Review of the ammonite genus *Pseudokossmaticeras* Spath, 1922 from the uppermost Campanian–lower Maastrichtian in Bulgaria

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Abstract. New data on the ammonite genus *Pseudokossmaticeras* Spath, 1922 have been obtained from several uppermost Campanian–lower Maastrichtian strata of the Fore-Balkan Mountains (Bulgaria). A review of the earlier Bulgarian records of the genus is also presented. The following species are here described and illustrated: *Pseudokossmaticeras brandti* (Redtenbacher, 1873), *P. galicianum* (Favre, 1869), *P. muratovi* Michailov, 1951 and *P. tercense* (Seunes, 1892). Our newly obtained ammonite records were constrained by the inoceramid zonation that has recently been proposed for successions of the Fore-Balkan area. Hence, the Bulgarian data are of importance for correlation with other occurrences of *Pseudokossmaticeras* across Europe.

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INTRODUCTION

Pseudokossmaticeras Spath, 1922 is a well-known ammonite genus that has often been recorded from Upper Cretaceous strata in Europe. It is best known for its distinctive and widespread species, *P. brandti* (Redtenbacher), and several other allied forms that were first described from localities in Galicia (present-day Ukraine) and France (Favre, 1869; Redtenbacher, 1873; Seunes, 1890a, b, 1892; de Grossouvre, 1894). Consequently, more progress has been made in this respect by Thiedig and Wiedemann (1976), who collected ammonites in Carinthia (Austria), as well as by Hancock and Kennedy (1993) and Kennedy and Summesberger (1987), who studied the ammonite faunas from Tercis,

Landes (France), and Ukraine. These authors, along with the papers of Kennedy and Summesberger (1991) and Summesberger and Zorn (2012), have done much to interpret the classic species of *Pseudokossmaticeras*. Knowledge about both the geographical and stratigraphical distribution and species composition of this genus in Europe has been greatly enriched by a number of works (e.g., Michailov, 1951; Naidin and Shimansky, 1959; Kennedy *et al.*, 1986, 2001; Ward and Kennedy, 1993; Kennedy and Bilotte, 1995; Kennedy and Odin, 2001; Courville and Odin, 2001; Summesberger *et al.*, 2002), and the well-dated European occurrences suggest that *Pseudokossmaticeras* is confined to the uppermost Campanian and mostly to the lower Maastrichtian. Stragglers outside Europe are rare

and usually consist of a smaller number of specimens and localities: South India (Stoliczka, 1865); Madagascar (Collignon, 1938); Tunisia (Salaj and Wiedmann, 1989); South Africa (Spath, 1922; Kennedy and Klinger, 2013); Turkmenistan (Arkadiev *et al.*, 2000); Jamaica (Donovan and Draper, 2001); and North America (Kennedy and Cobban, 1993). Thus, the European occurrences have provided the main data for our current concept of the genus.

The earliest Bulgarian record of *Pseudokossmaticeras* was that of Jélev (1934). From a few localities near the village of Ralyovo (Pleven District, central North Bulgaria), he described “*Pachydiscus Galicianus* Favre sp.”, “*Pachydiscus* cfr. *Brandti*, Redt.”, and “*Pachydiscus Brandti* var. *Pegoti*, Gross.”, but illustrated only the first of these taxa (Jélev, 1934, pl. 4, fig. 1). He also noted that his ammonites were obtained “from Senonian strata in association with *Bostrychoceras polyplacum* A. Roemer” (translated from Bulgarian by LM). At about the same time, V. Tzankov (1935, pp. 11–12, pl. 3, fig. 2) described “*Kossmaticeras galizianus* var. *tercensis* Seunes” and figured “*Kossmaticeras brandti* Redtenbacher”. Both taxa were from a locality near Ohoden Village (Vratsa District, NW Bulgaria) from what V. Tzankov also called “Senonian”. Tz. Tzankov (1964) published ammonites accompanied by abundant inoceramid bivalves. These faunas were obtained from eight levels, indicating Maastrichtian age, in a section near the village of Kladorub (Vidin District, NW Bulgaria). Eleven ammonite species, including *Pseudokossmaticeras brandti*, *P. galicianum* and *P. galicianum tercense*, were described. Detailed descriptions and a number of figures of *Pseudokossmaticeras* were given by V. Tzankov (1982). The material of his monographic study was referred to the Maastrichtian and divided into several species, namely *P. brandti*, *P. aturicus*, *P. galicianum* and *P. tchihatcheffi*. It came from eight localities in western and central North Bulgaria, including that of the earlier paper of V. Tzankov (1935): Novo Selo–Zavala and Yaroslavtsi (Pernik District, W Bulgaria); Kaleto, Darmantsi, Ohoden, Bukovets and Virovsko (Vratsa District, NW Bulgaria); and Ralyovo. Jolkičev (1989) noted several records of *Pseudokossmaticeras brandti* and used them as indicators for the Maastrichtian age of strata from the Fore-Balkan Mts but never published them. Specimens from the area between the villages of Reselets, Kunino and Dolna Beshovitsa (Vratsa and Pleven districts, NW Bulgaria), as well as from near the villages of Ralyovo and Varbinka (Varna District, East Bulgaria), were given the names *P. brandti*, *P. galicianum* and *P. tercense*.

More recently, Dochev *et al.* (2018) and Pavlishina *et al.* (2020) published a new record of *P. brandti* from the uppermost Campanian near the village of Reselets.

The current account includes our revision of the available localities and representatives of *Pseudokossmaticeras* from Bulgaria, but also of a new record from both previously known and new ammonite-bearing localities, Rumyantsevo (Lovech District, NW Bulgaria) and Tsonevo (Varna District, East Bulgaria), recently sampled by the authors. It should be noted that the entire material is exclusively from scattered occurrences, and therefore a superposition of these ammonites is difficult to demonstrate. The age assessments of the ammonite taxa described below are based on the stratigraphic data from both the above-listed and other related previous Bulgarian publications, and for some findings we have relied on the occurrence of accompanying inoceramid bivalves.

GEOLOGICAL AND STRATIGRAPHICAL BACKGROUND

As far back as the earliest studies of the Upper Cretaceous rocks in Bulgaria, it has been thought that, regionally, these strata represent distinct facies types. It was Zlatarski (1905) who distinguished at first the North European and South European (Mediterranean) types of Upper Cretaceous rocks in Bulgaria, and his view has remained in use to the present day. Subsequent workers (V. Tzankov *et al.*, 1960; Vaptzarova, 1965) recognized yet another type of Upper Cretaceous rocks, called Carpathian, which is also adopted by stratigraphers studying Upper Cretaceous Series in Bulgaria. From the viewpoint of current understanding, the North European type comprises moderately thick open-shelf carbonate deposits, whereas the Mediterranean type includes expanded and lithologically diverse, sedimentary and volcano-sedimentary rocks that are the product of extensive, subduction-related back-arc igneous activity and deposition (see Dabovski *et al.*, 2009, and references therein). The Carpathian type, in turn, corresponds to thick hemipelagic to upper slope deposits (*ibid.*). Apart from their overall distinct lithology and depositional settings, these types of Upper Cretaceous rocks also differ in their occurrence. The former two types are widespread and considered to be an integral part of the Moesian Platform and the marginal segments of the Balkan orogen in Bulgaria, referred to the Central Balkan–Fore-Balkan, East Balkan and Srednogorie zones

(sensu Ž. Ivanov, 2017), whereas the latter type occurs narrowly, and is a part of the Kula Zone, which is assumed to represent the Carpathian orogen in Bulgaria (*ibid.*) (see Fig. 1a). For each of these types, there are well-developed lithostratigraphic schemes, which were summarized by Dabovski *et al.* (2009) and recently amplified by Sinnyovsky *et al.* (2012, 2013) (see Fig. 1b).

According to the above-outlined framework, sixteen localities yielded a total of 36 ammonites that are the focus of the present work. Of these, one locality represents the Carpathian type, two localities belong to the Mediterranean type, and the remaining ammonite-bearing fields are associated with the North European type of Upper Cretaceous rocks (Fig. 1; see also Table 1).

The only locality corresponding to the Carpathian type is the one near the village of Kladorub, from which Tz. Tzankov (1964) published three examples of *Pseudokossmaticeras*. It refers to the type section for the Kladorub Formation, which spans the upper Campanian–Ypresian and has a well-established calcareous nannofossil biostratigraphy (see Grančovski, 2019, and references therein). Following Hancock and Kennedy (1993), who subsequently revised Tz. Tzankov's (1964) *Pseudokossmaticeras* specimens and thought that *P. brandti* was misidentified, we agree that the record of the genus from this locality corresponds to *P. galicianum* and *P. tercense*. These taxa have been proven to be species of a firm Maastrichtian occurrence (*ibid.*). Furthermore, as stated by Tz. Tzankov (1964), they were found in association with other ammonite taxa, such as *Pachydiscus neubergicus* (von Hauer, 1858) and *P. gollevillensis* (d'Orbigny, 1850), which are also Maastrichtian in age. In addition, several coeval inoceramid specimens were listed (Tz. Tzankov, 1964, p. 146), of which one, identified as "*Inoceramus impressus* d'Orbigny", is a typical example of *Endocostea typica* Whitfield, 1880. The latter taxon is the index species for the eponymous inoceramid zone of the lower Maastrichtian (Walaszczyk *et al.*, 2001, 2002), which has also been documented in Bulgaria (Dochev *et al.*, 2018; Dochev and Metodiev, 2020; Pavlishina *et al.*, 2020). Thus, *P. brandti* is again excluded as a record from Kladorub.

The localities of the Mediterranean type of Upper Cretaceous strata are Novo Selo–Zavala and Yaroslavtsi, both with single specimens, which were reported by V. Tzankov (1982). We confirm the previous record of *P. brandti*, recognizing one of the earlier definitions, but reinterpreting "*Pseudokossmaticeras aturicus* (Seunes)" as *P. brandti*. These occurrences are assigned, albeit conditional-

ly, to the uppermost levels of the Zavala Formation. The latter unit was recently formalized by Sinnyovsky *et al.* (2013) and dated, based on nannofossils, as late Campanian. Hence, our interpretation confirms that the Zavala Formation embraces the upper Campanian.

The bulk of the ammonites described in this paper are from rocks of the North European type of Upper Cretaceous strata (see Fig. 1 and Table 1). In terms of lithostratigraphy, the ammonite-bearing rocks of this type belong to the Darmantsi, Darmantsi-Kunino, Yankovo, and Kunino formations. The total chronostratigraphic extent of these units has been determined as upper Campanian (*pars.*)–lower Maastrichtian (*e.g.*, Jolkičev, 1986, 1989; Sinnyovsky and Vangelov, 2007; Dochev, 2012; Dochev and Metodiev, 2020; Pavlishina *et al.*, 2020). From the Darmantsi Formation, the overall record of *Pseudokossmaticeras* exclusively refers to *P. brandti*. Due to the lack of proper chronostratigraphic framework, previous accounts of this species from the upper Campanian, for example those from the Beglezh, Bukovets and Ralyovo localities (Jélev, 1934; V. Tzankov, 1982; Jolkičev, unpublished collection), are unreliable. Jélev (1934) claimed that his pseudokossmaticeratids co-occurred with *Bostrychoceras polyplacum*, which has long been known to be a late Campanian taxon (see Hancock and Kennedy, 1993), but we do not have any of his specimens for revision, and the only figured example, defined as "*Pachydiscus Galicianus* Favre sp.", is herein redefined as *P. tercense*, which is a species of typically lower Maastrichtian occurrence (*ibid.*). With a high degree of conditionality, we refer the examples of *P. brandti* of V. Tzankov (1982) and Jolkičev (unpublished collection) to the Darmantsi Formation, and to the upper Campanian. Thus, the only authentic late Campanian record of *P. brandti*, from the Darmantsi Formation, is that from Reselets, where two specimens were found in association with "*Inoceramus*" cf. *wyomingensis* Walaszczyk, Cobban and Harries 2001, immediately below the Campanian/Maastrichtian boundary (see Dochev *et al.*, 2018; Pavlishina *et al.*, 2020). The latter taxon is a characteristic inoceramid species for the uppermost Campanian, as evidenced in the U.S. Western Interior Basin and at Tercis, France (Walaszczyk *et al.*, 2001, 2002).

Almost the same record as that of Reselets was obtained from Rumyantsevo and Tsonevo. The strata of the Darmantsi-Kunino Formation at Rumyantsevo yielded an immature individual of *P. brandti*, accompanied by *Trochoceras costaecus* (Khalafova, 1969), which is also known to be restricted

in its occurrence to the uppermost Campanian (see Walaszczyk *et al.*, 1996, 2002). Above them were found, in superposition, the inoceramids *Cataceramus subcircularis* (Meek, 1876), *C. barabini* (Morton, 1834), and *C. palliseri* (Douglas, 1942), which both elsewhere and in Bulgaria have been proven

to occur in the lower Maastrichtian (Walaszczyk *et al.*, 2001, 2002; Pavlishina *et al.*, 2020). From the Yankovo Formation at Tsonevo, we obtained single specimens of *Pseudokossmaticeras* cf. *brandti* and *P. galicianum*. Based on the age assessments for the Yankovo Formation, from nearby deposits

Fig. 1. a) Tectonic sketch map showing the localities of *Pseudokossmaticeras* on the outcrop and subcrop occurrences of the Upper Cretaceous strata within the framework of the Balkan orogen in Bulgaria (after Dabovski *et al.*, 2009, and Ž. Ivanov, 2017) (the localities are marked by a dot and a number: 1 – Kladorub; 2 – Novo Selo–Zavala; 3 – Yaroslavtsi; 4 – Kaletso; 5 – Darmantsi; 6 – Ohoden; 7 – Bukovets; 8 – Virovsko; 9 – Kunino; 10 – Reselets; 11 – Dolna Beshovitsa; 12 – Rumyantsevo; 13 – Beglezh; 14 – Ralyovo; 15 – Varbinka; 16 – Tsonevo). b) Schematic diagram of the approximate positions of ammonite localities on the simplified lithostratigraphic scheme for the Campanian–Maastrichtian rocks in Bulgaria (after Dabovski *et al.*, 2009, and Sinnyovsky *et al.*, 2012, 2013).

Table 1
Summary of data on the localities and sections that yielded the ammonites for this study

Locality/Section	Lithostratigraphic unit	Stratigraphic age	References
1. Kladorub	Kladorub Fm.	lower Maastrichtian	Tz. Tzankov (1964); Granchovski (2019, and references therein)
2. Novo Selo–Zavala	?Zavala Fm.	upper Campanian	V. Tzankov (1982); Sinnyovsky <i>et al.</i> (2013)
3. Yaroslavtsi	?Zavala Fm.	upper Campanian	V. Tzankov (1982); Sinnyovsky <i>et al.</i> (2013)
4. Kaletso	?Kunino Fm.	lower Maastrichtian	V. Tzankov (1982)
5. Darmantsi	Kunino Fm.	lower Maastrichtian	V. Tzankov (1982); Pavlishina <i>et al.</i> (2020)
6. Ohoden	?Kunino Fm.	lower Maastrichtian	V. Tzankov (1935, 1982)
7. Bukovets	Darmantsi Fm.	uppermost Campanian–lower Maastrichtian	Jolkitshev and Vapzarova (1967); V. Tzankov (1982)
8. Virovsko	Darmantsi Fm.	uppermost Campanian	this study
9. Kunino	Kunino Fm.	lower Maastrichtian	Jolkičev (unpublished); Dochev <i>et al.</i> (2018); Pavlishina <i>et al.</i> (2020);
10. Reselets	Darmantsi Fm. Kunino Fm.	uppermost Campanian–lower Maastrichtian	Pavlishina <i>et al.</i> (2020); Jolkičev (unpublished)
11. Dolna Beshovitsa	Kunino Fm.	lower Maastrichtian	Jolkičev (unpublished)
12. Rumyantsevo	Darmantsi–Kunino Fm.	uppermost Campanian	Jolkičev (1986); this study
13. Beglezh	?Darmantsi Fm.	uppermost Campanian	Jélev (1934)
14. Ralyovo	?Rumyantsevo Fm.	uppermost Campanian–lower Maastrichtian	Jélev (1934); V. Tzankov (1982); Jolkičev (unpublished)
15. Varbinka	?Yankovo Fm.	lower Maastrichtian	Jolkičev (unpublished)
16. Tsonevo	Yankovo Fm.	uppermost Campanian–lower Maastrichtian	this study

that previously provided reliable records of nannofossils and inoceramids (Sinnyovsky and Vangelov, 2007; Dochev, 2012), we opine that our specimens relate to the upper Campanian and lower Maastrichtian levels of this unit. As another indication of the lower Maastrichtian in the Yankovo Formation, we

accept a fragmentary specimen of *P. galicianum* from Varbinka (Jolkičev, unpublished collection).

The rocks of the Kunino Formation are the main source of pseudokossmaticeratids in the present work, namely *P. muratovi*, *P. galicianum* and *P. tercense*, which are related to the lower Maastrich-

tian. The specimens available from previous workers were sufficiently supported by accompanying stratigraphic data [V. Tzankov, 1935, 1982; Tz. Tzankov, 1964 (*pars.*); Jolkitshev and Vapzarova, 1967; Jolkičev, unpublished], and with a few exceptions we agree with the previous identifications. In terms of the new records, it is worthy to note those from the localities of Reselets and Kunino, at which Pavlishina *et al.* (2020) have recently recognized the lower Maastrichtian *Endocostea typica* and *Trochoceras radiosus* inoceramid zones in the Kunino Formation. Among the rich and continuous inoceramid assemblages, we recorded a few examples of *P. galicianum* and *P. tercense*.

SYSTEMATIC PART

The ammonites described in the present study are kept at the Museum of Palaeontology and Historical Geology at Sofia University “St Kliment Ohridski”. The main part of this material was published by Tz. Tzankov (1964) and V. Tzankov (1982). Unpublished specimens, collected by Prof. Nikola Jolkičev, as well as several of our ammonites, are also included. Depending on the lithologies of the host rocks, the ammonites described herein display different degrees of preservation. All of them are composite molds, usually with well-preserved ornament. The ammonites obtained from clayey sediments are commonly fragmentary and more or less deformed, whereas those from limestones are better preserved. The latter, however, are also often distorted due to post-mortem deformations. Ammonite specimens were covered with ammonium chloride and illustrated at natural size. Standard dimensions were measured and given in millimeters and as percentages of the diameter as follows: *D* (diameter), *Wh* (whorl height), *Wb* (whorl breadth), *U* (umbilical diameter) (see Table 2).

Family Kossmaticeratidae Spath, 1922

Subfamily Kossmaticeratinae Spath, 1922

Genus *Pseudokossmaticeras* Spath, 1922

Type species. *Ammonites pacificus* Stoliczka, 1865, p. 160, pl. 77, fig. 9, by original designation (Spath, 1922, p. 126).

Diagnosis. Moderately evolute ammonites with rounded umbilical shoulder and whorl section, which is rather compressed than depressed. The flanks are either flat or broadly rounded. The ventrolateral shoulder and the venter are also broadly rounded. The ornamentation consists of primary ribs, rising as singles, but also in pairs and triplets, from sharp and pronounced umbilical bullae situated on the umbilical shoulder. Secondary ribs also exist, rising low, in the middle or high on the flanks. The ribs are prorsiradiate, straight or curved forwards at the ventrolateral shoulder. The bifurcate ribs cover both the inner and outer whorls, but in the adult specimens they become stronger and coarser, with intercalated short secondary ribs. The umbilical bullae are present in all stages of growth. Constrictions of varying depth can also be observed on both inner and outer whorls.

Remarks. The most extensive discussion of *Pseudokossmaticeras* is that of Thiedig and Wiedmann (1976). Following those authors, the species can be easily distinguished based on the type of coiling, whorl section, and the style of ornamentation in inner and outer whorls.

Occurrence. Upper Campanian–lower Maastrichtian. Europe: France, northern Spain, Poland, Austria, Italy, Ukraine (Donbass), Turkmenistan (Kopet Dag Mountain Range), Caucasus, Crimea and Bulgaria; South India, Tunisia, Madagascar, South Africa, Jamaica, USA.

Pseudokossmaticeras brandti

(Redtenbacher, 1873)

(Fig. 2a–c; Fig. 3a–d, g–h; Fig. 4h, i; Fig. 6a–c; Fig. 7e, f; Fig. 8a, b, e; Fig. 9 a–c; Fig. 12a–d)

- 1873. *Ammonites brandti* Redtenbacher, p. 106, Pl. 24, Fig. 1.
- 1892. *Pachydiscus aturicus* Seunes, p. 17, Pl. 15 (6), Figs 2, 3.
- 1894. *Pachydiscus brandti* (Redtenbacher): de Grossouvre, p. 192, Pl. 23, Figs 1–3.

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Fig. 2. *Pseudokossmaticeras brandti* (Redtenbacher, 1873) from the uppermost Campanian of the Western Fore-Balkan Mts. (Inv.-Nr. U.S., K₂ 1794, Reselets, bed 3, Darmantsi Formation): a, c – lateral views; b – ventral view. All figures are in natural size.

- non 1894. *Pachydiscus brandti* var. *pégoti* de Grossouvre, Pl. 30, Fig. 3 [= *Pseudokossmaticeras tercense* (Seunes)].
1934. *Pachydiscus* cfr. *Brandti* (Redtenbacher): Jélev, p. 199.
- V non 1935. *Kossmaticeras brandti* (Redtenbacher): V. Tzankov, Pl. 3, Fig. 2 [= *Pseudokossmaticeras galicianum*].
1951. *Pseudokossmaticeras brandti* (Redtenbacher): Michailov, p. 75, Pl. 11, Fig. 48.
1959. *Pseudokossmaticeras brandti* (Redtenbacher): Naidin and Shimansky, p. 190, Pl. 13, Fig. 2.
- V non 1964. *Pseudokossmaticeras brandti* (Redtenbacher): Tz. Tzankov, p. 156, Pl. 3, Fig. 1 [= *P. galicianum*, Favre, 1869].
1976. *Pseudokossmaticeras brandti* (Redtenbacher): Thiedig and Wiedmann, p. 15, Pl. 1, Fig. 1.
- V 1982. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): V. Tzankov, p. 30, Pl. 12, Figs 1–3.
- V 1982. *Pseudokossmaticeras aturicus* (Seunes, 1890): V. Tzankov, p. 32, Pl. 14, Fig. 1.
1989. *Pseudokossmaticeras brandti* (Redt): Salaj and Wiedmann, p. 303, Text-fig. 3.
1993. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): Hancock and Kennedy, p. 155, Pl. 2, Figs 4–6; Pl. 4, Figs 1–5; Pl. 5, Figs 1–8; Pl. 6, Figs 1–9; Pl. 7, Figs 5–11.
1995. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): Kennedy and Bilotte, p. 362, Pl. 2, Fig 1 a–c.
1997. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): Martinez, p. 375, Fig. 1a.
1997. *Pseudokossmaticeras brandti*: Ward and Orr, Fig. 4-2, 4.
2001. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): Kennedy *et al.*, Fig. 2.
2001. *Pseudokossmaticeras brandti* (Redtenbacher): Courville and Odin, Pl. 7, Figs 52–54.
2001. *Pseudokossmaticeras brandti* (Redtenbacher): Kennedy and Odin, Pl. 1, Fig. 3.
2001. *Pseudokossmaticeras brandti* (Redtenbacher): Kűchler *et al.*, Pl. 4, Figs 1, 3, 5, 6.
2002. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): Summesberger *et al.*, p. 388, Pl. 2, Fig. 2.
2012. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): Summesberger and Zorn, Pl. 10, Figs 1a–c (refigured lectotype).

Lectotype. The lectotype designated by Reyment (1958, p. 34) is the specimen of Redtenbacher (1873, p. 106, pl. 24, fig. 1a, b), from the Gosau Beds of Grűbach (Austria). It is housed in the collections of the Geological Survey of Austria (Inv.-Nr. 1873/001/0011). The lectotype was refigured by Summesberger and Zorn (2012, pl. 10, figs 1a–c).

Material and record. Twelve specimens: Novo Selo–Zavala, probably from the Zavala Formation (Inv.-Nr. Cr₂ 1138, original specimen of V. Tzankov, 1982, pl. 14, fig. 1, 1a, refigured herein in Fig. 6a–c); Yaroslavtsi, probably from the Zavala Formation (Inv.-Nr. Cr₂ 1127, original specimen of V. Tzankov, 1982, pl. 12, fig. 1, refigured herein in Fig. 8a, b, e); Bukovets, Darmantsi Formation (Inv.-Nr. Cr₂ 1126, original specimen of V. Tzankov, 1982, pl. 12, fig. 3, refigured herein in Fig. 7e, f); Virovsko, Darmantsi Formation (Inv.-Nr. U.S., K₂ 1806, this study); Reselets, Darmantsi Formation (Inv.-Nrs. U.S., K₂ 1794, U.S., K₂ 1795 and U.S., K₂ 1800, this study); Reselets (Kuklite area), probably from the Darmantsi Formation (Inv.-Nr. 255, unpublished specimen of Jolkičev); Rummyantsevo, Darmantsi-Kunino Formation (Inv.-Nr. U.S., K₂ 1799, this study); Beglezh, probably from the Darmantsi Formation (Inv.-Nr. Cr₂ 1128, original specimen of V. Tzankov, 1982, pl. 12, fig. 2, refigured herein in Fig. 4i); Ralyovo, probably from the Darmantsi Formation (Inv.-Nr. 242, unpublished specimen of Jolkičev); Tsonevo, Yankovo Formation (Inv.-Nr. U.S., K₂ 1803, this study). Upper Campanian.

Measurements. See Table 2.

Description. Adult specimens reach diameters of 137 mm (Fig. 2a–c) and 111.3 mm (Fig. 7e, f) and are characterized by very evolute coiling and

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Fig. 3. Latest Campanian–early Maastrichtian ammonites of the genus *Pseudokossmaticeras* from the Western and Eastern Fore-Balkan Mts.: a–c) *Pseudokossmaticeras* cf. *brandti* (Redtenbacher, 1873), Inv.-Nr. U.S., K₂ 1803 (Tsonevo, Yankovo Formation, uppermost Campanian); d) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. U.S., K₂ 1795 (Reselets, bed 3, Darmantsi Formation, uppermost Campanian); e) *Pseudokossmaticeras tercense* (Seunes, 1892), Inv.-Nr. U.S., K₂ 1802 (Reselets, bed 8, Kunino Formation, lower Maastrichtian); f) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. Cr₂ 1131 (right view of the original specimen of V. Tzankov, 1982, pl. 13, fig. 3; Bukovets, lower Maastrichtian); g–h) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. U.S., K₂ 1799 (Rummyantsevo section, base of bed 4, Darmantsi Formation, uppermost Campanian). All figures are in natural size.

Table 2
Ammonite whorl dimensions (in mm) as measured in this study

Specimen ID	D	Wh	Wh/D	Wb	Wb/D	Wb/Wh	U	U/D
<i>Pseudokossmaticeras brandti</i> (Redtenbacher, 1873)								
U.S., K ₂ 1794 (Fig. 2a–c)	137.0	40.0	0.29	27.0	0.20	0.68	52.0	0.38
U.S., K ₂ 1799 (Fig. 3d)	55.0	17.1	0.31	–	–	–	22.0	0.39
Cr ₂ 1128 (Fig. 4i)	75.0	27.0	0.36	–	–	–	29.5	0.39
Cr ₂ 1138 (Fig. 6a–c)	77.0	24.0	0.31	26.5	0.34	1.10	32.0	0.42
Cr ₂ 1126 (Fig. 7e, f)	113.0	45.0	0.40	27.5	0.24	0.61	42.0	0.37
Cr ₂ 1127 (Fig. 8a, b, e)	100.3	37.0	0.37	36.0	0.36	0.97	–	–
U.S., K ₂ 1806 (Fig. 9a–c)	101.0	38.0	0.38	29.0	0.29	0.76	41.0	0.41
No. 242 (Fig. 12d)	72.0	–	–	23.0	0.32	–	29.5	0.41
No. 255 (Fig. 12a–c)	108 (81.0)	50.0	0.46 (0.62)	21.0	0.19 (0.26)	0.42	39.0 (29.8)	0.36 (0.37)
<i>Pseudokossmaticeras galicianum</i> (Favre, 1869)								
Cr ₂ 1131 (Figs 3f, 10d)	104.0	40.0	0.38	20.0	0.19	0.5	41.5	0.40
BAS Cr ₂ 96 (Fig. 6d)	142.3	60.0	0.42	–	–	–	56.5	0.40
Cr ₂ 1136 (Fig. 8c, d)	122.0	42.0	0.34	21.2	0.17	0.5	42.0	0.34
Cr ₂ 1133 (Fig. 9d, e, h)	53.0	20.0	0.38	15.5	0.29	0.78	20.5	0.39
U.S., K ₂ 1796 (Fig. 10a, b)	–	41.0	–	30.0	–	0.73	46.0	–
No. 258 (Fig. 11e, f)	–	25.0	–	19.5	–	0.78	28.0	–
No. 254 (Fig. 13a, c)	95.0 (69.0)	33.0	0.35 (0.48)	30.0	0.32 (0.43)	0.91	37.0 (27.0)	0.39 (0.39)
<i>Pseudokossmaticeras muratovi</i> Michailov, 1951								
Cr ₂ 1132 (Fig. 7d)	60.0	20.0	0.33	–	–	–	28.0	0.47
<i>Pseudokossmaticeras tercense</i> (Seunes, 1892)								
U.S., K ₂ 1797 (Fig. 4a–c)	45.0	14.5	0.32	10.5	0.23	0.72	17.5	0.39
U.S., K ₂ 1804 (Fig. 4e, f)	78.5 (52.0)	31.8	0.41 (0.61)	18.1	0.23 (0.35)	0.57	30.0 (22.0)	0.38 (0.42)
U.S., K ₂ 1807 (Fig. 4j, k)	76.0	28.0	0.37	21.0	0.28	0.75	33.5	0.44
BAS Cr ₂ 98 (Fig. 5a–c)	93.5	43.5	0.47	25.0	0.28	0.57	37.0	0.40
U.S., K ₂ 1798 (Fig. 7b, c)	68.5	28.0	0.41	8.0	0.12	0.29	25.0	0.36
BAS Cr ₂ 103 (Figs 9f, g; 10e)	71.0	27.1	0.31	19.5	0.24	0.72	30.0	0.42

a moderately deep umbilicus. The early whorls are covered with coarse and straight single ribs, arising from prominent umbilical bullae and extending to the inner half of the flanks. The ornamentation of the outer whorls consists of 26 ribs per whorl. They are widely spaced, coarse, and straight to prorsiradate. There are also irregular secondary ribs, usually intercalated high on the flanks. The total number of

ribs is 31 per whorl. Three shallow constrictions are visible in one of the specimens (see Fig. 7e, f).

Specimen U.S., K₂ 1803 (Fig. 3a–c) is a deformed ammonite with a diameter of 72 mm. It is very evolute, with compressed whorl section, and umbilical width of 35 mm (comprising 42% of the diameter). The ornamentation is composed of 27 ribs, including thick and prorsiradate primary ribs, arising from

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Fig. 4. Latest Campanian–early Maastrichtian ammonites of the genus *Pseudokossmaticeras*: a–c) *Pseudokossmaticeras tercense* (Seunes, 1892), Inv.-Nr. U.S., K₂ 1797 (Kunino, bed 6, Kunino Formation, lower Maastrichtian); d, g) *Pseudokossmaticeras* cf. *tercense* (Seunes, 1892), Inv.-Nr. U.S., K₂ 1805 (Reselets, bed 20, Kunino Formation, lower Maastrichtian); e–f) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. U.S., K₂ 1804 (Tsonevo, Yankovo Formation, lower Maastrichtian); h) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. U.S., K₂ 1800 (Reselets, bed 3, Darmantsi Formation, uppermost Campanian); i) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. Cr₂ 1128 (original specimen of V. Tzankov, 1982, pl. 12, fig. 2; Beglezh, probably from the Darmantsi Formation, uppermost Campanian); j, k) *Pseudokossmaticeras tercense* (Seunes, 1892), Inv.-Nr. U.S., K₂ 1807 (Reselets, bed 17, Kunino Formation, lower Maastrichtian). All figures are in natural size.

umbilical bullae, as well as intercalated secondary ribs, starting either in the middle or high on the whorl sides, and crossing the venter. The deformation of the specimen affects not only the style of coiling and whorl section, but also the ribbing style, due to which it is considered in open nomenclature.

Two specimens, with approximate diameters of 65 mm (Fig. 3d) and 55 mm (Fig. 3g, h), represent deformed whorl fragments. Specimen U.S., K₂ 1795 (Fig. 3d) demonstrates a strong ribbing with nine prorsiradiate primary ribs and five intercalatories at the outer flank. Specimen U.S., K₂ 1799 (Fig. 3g, h) has nine prominent bullae at the base of the outer whorl that envelope a wide umbilicus and give rise to nine coarse primary ribs. The total number of ribs, including the secondaries, is 21. In addition, there are three constrictions that are clearly visible and framed by sharp ribs.

At larger diameters, a few more incomplete specimens (i.e., U.S., K₂ 1800, D ≈ 78 mm – Fig. 4h; Nr. Cr₂ 1128, D ≈ 75 mm – Fig. 4i; Nr. Cr₂ 1127, D ≈ 100.3 mm – Fig. 8a, b, e; and U.S., K₂ 1806, D ≈ 100.1 mm – Fig. 9a–c) correspond to forms with also little overlapping and a sculpture of 7 to 14 thick primary ribs and intercalated secondaries that arise high on the flanks. Although incomplete, these specimens show that both the primary and secondary ribs become coarser and more widely spaced as the whorl height increases.

Specimen Cr₂ 1138 (Fig. 6a–c) is a slightly deformed evolute ammonite with almost quadrate whorl section and steep umbilical walls. The umbilicus is wide and deep, comprising 40% of the diameter. The inner whorls are sculptured with coarse and straight bullate single ribs. Twenty-five thick, straight to prorsiradiate, and widely spaced primary ribs cover the last whorl. At this growth stage, the ribs arise from prominent bullae, starting from the umbilical seam, then crossing the umbilical walls, and strengthening on the umbilical shoulder. Some of the primary ribs bifurcate high on the flanks. A total of 36 ribs are developed on the outer half of the sides and cross the venter. Six collared ribs are associated with wide and deep constrictions.

Specimen Nr. 255 (Fig. 12a, c), from the unpublished collection of Jolkičev, is well preserved but deformed to an ellipse form, with a diameter of 108 (81) mm. The coiling is moderately evolute, with compressed whorl section. The umbilicus is shallow and wide, comprising 36% of the diameter. The ornamentation of the penultimate whorl shows 20 umbilical bullae (some of them, however, situated higher on the flanks due to deformation), which are narrow, sharp and distant. The bullae give rise to

straight and rounded prorsiradiate ribs. They retain on the last preserved whorl, where 25 prorsiradiate single ribs spring from them. Occasional rib pairs are also visible. The ribs are straight on the flanks, but flexing forward on the ventrolateral shoulder. There are also 11 intercalated ribs that are developed high on the flanks. All ribs cross the venter.

Discussion. Hancock and Kennedy (1993) described and discussed this species in detail and compared it with other closely related taxa, such as *Pseudokossmaticeras galicianum* (Favre, 1869) and *P. tercense* (Seunes, 1892). The main difference with *P. galicianum* is that the latter possesses compressed whorl section and much finer ornamentation, which is composed of narrow ribs that arise both in singles and pairs from umbilical bullae. *P. tercense* has compressed whorls that, in earlier growth stages, are sculptured with fine, delicate, narrow ribs, whereas in the outer whorls are ornamented with bar-like ribs (Hancock and Kennedy, 1993). *Pseudokossmaticeras muratovi* Michailov, 1951 is more densely ribbed (more than 50 ribs per whorl) and lacks prominent umbilical bullae (Hancock and Kennedy, 1993). In addition, *P. brandti* has lower whorl height compared to *P. galicianum* and *P. tercense*. Hancock and Kennedy (1993) considered *P. cerevicianum* (Pethö, 1906) and *P. aturicus* (Seunes, 1892) to be junior synonyms of *P. brandti*.

The *P. brandti* specimens described and figured by V. Tzankov (1982, p. 30, pl. 12, figs 1–3), and refigured herein (Figs 4i, 7e, f, 8a, b, e), mainly correspond to partially preserved and deformed whorls, but there is also a well-preserved adult with a diameter of 111.3 mm. The whorl section is generally deformed, but it seems to be depressed (Fig. 8e). The ornament of the inner whorls is composed of straight ribs, arising from umbilical bullae, whereas the outer whorls are covered by prominent, coarse, straight ribs and intercalated ribs that appear most often high on the flanks. Shallow constriction is visible on Cr₂ 1126 (see Fig. 7e, f). Another well-preserved specimen, described and figured by V. Tzankov (1982, pl. 14, fig. 1, 1a) as *P. aturicus* (Seunes, 1892), was also refigured herein (Fig. 6a–c). It is a completely preserved form, with a diameter of 77 mm and ornamented with very coarse primary ribs, arising from umbilical bullae, and secondary ribs that appear on the outer part of the flanks. This style of ribbing is typical for *P. brandti*, and thus we share the opinion of Hancock and Kennedy (1993) that *P. aturicus* is synonymous with *P. brandti*.

The specimen described as *P. brandti* by Tz. Tzankov (1964, pl. 3, fig. 1 = Fig. 6d herein) is

Fig. 5. *Pseudokossmaticeras tercense* (Seunes, 1892) from the lower Maastrichtian of the Western Fore-Balkan Mts., Inv.-Nr. BAS Cr₂ 98, original specimen of Tz. Tzankov (1964, pl. 5, fig. 2), Kladorub, Kladorub Formation: *a*, *c* – lateral views; *b* – ventral view. All figures are in natural size.

moderately evolute, with high whorls and shallow umbilicus. These morphological features, together with the ornamentation style (*i.e.*, narrow ribs arising from small umbilical bullae) are typical for *P. galicianum*.

Specimen Nr. 255, from the unpublished collection of Jolkichev, closely resembles *P. galicianum*, but based on both the roughly ornamented inner whorls and the small total number of the ribs it is easily attributable to *P. brandti*.

Our newly collected specimens possess typical characteristics for *P. brandti*. They are very evolute ammonites, with coarse ornamentation that consists of primary ribs arising from prominent bullae, and secondary ribs arising usually high on the flanks (see Figs 2a–c, 9a–c). The whorl section is compressed, due to post-mortem deformation.

Occurrence. Based on precise data from Tercis (France), Hancock and Kennedy (1993) and Kennedy *et al.* (2001) assigned the occurrence of *P. brandti* to the upper Campanian. The same occurrence was also documented in Austria, Spain, Crimea, Caucasus, and Tunisia. The previous Bulgarian record of *P. brandti* and *P. aturicus* (= *P. brandti* in V. Tzankov, 1982) was confined to the lower Maastrichtian, but we believe that it has upper Campanian occurrence (see above). Our new record from the Fore-Balkan localities is also confined to the uppermost Campanian.

***Pseudokossmaticeras galicianum* (Favre, 1869)**

(Fig. 3f; Fig. 4e, f; Fig. 6d; Fig. 8c, d, f; Fig. 9d, e, h; 10a–b, c, d; Fig. 11a–f; Fig. 13a–g)

1869. *Ammonites galicianus* Favre, p. 16, Pl. 3, Figs 5, 6.
non 1872 *Ammonites galicianus* Favre: Schlüter, p. 63, Pl. 19, Figs 3–5; Pl. 20, Fig. 9.
non 1890b. *Pachydiscus* aff. *galicianum* Favre: Seunes, p. 283, Pl. 9, Fig. 5.
1894. *Pachydiscus galicianus* Favre: de Grossouvre, p. 177.
1898. *Pachydiscus negri* Mariani: p. 54, Pl. 8 (1), Fig. 3.

1898. *Pachydiscus galicianus* Favre sp., Mariani, p. 55, Pl. 8 (1), Fig. 4.
?1927. *Kossmaticeras tchihatcheffi* Böhm, p. 121, Pl. 13, Fig. 1.
non 1934. *Pachydiscus Galicianus* Favre sp.: Jélev, p. 198, Pl. 4, Fig. 1 [= *Pseudokossmaticeras tercense*].
V 1935. *Kossmaticeras brandti* Redtenbacher: Tzankov, p. 11, Pl. 3, Fig. 2.
1951. *Pseudokossmaticeras* cf. *galicianum* Favre: Michailov, p. 78, Pl. 7, Fig. 38; Text-fig. 26.
non 1959. *Pseudokossmaticeras galicianum* (Favre): Naidin and Shimansky, p. 189, Pl. 13, Fig. 1.
V 1964. *Pseudokossmaticeras brandti* (Redtenbacher, 1873): Tz. Tzankov, p. 156, Pl. 3, Fig. 1.
V non 1964. *Pseudokossmaticeras galicianum* (Favre, 1869): Tz. Tzankov, p. 157, Pl. 4, Fig. 1; Pl. 5, Fig. 2 [= *Pseudokossmaticeras tercense*].
non 1974. *Pseudokossmaticeras galicianum* (Favre): Naidin, p. 179, Pl. 65, Fig. 4.
1976. *Pseudokossmaticeras galicianum* (Favre): Thiedig and Wiedmann, p. 17, Pl. 2, Figs 1, 3.
1980. *Pseudokossmaticeras galicianum* (Favre, 1869): Błaszkiwicz, p. 41, Pl. 56, Figs 1, 3.
V 1982. *Pseudokossmaticeras galicianum* (Favre, 1869): V. Tzankov, p. 31, Pl. 13, Figs 1, 3.
V non 1982. *Pseudokossmaticeras galicianum* (Favre, 1869): V. Tzankov, p. 31, Pl. 13, Fig. 2 (= *Pseudokossmaticeras muratovi* Michailov, 1951).
V 1982. *Pseudokossmaticeras tchihatcheffi* (Böhm, 1927): V. Tzankov, p. 32, Pl. 13, Figs 4, 5.
1987. *Pseudokossmaticeras galicianum* (Favre, 1869): Kennedy and Summesberger, p. 28, Pl. 2, Fig. 6 (refigured lectotype); Pl. 3, Figs 7–9 (refigured paralectotype).
1991. *Pseudokossmaticeras galicianum* (Favre, 1869): Kennedy and Summesberger, Pl. 1, Figs 1–6 (Figs 1–2 = refigured paralectotype; Figs 3–6 = refigured lectotype).
2001. *Pseudokossmaticeras galicianum* (Favre, 1869): Kühler *et al.*, Pl. 4, Figs 4, 7.
? 2001. *Pseudokossmaticeras galicianum* (Favre, 1869): Kennedy and Odin, Pl. 1, Fig. 2.
2012. *Pseudokossmaticeras galicianum* (Favre, 1869): Summesberger and Zorn, Pl. 6, Figs 1a–d (refigured lectotype); Figs 2a–c (refigured paralectotype).

Fig. 6. Latest Campanian–early Maastrichtian ammonites of the genus *Pseudokossmaticeras*: a–c) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. Cr₂ 1138, original specimen of V. Tzankov (1982, pl. 14, fig. 1, 1a), Novo Selo–Zavala (Zavala Formation, uppermost Campanian); d) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. BAS Cr₂ 96, original specimen of Tz. Tzankov (1964, pl. 3, fig. 1), Kladorub (Kladorub Formation, lower Maastrichtian). All figures are in natural size.

Lectotype. The lectotype is a specimen of Favre (1869, pl. 3, fig. 5; GBA 1869/006/0010/01), designated by Thiedig and Wiedmann (1976, p. 17), from the lower Maastrichtian at Nagoryany (Ukraine). It was refigured by Kennedy and Summesberger (1987, pl. 2, fig. 6; 1991, pl. 1, figs 3–6) and Summesberger and Zorn (2012, pl. 6, fig. 1). A paralectotype (Favre, 1866, pl. 3, fig. 6; GBA 1869/006/0010/02), from the same locality and level as the lectotype, is also known. It was refigured by Kennedy and Summesberger (1987, pl. 3, figs 7–9; 1991, pl. 1, figs 1, 2) and Summesberger and Zorn (2012, pl. 6, figs 2 a–c). Both original specimens are housed in the collections of the Geological Survey of Austria.

Material and record. Fourteen specimens: Darmantsi, Kunino Formation (Inv.-Nr. Cr₂ 1133, original specimen of V. Tzankov, 1982, pl. 13, figs 1, 1a, refigured herein in Fig. 9d, e, h); Ohoden, probably from the Kunino Formation (Inv.-Nrs. Cr₂ 1136 and Cr₂ 1137, original specimens of V. Tzankov, 1982, pl. 13, fig. 5, refigured herein in Fig. 8c, d, f); Bukovets, Kunino Formation (Inv.-Nr. BAS Cr₂ 96, original specimen of Tz. Tzankov, 1964, pl. 3, fig. 1, refigured herein in Fig. 6d; Inv.-Nr. Cr₂ 1131, original specimen of V. Tzankov, 1982, pl. 13, fig. 3, refigured herein in Fig. 3f (right view); Inv.-Nr. U.S., K₂ 1801; Kunino, Kunino Formation [Inv.-Nr. U.S., K₂ 1796, this study; Inv. Nrs. 254, 256 (two specimens) and 258, unpublished specimens of Jolkičev]; Dolna Beshovitsa, Kunino Formation (Inv.-Nr. 3940, unpublished specimen of Jolkičev); Varbinka, probably from the Yankovo Formation (Inv.-Nr. 5047, unpublished specimen of Jolkičev); Tsonevo, Yankovo Formation (Inv.-Nr. U.S., K₂ 1804, this study). Lower Maastrichtian.

Measurements. See Table 2.

Description. The ammonites published by Tz. Tzankov (1964, pl. 3, fig. 1, refigured here in Fig. 6d) and V. Tzankov (1982, pl. 13, fig. 3; Figs 3f,

10d in this study) are well-preserved adult forms having diameters of 142.3 mm and 104 mm, respectively. These are moderately evolute, with wide umbilicus and compressed whorl sections. The compression of the whorls is a result of compactional flattening. The umbilical walls and shoulders are rounded. Whorl sides are flat to slightly convex. In specimen Cr₂ 1131 (Figs 3f, 10d), 32 rounded and distant primary prorsiradiate ribs arise from narrow and sharp bullae situated on the umbilical shoulder. There are also nine secondary ribs developed high on the flanks. In the last half of the phragmocone, the ribs become more prominent and higher. Several wider and deeper rib interspaces appear to be shallow constrictions.

Specimen U.S., K₂ 1804 (Fig. 4e, f) is deformed to an elliptical shape, with a diameter of 78.5 (52) mm. The whorl section is very compressed ($Wb/Wh = 0.56$) due to taphonomic flattening. The umbilicus is moderately wide (38% of the diameter). The whorl sides are flat to slightly convex, convergent towards a rounded venter. Although the inner whorls are not well visible, the ornament at these growth stages appears to be represented by narrow and sharp, prorsiradiate, bullate ribs. On the last preserved whorl, 23 umbilical bullae arise from the umbilical seam. Bullae strengthen on the umbilical wall and are most pronounced on the umbilical shoulder. They give rise to wide and straight, flat to round-topped prorsiradiate primary ribs. From the beginning to the middle of the last whorl, some of the primary ribs may bifurcate either from the umbilical shoulder or in mid-flanks, giving rise to wide and round-topped secondary ribs. One or two intercalated ribs are also visible. The interspaces between the primary ribs become wider on the body chamber, and both the primary and secondary ribs become coarser and narrower.

The specimens of V. Tzankov (1982, pl. 13, figs 4, 5) are fragments of moderately evolute whorls;

Fig. 7. Latest Campanian–early Maastrichtian ammonites of the genus *Pseudokossmaticeras* from the Western Fore-Balkan Mts.: a) *Pseudokossmaticeras tercense* (Seunes, 1890), Inv.-Nr. BAS Cr₂ 97, original specimen of Tz. Tzankov (1964, pl. 4, fig. 1), Kladorub, Kladorub Formation, lower Maastrichtian; b–c) *Pseudokossmaticeras tercense* (Seunes, 1892), Inv.-Nr. U.S., K₂ 1798 (Kunino, bed 9, Kunino Formation, lower Maastrichtian); d) *Pseudokossmaticeras muratovi* Michailov, 1951 (Inv.-Nr. Cr₂ 1132, original specimen of V. Tzankov (1982, pl. 13, fig. 2), Kaletto, probably from the Kunino Formation, lower Maastrichtian; e–f) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. Cr₂ 1126, original specimen of V. Tzankov (1982, pl. 12, fig. 3), Bukovets, Darmantsi Formation, uppermost Campanian. All figures are in natural size.

the umbilical wall is flat and subvertical, with moderately rounded shoulder (see Fig. 8c, d, f). The inner whorls are ornamented with straight primary ribs starting from small umbilical bullae. Long secondary ribs are seen to be intercalated between the primaries. The sculpture of the last half whorls consists of 15 prorsiradiate primary ribs arising from sharp umbilical bullae. Some of the primaries appear to bifurcate above the mid-flanks, and eight intercalated ribs are present. The ribs are straight at 2/3 of the flanks, then bend forward on the ventrolateral shoulder, and cross the venter.

The juvenile specimen ($D = 53$ mm) in Fig. 9d, e, h is the original of V. Tzankov (1982, pl. 13, figs 1, 1a) and is moderately evolute, with compressed whorls. The umbilicus is wide (38.6% of the diameter), with almost flat and subvertical umbilical wall and narrowly rounded umbilical shoulder. The inner half of the flanks is rounded, whereas the outer half is convergent towards a broadly rounded venter. Small bullae (22 in total) arise from the umbilical seam and strengthen upon the umbilical wall, becoming sharp on the umbilical shoulder (see Fig. 9h). Straight and prorsiradiate, mainly single, ribs start from the umbilical bullae. Although irregularly, secondary ribs are also present in the outer parts of the flanks. The latter are intercalatory, but some of them are obliquely connected to the primaries and appear to bifurcate. The total number of ribs is 30. All ribs cross the venter. On the inner half of the flanks, the constrictions are straight, while on the outer half they are slightly bent forwards.

Specimen Nr. 258 (Fig. 11e, f), from the unpublished collection of Jolkičev, is a partially preserved ammonite with a compressed whorl section. The umbilicus is wide, with rounded wall and shoulder. The preserved part of the inner whorls is sculptured with closely spaced, narrow and sharp umbilical bullae, each giving rise to sharp prorsiradiate ribs. The outermost preserved whorl is ornamented with 14 primary ribs arising as singles (rarely in pairs)

from small umbilical bullae. Several intercalated ribs in the outer part of the flanks are also visible.

Specimen Nr. 254 (Fig. 13a–c), from the unpublished collection of Jolkičev, is a slightly deformed ammonite with a diameter of 95 (69) mm and well-preserved ornament. It is moderately evolute; flanks are slightly convex, and both the ventrolateral shoulder and venter are broadly rounded. The whorl section is slightly compressed ($Wb/Wh = 0.9$). The umbilicus is deep and wide, comprising 38% of the diameter. The umbilical wall is subvertical, with rounded umbilical shoulder. On the penultimate whorl, there are 21 bullae that are extended from the umbilical seam to the umbilical shoulder. The bullae are narrow and sharp, with wide interspaces. At the outermost part of the penultimate whorl, bullae give rise to narrow and straight prorsiradiate ribs. The umbilical bullae continue on the last whorl, where they are arranged on the umbilical shoulder and give rise to 24 straight, rounded prorsiradiate primary ribs. One, rarely two, rounded ribs are intercalated between the primaries. Most of the intercalated ribs (19 in total) arise high on the flanks, but some of them appear to be linked to the primaries low on or in the middle of the flanks. All ribs cross the venter. There are also three shallow, barely visible constrictions on the last whorl.

Discussion. The moderately evolute coiling, the compressed whorl section, as well as the style of ornamentation that consists of equally pronounced primary and secondary ribs are the main characteristics of *P. galicianum*. *Pseudokossmaticeras tercense* (Seunes, 1892) is very similar to *P. galicianum* but differs in having higher whorls and finer ornament, in which the secondary ribs arise lower on the flanks and markedly distinguished in relief from the primaries (Kennedy and Summesberger, 1987).

Kennedy and Summesberger (1987) revised and discussed *P. galicianum* and concluded that *Pseudokossmaticeras tchihatcheffi* (Böhm, 1927) is a

Fig. 8. Latest Campanian–early Maastrichtian ammonites of the genus *Pseudokossmaticeras* from the Western Fore-Balkan Mts.: a, b, e) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. Cr₂ 1127, original specimen of V. Tzankov (1982, pl. 12, fig. 1), Yaroslavtsi, probably from the Zavala Formation, uppermost Campanian); c, d) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. Cr₂ 1136, original specimen of V. Tzankov (1982, pl. 13, fig. 5), Ohoden, probably from the Kunino Formation, lower Maastrichtian; f) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. Cr₂ 1137, original specimen of V. Tzankov (1982, pl. 13, fig. 4) from the same locality and level as c, d. All figures are in natural size.

junior synonym of it. In two later works, a description was made, and the lectotype and paralectotype of *P. galicianum* were refigured (see Kennedy and Summesberger, 1991; Summesberger and Zorn, 2012). Following the opinion of these authors, we interpret the examples previously defined as *P. tchihatcheffi* by V. Tzankov (1982, pl. 13, figs 4, 5) as belonging to *P. galicianum*. Other definitions from the older Bulgarian literature that we believe to fit in *P. galicianum* are those of V. Tzankov (1982, pl. 13, fig. 3) and Tz. Tzankov (1964, pl. 3, fig. 1). The former corresponds to a specimen that shows enough morphological attributes to be interpreted as *P. galicianum* (see Fig. 3f, right view; Fig. 10d, left view), but also shows similarities with *P. tercense* (Seunes, 1892). However, at a larger diameter, *P. tercense* usually has a bigger whorl height, and in addition the secondary ribbing is developed lower on the flanks. Tz. Tzankov (*ibid.*) defined his specimen as *P. brandti*, but it is moderately evolute and has a denser ornamentation than the typical examples of this species, and therefore we interpret it as *P. galicianum*.

Specimen U.S., K₂ 1801 (Fig. 10c) is a poorly preserved ammonite with an approximate diameter of 110 mm. In the inner whorls, primary and secondary ribs are visible; the ribs are straight to the mid-flanks and flexing forwards in the ventrolateral area; secondary ribs are also present. The sculpture of the last preserved whorl consists of relatively closely spaced prorsiradiate ribs, which have the same projection as in the inner whorls. Rare secondary ribs, rising high on the flanks, are also visible. This specimen has both coiling and ornamentation styles that are typical for *P. galicianum*, but since it is poorly preserved we define it conditionally.

It should be noted that specimen Nr. 254 (Fig. 13a–c), from the unpublished collection of Jolkičev, shows some morphological attributes that are rather characteristic for *P. tercense*. For instance, the narrow and closely spaced primary ribs,

as well as the closely spaced secondary ribs that arise occasionally low on the flanks, are not typical for *P. galicianum*. However, this ammonite has roughly sculptured inner whorls and almost quadrate whorl section, which are both not observed in *P. tercense*.

Occurrence. The only record of *P. galicianum* from the upper Campanian was that of Błaszkiwicz (1980) from Poland. This species is widely recorded in the lower Maastrichtian of Ukraine, Crimea, Austria, France, and Spain. The record presented herein is also from the lower Maastrichtian.

Pseudokossmaticeras muratovi Michailov, 1951 (Fig. 7d)

1951. *Pseudokossmaticeras muratovi* Michailov, p. 77, Pl. 13, Fig. 52.
 V 1982. *Pseudokossmaticeras galicianum* Seunes: V. Tzankov, Pl. 13, Fig. 2.
 1984. *Pseudokossmaticeras muratovi* Michailov: Yamnichenko and Astachova, p. 86, Pl. 53, Fig. 1.

Holotype. The holotype is specimen 3501/67 of Michailov (1951, p. 77, Pl. 13, Fig. 52) from the lower Maastrichtian of Bakhchisaray region, Crimea. It is housed at the Museum of the Institute for Geological Sciences (Ukraine).

Material and record. One specimen: Kaletto, probably from the Kunino Formation (Inv.-Nr. Cr₂ 1132, original specimen of V. Tzankov, 1982, pl. 13, fig. 2, refigured herein in Fig. 7d). Lower Maastrichtian.

Measurements. See Table 2.

Description. The only specimen we have is a cast of an imprint (see Fig. 7d). It is a small and moderately evolute ammonite, with rounded umbilical area. Thirty-four slightly bullate primary ribs arise from the umbilical wall. The ribs are initially concave, and then bend forward on the flanks. Ribs bifurcate mid- to high on the flanks. A total of more than 60 ribs cross the venter. Three shallow constrictions,

Fig. 9. Latest Campanian–lower Maastrichtian ammonites of the genus *Pseudokossmaticeras* from the Western Fore-Balkan Mts.: a–c) *Pseudokossmaticeras brandti* (Redtenbacher, 1873), Inv.-Nr. U.S., K₂ 1806 (Virovsko, Darmantsi Formation, uppermost Campanian); d, e, h) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. Cr₂ 1133 (original specimen of V. Tzankov, 1982, pl. 13, fig. 1, 1a, Darmantsi, Kunino Formation, lower Maastrichtian); f, g) *Pseudokossmaticeras tercense* (Seunes, 1890), Inv.-Nr. BAS Cr₂ 103 (original specimen of Tz. Tzankov, 1964, pl. 6, fig. 1), right view; Kladorub, Kladorub Formation, lower Maastrichtian). All figures are in natural size.

flanked by prominent sharp ribs, were observed on the cast.

Discussion. Hancock and Kennedy (1993) and Kennedy and Klinger (2013) discussed the main differences between *P. muratovi* and the other similar species of *Pseudokossmaticeras*. The main difference with *P. galicianum* and *P. terense* is the lack of prominent umbilical bullae and the concave shape of the ribs in the umbilical area. *Pseudokossmaticeras brandti* is more evolute and has coarser ribbing. In addition, *P. muratovi* differs in having a larger number of ribs and denser ribbing, in which most of the primary ribs bifurcate high on the flanks.

Occurrence. Lower Maastrichtian, Crimea and Bulgaria.

Pseudokossmaticeras terense (Seunes, 1892)

(Fig. 3e; Fig. 4a–c, d, g, j, k; Fig. 5a–c; Fig. 7a–c; Fig. 9f, g; Fig. 10e; Fig. 11g, h)

- 1890b. *Pachydiscus* af. *galicianus* Favre: Seunes, p. 238, Pl. 9, Fig. 5.
 1892. *Pachydiscus galicianus* Favre sp. mut. *Tercensis* Seunes, p. 16, Pl. 15 (6), Fig. 4.
 1894. *Pachydiscus brandti* Redtenbacher sp. var. *Pégoti* de Grossouvre, p. 194, Pl. 30, Fig. 3.
 1934. *Pachydiscus Galicianus* Favre: Jélev, p. 198, Pl. 4, Fig. 1.
 1959. *Pseudokossmaticeras galicianum* (Favre): Naidin and Shimansky, p. 189, Pl. 13, Fig. 1.
 V 1964. *Pseudokossmaticeras galicianum terense* (Seunes, 1890): Tz. Tzankov, p. 158, Pl. 6, Fig. 1; Pl. 7, Fig. 2.
 V 1964. *Pseudokossmaticeras galicianum* (Favre, 1869): Tz. Tzankov, p. 157, Pl. 4, Fig. 1; Pl. 5, Fig. 2.
 1974. *Pseudokossmaticeras galicianum* (Favre, 1869): Naidin, p. 179, Pl. 65, Fig. 4.
 1976. *Pseudokossmaticeras terense* (Seunes): Thiedig and Wiedmann, p. 18, Pl. 1, Fig. 2; Pl. 2, Fig. 2.
 1986. *Pseudokossmaticeras terense* (Seunes, 1892): Kennedy *et al.*, p. 1007, Pl. 1, Figs 6, 7.
 1993. *Pseudokossmaticeras terense* (Seunes, 1892): Hancock and Kennedy, p. 157, Pl. 7, Figs 1–4 (Figs 3, 4 = refigured lectotype); Pl. 8, Figs 1–6.

1993. *Pseudokossmaticeras terense* (Seunes, 1892): Ward and Kennedy, p. 29, Fig. 25.5.
 2001. *Pseudokossmaticeras terense*: Courville and Odin, Pl. 7, Figs 55–59.
 2001. *Pseudokossmaticeras terense*: Kennedy and Odin, Pl. 1, Figs 1, 6, 7.
 2001. *Pseudokossmaticeras* cf. *terense*: Kennedy and Odin, Pl. 1, Fig. 4.

Lectotype. The original of Seunes (1892, Pl. 15 (6), Fig. 4), from the lower Maastrichtian at Tercis (France), was designated lectotype by Kennedy *et al.* (1986, p. 1008). The lectotype was refigured by Hancock and Kennedy (1993, Pl. 7, Figs 3, 4). According to Hancock and Kennedy (1993, p. 157), this type specimen is also original for *Pachydiscus Brandti* Redtenbacher var. *Pégoti* de Grossouvre, and therefore the latter name is a synonym of *P. terense*. The lectotype is housed at the Muséum national d'histoire naturelle, Paris (Cat. Nr. MNHN-F-A24293).

Material and record. Ten specimens: Kladorub, Kladorub Formation (Inv.-Nr. BAS Cr₂ 98, original specimen of Tz. Tzankov, 1964, pl. 5, fig. 2, refigured here in Fig. 5a–c; Inv.-Nr. BAS Cr₂ 97, original specimen of Tz. Tzankov, 1964, pl. 4, fig. 1, refigured here in Fig. 7a; Inv.-Nr. BAS Cr₂ 103, original specimen of Tz. Tzankov, 1964, pl. 6, fig. 1, pl. 7, fig. 2, refigured here in Figs 9f, g, 10e); Kunino, Kunino Formation (Inv.-Nrs. U.S., K₂ 1797 and U.S., K₂ 1798, this study); Reselets, Kunino Formation (Inv.-Nrs. U.S., K₂ 1802, U.S., K₂ 1805, U.S., K₂ 807, and U.S., K₂ 1808, this study); Dolna Beshovitsa, probably from the Kunino Formation (Inv.-Nr. 307, unpublished specimen of Jolkičev). Lower Maastrichtian.

Measurements. See Table 2.

Description. The early growth stages are represented by two small, moderately evolute specimens with diameters of 53 mm (Fig. 3e) and 45 mm (Fig. 4a–c). The latter specimen, U.S., K₂ 1797, has a compressed whorl section due to *post-mortem* flat-

Fig. 10. Early Maastrichtian ammonites of the genus *Pseudokossmaticeras* from the Western Fore-Balkan Mts.: a, b) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. U.S., K₂ 1796 (Kunino, bed 6, Kunino Formation); c) *Pseudokossmaticeras* cf. *galicianum* (Favre, 1869), Inv.-Nr. U.S., K₂ 1801 (Bukovets, Darmantsi Formation,); d) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. Cr₂ 1131 (original specimen of V. Tzankov, 1982, pl. 13, fig. 3, left view; Bukovets, Kunino Formation); e) *Pseudokossmaticeras terense* (Seunes, 1890), Inv.-Nr. BAS Cr₂ 103 (original specimen of Tz. Tzankov, 1964, pl. 6, fig. 1, left view; Kladorub, Kladorub Formation). All figures are in natural size.

Fig. 11. Early Maastrichtian ammonites of the genus *Pseudokossmaticeras* from the Western Fore-Balkan Mts.: a, d) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. 256 (unpublished specimen of Yolkichev; Kunino, Kunino Formation); b, c) *Pseudokossmaticeras* cf. *galicianum* (Favre, 1869), Inv.-Nr. 5047 (unpublished specimen of Yolkichev; Varbinka, probably from the Yankovo Formation); e, f) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. 258 (unpublished specimen of Yolkichev; Kunino, Kunino Formation); g) *Pseudokossmaticeras tercense* (Seunes, 1892), Inv.-Nr. 307 (unpublished specimen of Yolkichev; Dolna Beshovitsa, Kunino Formation); h) *Pseudokossmaticeras tercense* (Seunes, 1892), Inv.-Nr. U.S., K₂ 1808 (Reselets, bed 17, Kunino Formation). All figures are in natural size.

tening. It has a shallow umbilicus, which is bordered by a sloping umbilical wall, and a broadly rounded umbilical shoulder. There are 20 small but sharp umbilical bullae. Narrow and sharp prorsiradiate primary ribs arise from the bullae, usually in pairs, but single ribs may also occur. Non-bullate prorsiradiate intercalatory ribs may occasionally raise low on the flanks. All ribs cross the venter. The total number of the ribs is more than 45. Three shallow constrictions were also observed.

Specimen U.S., K₂ 1807 (Fig. 4j, k) is partially preserved, with a vertical umbilical wall and rounded umbilical shoulder, and differs in ornament. This specimen is also bullate, but the bullae are situated on the umbilical shoulder. The ornament is denser, with primary ribs that are straight on the flanks but concave on both the ventrolateral shoulder and the venter. Some of the intercalated ribs are lower in relief than the primaries. They arise low or in the middle part of the flanks. The total number of the ribs is 34.

The specimens of Tz. Tzankov (1964, pl. 4, fig. 1; pl. 5, fig. 2; Figs 5a–c, 7a herein), are adults with diameters of 93.5 mm and 102.3 mm, respectively. Both ammonites are compressed, with a moderately deep umbilicus, vertical umbilical wall and rounded umbilical shoulder. At sizes below 60 mm diameter, the ornamentation consists of dense, narrow and bullate ribs; shallow constrictions are also visible. The last preserved whorls are ornamented with sharp ribs arising from umbilical bullae. The former specimen (Fig. 5a–c) has 27 primary ribs and 17 secondaries; some of the primaries are initially slightly convex; on the flanks they become straight, and on the ventrolateral shoulder they are concave. The secondaries are usually intercalated low on to in the middle of the flanks. The ornament of the former specimen (Fig. 7a) consists of 33 prorsiradiate primary ribs and more than 17 intercalated ribs,

both round-topped and straight on the flanks but flexing forwards (some sharply) on the ventrolateral shoulder.

The specimen of Tz. Tzankov (1964, pl. 6, pl. 7, fig. 2) is a near-complete moderately evolute ammonite with a diameter of 53 mm (see Figs 9f, g, 10e herein). The whorl section is compressed ($Wb/Wh = 0.71$), with flat flanks that are convergent towards a rounded venter. The umbilicus comprises 42% of the diameter and is bordered by a vertical umbilical wall and narrowly rounded umbilical shoulder. The inner whorls are finely ornamented with narrow prorsiradiate ribs arising from 25 small, sharp umbilical bullae. Four shallow constrictions are also visible. The bullae continue on the last whorl, gradually becoming rougher. On the first quarter of this whorl, each bulla gives rise to two slightly rounded prorsiradiate ribs, which are straight on the flanks and slightly concave on the ventrolateral shoulder but become slightly convex when crossing the venter. The bullae of the outermost parts of the last whorl give rise to single and flat-topped primary ribs. The rib interspaces become wider. Rare intercalated, flat to round-topped ribs also arise low on the flanks. A total of 40 ribs are developed at this stage of coiling.

Discussion. Kennedy and Summesberger (1987), Hancock and Kennedy (1993) and Kennedy and Klinger (2013) discussed the main differences in the group of closely related species of *Pseudokossmaticeras* with similar morphology: *P. brandti*, *P. galicianum*, *P. tercense*, *P. muratovi*, *P. pacificum* (Stoliczka), and *P. dureri* (Redtenbacher). Among these, *P. tercense* clearly differs in having compressed whorl section, with greater whorl height at the last whorl. It also differs in having densely ornamented inner whorls (with finely bullate ribs), as well as in the sculpture of the last whorl. The latter consists of primary ribs, arising either in singles

Fig. 12. *Pseudokossmaticeras brandti* (Redtenbacher, 1873) from the uppermost Campanian of the Western Fore-Balkan Mts.: a–c) Inv.-Nr. 255 (unpublished specimen of Yolkichev; Reselets train station and “Kuklite” area, probably from the Darmantsi Formation); d) Inv.-Nr. 242 (unpublished specimen of Yolkichev; Ralyovo, probably from the Darmantsi Formation,). All figures are in natural size.

or in pairs from sharp umbilical bullae, and secondary ribs that commonly rise low on the flanks and are differentiated from the primaries. We consider that the ornament in *P. tercense* consists of two types: 1) straight, bullate and predominantly round-topped primary ribs that bifurcate on the umbilical shoulder or low (rarely in the middle) on the flanks and also round-topped secondaries (see Fig. 4a, b; see also Hancock and Kennedy, 1993, pl. 8, fig. 2, 3); this ornamentation style is observed more often in immature specimens; and 2) primary ribs that are straight on the flanks but become concave on the ventrolateral shoulder and the venter; secondary ribs arise low on the flank and are clearly discernible from the primaries (e.g., Figs 4j, 7a).

Although specimens U.S., K₂ 1802 (Fig. 3e) and U.S., K₂ 1798 (Fig. 7b, c) are incomplete, their ornament is characteristic, and thus we define them as *P. tercense*. The narrowly spaced primary ribs that arise as singles or in pairs from small umbilical bullae, and the secondary ribs that appear low on the flanks, are typical sculpture elements of *P. tercense*. Besides, the secondary ribs are differentiated from the primaries.

The specimens described as *P. galicianum* by Tz. Tzankov (1964, pl. 4, fig. 1; pl. 5, fig. 2) we reinterpret as *P. tercense* (see above; see also Figs 5a–c, 7a). Despite being deformed, these ammonites display moderately evolute coiling, highly compressed whorl sections, and ornament, in which the lower secondary ribs differ from the primaries, i.e., typical characteristics for *P. tercense*. We note in addition that in these specimens the direction of the ribs changes on the flanks. Ribs are straight on the inner half of the flanks, and then curve forwards. This is another feature, which can be used for distinguishing *P. tercense* from *P. galicianum* (see also Kennedy *et al.*, 1986, p. 1008).

Occurrence. According to Kennedy *et al.* (1986, p. 1008), the type material for *P. tercense*, from Tercis, is imprecisely dated as late Campanian. Ward and Kennedy (1993) reported *P. tercense* from the Campanian/Maastrichtian boundary interval and from the base of Member I (lower Maastrichtian) in the Bay of Biscay region. The occurrences from Carinthia, Austria (Thiedig and Wiedmann, 1976), and the localities of the former USSR (Naidin and Shimansky, 1959; Naidin, 1974) are from the lower Maastrichtian. The Bulgarian record is firmly from the lower Maastrichtian.

CONCLUDING REMARKS

A revision of the ammonite genus *Pseudokossmaticeras* from Bulgaria has been made. Based both on previously collected and new material, the following species have been identified: *P. brandti* (Redtenbacher, 1873); *P. galicianum* (Favre, 1869); *P. muratovi* Michailov, 1951; and *P. tercense* (Seunes, 1892). Due to the wide dispersal of Bulgarian localities, these species could not be defined in terms of their accurate superposition, but with the help of some coeval age-defining inoceramid taxa they were placed in an appropriate overall chronostratigraphic framework. Thus, *P. brandti* was confined to the uppermost Campanian, while the other three species were restricted to the lower Maastrichtian. From a taxonomical viewpoint, the following conclusions can be drawn for the Bulgarian examples of the genus *Pseudokossmaticeras*: 1) *P. brandti* stands out with the roughest ornament and the stoutest whorl section; 2) *P. tercense* features a compressed whorl section, which is particularly high at the last whorl, and also has densely ornamented inner whorls; 3) *P. muratovi* differs in lacking prominent umbilical bullae and

Fig. 13. Early Maastrichtian ammonites of the genus *Pseudokossmaticeras* from the Western Fore-Balkan Mts.: a–c) *Pseudokossmaticeras galicianum* (Favre, 1869), Inv.-Nr. 254 (unpublished specimen of Yolkichev; Kunino, Kunino Formation); d–f) *Pseudokossmaticeras* cf. *galicianum* (Favre, 1869), Inv.-Nr. 3940 (unpublished specimen of Yolkichev; Dolna Beshovitsa, Kunino Formation); g) *Pseudokossmaticeras* cf. *galicianum* (Favre, 1869), Inv. Nr. 256 (unpublished specimen of Yolkichev; Kunino, Kunino Formation). All figures are in natural size.

having dense ribbing, in which most of the primary ribs bifurcate high on the flanks; 4) *P. galicianum* has a consistently compressed whorl section and an ornament which is composed of equally pronounced primary and secondary ribs.

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