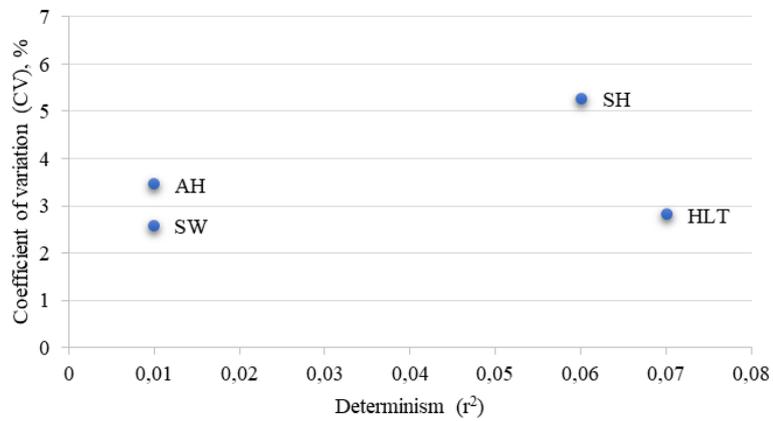


Diagram (2): Variability (CV, %) and determinism (r^2) features of terrestrial mollusks 2 populations.

In population 3 (Diag. 3), among the studied characters, the height of the penultimate whorls of the shell can be called relatively strongly deterministic characters. The variability of this trait depended on external factors. Mollusks were mainly affected by moisture and temperature factors.

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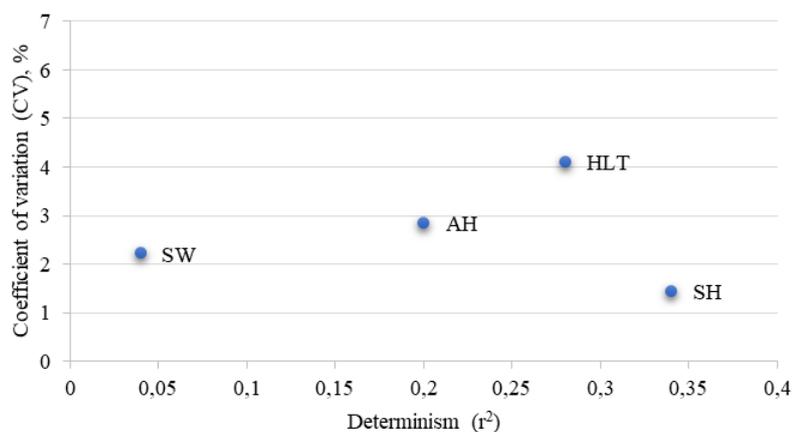


Diagram (3): Variability (CV, %) and determinism (r^2) of traits of terrestrial mollusks in 3 populations.

CONCLUSIONS

As a result of statistical data processing, it can be said that the nature of the variability and consistency of traits depended on external climatic factors, as well as the genotypic features of the objects. In each biotope, the studied characters differed in the degree of variability and consistency with others. For all biotypes, the height of the apertures can be called a relatively highly variable feature. The height of the shell turned out to be a relatively strongly deterministic feature; their variability is consistent with other features.

CONFLICT OF INTEREST STATEMENT

We declare that there is no conflict of interest between the authors. We confirm that all the pictures in the manuscript belong to us. We note in this study that there is no conflict of interest regarding the use of the Gulistan State University laboratory.

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التباين الصدفي لنوع القواقع الارضية
Chondrulopsina fedtschenkoi (Ancey, 1886)
(Gastropoda, Pulmonata, Enidae)
من سلسلة زرافشان ، أوزبكستان

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الخلاصة

يعرض هذا البحث نتائج دراسة التباين لنوع الرخويات الأرضية *Chondrulopsina fedtschenkoi* (Ancey, 1886) المعروف أنه يحدث في ثلاث مناطق من سلسلة جبال زرافشان (آسيا الوسطى): مضيق أورغوتساي، المنطقة المجاورة لخزان جيساراك وإنجيشكا - إيرماك جورج. تم تحديد التباين بناءً على التحليل الإحصائي. يختلف المناخ في المناطق الثلاث، وقد أدت العوامل البيئية إلى تغيرات في الصدفة استجابة للعوامل البيئية، التي تعد من سماتها التكيفية للبقاء على قيد الحياة. كذلك ان التباين في الصفات المظهرية يعكس لون القشرة، كما أن التطور الشديد للون الصدفة في الرخويات يعكس ميزة تكيفية، من ناحية انه يعكس قدرة الرخويات على التكيف مع أي بيئة حيوية، و من ناحية أخرى، يعكس الظروف المناخية والمناظر الطبيعية.