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MORPHOLOGICAL VARIABILITY AND TAXONOMIC STATUS OF THE HEDGEHOG (*ERINACEUS*) IN THE REPUBLIC OF MOLDOVA

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Key words

Erinaceus roumanicus, cranial morphology, naso-maxillary suture, Republic of Moldova

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Abstract

The hedgehog is a common and widespread species in the Republic of Moldova. In the studies from the past century and even in more recent papers, the hedgehog was considered to be the species *Erinaceus europaeus*. The aim of this study was to establish the taxonomic status of hedgehog in the Republic of Moldova based on external and cranial morphology and to confirm the occurrence of the species *E. roumanicus* in the territory of the country. The material was collected in 2010–2024 all over the territory of the Republic of Moldova, and hedgehogs were registered in over 120 locations. In 36 individuals, external biometric measurements were taken and 42 skulls were examined by using 15 linear measurements of the skull. In collected individuals the white spot had more or less symmetric or asymmetric shape and had various forms and dimensions. The external biometric measurements of *E. roumanicus* individuals from the Republic of Moldova showed wider limits of all the characters in comparison to previous data, fitting to those indicated for Central Europe. The skull is quite massive and changes significantly with age. The mandibular foramen is shifted towards the lower end of the mandible, and the articular condyle has the shape of an elongated drop. The mandibular coronary process is high and heavily curved, and there is a well-pronounced recess between the angular process and the horizontal ramus of the mandible. The cranial parameters vary within a low range thorough the territory of Moldova. The values of nasal, maxillary, and mandibular indexes vary slightly with low value of variation coefficient. The nasal index values, the shape of the mandibular bones, and the location of foramena exclude completely the occurrence of the species *E. europaeus* in the territory of the Republic of Moldova. The length of the naso-maxillary suture varies between 3.74–6.39 mm, which is particular for the morphotype *roumanicus*, while in the *concolor* morphotype this suture is very short or even absent. Thus, according to shape and size of the ventral white spot, morphology of the mandible, the nasal, maxillary and mandibular indexes, as well as the length of the naso-maxillary suture, the territory of the Republic of Moldova is inhabited by the species *E. roumanicus*.

Cite as

Nistreanu, V. 2026. Morphological variability and taxonomic status of the hedgehog (*Erinaceus*) in the Republic of Moldova. *Theriologia Ukrainica*, **31**: 77–85. [English, with Ukrainian summary]

Морфологічна мінливість і таксономічний статус їжака (*Erinaceus*) у Республіці Молдова

Вікторія Ністреану

Резюме. Їжак є звичайним і широко розповсюдженим видом у Республіці Молдова. У дослідженнях XX ст. і більш пізніх працях їжаки розглядали як вид *Erinaceus europaeus*. Метою дослідження є встановлення таксономічного статусу їжаків в Республіці Молдова на основі зовнішньої і черепної морфології з метою обгрунтування їх належності до виду *E. roumanicus*. Матеріал зібрано у 2010–2024 рр. на всій території республіки, їжаків зареєстровано у понад 120 локаціях. Для 36 особин проведено зовнішні біометричні вимірювання, а 42 черепи досліджено за допомогою 15 лінійних вимірювань. У зібраних особин біла пляма мала більш-менш симетричну або асиметричну форму та різні форми й розміри. Зовнішні біометричні виміри особин *E. roumanicus* показали ширші межі всіх ознак порівняно з попередніми даними, що відповідає показникам для Центральної Європи. Череп масивний і значно змінюється з віком. Нижньощелепний отвір зміщений до нижнього кінця нижньої щелепи, а суглобовий виріст має форму видовженої краплі. Нижньощелепний вінцевий відросток високий і сильно вигнутий, а між кутовим відростком і горизонтальною гілкою нижньої щелепи є добре виражена западина. Параметри черепа варіюються в малому діапазоні на всій території Молдови. Значення носового, верхньощелепного та нижньощелепного індексів дещо варіюються з низьким значенням коефіцієнта варіації. Значення носового індексу, форма нижньощелепних кісток і розташування отворів повністю виключають наявність виду *E. europaeus* на території Республіки Молдова. Довжина носо-верхньощелепного шва коливається в межах 3,74–6,39 мм, що є характерним для морфотипу *roumanicus*, тоді як у морфотипу *concolor* цей шов дуже короткий або навіть відсутній. Таким чином, за формою та розміром вентральної білої плями, морфологією нижньої щелепи, носовим, верхньощелепним та нижньощелепним індексами, а також довжиною носо-верхньощелепного шва територія Республіки Молдова заселена видом *E. roumanicus*.

Ключові слова: *Erinaceus roumanicus*, морфологія черепа, носо-щелепний шов, Республіка Молдова.

Introduction

In the territory of the Republic of Moldova, the hedgehog is a common widespread species. In previous studies from the past century, the hedgehog from the territory of the Republic of Moldova was considered to be the species *Erinaceus europaeus* [Gassovskii 1952; Saenko 1959; Kuchuc 1969; Lozan & Scramtai 1972; Averin *et al.* 1979; 1984 etc.]. The first and only paper dedicated exclusively to insectivoran species was published in 1975, where data gathered during 15 years (1957–1972) were presented [Lozan 1975]. In the paper, there are data on palaeozoology, morphology, taxonomy, some biological and ecological features of eight insectivoran species, including *E. europaeus* L. It is mentioned that hedgehogs from Moldova belong to the subspecies *E. europaeus roumanicus* Barr.-Ham., widely spread in the southern part of the European USSR.

In the 1990s, the species used to be identified as *E. concolor* [Mihailenko 1996, 1997; Mihailenko *et al.* 1992]. Nevertheless, since there were no special studies dedicated to the hedgehog, in subsequent papers other researchers did not mention the species as one occurring in Moldova and the hedgehog was still considered as *E. europaeus* [Munteanu & Lozanu 2004; Munteanu 2005; Postolache *et al.* 2012 etc.]. Since 2010, new data on species occurrence, distribution, and morphology have been collected and the presence of *E. concolor* in the territory of the republic has been mentioned in several papers [Munteanu *et al.* 2013; Sochircă *et al.* 2013; Nistreanu *et al.* 2015; 2016 etc.]. The intense studies of insectivoran species from the last years and preliminary analysis of skull morphology allows to state the presence of *E. roumanicus* in the territory of Moldova [Nistreanu 2019; Nistreanu & Larion 2022; Nistreanu *et al.* 2020; 2022; 2023 etc.].

In Europe, the eastern hedgehog was considered for many years as subspecies of *Erinaceus europaeus* [Barret-Hamilton, 1900; Gromov *et al.* 1963; Ellerman & Morrison-Scott 1966; Vasiliu & Sova 1968 etc.], although in 1912 Miller proposed the name of *Erinaceus roumanicus* for the eastern hedgehog, it being distinct from the western species [Miller 1912].

As a basis for differentiation between western and eastern hedgehogs was the clear shape and position variation of the maxillary and nasal bones, the maxillary, parietal and nasal indexes [Rodl 1966]. In the same period, it was proved that the ranges of the two species partially overlap in Central Europe [Kratochvil 1966]. Thus, the eastern hedgehog was recognised as a species under the name of *E. concolor* Martin, 1838. Since then, many authors found constant differences in skull structure and colouration of the ventral fur, the level of which proves the species-specific features of the western hedgehog [Wolff 1976; Skoudlin 1978; Krystufek 1983; Zaitsev 1982, 1984; Zagorodniuk & Mishta 1995 etc.]. The karyological studies confirmed the species rank of *E. concolor* according to differences in the shape of some autosome's localisation and some differences in heterochromatin [Kral 1967; Markov & Dobrijanov 1974; Giagia & Ondrias 1980; Sokolov *et al.* 1991; Gavlila *et al.* 1998].

The study of cranial variability in the eastern hedgehog demonstrated the existence of two distinct geographical morphotypes—*concolor* and *roumanicus*—thus confirming the existence of two distinct species with parapatric distribution [Krystufek & Vohralik 2001; Krystufek 2002]. The results obtained by molecular-genetic methods showed a deep divergence between the western and eastern clades of *E. concolor* and confirmed the validity of the taxon *E. concolor roumanicus* as a separate species in Central and Southern Europe [Bannikova *et al.* 2003; Arslan *et al.* 2008; Bogdanov et al. 2009; Bolfíková & Hulva 2012].

The aim of the paper is to establish the taxonomic status of hedgehogs in the Republic of Moldova according to external and cranial morphology in order to determine the exact species and to confirm the occurrence of *E. roumanicus* all over the territory of Moldova.

Material and Methods

The material was collected in 2010–2024 all over the territory of the Republic of Moldova (Fig. 1). The collected animals were measured and weighed, and their sex and age were determined. The age of live individuals was determined based on body weight and presence of growing spines. In dead individuals, the condylobasal and mandibular lengths, as well as tooth wear were used.

The following body measurements were taken: body length—from the tip of the nose to the anal orifice; tail length—from the anal orifice to the end of the last vertebra; hind foot length—from the tip of the heel to the tip of the longest toe, without the nail. The variability of ventral fur colouration was registered; the white spot was measured. For morphological craniometric investigations dead animals were collected, mostly roadkill. Hedgehogs from over 120 locations were registered and 42 skulls were examined. The taxonomic status was assessed according to cranial morphology [Wolf 1976; Pucek 1981; Zaitsev 1982, 1984; Krystufek 2002]. In the study, 15 linear measurements of the skull were used, taken with an electronic calliper (Fig. 2):

CBL—condylobasal length, UTR—upper tooth row length, RL—rostrum length, ZB—zygomatic breadth, IoC—interobital constriction, OD—orbital diameter, BcB—braincase breadth, BcH—braincase height, RBa—rostrum breadth in anterior part, RBp—rostrum breadth in posterior part, NMS—naso-maxillary suture length, ML—mandible length, MTR—mandibular tooth row length, CH—coronoid height, and MRH—height of mandibular ramus.

Fig. 1. Collecting points of *Erinaceus roumanicus* in the territory of the Republic of Moldova.

Рис. 1. Місця знаходження *Erinaceus roumanicus* на території Республіки Молдова.

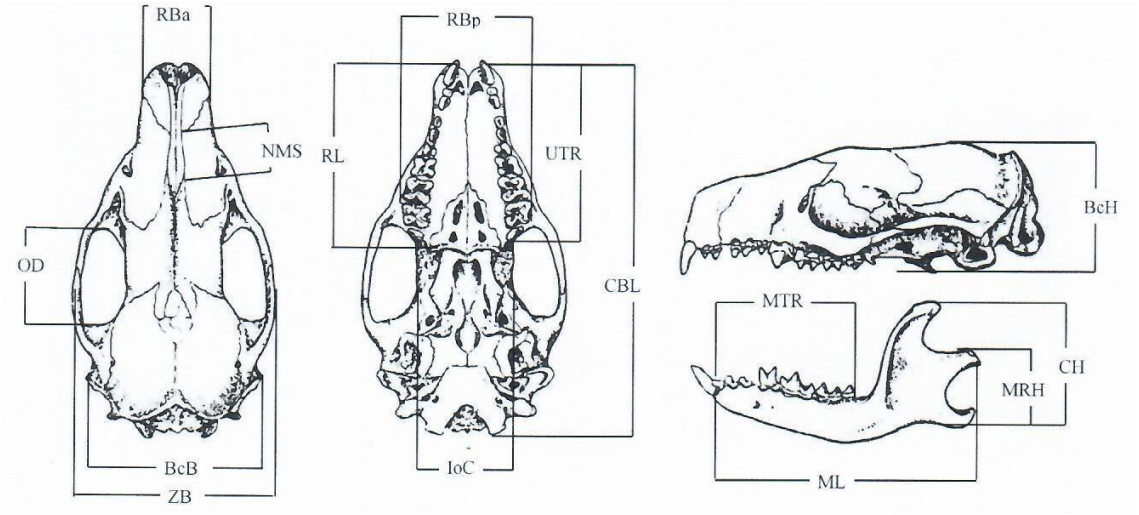

Fig. 2. Cranial parameters of studied hedgehog individuals.
Рис. 2. Параметри черепа досліджуваних особин їжаків.

Only adult individuals were taken for study, both males and females, because the differences between sexes are not significant. The following indexes were calculated [Zaitsev 1982]: nasal index NI (length of nasal bones to their minimal width), maxillary-nasal index MNI (length of maxillo-premaxillary suture to length of nasal bones), mandibular index MI (length from the posterior margin of M_3 alveola up to recess between angular and condyloid processes to length of posterior margin of M_3 alveola up to the end of angular process). For each parameter the following values were calculated: mean, minimum, maximum, standard deviation, standard error, and variance.

Results and Discussion

The northern white-breasted hedgehog *Erinaceus roumanicus* inhabits the territory of the Republic of Moldova. It has a robust body, rather large, without a clear boundary between the head and the trunk. The head is not too large and ends with a short and narrow snout. The ears are short and rounded, covered with bristles. The legs are short and plantigrade, with 5 fingers with long claws; the anterior limbs are longer than the hind legs. The muzzle is light-brown, with black tip, with nostrils straight ahead and separated by a trench. The dorsal and lateral body sides are covered with long spines of about 3 cm, which have an alternating colour of dark and light shades with light tips. The number and length of the spines increase with age.

The abdomen is dark, almost black, and on the chest, and sometimes on the throat, there is a white, whitish or dirty white spot that may have different shape and size. In the studied individuals (n = 88), the spot had a more or less symmetric or asymmetric shape and it had rounded, rhombic, rectangular or irregular forms and various dimensions. The maximum length of the spot was 196 mm and the maximum width was 98 mm. In 61.36% of the studied specimens, the spot covered the throat and the chest, while in 27.27% of the specimens the spot covered also a large part of the abdomen, reaching almost its lower extremity. In the rest of the individuals, the spot covered only the chest.

The external biometric data of *E. roumanicus* individuals from the Republic of Moldova (n = 36) showed wider limits of all the characters in comparison to previous data from Moldova (Table 1), except the maximum value of the hind foot, which was higher in previous studies. The mean value of body weight exceeds the maximum limit indicated for Moldova. In general, all the characters fit to those indicated for the species from Central Europe (Table 1).

The skull is quite massive and changes significantly with age. The most obvious features are the development of crests, especially of sagittal and supra-occipital ones. The lambdoid crest between the parietal and occipital bones is well developed (Fig. 3).

Among the upper unicuspid teeth, the first incisor is the longest, clearly separated from the second, which is the smallest unicuspid. There is a third, larger incisor, followed by the canine as long as the first incisor and larger than the first premolar. The second premolar is triangular in shape, and the third has three tubercles. The first two molars have the surface in the form of a quadrilateral, wider at the back with four cusps: protocone, paracone, hypocone, and metacone. The third molar is small and oblique to the previous molar.

The first lower incisor is forward and is joined by the second and is shorter than the canine. The first premolar has two cusps, one smaller and one obviously larger. The second premolar is high with three tubercles: protocone, paracone, and metacone. The first two molars have three anterior tubercles and two posterior ones, the surface of M_1 being larger than that of M_2. The third molar is triangular in shape and is much smaller (Fig. 4).

Table 1. External measurements of *E. roumanicus* from the Republic of Moldova and Central Europe

Таблиця 1. Зовнішні біометричні ознаки *E. roumanicus* з Республіки Молдова та Центральної Європи

Parameter	Body length, mm	Tail length, mm	Hind foot length, mm	Body weight, g
Mean ± SD	241.72 ± 1.95	29.59 ± 1.51	41.0 ± 0.99	837.28 ± 32.59
min–max	232–268	19.7–39	36–48	603–1117
Barret-Hamilton 1900	170–306	24–28	41–43	—
Lozan 1975	235–250	22–35	36–50	700–800
Pucek *et al*. 1981	171–285	14–39	30–45	238–1232
Murariu 2014	230–295	15–40	38–47	400–1200
Cerna Bolficova *et al.* 2020	160–370	—	—	230–795

Fig. 3. Skull of *E. roumanicus* from the central part of the Republic of Moldova.

Рис. 3. Череп *E. roumanicus* із центральної частини Республіки Молдова.

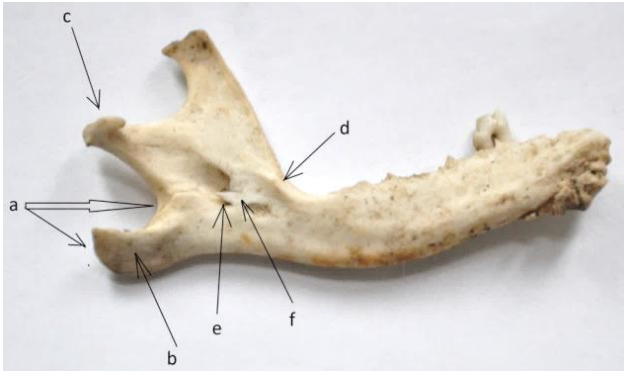

Fig. 4. Mandible of *E. roumanicus* from the central part of the Republic of Moldova.

Рис. 4. Нижня щелепа *E. roumanicus* із центральної частини Республіки Молдова.

The angular process of the mandible is long and narrow, and its upper edge is formed by the crest that runs along its medial side (Fig. 5 *a–b*). The mandibular foramen is shifted towards the lower end of the mandible (Fig. 5 *e–f*). The articular condyle has the shape of an elongated drop (Fig. 5 *c*). The temporal-mandibular joint is almost flat, the mandibular coronoid process is high and heavily curved, and there is a well-pronounced recess between the angular process and the horizontal ramus of the mandible (see: Fig. 5).

The cranial parameters vary within a small range throughout the territory of Moldova (Table 2). The variation coefficient is higher in condylobasal length and brain case breadth and in other cranial measurements it lies between 0.16 and 3.85. The values of nasal, maxillar, and mandibular indexes vary slightly with low value of variation coefficient.

In the studied individuals from Moldova, the naso-maxillary suture length varies between 3.74–6.39 mm, which is characteristic of the morphotype *roumanicus*, which has a long naso-maxillary suture, while in *E. concolor* this suture is very short or even absent.

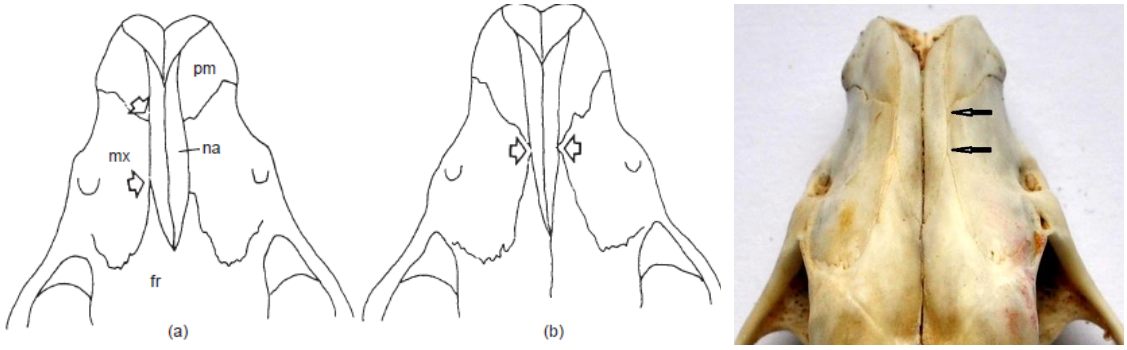

Fig. 5. Naso-maxillary suture in *E. roumanicus* (*a*) and *E. concolor* (*b*) (after [Krystufek 2002], left) and its form in hedgehog individuals from the Republic of Moldova (photo right).

Рис. 5. Носо-щелепний шов у *E. roumanicus* (*a*) та *E. concolor* (*b*) (за [Krystufek 2002], ліворуч) та його вигляд у їжаків з Республіки Молдова (фото праворуч).

Table 2. Cranial measurements of adult *E. roumanicus* from the Republic of Moldova

Таблиця 2. Краніальні виміри у *E. roumanicus* з Республіки Молдова

Parameter	Mean, mm	min–max, mm	SD	SE	Variance
CBL	53.49	50.86–55.88	2.039	0.832	4.157
RL	30.26	29.25–31.47	0.926	0.378	0.857
UTR	27.04	25.22–28.80	1.388	0.525	1.926
NMSL	4.92	3.74–6.39	0.973	0.435	0.947
OD	13.16	12.46–13.96	0.629	0.238	0.395
ZB	33.28	31.88–36.82	1.876	0.766	3.519
IoC	14.79	13.44–16.46	0.949	0.359	0.901
RoBA	11.71	11.02–12.04	0.409	0.167	0.168
RoBP	21.79	20.22–23.39	1.229	0.502	1.513
BcB	26.05	22.51–28.88	2.186	0.826	4.779
BcH	17.98	17.2–18.9	0.725	0.296	0.526
ML	41.73	39.84–44.98	1.797	0.599	3.229
MTR	22.58	19.34–24.01	1.479	0.523	2.189
CH	19.56	17.45–21.89	1.393	0.441	1.940
MRH	12.38	10.55–14.03	1.166	0.369	1.360
NI	4.045	2.97–4.78	0.592	0.769	0.385
MNI	1.255	1.14–1.39	0.011	0.107	0.053
MI	0.721	0.69–0.77	0.031	0.013	0.001

The cranial parameter of *E. roumanicus* from Moldova fit into those indicated for Czechoslovakia [Rodl 1966; Hrabe 1976] in the zone of sympatry of the two hedgehog species *E. europaeus* and *E. roumanicus*, for Poland [Ruprecht 1972], for Bulgaria [Peshev & Hussein 1990], while in some parts of Russia [Kirov, Voronezh, Rostov, and Orenburg regions] the measurements' values are bigger than in Moldova [Zaitsev, 1982]. In general, cranial parameters vary within large limits and overlap in the European hedgehog species [Zaithev 1982; Ruprecht 1972; Krystufek 2002].

In the area of sympatry, *E. europaeus* and *E. roumanicus* proved to be smaller and more similar to each other, with a convergent shape of the mandible [Černá-Bolfíková *et al.* 2020]. Even the skull indexes and nasal bone dimensions vary in a large range and indicate that these characters are of little practical value. Their variability, expressed in coefficients, was one of the highest in the examined series of two species *E. europaeus* and *E. roumanicus*, as well as and in different populations of these species across Europe [Ruprecht 1972]. Even some skull indexes, such as the nasal and parietal [Rodl 1966], show large variations and can only be important as convenient diagnostic characters under given local conditions [Ruprecht 1972]. Nevertheless, the nasal index values, the shape of the mandibular bones and the location of foramena [Wolf 1976] exclude completely the occurrence of the species *E. europaeus* in the territory of the Republic of Moldova.

The nasal, maxillary, and mandibular indexes are more effective in *Erinaceus* species diagnostics [Rodl 1966; Wolff 1976; Zaithev 1982; Zagorodniuk & Mishta 1995]. On the other hand, the mentioned indexes partly overlap between *E. concolor* and *E. roumanicus* [Hussein 2013]. Following the study of cranial variability in hedgehogs from Europe, the Caucasus, and the Middle East, two distinct morphotypes were highlighted—*concolor* and *roumanicus*—with significant differences in the naso-maxillary region [Krystufek 2002]. For the territory of Moldova, in all individuals, the naso-maxillary suture characteristic of the *roumanicus* morphotype was registered. Therefore, the species differentiation according to naso-maxillary suture [Krystufek & Vohralik 2001; Krystufek 2002] proved to be the most reliable diagnostic method.

Thus, according to shape and size of the ventral white spot, morphology of the mandible, the nasal, maxillar, and mandibular indexes, as well as naso-maxillary suture length, the territory of the Republic of Moldova is inhabited by the species *Erinaceus roumanicus*.

Conclusions

The external biometrics of hedgehogs from the Republic of Moldova showed wider limits of all the characters in comparison to previous data from Moldova, and all the characters fit those indicated for Central Europe.

The nasal index values, the shape of the mandibular bones, and the location of mandibular foramen in the studied individuals from different sites of the country exclude completely the occurrence of the species *Erinaceus europaeus* in the territory of the Republic of Moldova.

In the studied individuals from Moldova, the length of naso-maxillary suture varies between 3.74–6.39 mm, which is characteristic of the morphotype *roumanicus*, which t has a long naso-maxillary suture, while in *E. concolor* this suture is very short or even absent

Morphological characters, such as the shape and size of the ventral white spots, the morphology of the mandible, the nasal, maxillary, and mandibular indexes, as well as the length of the naso-maxillary suture prove that the territory of the Republic of Moldova is inhabited by the species *Erinaceus roumanicus*.

Declarations

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Conflict of interests. The author has no conflicts of interest that are relevant to the content of this article.

Handling of materials. The studied specimens were handled according to the current legislation of the Republic of Moldova.

Use of artificial intelligence. No generative artificial intelligence systems were used in the preparation of this manuscript. All scientific results, interpretations, and text are original contributions of the author.

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