

# TAXONOMIC AND BIOSTRATIGRAPHIC REMARKS ON *TORINOSUELLA* MAYNC, 1959 AND *BALKHANIA* MAMONTOVA, 1966, LARGER BENTHIC FORAMINIFERA FROM THE LOWER CRETACEOUS OF IRAN (SANGESTAN, TIRGAN FORMATIONS)

Felix Schlagintweit

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**Abstract.** The monospecific genera *Torinosuella* Maync [type-species *T. peneropliformis* (Yabe & Hanzawa)] and *Balkhania* Mamontova (type-species *B. balkhanica* Mamontova) have been reported from the Lower Cretaceous of Iran, respectively the ‘Carbonate Member’ of the Sangestan Formation (Central Iran) and the Tirgan Formation (NE Iran). The literature review reveals a range of late? Tithonian–early Barremian for *Torinosuella* and late Barremian–early Aptian for *Balkhania*. In a recent publication dealing with the ‘Taft’ Formation (Central Iran) and the Tirgan Formation (northeastern Iran), both taxa have been lumped together and described as two morphotypes of *B. balkhanica* based essentially on size differences. This mixing was associated with incorrect phylogenetic, taxonomic, biostratigraphic (e.g., First Appearance Datum) and palaeoecological conclusions that are herein addressed and corrected. Without clarification about the spatial and temporal distribution of individual taxa, the usefulness of larger benthic foraminifera for biostratigraphy, palaeoecology and palaeobiogeography would be distinctly reduced.

**Keywords:** Foraminifera, classification, Early Cretaceous, Iran

## INTRODUCTION

The informal group of larger benthic foraminifera provides valuable data for biostratigraphy (e.g., Schroeder & Neumann, 1985; Bassoullet, 1997; Simmons & Aretz, 2020), palaeoecology (e.g., Pélissié et al., 1984), and palaeobiogeography, namely the delineation of bioprovinces (e.g., Cherchi et al., 1981; Pelissié et al., 1982) or questions on migration pathways. This information is lost or diluted when incorrect determinations of taxa and incorrect age-calibrations find their way into the literature. Therefore, there is a need of clarification. Such inadequate identifications are often due to section planes in thin-sections that do not allow generic or specific determinations and should therefore necessarily be treated in open nomenclature. *Balkhania balkhanica* Mamontova represents a good example of a larger benthic foraminifera that is interesting from biostratigraphic, palaeobiogeographic and palaeoecological viewpoints. Originally described from the Barremian of Turkmenistan (Mamontova, 1966), it has subsequently been reported from late Barremian–early Aptian strata of Afghanistan (Kaefer, 1967 as *Pseudochoffatella gigantea*, see Cherchi & Schroeder, 1982), central Iran (Bucur et al., 2012; Schlagintweit et al., 2013a, b, 2020), northeastern Iran (Taherpour Khalil Abad et al., 2013), and Lebanon (Granier et al., 2016). From a microfacies viewpoint, *B. balkhanica* is found either in wacke- to floatstones with dasycladaleans and other benthic foraminifera or in strata with ooids, orbitolinids, calcareous benthic foraminifera, dasycladalean algae, echinoids and bryozoans in a more external platform or outer shelf setting. The literature review suggests a Barremian–early (or earliest upper?)

Aptian range for *B. balkhanica*. However, in a recent contribution (Gheiasvand & Bartolini, 2023), the first occurrence of *B. balkhanica* has been recorded ostensibly as far back as the late Valanginian with consequent implications for phylogenetic, taxonomic, biostratigraphic, and palaeoecological conclusions that are herein considered erroneous. As discussed below, this appears to be the result of conflating a morphotype of *B. balkhanica* with *Torinosuella peneropliformis* (Yabe & Hanzawa).

## TAXONOMY AND SYNONYMY

The two compared taxa, *Balkhania* and *Torinosuella*, are both assigned to the family Cyclamminidae Marie specifically the subfamily Pseudochoffatellinae Loeblich & Tappan (Kaminski, 2014). Genera belonging to this subfamily and also the Choffatellinae Maync share a ‘choffatellid’ network (see Hottinger, 2006). They are distinguished by type of coiling, apertural (foraminal) features and the presence/absence of endoskeleton features, e.g., pillars (Loeblich & Tappan, 1987). For descriptions the reader is referred to Maync (1959) and Cherchi & Schroeder (2005) for *Torinosuella* and to Mamontova (1966) and Cherchi & Schroeder (1982) for *Balkhania*. In the following treatment, updated synonymy lists are provided for both taxa.

*Balkhania balkhanica* Mamontova, 1966

Figs. 1a, c, e-f

\*1966 *Balkhania balkhanica* nov. gen., nov. sp. – Mamontova: p.145, figs.1-2.

1967 *Pseudochoffatella gigantea* n. sp. – Kaefer, pl. 23, fig. 8, pl. 24, figs. 1-7.

1982 *Balkhania balkhanica* Mamontova – Cherchi & Schroeder, pl. 3, figs. 1-3, 5 (illustrations from Mamontova), pl. 3, figs. 4, 6-8 (illustrations from Kaefer).

1987 *Balkhania balkhanica* Mamontova – Loeblich & Tappan: pl. 104, figs. 1-8 (illustrations from Mamontova and Kaefer).

2012 *Balkhania balkhanica* Mamontova – Bucur et al., fig. 7a.

2013b *Balkhania balkhanica* Mamontova – Schlagintweit et al., fig. 4B pars.

2015 *Dicyclina schlumbergeri*, *Pseudochoffatella cuvillieri* – Babazadeh & Dehej, fig. 7i-k, q-r.

2016 *Balkhania balkhanica* Mamontova – Granier et al., text-fig. 7, pl. 5, fig. 21, pl. 6, figs. 1-7.

non 2017 *Balkhania balkhanica* – Hemmati et al., pl. 1, figs. 13 and 19, pl. 3, fig. 14? (= *Torinosuella peneropliformis*).

2019 *Balkhania balkhanica* Mamontova – Bucur et al., fig. 14a-d.

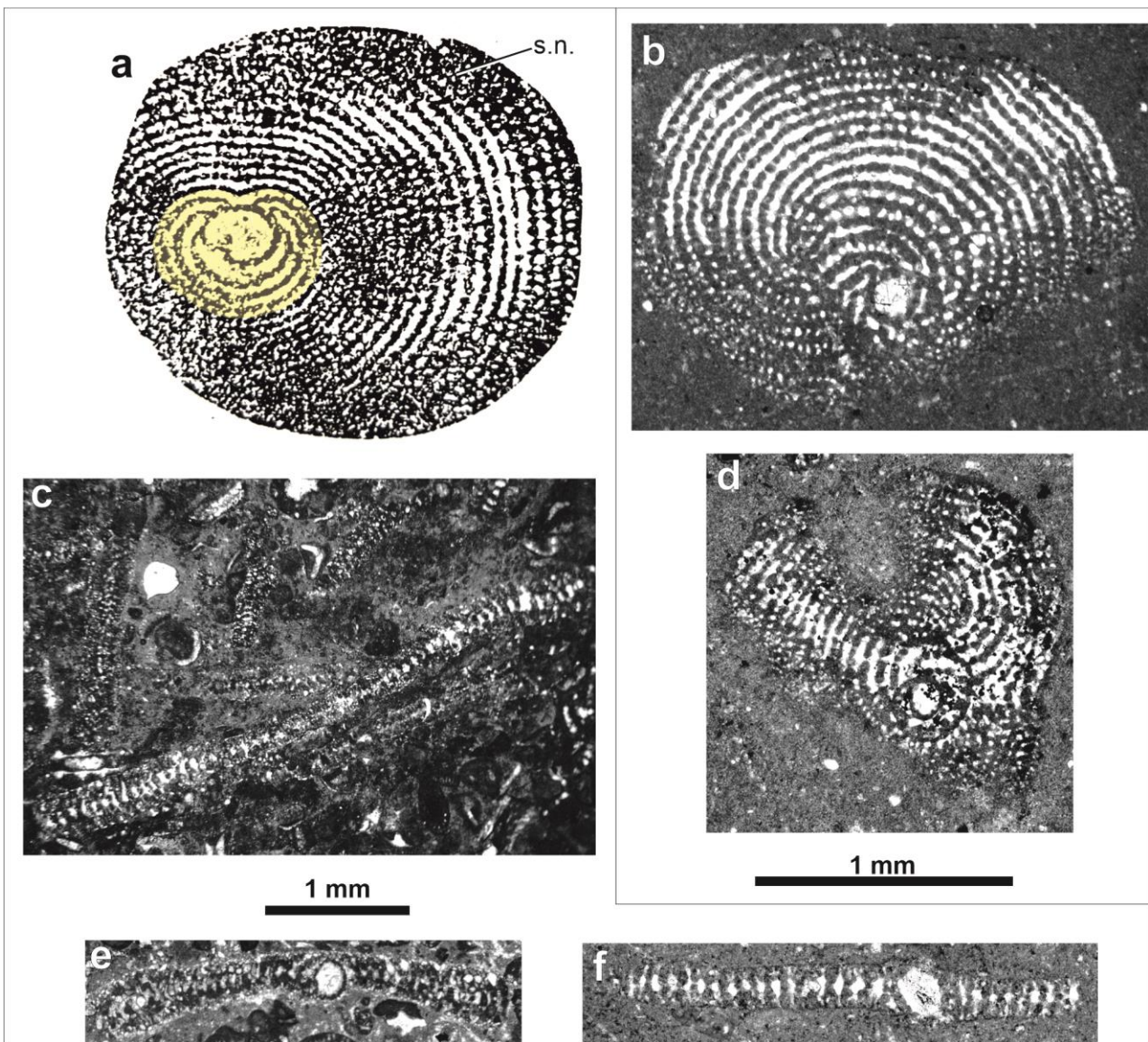
2019 *Balkhania balkhanica* – Gheiasvand et al., fig. 7 specimens S. no. 280 and no. 285, fig. 9d.

2020 *Balkhania balkhanica* Mamontova – Schlagintweit et al., pl. 5, figs. 6-11 (including images from Mamontova, 1960, and Cherchi & Schroeder, 1982).

2020 *Balkhania balkhanica* – Gheiasvand et al., fig. 6, S. no. 2, fig. 8K.

2023 *Balkhania balkhanica* Mamontova – Granier et al., p. 167, pl. 1, fids. AC, AJ, pl. 2, figs. E-G, I-J, pl. 4, fig. S.

2023 *Balkhania balkhanica* Mamontova – Gheiasvand & Bartolini, fig. 5.



**Fig. 1.** *Balkhania balkhanica* Mamontova (**a**, **c**, **e-f**) and *Pseudochoffatella minima* Schlagintweit et al. (**b**, **d**). **a**. From Mamontova (1960, fig. 2/3 modified showing early stage), Lower Barremian of Turkmenistan. **b**. From Schlagintweit et al. (pl. 5, fig. 12, holotype), lower Aptian of Central Iran (Taft Formation). **c**. From Taherpour Khalil Abad et al. (2013, fig. 4a), lower Aptian of northeastern Iran (Tirgan Fm). **d**. Same as **b**, so far unillustrated. **e-f**. lower Aptian of Central Iran (locality: see Schlagintweit et al., 2013b).

TAXONOMIC AND BIOSTRATIGRAPHIC REMARKS ON LARGER BENTHIC FORAMINIFERA FROM THE LOWER CRETACEOUS OF IRAN

*Torinosuella peneropliformis* Maync, 1959

Fig. 2

1926 *Choffatella peneropliformis* sp. nov. – Yabe & Hanzawa, p. 11, pl. 2, figs. 1-2.

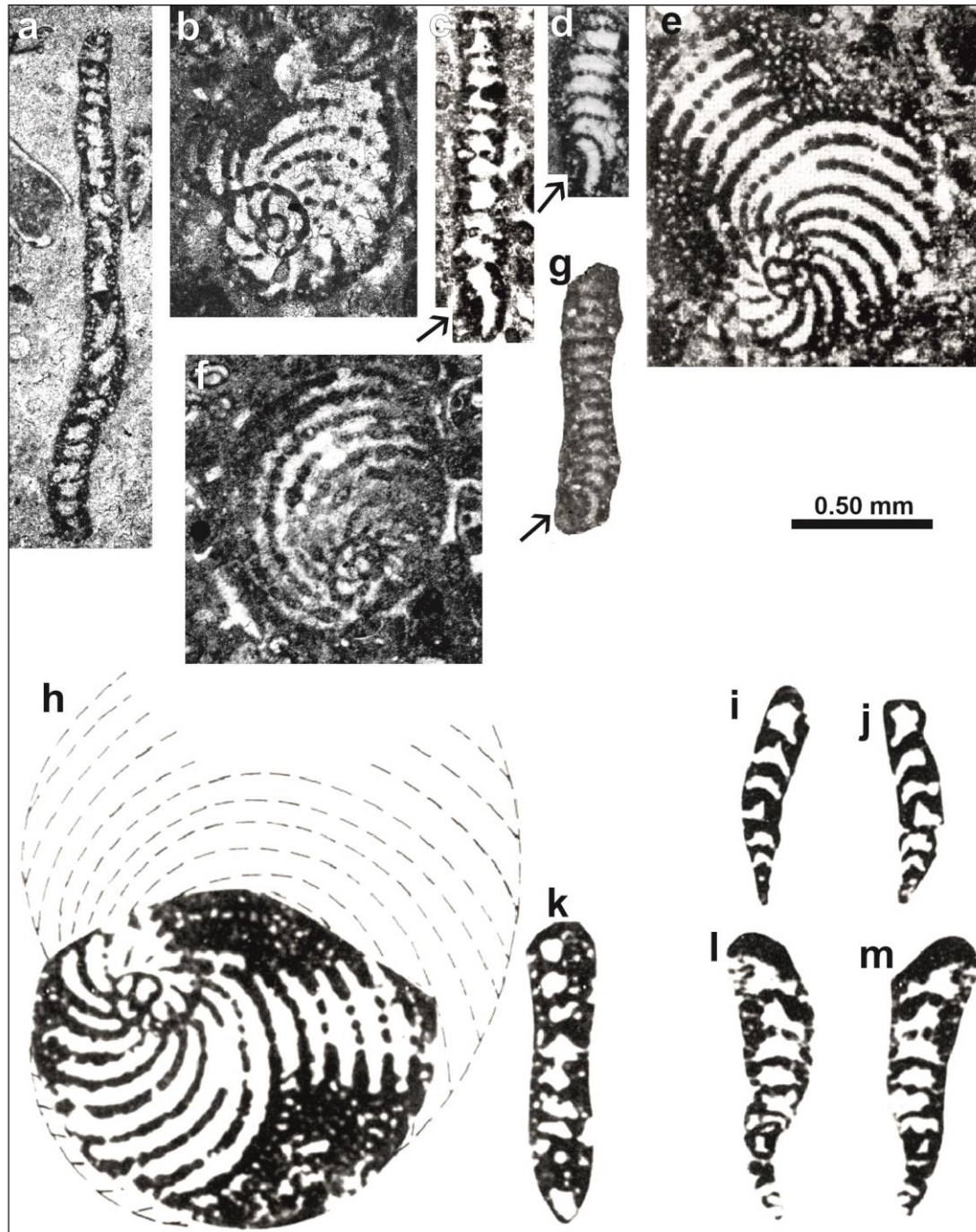
1959 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Maync, pl. 1, figs. 6a-b, 7-10, 14, 16 [non figs. 1-4, 11-13

(= *Pseudospirocyclus maynci* Hottinger)].

1967 *Torinosuella peneropliformis* (Yabe et Hanzawa) – Neumann, pl. 26, figs. 1-3, 6-9 [non text-fig. 100, pl. 26, figs. 4-5 (= *Pseudospirocyclus maynci* Hottinger, 1967)].

1998 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Jerotijević-Polavder, pl. 1.

2002 *Pseudochoffatella* sp. – Eren & Tasli, fig. 9E1.



**Fig. 2.** *Torinosuella peneropliformis* (Yabe & Hanzawa). **a-b.** Late Berriasian of Serbia (locality: see Bucur et al., 2020, e.g., fig. 6J). **c, e.** From Cherchi & Schroeder (2005, pl. 1, figs. 1, 4), Upper Hauterivian-lower Barremian of NE Spain. **d.** From Bucur et al. (2003, pl. 41, fig. 4), ‘late Neocomian Carbonate Member’, Sangestan Formation, Central Iran. **f.** From Granier et al. (2023, pl. 3, fig. T), Upper Barremian Tirgan Formation of NE Iran. **g.** From Gheiasvand & Bartolini (2023, fig. 4B), Hauterivian? lower Barremian? of northeastern Iran. **h-m.** From Maync (1959, pl. 1, figs. 6a-b, 7-10, Copyright by Swiss Geological Society), Torinosu Limestone of Japan.

2003 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Bucur et al., pl. 41, figs. 4-7.

2005 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Cherchi & Schroeder, p. 7, pl. 1, figs. 1-13 (with synonymy).

2008 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Schlagintweit et al., fig. 8e.

2017 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Hemmati et al., pl. 1, figs. 7?, pl. 3, fig. 7.

2018 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Schlagintweit & Wilmsen, fig. 4F.

2019 *Balkhania* sp. – Gheiasvand et al., fig. 7 specimens S. no. 137, no. 145, no. 154.

2023 *Torinosuella peneropliformis* (Yabe & Hanzawa) – Granier et al., p. 167, pl. 1, figs. W-AB, AF-AH, pl. 2, figs. A-D, pl. 3, figs. M-AB.

2023 small-size morphotype of *Balkhania balkhanica* Mamontova – Gheiasvand & Bartolini, fig. 4.

## DISCUSSION

Gheiasvand & Bartolini (2023) described three morphotypes of *Balkhania balkhanica* Mamontova from the Lower Cretaceous of northeastern Iran (Kopet Dagh area), (1) *Balkhania balkhanica* sensu stricto, (2) *B. balkhanica* arenaceous morphotype and (3) *B. balkhanica* small size morphotype. Types (1) and (2) were recorded from the Upper Barremian to Lower Aptian, and type (3) from the Upper Valanginian - Upper Hauterivian interval. The author agrees with the identity of the types (1) and (2) with *B. balkhanica* showing different agglutination behavior due to material availability in the respective ambient environments. The dimensions (diameter of test up to 4 mm and proloculus of 0.25 mm) of both morphotypes indicated by Gheiasvand & Bartolini (2023) are identical (Table 1). Concerning the size of the proloculus, Gheiasvand & Bartolini (2023) indicate 0.25 mm thereby quoting Mamontova (1960), Kaefer (1967) and Cherchi & Schroeder (1982). The size of the proloculus has not been indicated by Mamontova (1966) but stating a maximum test thickness (measured in axial sections) of 0.75 mm. This corresponds exactly to the maximum value of the proloculus indicated by Kaefer (1967, p. 205) for its junior synonym *Pseudochoffatella gigantea* (see Cherchi & Schroeder, 1982). It is worth mentioning that the proloculus of *Balkhania* situated in the test center is protruding slightly laterally thereby amounting for the maximum measured test thickness. Cherchi & Schroeder (1982) did not indicate any size for the proloculus of *Balkhania*.

The so-called '*Balkhania balkhanica* small size morphotype' (type 3) however is distinctly smaller with test diameters ranging from 0.7 to 1.2 mm whereas the proloculus diameter could not be indicated due to inadequate sections. This morphotype is not considered to belong to *Balkhania balkhanica* Mamontova but to

*Torinosuella peneropliformis* (Yabe & Hanzawa). The differences between both taxa refer mainly to the overall coiling mode with annular chambers in *Balkhania* against planispiral early and peneroplid main coiling parts in *Torinosuella* (Table 1).

The initial planispiral coiling part is well discernible in the oblique section and hinted also in the slightly oblique axial section provided by Gheiasvand & Bartolini (2023, fig. 4A, 4B) (see also Figs. 2c-d, g). Due to the different types of coiling, the proloculus is situated more or less in the centre of the test in *Balkhania* (Fig. 1e) and clearly shifted to one side (= juvenile planispiral part) in *Torinosuella* (e.g., Fig. 2b). As anticipated, the dimensions indicated by Gheiasvand & Bartolini (2023) for the '*Balkhania balkhanica* small size morphotype' fit well to the data in the literature indicated for *T. peneropliformis* (Tab. 1). In the subaxial and oblique sections provided by Gheiasvand & Bartolini (2023, fig. 4), the embryo of *T. peneropliformis* was not sectioned. Maync (1959) did not indicate any values for the proloculus diameter while according to Cherchi & Schroeder (2005) it is 0.07 mm. For completeness, the presence of another larger benthic foraminifer from the Lower Cretaceous Taft Formation with annular chambers in the ultimate stage, *Pseudochoffatella minima* Schlagintweit et al., 2020, is worth mentioning (Fig. 1b, d).

Based on the incorrect determinations and the taxonomic lumping, the resulting conclusions put forward by Gheiasvand & Bartolini (2023) are null and void. First of all, the authors conclude a phylogenetic size increase within the same species from the Upper Hauterivian (Type 3) to the Aptian (Types 1-2) with the 'small size morphotype' considered as a primitive character. In the same way the remarks provided upon more symbionts in larger tests or an intraspecific morphological impact of palaeoenvironmental changes can accordingly be considered as insignificant as based on wrong assumptions being related to the same species.

Concerning biostratigraphy, Gheiasvand & Bartolini (2023, p. 1, abstract) correctly stated that 'among large benthic foraminifera, *Balkhania* genus is one of the most valuable taxa that has been used to better constrain the biostratigraphy of the Lower Cretaceous successions along the Tethyan carbonate platforms'. The species is so far known in the literature only from Barremian-early Aptian interval. With the (erroneous) assignment of the late Valanginian-late Hauterivian 'small size morphotype' to *B. balkhanica*, its first appearance datum has been significantly shifted towards older strata and thereby reducing much of its biostratigraphic relevance.

Concerning the occurrences in Iran, *B. balkhanica* is known from the Tigran Formation of NE Iran (e.g., Taherpour-Khalil-Abad et al., 2013; Bucur et al., 2019; Granier et al., 2023) and the Taft Formation of Central Iran (e.g., Schlagintweit et al., 2013b). *T. peneropliformis*

**TAXONOMIC AND BIOSTRATIGRAPHIC REMARKS ON LARGER BENTHIC FORAMINIFERA FROM THE LOWER CRETACEOUS OF IRAN**

**Table 1.** *Balkhania* Mamontova, 1966, against *Torinosuella* Maync, 1959; compiled from data (in order of appearance) of Maync (1959), Mamontova (1966), Kaefer (1967), Cherchi & Schroeder (1982, 2005), and Loeblich & Tappan (1987).

Family	Cyclamminidae Marie, 1941	
Subfamily	Choffatellinae Maync, 1958	Pseudochoffatellinae Loeblich & Tappan, 1985
Genus	<i>Torinosuella</i> Maync, 1959	<i>Balkhania</i> Mamontova, 1966
Morphology	Oval, flattened, with acute periphery, megalospheric embryo not centric, shifted to the early ontogenetic stage	Round discoidal, center in megalospheric specimens elevated (protoconch of large size!), periphery rounded
Growth modus	Chambers in planispiral, peneropline to flabelliform growth	Protoconch followed by a few reniform chambers, main part with annular chambers
Exoskeleton	Choffatellid subepidermal network	
Aperture (foramina)	Multiple, in the median plane	
Equatorial diameter	0.40-1.10 mm (0.70-1.50 mm Gheiasvand & Bartolini, 2023)	2.0 mm to 15 mm acc. to Mamontova, 1966
Axial diameter	Mean 0.15 mm	0.50 mm – 0.75 mm (B form) 0.25 mm – 0.5 mm (A form) acc. to Mamontova, 1966
Proloculus diameter	0.05 mm Cherchi & Schroeder, 2005 0.045 mm – 0.055 mm *	up to 0.75 mm acc. to Kaefer, 1967
Stratigraphic range	Late Tithonian-pp. late Barremian acc. to Cherchi & Schroeder, 2005; Granier et al., 2023	Barremian-early (early late?) Aptian (late Valanginian-late Aptian acc. to Gheiasvand & Bartolini, 2023)
Gheiasvand and Bartolini, 2023	' <i>B. balkhanica</i> small size morphotype'	' <i>B. balkhanica sensu stricto</i> ' ' <i>B. balkhanica</i> arenaceous morphotype'

has been reported from the Carbonate Member of the Sangestan Formation, Central Iran (Bucur et al., 2003; Schlagintweit & Wilmsen, 2018), the 'Tirgan Formation' (Gheiasvand & Bartolini, 2023 as *Balkhania balkhanica* small-size morphotype; Granier et al., 2023) and from both the Zard and the Tirgan formations of NE Iran (Granier et al., 2023). It is worth mentioning that Granier et al. (2023) use *Balkhania* as a marker of the Tirgan Formation.

## CONCLUSIONS

*Torinosuella* Maync and *Balkhania* Mamantova are two discrete taxa distinguished primarily by the coiling mode. The biostratigraphic ranges are also distinct, late Tithonian–Barremian for *Torinosuella* and Barremian–early Aptian for *Balkhania*, with a small overlap in the Barremian (see Granier et al., 2023).

Adequate sections at hand and their experienced interpretation are basic requirements for correct species-genus identifications and all further conclusions based on these about other issues such as for example biostratigraphy, phylogeny and palaeoenvironment. Identification of one morphotype of *B. balkhanica* by Gheiasvand & Bartolini (2023) from Iran which would otherwise increase the biostratigraphic range of that species, is shown to be erroneous because it is referable instead to *T. peneropliformis*. The different occurrences

of the two taxa in different formations in Iran provide further evidence for the pending definition-review of some Lower Cretaceous lithostratigraphic units, respectively Tirgan, Sangestan and Zard formations.

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TAXONOMIC AND BIOSTRATIGRAPHIC REMARKS ON LARGER BENTHIC FORAMINIFERA FROM THE LOWER CRETACEOUS OF IRAN

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