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LEPINOCONUS CHIOCCHINII GEN. N., SP. N., A CONICAL AGGLUTINATED FORAMINIFERA FROM THE UPPER CRETACEOUS OF ITALY

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Keywords: Larger benthic foraminifera; Coskinolinoidea; Systematics; Late Cretaceous; Central Italy.

*Abstract***.** A new conical agglutinated foraminifer, *Lepinoconus chiocchinii* gen. n., sp. n. from the lower Campanian shallow-water platform deposits of the Lepini Mountains (central Apennines, Italy), is described. It has a pseudo-keriothecal wall structure, uniserial arrangement of the adult chambers and multiple apertures. The exoskeleton is constituted by beams (main and intercalary) continuous from one chamber to the next, while the endoskeleton bears pillars. The new taxon is included in the Coskinolinidae family. *Lepinoconus chiocchinii* gen. n., sp. n. is known from southern Italy, Greece and Albania.

Introduction

The uniserial conical agglutinated foraminifera (called informally orbitoliniform foraminifera) are widespread in the shallow platform deposits of the Early and "middle" Cretaceous, but they are much more restricted in their distribution in the Late Cretaceous and Palaeogene, where they occupied only marginal areas of the shallow carbonate platform (Chiocchini & Mancinelli 1977, Hottinger & Drobne 1980; Caus & Cornella 1981; Vecchio et al. 2007; among others). Moreover, the large flat-cones built by ring-shaped chambers typical of the "middle" Cretaceous orbitolines disappeared during the Cenomanian. Hottinger & Drobne (1980) suggested that these large forms developed only during Early and "middle" Cretaceous where these agglutinated foraminifera are not in competition with other larger benthic foraminifera. In the Late Cretaceous, the conical agglutinated foraminifera are in competition with large porcelaneous and lamellar-perforated foraminifera. Consequently, the Late Cretaceous orbitoliniform foraminifera are relatively small, their facies distribution is very limited and their fossil record is discontinuous. These are probably the main reasons why only few taxa have been reported in the literature (*Pseudorbitolina marthae* Douvillé; *Dictyoconella complanata* Henson, *D. minima* Henson , *Dictyoconus mosae* Hofker, *Orbitolinopsis senonicus* Gendrot, *Paleodictyoconus senonicus* Moullade & Viallard, *Abrardia catalaunica* Bilotte, *Calveziconus lecalvezae* Caus & Cornella, *Falsugonina parva* Luperto-Sinni & Martin-Chivelet and *Dictyoconus bakhtiari* Schlagintweit, Rashidi & Babadipour although in several geological works they were mentioned as indeterminate Orbitolinidae (see, for instance, Luperto Sinni & Ricchetti 1978; Chiocchini & Mancinelli 1977).

Therefore the aim of this paper is to contribute to the knowledge of the Late Cretaceous uniserial conical agglutinated foraminifera by describing a new taxon from the Campanian deposits cropping out in the Lepini Mountains.

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Geological Setting

The Lepini Mountains are located in the southern part of the Latium region, central Italy (Fig. 1A). Together with the adjacent Ausoni and Aurunci Mountains, they constitute the Vosci Range (Fig. 1B), which represents a continuous mountain belt of almost 80 km in length and mainly composed of shallow-water carbonates (Accordi 1966; Centamore et al. 2007). During the Mesozoic, the Volsci Range was part of a tropical Tethyan carbonate platform bordered by deep hemipelagic to pelagic domains (Cosentino et al. 2010; Zarcone et al. 2010). From the Early Jurassic to the early Miocene, the shallow-water carbonate sedimentation persisted in

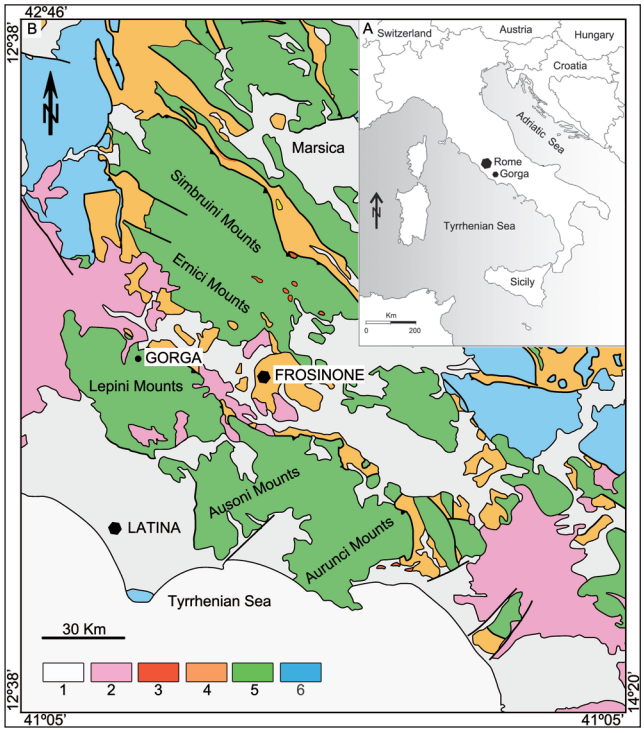

Fig. 1 - A) Geological map of the Central Apennines. 1: Plio-Pleistocene marine and continental deposits; 2: Pleistocene volcanics; 3: Messinian clastic deposits and evaporites; 4: fore-deep siliciclastic deposits of undifferentiated age; 5: Meso-Cenozoic shallow-water limestones; 6: Meso-Cenozoic deep-water limestones. Redrawn from Cosentino et al. (2010). B) Map of Italy showing the geographic position of the village of Gorga.

a long-standing palaeogeographic element (Apennine Platform formerly named Latium-Abruzzi Platform; e.g., Accordi 1966; Chiocchini & Mancinelli 1977; Chiocchini et al., 1995; Chiocchini & Pichezzi, 2016). These deposits were subsequently deformed during the Apennine compressional phase resulting in a fold-and-thrust belt structure (Centamore et al. 2007; Parotto & Tallini 2013; Cardello & Doglioni 2015). The sedimentology, stratigraphy and biostratigraphy of the Cretaceous deposits from Lepini Mountains were previously studied by Carbone & Catenacci (1978), Chiocchini & Mancinelli (2001) and Brandano & Loche (2014) among others. In particular, the classical "Rava Santa Maria" section of Chiocchini & Mancinelli (2001) is located in the Lepini Mountains. The stratigraphic distribution of benthic foraminifera in this section was crucial to the definition of many of the biozones used for the biostratigraphy of Upper Cretaceous shallow water carbonates of the central Apennines (Chiocchini et al. 2008).

Material and Methods

The new taxon comes from a stratigraphic section about 100 m thick measured on the dirt track leading to the base of the Monte Filaro, east of the village of Gorga (base of the section: N 41°39'19"-E 13°07'17"; top of the section: N 41°39'25" -E13°07'11", Fig. 2A, C). This section, falling in the lower part of the Rava Santa Maria section of Chiocchini & Mancinelli (2001), can be attributed lithostratigraphically to the Radiolitid Limestone Formation (Di Stefano et al. 2011) and biostratigraphically to the *A. conica* and *R. scarsellai* biozone (Chiocchini et al. 2008; 2012).

The series is composed of limestones, with intercalated dolomitic levels, characterized by birdseyes and other desiccation structures. The fossil content consists of benthic foraminifera (mainly rotaliids, see fig. 4D in Consorti et al. 2017), the demosponge *Sarmentofascis zamparelliae* Schlagintweit, Frijia & Parente, *Thaumatoporella*, cyanobacteria probably referable to *Decastronema kotori* (Radiočić) and crustacean remains. The most common foraminifera are *Accordiella conica* Farinacci, *Moncharmontia apenninica* (De Castro), *Scandonea mediterranea* De Castro, *Rotalispira scarsellai* (Torre), *R. maxima* Consorti, Frijia & Caus and *Dicyclina schlumbergeri* Munier-Chalmas. *Lepinoconus chiocchinii* gen. n., sp. n. has been found only within its type-level, which is also the type-level of *R. maxima* (Consorti et al. 2017).

The study is based on sixteen thin-sections of limestone. About fifty random sections of *Lepinoconus chiocchinii* have been obtained from sample 057. The studied material is housed in the micropalaeontological collection of the *Universitat Autònoma de Barcelona*, Spain, under the numbers PUAB 82524LP01-16.

For the definition of the architectural terms used in the diagnosis and description of the genus we refer to Hottinger & Drobne (1980) and Hottinger (2006).

Systematic Paleontology

Phylum **Foraminifera** D'Orbigny, 1826
Class **Globothalamea** Pawlowski et al., 2013
Order **Textulariina** Delage & Hérouard, 1896
Superfamily Coskinolinoidea Moullade, 1965
Family Coskinolinidae Moullade, 1965
Genus *Lepinoconus* gen. n.
Type species: *Lepinoconus chiocchinii* sp. n.

Derivatio nominis: named after Lepini Mountains.

Diagnosis: Pseudo-keriothecal shells of high-conical shape with flat or slightly convex base. In the earliest stages of growth, the chambers are probably spirally arranged, and later, uniserial. The multiple apertures are situated in the central area of the cone. The exoskeleton consists of radial partitions (main beams and intercalary beams) in line from one chamber to the next. The endoskeleton consists of irregularly positioned pillars.

Differential diagnosis: The textural and main architectural characteristics of the new genus *Lepinoconus* seem to correspond to those described for the American Palaeogene *Coskinolina* (*Coleiconus*) *elongata* Cole (for details, see Hottinger & Drobne

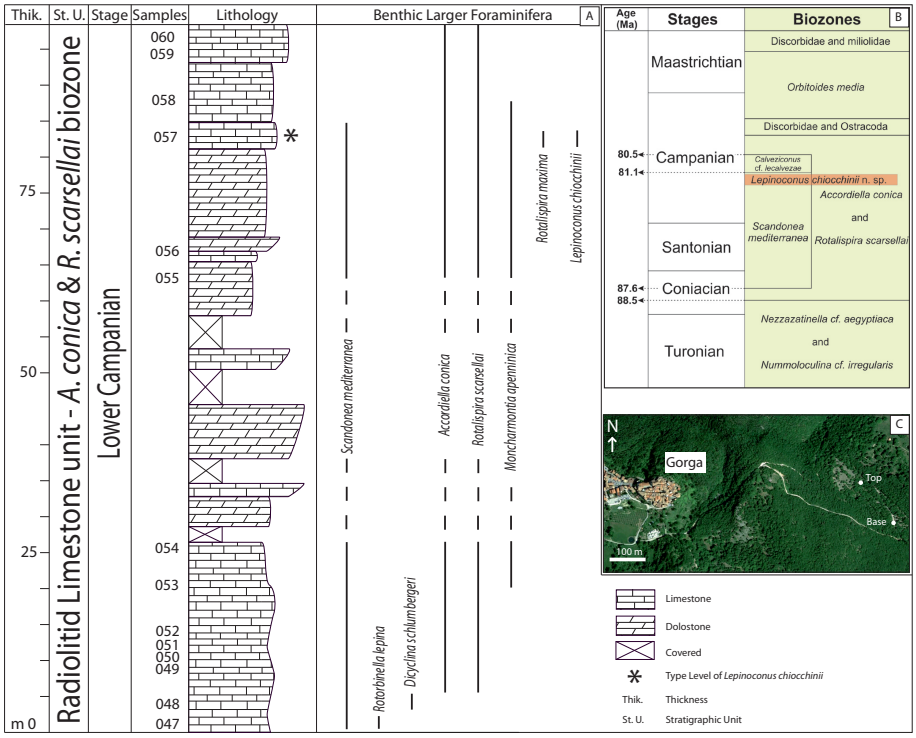

Fig. 2 - A) Stratigraphic log of the section studied in this work with the distribution of selected larger benthic foraminifera. B) Biozones and subzones of the inner platform facies of the Apennine Carbonate Platform according Chiocchini et al. (2008) and Frijia et al. (2015). Numerical age from strontium isotope stratigraphy of Frijia et al. (2015). C) Location of the measured section in the field.

1980, p. 233-234, text-fig. 11; pl. 13, fig. 7-14), but this last taxon (see Loeblich & Tappan 1987, for generic reassessment) has marginal apertures that are lacking in *Lepinoconus*. The representatives of the Tethyan *Coskinolina* (*Coskinolina*) *liburnica* Stache (type species of the genus, for details, see Hottinger & Drobne 1980, p.226, text-fig, 2; pl. 4, fig. 14; pl. 6, fig. 1, 3, 5; pl. 7, fig. 1-15; pl. 8, fig. 1-10) lack exoskeletal elements. The lower Cretaceous genera *Paracoskinolina* Moullade and *Coskinolinoides* Keijzer have simple *Lepinoconus*-like exoskeletal elements, but they do not develop a thick keriothecal structured wall. The new genus differs from *Abrardia* Neumann & Damotte (species type: *Dictyoconus mosae* Hofker) due to the complexity of the exoskeleton of this latter genus, which is formed by beams and rafters; moreover, it lacks a keriothecal structure. *Calveziconus* Caus & Cornella (species type: *C. lecalvezae*) occurs in the same stratigraphic interval as *Lepinoconus* and possess an exoskeleton constituted by alcoves, but the chamber lumen is subdivided by septula. After the illustrations given by the authors and reproduced by Loeblich & Tappan (1987, pl. 170, fig. 7; pl. 171, fig. 1-8; pl. 172, fig. 8-11), the genus *Pseudorbitolina* Douvillé and *Dictyoconella* Henson, unlike *Lepinoconus* gen. n., seem to have a reticulated subepidermal exoskeleton (see also Schlagintweit et al. 2017).

Lepinoconus chiocchinii gen n., sp. n.

Pl. 1, 2

1970 *Coskinolina* sp. – Fleury, pl. 1, fig. 5-7
1976 *Urgonina* sp. - Luperto Sinni, pl. 37, fig. 1-6
1976 *Paracoskinolina* sp. - Luperto Sinni, pl. 38, fig, 1-3
1976 *Abrardia mosae* (Hofker) - Luperto Sinni, pl. 41, fig 1-12.
1977 Orbitolinidae - Chiocchini and Mancinelli, pl. 42, fig. 1,2
1978 Orbitolinidae gen. indet. - Luperto Sinni and Ricchetti, pl. 42, fig. 1-2; 4-6; pl. 43, fig 4; pl. 44, fig. 7-9; pl. 45, fig. 15-17.
2008 Orbitolinidae - Chiocchini et al., pl. 31, fig 1.
?2015 *Accordiella* aff. *conica* - Schlagintweit et al., fig. 6D.

Derivatio nominis: In honour of Prof. Maurizio Chiocchini, who studied the Mesozoic benthic foraminifera from Central Italy and their application in biostratigraphy.

Holotype: Specimen figured in Figure A from Plate I. PUAB 825224LP-01.

Paratypes: Specimens figured in Figure B-D from Plate I. PUAB 825224LP01, 825224LP07, 825224LP02, respectively.

Type locality: Gorga Village, Lepini Mounts (Central Italy). Coordinates: N 41°39'26"- E 13°07'05" (see also fig. 1B, sample 057, of Consorti et al. 2017).

Type level and age: Packstone with *Rotalispira maxima, R. scarsellai, Accordiella conica* and "*Thaumatoporella - Decastronema association*". Campanian.

Diagnosis: High conical shell with pseudo-keriothecal structure (Fig. 3). The marginal chamber cavity is subdivided by exoskeletal elements consisting of beams (main and intercalary) aligned from one chamber to the next. The endoskeleton consists of irregularly positioned pillars. The chambers in the earliest stages of growth form probably a spire. Later, chambers consist of discs uniserially arranged. The available sections are not sufficient to define if there is a significant dimorphism between A and B generations.

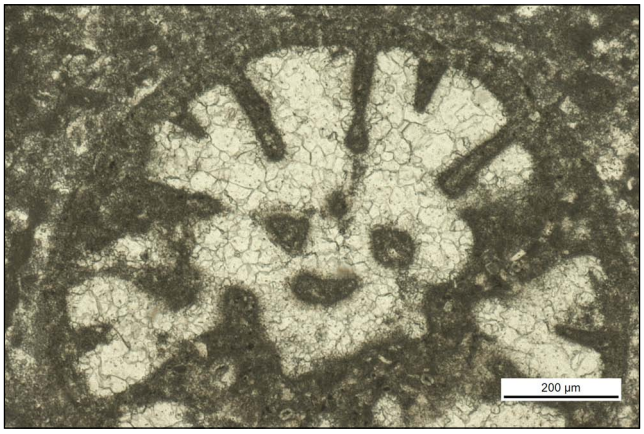

Fig. 3 - Detail of the pseudo-keriothecal structure in transverse section.

Description. Small-sized (maximum length 2 mm; maximum diameter 1 mm; D/L 1/2), high-conical shells with flat to slightly convex apertural face. The chambers in the earliest stage of growth probably form a small trochospire followed by discoidal uniserially arranged chambers, which constitute the main shell. There are 12-13 uniserial chambers per 1 mm axial length in the adult part of the cone. The comparatively thick chamber wall (about 40 µm, Fig. 2) results in a texture formed by closely spaced radial elements ("traverse pores" in Douglas, 1960). The exoskeleton consists of a few and relatively spaced thick beams of two orders (main and intercalary beams), which are aligned from one chamber to the next. The main beams extend from the external wall to the center of the chamber about one half of the radius of the disc, while the intercalary beams occupy only one third of this radius. In transversal sections there are about 10 partitions (main and intercalary beams) for a circumference diameter of 0.5 mm, and 18-20 (main and intercalary beams) for a diameter of 1mm have been counted in transverse sections.

The central part of the uniserial discoid chambers is occupied by few pillar-shaped elements. There are about 2-3 pillars in the growth stage corresponding to a cone diameter of 0.5 mm; 5-6 for a cone diameter of 1 mm. The earliest stages lack endoskeletal elements. The apertures are rounded and have a large caliber which is around 0.04 mm. The early growth stages are difficult to recognize, although some sections cutting the apex of the shell almost axially suggest a short spire of half moon-shaped chambers following a simple proloculus.

Differences and similarities. *Lepinoconus chiocchinii* differs from *Orbitolinopsis senonicus* Gendrot (from the Coniacian-Santonian of Martigues, South-east of France) and from *Calveziconus lecalvezae* Caus & Cornella (from the Campanian of the Southern Pyrenees, North-east of Spain) in their endoskeleton-type, with "cupola" in *O. senonicus* and septula in *C. lecalvezae*, respectively. *Abrardia mosae* and *A. catalaunica* from Aquitania (South-west France) and Southern Pyrenees, respectively, have an exoskeleton constituted by beams and rafters, instead of only beams. *Paleodictyoconus senonicus* (from the Santonian of the Iberian Ranges) differs from *L. chiocchinii* for the greater complexity of its complex exoskeleton (beams and rafters forming a sub-epidermal network). *Falsurgonina parva* (from the Santonian of the Prebetic domain), differs from

PLATE I

Transmitted light microphotographs of *Lepidoconus chiocchini* gen. n., sp. n. A: Holotype; B-D: Paratypes.
A - Approximately axial section (non-centered).
B-D - Slightly oblique transverse sections cutting at different steps of growth (see their position in figure A) and showing the pillar development through the ontogeny.
E, F, K-N - Slightly oblique section close to the axial plane showing the beams extending deep in the chamber lumen. Note the earliest apical planispiral chambers in F.
G, H - Oblique sections cutting successive septa.
I, J, M - Oblique transverse sections.
A, B: PUAB82524LP01. C: PUAB 82524LP07. D: PUAB 82524LP02. E, J, K: PUAB 82524LP11. F, G: PUAB 82524LP03. H, I, N: PUAB 82524LP06. L: PUAB 82524LP12. M: PUAB 82524LP05.
b: beam, ch: chamber, ew: external wall, f: intercameral foramina, p: pillar, s: septum.

PLATE II

Transmitted light microphotographs of *Lepidoconus chiocchini* gen. n., sp. n.
O, P - Tangential sections parallel to the cone lateral surface, showing the exoskeletal elements aligned from one chamber to the next.
Q, U - Fragmented tangential sections with the exoskeletal elements.
R, T - Slightly oblique section close to the axial plane.
S, V-X, Z-AB - Tangential oblique sections.
Y - Oblique transverse section.
O: PUAB 82524LP09. P, Q, W: PUAB 82524LP13. R, V: PUAB 82524LP10. S, AB: PUAB 82524LP12. T: PUAB 82524LP06. U: PUAB 82524LP02. X: PUAB 82524LP08. Y, Z: PUAB 82524LP04.
b: beam, ch: chamber, ew: external wall, f: intercameral foramina, p: pillar, s: septum.

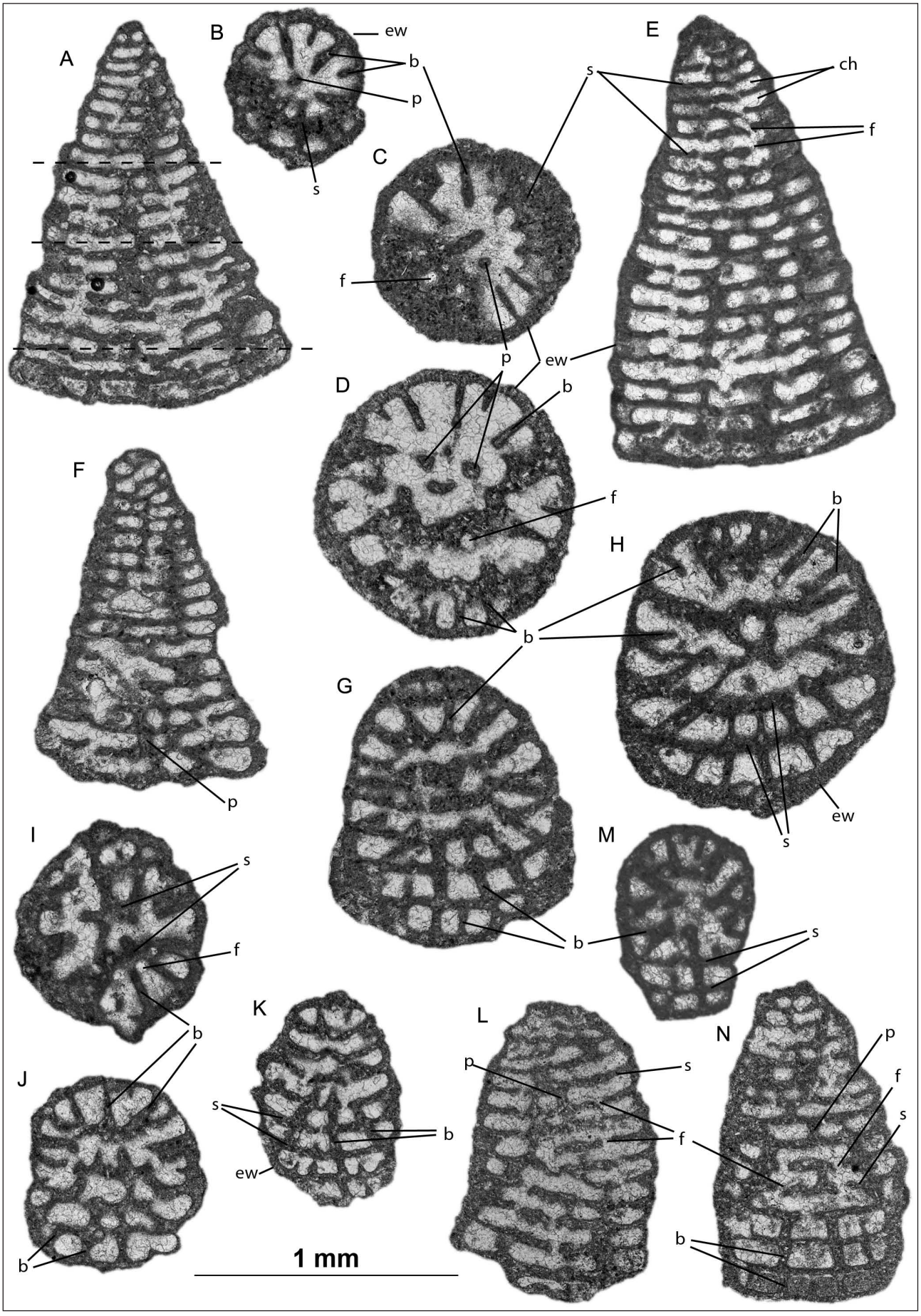
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PLATE I

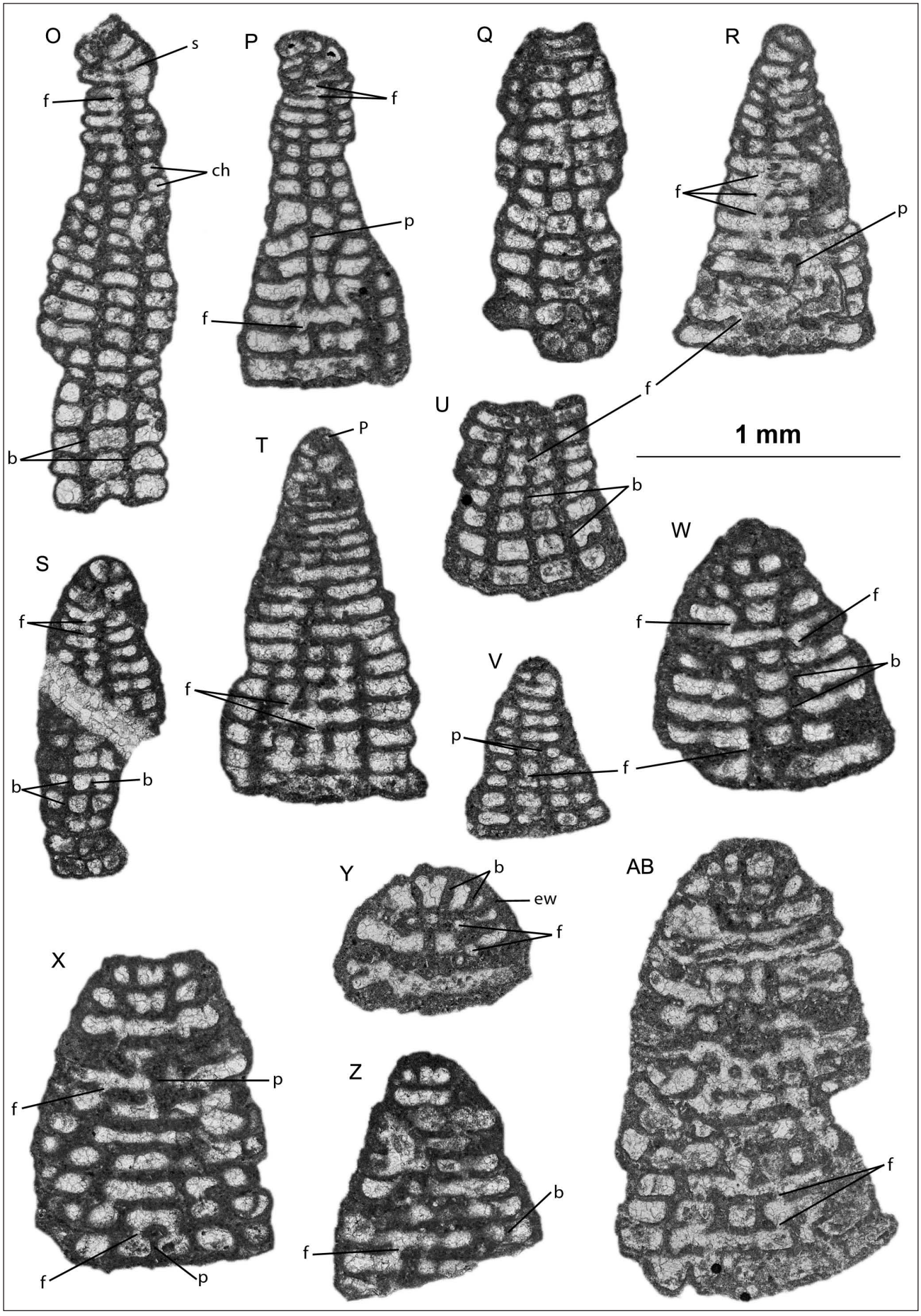
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PLATE II

L. chiocchinii for the endoskeleton made of "cupola". The recently described *Dictyoconus bakhtiari* from the Tarbur Fm. in the Zagros Mountains (Iran, Schlagintweit et al., 2017) has a complex reticular subepidermal exoskeleton like the species attributed to *Dictyorbitolina* and *Pseudorbitolina.*

Stratigraphic and geographic occurrence. Lower Campanian of Central and Southern Italy, Greece and Albania.

Discussion

The high conical, agglutinated uniserial *Lepinoconus chiocchinii* gen. n., sp. n. shears with the Palaeogene American genus *Coleiconus* Hottinger and Drobne the presence of exoskeleton in alcoves (only beams) with a thick pseudo-keriothecal structured wall and a pillared endoskeleton. In contrast, the marginal apertures visible in *Coleiconus* are not present in *Lepinoconus* gen. n. The exoskeleton pattern with deep main beams (and short intercalary beams) in line from one chamber to the next reminds *Coskinolinoides* Keijzer, but this latter genus lacks endoskeletal elements.

Lepinoconus chiocchini gen. n., sp. n. is a characteristic component of mudstone-wackestone facies deposited in restricted shallow-water environments. The type-level consists of foraminiferal-calcimicrobial laminated facies with *"Thaumatoporella-Decastronema* association" and crustacean remains (see fig. 4D in Consorti et al. 2017; other examples of this facies are figured in Ruberti & Toscano 2002, fig. 4B, and Schlagintweit et al. 2015, fig. 4C, 5A).

Field correlation suggests that the section studied in this paper corresponds to the upper part of the section of Consorti et al. (2017), which is located only 1.5 km to the south of the section studied in this paper. According to this correlation, the type-level of *L. chiocchinii* is younger than the *Keramosphaerina tergestina* level, which was dated by means of strontium isotope stratigraphy as early Campanian (82.09 Ma) in Consorti et al. (2017).

In the studied section, the type-level of *L. chiocchinii* coincides with the last occurrence of *Scandonea mediterranea*, which is dated 81.1 Ma in the southern Apennines (Frijia et al. 2015). The distribution of *Lepinoconus chiocchinii* gen. n., sp. n. in the Lepini Mountains seems thus to be very narrow. It is bracketed within the *K. tergestina* level and the upper limit of the *S. mediterranea* subzone, spanning in a range of nearly 1 Ma. This record is only partially in agreement with Luperto Sinni & Richetti (1978), who indicated the stratigraphical distribution of *L. chiocchinii* (reported as *Urgonina* sp., *Paracoskinolina* sp. and *Abrardia mosae*; see synonym list in this paper) in the Apulian Platform spanning from the base of *Keramosphaerina* level until the upper part of the *Orbitoides* subzone.

Conclusions

A detailed study of the Upper Cretaceous shallow-water platform deposits of Lepini Mountains has provided abundant and well preserved specimens of a new conical, agglutinated, uniserial foraminifer that has been included in the Coskinolinoidea Superfamily. *Lepinoconus chiocchinii* gen. n., sp. n. has a typical exoskeleton in alcoves (only beams) with a pseudo-keriothecal wall. The endoskeleton is constituted by irregularly distributed pillars. The new taxon has been found in restricted platform areas with *"Thaumatoporella-Decastronema* association" and crustacean remains. The stratigraphic distribution of *Lepinoconus chiocchinii* gen. n., sp. n. in the Lepini Mounts seems to be very narrow (early Campanian). *Lepinoconus chiocchinii* gen. n., sp. n. geographical distribution seems to be wide, comprising southern Italy, Greece and Albania.

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