

## **CRIBELLOPSIS MOULLADEI (SAINT-MARC, 1974) NOV. COMB. (FORAMINIFERIDA, ORBITOLINIDAE): AN ALBIAN MARKER TAXON OF THE SOUTHERN NEOTETHYSIAN MARGIN**

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**Abstract** The species *Simplorbitolina moulladei* described by Saint-Marc, 1974 from the middle Albian of Lebanon is taxonomically revised and assigned to the genus *Cribellopsis* Arnaud-Vanneau, 1980. Both, *Paracoskinolina prestatii* Delmas & Peybernès, 1981 (middle-upper Albian of Somalia) and *Cribellopsis arnaudae* Chiocchini, 1989 (Albian of Italy) are considered as subjective junior synonyms. *Cribellopsis moulladei* is regarded a taxon restricted to the southern (here: "African") Neotethysian margin. All other representatives of the genus *Cribellopsis* were reported from the northern Neotethysian margin.

**Keywords:** Foraminifera, Lower Cretaceous, Systematics, Biostratigraphy, Palaeogeography

### INTRODUCTION

Saint-Marc (1974) described a new Orbitolinidae as *Simplorbitolina moulladei* from the middle Albian of Lebanon, respectively a section named Dlebta-Chenan Aaïr, located about 12 km north-east of Beirut. It was illustrated by six sections (three axial and three transverse). *S. moulladei* represents a poorly known taxon and has not been illustrated in the literature since then. It has been validly described (holotype designation etc.), but its taxonomy needs revision. The marginal zone of *S. moulladei* species lacks rafters (= horizontal partitions), possesses beams and up to three intercalary beams. The rather wide central part of the test consists of a poorly defined reticular zone, formed by anastomosing short radial partitions (beams) which alternate in position between subsequent chambers (Saint-Marc, 1974, p. 226 "structure partiellement réticulaire"). In *Simplorbitolina* Ciry & Rat, 1953 instead the primary partitions are rather long (almost reaching the centre of the test), meandriform, forming a radial zone (see Hottinger, 2006), followed by a distinctly reduced reticulate central part (Arnaud-Vanneau, 1980, fig. 218; Schroeder, 1985). The taxonomic revision provided in the present paper results in the assignment of the species *Simplorbitolina moulladei* to the genus *Cribellopsis* Arnaud-Vanneau, 1980.

### SYSTEMATICS

Phylum Foraminifera d'Orbigny, 1826  
 Class Globothalamea Pawlowski et al., 2013  
 Order Loftusiida Kaminski & Mikhalevich in Kaminski, 2004  
 Suborder Orbitolinina Kaminski, 2004  
 Superfamily Orbitolinoidea Martin, 1890  
 Family Orbitolinidae Martin, 1980  
 Subfamily Dictyoconinae Moullade, 1965  
 Genus *Cribellopsis* Arnaud-Vanneau, 1980  
 Type-species: *Orbitolinopsis neolongata* Cherchi & Schroeder, 1978

**Remarks:** The genus *Cribellopsis* is characterized by a simple (= without partitions), often bilocular (= protoconch and deuteroconch) embryo located slightly eccentric near the apex or at the beginning of a small spire, a marginal zone subdivided by vertical partitions (beams, Hottinger, 2006), often with several orders, and a rather wide central reticulate zone. Horizontal partitions (rafters) are absent in the species described so far. Foramina show an oblique and vertical arrangement (Arnaud-Vanneau, 1980; Chiocchini, 1989; Clavel in Granier et al., 2013). *Cribellopsis* represents a rather simply structured orbitolinid whose species are classically differentiated above all by dimensional and morphological criteria.

*Cribellopsis moulladei* (Saint-Marc, 1974) comb. nov.  
 Fig. 1a–s

1974 *Simplorbitolina moulladei* n. sp. – Saint-Marc, p. 225, pl. 2, figs. 3–8.

1977 *Coskinolina sunnilandensis* Maync – Prestat, pl. 12, figs. 1–2.

1977 *Coskinolina* sp. – Prestat, pl. 12, figs. 3–7, 14–17.

1977 *Iraqia* sp. – Prestat, pl. 12, figs. 8–10 (B-forms).

1981 *Paracoskinolina prestatii* n. sp. – Peybernès and Delmas, 81, figs. 1–7.

1982 *Paracoskinolina prestatii* nom. nud. – Peybernès, pl. 2, figs. 9–12.

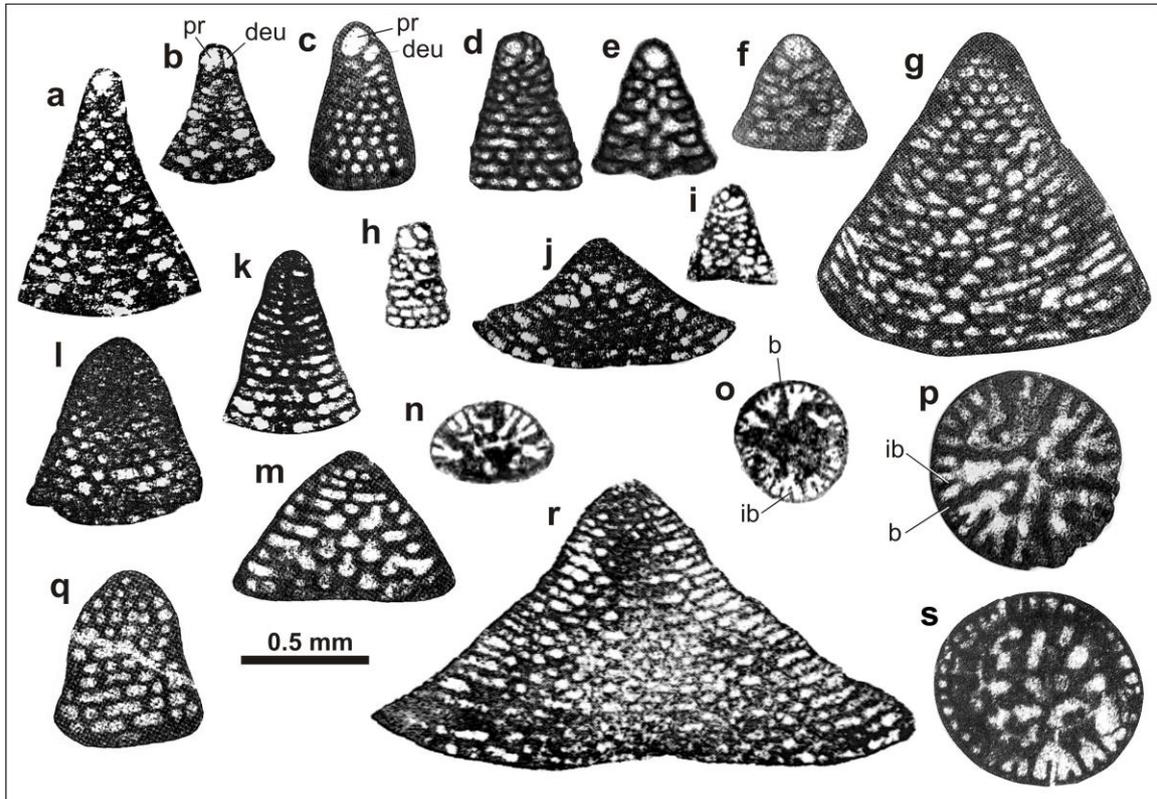
1989 *Cribellopsis arnaudae* n. sp. – Chiocchini. p. 42, pls. 1–2.

2012 *Cribellopsis arnaudae* Chiocchini – Chiocchini et al., pl. 69, fig. 1 pars, figs. 2–10.

2018 *Cribellopsis* aff. *arnaudae* Chiocchini – Cruz Abad, p. 111, figs. 92–93.

2019 in press *Cribellopsis arnaudae* Chiocchini – Schmitt et al., fig. 5D.

**Descriptions:** Test finely agglutinating, medium- to high conical. The cone base is almost flat in juvenile specimens, becoming convex in adult forms. Large sized,



**Fig. 1** *Cribellopsis moulladei* (Saint-Marc) nov. comb., Albian of Somalia (a–b, j–l, r), Italy (c–g, m, p–q, s), and Lebanon (h–i, n–o; type material). a–f Axial sections of megalospheric specimens. g, r Subaxial sections of possibly microspheric specimens. h–i, k Subaxial sections of megalospheric specimens. j, m Tangential-oblique sections. l, q Tangential sections. n–p, s Transverse sections. a–b, k extracted from Peybernès & Delmas (1981, pl. 1, fig. 1–2, h) as *Paracoskinolina prestatii*; j, l extracted from Peybernès (1982, pl. 2, fig. 12, fig. 11) illustrated as *Paracoskinolina prestatii*; c, f–g, m, p, q, s extracted from Chiocchini (1989, pl. 1, fig. 14, fig. 5, pl. 2, fig. 8, pl. 1, fig. 11, fig. 10, fig. 12, fig. 4) illustrated as *Cribellopsis arnaudae* n. sp.; d extracted from Schmitt et al. (2019, in press, fig. 5d) illustrated as *Cribellopsis arnaudae* Chiocchini; e extracted from Cruz-Abad (2018, fig. 93J) illustrated as *Cribellopsis* aff. *arnaudae* Chiocchini; h–i, n–o extracted from Saint-Marc (1974, pl. 2, figs. 6, 3–4, 7) illustrated as *Simplorbitolina moulladei* n. sp. r extracted from Prestat (1977, pl. 12, fig. 10) illustrated as *Iraqia* sp. Abbreviations: b = beam (or main partition), deu = deuteroconch, ib = intercalary beam, pr = proloculus

medium-conical specimens, which may show a slight depression in the central part of the base are interpreted as microspheric forms (Fig. 1j, r). The megalospheric embryo is situated at the rounded apex or positioned slightly eccentrically (Fig. 1a–f, ?h). Sometimes a two-chambered simple (= no partitions) embryo consisting of a subspherical protoconch and a smaller hemispherical deuteroconch is observable (Fig. 1b–c, ?h). There are up to ~25 uniserial chambers in adult specimens. The well-developed marginal zone is subdivided by two orders of beams, primary beams and up to 3 short intercalary beams (Fig. 1o–p, s). The primary beams are either straight or slightly undulating. Inwards they fuse laterally thereby forming a loose central network (Fig. 1n, p, s). In axial sections, they display an alternating position between subsequent chambers and a tendency to thicken in direction to the apex resulting in a triangular shape. In shallow tangential sections the beams exhibit an alternating rectangular pattern (Fig. 1c, h, l, q). The foramina distributed in the central zone are predominantly arranged oblique but may be also vertical.

**Dimensions:** see Table 1 for *Cribellopsis moulladei* (Saint-Marc) nov. comb., compared to proposed syno-

nymy. Further comments are provided in the subchapter "Comparisons".

**Comparisons:** The following comparisons and remarks essentially refer to the proposed synonymy with the species *Paracoskinolina prestatii*, *Cribellopsis arnaudae*, and a form recently described by Cruz-Abad (2018) as *Cribellopsis* aff. *arnaudae*. It is worth mentioning that all the mentioned taxa do not show any structural differences and cannot satisfactorily be separated biometrically (Table 1; and further comments in the text). For "*Simplorbitolina*" *moulladei*, no section displaying the embryo was provided. Saint-Marc (1974) just noted an initial spire of 3 to 4 chambers, but a simple (= non-septulate) bilocular embryo (protoconch + deuteroconch) is barely recognizable in the specimen illustrated in his plate 2, figure 6 (re-illustrated in Fig. 1h). A slightly eccentric biloculine embryo is reported from both "*Paracoskinolina*" *prestatii* (see Fig. 1b), and *Cribellopsis arnaudae* (Fig. 1c). The differences of the mentioned taxa refer to the dimensional data as indicated in the original works.

**Table 1** Biometrical parameters of *Cribellopsis moulladei* (Saint-Marc, 1974) nov. comb. and its assumed junior synonyms *Paracoskinolina prestatii* Peybernès & Delmas, 1981, *Cribellopsis arnaudae* Chiocchini, 1989 and *Cribellopsis* aff. *arnaudae* Chiocchini (see Cruz-Abad, 2018). a.a. = apical angle; H = test height; D = test diameter; n = number of chambers last 0.5 mm of the test; \* measured from the original illustrations; ? uncertainty due to poor quality of illustration.

Species	a.a.	H (mm)	D (mm)	H/D	chamber height (µm)	n	Diameter proloculus (mm)
<i>Simplorbitolina moulladei</i> Saint-Marc, 1975	30-50 *	up to 0.55	up to 0.53	1.0-1.63	40 *-50	-	-
<i>Paracoskinolina prestatii</i> Peybernès & Delmas, 1981	40-50 * (A-form) ~90 (B-form)	up to 0.86	0.45-0.61	1.0-1.5	45 *?	11 *?	~0.05-0.1 *?
<i>Cribellopsis arnaudae</i> Chiocchini, 1988	40 *-65	0.45 *-1.290	0.45 *-1.275	~ 1 or slightly higher	65-85 (40-50 ?B-forms)	7-10	~0.09-0.095
<i>Cribellopsis</i> aff. <i>arnaudae</i> Chiocchini sensu Cruz (2018)	30-45	up to 1.7 mostly ~ 0.8-1.0	up to 1.1 mostly 0.5-0.7	1.1-1.7	40-60	6-9	-

#### ***Paracoskinolina prestatii* Peybernès & Delmas, 1981**

The axial sections provided by Peybernès and Delmas (1981) as well as those from Prestat (1977; see synonymy) clearly evidence that the "pillars" are not aligned between subsequent chambers (Fig. 1a–b, j–l, r). This feature, however, is one of the diagnostic characteristics of the genus *Paracoskinolina* Moullade (see Arnaud-Vanneau, 1980, or Clavel in Granier et al., 2013, p. 153). Therefore, the upper? Albian Somali taxon can not be a species of *Paracoskinolina*. In fact, the partitions of the central zone in *Cribellopsis* are thickening "upwards" (= towards the apex; Arnaud-Vanneau, 1980, p. 668, "épaississement vers le haut"). This feature observable in axial sections, was also reported by Saint-Marc (1974, p. 225) for "*Simplorbitolina*" *moulladei* ("cloisons radiales ont une section triangulaire, en cône renversé"). It is worth mentioning here that this aspect of the central zone is described from several doubtful paracoskinolinas such as *P. tunesiana* Peybernès, *P. pfenderae* Canérot & Moullade, *P. hispanica* Peybernès, or *P. querolensis* Canérot & Peybernès as "hemi-pillars...pointe en haut" (e.g., Peybernès and Delmas, 1981, p. 82). Transverse sections of *Cribellopsis* show that the vertical elements of the central zone are not isolated columnar pillars but sections of a reticulate (or anastomosing), often loose and poorly constrained, network formed by laterally fused main partitions (e.g., Fig. 1s). This statement does not mean *per se* that all of the above cited species belong to *Cribellopsis*. Their taxonomic status must be clarified individually.

#### ***Cribellopsis arnaudae* Chiocchini, 1989**

The Somali species *Cribellopsis prestatii* possess striking similarities (e.g., rather voluminous embryo at the apex or slightly eccentric, bilocular with deuteroconch, equivalent exoskeleton, central zone with poor tendency to form an anastomosing reticulum, first and second order vertical partitions) with a taxon described by Chiocchini (1989)

as *Cribellopsis arnaudae* from the upper Albian of southern Italy (see Chiocchini et al., 2012, fig. 9) (Fig. 1c, f–g, m, p, q, s). For both *P. prestatii* and *C. arnaudae*, the original descriptions indicate (among others) as distinguishing criteria the comparably large-sized (sub)apical bilocular embryo and the ratio test height/diameter commonly around 1 (Peybernès and Delmas, 1981, p. 82; Chiocchini 1989, p. 46). Although Peybernès and Delmas (1981, p. 82) had only poorly preserved transverse sections at hand, they noted the presence of three intercalary beams ("trois cloisons secondaires"). The only differences seem to be a higher apical angle (see comments below for *C. aff. arnaudae* of Cruz-Abad 2018) and smaller dimensions in *C. prestatii*, as indicated in the original descriptions (see comments below) (see Table 1). The differences can partly be explained by the exclusion of large-sized (presumably B-forms) of *C. prestatii* on the one hand, combined with exclusion of juvenile specimens of *C. arnaudae* on the other hand. Prestat (1977, pl. 12, fig. 10) illustrated from the same level a large-sized low-conical orbitolinid of visibly identical internal structure as *Iraqia* sp. This specimen, here interpreted as a microspheric specimen, was not included in the species concept of *P. prestatii* by Peybernès and Delmas (1981), and is here re-illustrated in Fig. 1r. Chiocchini (1989, pl. 2, figs. 2, 6, 15), on the other side, illustrated specimens of *C. arnaudae* with test diameter < 0.4 mm, but the lowest value for the corresponding range was indicated as 0.685 mm. With maximum test height of 0.55 mm (Saint-Marc, 1974), the Lebanese specimens obviously belong to small-sized juvenile forms. Another example is the number of chambers in adult specimens indicated as "12 to 18" by Chiocchini (1989). The two large specimens shown in Chiocchini (1989, pl. 2, figs. 1 and 8), display about 25 chambers (almost the double maximum size as indicated). Summarizing, this means principally, that biometric data and respectively comparison tables included in original

**Table 2** Palaeogeographic distribution of species of *Cribellopsis* Arnaud-Vanneau along the two opposite margins of the Neotethysian Ocean (for further details on the species see Arnaud-Vanneau, 1980).

Species of <i>Cribellopsis</i>	Northern Neotethysian margin	Southern Neotethysian margin
<i>C. moulladei</i> (Saint-Marc)	-	X
<i>C. elongata</i> (Dieni, Massari & Moullade)	X	-
<i>C. neoelongata</i> (Cherchi & Schroeder)	X	-
<i>C. schroederi</i> Arnaud-Vanneau	X	-
<i>C. thieuloyi</i> Arnaud-Vanneau	X	-

descriptions must be carefully checked, in cases be re-measured, and interpreted by subsequent workers (e.g., exclusion/inclusion/mixing of juvenile, adult specimens, A- and B-forms).

### *Cribellopsis* aff. *arnaudae* Chiocchini (Cruz-Abad, 2018)

Last but not least, *Cribellopsis* aff. *arnaudae* Chiocchini has recently been reported from the upper Albian of southern Italy by Cruz (2018) differing from *C. arnaudae* by a more acute apical angle and a higher number of chambers in the last 0.5 mm test length. In any case, the higher apical angle fits within the range observed in "*P. prestatii*". The differences are here interpreted as environmentally driven rather than being of taxonomic importance (= separate species). It is worth mentioning, that in juvenile specimens the apical angle is mostly higher whereas in adult stages there is a tendency for test widening (Schroeder, 1962, p. 174). In conclusion, also the forms described as *Cribellopsis* aff. *arnaudae* Chiocchini by Cruz-Abad (2018) are considered as subjective synonyms of *Cribellopsis moulladei* as interpreted herein.

**Stratigraphy:** Peybernès and Delmas (1981) described *Paracoskinolina prestatii* from the upper? Albian Mustahil Formation of Somalia based on material from Prestat (1977) (see synonymy). It is worth mentioning that the top of the Mustahil Formation is considered an early-middle Albian age by Russo et al. (1991). There are contrasting views about the stratigraphic distribution of *Cribellopsis arnaudae* from Italy. In the original description *C. arnaudae* was considered a good marker species for lower Albian inner platform carbonate facies (Chiocchini, 1989, p. 40). Later, in a new stratigraphic compilation, *C. arnaudae* was assigned a short interval within the lowermost upper Albian (Chiocchini et al., 2012, fig. 9). In a recent contribution by Schmitt et al. (2019, in press), *C. arnaudae* was reported from the lower Albian based on Strontium isotope stratigraphy (and biostratigraphic data). Taking into account these contrasting views, it appears pragmatic, for the moment being, to consider *C. moulladei* an Albian marker taxon.

**Palaeobiogeography:** *C. moulladei* (Saint-Marc) and the proposed junior synonyms *Paracoskinolina prestatii* and *Cribellopsis arnaudae* have so far not been reported from the northern Neotethysian margin. Lebanon, southern Italy and Somalia were belonging to the southern Neotethysian margin (e.g., Dercourt et al., 1993). With respect to the Northern Neotethysian margin, there were

more endemic taxa of Lower Cretaceous Orbitolinidae (Cherchi et al. 1981; Arnaud-Vanneau 2006) (Table 2). *C. neoelongata* (Cherchi & Schroeder, 1978), *C. elongata* (Dieni et al., 1963), *C. thieuloyi* Arnaud-Vanneau, 1980 and *C. schroederi* Arnaud-Vanneau, 1980 are all only known from areas formerly belonging to the northern Neotethysian margin in the upper Hauterivian-lower Aptian period (Clavel in Granier et al., 2013).

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