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Taxonomy and paleobiogeographic implication of *Glabrobournonia* Morris and Skelton (Hippuritida, Radiolitidae) from the Late Cretaceous Yigeziya Formation, southwestern Tarim Basin

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Abstract

A re-examination of the specimens that were identified as *Biradiolites minor* Pojarkova from the late Campanian to early Maastrichtian middle member of the Yigeziya Formation of southwestern Tarim Basin, reveals that they should be assigned to the genus *Glabrobournonia* Morris and Skelton. *Glabrobournonia* is a group of radiolitids characterized by the indented radial bands, the sinuses or ridges on the shell margins and the absence of fine ribs on the surface of the right valve. Apart from southwestern Tarim Basin, *Glabrobournonia minor* (Pojarkova) has also been recorded from the late Campanian of Fergana and Alai basins. The central
Asian, late Campanian to early Maastrichtian *G. minor* differs from the late Campanian to Maastrichtian, eastern Arabian type species *Glabrobournonia arabica* Morris and Skelton in the flat left valve and an additional fourth ridge on the junction of the dorsal and posterior sides of the right valve. *Biradiolites ingens* (Des Moulins) is probably the direct ancestor of *Glabrobournonia*. The paleogeographic distribution of *Glabrobournonia* suggests that this genus dispersed to central Asia from the late Campanian time, indicating that it is widely distributed in the eastern Tethyan region rather than endemic to eastern Arabia. Correspondingly, specimens belonging to *Gyropleura* yielded from the same bed with *G. minor* in southwestern Tarim Basin, are similar to the specimens which were attributed to the eastern Arabian *Gyropleura* sp.; Campanian to early Maastrichtian *Osculigera* specimens described from the Yigeziya Formation are comparable with those known from the Campanian–Maastrichtian of Iran, Afghanistan and eastern Arabia. The similarity of the rudist assemblages between central Asia and eastern Arabia suggests a faunal connection and affinity between the north and south margins of the eastern Tethyan realm during Campanian to early Maastrichtian times.

**Keywords**: Cretaceous; Tarim Basin; central Asia; Tethys; Yigeziya Formation; *Glabrobournonia*

1. Introduction

The Tarim Basin in Xinjiang Uygur Autonomous Region of Northwest China is situated south of the Tianshan Ranges, north of the West Kunlun Ranges, and east of the Pamir Plateau (Hao et al., 1982; Sun et al., 2016). During Cretaceous to Paleogene, a shallow epicontinental sea extended across Eurasia from the Mediterranean Tethys to the southwestern Tarim Basin, and its eastern extremity being referred to as the Tarim Sea (Tang et al., 1992; Bosboom et al., 2014). Some researchers termed this epicontinental sea as the proto-Paratethys (Kaya et al., 2019, 2020), while it was commonly regarded as a branch of the Neotethys (Zhang et al., 2018; Xi et al., 2020). Its drastic retreat during the Eocene/Oligocene boundary
formed the relatively isolated Paratethys (Rögl, 1999; Schulz et al., 2005). During Late Cretaceous, two distinct transgressive events have been identified in Tarim Sea: the first is represented by the deposition of early Cenomanian to Turonian Kukebai Formation, and the second formed the Campanian to early Maastrichtian Yigeziya Formation (Xi et al., 2016, 2019; Zhang et al., 2018).

Abundant rudists have been reported from the Yigeziya Formation (Yang, 1984; Lan and Wei, 1995; Scott et al., 2010; Rao, 2019), most of them were considered as endemic taxa that were restricted to central Asia including Tajik, Fergana, Alai and Tarim basins (Lan and Wei, 1995). *Biradiolites minor* Pojarkova, described by Lan and Wei (1995) from the middle member of the Yigeziya Formation, is characterized by the glabrous outer shell layer except for four sinuses or ridges on the shell margin of the right valve. This feature is inconsistent with the genus *Biradiolites* d’Orbigny which is normally ornamented with strongly protruding longitudinal ridges over whole right valve (Vicens et al., 2004; Mitchell et al., 2007). Rao (2019) mentioned the similarity between *B. minor* and the eastern Arabian genus *Glabrobournonia* Morris and Skelton, which differs from *Bournonia* in the absence of ribbing on the right valve.

In this paper, we restudy the species *B. minor* based on the published and new specimens, transfer it to the genus *Glabrobournonia* according to our taxonomic re-examination, and discuss on its evolutionary origin and paleobiogeographic implications.

2. Geological setting

The southwestern Tarim Basin is one of the main areas in China where the marine Cretaceous is well developed (Hao et al., 2001) (Fig. 1). The Lower Cretaceous Kezilesu Group mainly consists of the red clastics of conglomerates, sandstones, and mudstones, and contains few marine fossils in its upper layers (Chen et al., 2001; Guo et al., 2015). The Upper Cretaceous gulf deposits which crop out as a narrow belt along the southwest border of the Tarim Basin (Fig. 1b), are represented by sediments of littoral, near-shore neritic and estuarine facies divided in ascending
order into the Kukebai, Wuyitake, Yigeziya and Tuyiluoke formations (Meng et al., 2001; Xi et al., 2019).

The Yigeziya Formation outcrops along the north piedmont of West Kunlun Mountains, as a narrow north-northwest belt encompassing Kashi, Wuqia, Aketao, Yingjisha, Shache and Yecheng counties, with the thickness thinning gradually from west to east, changing from 125 m to 10 m (Zhang et al., 2002). Based on the lithologic characteristics, the Yigeziya Formation can be divided into the lower, middle, and upper members (Tang et al., 1992; Lan and Wei, 1995). The lower Member is characterized by limestone interbedded with dolomite, occasionally with gypsum lump and thread veins. The middle member is composed of thick-bedded skeletal-debris micritic limestone and sparite limestone. The upper Member, known only from the Wuyitake and Akecheyi areas, is characterized by pale red micritic limestone with birds-eye pellets, and comparatively numerous dolomite and calcisiltite.

The Yigeziya Formation is rich in bivalves, foraminifera, ostracods, gastropods, and brachiopods. Lan and Wei (1995) considered this formation to be of Coniacian to early Maastrichtian age based on the comparison of the bivalve assemblages with those from the central Asia and Europe. Hao et al. (2001) distinguished the
Quinqueloculina-Nodosaria-Textularia and Pseudotriloculina-Ammodiscus-Protelphiddum forminiferal biozones from the middle and upper parts of the Yigeziya Formation, of Maastrichtian age. Based on comprehensive biostratigraphic and chronostratigraphic studies, Xi et al. (2020) concluded that the Yigeziya Formation includes Campanian to early Maastrichtian strata, but may extend to late Santonian and late Maastrichtian. Based on these studies, we here assume the age of the Yigeziya Formation to be Campanian to early Maastrichtian.

The Glabrobournonia specimens described herein were collected from the middle member of the Yigeziya Formation at the Yigeziya section in Yingjisha
County (Lan and Wei, 1995) (Fig. 1c). In this section, *Glabrobournonia* co-occurred with the rudists *Gyropleura vakhschensis* Bobkova, *Gyropleura vakhschensis darwaseana* Bobkova, *Gyropleura magianensis* Pojarkova, and other bivalves like *Neithea (Neithea) coquandi* (Peron) and *Lima marrotiana* d’Orbigny. This rudist assemblage is mainly composed of taxa preserved of small individuals, and of late Campanian age based on the biostratigraphic correlation with the adjacent central Asian basins yielding similar rudist taxa (Pojarkova, 1955, 1976; Bobkova, 1961; Lan and Wei, 1995). Taking into account that the foraminiferal assemblage from the middle member of the Yigeziya Formation indicates a Maastrichtian age (Hao et al., 2001), and the bivalve assemblage from the upper member of this Formation suggests an early Maastrichtian age (Lan and Wei, 1995), the age of the middle member of the Yigeziya Formation could be assigned to late Campanian to early Maastrichtian.

3. Materials and methods

The rudist material described in present paper was collected from the middle member of the Yigeziya Formation of Yigeziya section, located in the south of the Yingjisha County, southwestern Tarim Basin. The specimens are reposited at Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences.

Five of these specimens were described by Lan and Wei (1995) and were assigned to *Biradiolites minor* (NIGP 117509–117512) and *Gyropleura vakhschensis* (NIGP 117514). The rest ten specimens (NIGP 172216–172225) were collected from the same bed with the published five specimens. The rudists are preserved as small individuals, including four articulated specimens (NIGP 117510, 117511, 172216, 172219) and eleven right valve specimens (NIGP 117509, 117512, 117514, 172217, 172218, 172220–172225). Transverse sections close and nearly parallel to the commissural plane were prepared to examine the myocardinal structure, which could also been observed on the natural section of some specimens. Dorso-ventrally longitudinal sections were made to observe the structure of the left valve. The diagnostic characters of *Glabrobournonia* based on transverse and longitudinal sections are shown on Fig. 2.
**Abbreviations:** *ab*, anterior radial band; *am*, anterior myophore; *at*, anterior tooth; *AVC*, antero-ventral carina; *bc*, body cavity; *DC*, dorsal carina; *HR*, height of *RV*; *IB*, inter band; *il*, inner shell layer (aragonitic); *LV*, left valve; *ol*, outer shell layer (calcitic); *pb*, posterior radial band; *PDR*, postero-dorsal ridge; *pm*, posterior myophore; *pt*, posterior tooth; *RV*, right valve.

[Fig. 2 hereabouts]

4. **Systematic paleontology**

The classification scheme used herein follows Skelton (2013a, 2013b).

Class Bivalvia Linnaeus, 1758
Order Hippuritida Newell, 1965
Suborder Hippuritidina Newell, 1965
Superfamily Radiolitoidea d’Orbigny, 1847
Family Radiolitidea d’Orbigny, 1847

Genus *Glabrobournonia* Morris and Skelton, 1995

**Type species:** *Glabrobournonia arabica* Morris and Skelton, 1995.

*Glabrobournonia minor* (Pojarkova, 1955)

(Figs. 3, 4)

1955 *Biradiolites fissicostatus* var. *minor* – Pojakova, p. 49, pl. 4, figs. 1–3.
1974 *Biradiolites fissicostatus* var. *minor* – Bobkova, p. 106, pl. 49, figs. 1–3.
1976 *Biradiolites minor* – Pojakova, p. 135, pl. 64, figs. 3, 4.
1995 *Biradiolites minor* – Lan and Wei, p. 156, pl. 24, figs. 3–5, 7, 10, 12.
1995 *Gyropleura vakhschensis* – Lan and Wei, p. 154, pl. 24, fig. 11.

**Emended diagnosis:** *Glabrobournonia* with flat *LV*, four sinuses or ridges on the
shell margins of RV, and fine ribs on the surface of the inner shell layer in RV.

**Description:** Majority of the specimens are preserved as individuals. Shell small, *HR* (from commissural plane to apex) ranges from 15 mm to 35 mm. RV conical, curved in dorso-ventral direction (Figs. 2b, 3h, i, 4b, e). *LV* nearly flat (Figs. 2b, 3f, j, 4b, e).

Outer surface of RV is predominantly smooth except for fine growth lines (Fig. 4a, f), in contrast, faint concentric and radial ornamentations are developed on the surface of LV (Fig. 3g). The cross-section of RV is sub-quadrangular (Figs. 2a, 3k, 4c, d), with four sinuses or ridges on the margin of each side (*DC, AVC, IB and PDR*). The anterior side is broad and flat, forming sinusoidal and acute protruding carinae on its dorsal (*DC*) and ventral (*AVC*) margins respectively (Figs. 3a–c, f, 4a, b, f–i), which indicates that the shell is probably lay with the flat anterior face reclining on the substrate in life (as a ‘lateral cling er’ morphotype). The radial bands are represent by two broad indentations on the ventral and posterior sides. Anterior band is slightly wider than the posterior one (Fig. 3k), separating from the *AVC* and *IB* by shallow furrows (Fig. 4f). The acute ridge which locates at the junction of the ventral and posterior sides (Fig. 4f), represents the inter band. *PDR* is sharp, situates on the junction of the dorsal and posterior sides (Fig. 4h, i). As *ol* is poorly preserved in most of the specimens, it is difficult to find all these four sinuses in one single specimen.

The thickness of *ol* in the RV is about 0.5 mm to 1 mm, and could reach 9 mm on the ridge area (Fig. 4b). The growth lamellae are steeply inclined, with cellular structure in radial ridge pattern on the surface (Fig. 3a, e), which lead to sub-quadrangular cellular pattern when the sections cut through more than one lamellae tangentially or perpendicularly (Fig. 4b). The inner shell is thin, with fine, evenly and closely spaced ribs on its outer surface (Fig. 3i). The thickness of *ol* in the LV ranges from about 0.5 mm to 2 mm, and the cellular structure could be observed on the longitudinal section (Fig. 4b).

Two teeth (anterior tooth and posterior tooth) develop on the LV, connecting to each other so that forming the broad ‘V’ shaped hinge plate (Fig. 4c, d). They project into the teeth grooves of RV which probably develop on the inner surface of the inner shell layer. The anterior and posterior myophore plates form a longer reversed ‘V’
compared with the hinge plate (Fig. 4c, d). Ligamentary infolding and central tooth of \( RV \) are absent.

[Fig. 3 hereabouts]
[Fig. 4 hereabouts]

**Remarks:**

Pojarkova (1955, 1976) and Bobkova (1974) described *Biradiolites minor* from the upper Campanian of southwestern Fergana and Alai basins, and Campanian of Kashi in southwestern Tarim Basin. Based on the specimens from Fergana and Alai basins (Pojarkova, 1976), the critical features of *B. minor* include the flat anterior side, smooth shell surface, indented flat radial bands, and trapezoid cross-section of the \( RV \). Pojarkova (1976) considered that the commissure is dorsally inclined, with the height of the ventral margin ranges from 30.5 mm to 50.6 mm, and the dorsal margin ranges from 22.9 mm to 34.6 mm. Lan and Wei (1995) described four specimens of the same species (NIGP 117409–117412) from the upper Campanian to lower Maastrichtian middle member of the Yigeziya Formation of southwestern Tarim Basin, and considered that *B. minor* is endemic to central Asia.

The genus *Biradiolites*, defined by d’Orbigny (1850) with the type species *Biradiolites canaliculatus*, is widely distributed in the Tethyan and Caribbean regions from Turonian to Maastrichtian (Vicens et al., 2004; Mitchell et al., 2007; Steuber et al., 2016). *Biradiolites* is a large genus represented by dozens of species, characterized by the flat, smooth, depressed radial bands and the distinct longitudinal ridges on the shell surface (Toucas, 1909; Cestari, 2008). On the other hand, previous reported fossils of putative *Biradiolites minor* in central Asia are characterized by their shell surface of \( RV \) being glabrous with inconspicuous fine growth lines and four sinuses/ridges on shell margins, inconsistent with other known species of the genus *Biradiolites*.

The genus *Glabrobournonia* Morris and Skelton, erected based on the specimens from the upper Campanian–Maastrichtian of the United Arab Emirates–Oman border
region, was monotypic, including only the type species *Glabrobournonia arabica*. Morris and Skelton (1995) noted that *Glabrobournonia* is a small genus with a cornuted lower valve and a very low, slightly convex upper valve. Right valve smooth except for fine growth lines and three major sinuses in the shell margin which leave sinusoidal traces, one at the ventral margin, one at the dorsal margin and one centrally on the posterior margin. Upper valve with reticulate sculpture of fine radiating ribs and concentric growth laminae’, and distinguished it from *Bournonia* by the absence of ribbing on the RV. The specimens from central Asia that were identified as *Biradiolites minor* should be transferred to *Glabrobournonia* as they show typical characteristics of this genus, including the smooth outer shell layer in the RV and the simple sinuses or ridges on the shell margins. Morris and Skelton (1995) illustrated the two sinuses on the ventral and posterior margins as the radial structure of *G. arabica*, but the abundant material described herein make it possible to reconsider the arrangement of the radial bands of this genus. Probably, both *G. minor* and *G. arabica* are clingers as they have broad, flat anterior side, which lead to the formation of two carinae on its dorsal and ventral margins, so that the ventral carina structure is more likely related to the shell morphotype and growth pattern, rather than the radial structure. Here we redefined the indentations on the ventral and posterior sides as the radial bands of *Glabrobournonia*, and the posterior ridge between two radial bands as the inter band (Fig. 5). Therefore, *Glabrobournonia* can be distinguished from *Bournonia* not only by the absence of ribbing on the RV as Morris and Skelton (1995) mentioned, but also by the arrangement of the radial bands which are represent by protruding ridges in *Bournonia*.

It is noted that one specimen from the same bed with *Glabrobournonia minor*, described as *Gyropleura vakhschensis* Bobkova by Lan and Wei (1995, pl. 24, fig. 11; NIGP 117514), may not be assigned to *Gyropleura* because of the absence of ligament which is an essential feature of this genus (Skelton, 2013a). HV of this specimen is about 20 mm, ol is smooth, il ornamented with fine ribs, and the natural cross-section is sub-quadrangular, and all these features indicate that it should be attributed to *Glabrobournonia minor*. 
The central Asian *Glabrobournonia minor* differs from the eastern Arabia type species *G. arabica* in the following aspects: (1) *LV* is nearly flat, contrasting with the slightly convex *LV* of *G. arabica*; (2) *RV* has four sinuses/ridges on the margin of each side, while there are only three sinuses at the dorsal, ventral and posterior margins in *G. arabica*; (3) the outer surface of inner shell develops fine ribs, not recorded in *G. arabica*. Combining the characteristics of these two species, the definition of *Glabrobournonia* may be revised as follows.

‘Small genus with a cornuted right valve and a flat to slightly convex left valve. Right valve smooth except for fine concentric growth lines and three sinuses or ridges at the dorsal, ventral and posterior margins, or an additional ridge at the junction of the dorsal and posterior sides. Two of the three sinuses/ridges are carinae formed by the expansion of the broad, flat anterior face of the right valve, another one represents the inter band. Radial bands are situated in the two indentations on the ventral and posterior sides. Left valve with reticulate sculpture of fine radiating ribbing and concentric growth lines’.

As *G. minor* has been reported from upper Campanian–lower Maastrichtian of central Asia, and *G. arabica* from upper Campanian–Maastrichtian of eastern Arabia, the genus *Glabrobournonia* is assignable to late Campanian to Maastrichtian in age.

5. Discussion

5.1. Comparison with *Biradiolites* and evolutionary origin of *Glabrobournonia*

*Glabrobournonia* resembles *Biradiolites* in the intended flat anterior band and posterior band which are separated by the protruding inter band, and the absence of the ligament and central tooth of the right valve. However, the two genera differ in that, (1) in *Glabrobournonia*, the shell surface of *RV* is glabrous with inconspicuous fine growth lines and three or four sinuses/ridges on shell margins (Figs. 4a, f–i, 5a–d), whereas the protruding longitudinal ridges and concentric growth rugae are commonly developed over the whole shell of *RV* in *Biradiolites* (e.g., Morris and
Skelton, 1995, pl. 8, figs. 1–5; Pons and Vicens, 2008, fig. 1E); (2) the anterior surface of *Glabrobournonia* is broad and flat, suggesting that this genus is probably attached to the substrate by the anterior face in life, as a ‘lateral clinger’ morphotype, whereas most of the *Biradiolites* species are ‘elevator’, whose ridges develop on the anterior side as the rest parts of the shell (Mitchell, 2002; Mitchell et al., 2007).

*Biradiolites fissicostatus* d’Orbigny and *Biradiolites ingens* (Des Moulins) from the Mediterranean Tethys show similar shell morphology to *Glabrobournonia*. *B. fissicostatus* has been well documented from the Coniacian to Maastrichtian of France, Italy, Spain, Greece, Albania, Austria, Romania, Slovenia, Serbia and Montenegro, and *B. ingens* has been recorded from Campanian to Maastrichtian of France, Italy and Bulgaria (Steuber, 2002). The broad flat anterior surface and the organization of the radial bands of these two *Biradiolites* species are nearly identical to *Glabrobournonia* (Toucas, 1909; Caffau et al., 1992; Cestari and Sartorio, 1995; Caffau and Pleničar, 2004). The main difference between them is that two ridges on the edge of the anterior side in *B. fissicostatus* and *B. ingens* are sharp and strongly protruding, whereas the edges of the anterior side of *Glabrobournonia* are represented by sinuses (*G. arabica* and *DC* in *G. minor*) or weakly to moderately protruding ridges (*AVC* in *G. minor*). Compared to *B. fissicostatus*, *B. ingens* shows greater similarity and affinity with *Glabrobournonia* in the following two aspects: (1) the length of the anterior ridges in *B. ingens* is normally less than half of the dorso-ventral diameter of the commissure (Toucas, 1909, pl. 23, fig. 11a), while in *B. fissicostatus*, the anterior ridges are more strongly projecting that could be longer than the diameter of the commissure (Cestari and Sartorio, 1995, pp. 160, 161); (2) the external surface of *B. ingens* is entirely smooth without trace of longitudinal ribs, whereas ribs are developed on the ventral and posterior sides in *B. fissicostatus*. To conclude, although there are generic-level differences between *Glabrobournonia* and *Biradiolites ingens*, the similarities between them suggest that *Biradiolites ingens* is probably the direct ancestor of *Glabrobournonia*.

5.2. Paleobiogeographic significance of the Late Cretaceous rudists from the
Rudists have been recorded from both of the Late Cretaceous Kukebai and Yigeziya formations of the southwestern Tarim Basin (Yang, 1984; Lan and Wei, 1995; Rao, 2019). Only one species, *Ichthyosarcolites tricarinatus* Parona, has been described from the early Cenomanian to Turonian Kukebai Formation. The attribution of the Tarim specimens to *I. tricarinatus* needs further study, as their transverse sections are subquadrate or trapezoidal in shape, contrasting with the triangular to ovoid form of that in *I. tricarinatus* (Rineau and Villier, 2018). Furthermore, small projecting flange fragments pervaded by fine, capillary-like pallial canals are preserved inside the body cavity and surrounded by sediments. Although these specimens need further examination, the characters of the flange fragments are consistent with Albian–Cenomanian genus *Ichthyosarcolites* which has a relatively cosmopolitan distribution along the northern and southern Tethyan margins (Filkorn, 2002; Rineau and Villier, 2018; Özer and Kahrıman, 2019).

Majority of the rudist taxa known from the Campanian to early Maastrichtian Yigeziya Formation were considered endemic to central Asia and adjacent regions, or restricted to southwestern Tarim Basin in previous publications (Lan and Wei, 1995; Scott et al., 2010). For example, apart from the Tarim Basin, *Gyropleura vakhschensis* Bobkova with flat LV (Lan and Wei, 1995, pl. 24, figs. 8, 11, 14) has been reported only from the late Campanian of central Asia like Tajik Basin (Bobkova, 1961). *Osculigera oytarenensis* Lan and Wei from the Yigeziya Formation shows great similarity with the *Osculigera cleggi* Kühn of the eastern Iran and Afghanistan (Vogel, 1970). All these regions were situated on the north margin of the eastern Tethys during Late Cretaceous (Hao et al., 1987; Chen et al., 1993; Scotese, 2014), in contrast with the cosmopolitan distribution of *Ichthyosarcolites* from the Kukebai Formation.

Rao (2019) pointed out that *Biradiolites boldjuanensis* and *Biradiolites minor* from the Yigeziya Formation probably had a relatively wider Tethyan distribution, based on the comparison with similar species recorded from other Tethyan regions; here we confirm this perception. *Glabrobournonia minor* (= *Biradiolites minor* in Lan
and Wei, 1995 and Rao, 2019) is rich in the upper Campanian of Fergana Basin, Alai, and southwestern Tarim Basin, all located on the north branches of the eastern Tethys in Late Cretaceous. The type species *G. arabica* discovered from the Upper Campanian and Maastrichtian of the United Arab Emirates–Oman border region, supports the distribution of this genus in the south margin of eastern Tethys (Morris and Skelton, 1995; Steuber and Löser, 2000; Skelton, 2003) (Fig. 6). We also note that some *Gyropleura* specimens with low exogyriform LV (Lan and Wei, 1995, pl. 24, figs. 13, 16) from the middle member of Yigeziya Formation are comparable with *Gyropleura* sp. associated with *G. arabica* in eastern Arabia (Morris and Skelton, 1995). The *Glabrobournonia* and *Gyropleura* taxa discussed above were reported from the middle member of the Yigeziya Formation, and the *Osculigera* Kühn from the lower and upper members of the Yigeziya Formation has similar distribution pattern. In addition to the southwestern Tarim Basin, Iran and Afghanistan, *Osculigera* has also been reported from eastern Arabia (Morris and Skelton, 1995). Our comparative analysis of Campanian to early Maastrichtian rudists between western Asia, central Asia and eastern Arabia of the eastern Tethyan realm, suggests that they are cosmopolitan rather than endemic taxa, displaying a faunal connection and affinity between the north and south margins of the eastern Tethyan realm at that time.

[Fig. 6 hereabouts]

6. Conclusion

Our re-examination of the specimens that were identified as *Biradiolites minor* Pojakroka from the late Campanian to early Maastrichtian middle member of the Yigeziya Formation in southwestern Tarim Basin, shows that the species should be assigned to *Glabrobournonia* Morris and Skelton, which is characterized by the indented flat radial bands and absence of ribs on the right valve. Apart from the southwestern Tarim Basin, *Glabrobournonia minor* (Pojarkova) has also been recorded from the late Campanian of southwestern Fergana and Alai basins. The
paleogeographic distribution of *Glabrobournonia* suggests that it already expanded to the eastern Arabia of the south eastern Tethys and central Asia of the north eastern Tethys from late Campanian. Our analysis of the rudist taxa between central Asia and eastern Arabia suggests a faunal connection and affinity between the north and south margins of the eastern Tethyan realm during the Campanian to early Maastrichtian times.

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**References**


**Figure captions**

Fig. 1. (a) Map of the southwestern Tarim Basin and adjacent basins bearing Late Cretaceous rudists (modified after Tang et al., 2015). (b) Geologic map showing the fossil locality in southwestern Tarim Basin (based on Lan and Wei, 1995 and Sun et al., 2016). (c) Stratigraphic column of the Yigeziya section and the occurrence of *Glabrobournonia minor* within the section.

Fig. 2. Diagrammatic transverse (a) and longitudinal (b) sections of *Glabrobournonia minor* (Pojarkova).

Fig. 3. *Glabrobournonia minor* (Pojarkova) from the Yigeziya Formation of the Yingjisha County, southwestern Tarim Basin. (a–f) NIGP 117511, articulated specimen; (a) anterior view; (b) dorsal view; (c) posterior view; (d) ventral view; (e) detail from red square in (a); (f) *LV*, abumonal view. (g) NIGP 117510, articulated specimen, *LV* in abumonal view, showing the concentric (black arrow) and radial (white arrow) ornamentations. (h–k) NIGP 117509, *RV*; (h) anterior view; (i) postero-ventral view, showing the fine ribs on the surface of the inner shell (black arrow); (j)
ventral view; (k) adumbonal view. Scale bar represents 10 mm.

Fig. 4. *Glabrobournonia minor* (Pojarkova) from the Yigeziya Formation of the Yingjisha County, southwestern Tarim Basin. (a, b) NIGP 172216, articulated specimen; (a) anterior view, showing the flat anterior surface, and the fine growth lines (red arrow); (b) dorso-ventral longitudinal section. (c) NIGP 172217, *RV* in adumbonal view. (d) NIGP 172218, transverse section of *RV* in adumbonal view. (e) NIGP 172219, articulated specimen, dorso-ventral longitudinal section. (f) NIGP 172220, *RV*, ventral view. (g–i) NIGP 172221, *RV*; (g) anterior view; (h) ventral view; (i) postero-ventral view. Scale bar represents 10 mm.

Fig. 5. Holotype of *Glabrobournonia arabica* Morris and Skelton, from the lower Simsima Formation of the United Arab Emirates–Oman border region (based on Morris and Skelton, 1995, pl. 9, fig. 1). (a) Ventral view; (b) posterior view; (c) dorsal view; (d) anterior view. Scale bar represents 10 mm.

Fig. 6. Paleogeographic map of late Campanian showing the reconstructed situations of the fossil localities bearing *Glabrobournonia* (base map after Scotese, 2014).