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Revision of the rudist genus *Orestella* Lupu, 1982 (Bivalvia, Order Hippuritida) from the Upper Cretaceous of Romania

Sacit Özer [a,*], Liana Săsăran [b]

[a] *Dokuz Eylül University, Engineering Faculty, Department of Geological Engineering, Tınaztepe Campus, Buca, TR-35160 İzmir, Turkey*
[b] *Babeş-Bolyai University, Department of Geology, 1 Mihail Kogălniceanu Street, 400084 Cluj-Napoca, Romania*

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ABSTRACT

Re-examination of the *Orestella* Lupu, 1982 (formerly *Orestia* Lupu, 1972) type material in the Geological Institute, Bucharest, Romania, revealed the need for revision of its taxonomic status. The holotype and paratypes of this taxon show the diagnostic characteristics of the Family Hippuritidae, not the Radiolitidae as previously indicated. This genus should therefore be transferred to the Hippuritidae. The structure of the pillars, the ligamental ridge and the outer shell layer of the right valve as illustrated by the type material point to an affiliation either with *Hippurites* or with *Hippuritella*. We discuss this assignment by taking into account the similarities with *Hippurites organisans* (de Montfort), *Hippuritella lapeirousei* Goldfuss and *Hippuritella variabilis* (Munier-Chalmas). The stratigraphic framework of the study material is also discussed with respect to the Upper Cretaceous successions in the Central-Eastern Carpathians of Romania.

1. Introduction

The new rudist genus *Orestia* was described and assigned to the Radiolitidae by Lupu (1972) based on her interpretation of the outer shell layer of the right valve in five specimens recorded by Mirăuţă and Mirăuţă (1964) from the bioclastic breccia of Campanian–Maastrichtian age (Lower Hangu Beds) from the Cuejdiu Valley, north of the town of Piatra Neamt in the central area of the East Carpathians (Fig. 1). Later, Lupu (1982) replaced the genus name by *Orestella* due to preoccupation of the former name by *Orestia* Chevrolat in Dejean, 1836, p. 440 (Insecta, Order Coleoptera). Subsequently, no additional specimens of this taxon were recorded either in the Romanian Upper Cretaceous rudist-bearing formations or in the Mediterranean Tethys area in general (cf. Steuber, 2002). Nevertheless, the assignment of *Orestella* to the Family Radiolitidae was carried over in the classification of rudists proposed for the revised Bivalvia volumes of the '*Treatise on Invertebrate Paleontology*' (Carter et al., 2011), and also more recently by Skelton (2013).

The main aim of our study is the taxonomic revision of *Orestella* Lupu, 1982 based on re-investigation of the holotype and paratypes housed in the Geological Institute of Romania collection in Bucharest. The age and stratigraphic assignment of the study material are also discussed. A new taxonomic status of *Orestella* is proposed for inclusion in the revision of the Bivalvia volumes of the '*Treatise on Invertebrate Paleontology*'.

2. Geological setting

The specimens were collected by Mirăuţă and Mirăuţă (1964) from the Cuejdiu Valley, north of Piatra-Neamţ. Stratigraphically, the deposits belong to the Lepşa Formation from the Vrancea Nappe (Marginal Folds Nappe, *sensu* Săndulescu, 1984) representing the external tectonic units of the Outer Moldavidian domain of the Romanian Carpathians (Fig. 1). The sedimentary succession of the Vrancea Nappe (Marginal Folds) range in age from the Early Cretaceous to the Early Miocene (Dumitrescu, 1952; Băncilă, 1958; Grasu et al., 1988; Guerrera et al., 2012) and the following units crop out in ascending stratigraphic order: the Sărata, Lepşa, Piatra Uscată, Jgheabu Mare, Doamna Limestone, Bisericani, Globigerina Marls and Lucăceşti Sandstone, Lower Menilite, Bituminous Marl, Lower Dysodilic Shale with Kliwa Sandstones, Upper Dysodilic Shale and Menilite and, finally, Gura Şoimului formations (Miclăuş et al., 2010). In our study area from the Cuejdiu basin, the Vrancea Nappe crops out in the Bistriţa tectonic half-window (Băncilă, 1958; Grasu et al., 1988) and the Early–Late Cretaceous deposits belong to the Sărata and Lepşa Formations (Guerrera et al., 2012). The specimens of *Orestella* under review originate from the

* Corresponding author.
E-mail address: sacit.ozer@deu.edu.tr (S. Özer).

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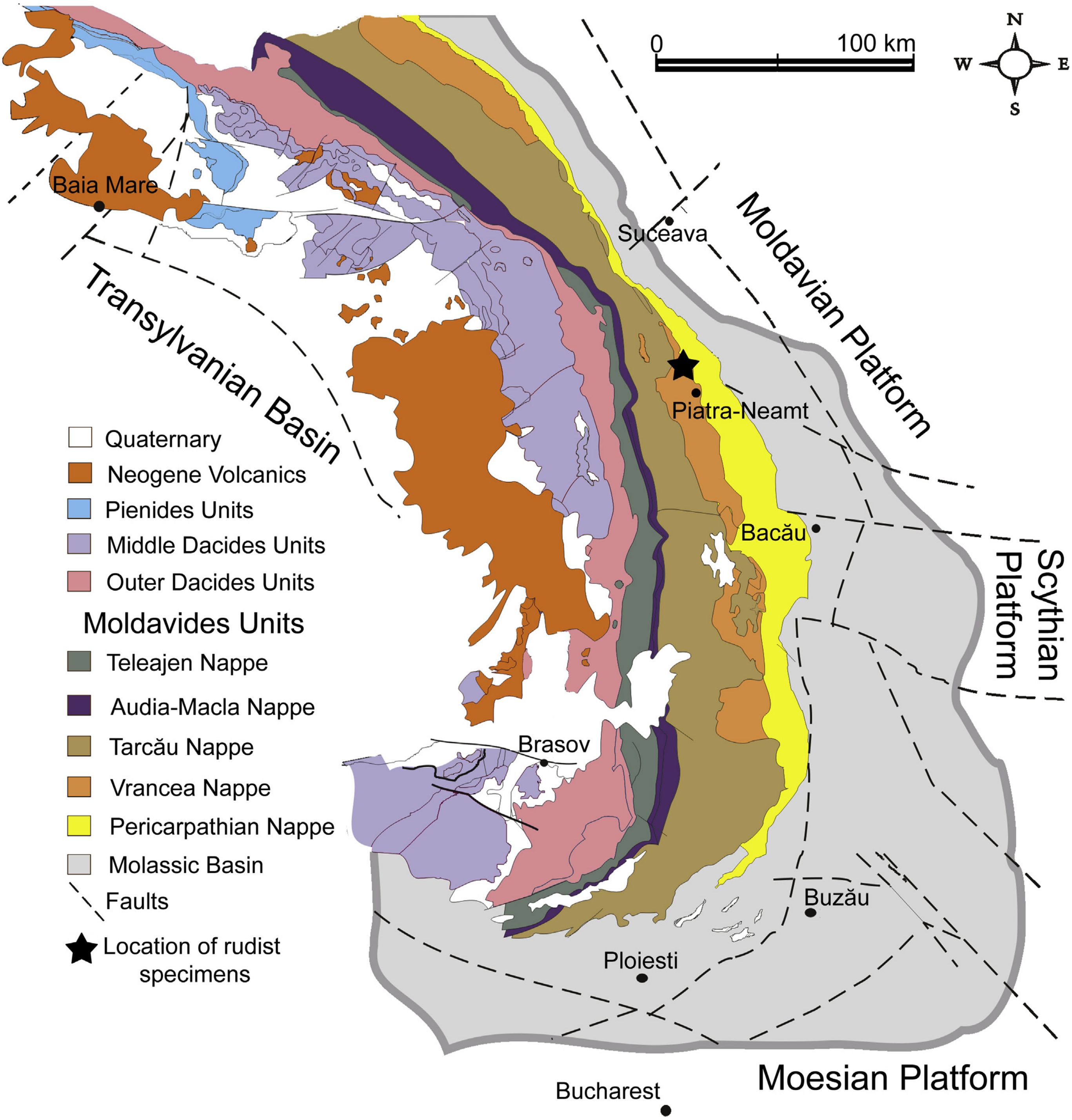

Fig. 1. Geological map of the Eastern Carpathians showing the *Orestella* locality (modified after Bădescu, 2005; Guerrera et al., 2012).

Campanian–Maastrichtian deposits of the 70 m thick Lepşa Formation that crops out in the Cuejdiu Valley (Guerrera et al., 2012). The stratigraphic succession is characterized by grey sandy marls, locally interlayered with coarse-grained beds, such as calcareous turbidites, siliciclastic turbidites and conglomerates/breccias with limestone and green-schist clasts (Guerrera et al., 2012). It is possible that the specimens of *Orestella* collected by Mirăuţă and Mirăuţă (1964) originated from this breccia level with limestone and green-schist clasts.

3. Materials and methods

The studied material was described by Lupu (1972) and is currently housed in the collection of the Geological Museum of Romania in Bucharest. Although the original description of this new taxon indicated the existence of five specimens (Lupu, 1972), the second author of this study could identify only three specimens of *Orestella* (see photos of the holotype and paratypes I and II, Figs. 2–4). In order to establish the validity of the genus

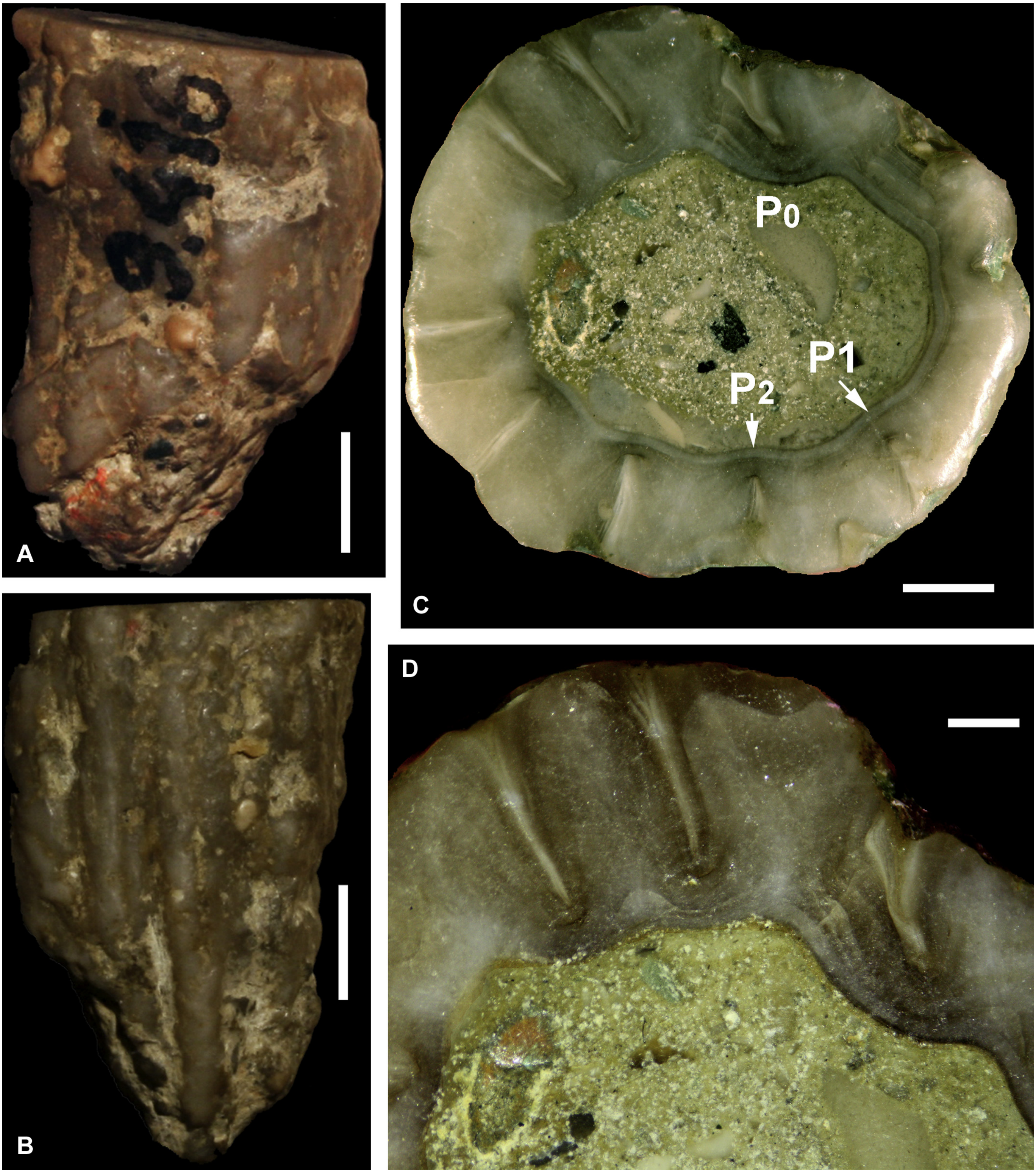

Fig. 2. The holotype of *Orestella* (No. 9.416). A, ventral side of the right valve; B, right valve showing the pronounced longitudinal costae and the furrows that corresponding to infolds; C, transverse section showing the compact structure of the outer shell layer. Note the shape of the first and second pillars (P1, P2), ligamental ridge (P0) and the folds of the outer shell layer. D, detail of the compact microstructure of the outer shell layer: the growth lamellae are completely filled with calcite. Scale bar represents 5 mm (A, B), 2 mm (C) and 1 mm (D).

Orestella, these specimens were re-measured and described in detail.

The careful study of the holotype and paratypes and correlation with the data in Lupu (1972) revealed several disagreements:

1 – The description of the paratypes does not correspond to the illustrated specimens. Paratype I of Lupu (1972, pl. I, fig. 2) is described as a single specimen embedded in the rock; in fact, it consists of two fragmented conjoined specimens (Fig. 3A–F in this paper).

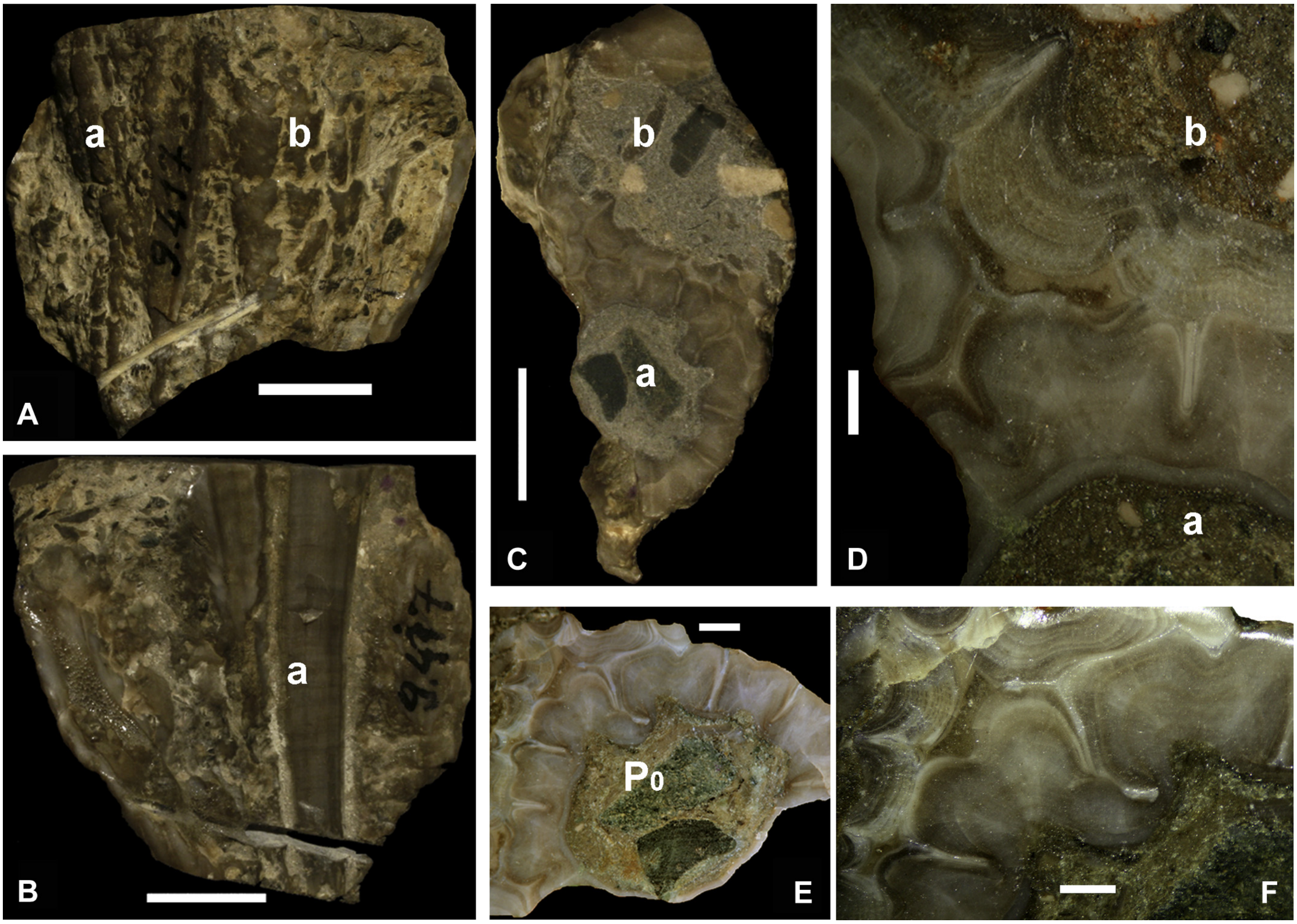

Fig. 3. *Hippurites* or *Hippuritella* sp. No. 9. 417/a-b (former paratype I of *Orestella*). A, two conjoined right valves of specimens a (left) and b (right) showing the pronounced longitudinal costae. B, dorsal side of specimen a showing the rudist's internal mould and the surrounding embedding sediment; the fragment representing specimen b is completely embedded in the rock, thus not visible in this part of the sample. C, transverse sections through the two mutually attached specimens a and b, showing radially folded structure of the outer shell layers in both specimens. E, detail of the folded outer shell layer and short ligamental ridge with rounded ending in specimen a. D, F, details of the two conjoined specimens showing the microstructure of the outer shell layers: the radially folded growth lamellae completely filled with fibrous calcite giving a compact pattern of the outer shell layer in specimen a; and the radially folded growth lamellae that are not completely filled with the calcite are visible in specimen b. Scale bar represents 10 mm (A, B, C), 2 mm (E) and 1 mm (D, F).

Paratype II (Fig. 4A–E) is figured as a single specimen (pl. II, fig.3, 3a in Lupu, 1972) but is described as "specimens embedded in the rock" (Lupu, 1972, p. 136). Indeed, paratype II consists of a single right valve but detached from the rock (Fig. 4A–B in this paper). The cross section can be fully observed in our figure (Fig. 4C), including the outer shell layer, and contrasts with Lupu's partial illustrations (Lupu, 1972, pl. II, fig. 3a; pl. III, fig. 7). The specimen representing paratypes III and IV is described as being detached from the rock, but the photo clearly shows two attached specimens embedded in the rock (Lupu, 1972, pl. II, fig. 4). These specimens may have escaped identification in the Geological Museum collection in Bucharest.

2 – The values for the length, diameter and outer shell layer of the right valve specimens in both the holotype and the paratypes completely differ from those given by Lupu (1972, p. 135), in her systematic section.

3 – The rectangular cellules of the outer shell layer described by Lupu (1972, pl. II, fig. 3a; pl. III, figs. 5–7), based on which these specimens were assigned to the Family Radiolitidae, were misinterpreted. The presence of these rectangular cellules and their significance in the compact outer shell layer of the specimens of *Orestella* will be discussed below in the taxonomic revision.

Additionally, for comparison, we studied another specimen originating from the same deposits of the Cuejdiu Valley (Lepşa Formation) as the *Orestella* specimens (Fig. 5 A–E in this paper). We have also reinvestigated three specimens of *Hippurites* ('*Batolites*') *organisans* determined by Koch (1876) and housed in the Museum of Paleontology-Stratigraphy, Babeş-Bolyai University Cluj-Napoca, Romania.

The terminology used follows Steuber (1999) and the classification of Skelton (2013).

3.1. Repository

Unless otherwise stated, the specimens are housed in the collection of the Geological Museum of Romania, in Bucharest. The new specimen (No.23950-BBUMP) from the Cuejdiu Valley is kept in the collection of the Museum of Paleontology-Stratigraphy, Babeş-Bolyai University Cluj-Napoca, Romania.

4. Taxonomic revision

Orestia was created as a new genus by Lupu (1972) with the purported (cellulo-)prismatic structure of the outer shell layer

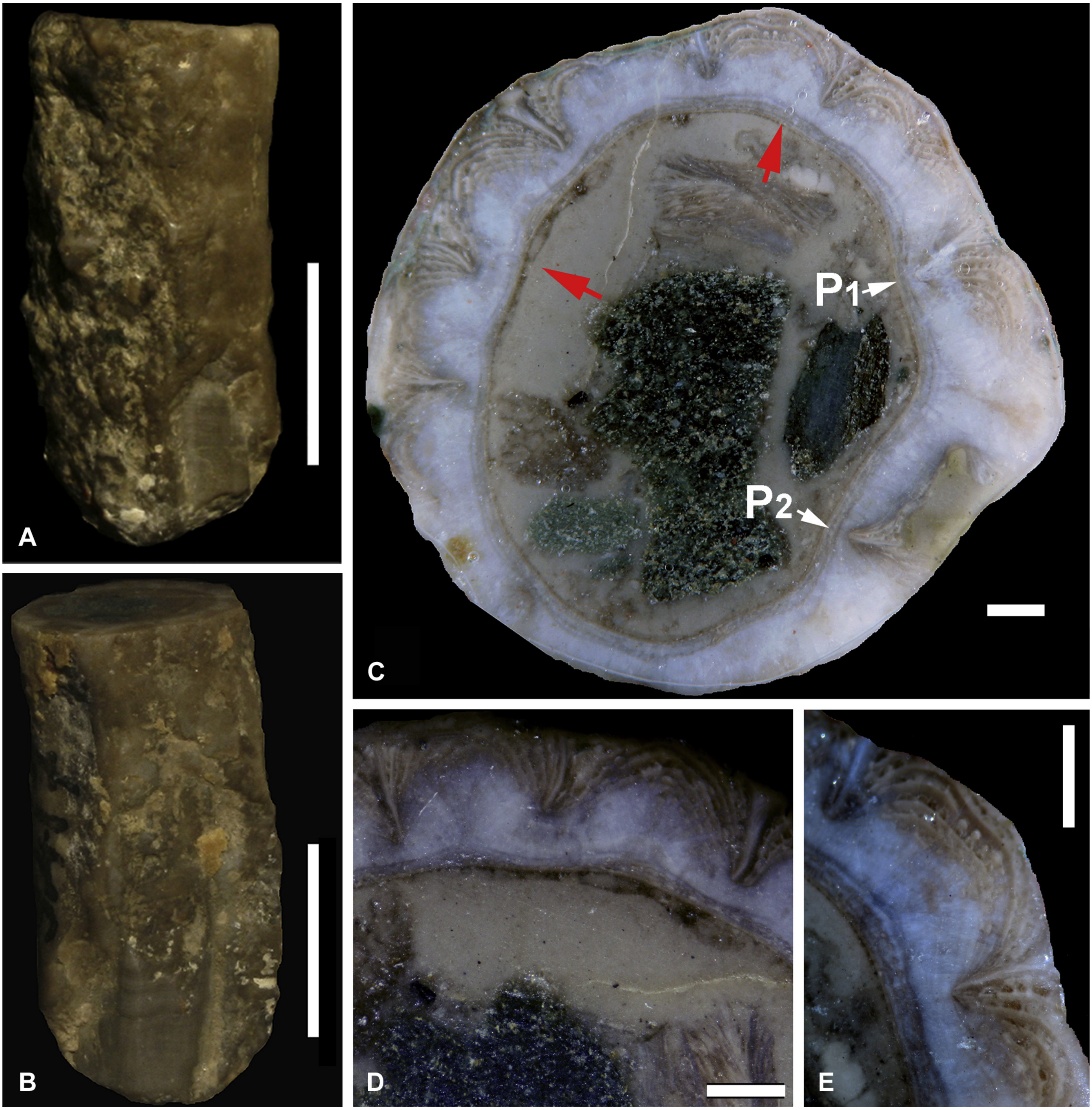

Fig. 4. *Hippurites* or *Hippuritella* sp. No. 9.417/c (former paratype II of *Orestella*). A, B, right valve showing the pronounced longitudinal costae. C, transverse section of the right valve showing less developed pillars and folds of the outer shell layer. D, E, details of the microstructure of the outer shell layer in dorsal side (indicated by red arrows) of the valve. Note the radially folded growth lamellae that start getting filled with the fibrous prismatic calcite with the long axis perpendicular to the growth surface. Scale bar represents 10 mm (A, B), 1 mm (C, D) and 0.5 mm (E).

and the apparent absence of the pillars as diagnostic features. Based on these characteristics, the new taxon was assigned to the Family Radiolitidae. Considering the structure of the outer shell layer to consist of rectangular cells, Lupu (1972) compared the new taxon with *Chiapasella* Muellerried, 1931 and *Bournonia* Fischer, 1887 but without presenting the actual differences. On the other hand, Lupu (1972) pointed out that the folds of the outer shell layer resemble those of *Batolites* de Montfort and *Pironaea* Meneghini, 1868. Subsequently, Lupu (1982) proposed the replacement name *Orestella* for the pre-occupied name *Orestia*, as noted in the Introduction. Currently, only a single species, namely *Orestella oresti* (Lupu, 1972) was determined from the Campanian–Maastrichtian deposits of the Central-Eastern Carpathians of Romania.

A careful investigation of the *Orestella* Lupu, 1982 material shows that the structure of the outer shell layer of the right valve is perfectly compact (Figs. 2C, D; 3D–F), as observed in hippuritids (Douvillé, 1894, 1897; Steuber, 1999; Pons et al., 2010; Skelton,

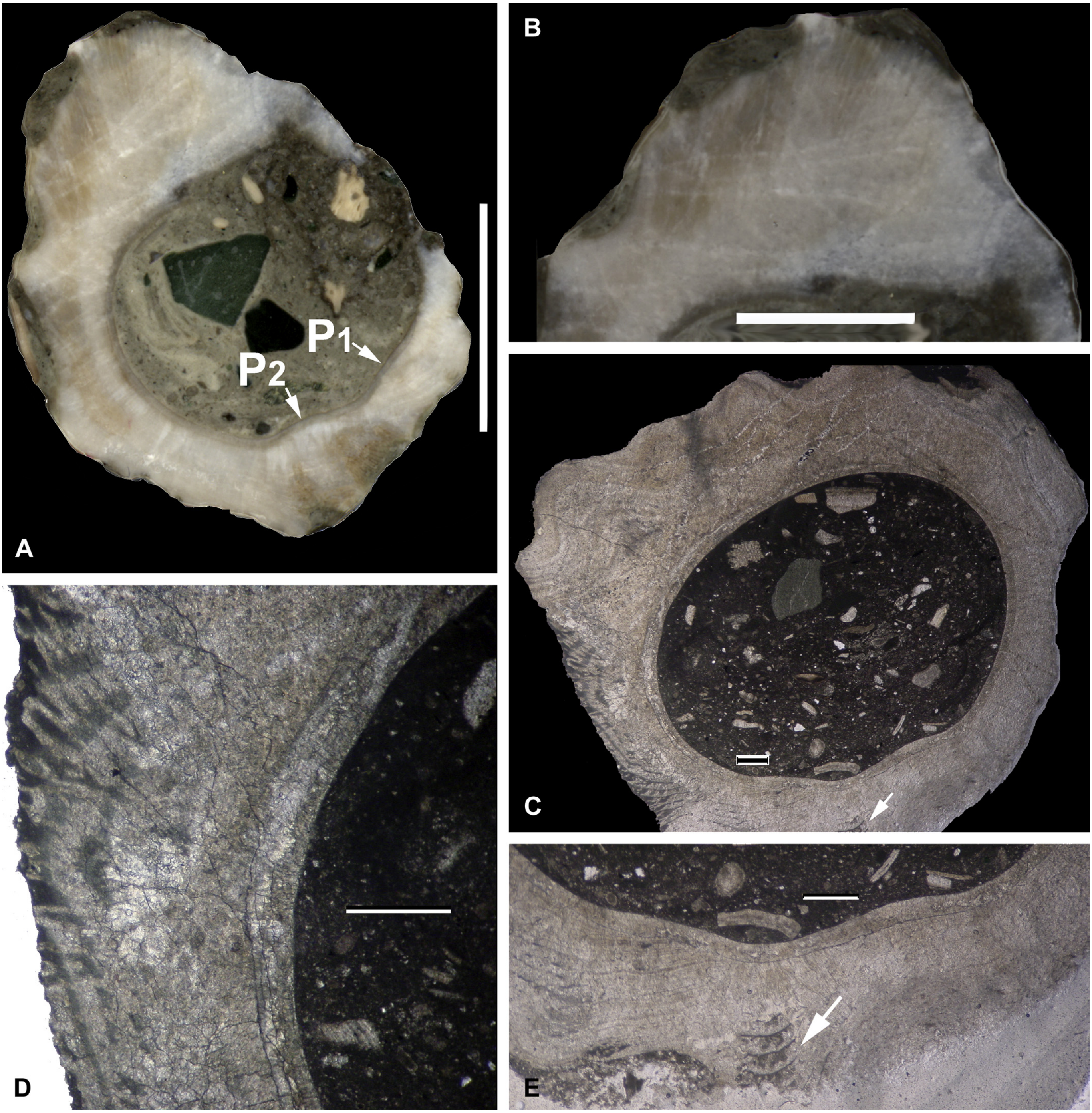

Fig. 5. *Hippurites* or *Hippuritella* sp. (No.23950-BBUMP) specimen originating from the same deposits with *Orestella*. A, cross section through the right valve showing the compact structure of the outer shell layer and the shape of the pillars. B, detail of the thick outer shell layer showing the radially fibrous calcite prism. C, cross section of the right valve in thin section showing the microstructure of the outer shell layer (white arrow indicates the position of the concave tabulae seen in detail in E). D, the radially fibrous calcite of the outer shell layer observed in antero-ventral side of the shell. E, concave tabulae in ventral side of the outer shell layer visible in thin section (indicated by white arrow). Scale bar represents 10 mm (A, B) and 1 mm (C, D, E).

2013). However, Lupu (1972) wrote: "the shell consists of rectangular prisms, arranged in concentric layers" concerning the holotype and "the rectangular prisms of the shell can be clearly observed" with respect to one of the paratypes. Indeed, these hollow prism-like structures can be observed in small areas of the radially folded outer shell layer of the paratype I (Fig. 3D–F) and in the dorsal side of the paratype II (Fig. 4C–E) but not around the whole outer shell layer.

The outer shell layer of the right valve of Hippuritidae has calcitic compact structure according to the general aspects (Douvillé, 1894, 1897; Steuber, 1999; Pons et al., 2010; Skelton, 1976, 2013). However, previous studies suggest that the following structures can be also observed in this layer:

1) Localized sharp folds (grooves and tubercles) are clearly demonstrated in *Vaccinites vermunti* by Pons et al. (2010, fig. 12-

7). The same structure is also observed in *Ugarella* Polšak & Slišković, 1989 (Fenerci, 2004, pl. 4, figs. 4, 5; included in *Hippurites*: see Skelton, 2013), *Vaccinites plenicari* (Polšak and Slisković, 1989), *Hippurites heritschi* (Sladić-Trifunović, 1978, pl. V, figs. 1, 2) and *Vaccinites* aff. *oppeli* (Skelton and Wright, 1995, pl. 3, fig. 3).

2) Radial ribs are frequently determined in hippuritids such as *Hippurites heritschi* (Sladić-Trifunović, 1978, pl. III, figs. 1, 2, pl. VII, figs. 1–3; Özer, 1983, pl. 3, fig. 1), *Hippurites radiosus* (Douvillé, 1893, pl. XI, fig. 2), *Hippurites cornucopiae* (Sladić-Trifunović, 1972, pl. XI, fig. 3; Skelton and Wright, 1995, pl. 5, fig. 8; Özer et al., 2013, pl. 4, fig. G), *Vaccinites convergens* (Pejović, 1970, pl. I, figs. 1, 2) and *Yvaniella maestrichtiensis* (Karacabey, 1968, pl. II, fig. 1; Özer, 2006).
3) Cellular structure is rarely observed but its presence is clearly demonstrated in *Laluzia* Götz & Mitchell, 2009 by Götz and Mitchell (2009, fig. 8g). Cellular-like structure has also been illustrated in *Hippurites heritschi* by Pleničar and Jurkovšek (1998, pl. 5, fig.1) and in *Hippurites cornucopiae* by Gregorio (1882, pl. VI, fig. 31) and Pejović (2002, pl. VI, fig. 1).
4) Concave tabulae are well described in American rudists such as *Barrettia* Woodward, 1862 and *Whitfieldiella* Mitchell, 2010 (Grubić, 2004; Mitchell, 2010, fig. 6-D, figs. 11, 12).
5) Folded structure is mostly determined in *Hippurites organisans* (de Montfort), *Hippurites tirolicus* Douvillé, *Hippurites socialis* Douvillé, *Hippurites requieni* Matheron and *Hippurites vidali* Matheron (de Montfort, 1808; Zittel, 1865, 1866; Douvillé, 1894, 1895, 1897; Toucas, 1903; Bilotte, 1985, 2009; Vicens, 1992)

Pons et al. (2010) proposed that the cellular and folded structures are occasionally developed in the Hippuritidae due to the good preservation of the outer shell layer of the right valve, other structures may be also preserved in the same way.

The cross section and thin section of a new specimen (No.23950-BBUMP) collected from the type locality of *Orestella* (Fig. 5A–E) clearly support this observation. The specimen consists of a small fragment of the right valve embedded in rock, with a length of 10 mm and a diameter of 19–24 mm. On its visible part, the shell valve is ornamented with three to four longitudinal ribs with shallow grooves between them. The commissure is unknown. The thickness of the outer shell layer varies between 3 and 8 mm. The thick calcitic outer shell layer shows a well preserved structure. The outer shell layer structure is generally compact (Fig. 5A, C) but looking at the microstructure of the outer shell layer, successive finely folded growth laminae (Fig. 5D) and fibrous prismatic calcite with the long axis perpendicular to the growth surface can be seen (Fig. 5B, C, D) in the dorsal and antero-ventral sides. The concave tabulae can be observed also in the ventral side of the shell (Fig. 5E). The shape and size of the pillars, represented by very simple infolds, and the lack of a ligamental ridge allow this specimen to be assigned to *Hippurites or Hippuritella* sp.

Skelton (1976) showed that the compact layer of the Hippuritidae consisted of “fibrous prismatic calcite”, as accepted by many studies (Polšak, 1967; Vicens, 1992; Steuber, 1999). The prismatic structure of Hippuritidae was explained as an exceptional structure like “hollow prisms” by Milovanović (1935) and as “diagenetic” by Pejović (2002).

To conclude, we find the “prismatic structure of the shell, a feature that makes it assignable to the Radiolitinae” cited by Lupu (1972) in creating the new taxon, to have been misinterpreted.

Moreover, in contrast with the observation of Lupu (1972), our re-examination of the *Orestella* material reveals the presence of pillars in the structure of the outer shell layer of the right valves (Figs. 2C; 3C, E; 4C).

All these features allow us to conclude that the holotype and paratypes of *Orestella* undoubtedly reflect the characters of the Family Hippuritidae, and not those of the Radiolitidae, as classified by Lupu (1972). At this point, based on the structure of the outer shell layer of the right valve, the material may be compared with *Batolites* de Montfort, 1808. However, Douvillé (1894) indicated that this genus shows folds only within the outer shell layer, unlike the pillars. Toucas (1903) noticed folds typical of *Batolites* in the outer shell layer, but he described these specimens as *Orbignya requieni* var. *subpolygonia* and also assigned two previously-known species of *Batolites*, *B. organisans* de Montfort *and B. tirolicus* Douvillé, to the genus *Orbignya* Fischer, 1887 (*pro Dorbignya* Woodward, 1862; a junior subjective synonym of *Hippurites* Lamarck, 1801). Steuber (2002) assigned the two species of this taxon to *Hippurites*, while Pons et al. (2010) pointed out that *Batolites* is an unnecessary genus name for Hippuritidae based on the radially folded growth lamellae. Currently, *Batolites* is listed as synonymous with *Hippurites* Lamarck, 1801 by Skelton (2013).

5. Taxonomic status

Following publication of the section on rudists (as Superfamily Hippuritacea Gray, 1848) in the Bivalvia volumes of the ‘*Treatise on Invertebrate Paleontology*’ by Dechaseaux et al. (1969) many new rudist taxa were described (see Steuber, 2002), while rudist taxonomy and phylogeny were subject to many studies, especially underpinned by the nine international rudist congresses held from 1988 to 2011 in different countries around the world. Carter et al. (2011) elaborated the new suprageneric classification of rudists for the Bivalvia volumes of the revised ‘*Treatise on Invertebrate Paleontology*’. Recently, an updated phylogenetic classification of rudist bivalves was proposed by Skelton (2013), with *Orestella* Lupu, 1982, installed in the Family Radiolitidae d'Orbigny, 1847 as *Orestia* Lupu, 1972. This entry thus overlooked the replacement name published by Lupu (1982) in a journal having a very limited circulation. However, Skelton (2013) presented this genus with a question mark, as “*Orestia* Lupu, 1972 (??)” thus drawing attention to the taxonomic issues related to this genus. As an answer, our study shows that *Orestella* Lupu, 1982 must be transferred to the Family Hippuritidae, in which possible synonymy with an existing hippuritid genus has to be considered.

6. Systematic palaeontology

Order: Hippuritida Newell, 1965
Suborder: Hippuritidina Newell, 1965
Superfamily: Radiolitoidea d'Orbigny, 1847
Family: Hippuritidae Gray, 1848

Hippurites or Hippuritella sp.
Figs. 2A–D; 3A–F; 4A–E; 5A–E
Material: Four right valves, No. 9.416 (previously defined as the holotype of *Orestia* Lupu, 1972), No. 9.417/a-b (former paratype I) and No. 9.417/c (former paratype II).
Additional material: One right valve, (No.23950/BBUMP) from the type locality of *Orestia*.
Description: The right valve shows two shape types: cylindrical-conical (specimens 9.416 and 9.417/a-b) and cylindrical (specimen 9.417/c). The left valve is not preserved, thus the commissure of the valves is unknown. The actual lengths of the valves are 22 mm in specimen 9.416; 30 mm in the two conjoined right valves (9.417/a-b); and 20 mm in specimen 9.417/c. In all of the specimens, the surface of the valve is ornamented with pronounced, longitudinal rounded ribs, 2–5 mm wide, some of them with a shallow central groove. The

rounded grooves (1–2 mm) between the ribs correspond to folds in the outer shell layer. Externally, the pillars and the ligamental ridge are represented by longitudinal furrows.

The transverse sections across the valves are circular to semicircular; the diameter varies from 11 mm to 16 mm. As is typical for hippuritids, the outer shell layer is compact, 2–4 mm thick (Figs. 2C, D; 3C–F). As previously mentioned, it presents ten regular well-developed folds all around the layer (Fig. 2C) in the better preserved specimen 9.416 and seven folds in the partially preserved outer shell layer of former paratype I (9.417/a). In the paratype II (9.417/c) nine folds are clearly developed where the outer shell layer can be seen (Fig. 4C). The folds in the outer shell layer of *Orestella* are similar to those that have been already observed in hippuritids (e.g. Zittel, 1865; Douvillé, 1894, 1897; Toucas, 1903; Bilotte, 1985, 2009; Pleničar, 1994) and they were considered as being sets of radially folded growth lamellae (Pons et al., 2010). These radially folded growth lamellae are visible in the outer shell layers of the paratypes (Figs. 3D, F; 4C–E) and they start getting filled with the fibrous prismatic calcite with the long axis perpendicular to the growth surface (Fig. 4C–E). Thus, this feature is not enough of an argument to create a new taxon.

The inner margin of the outer shell layer is somewhat undulating. The first and second pillars and the ligamental ridge are represented by very simple infolds, with the exception of specimen 9.417/a-b where they are relatively more developed (Fig. 3C, E). Transverse sections through these valves illustrate a short ligamental ridge with rounded ending. The two pillars, 1–2 mm in length, are invariably uneven and open at the base (Fig. 3C, E).

The cardinal apparatus is not preserved.

Discussion and remarks: Although the poor development of the ligamental ridge and pillars allow assignment to either *Hippurites* or *Hippuritella*, the left valve of the studied specimens was not preserved, and hence the pore-canal system is unknown. For this reason, it is problematic to assign the studied specimens to one or the other of the two genera. The following description is based only on the exterior and interior features of the right valves.

The transverse section of the right valve of specimen 9.416 (former holotype of Lupu, 1972) shows a poorly developed ligamental ridge, and first and second pillars (Fig. 2C). These features can be found in some of the descriptions for *Hippuritella lapeirousei* Goldfuss (e.g., Douvillé, 1895; Toucas, 1903; Pleničar, 1975; Pons, 1977; Steuber, 1999). However, the outer shell layer in our studied material is much thicker than in that of the latter species.

Two conjoined specimens, 9.417/a-b (former paratype I of Lupu, 1972) show a relatively more developed ligamental ridge and pillars (Fig. 3C, E). Thus, they are more similar to *Hippuritella variabilis* (Munier-Chalmas) as described by Douvillé (1897, text-figs. 68–70), Toucas (1903, figs. 80–82), Douvillé (1910, pl.2, figs.7–9, text-figs. 1a–c, 3, 45), Vicens (1992, pl I, figs. 9–15), Steuber (1999, text-fig. 46d, g, i) and Sarı and Özer (2009, fig. 16-6). However, they differ from the latter species in having a very thick outer shell layer, less prominent pillars and pronounced regular longitudinal ribs (Fig. 3A).

Specimen 9.417/c (former paratype II of Lupu, 1972) shows a similar shape of the pillars to those of the other specimens described by Lupu (1972). Its uniqueness is represented by an atypical thin outer shell layer and a very simple infold of the ligamental ridge (Fig. 4C). These features are more typical of *Hippuritella lapeirousei* Goldfuss, as indicated by Douvillé (1895, pl. 24, figs. 8–10), Toucas (1903, figs. 83, 84) and Steuber (1999, text-fig. 46h, j–m).

Similar to the case of the holotype and paratype II, the transverse sections through the right valves of paratypes III and IV of Lupu (1972, Pl. II, fig. 4) illustrate similar shapes for the ligamental ridge and the pillars, comparable with the corresponding features of *Hippuritella lapeirousei* Goldfuss.

However, despite the above-mentioned resemblance of the studied specimens with some species of *Hippuritella*, in the case of hippuritids the pillars and ligamental ridge can show variability along serial sections through the right valve (e.g., Vicens, 1992; Pons and Sirna, 1994; Pons et al., 1992, 1996; Caffau and Pleničar, 1994; Steuber, 1999; Simonpiétri and Philip, 2000; Moro et al., 2010). Because it is impossible to observe the ontogenetic variability in the studied material, we have avoided an identification at species level.

A similar folded structure of the outer shell layer was also observed in some hippuritid species such as *Hippurites organisans* (de Montfort), *Hippurites tirolicus* Douvillé, *Hippurites socialis* Douvillé, *Hippurites requieni* Matheron, or *Hippurites vidali* Matheron (de Montfort, 1808; Zittel, 1865, 1866; Douvillé, 1894, 1895, 1897; Toucas, 1903; Bilotte, 1985, 2009; Vicens, 1992). Nevertheless, a difference in the studied specimens is represented by the very simple infold of the ligamental ridge and pillars.

The studied specimens of Lupu (1972), show close similarities with *H. organisans* (de Montfort) in view of the folded structure in the outer shell layer (Figs. 2C; 3C, E; 4C). For this reason, we decided to compare the studied material with other specimens of *H. organisans* described from Romania and abroad. Previously, three specimens from the Gilău Mountains (eastern part of the Apuseni Mountains), were determined as *Hippurites* (*Batolites*) *organisans* by Koch (1876). As in the case of the specimens studied by Lupu, they seem to contain the folds within the compact structure of the outer shell layer. However, as a distinctive feature, the Koch specimens show very prominent triangular ligamental ridges, probably truncated at the top. This is a clear argument that the specimens described by Koch (1876) cannot be assigned to *Hippurites* (*Batolites*) *organisans*. On the other hand, in her synthesis of the Senonian rudists from the Apuseni Mountains Lupu (1976) did not record the presence of the species *H. organisans*. Also, recent studies of the rudist faunas from different occurrences (Săsăran and Săsăran, 2007; Săsăran and Özer, 2011; Săsăran et al., 2005, 2010, 2013) did not identify *H. organisans* in the rudist-bearing deposits from the Apuseni Mountains. Thus, comparison of the studied material with other specimens of *H. organisans* described from Romania is not possible and the presence of *H. organisans* in Upper Cretaceous deposits from Romania still remains an open question.

Comparison of the *Orestella* right valves with different specimens of *H. organisans* described from abroad (de Montfort, 1808; Douvillé, 1894; Toucas, 1903; Bilotte, 1985, 2009) reveals clear resemblances with this species. Due to the good preservation of the outer shell layer, specimens 9.416 and 9.417 (the holotype and paratype I of *Orestia*, Lupu, 1972) clearly show regular folds all around the layer like in *H. organisans* but, in contrast to this species, the ligamental ridge and pillars are represented by the very simple infold (Figs. 2C; 3E; 4C).

7. Age of the studied material

According to Lupu (1972), the *Orestia* material was collected from the Upper Senonian Lower Hangu Beds from the Cuejdiu Valley, north of Piatra-Neamţ. Subsequent reviews (Grasu et al., 1988; Guerrera et al., 2012) of these Late Cretaceous deposits of the Vrancea Nappe re-assigned them to the Lepşa Formation. Lupu (1972) perpetuated this confusion from Mirăuţă and Mirăuţă (1964), a paper in which the stratigraphic succession cropping out in the Cuejdiu Valley included the lithostratigraphic units of the Tarcău Nappe (Horăicioara conglomerates, Upper and Lower Hangu Beds) that are mixed with those of the Vrancea Nappe (Lepşa Formation). These authors also erroneously indicated a Turonian–early Senonian age for the Lepşa Formation and a late Senonian–Paleocene age for the Lower and Upper Hangu Beds. The Lepşa Formation (Vrancea Nappe, or Marginal Folds Nappe) is nearly contemporaneous with the Hangu Beds (Tarcău nappe); unlike the latter unit, however, it does not show characteristic flysch features and it is not a typical pelagic formation (Bădescu, 2005). Both the Lepşa and Hangu formations contain beds with inoceramid bivalves and show almost the same lithology. However, the Lepşa Formation is located in an external position compared to the Hangu Beds. Probably its deposits accumulated in elevated submerged areas situated between the submarine canyons that generated the Hangu Beds (Bădescu, 2005). A recent paper of Guerrera et al. (2012) has described the detailed stratigraphic succession of the Lepşa Formation cropping out in the Cuejdiu Valley as consisting of polygenic breccias/conglomerates (with limestone and green-schist clasts), turbiditic sandstone and slump deposits. It is possible that the specimens of *Orestella* collected by Mirăuţă and Mirăuţă (1964) originated from this breccia level with limestone and green-schist clasts. New biostratigraphic data based on planktonic foraminifers and calcareous nannoplankton in the Lepşa Formation have established a Campanian–late Maastrichtian age for these deposits (Guerrera et al., 2012). Accordingly, we consider that the *Orestella* material is of the same age.

8. Conclusions

We have reviewed the *Orestella* holotype and paratype material, formerly described as *Orestia* by Lupu (1972). Our new results allow its taxonomic status to be revised. We consider the presence of the pillars and the compact structure of the outer shell layer of the right valve as diagnostic characters of the Family Hippuritidae, rather than those of the Family Radiolitidae, to which the specimens were originally referred.

We have demonstrated that the type material undoubtedly represents either *Hippurites or Hippuritella* sp., of which *Orestella* Lupu, 1982 can now be considered a junior synonym – a correction to Skelton (2013) that should be adopted in the revised Bivalvia volumes of the '*Treatise on Invertebrate Paleontology*'.

The Campanian–late Maastrichtian age of the rudist material, as indicated by Lupu (1972), is confirmed by the recent micropaleontological results of Guerrera et al. (2012). The assumption that these specimens were reworked in the level of breccia with limestone and green-schist clasts within the Lepşa Formation (Vrancea nappe) is based on the characters of these slump deposits and turbiditic sandstones. The *Orestella* specimens under review cannot have originated from the Hangu Formation (Tarcău Nappe), as previously stated (Mirăuţă and Mirăuţă, 1964; Lupu, 1972) because of its typical flysch characters.

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