AGGLUTINATED CONICAL FORAMINIFERA (ORBITOLINIDAE, COSKINOLINIDAE) FROM THE UPPER CRETACEOUS (CAMPANIAN) OF GREECE, WITH DESCRIPTION OF *PARACOSKINOLINA KLOKOVAENSIS* N. SP.

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Abstract An assemblage of agglutinated conical foraminifera including *Lepinoconus chiochinii* Cruz-Abad et al., *Calveziconus lecalvezae* Caus & Cornella, *Paleodictyoconus* sp., and *Paracoskinolina klokovaensis* n. sp. are described from the upper lower-middle Campanian of Klokova Mountain of the Gavrovo-Tripolitza Zone, SW continental Greece. With the presence of one rafter in the marginal zone, the new species *P. klokovaensis* compares to the Lower Cretaceous species *Paracoskinolina arcuata* (Arnaud-Vanneau) that is distinguished by its cylindroconical test morphology and much larger size. The assemblage occurs in inner platform carbonates associated with other foraminifers such as dicyclinids, and *Accordiella conica* Farinacci. Representatives of the genus *Paracoskinolina* were so far only reliably reported from the Upper Berriasian–Albian interval. This new record suggests that the genus either survived the larger benthic foraminifera extinction event associated with the Cenomanian – Turonian boundary anoxic event, or may be an example of an Elvis taxon or homoplasy.

Keywords: Late Cretaceous, Larger Benthic Foraminifera, Dictyoconinae, taxonomy, biostratigraphy

INTRODUCTION

Larger agglutinated conical foraminifers (Orbitolinidae, Coskinolinidae) are widespread in Lower Cretaceous shallow-water platform carbonates (e.g., Arnaud-Vanneau, 1980; Clavel et al., 2014). Records from the Upper Cretaceous (post-Cenomanian) are restricted to a distinctly reduced number of genera and species (Gendrot, 1968; Moullade and Viallard, 1973; Neumann, 1978; Bilotte, 1974; Luperto Sinni and Martin-Chivelet, 1999; Schlagintweit et al., 2016; Luger, 2018; Schlagintweit and Rashidi, 2021). In the Adriatic-Dinaridic carbonate platforms, occurrences of Upper Cretaceous orbitolinids are known, where these have been described in open nomenclature (Fleury, 1970; Luperto Sinni, 1976). From the “lower Senonian” of Greece, Orbitolinid foraminifers have been described and illustrated by Fleury (1970). Referring to the locality Mount Klokova, and their description in open nomenclature, they have been grouped as “K orbitolinidés”. Fleury (1970, p. 36) noted that the observed forms could not be assigned to any known species. In fact, three different forms were described as Orbitolinidae gen. ind., *Coskinolina* sp., and *Dictyoconus* sp. This assemblage of agglutinated conical foraminifers is herein taxonomically reassessed, including a description of *Paracoskinolina klokovaensis* n. sp. It contributes to the still relatively poor knowledge of this group of larger benthic foraminifera from Upper Cretaceous shallow-water carbonates, and their distribution within the peri-Mediterranean realm.

GEOLOGICAL SETTING

The Gavrovo–Tripolitza Platform (Dercourt, 1964)

belongs to the external Hellenides and crops out in the western part of continental Greece, the Peloponnesus, and some islands (Zambetakis-Lekkas and Alexopoulos, 2007, Fig. 1). Composed mainly of Upper Cretaceous and Eocene shallow-water carbonates, these sedimentary rocks form the mountains of Varassova and Klokova in south Akarnania, as well as the Gavrovo massif (Ori Valtou) further north, and a discontinuous chain of smaller massifs at the Peloponnesus western edge, from Skolis to Pylos-Methoni (Auboin et al., 1958; Fleury, 1970, 1980; Bernier and Fleury, 1980; Mavrikas, 1993). In a greater paleotectonic context, the Gavrovo-Tripolitza Zone represents “an Adria-derived” (Nirta et al., 2020) or “South Adriatic” unit (Zelic et al., 2010), so that the successions and their fossil biota can be compared with Apulia, and the “Senonian” occurrences of orbitolinids there (Luperto Sinni, 1976). The material studied herein comes from Klokova Mountain in Akarnania, a region of west-central Greece. The locality has been studied in detail by Fleury (1970), distinguishing eight lithologic units. Orbitolinid foraminifers have been observed in the lower-middle part (~60 m vertical range in Klokova section) (Fleury, 1970, Fig. 1) (Fig. 2). The orbitolinid assemblage occurs in biomicritic (occasional fenestral) limestones, indicating inner platform facies. Accompanying benthic foraminifers include *Accordiella conica* Farinacci, dicyclinids and *Senalveolina aubouini* Fleury (Fig. 3). The succession studied by Fleury (1970, p. 93, figs. 28–29, 1980) is exposed on the southern side of Klokova Mountain along the road between Nafpaktos and Messo-longhi. It is also the type-locality of *Senalveolina aubouini* (Fleury, 1984). The levels with “Orbitolinidés K”

Fig. 1 Geographic sketch map showing the location of Klokova mountains on the opposite side of the Gulf of Corinth facing Patra. This is the type-locality of *Paracoskinolina klokovaensis* n. sp.

(for Klokova) have been placed into the upper Santonian-Lower Campanian by Fleury (1980, fig. 8, p. 44). Based on Orbitolinid and other larger benthic foraminifera, they can be assigned to the uppermost lower-middle Campanian (see subchapter Biostratigraphy following the systematic descriptions for details).

MATERIAL AND DEPOSITORY

The four thin sections containing the illustrated specimens from Klokova Mountain (material from Fleury, 1970, 1980) are hosted by the Paleontology Museum, Department of Geology of Babeş-Bolyai University, Cluj-Napoca, Romania, under the official depository numbers 24307 to 24310 (Table 1). The two specimens illustrated from Brač Island, Croatia, are the property of the Croatian Geological Survey and their repository is currently in the Geological-Paleontological Department of the Croatian Natural History Museum, Demetrova 1, Zagreb, Croatia.

SYSTEMATIC MICROPALAEONTOLOGY

The classification follows Kaminski (2014).

Phylum Foraminifera d'Orbigny, 1826

Class Globothalamea Pawlowski et al., 2013
Order Loftusiida Kaminski & Mikhalevich, 2004
Suborder Orbitolinina Kaminski, 2004
Superfamily Coskinolinoidea Moullade, 1965
Family Coskinolinidae Moullade, 1965

Remarks: While the family Coskinolinidae is placed in the order Loftusiida by Kaminski (2014), it is included in the order Textulariina by Cruz-Abad et al. (2017).

Genus *Lepinoconus* Cruz-Abad, Consorti & Caus, 2017
Lepinoconus chiochinii Cruz-Abad, Consorti & Caus, 2017

Fig. 4a, d, g, j

1970 *Coskinolina* sp. – Fleury, p. 36, pl.1, figs. 5-7.

1976 *Urgonina* sp. – Luperto Sinni, p. 312, pl. 37, figs. 1-6.

1976 *Paracoskinolina* sp. – p. 313, Luperto Sinni, pl. 38, figs. 1-3.

1976 *Abradia mosae* (Hofker) – p. 316, Luperto Sinni, pl. 41, figs. 1-12.

1993 Orbitolinidés K – Mavrikas, pl. 1, fig. 10.

*2017 *Lepinoconus chiochinii* gen. et sp. nov. – Cruz-Abad et al., p. 348-350, pls. 1-2 (with synonymy)

Table 1. Sample numbers

Inventory number	Field Number	Collection
24307	273-GKL39-3357	Bucur & Schlagintweit
24308	276-GKL43X-3845	Bucur & Schlagintweit
24309	276-GKL43-511	Bucur & Schlagintweit
24310	276-GKL43-1780	Bucur & Schlagintweit

Remarks: For a detailed description of this monospecific genus see Cruz-Abad et al. (2017). The thick wall (with pseudo-keriotheca) and the aligned pillars are clearly discernible in the Greek specimens (Fig. 4A, D, J). The broken transverse section shown in Fig. 4D has a diameter of ~1.1 mm, slightly larger as the maximum test diameter indicated by Cruz-Abad et al. (2017) as 1.0 mm. Apart from the occurrences in Greece, Italy, and ?Albania (see synonymy in Cruz-Abad et al., 2017), a further occurrence can be added from Brač Island, Croatia, also in association with *Calveziconus lecalvezae* and *Paracoskinolina klokovaensis* and at an equivalent stratigraphic position (Gušić and Jelaska, 1990; Cvetko-Tešović et al., 2001).

Superfamily Orbitolinoidea Martin, 1890

Family Orbitolinidae Martin, 1890

Subfamily Dictyoconinae Schubert, 1912

Remarks: Schubert (1912, p. 207) introduced the name Dictyoconinae for a “group” (Gruppe) of agglutinated foraminifers comprising the five genera: *Lituonella*

Fig. 2 Upper Cretaceous successions of Klokova Mountain, SW Greece (see Fleury, 1970, fig. 1, for details) with the distribution of some benthic foraminifers (A-B: *Senalveolina aubouini* Fleury, sample GKL 43; C-D *Accordiella conica* Fari-nacci, sample GKL 43x, without scale). Note: the lower/middle Campanian boundary is approximately placed at the LAD of *K. tergestina* (Frijia et al., 2015, fig. 15). For microfacies of sample GKL 39 see Figure 3.

Schlumberger in Schlumberger and Douvillé, 1905, *Cos-kinolina* Stache, 1875, *Chapmania* Silvestri, 1904, the eponymous *Dictyoconus* Blanckenhorn, 1900, and *Litu-ola* Lamarck, 1804, and suggested that this “row” of taxa represented a stratigraphic succession. With reservation, Schubert (1912) added *Conulites* Carter, 1861 and *Con-ulina* d’Orbigny, 1831. Without going into details about the taxonomic status of these genera, only *Dictyoconus* is left as a member of this “group”. Others are partly junior synonyms of other genera (e.g. *Lituonella* and *Cos-kinolina*), and belong to other families and orders (e.g. *Chapmanina*). Obviously, the work of Schubert (1912), written in German, was overlooked by Moullade (1965) when he established the new subfamily Dictyoconinae. Shortly afterwards, the priority of the name introduced by Schubert (1912) was recognized by Moullade (1966, p. 35). Although both, Schubert (1912) and Moullade (1965) are included in the reference list of Loeblich and Tappan (1987), confusingly, they choose to retain the name Dictyoconinae Moullade, 1965. While some workers correctly used Schubert as author of the subfami-

ly (e.g. Arnaud-Vanneau, 1976; Decrouez and Moullade, 1974), many have not questioned Loeblich and Tappan (1987) and follow their incorrect taxonomy (e.g. Mancinelli and Chiochini, 2006; Vecchio and Hottinger, 2007; Clavel in Granier et al., 2013; Kaminski, 2014; Vicedo et al., 2014; Schlagintweit et al., 2016; Serra-Kiel et al., 2016; Villalonga et al., 2019).

Genus *Paleodictyoconus* Moullade, 1965

Paleodictyoconus cf. *senonicus* Moullade & Viallard, 1973

Figs. 3 pars, 4b-c, e-f

1970 *Dictyoconus* sp. – Fleury, pl. 1, 1?, 4.

*1973 *Paleodictyoconus senonicus* n. sp. – Moullade and Viallard, p. 338-340, pls. 1-3.

?1976 *Paleodictyoconus* sp. – Luperto Sinni, p. 315-316, pl. 39, figs. 1-6, pl. 40, figs. 1-4.

1985 *Paleodictyoconus senonicus* Moullade & Viallard – Bilotte, p. 358, pl. 16, figs. 1-5.

Fig. 3 Upper Cretaceous (middle Campanian) microfossils of sample GKL 39. *Pa* = *Paracoskinolina klokovaensis* n. sp., *Pal* = *Paleodictyoconus senonicus* Moullade & Viallard, *Di* = *Dicyclina schlumbergeri* Munier-Chalmas.

Remarks: Although Moullade and Viallard (1973, p. 340, footnote) noted similarities of the specimens illustrated by Fleury (1970) as *Dictyoconus* sp. with *Paleodictyoconus senonicus*, they refrained from a concluding assessment because the Greece material lacks axial sections showing the pronounced initial spire, a circumstance also accounting for some reservations expressed herein (cf.). *P. cf. senonicus* has been observed in association with *P. klokovaensis* in the same samples (Fig. 3). The dimensions of *P. senonicus* are larger (height up to 1.5 mm, diameter up to 1.15 mm), there are 1 to 2 rafters (according to Moullade and Viallard, 1973), the test diameter is not increasing continuously from apex to base as in *P. klokovaensis*, but may decrease later resulting in a bell-shaped outline in axial sections (e.g. Moullade and Viallard, 1973, pl. 1, figs. 1, 5, 8). The pillars of *P. senonicus*, with a tendency to anastomization, are alternating between subsequent chambers (Fig. 4C, F). Last but not least, there are 8-9 chambers per last 0.5 mm axial length, meaning that the chamber height of *P. cf. senonicus* is reduced compared to *P. klokovaensis*.

Remarks: Bilotte (1985) reported *P. senonicus* from the lower Campanian of the French Pyrenees. For the orbitolinid occurrences in southern Italy, the exact stratigraphic position is still uncertain (Luperto Sinni, 1976, p. 303, "restano...datati con molta precisione"). At the type-locality, *P. senonicus* occurs in levels with *Lacazina*

elongata Munier-Chalmas & Schlumberger below and above. This species is reported from the upper Santonian-lower Campanian (Gräfe, 2005, fig. 4).

Genus *Calveziconus* Caus & Cornella, 1982

Calveziconus lecalvezae Caus & Cornella, 1982

Fig. 4h-k

1976 *Paleodictyoconus* sp. – Luperto Sinni, pl. 39, figs. 1-6, pl. 40, figs. 1-4

1981 *Calveziconus lecalvezae* n. gen., n. sp. – Caus and Cornella, p. 27-34, ps. 1-2.

1985 *Calveziconus lecalvezae* Caus and Cornella – Bilotte, p. 358, pl. 17, figs. 1-12.

1988 *Calveziconus lecalvezae* Caus and Cornella – Caus et al., pl. 2, fig. 4.

1988 *Calveziconus lecalvezae* – Gusič and Jelaska, pl. 2, fig. 8 pars.

1990 *Calveziconus lecalvezae* – Gusič and Jelaska, pl. 8, fig. 2, pars. 3, pl. 9, fig. 1.

1992 *Calveziconus lecalvezae* Caus and Cornella – Pleničar and Šribar, pl. 4, fig. 6.

2001 *Calveziconus lecalvezae* Caus and Cornella – Cvetko-Tešović et al., p. 608, fig. 9A.

2007 *Calveziconus lecalvezae* Caus and Cornella – Velić, pl. 25, figs. 1-4.

2010 *Calveziconus lecalvezae* Caus and Cornella – Zambetakis-Lekkas, fig. 4.2.

Fig. 4 Coskinolinidae (**a, d, g, j**) and Orbitolinidae (**b-c, e-f, h-i, k-l**) from the Campanian of Klokova Mountain SW Greece (**a-f, h-l**) and Brač Island, Croatia (**g**). *Lepinoconus chiochinii* Cruz-Abad et al. **a** Oblique section. **d** Broken transverse section. **g, j** Subaxial sections. *Paleodictyoconus senonicus* Moullade & Viallard **b, e** Oblique transverse sections. **c, f** Subaxial sections. *Calveziconus lecalvezae* Caus & Cornella. **h, k** Oblique sections. **i** Oblique section passing the biloculine, slightly inclined megalospheric embryo. *Dictyoconella complanata* Henson. **l** Oblique section in the plane of compression. Abbreviations: b = beam, de = deuteroconch, f = foramen, p = protoconch, pi = pillar, s = septum. Thin sections: GKL 43 (**a, j, i, l**), GKL 43x (**d, k**), GKL 39 (**b-c, e, h**), GKL 39x (**f**).

2012 *Calveziconus lecalvezae* Caus and Cornella – Sokač et al., pl. 19, figs. 7-10.

2013 *Calveziconus lecalvezae* Caus and Cornella – Molina et al., fig. 8.6 and fig. 8.8 pars.

2015 *Calveziconus* cf. *lecalvezae* Caus and Cornella – Frijia et al., fig. 8L.

2016 *Calveziconus* cf. *lecalvezae* Caus and Cornella – Moro et al., fig. 5c, f, o, p, t, and u.

2019 *Calveziconus lecalvezae* Caus and Cornella – Villalonga et al., p. 20, pl. 1, figs. 1-6, pl. 2, figs. 1-11.

2020 *Calveziconus lecalvezae* Caus and Cornella – Sha et al., fig. 9d, f, ?g.

Remarks: Rare sections, not allowing a detailed description have been observed in the orbitolinid assemblage of Klokova Mountain. The species has a wide palaeogeographic distribution from Spain, Slovenia, Croatia, Greece, to India (see synonymy). In the original description, *Calveziconus* has been compared with the genera *Orbitolinopsis* Henson, *Neorbitolinopsis* Schroeder, and *Abrardia* Neumann & Damotte. Instead, striking structural matches with the Lower Aptian *Iraqia* Henson can be stated. These comprise the medium-high conical test, a simple, slightly eccentric embryo, a marginal zone with several beams and one rafter, and a reticulate central zone. From the Maastrichtian Simsim Formation of

Fig. 5 *Paracoskinolina klokovaensis* n. sp., from the late early-middle Campanian of Mount Klokova, SW Greece (**a-f, h-j**) and Brač Island, Croatia (**g**). **a** Axial section. **b-c, f-g** Subaxial sections. **d** Oblique transverse section. **h** Oblique section. **i** Tangential section. **j** Axial section, holotype specimen. Abbreviations: b = beam, f = foramen, ib = intercalary beam, pi = pillar, r = rafter. Thin sections: **a** GKL 39 (1754) (from Fleury, 1970, pl. 1, fig. 2), **b-j** GKL 39 (3357).

Qatar, Whittaker et al. (1998) reported “*Calveziconus*” sp. nov. showing a complex marginal zone (with up to four orders of rafters, pl. 42, fig. 3 therein) and pillars in the central zone (pl. 42, figs. 4-5 therein); this form is different from *Calveziconus* Caus & Cornella. More sections are needed for a better characterization of the Middle East form.

Genus *Dictyoconella* Henson, 1948

Type species: *Dictyoconella complanata* Henson, 1948

Dictyoconella complanata Henson, 1948

Fig. 41

*1948 *Dictyoconella complanata* n. gen., n. sp. – Henson, p. 25, plate 6, figs. 2-3, 16, pl. 10, fig. 14.

1998 *Dictyoconella complanata* Henson – Whittaker et al., pl. 47, figs. 4-6.

2021 *Dictyoconella complanata* Henson – Schlagintweit and Rashidi, p. 7, figs. 2a-b pars, 3-4 (with synonymy).

Remarks: A single specimen (~ 4 mm in diameter) in a slightly oblique section parallel to the plane of test compression. *D. complanata* has so far been reported from Maastrichtian strata; the occurrence in the Campanian of Greece extends its stratigraphic record and also the previously assumed palaeogeographic restriction to the Arabian Plate (see Schlagintweit and Rashidi, 2021).

Subfamily Dictyorbitolininae Schroeder in Schroeder et al., 1990

Genus *Paracoskinolina* Moullade, 1965

Type species: *Coskinolina sunnilandensis* Maync, 1950

Paracoskinolina klokovaensis n. sp.

Figs. 3 pars, 5a-j, 6a

1970 *Dictyoconus* sp. – Fleury, p. 37, pl. 1, figs. 2-3.

Origin of the name: Referring to the type-locality of the new species: Mount Klokova in western Greece.

Holotype: Subaxial section shown in Fig. 5a.

Paratypes: Specimens illustrated in Fig. 5b-j.

Horizon and locality: late early-middle Campanian of Mount Klokova, SW Greece.

Description: Medium- to high-conical test displaying smooth surface and plane to slightly convex base. The test height may slightly exceed the diameter, often the latter accounts for about 2/3 of the former. A small initial spire is barely visible (Fig. 5a, i); the embryo has not been observed. Each adult rectilinear chamber (up to 16 in adult specimens) is subdivided into a marginal and central zone. The exoskeleton of the marginal zone consists of one horizontal partition (rafter) (e.g. Fig. 5b) and 1 to 2 intercalary beams between the vertical main partitions (beams). The latter are straight and slightly but continuously widening inwards and exceed the length of the intercalary beams distinctly (about 4 times). The pillars of the central zone are aligned between subsequent chambers as visible in axial sections (Fig. 5b). In oblique section, they appear slightly offset against each other (Fig. 5e). The pillars are widened at the base and top and may have a string-of-pearls appearance (Fig. 5a). There are ~5 pillars in axial section for a test diameter of 0.5 mm. The foramina of the central zone are, like the pillars, aligned; the outermost foramina (towards the marginal zone) are arranged in a circle (Fig. 5d, left side). The wall is finely agglutinated.

Dimensions (in mm):

Test diameter: 0.85-1.1 mm

Test height: 0.75-1.2 mm

Number of chambers per last 0.5 mm cone axis: 6-7

Apical angle: ~28 to 55 degrees

Remarks: From the upper Albian-Cenomanian shallow-water carbonates of the Argolis Peninsula of Greece, Decrouez and Moullade (1974) described four new Orbitolinidae, which amongst them *Paracoskinolina fleuryi*. This taxon does not possess aligned pillars, instead alternating main partitions, and is therefore excluded from the

genus *Paracoskinolina* Moullade (see emended genus diagnosis of Arnaud-Vanneau, 1980). Although nothing is known about the embryo and the internal structure displayed in transverse sections, this taxon lacks horizontal partitions and has been tentatively transferred to *Cribellopsis* Arnaud-Vanneau by Yazdi-Moghadam and Schlagintweit (2021). The form described as *Dictyoconus walnutensis* (Carsey) subspecies *pyrenaicus* by Moullade and Peybernès (1975) from the lower-middle Albian of northern Spain is similar to the Campanian species from Greece to some extent (e.g. dimensions, one rafter). Schroeder (1985) clarified that this Spanish taxon does not belong to *Dictyoconus* Blanckenhorn because of the aligned pillars in the former. In addition, Schroeder (1985, p. 46) concluded that “*Dictyoconus*” *pyrenaicus* should be transferred to *Paracoskinolina* or an allied form due to the aligned pillars and foramina. In fact, the transverse section provided by Moullade and Peybernès (1975, pl. 1, fig. 1) nicely shows the concentric arrangement of the foramina, a diagnostic feature of the Dictyorbitolininae sensu Schroeder in Schroeder et al. (1990). Some morphological differences, such as a more inflated test and differing apical angle (50-70 degrees, acc. to Schroeder, 1985), of *Paracoskinolina pyrenaicus* (Moullade and Peybernès) comb. nov. are worth mentioning.

Comparisons: The new species has been described and illustrated by Fleury (1970) as *Dictyoconus* sp. Contrasting with *Paracoskinolina* Moullade, *Dictyoconus* Blanckenhorn has pillars in the central zone that alternate in position between subsequent chambers (e.g., Davies, 1930, 1939; Arnaud-Vanneau, 1980; Loeblich and Tappan, 1987). Having a single rafter in the chamber marginal zone, *P. klokovaensis* can be compared with *P. arcuata* Arnaud-Vanneau, 1976 and *P. reicheli* (Guillaume, 1956) (Fig. 6). *P. arcuata* is morphologically different with its cylindro-conical test also displaying larger dimensions (e.g., height > 3 mm) (Arnaud-Vanneau, 1976, 1980). *P. reicheli* (Guillaume) is slightly larger as *P. klokovaensis* and with up to four intercalary beams (e.g. Guillaume, 1956, pl. 1, fig. 6), its marginal zone is more complex. The other species, *P. maynci* (Chevalier, 1961), *P. sunnilandensis* (Maync, 1950), and *P. coogani* Scott, 2002 lack rafters in the marginal zone. Note that many other “*Paracoskinolina*” have already been taxonomically revised or are still in need of revision (e.g., Cherchi and Schroeder, 1982; Schlagintweit, 2020; Yazdi-Moghadam, 2021). These include those described before the taxonomic clarification of the genus provided by Arnaud-Vanneau (1980).

Biostratigraphy: The levels with “Orbitolinidés K” (for Klokova) have been placed into the upper Santonian-Lower Campanian (Fleury, 1980, fig. 8, p. 44). Fleury (1980) respectively established a zone “Cs B 5 à “Orbitolinidés K” et *Montcharmontia apenninica* s.s.” In some sections, these orbitolinids appear some metres above the

Species	<i>P. klokovaensis</i>	<i>P. reicheli</i>	<i>P. arcuata</i>
	D	0.85-1.1	1.12-1.53 (1.28)	0.60-1.25
	H	0.75-1.2	1.05-1.42 (1.16)	0.85-3.25
	D/H	0.58-0.92	0.65-0.95 *	0.2-0.7 *
	n	6-7	5-6	5-7
	h	0.065-0.085	0.1-0.11	0.08-0.10
	Stratigraphy	lower-middle Campanian	upper Hauterivian- lower Aptian	

Fig. 6 Comparison of *Paracoskinolina* species with one horizontal partition in the marginal zone: **a** *P. klokovaensis* sp. nov., **b** *P. reicheli* Guillaume, 1956. **c** *P. arcuata* (Arnaud-Vanneau 1976). D = test diameter, H = test height, n = number of chambers per last 0.5 mm axial length, h = chamber height (all data except D/H in mm). * measured from original illustrations. Stratigraphy of the two Lower Cretaceous species according to Clavel et al. (2014).

Fig. 7 Central Mediterranean area (modified from Google Earth) with occurrences of Campanian Orbitolinidae-Coskinolinidae. 1: Zambetakis-Lekkas and Alexopoulos (2007) 2: Fleury (1970, 1980, this work) 3: Mount Biokovo (Sokač et al., 2012) 4: Brač Island (Gušić and Jelaska, 1990; Cvetko-Tešović et al., 2001) 5-7: Moro et al. (2016) 8: Luperto-Sinni (1976) 9: Frijia et al. (2015) 10: Cruz-Abad et al. (2017).

LAD of *Murgella lata* Luperto Sinni and *Keramosphaera tergestina* (Stache) (Fleury, 1980, figs. 18 and 30) while in others (including the material studied herein) *M. lata* and the first Orbitolinids display overlapping ranges (op. cit., Fig. 25). *Lepinoconus chiochchini* was reported within a rather short interval at its type-locality in southern Italy, “bracketed between the *K. tergestina* level....and the upper limit of the *S. mediterranea* subzone”, that is lower Campanian. With this data, the Orbitolinid levels of Klokova Mountain can be assigned to the uppermost lower-middle Campanian (see Fig. 15 in Frijia et al., 2015: SIS data; Cruz-Abad et al., 2017; Villalonga et al., 2019).

DISCUSSION

The genus *Paracoskinolina* was so far recorded from the upper Berriasian (Bucur et al., 2020) to the middle-upper Albian interval (Maync, 1955; Scott, 2002). The occurrence of an individual species in the Upper Cretaceous was already reported for the genera *Falsurgonina* Arnaud-Vanneau, 1980 (*F. parva* Luperto Sinni & Martin-Chivelet), *Orbitolinopsis* Henson, 1948 (*O. senonicus* Gendrot, 1968), and *Paleodictyoconus* Moullade, 1965 (*P. senonicus* Moullade & Viallard, 1973). As already noted previously, also *Calveziconus* Caus & Cornella, 1982 might belong to this group, showing striking similarities with the lower Aptian *Iraqia* Henson. Concerning *Orbitolinopsis senonicus*, Gendrot (1968, p. 680) noted the presence of a pseudo-keriothecal wall structure *sensu* Douglass (1960) visible only in extreme thin thin-sections. Poorly discernible in the detailed view provided by Gendrot (1968, pl. 6, fig. 6), such a feature has so far not been described from any other species of the genus (e.g., Arnaud-Vanneau, 1980). The four species appear several million years after the larger benthic foraminifera extinction event associated with the Cenomanian – Turonian boundary anoxic/eutrophication event (e.g., Parente et al., 2008). This phenomenon of “reappearance” after longer gaps (or “ghost ranges”; Wills, 2007) may be related to morphological convergence (homeomorphism) (see also Elvis taxa; Fara, 2001) or iterative evolution reflecting common functional constraints. The repeated evolution of peculiar shell morphologies (e.g., digitate) for example are known from planktonic foraminifera during the Cretaceous and Cenozoic (Coxall et al., 2007). Iterative evolution as the main mode of morphological variation in Mesozoic imperforate larger benthic foraminifera has been recently discussed by Septfontaine (2020). This phenomenon appears to be present also in the long-lasting and complex history of the Orbitolinidae stretching from the upper Berriasian to the Paleogene (lower Oligocene) including two main-mass extinctions (Ce/T and K/T). The functional significance of individual test morphologies and structures in the Orbitolinidae (e.g., Hottinger and Drobne, 1980) is poorly constrained and needs further studies.

The distribution pattern of the conical agglutinated taxa reported from the Upper Cretaceous of Greece herein within the Central Mediterranean realm is shown in figure 7. The occurrence of comparable assemblages seems to be characteristic for distinct levels in the lower-middle Campanian of the Adriatic-Dinaridic Carbonate Platform (Italy, Slovenia, Bosnia, Croatia, Greece).

CONCLUSIONS

The taxonomic assessment of the assemblage of conical agglutinated foraminifera (Coskinolinidae, Orbitolinidae) from the Gavrovo–Tripolitza Platform of the external Hellenides (Greece), first described by Fleury (1970) demonstrates that the following taxa are present: *Lepinoconus chiochchini* Cruz-Abad, Consorti & Caus, *Paleodictyoconus* cf. *senonicus* Moullade & Viallard, *Calveziconus lecalvezae* Caus & Cornella, *Dictyoconella complanata* Henson, and *Paracoskinolina klokovaensis* n. sp. The age of this assemblage can be revised to the uppermost lower-middle Campanian. *Paracoskinolina klokovaensis* represents the first record of the genus *Paracoskinolina* Arnaud-Vanneau in the Upper Cretaceous, thus representing either a survivor of the Cenomanian-Turonian boundary extinction or the reappearance of a peculiar morphological trait. Displaying a comparably complex exoskeleton (one rafter and several orders of intercalary beams), *P. klokovaensis* can be considered a rather advanced (or complex) representative of the genus. The occurrence of comparable assemblages of agglutinated conical larger benthic foraminifera seems to be characteristic for distinct levels in the lower-middle Campanian of the Adriatic-Dinaridic Carbonate Platform (Italy, Slovenia, Bosnia, Croatia, Greece).

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