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First Record of the Rare Gastropod *Episcomitra zonata* (Marryat, 1819) (Mollusca: Gastropoda: Mitridae) in Montenegro (South Adriatic Sea)

***Slavica Petović*[1,*] *& Nikola Đorđević*[1]**

[1]Institute of Marine Biology, University of Montenegro, Put I Bokeljske brigade 68, 85330; E-mail: kascelanslavica@gmail.com
[1]Institute of Marine Biology, University of Montenegro, Put I Bokeljske brigade 68, 85330; E-mail: djordjevic.r.nikola@gmail.com

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Abstract: This paper presents the first documented record of the rare gastropod *Episcomitra zonata* (Marryat, 1819) in the Montenegrin part of the Southern Adriatic Sea. Over the period 2021–2024, five shells were collected and their morphological and biometric characteristics were analysed. The analysis of biometric parameters showed that the shell height ranged from a maximum of 87.2 mm to a minimum of 69.9 mm, while the width ranged from 16.2 mm to 20.0 mm. The findings fill a significant gap in the literature, as no previous data existed on the presence, distribution or biometric parameters of *E. zonata* in this region. By providing new baseline data, this study contributes important knowledge for the conservation and management of this endangered Mediterranean species.

Key words: Adriatic Sea, *Episcomitra zonata*, gastropod, molluscs, Montenegro

Introduction

Episcomitra zonata (Marryat, 1819), commonly known as the zoned mitre, is a marine gastropod mollusc in the family Mitridae, well differentiated from the other extant congeneric species [*Episcomitra angelesae* Caballero-Herrera, Gofas & Rueda, 2022 and *Episcomitra cornicula* (Linnaeus, 1758)] due to its larger size (Katsanevakis et al. 2008). The zoned mitre can be found from the lower limit of the intertidal zone to the shelf edge. In the Northern Adriatic it can be found even up to 30 m deep, as well as between 50-70 m where *Peyssonnelia polymorpha* is present (Parenzan 1970). It prefers sandy or muddy bottoms in deep waters, as well as coralligenous habitats.

Episcomitra zonata has an elongated and slender shell that ranges in length from 55 to 100 mm. Most often surface light brown with a dark stripe; last whorl closest to the aperture bordered by a darker-coloured band. Unlike the exterior, the inside of the aperture is always white or orange and features four folds (Alf & Haszprunar 2015).

This quite rare and endangered marine species in the Mediterranean Sea has also been found off the coast of the Azores. Reporting distribution of the *E. zonata*, Vatova (1943) stated that the species was firstly described by Marryat in 1817 based on a

*Corresponding author: kascelanslavica@gmail.com

specimen from Nice (France). Stossich (1880) considered it one of the greatest malacological rarities of the Adriatic, while Bellini (1929) referred to it as a jewel of Mediterranean malacology. Furthermore, data indicate its presence along the Italian, Spanish and African coast of the Mediterranean Sea, while in the Adriatic Sea, it was first collected at the locality Lesina in 1875 and the species was also listed in Split in the same year (Vatova, 1943). Parenzan (1970) stated that a biocenosis characterised by the presence of *E. zonata* has developed on the seabed of the Sea of Porto Cesareo. This rare Mediterranean species is reported to occur in a few localities of the Eastern Atlantic Ocean (e.g. the Canary Islands, the Azores, Madeira, Angola). In Hellenic seas, it has been reported in the Saronikos and Evvoikos Gulfs, Chalkidiki, Kymi (Evvoia), the Ionian Sea and the North Sporades Islands (Katsanevakis et al. 2008, Manousis 2023). Along the Italian coast, it is recorded in the Ligurian Sea, Tyrrhenian Sea, Messina Strait, Eastern Mediterranean Basin, Ionian Sea and Southern Adriatic Sea (Renda et al. 2022). Documented data on the presence of the species can also be found for the area of Cyprus (Manousis & Kolokotronis 2024). Öztürk et al. (2024) do not mention *E. zonata* among the 1133 recorded species in their paper on diversity of Mollusca along the coasts of Türkiye. The presence of *E. zonata* along the Montenegrin coast has never been previously documented: despite extensive malacological research in Montenegro over the past five decades (Stjepčević 1967, Karaman & Gamulin-Brida 1970, Stjepčević & Parenzan 1982, Petović et al. 2017, Petović et al. 2021) there has been a complete lack of records for this species in the area.

Due to its rarity it is mentioned in the following international legal instruments and agreements: Bern Convention (Annex II: strictly protected fauna species)(Council of Europe 1979) and SPA/BD Protocol (Annex II: Endangered or threatened species that the Parties shall manage with the aim of maintaining them in a favourable state of conservation) (UNEP/MAP-SPA/RAC 2018). These agreements require the maximum possible protection and recovery of the species.

The aim of this study is to provide the first evidence of *E. zonata* in the Montenegrin Adriatic, accompanied by detailed morphological and biometric analysis of collected shells. By doing so, the research addresses a critical knowledge gap and offers new data that are vital for understanding the species' distribution, ecology and conservation status in the region.

Materials and Methods

Five shells of dead individuals were collected between 2021 and 2024 along the Montenegrin coast, at different locations (Fig. 1). Four were collected sporadically during diving activities using scuba diving equipment, while one individual was obtained using gillnet at the Mogren site.

The depths ranged from 10 to 30 m and the shells were found on the fine sandy bottom (Jaz, Mogren), coarse gravel and stones (Cape Trašte), as well as in areas with meadows of *Posidonia* (Cape Ratac) (Table 1).

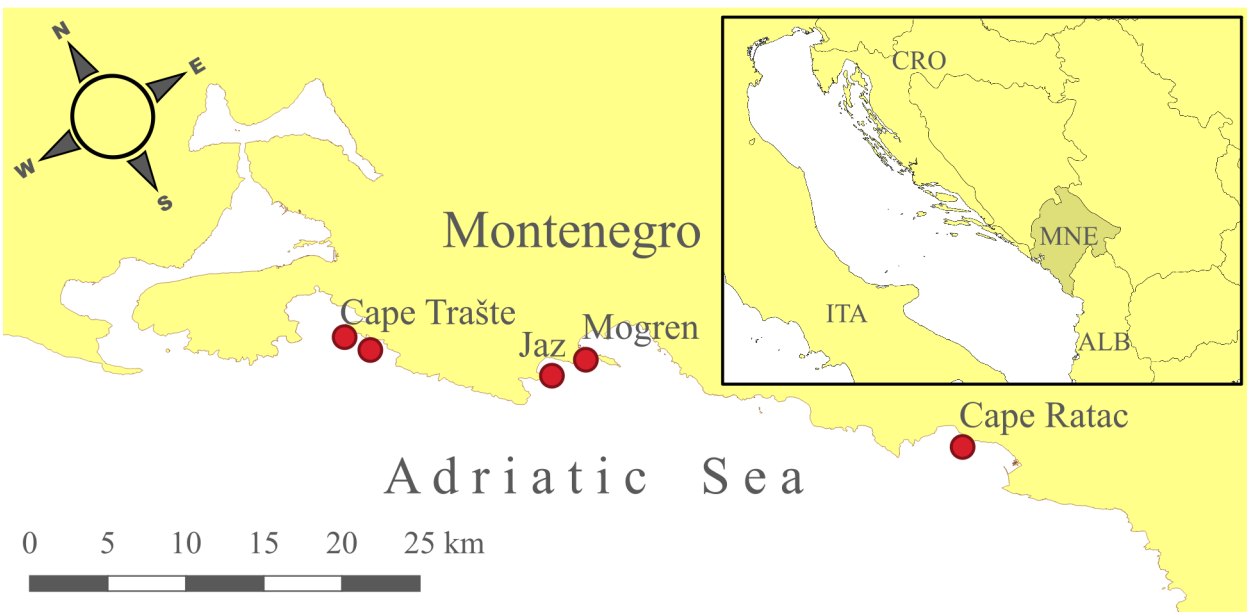

Fig. 1. Map with indicated localities where the specimens of *Episcomitra zonata* were collected (red dots).

Table 1. Data on locations where specimen of *Episcomitra zonata* were collected (depth, substrate, year of collecting, sampling methods).

	Location	Depth (m)	Substrate	Year	Sampling method
1.	Cape Trašte	10-11	coarse gravel-stones	2021	SCUBA diving
2.	Cape Trašte	10-11	coarse gravel-stones	2021	SCUBA diving
3.	Jaz	22	fine sand	2024	SCUBA diving
4.	Mogren	30	sandy	2024	Gillnet
5.	Cape Ratac	20	Meadow of *Posidonia*	2023	SCUBA diving

The collected materials were measured using an electronic digital calliper (with a precision of 0.01 mm). To better understand the morphology of the shell, the following characteristics were measured: aperture length (ML), height (H), width (W), body whorl (BW) and spire (S) (Fig. 2).

The shells were photographed using a Sony α6400 mirrorless digital camera with a 16-50mm lens, taking a series of photographs which were assembled using Adobe Photoshop CS6 software.

Regarding taxonomy, it follows the classification of the World Register of Marine Species (WoRMS) (https://www.marinespecies.org/).

The collected material is part of the collection of the Institute of Marine Biology, University of Montenegro in Kotor.

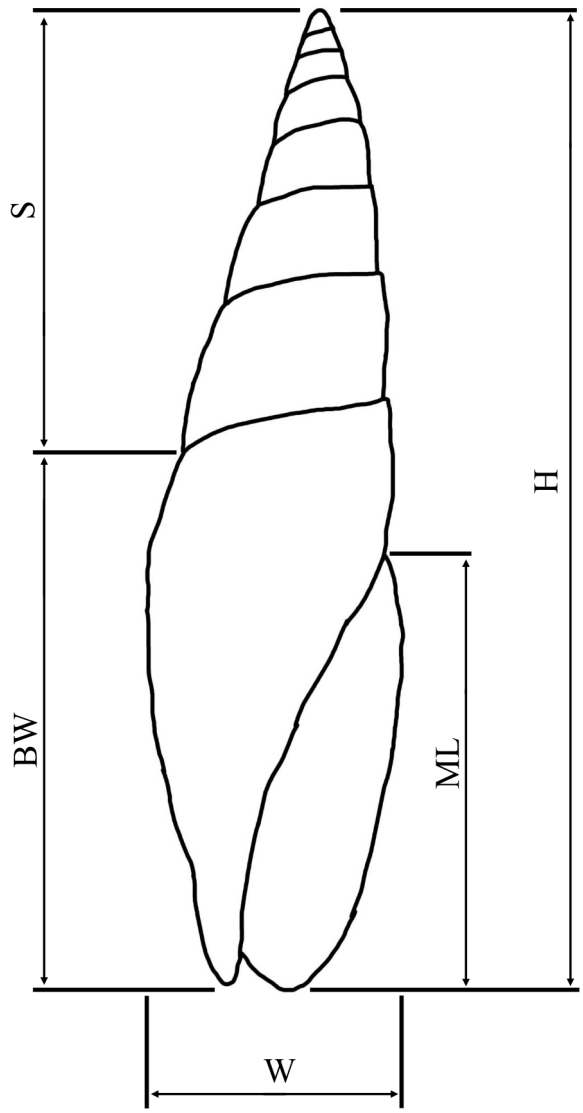

Fig. 2. Scheme of *Episcomitra zonata:* aperture length (ML), height (H), width (W), body whorl (BW) and spires (S).

Results

Taxonomy
Phylum Mollusca
Class Gastropoda Cuvier, 1795
Subclass Caenogastropoda Cox, 1960
Order Neogastropoda Wenz, 1938
Superfamily Mitroidea Swainson, 1831
Family Mitridae Swainson, 1831
Subfamily Mitrinae Swainson, 1831
Genus *Episcomitra* Monterosato, 1917

Episcomitra zonata (Marryat, 1819)

Five empty shells of the rare gastropod *E. zonata* were collected along the Montenegrin coast in the period between 2021 and 2024. In 2024, one specimen was collected at the Jaz site using scuba diving equipment at a depth of 22 m (Fig. 3A), from the sediment composed of fine sand and fragments of broken shells. The shell is coloured with dark brown and light yellowish-brown marble bands. Since the shell is quite well preserved, i.e. with no limestone deposits, it can be inferred that the snail remained alive until relatively recently. During fishing activities in October 2024, one shell of *E. zonata* was collected at the Mogren site using a gillnet (Fig. 3B) from the depth of about 30 m. The shell is dark brown with light stripes, appearing more yellowish on the dorsal side and more brownish-yellow marble on the ventral side. Like the previously described specimen, this shell is without limestone deposits. Two shells of *E. zonata* were collected at the Cape Trašte site from sediment composed of coarse grav-

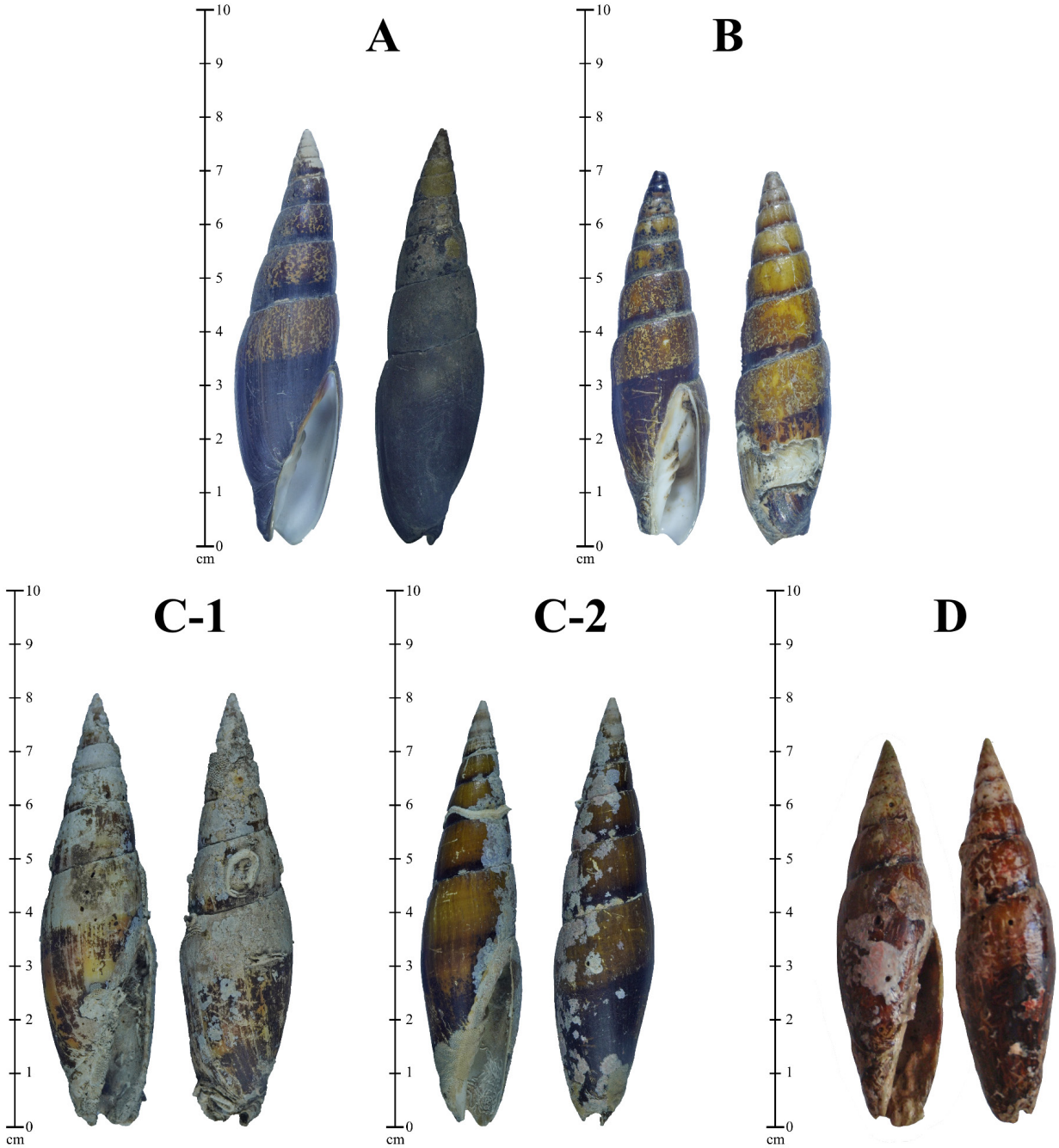

Fig. 3. Photos of the five collected specimens of *Episcomitra zonata*.

Table 2. Biometric parameters of the collected specimens of *Episcomitra zonata* (mm).

Specimen	Height (H)	Body whorl (BW)	Spire (S)	Aperture length (ML)	Width (W)	Number of whorls	W/H
A	78.3	41.6	36.6	34.8	19.8	9	0.25
B	69.9	38.8	31.0	27.2	16.2	9	0.23
C1	87.2	49.8	37.7	36.1	18.8	9	0.22
C2	81.0	48.3	34.4	36.6	20.0	9	0.25
D	71.2	42.7	27.8	32.2	18.3	9	0.26

el and stones (Fig. C-1, C-2). Although the shells have the colouring typical of *E. zonata*, the colour bands are rather weak due to evident limestone deposits. This indicates that living organisms died relatively long ago. Furthermore, during a survey of meadows of *Posidonia* near Cape Ratac, one empty shell was collected from a depth of 20 m (Fig. 3 D). The typical dark-light banding pattern is still visible, although the colour intensity is weak due to the presence of limestone deposits.

The analysis of biometric parameters showed that the shell height ranged from the maximum measured 87.2 mm (shell from Cape Trašte-C1) to the minimum 69.9 mm (shell from Mogren B) (Tab. 2). The width ranged from 16.2 mm (shell from Mogren B) to 20.0 mm (shell from Cape Trašte C2).

Discussion

The collected shells exhibited the morphological characteristics consistent with the literature description of *E. zonata* (Fedosov et al. 2018) in terms of length (69.9-87.2 mm) and shape (fusiform or elongate-fusiform, smooth, with well-developed periostracum). Spire tall or rather low, suture impressed. Spire whorls evenly convex in outline; sculpture represented by fine, dense, collabral lines. Last adult whorl typically evenly convex with a rather short siphonal canal bearing a distinct fasciole, separated from shell base by a deep groove. Inner aperture lip with four fine, subequal columellar folds. Shell covered with light brown to dark brown or olive-green periostracum with uniform or with multiple dark freckles. Adapical two-thirds of spire whorls typically lighter than their abapical portions. Inside of aperture white.

Body whorl (BW) of all collected specimens longer than the spire (S). This agrees with the data obtained through comparative analysis of specimens collected from Piran, Ancona and Malaga (De Min et al. 2006). Furthermore, with regard to the length of the aperture opening (ML) the samples from Jaz (A), Mogren (B) and Cape Trašte (C1) correspond to the material collected from Piran and Malaga, where the aperture opening is longer than the spire (S). In contrast, the shells collected from Cape Trašte (C2) and Cape Ratac (D) had a shorter aperture opening (ML) compared to the spire (S), similar to the sample from Ancona.

The data obtained for the W/H ratio show that the values range from 0.22 to 0.26. Analysing the L/W ratio, De Min et al. (2006) conclude that the species exhibits sexual dimorphism with males being larger, elongated and narrower, while females are relatively shorter and wider. Following the method in which all specimens with a W/H ratio ≤ 0.28 are considered males and values W/H ≥ 0.28 are females, De Min et al. (2006), point out that this method of calculation cannot be widely applied. If this principle is applied to the shells collected from Montenegro, the calculated mean value is 0.24, resulting in two males and three females. However, we must be cautious, as this is a very small sample size for such conclusions to be valid. Additionally, the habitat should be considered, as it plays an important role in the development of gastropods.

Analysing the impact of climate change on the Mediterranean marine molluscs of conservation concern, Schultz et al. (2024) concluded that projected range loss in the Mediterranean Sea is more pronounced for Mediterranean (sub)endemic species than for species occurring over larger areas outside the basin. Furthermore, three of the four Mediterranean species, namely *Patella ferruginea*, *E. zonata and Pinna nobilis*, are predicted to go extinct in the basin by the end of the century. The same authors report that *E. zonata* currently finds suitable conditions in the Western and Central Mediterranean but will restrict its range to the Gulf of Lion and the Alboran Sea already by the mid-21st century and it is predicted to go extinct in the Mediterranean by the end of the century, under the most severe climate change scenario.

Apart from the threats posed by climate change, this species is under pressure of shell collectors, owing to the stunning contrast of its beautiful colours and rarity (Katsanevakis et al. 2008). It has been used for making necklaces even in the Neolithic era (Micheli 2004).

Conclusion

This study represents a significant contribution to Adriatic malacology by documenting, for the first time, the occurrence of *E. zonata* in Montenegrin waters. The morphological and biometric data obtained are consistent with the literature from other Mediterranean localities, confirming the identification and expanding the known range of this rare species. Since the limited data on distribution, ecology and biometric characteristics available in the literature, these data will contribute significantly to filling the gaps. Given the species' endangered status and the threats it faces from climate change and collection, these findings provide a crucial foundation for future conservation efforts and highlight the importance of continued monitoring and protection of *E. zonata* in the Adriatic Sea.

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