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Monograph

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The Changhsingian (Late Permian) ammonoids from Baghuk Mountain (Central Iran)

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Abstract. The Changhsingian (Late Permian) Hambast Formation of sections at Baghuk Mountain (Central Iran) has yielded diverse ammonoid assemblages composed of the genera *Pseudogastrioceras*, *Shevyrevites*, *Arasella*, *Dzhulfites*, *Paratirolites*, *Clivotirolites* gen. nov., *Esfahanites* gen. nov., *Alibashites*, *Lutites* gen. nov., *Abichites* and *Stoyanowites*. The succession of ammonoid species allows for a subdivision of the rock unit into biozones, which largely correlate with the occurrences in north-western Iran. Three new genera, *Clivotirolites* Korn & Hairapetian gen. nov., *Esfahanites* Korn & Hairapetian gen. nov. and *Lutites* Korn & Hairapetian gen. nov., as well as 19 new species are described: *Shevyrevites corrugatus* Korn & Hairapetian sp. nov., *Arasella falcata* Korn & Hairapetian sp. nov., *Dzhulfites brevisellatus* Korn & Hairapetian sp. nov., *Paratirolites rubens* Korn & Hairapetian sp. nov., *Paratirolites lanceolobatus* Korn & Hairapetian sp. nov., *Paratirolites robustus* Korn & Hairapetian sp. nov., *Paratirolites baghukensis* Korn & Hairapetian sp. nov., *Paratirolites aduncus* Korn & Hairapetian sp. nov., *Clivotirolites decoratus* Korn & Hairapetian gen. et sp. nov., *Clivotirolites petilus* Korn & Hairapetian gen. et sp. nov., *Esfahanites armatus* Korn & Hairapetian gen. et sp. nov., *Lutites paucis* Korn & Hairapetian gen. et sp. nov., *Lutites lyriformis* Korn & Hairapetian gen. et sp. nov., *Lutites*

profundus Korn & Hairapetian gen. et sp. nov., *Lutites alius* Korn & Hairapetian gen. et sp. nov., *Lutites plicatus* Korn & Hairapetian gen. et sp. nov., *Abichites ovalis* Korn & Hairapetian sp. nov., *Abichites infirmus* Korn & Hairapetian sp. nov. and *Stoyanowites parallelus* Korn & Hairapetian sp. nov. The material described here is, together with the material from NW Iran, the most diverse assemblage known from the interval before the end-Permian mass extinction.

Keywords. Ammonoids, Late Permian, Central Iran, biostratigraphy, morphometrics.

Korn D., Hairapetian V., Ghaderi A., Leda L., Schobben M. & Akbari A. 2021. The Changhsingian (Late Permian) ammonoids from Baghuk Mountain (Central Iran). *European Journal of Taxonomy* 776: 1–106. <https://doi.org/10.5852/ejt.2021.776.1559>

Introduction

The evolution of the organisms at the transition from the Palaeozoic to the Mesozoic is currently one of the major study areas in the field of palaeontology. Intensive investigations, however, are often hampered by the low number of regions in which fossil-rich sedimentary successions are exposed, both in the marine and the terrestrial realm. Sections that represent the deeper shelf and contain ammonoid assemblages, for instance, are known from only few regions worldwide, such as the Transcaucasus/NW Iranian region (e.g., Stoyanow 1910; Shevyrev 1965, 1968; Stepanov *et al.* 1969; Teichert *et al.* 1973; Kotlyar *et al.* 1983; Zakharov 1992; Ghaderi *et al.* 2014; Korn *et al.* 2016, 2019; Korn & Ghaderi 2019) and South China (e.g., Zhao *et al.* 1978; Zheng 1981; Liang 1983; Yang 1987; Yang & Yang 1992). For this reason, any new occurrence of latest Permian ammonoids bears the potential for a significant contribution to the knowledge of this fossil group.

Late Permian ammonoids from the area of Abadeh in Central Iran were discovered only half a century ago by Taraz (1969, 1971, 1973) who briefly mentioned this discovery in several short reports. Subsequently, these sections in the Hambast Range (Kuh-e-Hambast; Fig. 1) were intensely studied by the Iranian-Japanese Research Group (Taraz *et al.* 1981) where a total of 50 (but almost half of them in open nomenclature) Wuchiapingian and Changhsingian ammonoid species were listed in a stratigraphic

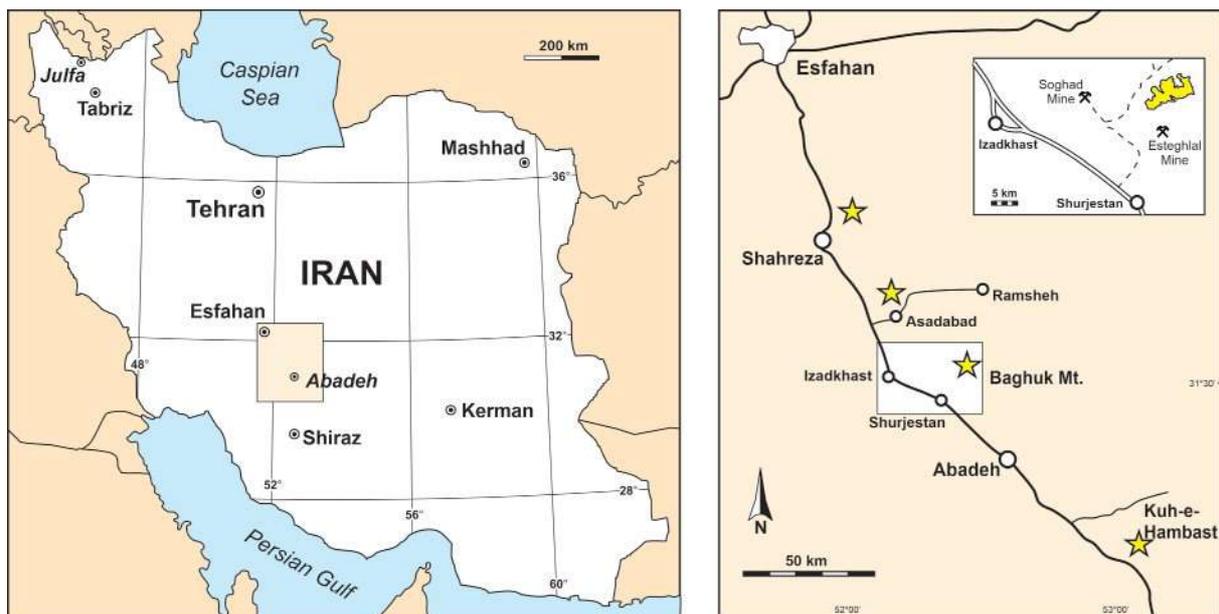


Fig. 1. Geographic position of Permian–Triassic boundary sections at Baghuk Mountain.

chart. Descriptions of the Permian and the less species-rich Triassic assemblages were provided in the monographs by Bando (1979, 1981). In the first article, more than twenty ammonoid species, some in open nomenclature, were assigned to the Changhsingian.

The range charts of the ammonoids from the Hambast Range provided by Bando (1979) and Taraz *et al.* (1981) showed a mixture of Wuchiapingian and Changhsingian ammonoids, which putatively co-occur in some of the horizons. *Araxoceras* Ruzhencev, 1959, a characteristic early Wuchiapingian ammonoid genus, for instance, was reported to co-occur with the characteristic Changhsingian genera *Shevyrevites* Teichert & Kummel, 1973 and *Paratirolites* Stoyanow, 1910. Problems of this kind in the stratigraphic succession of genera and species have not been discussed since. However, Zakharov *et al.* (2010) revised some Wuchiapingian ammonoids from the Hambast range and did not report such a co-occurrence.

The discovery of an ammonoid-bearing succession of Late Permian age at Baghuk Mountain allows for a study of the stratigraphic range of a number of ammonoid species in great detail. The outcrops enabled us to collect a large number of more than 570 determinable ammonoid specimens, of which 220 were collected in situ with precise assignment to the respective horizon. In the following, we present the first monographic description of the Changhsingian species of these assemblages, which range among the most diverse in a global scale.

Material and methods

Investigated outcrops

Permian–Triassic strata are exposed in a number of outcrops at Baghuk Mountain (Fig. 1), a locality in Central Iran between the cities of Shahreza and Abadeh, that had a palaeogeographic position in the Palaeotethys near the equator (e.g., Stampfli & Borel 2002) (Fig. 2). We investigated a total of eight parallel sections, all of which are very similar in their lithological succession (four of them illustrated in Fig. 3).

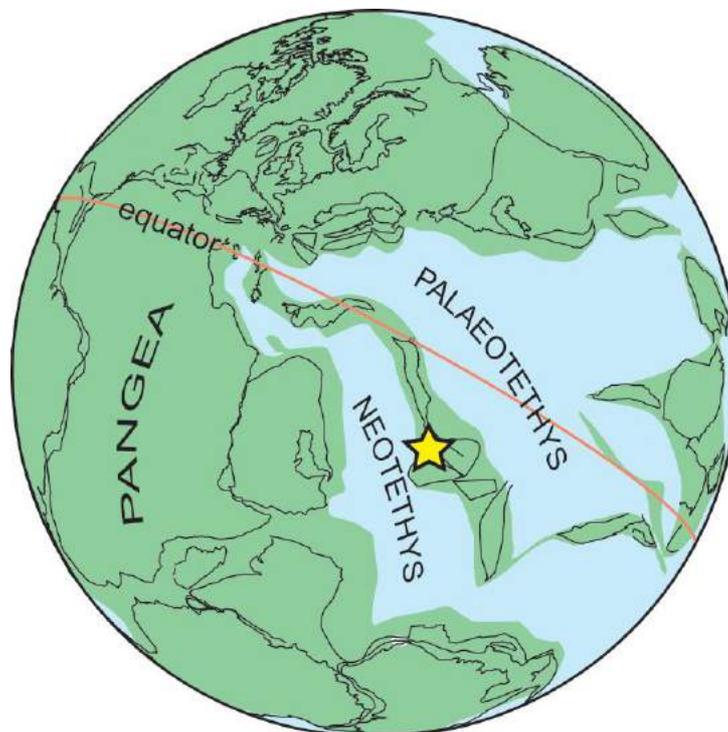


Fig. 2. Palaeogeographic position of the Baghuk Mountain area (after Stampfli & Borel 2002).

The Changhsingian stage is, in all sections of the area between Shahreza and Abadeh, composed of two major lithological units, (1) the upper part of the Hambast Formation (Taraz *et al.* 1981) and (2) the ‘Boundary Clay’, which was named Baghuk Member in the Central Iranian sections (Korn *et al.* 2021) and Aras Member in the sections of the Julfa region (Ghaderi *et al.* 2014).

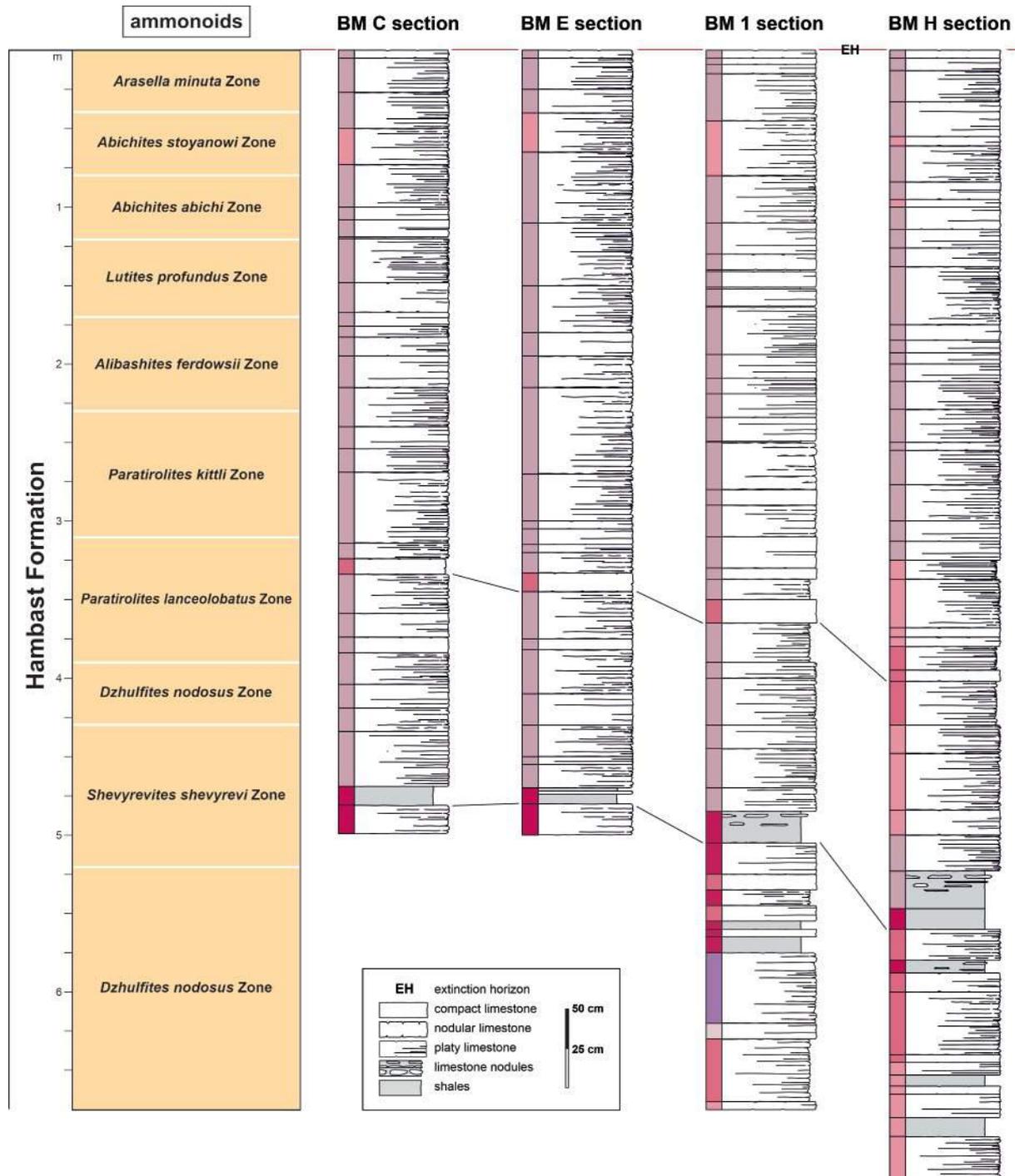


Fig. 3. Four selected columnar sections of the upper part of the Hambast Formation (*Paratirolites* Limestone equivalent) at Baghuk Mountain with their ammonoid zonation.

(1) The upper part of the Hambast Formation has a thickness of about 17 m, of which ca 8 m belong in the Wuchiapingian and 9 m in the Changhsingian (based on the discovery of a specimen of *Vedioceras* Ruzhencev, 1962 about 9.50 metres below the extinction horizon). Of these, the upper four metres can be correlated with the *Paratirolites* Limestone of the Julfa region. The unit ends with the end-Permian extinction event at the base of the Baghuk Member ('Boundary Clay'). The upper part of the Hambast Formation is nearly monotonic in its lithology, being composed of micritic nodular limestone forming beds of less than 10 cm thickness (Leda *et al.* 2014; Korn *et al.* 2021; Heuer *et al.* in press). Thin marly shale units of up to 40 cm thickness are intercalated and can be used as local index horizons. The most conspicuous of these is the purple shale unit within the range of the ammonoid species *Shevyrevites shevyrevi*; it has, in the parallel sections, a position between 4.70 and 5.50 m below the extinction horizon. A second very conspicuous local index horizon is a reddish-brown marly and compact limestone bed of 7 to 15 cm thickness in a position between 3.30 and 3.90 m below the extinction horizon.

(2) The interval described as the Baghuk Member ('Boundary Clay') is much more variable in thickness, composition and lithological succession. The unit begins with a shale unit of 50 to 100 cm thickness, but in section C, a grey nodular limestone of 8 cm thickness is present close to the base. It yielded only poorly preserved ammonoids (Korn *et al.* 2021). At some places, the so-called 'calcite fans' (Taraz *et al.* 1981), recently interpreted as digitate stromatolites (Baud *et al.* 2021) occur in the upper part of this unit.

We sampled the following sections for ammonoids at Baghuk Mountain (for a detailed description of the sections, see Korn *et al.* 2021):

Baghuk Mountain A section (31.56354° N, 52.43763° E): it is the south-westernmost of the sections and exposes, in moderate outcrop conditions, the Hambast Formation and the early Triassic strata. Only a few ammonoids have been collected.



Fig. 4. The upper portion of the Hambast Formation (*Paratirolites* Limestone equivalent) in Baghuk Mountain 1 section.

Baghuk Mountain 1 section (31.56745° N, 52.44357° E; Fig. 5): it is the north-easternmost of the sections. The top five metres of the Hambast Formation are excellently exposed in a vertical gorge outcrop. The outcrop yielded numerous ammonoids with precise stratigraphic position (Figs 4–5).

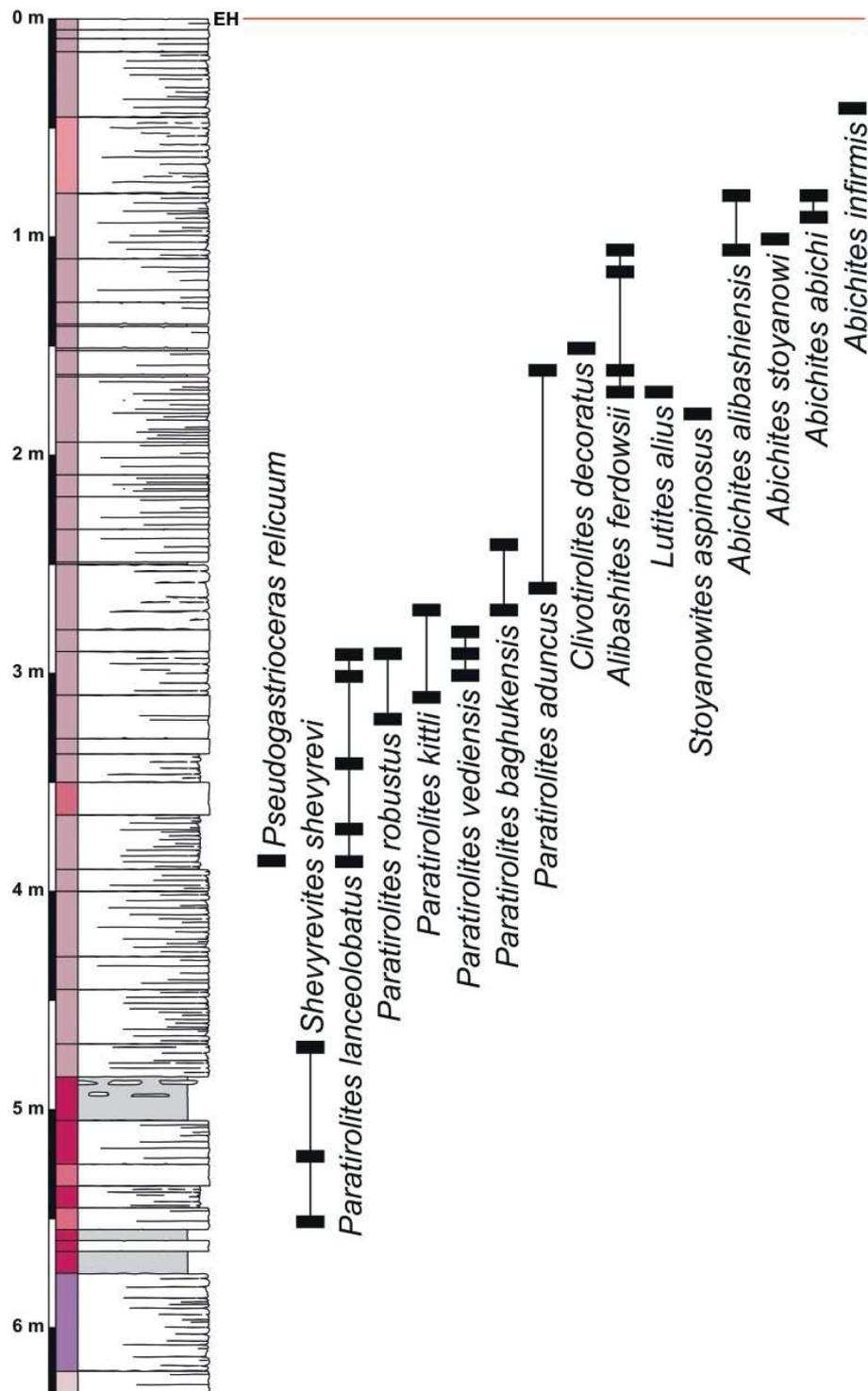


Fig. 5. The stratigraphic occurrence of the ammonoid species in the upper part of the Hambast Formation at Baghuk Mountain 1 section. EH=extinction horizon.

Baghuk Mountain C section (31.56725° N, 52.44284° E; Fig. 6): the section is located 70 m WSW of Baghuk Mountain 1 section in the next small gorge. The topmost four metres of the Hambast formation are exposed in a vertical gorge outcrop, followed by well-exposed Baghuk Member (‘Boundary Clay’) and the *Claraia* Beds, which belong to the earliest Triassic.

Baghuk Mountain E section (31.56642° N, 52.44284° E; Fig. 7): the section is located 90 m south of the C section on the eastern side of the same gorge.

Baghuk Mountain G section (31.56681° N, 52.44305° E; Fig. 8): the section is located 50 m south-southeast of the C section on the eastern side of the same gorge.

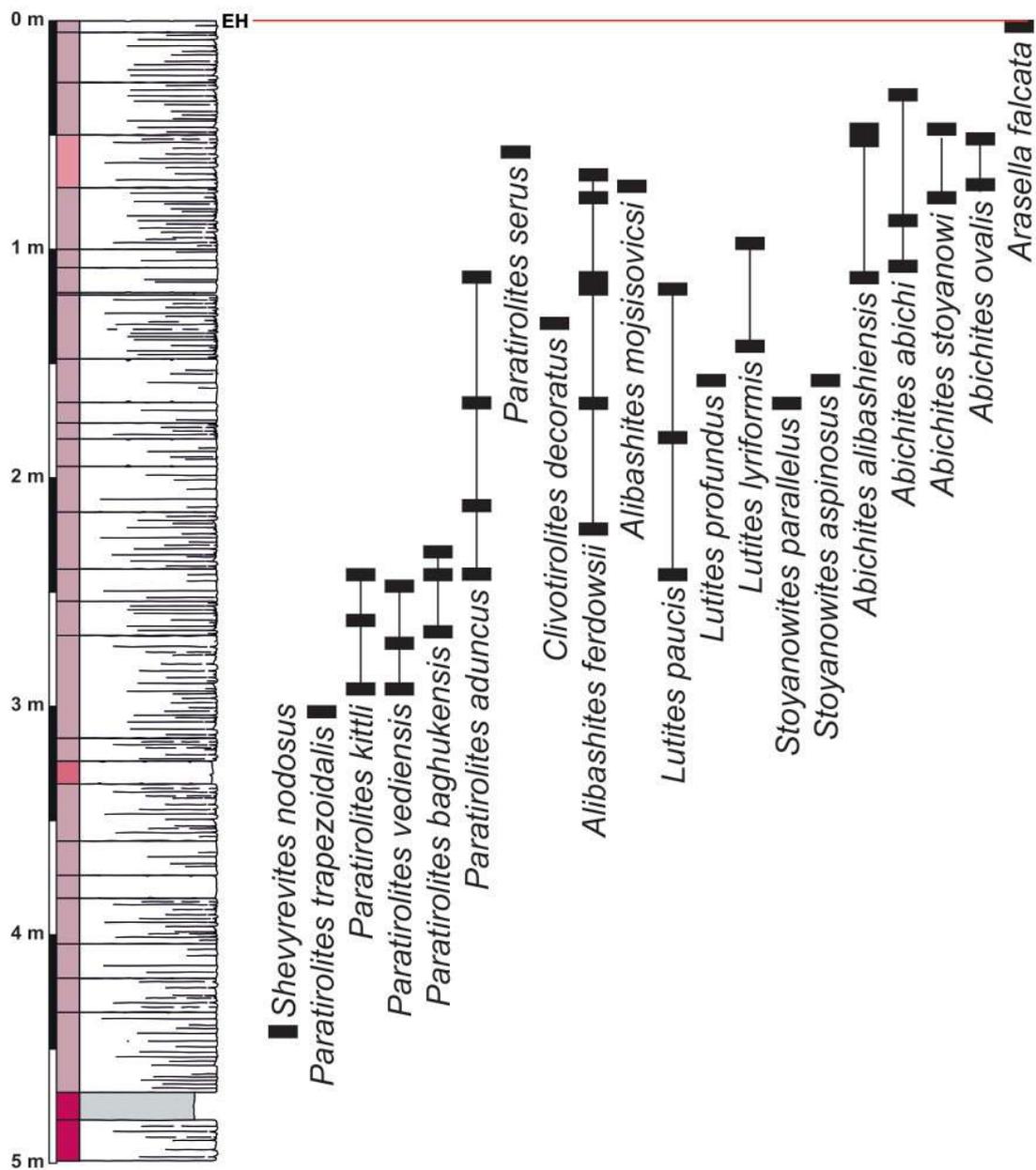


Fig. 6. The stratigraphic occurrence of the ammonoid species in the upper part of the Hambast Formation at Baghuk Mountain C section. EH=extinction horizon.

Baghuk Mountain H section (31.56701° N, 52.44350° E; Fig. 9): the section is located 50 m south of Baghuk Mountain 1 section along the strike in the same gorge.

Baghuk Mountain F section (31.56663° N, 52.44328° E): the section is located 50 m SSW of Baghuk Mountain H section along the strike in the same gorge. It is composed of several small fossiliferous outcrops.

Baghuk Mountain B section (31.56425° N, 52.44159° E): 350 m south-southwest of the Baghuk Mountain C section.

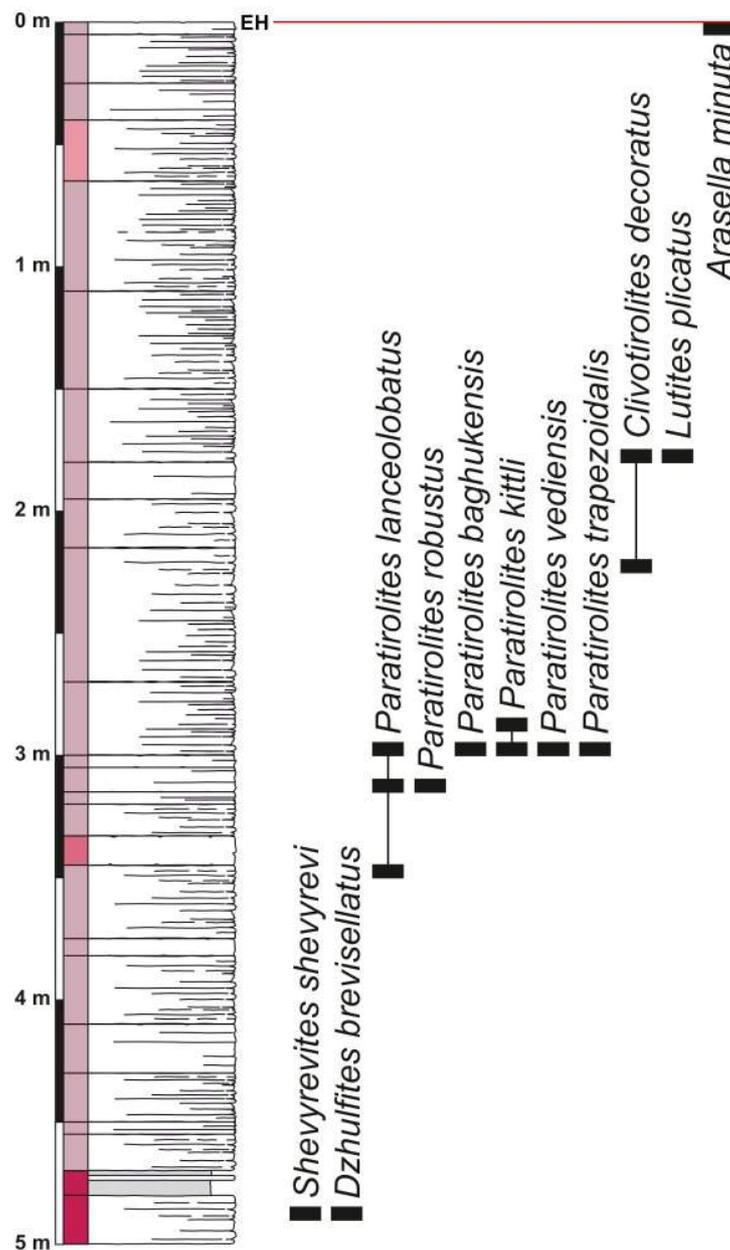


Fig. 7. The stratigraphic occurrence of the ammonoid species in the upper part of the Hambast Formation at Baghuk Mountain E section. EH=extinction horizon.

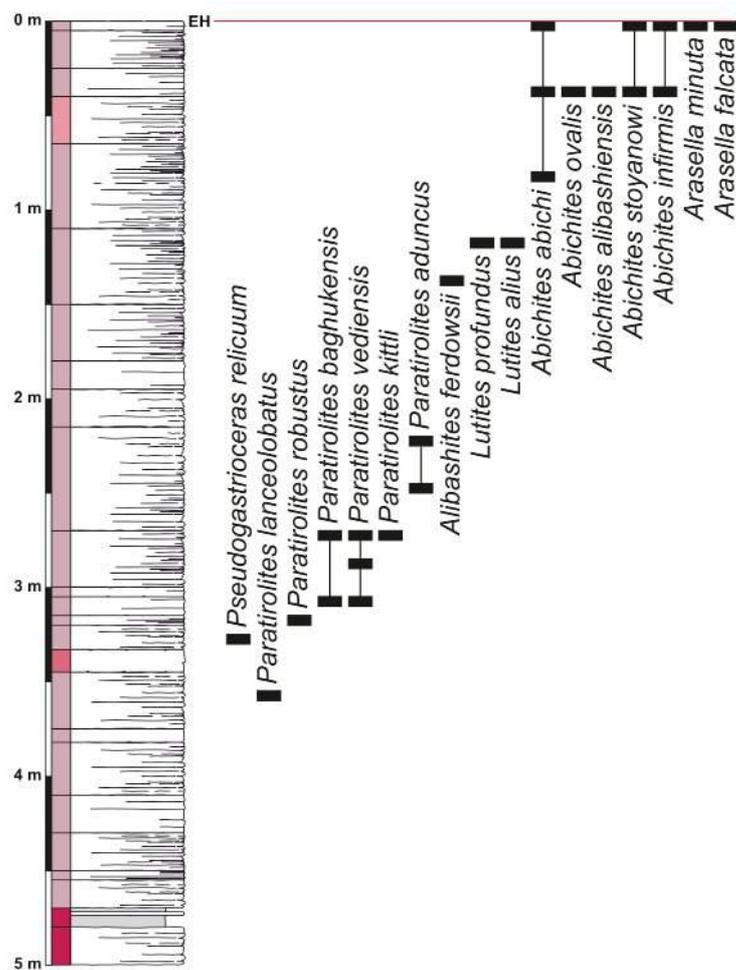


Fig. 8. The stratigraphic occurrence of the ammonoid species in the upper part of the Hambast Formation at Baghuk Mountain G section. EH=extinction horizon.

Biostratigraphy of the Late Permian ammonoids from Central Iran

Hambast Range

The Late Permian ammonoid succession in the Hambast range was outlined in two monographs by Bando (1979) and Taraz *et al.* (1981). While in the first of these the ammonoid material was described, a range chart was added to a detailed lithological description of the sections in the second.

Bando (1979) subdivided the Late Permian Hambast Formation in two units; he attributed the stratigraphically lower Unit 6 (dark grey limestone and marl) to the “Dzhulfian” (= Wuchiapingian) *Araxoceras rotoides* Zone with the *Araxoceras rotoides* and the *Vedioceras nakamurai* subzones and the stratigraphically upper Unit 7 (red to purple marly limestone) to the “Dorashamian” (= Changhsingian) *Shevyrevites shevyrevi* Zone with the *Shevyrevites shevyrevi* and the *Paratirolites kittli* subzones. According to Bando (1979), the latter subzone has a thickness of 12 metres and contains, besides several species of *Paratirolites* Stoyanow, 1910, also *Araxoceras* Ruzhencev, 1959, *Julfoceras* Bando, 1973, *Dzhulfoceras* Ruzhencev, 1962, *Shevyrevites* Teichert & Kummel, 1973 and *Iranites* Teichert & Kummel, 1973 – genera which are not known to co-occur with *Paratirolites* at any other place.

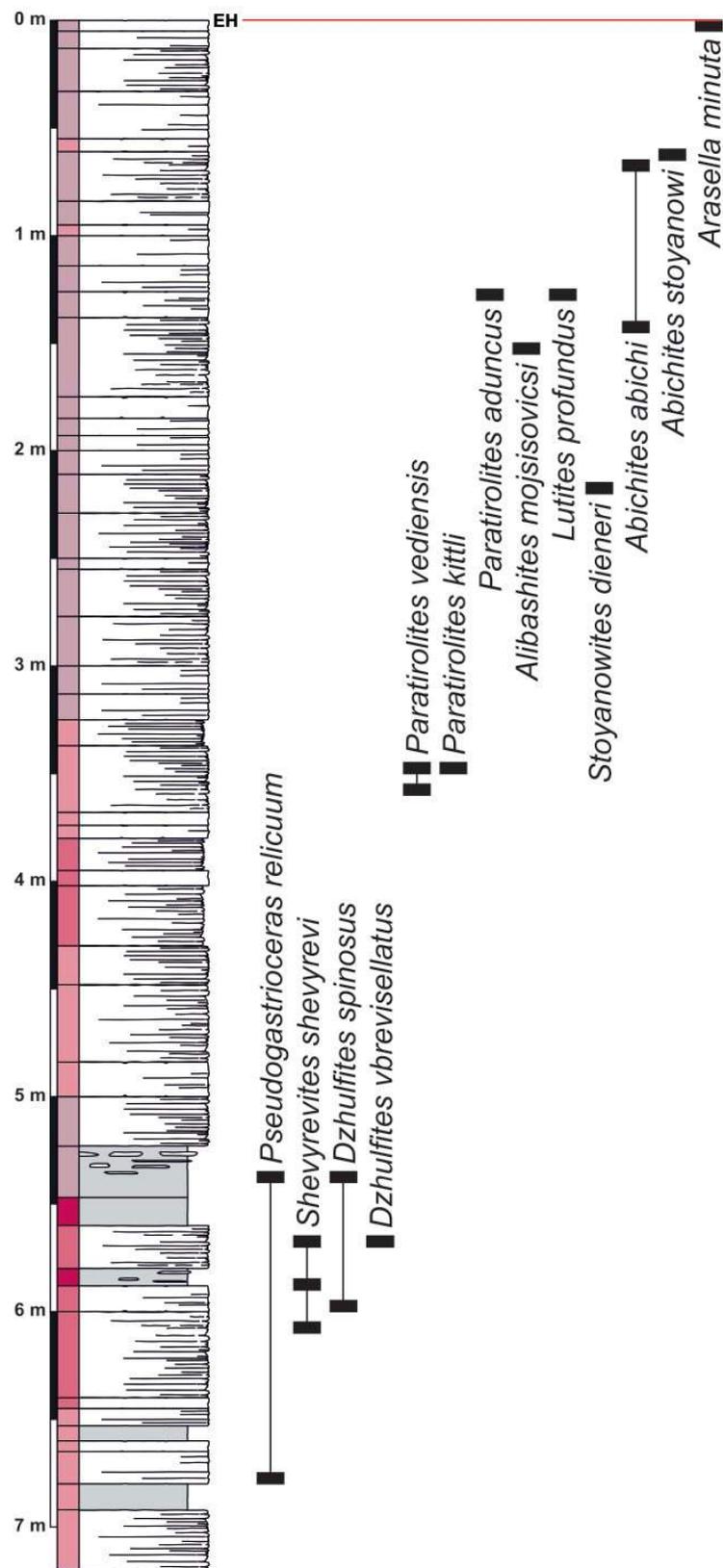


Fig. 9. The stratigraphic occurrence of the ammonoid species in the upper part of the Hambast Formation at Baghuk Mountain H section. EH=extinction horizon.

The conspicuous discrepancy in the putative ammonoid succession between the Hambast Range and other regions such as NW Iran (e.g., Ghaderi *et al.* 2014; Korn *et al.* 2016, 2019; Kiessling *et al.* 2018) and Baghuk Mountain (this paper) is surprising. According to current knowledge, all Late Permian sections between Shahreza and the Hambast Range are very similar in their lithology; significant changes in thickness and lithology are not known. Kozur (2005), for instance, showed that the sections of the Hambast Range do not differ, in their thickness of the latest Permian portion, from the sections in NW Iran. There is thus no reason to assume large differences in the thickness of subunits of the Hambast Formation and their ammonoid succession between the neighbouring sections in the Hambast Range and Baghuk Mountain. It is more likely that mixing of material described by Bando (1979) resulted in the discrepancies.

Baghuk Mountain

All of the sections at Baghuk Mountain show a very similar lithological succession (Fig. 3), and hence correlation between them can easily be done with laterally continuous beds. The interval studied here comprises of the upper part of the Hambast Formation, of which the top four metres are an equivalent of the *Paratirolites* Limestone of Transcaucasia and NW Iran (e.g., Ghaderi *et al.* 2014; Leda *et al.* 2014; Korn *et al.* 2016; Kiessling *et al.* 2018). In contrast to the NW Iranian sections, the Late Permian succession at Baghuk Mountain is almost entirely composed of carbonates; a shale equivalent of the Zal Member is missing in Central Iran.

We recorded a total of 37 Changhsingian ammonoid species from Baghuk Mountain; material of all except for four were collected in situ with distinct stratigraphic position (Figs 5–9) and the remaining are from float collections.

Of the classical succession of ammonoids known from Transcaucasia (Shevyrev 1965, 1968; Teichert *et al.* 1973) with the genera *Phisonites*, *Iranites*, *Dzhulfites*, *Shevyrevites* and *Paratirolites*, only the latter three have been recorded at Baghuk Mountain. However, when compared with the sections near Julfa, several other differences occur between the two sites (Fig. 10):

Julfa	Baghuk Mountain	Conodont zonation
<i>Arasella minuta</i> Zone	<i>Arasella minuta</i> Zone	<i>Clarkina hauschkei</i> Zone <i>Clarkina abadehensis</i> Zone
<i>Abichites stoyanowi</i> Zone	<i>Abichites stoyanowi</i> Zone	<i>Clarkina yini</i> Zone
<i>Abichites abichi</i> Zone	<i>Abichites abichi</i> Zone	
<i>Alibashites mojsisovicsi</i> Zone	<i>Alibashites profundus</i> Zone	
<i>Stoyanowites dieneri</i> Zone	<i>Alibashites ferdowsii</i> Zone	
<i>Paratirolites kittli</i> Zone	<i>Paratirolites kittli</i> Zone	<i>Clarkina nodosa</i> Zone
<i>Paratirolites trapezoidalis</i> Zone	<i>Paratirolites lanceolobatus</i> Zone	<i>Clarkina bachmanni</i> Zone
<i>Dzhulfites zalensis</i> Zone	<i>Shevyrevites nodosus</i> Zone	<i>Clarkina changxingensis</i> Zone
<i>Shevyrevites shevyrevi</i> Zone	<i>Shevyrevites shevyrevi</i> Zone	
<i>Dzhulfites spinosus</i> Zone	<i>Dzhulfites spinosus</i> Zone	<i>Clarkina subcarinata</i> Zone

Fig. 10. Correlation of the ammonoid zonations of the Julfa region in NW Iran (after Korn *et al.* 2016) and Baghuk Mountain with the conodont stratigraphy (after Farshid *et al.* 2016).

- An interval between *Shevyrevites shevyrevi* and first *Paratirolites*, characterised by species of *Dzhulfites* in the Julfa region, has not been found at Baghuk Mountain. At Baghuk Mountain, *Shevyrevites nodosus* serves as an index fossil for this interval.
- The earliest species of *Paratirolites* at Baghuk Mountain is *P. lanceolobatus* sp. nov. (Fig. 11); *P. trapezoidalis*, the index in the Julfa sections, is rare at Baghuk Mountain and thus less suitable.
- The first occurrences of ammonoid species near Julfa and Baghuk Mountain differs to some degree. For instance, the zones of *Stoyanowites dieneri* and *Alibashites mojsisovicsi* of the Julfa sections

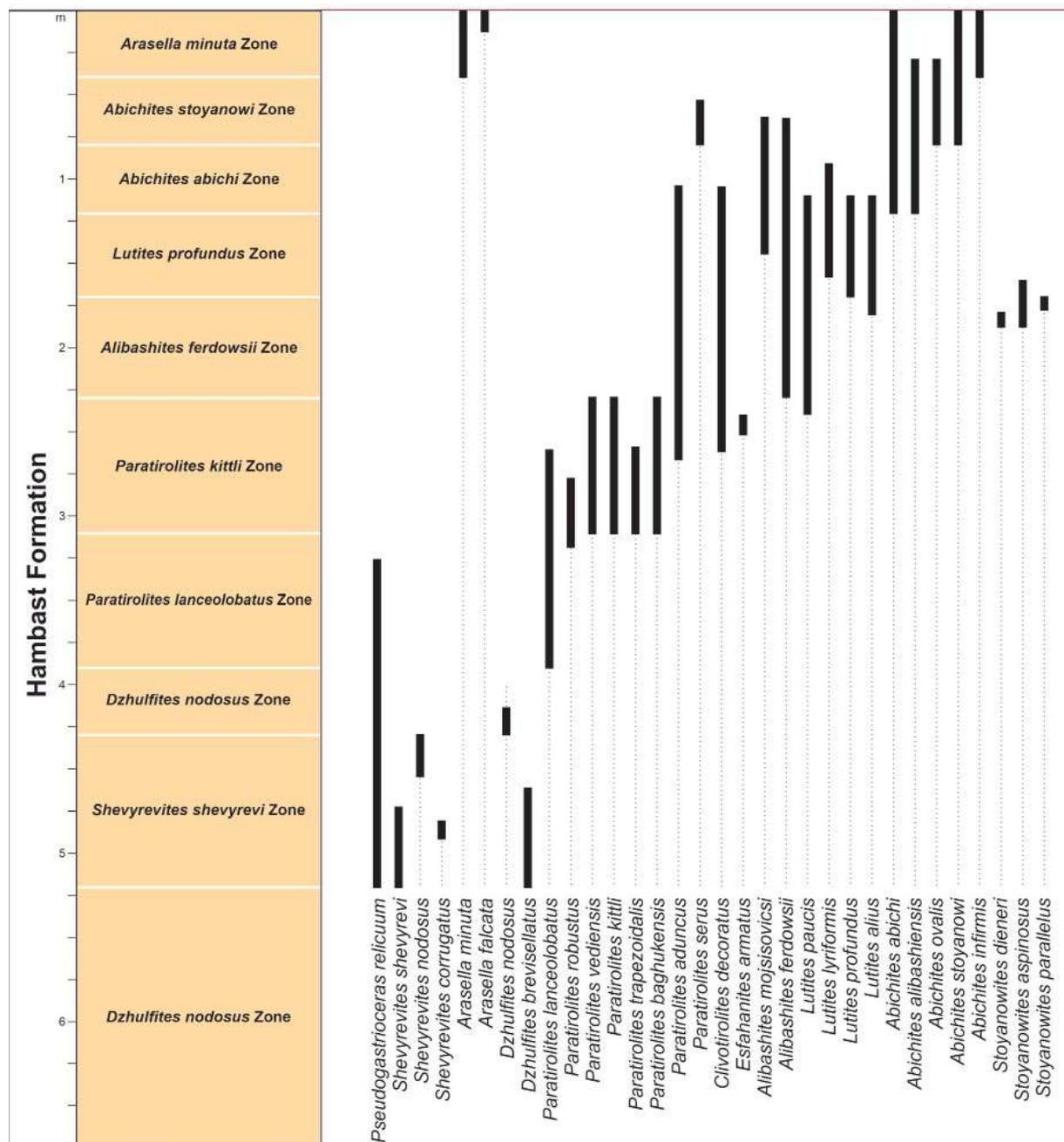


Fig. 11. Summary of the stratigraphic occurrence of the ammonoid species at Baghuk Mountain.

have to be replaced, in the Baghuk Mountain sections, by the zones of *Alibashites ferdowsii* and *Lutites profundus* gen. et sp. nov.

- The genera *Clivotirolites* gen. nov. and *Esfahanites* gen. nov. are not known from Julfa.
- The genus *Alibashites* is more common and diverse at Baghuk Mountain.

Similarities are as follows:

- The general stratigraphic position of the genera *Paratirolites*, *Alibashites*, *Abichites* and *Stoyanowites* at Baghuk Mountain agrees with Julfa.
- At the top of the *Paratirolites* Limestone, in both regions occur very small ammonoids of the genus *Arasella* with simple suture line (Fig. 12).

In the systematic descriptions of the ammonoids, stratigraphic positions of the records are given in metres below the extinction horizon (the plane that separates the nodular limestone from the Baghuk Member). Baghuk Mountain C section was used as the reference; the other sections were correlated by graphic correlation using the two index horizons (red shale with *Shevyrevites* and dark-red limestone marker bed) as references.

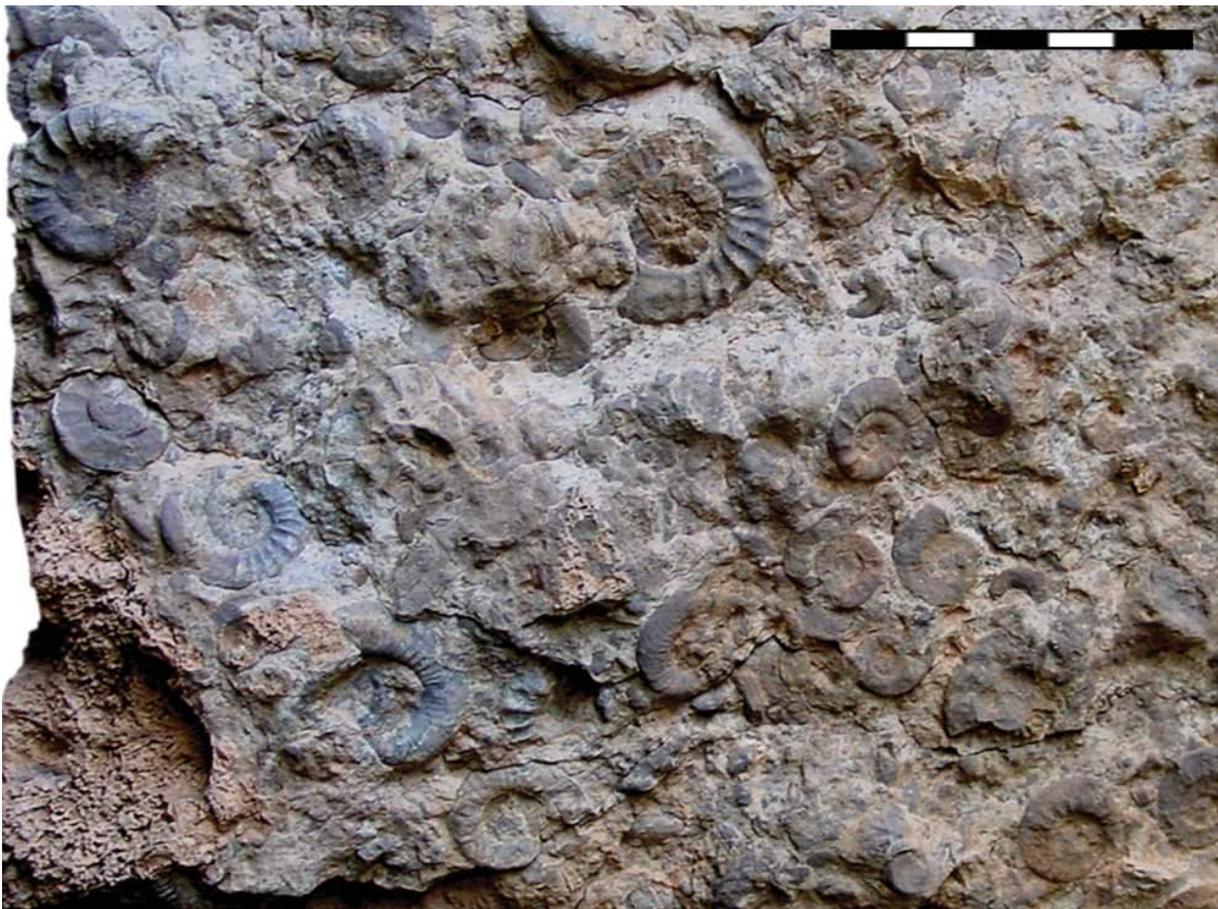


Fig. 12. Mass occurrence of small ammonoids of the genus *Arasella* Korn in Ghaderi *et al.*, 2014 on the bedding surface at the base of the topmost 5 cm limestone bed, Baghuk Mountain section H. Scale bar units = 10 mm.

Specimens studied

We investigated a total of more than 700 specimens from the upper seven metres of the Hambast Formation, of which 571 specimens were identified to the species level. The following species are represented:

- Pseudogastrioceras relicuum* Korn & Ghaderi in Korn *et al.*, 2016 – 5 specimens
Shevyrevites shevyrevi Teichert & Kummel in Teichert *et al.*, 1973 – 173 specimens
Shevyrevites nodosus (Shevyrev, 1965) – 5 specimens
Shevyrevites corrugatus Korn & Hairapetian sp. nov. – 2 specimens
Arasella minuta (Zakharov in Kotlyar *et al.*, 1983) – 13 specimens
Arasella falcata Korn & Hairapetian sp. nov. – 5 specimens
Dzhulfites spinosus Shevyrev, 1965 – 8 specimens
Dzhulfites brevisellatus Korn & Hairapetian sp. nov. – 3 specimens
Paratirolites rubens Korn & Hairapetian sp. nov. – 2 specimens
Paratirolites lanceolobatus Korn & Hairapetian sp. nov. – 25 specimens
Paratirolites robustus Korn & Hairapetian sp. nov. – 9 specimens
Paratirolites vediensis Shevyrev, 1965 – 28 specimens
Paratirolites kittli Stoyanow, 1910 – 29 specimens
Paratirolites coronatus Korn & Ghaderi in Korn *et al.*, 2016 – 1 specimen
Paratirolites trapezoidalis Shevyrev, 1965 – 6 specimens
Paratirolites baghukensis Korn & Hairapetian sp. nov. – 31 specimens
Paratirolites aduncus Korn & Hairapetian sp. nov. – 51 specimens
Paratirolites quadratus Korn & Ghaderi in Korn *et al.*, 2016 – 3 specimens
Paratirolites serus Korn & Ghaderi in Korn *et al.*, 2016 – 4 specimens
Clivotirolites decoratus Korn & Hairapetian gen. et sp. nov. – 24 specimens
Clivotirolites petilus Korn & Hairapetian gen. et sp. nov. – 1 specimen
Esfahanites armatus Korn & Hairapetian gen. et sp. nov. – 6 specimens
Alibashites mojsisovicsi (Stoyanow, 1910) – 4 specimens
Alibashites ferdowsii Korn & Ghaderi in Korn *et al.*, 2016 – 18 specimens
Lutites paucis Korn & Hairapetian gen. et sp. nov. – 3 specimens
Lutites lyriformis Korn & Hairapetian gen. et sp. nov. – 8 specimens
Lutites profundus Korn & Hairapetian gen. et sp. nov. – 7 specimens
Lutites alius Korn & Hairapetian gen. et sp. nov. – 9 specimens
Lutites plicatus Korn & Hairapetian gen. et sp. nov. – 1 specimen
Abichites abichi Shevyrev, 1965 – 22 specimens
Abichites alibashiensis Korn & Ghaderi in Korn *et al.*, 2016 – 18 specimens
Abichites ovalis Korn & Hairapetian sp. nov. – 13 specimens
Abichites stoyanowi (Kiparisova in Voinova *et al.*, 1947) – 10 specimens
Abichites infirmis Korn & Hairapetian sp. nov. – 6 specimens
Stoyanowites dieneri (Stoyanow, 1910) – 8 specimens
Stoyanowites aspinsus Korn & Ghaderi in Korn *et al.*, 2016 – 5 specimens
Stoyanowites parallelus Korn & Hairapetian sp. nov. – 4 specimens

All specimens were embedded in thin bedded flaser limestone and display a specific mode of preservation (Leda *et al.* 2014). The upper surface of the originally aragonitic ammonoid conchs is truncated by dissolution, whereas the lower face is usually much better preserved (Fig. 13). Dissolution of the shell material probably resulted from selective, partial dissolution of aragonite. This mode of preservation is the reason for the incomplete specimens, which are usually preserved only on one side. For this reason, the specimens are illustrated here by photographs in lateral view, while dorsal views are shown as reconstructions.

Descriptions of the ammonoids largely follow the scheme and terminology proposed by Korn (2010) and Klug *et al.* (2015) for Palaeozoic ammonoids (Fig. 14). For the shape of the cross sections, an additional explanation of terminology was given by Korn *et al.* (2016), distinguishing between trapezoidal, quadrate, subtrapezoidal, circular and oval (Fig. 15). The terminology of the suture line follows Korn *et al.* (2003), meaning that a difference between an A-mode (goniatitic) and U-mode (prolecanitic and thus also ceratitic) sutural ontogeny, as proposed by Schindewolf (1929), is not accepted. The sutural elements described here are therefore external (E), adventive (A), lateral (L), umbilical (U) and internal (I) lobes (Fig. 15). In the following, the stratigraphic position of individual specimens and the range of species are explained in metres below the extinction horizon (top surface of the Hambast Formation).

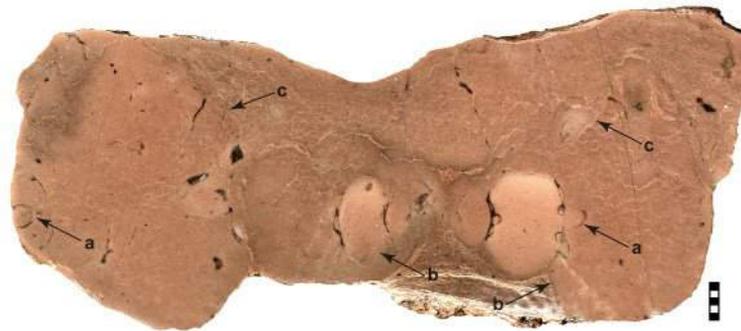


Fig. 13. Cross section of a specimen of *Paratirorites* sp. from Baghuk Mountain, MB.C.22215; note the different states of preservation of shell walls and septa: a=recrystallized but rather well-preserved shell wall and septa preferably in the mid-dorsal portion of the ammonoid conch; b=dissolved shell wall but sharp demarcation of the ammonoid's internal mould from the sediment at the lower side of the ammonoid conch; c=dissolved shell wall and nearly continuous transition from the ammonoid's internal mould towards the sediment on the upper side of the ammonoid conch (from Leda *et al.* 2014).

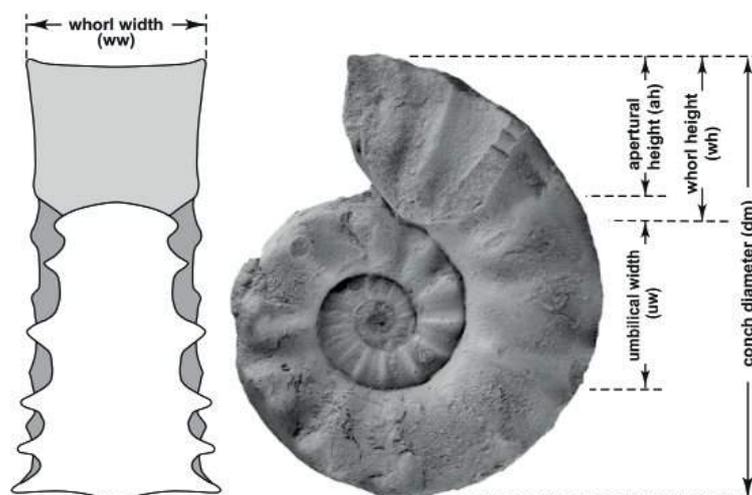


Fig. 14. Descriptive terms for the conch geometry of the ammonoids described here (from Korn *et al.* 2016).

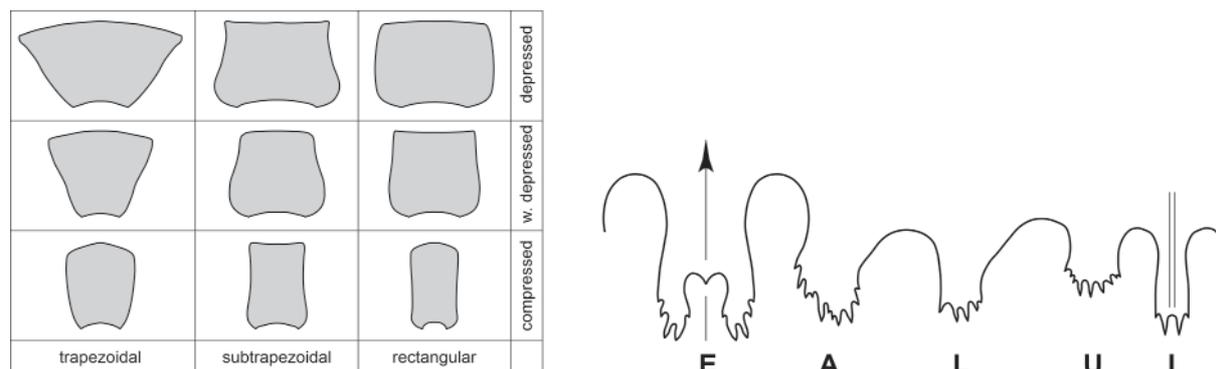


Fig. 15. Descriptive terms for the whorl profiles and suture lines (exemplified in *Paratirolites kittli* Stoyanow, 1910) of the paratirolitid ammonoids described here (from Korn *et al.* 2016).

Abbreviations used in the species descriptions:

- ah = apertural height
- dm = conch diameter
- IZR = imprint zone rate
- uw = umbilical width
- WER = whorl expansion rate
- wh = whorl height
- ww = whorl width

Abbreviations of the repositories:

- MB.C. = Cephalopod collection of the Museum für Naturkunde, Berlin
- PIN = Palaeontological Institute of the Academy of Sciences, Moscow
- MCZ = Museum of Comparative Zoology, Harvard

Results (Korn & Hairapetian)

Order Goniatitida Hyatt, 1884
 Suborder Goniatitina Hyatt, 1884
 Superfamily Neiocerataidea Hyatt, 1900
 Family Paragastrioceratidae Ruzhencev, 1951

Subfamily **Pseudogastrioceratinae** Furnish, 1966

For the composition of the subfamily, see Korn & Ghaderi in Korn *et al.* (2016).

Genus **Pseudogastrioceras** Spath, 1930

For the composition of the genus, see Korn & Ghaderi in Korn *et al.* (2016).

Pseudogastrioceras relicuum Korn & Ghaderi in Korn *et al.*, 2016
 Fig. 16; Table 1

Pseudogastrioceras relicuum Korn & Ghaderi in Korn *et al.*, 2016: 852, text-fig. 12.

Table 1. Conch dimensions (partly estimated) and ratios of a specimen of *Pseudogastrioceras relicuum* Korn & Ghaderi in Korn *et al.*, 2016 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29661	57.4	–	28.1	5.3	16.8	–	–	0.09	2.00	0.40
	41.5	18.5	21.3	3.1	–	0.45	0.87	0.07	–	–

Diagnosis

Pseudogastrioceras with moderately large conch; diameter attaining 70 mm. Conch shape thinly discoidal ($ww/dm=0.40-0.45$), involute ($uw/dm=0.05-0.10$) with converging flanks and broadly rounded venter. Ornament with about 15 faint spiral lines on the venter.

Material examined**Holotype**

IRAN • East Azerbaijan, Ali Bashi N section; *Paratirolites* Limestone; illustrated by Korn & Ghaderi in Korn *et al.* (2016: text-fig. 12); MB.C.25173.

Additional material

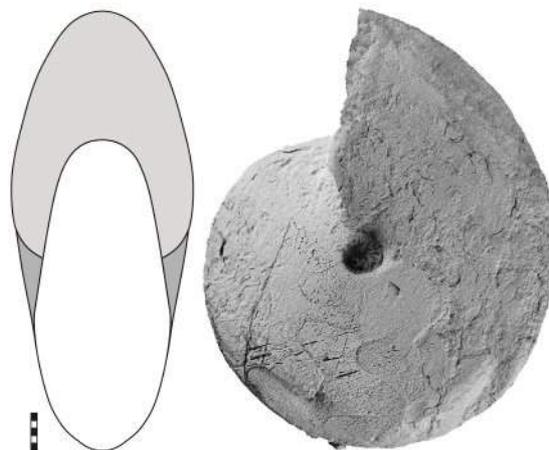
IRAN • 2 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29659 to MB.C.29660 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29661 • 2 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29662 to MB.C.29663.

Description

All specimens are rather poorly preserved, but MB.C.29661 is the best of them, though somewhat deformed (Fig. 16). It is a corroded specimen with a 56 mm conch diameter, which does not allow accurate measurements of the conch.

Stratigraphic range

Paratirolites Limestone; 6.80 to 3.30 m below the extinction horizon (*Dzhulfites nodosus* Zone to *Paratirolites lanceolobatus* Zone).

**Fig. 16.** *Pseudogastrioceras relicuum* Korn & Ghaderi, 2016, lateral and reconstructed dorsal views of specimen MB.C.29661. Scale bar units=1 mm.

Order Ceratitida Hyatt, 1884
Suborder Paraceltitina Shevyrev, 1968
Superfamily Xenodiscoidea Frech, 1902
Family **Xenodiscidae** Frech, 1902

Diagnosis

Representatives of the superfamily Xenodiscoidea with a small to moderately large conch, in which the ontogeny displays up to three stages, beginning with an unsculptured initial stage followed by a juvenile stage with transverse ribs, and an adult stage with a weakening of the sculpture. Suture line with unserrated or weakly serrated, short but rather wide external lobe; adventive, lateral and umbilical lobe often multidentate; some species with a simplified suture line without serrations.

Included Permian genera

Iranites Teichert & Kummel, 1973; *Laibinoceras* Yang, 1987; *Multisulcites* Liang, 1983; *Paraceltitoides* Zheng & Chen, 1979; *Penglaites* Yang, 1987; *Phisonites* Shevyrev, 1965; *Shevyrevites* Teichert & Kummel in Teichert *et al.*, 1973; *Xenodiscus* Waagen, 1879.

Genus *Shevyrevites* Teichert & Kummel in Teichert *et al.*, 1973

Type species

Shevyrevites shevyrevi Teichert & Kummel in Teichert *et al.*, 1973, by original designation.

Diagnosis

Representatives of the family Xenodiscidae with a moderately large to large conch; maximum adult diameter between 60 and 80 mm. Subadult stage with a trapezoidal whorl profile, adult stage variable. Subadult stage with small to large conical ventrolateral nodes, adult stage with a weakening sculpture with predominant ribs. Suture line with external lobe that does not reach the depth of the adventive lobe; prongs of the external lobe simple or bifid.

Included species

Shevyrevites shevyrevi Teichert & Kummel in Teichert *et al.*, 1973; *Bernhardites nodosus* Shevyrev, 1965; *Shevyrevites corrugatus* Korn & Hairapetian sp. nov.

Remarks

The species of *Shevyrevites* show a coarse ornament consisting of lateral ribs and sometimes also coarse conical nodes in the inner whorls, and are hereby clearly separated from the other genera of the family. Regarding the presence of ventrolateral nodes, there are some similarities to the genera of the family Dzhulfitidae, but these differ in the shape of the suture line: while the external lobe is wide in *Shevyrevites*, it is always narrow in the Dzhulfitidae.

Teichert & Kummel (in Teichert *et al.* 1973) caused some nomenclatorial confusion with their opinion on the species of their new genus *Shevyrevites*. They made clear that “*Celtites radiosus*”, the Triassic type species of *Bernhardites* Shevyrev, 1965, differs from the Late Permian forms and that for the latter, a new genus name (*Shevyrevites*) had to be introduced. At the same time, they treated the two species “*Bernhardites radiosus* (Frech in Noetling, 1905)” and “*Bernhardites nodosus* Shevyrev, 1965”, both of which were separated by Shevyrev (1965), as synonyms; they described these under the new genus and species name *Shevyrevites shevyrevi*. This procedure is not acceptable because it suppresses the species name *Shevyrevites nodosus*, which in case of synonymy of the two species has priority over *Shevyrevites shevyrevi*. However, this problem is regarded here minor, as we accept both species as valid.

Shevyrevites shevyrevi Teichert & Kummel in Teichert *et al.*, 1973
Fig. 17; Table 2

Shevyrevites shevyrevi Teichert & Kummel in Teichert *et al.*, 1973: 410, pl. 3 figs 1–3, 6.

Bernhardites radiosus – Shevyrev 1965: 171, pl. 21 fig. 7; 1968: 86, pl. 1 fig. 7, pl. 2 fig. 1.

Shevyrevites shevyrevi – Bando 1979: 133, pl. 5 figs 1, 5, pl. 8 figs 6–7. — Korn *et al.* 2019: 46, text-figs 11–12.

non *Shevyrevites shevyrevi* – Zhao *et al.* 1978: 107, pl. 11 figs 2–4, 6–7.

Diagnosis

Species of *Shevyrevites* with conch reaching 70 mm dm. Subadult stage with oval, compressed whorl profile ($ww/wh=0.70-0.90$) and rounded venter; 30 coarse ribs per volution. Adult stage with rectangular and compressed whorl profile ($ww/wh=0.70-0.80$), flattened flanks, flattened venter and subangular ventrolateral shoulder; coarse and sharp ribs on the flank, venter smooth. Prongs of external lobe usually bifid; altogether 20–25 notches of E, A and L lobes.

Type material

Holotype

IRAN • East Azerbaijan, Ali Bashi Mountains; Ali Bashi Formation; illustrated by Teichert & Kummel in Teichert *et al.* (1973: pl. 3 figs 1–2); MCZ 9678.

Material examined

IRAN • 30 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29664 to MB.C.29669 • 4 specimens; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.29670 to MB.C.29673 • 12 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29674 to MB.C.29678 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29679 • 33 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29680 to MB.C.29687 • 92 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29688 to MB.C.29712.

Description

There is little morphological variation in the material when the conch proportions are regarded. specimen MB.C.29674 is an incomplete but comparatively well-preserved specimen with 52 mm diameter (Fig. 17A). It is extremely discoidal ($ww/wh=0.24$) and evolute ($uw/dm=0.48$) with a compressed, parallel-sided whorl profile with flat venter and an angular ventrolateral shoulder. The sculpture consists, on the last volution of the phragmocone as well as the body chamber, of sharp and slightly sigmoidal ribs on the flanks; on half a volution around 20 of such ribs can be counted.

The suture line of specimen MB.C.29674 has a short external lobe with concave flanks and bifid prongs (Fig. 17D). The ventrolateral saddle is asymmetric and appears dorsally inclined. The adventive lobe is semicircular in shape with twelve small notches of equal size. In contrast to this is the lateral lobe almost flat at its base; it is also serrated by numerous small notches.

There is some variation in the shape of the venter. In contrast to specimen MB.C.29674, the other two figured specimens MB.C.29672 (Fig. 17B) and MB.C.29670 (Fig. 17C) show a less flattened or even a rounded venter. These two specimens do not show as sharp ribs as specimen MB.C.29674.

Remarks

Shevyrevites shevyrevi differs from *S. nodosus* in the lack of the coarse nodes of the subadult stage and from *S. corrugatus* sp. nov. in the much coarser and less numerous ribs.

Table 2. Conch dimensions (partly estimated) and ratios of selected specimens of *Shevyrevites shevyrevi* Teichert & Kummel in Teichert *et al.* (1973) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29674	52.1	12.3	15.4	24.8	15.2	0.24	0.80	0.48	1.99	0.01
MB.C.29670	45.4	9.9	14.4	18.9	14.1	0.22	0.69	0.42	2.10	0.02
MB.C.29672	43.8	11.2	13.4	20.9	13.0	0.26	0.84	0.48	2.02	0.03
MB.C.29705.5	56.8	12.5	16.8	26.4	16.0	0.22	0.74	0.46	1.94	0.05
MB.C.29676.2	54.3	12.8	17.2	25.3	16.6	0.24	0.74	0.47	2.07	0.03
MB.C.29676.3	50.1	11.2	16.2	22.2	15.6	0.22	0.69	0.44	2.11	0.04
MB.C.29676.1	48.8	12.5	15.5	23.3	15.0	0.26	0.81	0.48	2.08	0.03
MB.C.29705.4	47.7	11.7	13.9	21.5	13.4	0.25	0.84	0.45	1.93	0.04
MB.C.29693.1	46.8	10.7	13.2	22.2	12.5	0.23	0.81	0.47	1.86	0.05
MB.C.29705.7	45.2	11.4	13.7	20.1	13.4	0.25	0.83	0.44	2.02	0.02
MB.C.29676.4	45.0	11.7	12.9	22.4	12.3	0.26	0.91	0.50	1.89	0.05
MB.C.29704.1	35.6	9.2	9.5	17.9	9.2	0.26	0.97	0.50	1.82	0.03

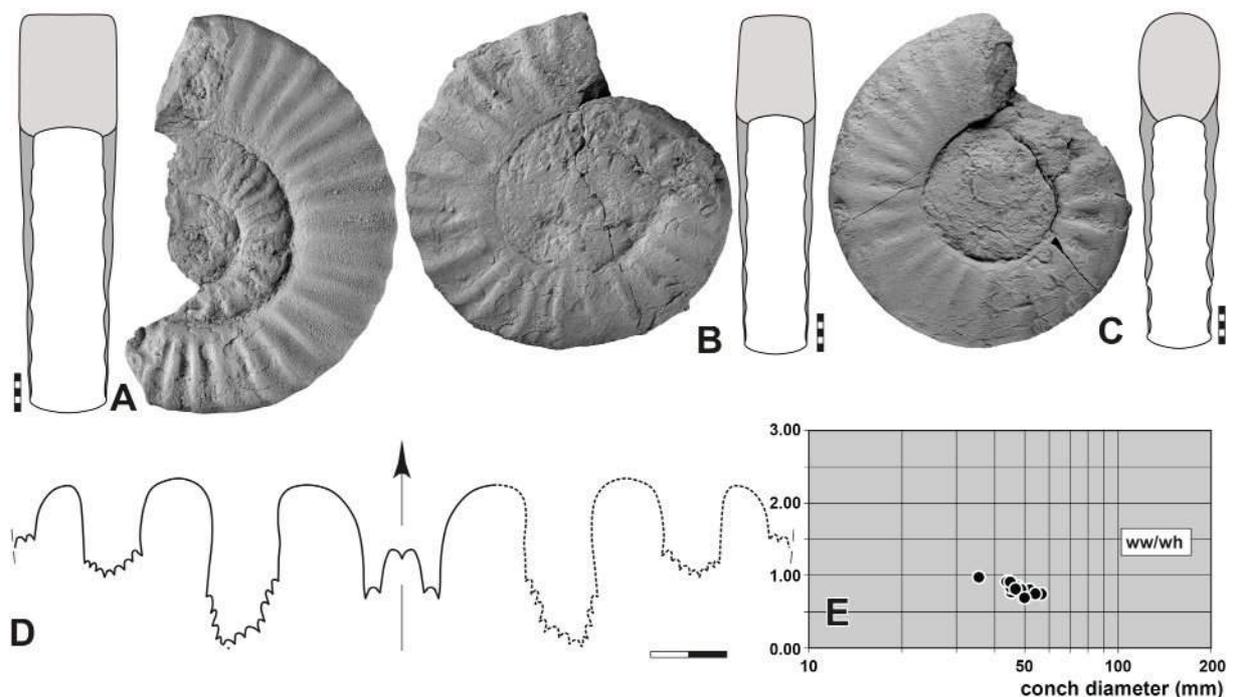


Fig. 17. *Shevyrevites shevyrevi* Teichert & Kummel in Teichert *et al.*, 1973. **A.** Lateral and dorsal view, specimen MB.C.29674, section E, float. **B.** Lateral and dorsal view, specimen MB.C.29672, section B, float. **C.** Lateral and dorsal view, specimen MB.C.29670, section B, float. **D.** Suture line, specimen MB.C.29674, at 10.8 mm ww, 13.0 mm wh. **E.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Stratigraphic range

Upper part of the Hambast Formation; 5.20 to 4.70 m below the extinction horizon (*Shevyrevites shevyrevi* Zone).

***Shevyrevites nodosus* (Shevyrev, 1965)**

Fig. 18; Table 3

Bernhardites nodosus Shevyrev, 1965: 171, pl. 21 fig. 8.

Bernhardites nodosus – Shevyrev 1968: 87, pl. 2 fig. 2.

Shevyrevites nodosus – Korn *et al.* 2019: 46, text-fig. 13.

non *Shevyrevites nodosus* – Korn in Ghaderi *et al.* 2014: text-fig. 7d.

Diagnosis

Species of *Shevyrevites* with conch reaching 80 mm dm. Subadult stage with circular, slightly compressed whorl profile (ww/wh=0.60–0.75) and rounded venter; 10 coarse lateral nodes per volution. Adult stage with parallel-sided, slightly compressed whorl profile (ww/wh=0.60–0.75), flattened venter and subangular ventrolateral shoulder; radial plications. Prongs of external lobe simple or bifid; altogether about 15 notches of E, A and L lobes.

Type material**Holotype**

ARMENIA • Ogbin; Late Permian; illustrated by Shevyrev (1965: pl. 24 fig. 1); PIN 1478/31.

Material examined

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29713 •
1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29714 •
1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29715 •
2 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29716 to MB.C.29717.

Description

Specimen MB.C.29713 has 53 mm diameter and shows the partly crushed phragmocone and less than half a volution of the terminal body chamber (Fig. 18). The whorl profile of the body chamber is

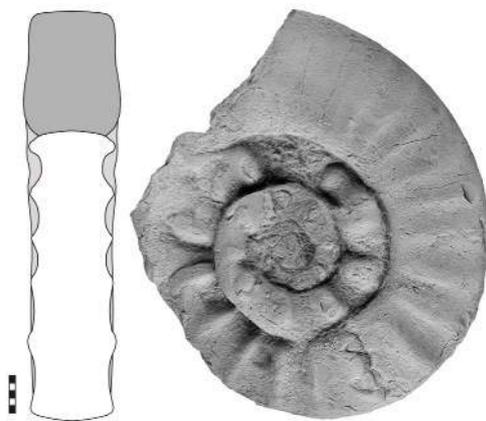


Fig. 18. *Shevyrevites nodosus* (Shevyrev, 1965), lateral and reconstructed dorsal view of specimen MB.C.29713. Scale bar units=1 mm.

Table 3. Conch dimensions (partly estimated) and ratios of selected specimens of *Shevyrevites nodosus* Shevyrev, 1965 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29713	53.2	11.9	15.6	24.8	15.2	0.22	0.76	0.47	1.96	0.03
MB.C.29714	45.1	9.9	14.8	23.6	14.0	0.22	0.67	0.52	2.10	0.05

subtrapezoidal with weakly converging flanks, a subangular ventrolateral shoulder and a flattened venter. The sculpture of the phragmocone differs significantly from the body chamber; while the phragmocone bears coarse conical nodes (10 per volution) and later elongate sharp ribs on the midflank, the body chamber has weak and blunt radial ribs. Only portions of the suture line can be seen on the flank; they show a finely serrated adventive lobe.

Remarks

Shevyrevites nodosus differs in the coarse lateral nodes of the subadult stage from *S. shevyrevi* and *S. corrugatus* sp. nov.

Stratigraphic range

Upper part of the Hambast Formation; 4.45 m below the extinction horizon (*Shevyrevites nodosus* Zone).

Shevyrevites corrugatus Korn & Hairapetian sp. nov.

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Fig. 19; Table 4

Diagnosis

Species of *Shevyrevites* with conch reaching 60 mm dm. Subadult stage with oval, slightly compressed whorl profile ($ww/wh=0.60-0.75$) and rounded venter; multiple fine ribs. Adult stage with parallel-sided, slightly compressed whorl profile ($ww/wh=0.60-0.75$), rounded venter and rounded ventrolateral shoulder; multiple fine riblets on the flank. Prongs of external lobe bifid; altogether 11 notches of E, A and L lobes.

Etymology

From the Latin ‘*corrugatus*’, meaning ‘folded’, because of the corrugate sculpture.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain A section; Hambast Formation; illustrated in Fig. 19B; MB.C.29718.

Paratype

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.29719; illustrated in Fig. 19A.

Description

Holotype MB.C.29718 has 37 mm conch diameter and shows half of a volution preserved that belongs to the terminal body chamber (Fig. 19B); the maximum phragmocone diameter is 27 mm. The phragmocone

Table 4. Conch dimensions (partly estimated) and ratios of selected specimens of *Shevyrevites corrugatus* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29719	41.1	9.3	12.8	18.2	–	0.23	0.73	0.44	–	–
MB.C.29718	36.7	7.3	11.5	15.7	10.2	0.20	0.63	0.43	1.92	0.11

shows rather densely spaced septa (18 per volution), but the last four are then strikingly crowded and indicate adulthood. The conch is extremely discoidal ($ww/dm=0.20$) and subevolute ($uw/dm=0.43$) with applanate flanks and a rounded venter. The sculpture consists of numerous densely spaced and sharp radial riblets (about 30 on half a volution in the adult stage), which on the body chamber extend with a shallow concave sinus across the flanks.

The suture line of the holotype has a nearly parallel-sided, weakly pouched external lobe that is almost as deep as the adventive lobe; it has asymmetric prongs that are subdivided by two notches. The slightly asymmetric ventrolateral saddle is inverted U-shaped and followed by the asymmetric adventive lobe with five small notches, an asymmetric lateral saddle and an asymmetric lateral lobe with four notches (Fig. 19C).

Remarks

The new species differs from the other species of *Shevyrevites* by the much weaker sculpture, which consists of feeble riblets in contrast to the coarser ribs in *S. shevyrevi* and the conical nodes in *S. nodosus*.

Stratigraphic range

Upper part of the Hambast Formation; float but probably 4.80 m below the extinction horizon (red nodular limestone in the *Shevyrevites shevyrevi* Zone).

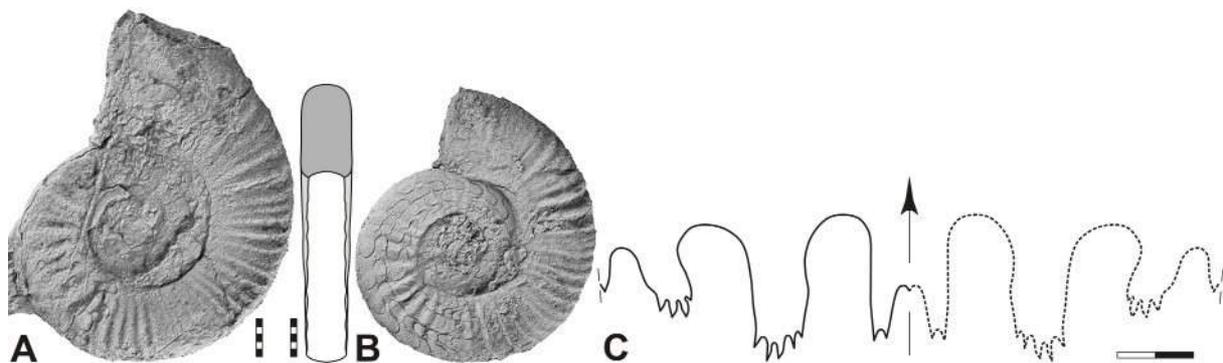


Fig. 19. *Shevyrevites corrugatus* Korn & Hairapetian sp. nov. **A.** Lateral and dorsal view, paratype MB.C.29719, section A, float. **B.** Lateral and dorsal view, holotype MB.C.29718, section A, float. **C.** Suture line, holotype MB.C.29718, at 9.4 mm wh. Abbreviation: see Material and methods. Scale bar units=1 mm.

Genus *Arasella* Korn in Ghaderi *et al.*, 2014

Type species

Sinoceltites? minutus Zakharov in Kotlyar *et al.*, 1983, by original designation

Included species

Sinoceltites? minutus Zakharov in Kotlyar *et al.*, 1983; *Arasella falcata* Korn & Hairapetian sp. nov.

Remarks

The genus *Arasella* is somewhat problematic because of its very simple suture line; an unambiguous attribution to a distinct family is therefore difficult. The shape of the external lobe rather speaks for placing it in the family Xenodiscidae rather than the Dzhulfitidae. The shape of the conch and the sculpture are similar to the early Changhsingian *Shevyrevites*, but this genus has multidentate adventive and lateral lobes.

Arasella minuta (Zakharov, 1983)

Fig. 20; Table 5

Sinoceltites? minutus Zakharov in Kotlyar *et al.*, 1983: 153, pl. 15 fig. 1, 2.

Arasella minuta – Korn in Ghaderi *et al.* 2014: text-fig. 7I. — Korn & Ghaderi in Korn *et al.* 2016: 887, text-fig. 44.

Diagnosis

Species of *Arasella* with conch reaching 35 mm dm. Subadult and adult stage with circular whorl profile ($w/w_h=0.85-1.05$) and rounded venter; 20–22 sharp ribs on the flanks. External lobe with V-shaped prongs; adventive and lateral lobes broadly rounded.

Type material

Holotype

AZERBAIJAN • Nakhichevan Province, Akhura; probably top of the *Paratirolites* Limestone; illustrated by Zakharov (in Kotlyar *et al.* 1983: pl. 15 fig. 1); BPI 4/813.

Material examined

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29720 • 3 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29721 to MB.C.29723 • 8 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29724 to MB.C.29729 • 1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29730 • 2 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29731 to MB.C.29732.

Description

Specimen MB.C.29720 has 25 mm conch diameter and is moderately well preserved (Fig. 20A). Less than half of the last volution belongs to the body chamber. The extremely and evolute conch ($u/w/dm=0.48$) shows a nearly circular whorl profile of the body chamber. The sculpture of the phragmocone and the terminal body chamber does not differ markedly; the phragmocone has slightly coarser but more rounded radial and sharp ribs on the flank, while the ribs on the body chamber are sharper and coarsest in the ventrolateral area. There are about 15 ribs per half volution.

Table 5. Conch dimensions (partly estimated) and ratios of selected specimens of *Arasella minuta* (Zakharov in Kotlyar *et al.* 1983) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29732	27.5	7.1	7.3	13.3	6.8	0.26	0.97	0.48	1.76	0.07
MB.C.29720	25.5	–	6.9	12.1	6.7	–	–	0.48	1.84	0.03

Remarks

Species of *Arasella minuta* can easily be separated from all other contemporaneous ammonoids from the Iranian localities because of its very simple suture line with rounded adventive and lateral lobes and the short external lobe (Korn *et al.* 2016). *Arasella falcata* sp. nov. possesses a much weaker sculpture with ribs coarsest in in dorsolateral area.

Stratigraphic range

Topmost part of the Hambast Formation; immediately below the extinction horizon (*Arasella minuta* Zone).

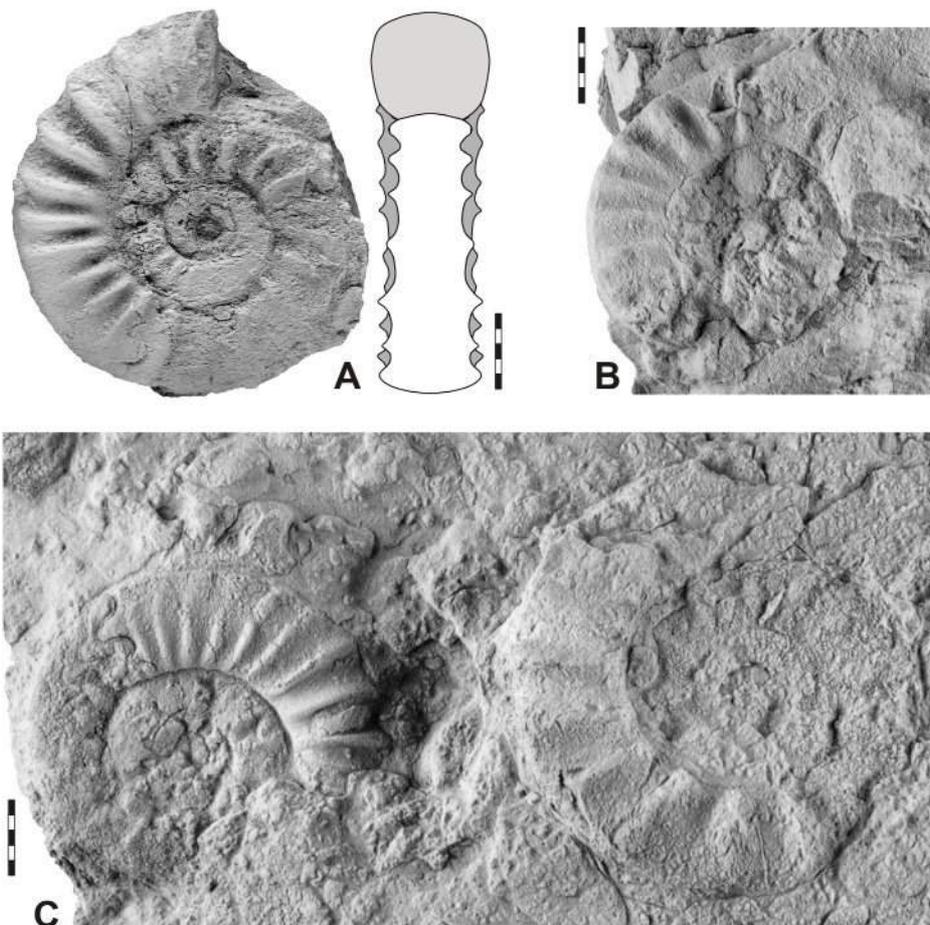


Fig. 20. *Arasella minuta* (Zakharov, 1983). **A.** Lateral and dorsal view, specimen MB.C.29720, section C, -0.05 m. **B.** Lateral view, specimen MB.C.29728, section G, -0.05 m. **C.** *Arasella falcata* Korn & Hairapetian sp. nov.; right = specimen MB.C.29731; left = paratype MB.C.29737, section C, -0.05 m. Scale bar units = 1 mm.

Arasella falcata Korn & Hairapetian sp. nov.

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Fig. 21; Table 6

Diagnosis

Species of *Arasella* with conch reaching 35 mm dm. Subadult and adult stage with compressed whorl profile (ww/wh=0.60–0.70) and rounded venter; 25 curved ribs which are coarsest on the inner flanks.

Etymology

From the Latin ‘*falx*’, meaning ‘sickle’, because of the rib course.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain C section; Hambast Formation, 0.05 m below top; illustrated in Fig. 21A; MB.C.29734.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29733 •
1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29735 •

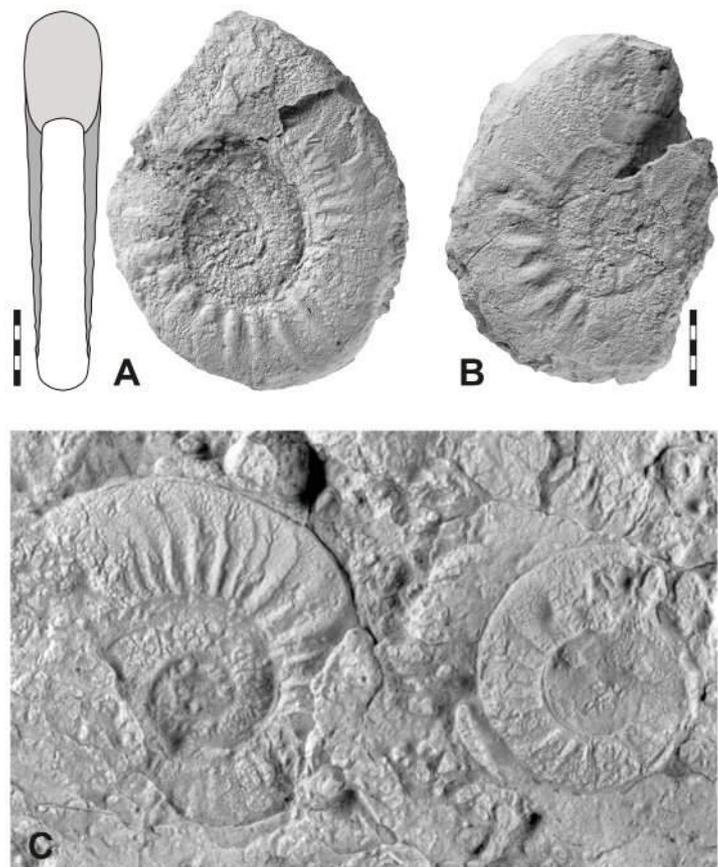


Fig. 21. *Arasella falcata* Korn & Hairapetian sp. nov. **A.** Lateral and dorsal view, holotype MB.C.29734, section C, -0.05 m. **B.** Lateral view, paratype MB.C.29733, section 1, -0.05 m. **C.** Lateral views, paratype MB.C.29736, section H, -0.05 m. Scale bar units = 1 mm.

Table 6. Conch dimensions (partly estimated) and ratios of selected specimens of *Arasella falcata* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29734	25.1	5.1	8.1	10.4	7.1	0.20	0.63	0.41	1.94	0.12
MB.C.29734	18.0	3.6	5.8	7.7	–	0.20	0.62	0.43	–	–

1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29736 •
1 specimen; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29737.

Description

Holotype MB.C.29734 is a somewhat corroded specimen with a conch diameter of 24 mm (Fig. 21A). It is extremely discoidal ($ww/dm=0.20$) and subevolute ($uw/dm=0.43$) with a compressed whorl profile ($ww/wh=0.63$). The flanks are nearly parallel and the venter is rounded. The last volution shows about 25 ribs, which are sharpest and coarsest on the inner flank; they turn slightly forward and become weaker on the outer flank to diminish.

Remarks

Arasella minuta shows much coarser ribs, particularly on the outer flanks, while *A. falcata* sp. nov. possesses a much weaker sculpture with ribs strongest in in dorsolateral area.

Stratigraphic range

Topmost part of the Hambast Formation; immediately below the extinction horizon (*Arasella minuta* Zone).

Family *Dzhulfitidae* Shevyrev, 1965

For the composition and diagnosis of the family, see Korn & Ghaderi in Korn *et al.* (2016).

Genus *Dzhulfites* Shevyrev, 1965

Type species

Dzhulfites spinosus Shevyrev, 1965, by original designation.

Included species

Dzhulfites hebes Korn & Ghaderi in Korn *et al.* (2016); *Dzhulfites nodosus* Shevyrev, 1965;

Dzhulfites spinosus Shevyrev, 1965; *Dzhulfites zalensis* Korn & Ghaderi in Korn *et al.* (2016); *Dzhulfites brevisellatus* Korn & Hairapetian sp. nov.

Diagnosis

Representatives of the family *Dzhulfitidae* with moderately large to large conch; maximum adult diameters are between 80 and 160 mm. Subadult stage with trapezoidal whorl profile, adult stage variable. Subadult stage with small to large conical ventrolateral nodes, adult stage with weakening sculpture. Suture line with external lobe that does not reach the depth of the adventive lobe; prongs of external lobe simple to trifid.

Remarks

For a discussion of the genus, see Korn & Ghaderi in Korn *et al.* (2016).

Dzhulfites spinosus Shevyrev, 1965
Fig. 22; Table 7

Dzhulfites spinosus Shevyrev, 1965: 173, pl. 21 fig. 9, pl. 22 fig. 1.

Dzhulfites spinosus – Shevyrev 1968: 88, pl. 2 figs 3–4. — Korn *et al.* 2019: 51, text-figs 20–21.

Diagnosis

Species of *Dzhulfites* with conch reaching 90 mm dm. Subadult stage with weakly trapezoidal, moderately depressed whorl profile ($ww/wh = 1.50–1.60$) and broadly rounded venter; 6–8 coarse conical nodes on midflank per volution. Prongs of external lobe simple to trifid; altogether 14–18 notches of E, A and L lobes.

Type material

Holotype

AZERBAIJAN • Nakhichevan Province, Dorasham 2 section; Late Permian; illustrated by Shevyrev (1965: pl. 21 fig. 9); PIN 1478/60.

Material examined

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29738 • 1 specimen; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.29739 • 1 specimen; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.29740 • 2 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29741 to MB.C.29742 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29743 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29744 to MB.C.29745.

Description

Specimen MB.C.29739 has a conch diameter of 47 mm, but the beginning of the terminal body chamber is already at 31 mm, as indicated by two narrowly spaced septa (Fig. 22B). The weakly corroded specimen shows a ww/wh ratio of 1.50 at 32 mm dm; the whorl profile is trapezoidal with broadly rounded venter. The sculpture possesses six as well as eight conical midflank nodes on the last two volutions of the phragmocone, respectively.

The suture line of specimen MB.C.29739 has an external lobe that is almost as deep as the adventive lobe; it possesses three small notches. There follow an inverted U-shaped ventrolateral saddle and an adventive lobe that is widest at its base. It has about eight small notches. The parallel-sided lateral saddle is lower than the ventrolateral saddle and the lateral lobe, subdivided by seven very small notches, is only half as deep as the adventive lobe (Fig. 22F).

Specimen MB.C.29743 is a specimen with 48 mm conch diameter and has a phragmocone diameter of 36 mm (Fig. 22C). Its body chamber has a rounded-trapezoidal, weakly depressed whorl profile ($ww/wh = 1.30$) with broadly rounded venter. In the subadult stage, the ww/wh ratio is higher than 1.50 and the whorl profile has a depressed oval shape. The sculpture in the subadult stage has eight coarse and pointed conical midflank nodes per volution; these nodes become much weaker on the body chamber and are replaced by weak, radial ribs, which are coarsest in the ventrolateral region.

The suture line of specimen MB.C.29743 differs from the preceding in the simple, unsubdivided prongs of the external lobe that is not as deep as the adventive lobe, the inflated ventrolateral saddle and the wider lateral saddle (Fig. 22E).

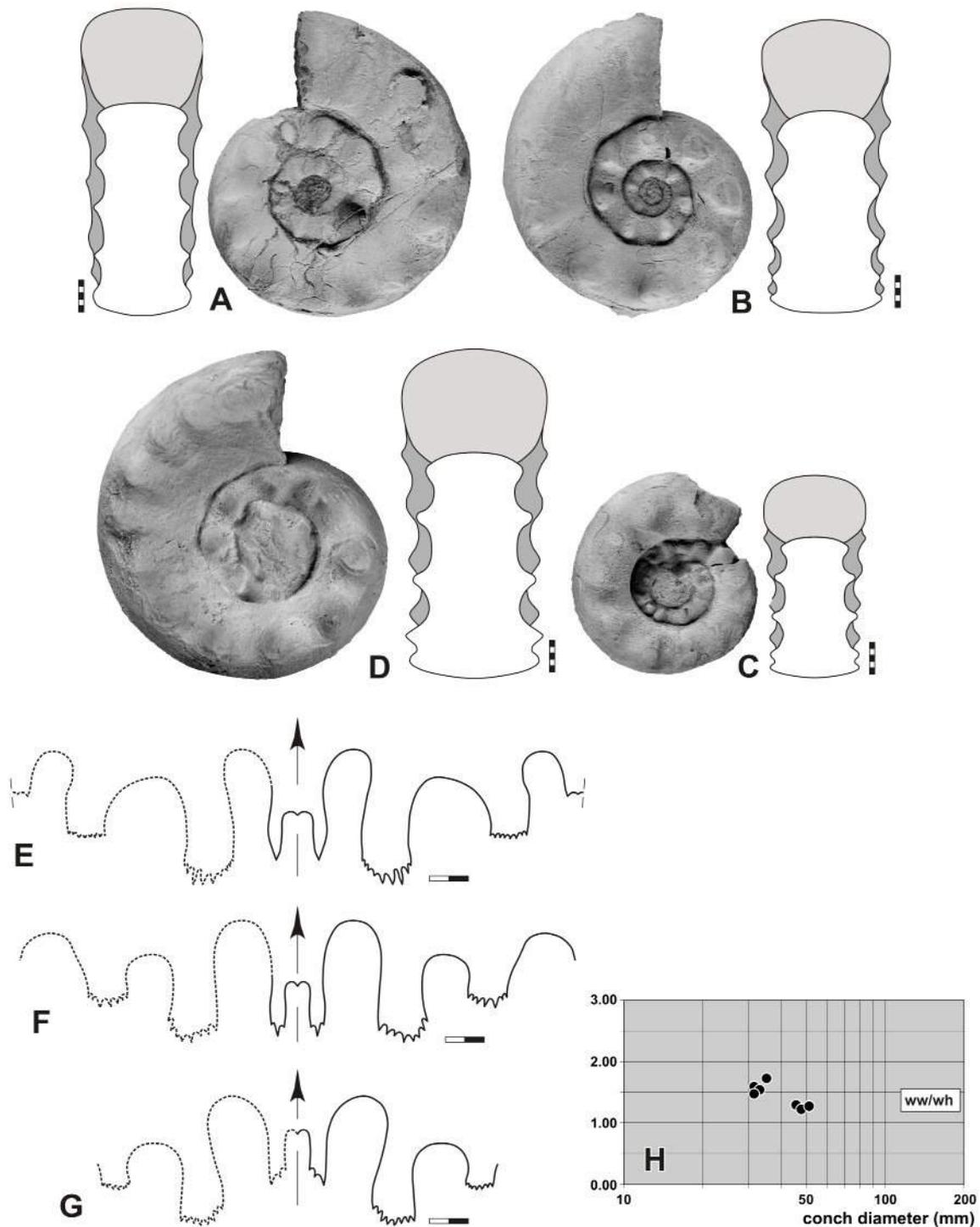


Fig. 22. *Dzhulfites spinosus* Shevyrev, 1965. **A–D.** Lateral and dorsal views. **A.** Specimen MB.C.29741, section E, float. **B.** Specimen MB.C.29739, float. **C.** Specimen MB.C.29743, section G, float. **D.** Specimen MB.C.29744, section H, -5.40 m. **E–G.** Suture lines. **E.** Specimen MB.C.29743, at 32.5 mm dm, 16.5 mm ww, 10.5 mm wh. **F.** Holotype. MB.C.29739, at 32.0 mm dm, 16.0 mm ww, 10.0 mm wh. **G.** Specimen MB.C.29744, at 29.5 mm dm, 16.5 mm ww, 9.7 mm wh. **H.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 7. Conch dimensions (partly estimated) and ratios of selected specimens of *Dzhulfites spinosus* Shevyrev, 1965 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29743	51.4	22.5	17.8	21.7	15.8	0.44	1.26	0.42	2.08	0.11
MB.C.29741	48.0	18.9	15.6	21.2	14.8	0.39	1.21	0.44	2.09	0.05
MB.C.29739	45.8	19.9	15.5	20.0	14.5	0.43	1.28	0.44	2.14	0.06
MB.C.29744	31.6	15.8	10.8	13.2	–	0.50	1.46	0.42	–	–

The suture line of the smaller specimen MB.C.29744 is remarkable because of its asymmetric external lobe with one prong being unsubdivided and the other possessing three small notches. It shows a narrow, dorsally inclined and weakly inflated ventrolateral saddle and a multiply serrated, asymmetric adventive lobe that is widest at its base (Fig. 22G).

Remarks

Dzhulfites spinosus differs most of the other species of *Dzhulfites* in the shape of the venter, which is broadly rounded in the new species but more or less flattened in *D. nodosus* and *D. zalensis*. *Dzhulfites hebes* is a very similar species in conch proportions and sculpture, but differs in the coarser, blunt nodes of the sculpture. *Paratirolites kittli* is a species with similar conch morphology, but possesses a deep external lobe, which is much shorter in *D. spinosus*.

Stratigraphic range

Upper part of the Hambast Formation; 7.00 to 4.70 m below the extinction horizon (*Dzhulfites spinosus* Zone to *Shevyrevites shevyrevi* Zone).

Dzhulfites brevisellatus Korn & Hairapetian sp. nov.

urn:lsid:zoobank.org:act:1FDCA9D7-546A-48FA-94E1-0053EB7F7C23

Fig. 23; Table 8

Diagnosis

Species of *Dzhulfites* with conch reaching 160 mm dm. Subadult stage with weakly trapezoidal, moderately depressed whorl profile ($ww/wh=1.50-1.80$) and broadly rounded venter; 10–13 coarse conical nodes on midflank per volution. Adult stage with numerous weak ribs and small ventrolateral nodes. Prongs of external lobe bifid or trifid; altogether 15–20 notches of E, A and L lobes.

Etymology

From the Latin ‘*brevis*’, meaning ‘low’ and ‘*sella*’, meaning ‘saddle’, after the low amplitude of lobes and saddles in the suture line.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain H section; Hambast Formation, 5.70 m below top; illustrated in Fig. 23B; MB.C.29748.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29746 • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29747.

Table 8. Conch dimensions (partly estimated) and ratios of selected specimens of *Dzhulfites brevisellatus* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29746	124.0	–	39.0	61.0	37.0	–	–	0.49	2.03	0.05
MB.C.29748	50.4	25.1	16.6	21.7	15.0	0.50	1.51	0.43	2.03	0.10

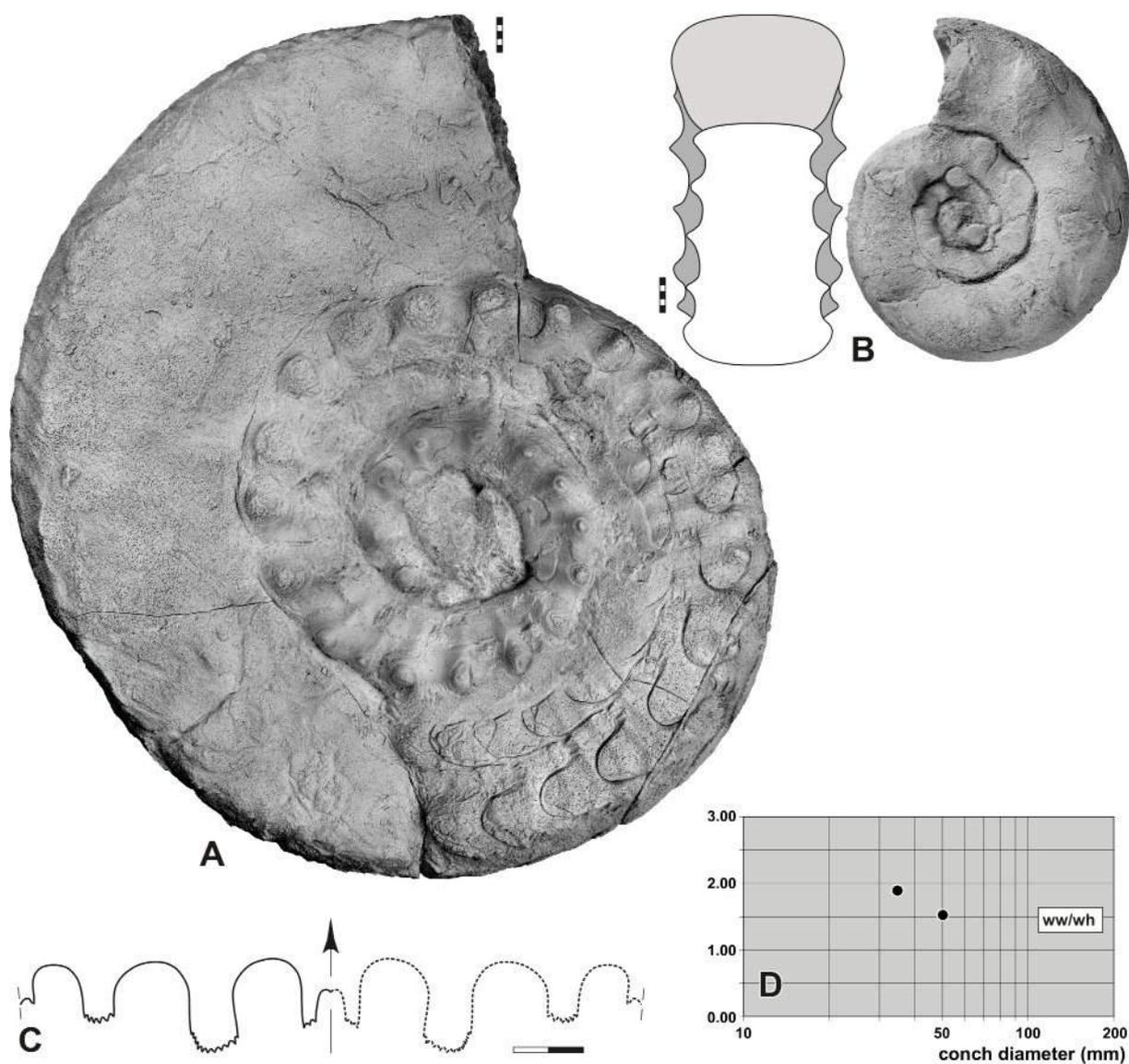


Fig. 23. *Dzhulfites brevisellatus* Korn & Hairapetian sp. nov. **A–B.** Lateral and dorsal views. **A.** Paratype MB.C.29746, float. **B.** Holotype MB.C.29748, section H, -5.70 m. **C.** Suture line, holotype MB.C.29748, at 21.0 mm ww, 13.5 mm wh. **D.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Description

The large paratype MB.C.29746 has 125 mm conch diameter, of which half of the last whorl belongs to the strongly weathered body chamber (Fig. 23A). The phragmocone is 90 mm in diameter and is partly crushed; it shows that the whorl profile is trapezoidal with a broadly rounded venter. The sculpture changes dramatically throughout ontogeny. At 40 mm dm there are 13 coarse, spiny ventrolateral nodes per volution; these nodes become weaker and more numerous so that the last 120° of the phragmocone have about 20 weak ventrolateral nodes, which are connected with weak and slightly sinuous radial ribs on the flank. The suture line of the specimen suffered from weathering, but, most probably, the prongs of the very short external lobe are bifid.

Holotype MB.C.29748 is a fairly well-preserved, fully septate specimen with 51 mm conch diameter (Fig. 23B). It has a weakly trapezoidal whorl profile with broadly rounded flanks and venter. The sculpture shows about ten coarse conical nodes, which are positioned on the midflank, on the last preserved volution.

The suture line of the holotype shows an external lobe with subparallel, weakly diverging flanks and weakly asymmetric, trifid prongs. All three saddles of the outer suture line are similar in shape, being inverted U-shaped and broadly rounded. The adventive lobe and the lateral lobe are similar in shape with parallel flanks and many small notches at the base. They differ in their depth; the adventive lobe is much deeper than the external lobe (Fig. 23C).

Remarks

Among the species of *Dzhulfites*, only *D. nodosus* is similar in conch shape and sculpture, but this species shows an appanate venter in the adult stage. *Dzhulfites brevisellatus* sp. nov. differs from *D. spinosus* and the other species of the genus in the suture line, which in *D. brevisellatus* sp. nov. shows much wider elements; particularly the saddles are wider than the lobes. In the shape of the suture line, *D. brevisellatus* sp. nov. has some resemblance to representatives of the family Xenodiscidae.

Stratigraphic range

Upper part of the Hambast Formation; 5.70 to 4.70 m below the extinction horizon (*Dzhulfites spinosus* Zone to *Shevyrevites shevyrevi* Zone).

Genus *Paratirolites* Stoyanow, 1910

Type species

Paratirolites Kittli Stoyanow, 1910, by original designation.

Included species

Paratirolites birunii Korn & Ghaderi, 2016; *Paratirolites coronatus* Korn & Ghaderi, 2016; *Paratirolites kittli* Stoyanow, 1910; *Paratirolites multiconus* Korn & Ghaderi in Korn *et al.*, 2016; *Paratirolites quadratus* Korn & Ghaderi in Korn *et al.*, 2016; *Paratirolites serus* Korn & Ghaderi in Korn *et al.*, 2016; *Paratirolites trapezoidalis* Shevyrev, 1965; *Paratirolites vediensis* Shevyrev, 1965; *Stephanites* (?) *Waageni* Stoyanow, 1910; Azerbaijan (synonym of *Paratirolites kittli* Stoyanow, 1910); *Paratirolites rubens* Korn & Hairapetian sp. nov.; *Paratirolites lanceolobatus* Korn & Hairapetian sp. nov.; *Paratirolites robustus* Korn & Hairapetian sp. nov.; *Paratirolites baghukensis* Korn & Hairapetian sp. nov.; *Paratirolites aduncus* Korn & Hairapetian sp. nov.

Diagnosis

Representatives of the family Dzhulfitidae with moderately large to very large conch; maximum adult diameters between 60 and 250 mm. Adult stage with trapezoidal whorl profile. Subadult stage with large conical ventrolateral nodes; adult stage with significantly weakening sculpture. Suture line with deep external lobe; depths of external lobe and adventive lobe are nearly identical.

Remarks

For a discussion of the genus, see Korn & Ghaderi in Korn *et al.* (2016).

***Paratirolites rubens* Korn & Hairapetian sp. nov.**

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Fig. 24; Table 9

Diagnosis

Species of *Paratirolites* with conch reaching 110 mm dm. Subadult stage with broadly oval, moderately depressed whorl profile ($w/w_h = 1.60$) and broadly rounded venter; about 8 coarse ventrolateral nodes per volution. Adult stage with broadly oval, weakly depressed whorl profile ($w/w_h = 1.30$), broadly rounded venter and rounded ventrolateral shoulder; coarse ventrolateral nodes. Prongs of external lobe unserrated; altogether 16 notches of E, A and L lobes.

Etymology

From the Latin '*rubens*', meaning 'red', because of the red limestone horizon where the material comes from.

Material examined**Holotype**

IRAN • Esfahan Province, Baghuk Mountain E section; Hambast Formation; illustrated in Fig. 24; MB.C.29749.

Paratype

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29750.

Description

Holotype MB.C.29749 is a rather well-preserved individual of 50 mm conch diameter (Fig. 24A). It is fully chambered with septal crowing at the end; therefore the adult diameter including body chamber has been about 90 mm. The whorl profile is, at 50 mm conch diameter, broadly oval ($w/w_h = 1.80$) with broadly convex flanks and venter. Half a volution earlier, the w/w_h ratio is even higher (1.90). The sculpture consists of eight coarse conical nodes with a position on the midflank of the last volution; the penultimate volution bears only six nodes.

The suture line of the holotype has a narrow external lobe that is wider near its base and weakly constricted in the upper part. It possesses very narrow, non-serrated prongs. A narrow and slightly inflated ventrolateral saddle and an asymmetric adventive lobe with ten little notches follow on the sides of the venter, while the continuously rounded lateral saddle and the nearly symmetric lateral lobe (with five small notches) have a position on the flank (Fig. 24B).

Remarks

Paratirolites rubens sp. nov. is the species of the genus with the lowest number of ventrolateral nodes. Furthermore, the broadly rounded venter is a criterion of clear separation from species such as *P. vediensis*

Table 9. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites rubens* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29749	51.2	24.4	18.3	20.3	16.3	0.48	1.33	0.40	2.15	0.11
MB.C.29749	34.9	19.9	12.6	14.2	–	0.57	1.58	0.41	–	–

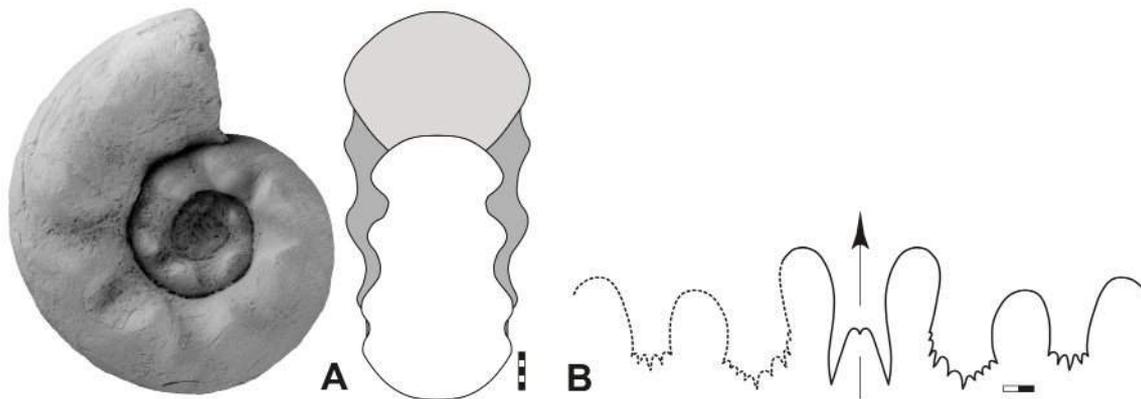


Fig. 24. *Paratirolites rubens* Korn & Hairapetian sp. nov. **A.** Lateral and dorsal view, holotype MB.C.29749, section E, float. **B.** Suture line, holotype MB.C.29749, at 36.0 mm dm, 22.0 mm ww, 13.0 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

and *P. kittli*. There is also some similarity to the species *Dzhulfites spinosus* and *D. hebes*, but these differ in the very short external lobe.

Stratigraphic range

None of the specimens was collected in situ, but according to the intensive red colour of the host sediment, a position in the Hambast Formation about five metres below the extinction horizon is most likely (probably *Shevyrevites shevyrevi* Zone).

Paratirolites lanceolobatus Korn & Hairapetian sp. nov.

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Fig. 25; Table 10

Diagnosis

Species of *Paratirolites* with conch reaching 90 mm dm. Subadult stage with weakly trapezoidal, weakly depressed whorl profile ($ww/wh=1.10-1.30$) and broadly rounded venter; about 12 radial ribs ending in coarse conical ventrolateral nodes per revolution. Adult stage with rectangular and weakly compressed whorl profile ($ww/wh=0.85-1.00$), flattened, weakly tectiform venter and subangular ventrolateral shoulder; numerous rounded ventrolateral nodes. Prongs of external lobe lanceolate and usually unsubdivided; altogether 11–15 notches of E, A and L lobes.

Etymology

From the Latin 'lancea', meaning 'lance', because of the lanceolate prongs of the external lobe.

Material examined**Holotype**

IRAN • Esfahan Province, Baghuk Mountain B section; Hambast Formation; illustrated in Fig. 25A; MB.C.29769.

Paratypes

IRAN • 18 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29751 to MB.C.29768 • 3 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29770 to MB.C.29772 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29773 • 2 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29774 to MB.C.29775.

Description

Holotype MB.C.29769 is a comparatively well-preserved individual with 73 mm conch diameter; a little more than half of the last whorl belongs to the partly corroded body chamber. The last two and a half whorls of the phragmocone are better preserved (Fig. 25A). The beginning of the terminal body chamber is at 50 mm diameter; it is well identifiable by the crowding of two septa. This boundary is not identical with spontaneous changes in conch shape and sculpture. At the beginning of the body chamber, the whorl profile is trapezoidal with a flattened, broadly rounded venter; at the end, the whorl profile is slightly trapezoidal with weakly diverging flanks. The rounded, weakly tectiform venter is delimited from the flanks by rounded ventrolateral shoulders. The sculpture shows three ontogenetic stages: (1) The inner whorls (up to 10 mm dm) appear to be smooth without ribs or nodes. (2) The intermediate stage (between 10 and 50 mm dm) shows radial ribs that end in coarse conical ventrolateral nodes (12 per revolution in the smaller growth stage and more densely arranged in the larger stage), which weaken at the beginning of the body chamber. (3) The main portion of the body chamber shows smoothing of the sculpture.

The suture line of holotype MB.C.29769 possesses a parallel-sided external lobe with very narrow, lanceolate non-serrated prongs. The ventrolateral saddle is rather narrow (much narrower than the external lobe) and weakly inflated; it is followed by a rather broad, drop-shaped adventive lobe that is multiply serrated, a wide and broadly rounded lateral saddle and a V-shaped, weakly serrated lateral lobe (Fig. 25E).

The smaller paratype MB.C.29770 with 55 mm conch diameter resembles the holotype in conch proportions and sculpture, but appears to enter the adult growth stage at a smaller conch diameter with a maximum phragmocone diameter of 38 mm (Fig. 25C). Very coarse ventrolateral nodes are present in an interval of about 270 degrees of the phragmocone. The suture line of this specimen also shows non-serrated prongs of the external lobe.

Suture lines of the further two paratypes MB.C.29751 and MB.C.29757 (both at about 11 mm whorl height) demonstrate, when compared with the holotype, the variability within the Material examined

Common to all three specimens are the simple prongs of the external lobe, which in the paratypes MB.C.29751 and MB.C.29757 is less deep as the adventive lobe. All three specimens show an asymmetric adventive lobe that appears to be dorsally inclined (Fig. 25E–G).

Table 10. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites lanceolobatus* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29769	73.3	22.6	26.6	29.6	24.1	0.31	0.85	0.40	2.22	0.09
MB.C.29751	65.2	19.5	22.3	29.5	20.5	0.30	0.87	0.45	2.13	0.08
MB.C.29770	53.5	17.8	17.9	24.1	16.5	0.33	0.99	0.45	2.09	0.08
MB.C.29752	51.9	16.2	17.4	21.4	16.0	0.31	0.93	0.41	2.09	0.08
MB.C.29773	51.5	17.9	16.4	23.7	15.8	0.35	1.09	0.46	2.08	0.04
MB.C.29757	51.2	–	17.2	22.7	16.7	–	–	0.44	2.20	0.03
MB.C.29758	31.6	16.8	11.4	12.7	11.0	0.53	1.47	0.40	2.35	0.04

Remarks

The new species shows some similarities to species of the genus *Dzhulfites*, particularly in the reduced depth of the external and lateral lobes. It may thus represent a link between the two genera. The low stratigraphic position at the base of the *Paratirolites* Limestone supports this hypothesis.

Paratirolites lanceolobatus sp. nov. differs in the non-serrated prongs of the external lobe from most of the other species of the genus. Similar species are the Transcaucasian *P. trapezoidalis* and *P. birunii*, but both possess an adult body chamber with numerous small nodes at the angular ventrolateral shoulder. *Paratirolites robustus* sp. nov. is the most similar of the Central Iranian species but differs in the wider whorl profile ($ww/wh=1.20$ at 70 mm dm) from *P. lanceolobatus* sp. nov. ($ww/wh=0.85$). Furthermore, *P. robustus* sp. nov. has bifid prongs of the external lobe.

Stratigraphic range

Upper part of the Hambast Formation; 3.85 to 2.80 m below the extinction horizon (*Paratirolites lanceolobatus* Zone to lower part of the *Paratirolites kittli* Zone).

Paratirolites robustus Korn & Hairapetian sp. nov.

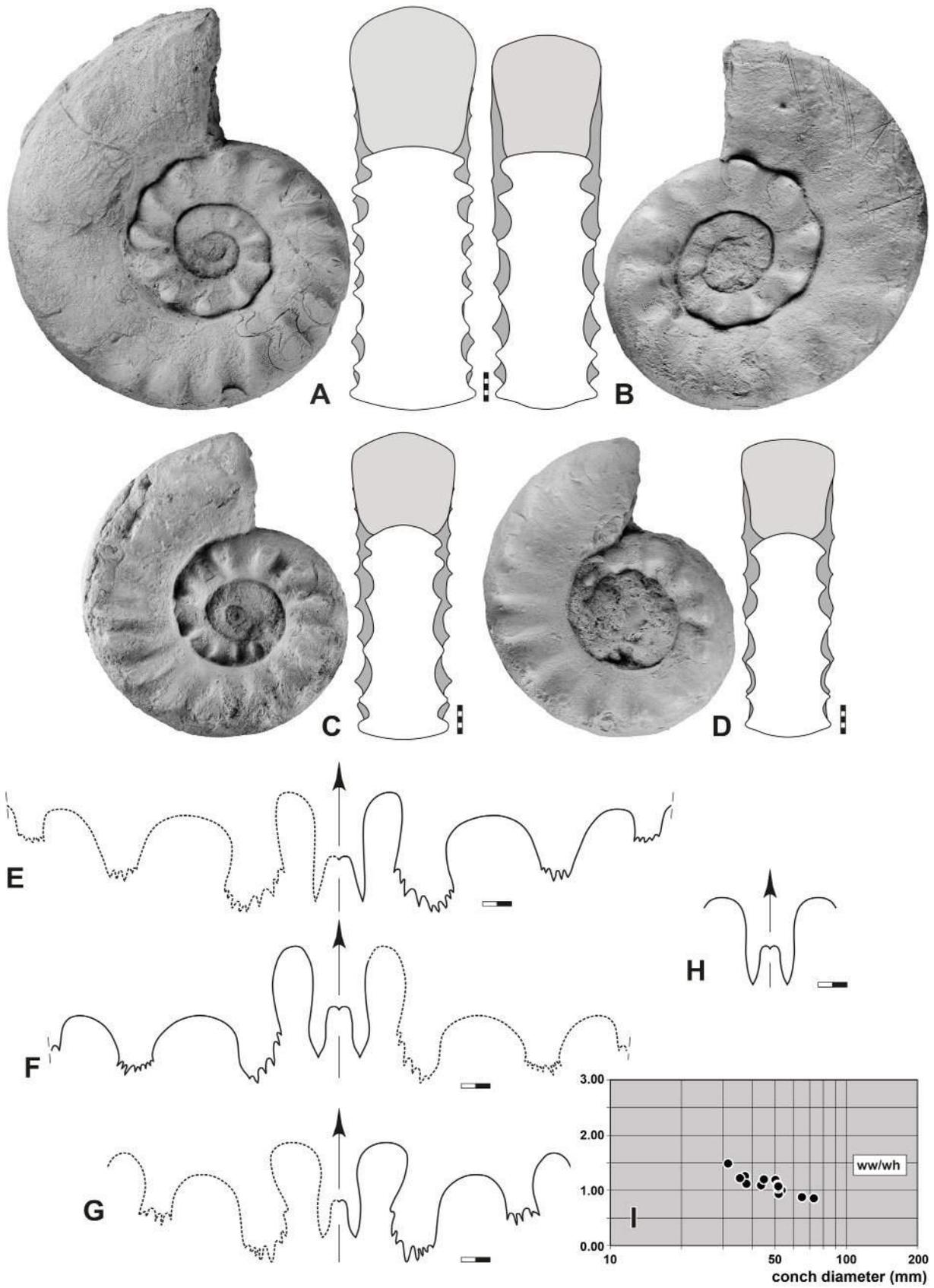
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Figs 26–27; Table 11

Diagnosis

Species of *Paratirolites* with conch reaching 120 mm dm. Subadult stage with trapezoidal, weakly depressed whorl profile ($ww/wh=1.30–1.50$) and rounded venter; 8–12 coarse, radially elongated midflank nodes per volution. Adult stage with trapezoidal and weakly depressed whorl profile

Fig. 25 (next page). *Paratirolites lanceolobatus* Korn & Hairapetian sp. nov. **A–E**. Lateral and dorsal views. **A**. Holotype MB.C.29769, section B, float. **B**. Paratype MB.C.29751, section 1, float. **C**. Paratype MB.C.29770, section E, -3.30 m. **D**. Paratype MB.C.29752, section A, float. **E–H**. Suture lines. **E**. Holotype MB.C.29769, at 13.5 mm wh. **F**. Paratype MB.C.29751, at 11.2 mm wh. **G**. Paratype MB.C.29757, at 11.2 mm wh. **H**. Paratype MB.C.29770, at 11.1 mm wh. **I**. Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.



(ww/wh=1.00–1.10), flattened, tectiform venter and angular ventrolateral shoulder; numerous weak ribs on flank. Prongs of external lobe simple to trifid; altogether 12–17 notches of E, A and L lobes.

Etymology

From the Latin '*robustus*', meaning 'robust', because of the coarse ribs.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain E section; Hambast Formation, 2.95 m below top; illustrated in Fig. 26A; MB.C.29778.

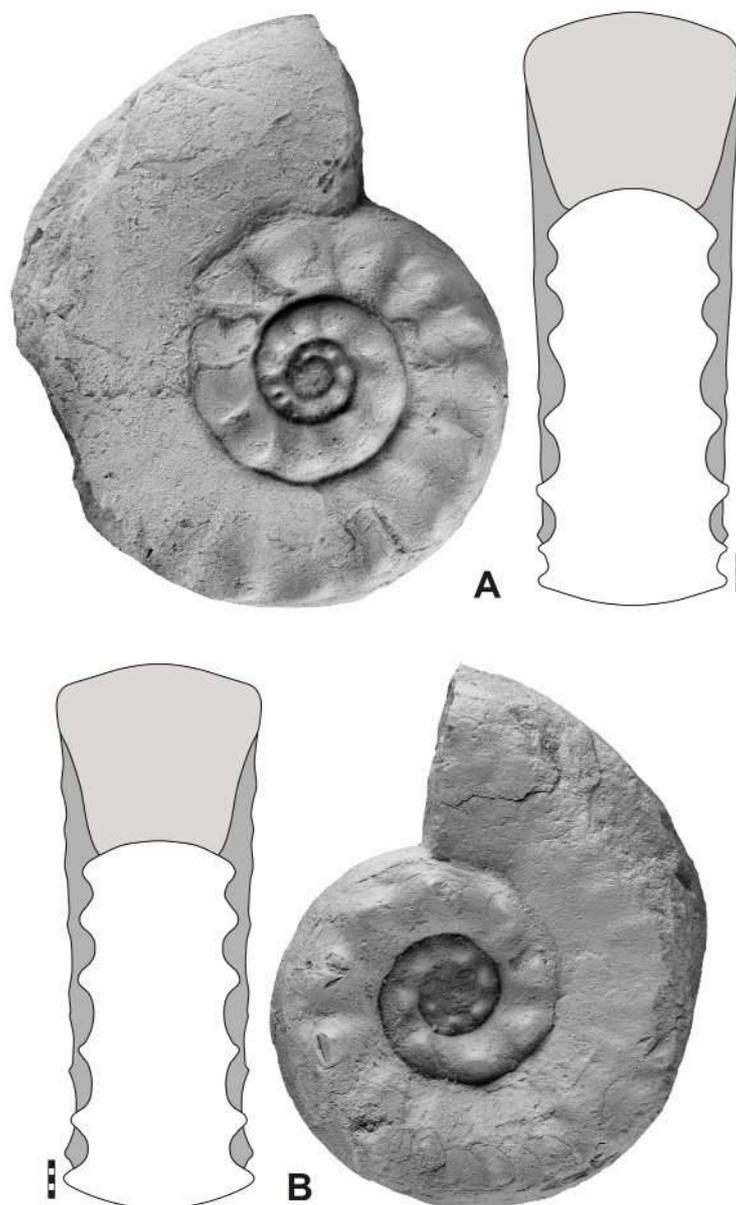


Fig. 26. *Paratirolites robustus* Korn & Hairapetian sp. nov., lateral and dorsal views. **A.** Holotype MB.C.29778, section E, -2.95 m. **B.** Paratype MB.C.29782, float. Scale bar units=1 mm.

Paratypes

IRAN • 2 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29776 to MB.C.29777 • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29779 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29780 • 4 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29781 to MB.C.29784.

Description

Holotype MB.C.29778 has 80 mm conch diameter and consists of a rather well-preserved phragmocone and a more or less strongly weathered body chamber (Fig. 26A). Septal crowding indicates that the maximum phragmocone diameter is 48 mm. The conch shape changes during growth; there is a strongly trapezoidal whorl profile of the phragmocone and a weakly trapezoidal profile of the body chamber. The sculpture of the phragmocone shows 12 conical nodes, which are circular and symmetric in section in the penultimate whorl but become asymmetric and radially elongated towards the end of the phragmocone.

The suture line of holotype MB.C.29778 has a Y-shaped external lobe, in which the prongs are weakly serrated including two notches. The adventive lobe is asymmetric and ventrally inclined with nearly parallel flanks and asymmetric notching. It is dorsolaterally followed by an asymmetric lateral saddle and a nearly symmetric lateral lobe with seven small notches (Fig. 27A).

The slightly smaller paratype MB.C.29782 (73 mm dm) is very similar in conch shape and suture line. The penultimate whorl has eight coarse conical nodes, which transform, at the end of the phragmocone, into weakly curved elongated nodes (Fig. 26B). The suture line has an external lobe with weakly diverging

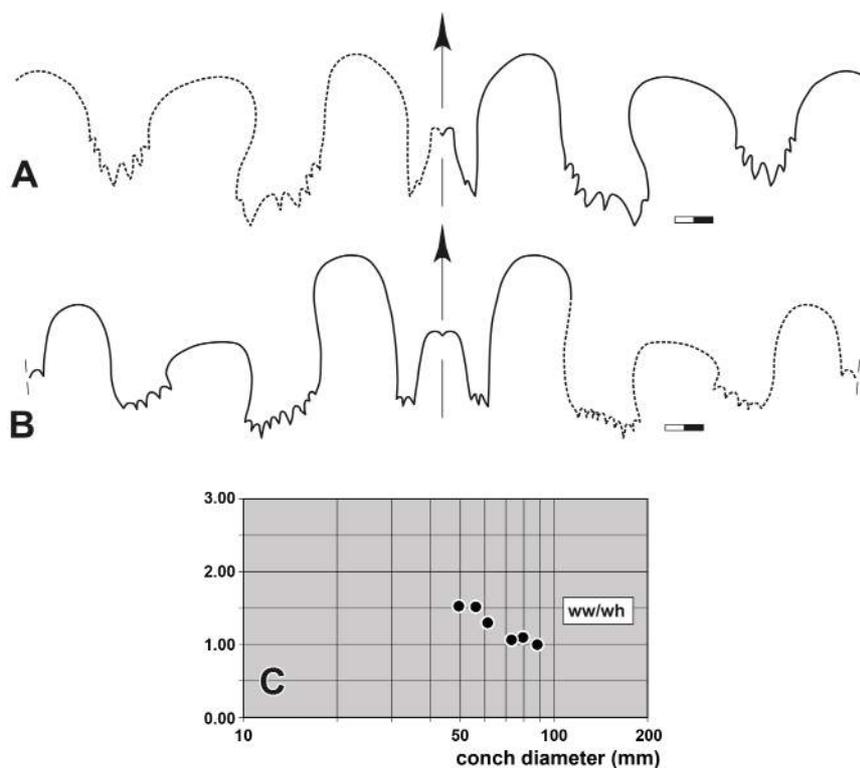


Fig. 27. *Paratiroilites robustus* Korn & Hairapetian sp. nov. **A.** Suture line, holotype MB.C.29778, at 14.2 mm wh. **B.** Suture line, paratype MB.C.29782, at 13.2 mm wh. **C.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 11. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites robustus* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29778	80.0	29.0	26.7	35.9	25.2	0.36	1.09	0.45	2.13	0.06
MB.C.29782	73.4	27.4	26.0	30.9	24.2	0.37	1.05	0.42	2.23	0.07
MB.C.29780	61.5	26.5	20.6	26.4	–	0.43	1.29	0.43	–	–

flanks, an asymmetric ventrolateral saddle and a weakly asymmetric, strongly notched adventive lobe with nearly flat base and parallel flanks (Fig. 27B).

Remarks

Paratirolites robustus sp. nov. differs from the most similar of the Central Iranian species *P. lanceolobatus* sp. nov. in the stouter whorl profile ($ww/wh=1.20$ in *P. robustus* sp. nov. at 70 mm conch diameter and only 0.85 in *P. lanceolobatus*). Furthermore, *P. lanceolobatus* sp. nov. has non-serrated prongs of the parallel-sided external lobe. *Paratirolites robustus* sp. nov. differs from *P. vediensis* in the rounded venter and from *P. kittli* in the radially elongated nodes of the subadult stage and the presence of weak radial ribs of the body chamber.

Stratigraphic range

Upper part of the Hambast Formation; 3.20 to 2.90 m below the extinction horizon (uppermost part of the *Paratirolites lanceolobatus* Zone to *Paratirolites kittli* Zone).

Paratirolites vediensis Shevyrev, 1965

Figs 28–29; Table 12

Paratirolites vediensis Shevyrev, 1965: 176, pl. 23 fig. 1.

Paratirolites vediensis – Shevyrev 1968: 92, pl. 5 fig. 1. — Stepanov *et al.* 1969: pl. 13 fig. 5. — Korn in Ghaderi *et al.* 2014: text-fig. 7g. — Korn & Ghaderi in Korn *et al.* 2016: 864, text-figs 23–24.

Diagnosis

Species of *Paratirolites* with conch reaching 250 mm dm. Subadult stage with trapezoidal, weakly depressed whorl profile ($ww/wh=1.20–1.50$) and flattened tectiform venter; 10–15 coarse ventrolateral nodes per revolution. Adult stage with strongly trapezoidal and weakly depressed whorl profile ($ww/wh=1.00–1.20$), flattened tectiform venter and angular ventrolateral shoulder; weak ventrolateral nodes. Prongs of external lobe usually multiply serrated; altogether 12–20 notches of E, A and L lobes.

Type material

Holotype

ARMENIA • 1 specimen; Vedi; *Paratirolites* Limestone; illustrated by Shevyrev (1965: pl. 23 fig.1); PIN 1478/2.

Material examined

IRAN • 6 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29785 to MB.C.29790 • 1 specimen; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.29791 • 4 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29792 to MB.C.29795 • 4 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29796 to MB.C.29799 • 6 specimens; Esfahan Province, Baghuk Mountain G section;

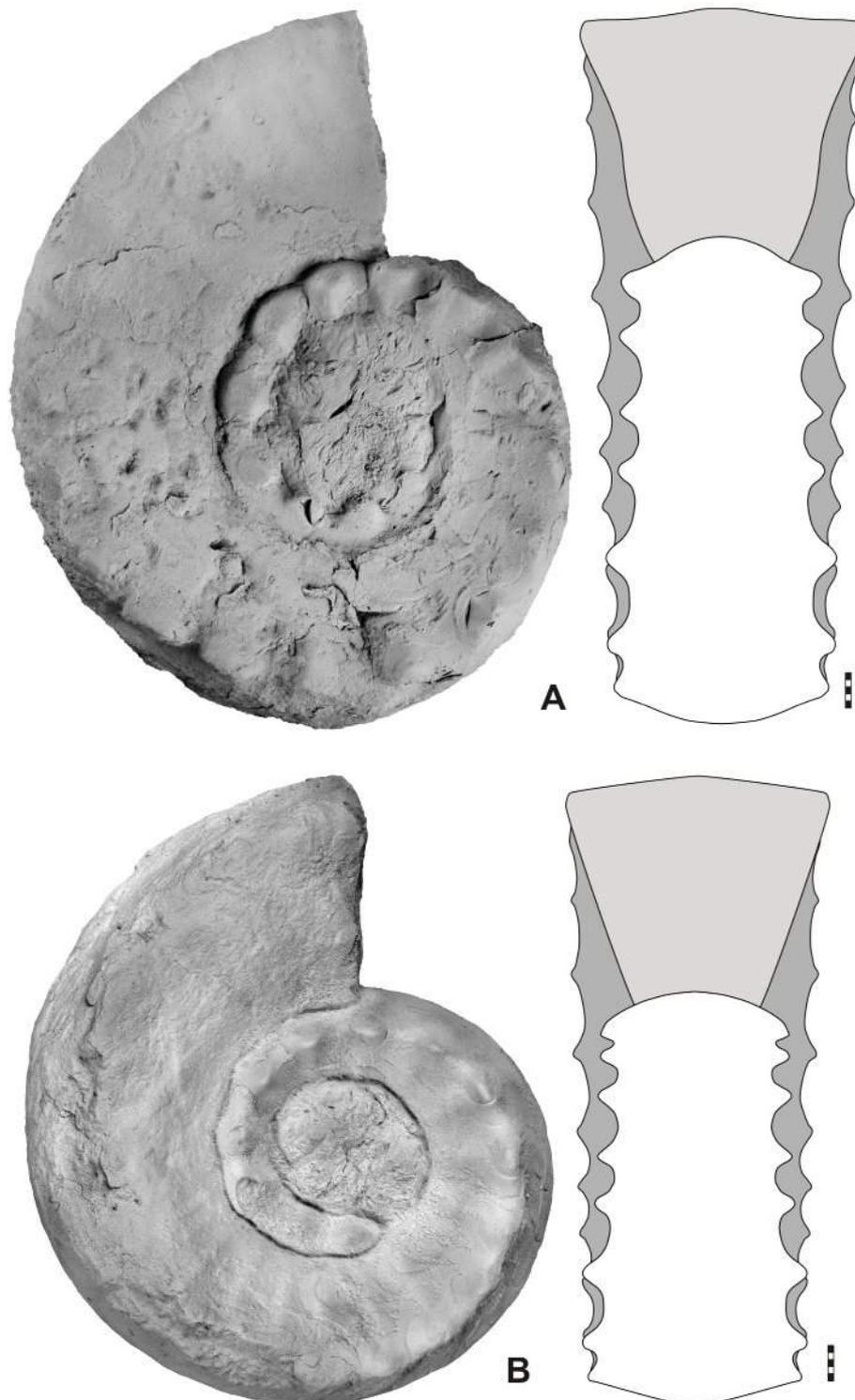


Fig. 28. *Paratirolites vediensis* Shevyrev, 1965, lateral and dorsal views. **A.** Specimen MB.C.29804, section G, -2.75 m. **B.** Specimen MB.C.29798, section E, float. Scale bar units=1 mm.

Hambast Formation; MB.C.29800 to MB.C.29805 • 5 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29806 to MB.C.29810 • 2 specimens; Esfahan Province, Baghuk Mountain section; Hambast Formation; MB.C.29811 to MB.C.29812.

Description

Specimens MB.C.29811 and MB.C.29794 are the largest specimens with terminal phragmocone diameters of approximately 85 mm. They indicate that the maximum diameter including body chamber has been about 155 mm. Unfortunately, both specimens are poorly preserved.

Specimen MB.C.29804 (100 mm dm; Fig. 28A) shows septal crowding at a phragmocone diameter of 65 mm, which means that the maximum conch diameter was approximately 120 mm. It is slightly corroded but shows that the shape of the whorl profile is trapezoidal in the subadult and adult stage. The venter becomes flat with an angular ventrolateral shoulder during formation of the terminal body chamber but is more flattened in the phragmocone stage. The specimen shows a sculpture of the phragmocone that consists of 12 coarse conical nodes on the ventrolateral shoulder and both specimens demonstrate that these nodes become continuously weaker and more numerous (15 on half a volution in) on the body chamber. Specimen MB.C.29798 (88 mm dm; Fig. 28B) closely resembles specimen MB.C.29804 but possesses more longitudinally elongate ventrolateral spines.

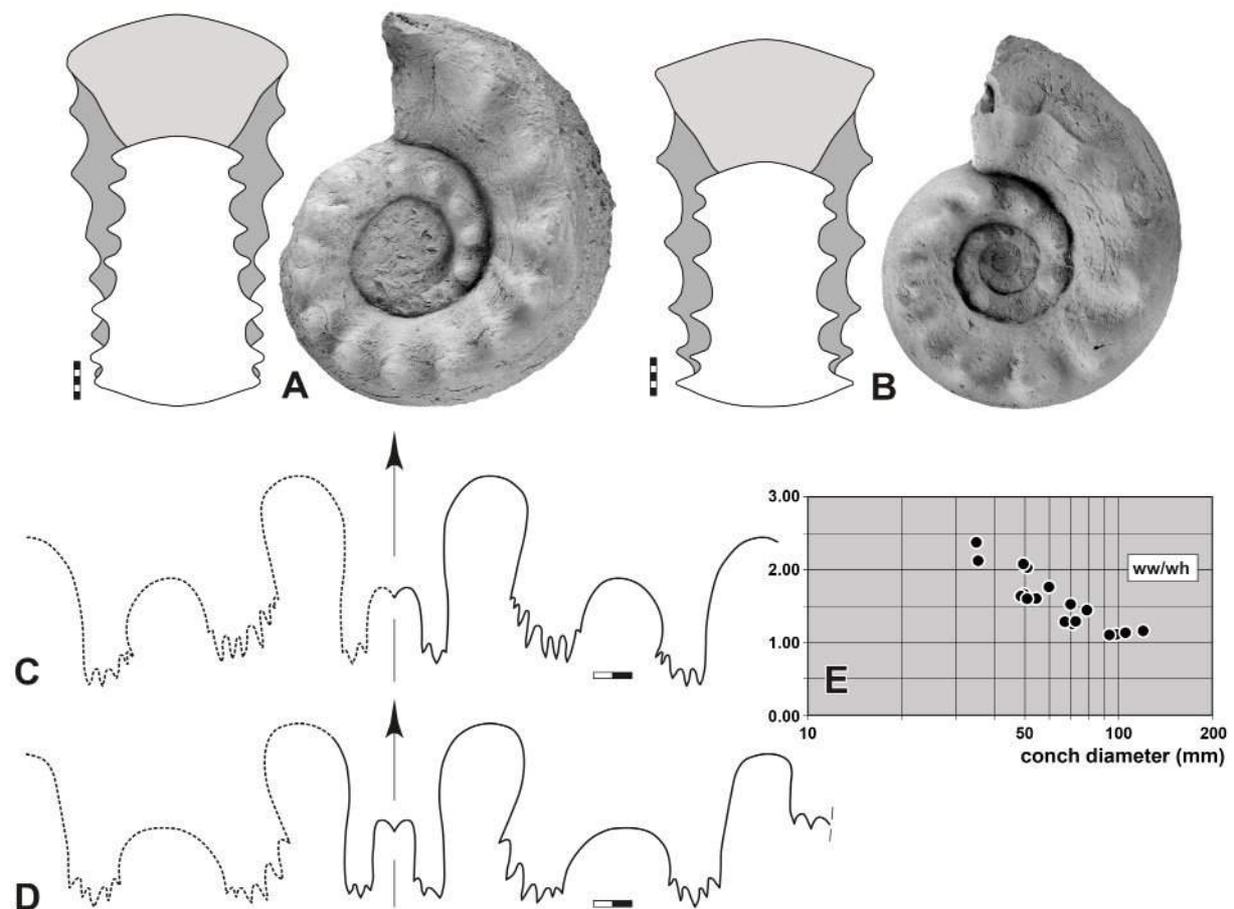


Fig. 29. *Paratirolites vediensis* Shevyrev, 1965. A–B. Lateral and dorsal views. A. Specimen MB.C.29792, section C, -2.75 m. B. Specimen MB.C.29785, section 1, -2.80 m. – C–D. Suture lines. C. Specimen MB.C.29792, at 13.0 mm wh. D. Specimen MB.C.29785, at 12.8 mm wh. – E. Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 12. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites vediensis* Shevrev, 1965 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29804	99.2	38.8	35.2	40.0	31.5	0.39	1.10	0.40	2.15	0.11
MB.C.29810	94.0	34.0	31.0	39.0	29.0	0.36	1.10	0.41	2.09	0.06
MB.C.29795	79.5	38.0	26.5	33.2	24.2	0.48	1.43	0.42	2.07	0.09
MB.C.29799	73.2	32.0	25.0	31.0	24.0	0.44	1.28	0.42	2.21	0.04
MB.C.29801	71.5	32.0	25.7	29.3	–	0.45	1.25	0.41	–	–
MB.C.29807	70.5	34.2	22.6	31.2	20.3	0.49	1.51	0.44	1.97	0.10
MB.C.29792	49.9	27.9	16.9	22.0	15.5	0.56	1.65	0.44	2.10	0.08
MB.C.29785	48.7	28.7	17.7	20.0	16.2	0.59	1.62	0.41	2.25	0.08
MB.C.29794	121.0	46.0	40.0	52.0	36.0	0.38	1.15	0.43	2.03	0.10
MB.C.29797	106.0	40.0	35.5	46.0	34.0	0.38	1.13	0.43	2.17	0.04
MB.C.29798	89.0	31.5	31.8	34.7	30.5	0.35	0.99	0.39	2.31	0.04

The two smaller specimens MB.C.29792 (Fig. 29A) and MB.C.29785 (Fig. 29B), both with about 50 mm conch diameter, are rather well preserved phragmocones. Both possess trapezoidal whorl profiles ($ww/wh = 1.65–1.75$) with strongly diverging flattened flanks, a subangular or angular ventrolateral shoulder and a slightly flattened, tectiform venter. The sculpture consists of 11 or 12 spiny ventrolateral nodes per volution, which begin as isolated nodes and develop to spiny nodes that show a rib-alike elongation toward the umbilicus.

The suture lines of the two specimens resemble each other (Fig. 29C–D) and possess a parallel-sided external lobe that is as deep as the adventive lobe. Its prongs are narrow and parallel-sided with three small notches. The ventrolateral saddle is inflated and asymmetric and the lateral saddle reaches only half the height of the ventrolateral saddle. The adventive lobe is asymmetric in both specimens and dorsally inclined; it is serrated with 6 and 8 little notches, respectively.

Remarks

The material from Baghuk Mountain closely resembles, in conch shape and ornament, the material from the type area near Julfa, but differs in the maximum conch size. While the maximum phragmocone diameter of the Julfa material ranges between 70 and 128 dm (Korn & Ghederi in Korn *et al.* 2016), the Baghuk Mountain material reaches 85 mm only.

Paratirolites vediensis differs from *P. kittli* in the strongly trapezoidal whorl profile with a flattened venter of the subadult stage, which shows a rounded venter in *P. kittli*. It differs from *P. trapezoidalis*, which possesses a very similar conch geometry, in the much coarser ribs of the adult stage (which in *P. trapezoidalis* are much more numerous and delicate), and in the stronger serrated prongs of the external lobes (usually multiply serrated in *P. vediensis*, but simple or bifid in *P. trapezoidalis*).

Stratigraphic range

Upper part of the Hambast Formation; 3.10 to 2.40 m below the extinction horizon (*Paratirolites kittli* Zone).

Paratirolites kittli Stoyanow, 1910

Fig. 30; Table 13

Paratirolites Kittli Stoyanow, 1910: 82, pl. 9 figs 1–2.

Stephanites? Waageni Stoyanow, 1910: 89, pl. 8 fig. 3.

Pseudotirolites azariani Rostovtsev in Kotlyar *et al.*, 1983: 154, pl. 15 fig. 5.

?*Stephanites* sp. indet. Stoyanow, 1910: 89, pl. 7 fig. 8.

Paratirolites kittli – Spath 1934: 366, text-fig. 125a–d. — Voinova *et al.* 1947: 169, pl. 40 fig. 4, text-fig. 67. — Kummel 1957: 179, text-fig. 1a–b. — Shevyrev 1965: 174, pl. 22 fig. 4; 1968: 90, pl. 3 fig. 1. — Korn & Ghaderi in Korn *et al.* 2016: 862, text-figs 20–22.

Paratirolites waageni – Spath 1934: 367. — Shevyrev 1965: 175, pl. 22 figs 5–6; 1968: 90, pl. 2 figs 6–7.

Stephanites? waageni – Voinova *et al.* 1947: 167, pl. 40 fig. 3.

Diagnosis

Species of *Paratirolites* with conch reaching 190 mm dm. Subadult stage with rounded trapezoidal, weakly to moderately depressed whorl profile ($ww/wh=1.30-1.60$) and rounded venter; 10–12 very coarse ventrolateral nodes per volution. Adult stage with strongly trapezoidal and weakly depressed whorl profile ($ww/wh=1.00-1.30$), flattened tectiform venter and subangular ventrolateral shoulder; weak ventrolateral nodes. Prongs of external lobe usually multiply serrated; altogether 12–21 notches of E, A and L lobes.

Material examined

IRAN • 6 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29813 to MB.C.29818 • 1 specimen; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.29819 • 1 specimen; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.29820 • 5 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29821 to MB.C.29825 • 3 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29826 to MB.C.29828 • 1 specimen; Esfahan Province, Baghuk Mountain F section; Hambast Formation; MB.C.29829 • 6 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29830 to MB.C.29835 • 2 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29836 to MB.C.29837 • 4 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29838 to MB.C.29841.

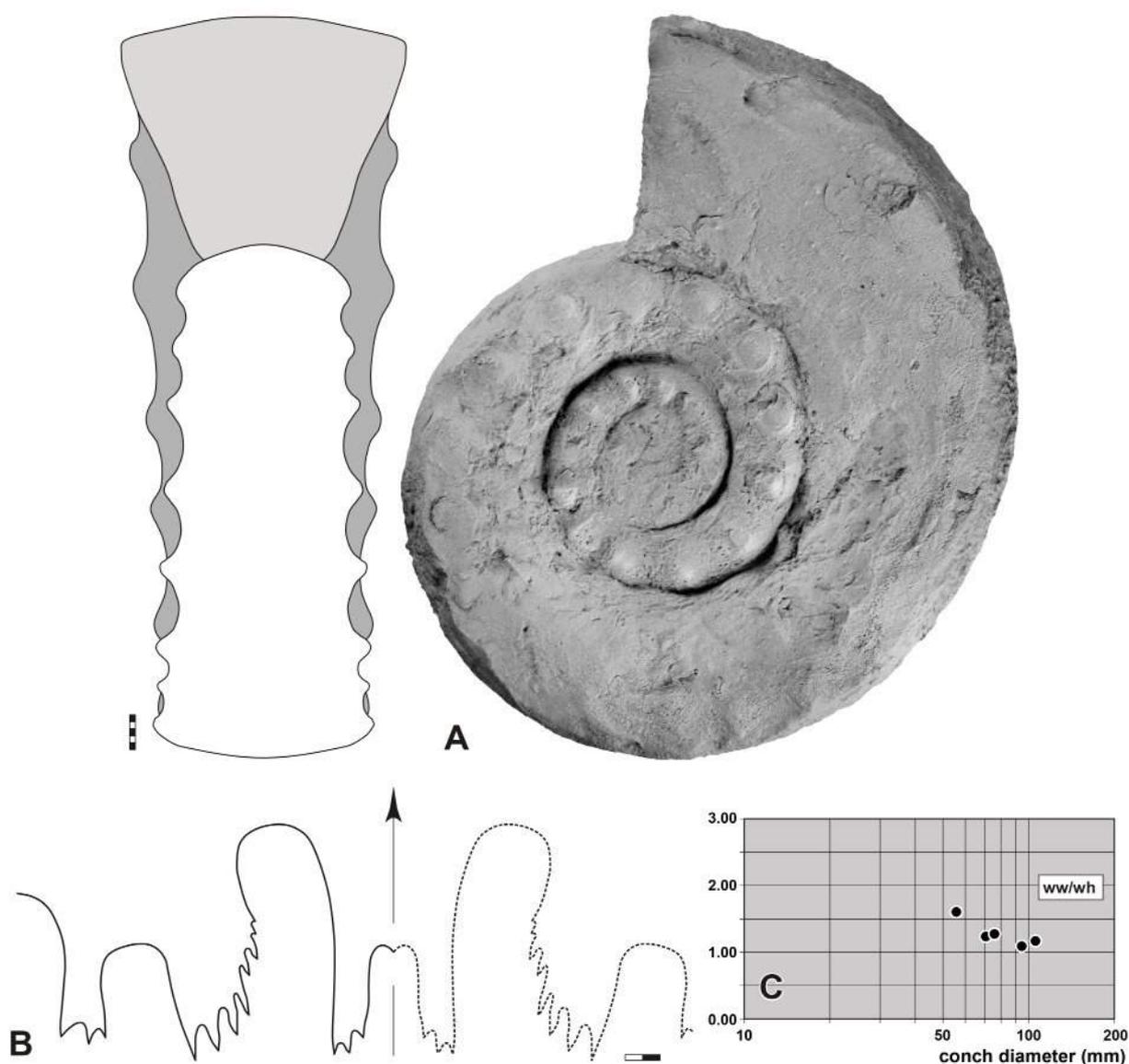
Description

The large specimen MB.C.29833 (107 mm dm; Fig. 30A) shows septal crowding at a phragmocone diameter of 70 mm, which indicates that the maximum conch diameter of this specimen was about 130 mm. The body chamber of the specimen is corroded but shows that the shape of the whorl profile is trapezoidal in the subadult and adult stage. The venter becomes nearly flat with an angular ventrolateral shoulder during formation of the terminal body chamber but is broadly rounded in the phragmocone. This specimen shows a sculpture of the phragmocone that consist of 12 coarse conical nodes on the outer flanks. These nodes become continuously weaker on the terminal body chamber.

The suture line of specimen MB.C.29833 has an external lobe with weakly diverging flanks, nearly parallel-sided prongs with three small notches. The ventrolateral saddle is narrow and dorsally inclined; it continues into the strongly asymmetric adventive lobe, which is asymmetrically serrated with numerous small notches climbing high up the ventral flank. By contrast, the lateral lobe is trifid and nearly symmetric (Fig. 30B).

Table 13. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites kittli* Stoyanow, 1910 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29831	95.3	32.2	29.7	42.2	28.3	0.34	1.08	0.44	2.02	0.05
MB.C.29833	106.5	40.7	35.0	46.6	33.7	0.38	1.16	0.44	2.14	0.04
MB.C.29815	86.9	–	30.0	36.0	28.3	–	–	0.41	2.20	0.06
MB.C.29818	71.0	–	24.5	31.2	23.5	–	–	0.44	2.23	0.04
MB.C.29813	64.8	–	20.5	26.3	19.8	–	–	0.41	2.07	0.03
MB.C.29821	56.0	32.8	20.6	21.0	19.0	0.59	1.59	0.38	2.29	0.08
MB.C.29830	92.0	–	32.8	40.0	31.0	–	–	0.43	2.27	0.05

**Fig. 30.** *Paratirolites kittli* Stoyanow, 1910. **A.** Lateral and dorsal view, specimen MB.C.29833, section G, -2.75 m. **B.** Suture line, specimen MB.C.29833, at 30 mm ww, 16.0 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Remarks

Paratirolites kittli differs from the otherwise similar *P. vediensis* in the more rounded whorl profile of the subadult stage, which in the latter is trapezoidal with a flattened venter and flattened diverging flanks.

Stratigraphic range

Upper part of the Hambast Formation; 3.10 to 2.40 m below the extinction horizon (*Paratirolites kittli* Zone).

Paratirolites coronatus Korn & Ghaderi in Korn *et al.*, 2016

Fig. 31; Table 14

Paratirolites coronatus Korn & Ghaderi in Korn *et al.*, 2016: 860, text-figs 17–18.

Diagnosis

Species of *Paratirolites* with conch reaching 125 mm dm. Subadult stage with trapezoidal, moderately depressed whorl profile ($ww/wh=1.60\text{--}1.90$) and flattened tectiform venter; 15 coarse conical ventrolateral nodes per volution. Adult stage with extremely trapezoidal and moderately depressed whorl profile ($ww/wh=1.60\text{--}1.90$), flattened tectiform venter and subangular ventrolateral shoulder; weak ventrolateral nodes. Prongs of external lobe trifid or multiply serrated; altogether 11–24 notches of E, A and L lobes.

Material examined

Holotype

IRAN • West Azerbaijan, Aras Valley section; *Paratirolites* Limestone, 2.90 m below the top; illustrated by Korn *et al.* (2016: text-fig. 17A); MB.C.25095.

Additional material

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29842.

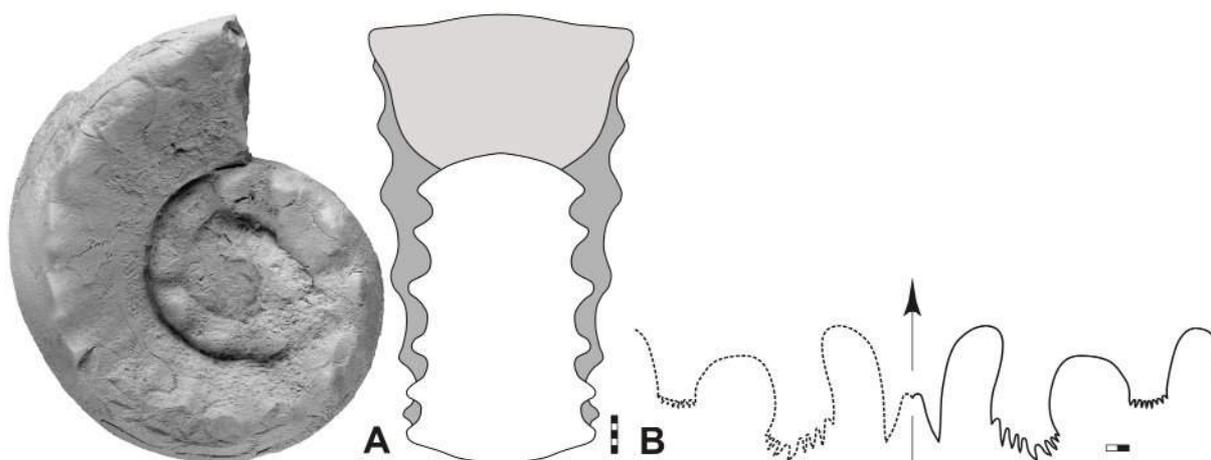


Fig. 31. *Paratirolites coronatus* Korn & Ghaderi, 2015. **A.** Lateral and dorsal view, specimen MB.C.29842, section E, float. **B.** Suture line, specimen MB.C.29842, at 48.7 mm dm, 17.8 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 14. Conch dimensions (partly estimated) and ratios of *Paratirolites coronatus* Korn & Ghaderi in Korn *et al.* (2016) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29842	54.5	34.0	19.4	24.6	18.7	0.62	1.75	0.45	2.32	0.04
MB.C.29842	41.2	24.0	12.7	17.9	–	0.58	1.89	0.43	–	–

Description

Specimen MB.C.29842 is a fully chambered specimen with 55 mm conch diameter and allows the study of one and a half whorls (Fig. 31A). It has a strongly trapezoidal, depressed whorl profile ($ww/wh=1.75$), weakly sinuous flanks, an angular ventrolateral shoulder and a flattened tectiform venter. Half a volution earlier, the venter is weakly flattened but still rounded and another half volution back, the venter is broadly rounded. The sculpture changes during the last volution of the phragmocone; strong conical nodes at the beginning of this volution are transformed into smaller, longitudinally elongated nodes, which have a position at the ventrolateral shoulder.

The suture line of specimen MB.C.29842 has a V-shaped external lobe with concave flanks and symmetric, narrowly V-shaped simple prongs. The ventrolateral saddle is asymmetric and dorsally inclined and the asymmetric, nearly parallel-sided adventive lobe has nine little notches. The lateral lobe is nearly flat at its base and subdivided in small equally sized notches (Fig. 31B).

Remarks

Paratirolites coronatus is the paratirolitid with the widest conch, resulting from the coronate ventrolateral shoulder. Therefore, it cannot be confused with any other species. *Paratirolites coronatus* differs from *P. vediensis* and the other species in the more strongly trapezoidal whorl profile of the adult stage.

Stratigraphic range

Upper part of the Hambast Formation; precise horizon at Baghuk Mountain not known.

***Paratirolites trapezoidalis* Shevyrev, 1965**

Fig. 32; Table 15

Paratirolites trapezoidalis Shevyrev, 1965: 177, pl. 24 fig. 1.

Paratirolites trapezoidalis – Shevyrev 1968: 92, pl. 4 fig. 1. — Korn in Ghaderi *et al.* 2014: text-fig. 7e.

— Korn & Ghaderi in Korn *et al.* 2016: 858, text-fig. 16.

Diagnosis

Species of *Paratirolites* with conch reaching 120 mm dm. Subadult stage with trapezoidal, depressed whorl profile ($ww/wh=1.40-1.60$) and flattened, slightly tectiform venter; 10–15 coarse ribs, which end in coarse conical ventrolateral nodes, per volution. Adult stage with strongly trapezoidal and weakly depressed whorl profile ($ww/wh=1.00-1.40$), flattened venter and angular ventrolateral shoulder; weak straight riblets and numerous small ventrolateral nodes. Prongs of external lobe usually unsubdivided, rarely trifid; altogether 12–19 notches of E, A and L lobes.

Type material**Holotype**

AZERBAIJAN • Nakhichevan Province, Dorasham 2 section; *Paratirolites* Limestone; illustrated by Shevyrev (1965: pl. 24 fig. 1); PIN 1252/129.

Table 15. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites trapezoidalis* Shevyrev, 1965 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29845	79.0	30.6	28.1	30.5	26.0	0.39	1.09	0.39	2.22	0.07
MB.C.29844	71.0	26.4	25.3	29.3	23.7	0.37	1.04	0.41	2.25	0.06
MB.C.29846	88.9	–	28.5	39.3	27.2	–	–	0.44	2.08	0.05

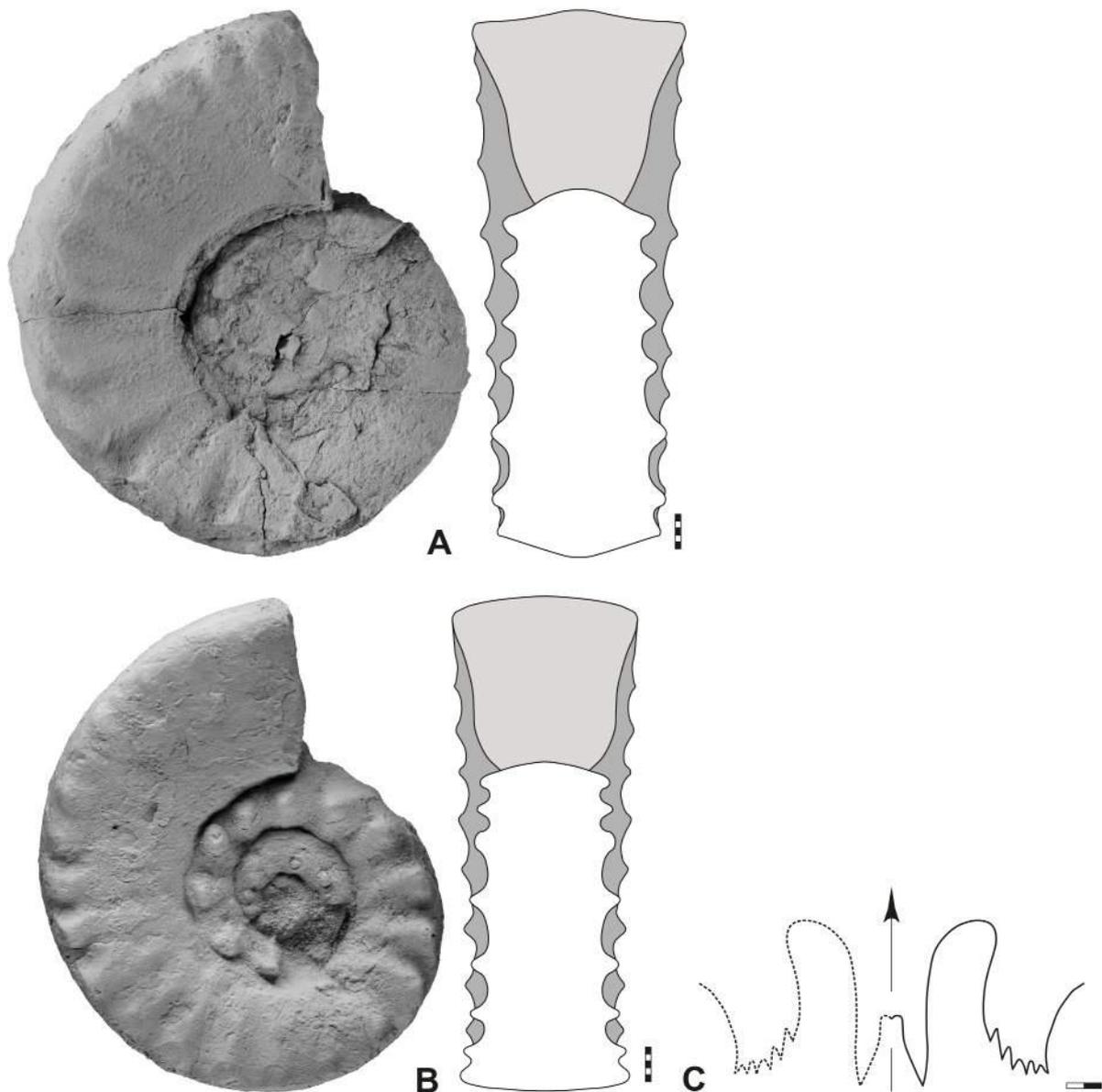


Fig. 32. *Paratirolites trapezoidalis* Shevyrev, 1965. **A–B.** Lateral and dorsal views. **A.** Specimen MB.C.29845, section E, -2.80 m. **B.** Specimen MB.C.29844, section E, float. **C.** Suture line of specimen MB.C.29844, at 13.3 mm wh. Abbreviation: see Material and methods. Scale bar units = 1 mm.

Material examined

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29843 • 2 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29844 to MB.C.29845 • 3 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29846 to MB.C.29848.

Description

Specimen MB.C.29844 is a moderately well-preserved individual of 71 mm conch diameter and allows the study of one and a half whorls (Fig. 32B). The last segment of 210 degrees belongs to the body chamber, which has a weakly depressed trapezoidal whorl profile ($ww/wh=1.05$) with weakly concave flanks and a nearly flat venter and an angular ventrolateral shoulder. The sculpture of the subadult stage consists of conical and coarse, spiny ventrolateral nodes, 13 on the last phragmocone volution. The nodes become significantly weaker and more numerous on the body chamber, where about 16 of them are present on half a volution.

Specimen MB.C.29844 allows only the study of the suture line on the venter. The external lobe is narrow and parallel-sided with non-serrated, narrow lanceolate prongs. The ventrolateral saddle is very asymmetric and dorsally inclined and the asymmetric adventive lobe has an oblique base that is serrated by six small notches (Fig. 32C). specimen MB.C.29845 (Fig. 32A) is similar in conch shape and sculpture but possesses a suture line with trifid prongs of the external lobe.

Remarks

Paratirolites vediensis has a similar conch shape, but differs from *P. trapezoidalis* in the stronger ventrolateral nodes in the adult stage. *P. coronatus* has an even wider whorl profile ($ww/wh=1.60-1.80$ in *P. coronatus* but only 1.40 in *P. trapezoidalis*); the species has also less coarse but more numerous ventrolateral nodes in the subadult stage (15 in *P. coronatus* but only 10 in *P. trapezoidalis*).

Stratigraphic range

Upper part of the Hambast Formation; 3.05 to 2.80 m below the extinction horizon (*Paratirolites kittli* Zone).

Paratirolites baghukensis Korn & Hairapetian sp. nov.
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Figs 33–34; Table 16

Diagnosis

Species of *Paratirolites* with conch reaching 130 mm dm. Subadult stage with trapezoidal, weakly depressed whorl profile ($ww/wh=1.00-1.20$) and rounded venter; about 12 moderately coarse ribs ending in conical ventrolateral nodes per volution. Adult stage with trapezoidal and weakly compressed whorl profile ($ww/wh=0.70-0.90$), flattened tectiform venter and subangular ventrolateral shoulder; numerous sharp ribs ending in sharp radially elongated ventrolateral nodes. Prongs of external lobe usually trifid; altogether 13–15 notches of E, A and L lobes.

Etymology

Named after the occurrence at Baghuk Mountain.

Material examined**Holotype**

IRAN • Esfahan Province, Baghuk Mountain G section; Hambast Formation; illustrated in Fig. 33A; MB.C.29868.

Paratypes

IRAN • 2 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29849 to MB.C.29850 • 4 specimens; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.29851 to MB.C.29854 • 5 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29855 to MB.C.29859 • 8 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29860 to MB.C.29867 • 7 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29869 to MB.C.29875 • 1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29876 • 3 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29877 to MB.C.29879.

Description

Holotype MB.C.29868 has 70 mm conch diameter and is fairly well-preserved but slightly corroded. The last third of the terminal volution belongs to the body chamber (which is thus only incompletely preserved); adulthood of the specimen is obvious because of the crowding of the last septa of the phragmocone (Fig. 33A). The penultimate of the preserved whorls shows a trapezoidal profile with a rounded venter. The body chamber finally shows a trapezoidal whorl profile with weakly diverging flanks, an angular ventrolateral shoulder and a nearly flat, tectiform venter. The sculpture changes with the beginning of the terminal body chamber, but this change is continuous without sudden breaks. One subadult volution has ten isolated spiny ventrolateral nodes. Already towards the end of the phragmocone,

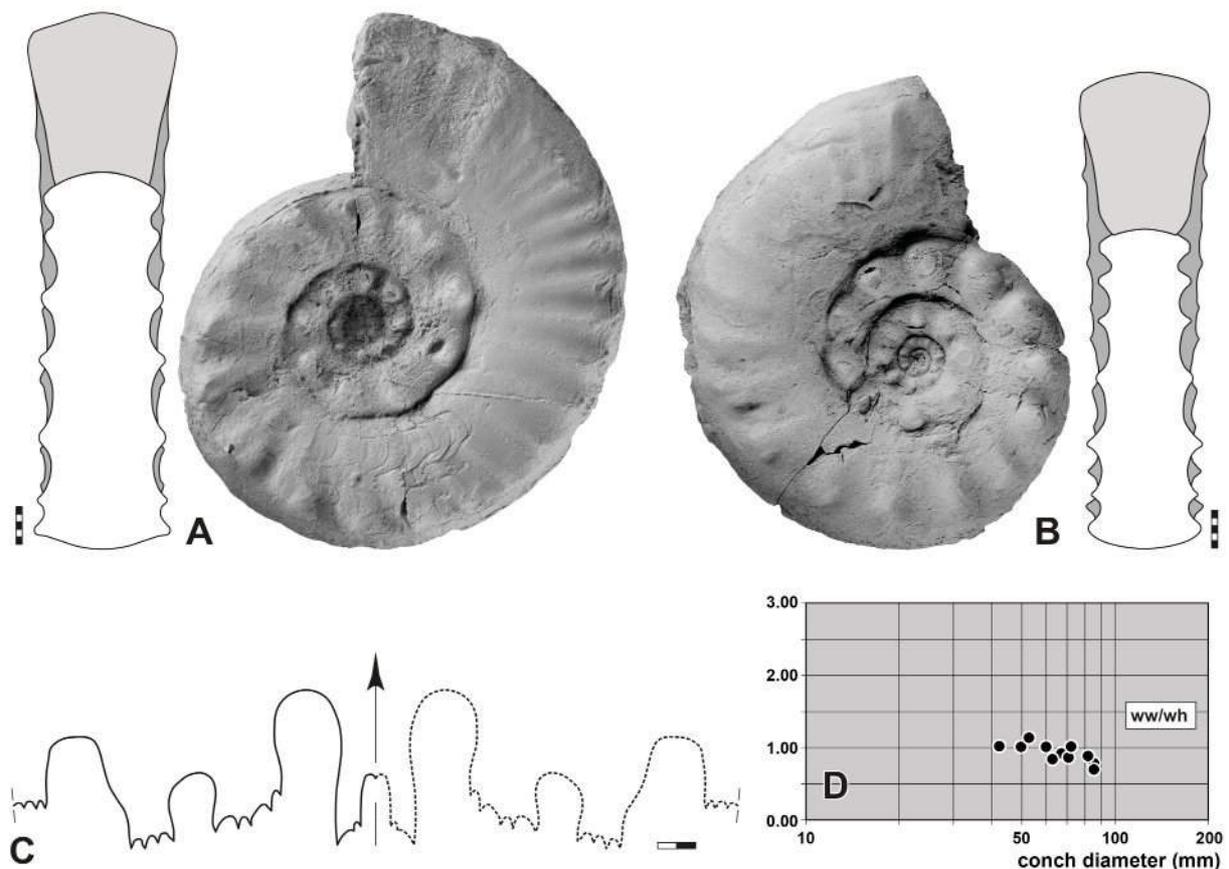


Fig. 33. *Paratirolites baghukensis* Korn & Hairapetian sp. nov. **A–B.** Lateral and dorsal views. **A.** Holotype MB.C.29868, section G, float. **B.** Paratype MB.C.29860, section E, -2.55 m. **C.** Suture line of holotype MB.C.29868, at 49.0 mm dm, 21.0 mm ww, 16.0 mm wh. **D.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

these nodes become radially elongate and form coarse ribs across the flank. At the beginning of the terminal body chamber, the ventrolateral nodes weaken and finally, only sharp ribs, about 15 per quarter of a volution, are present.

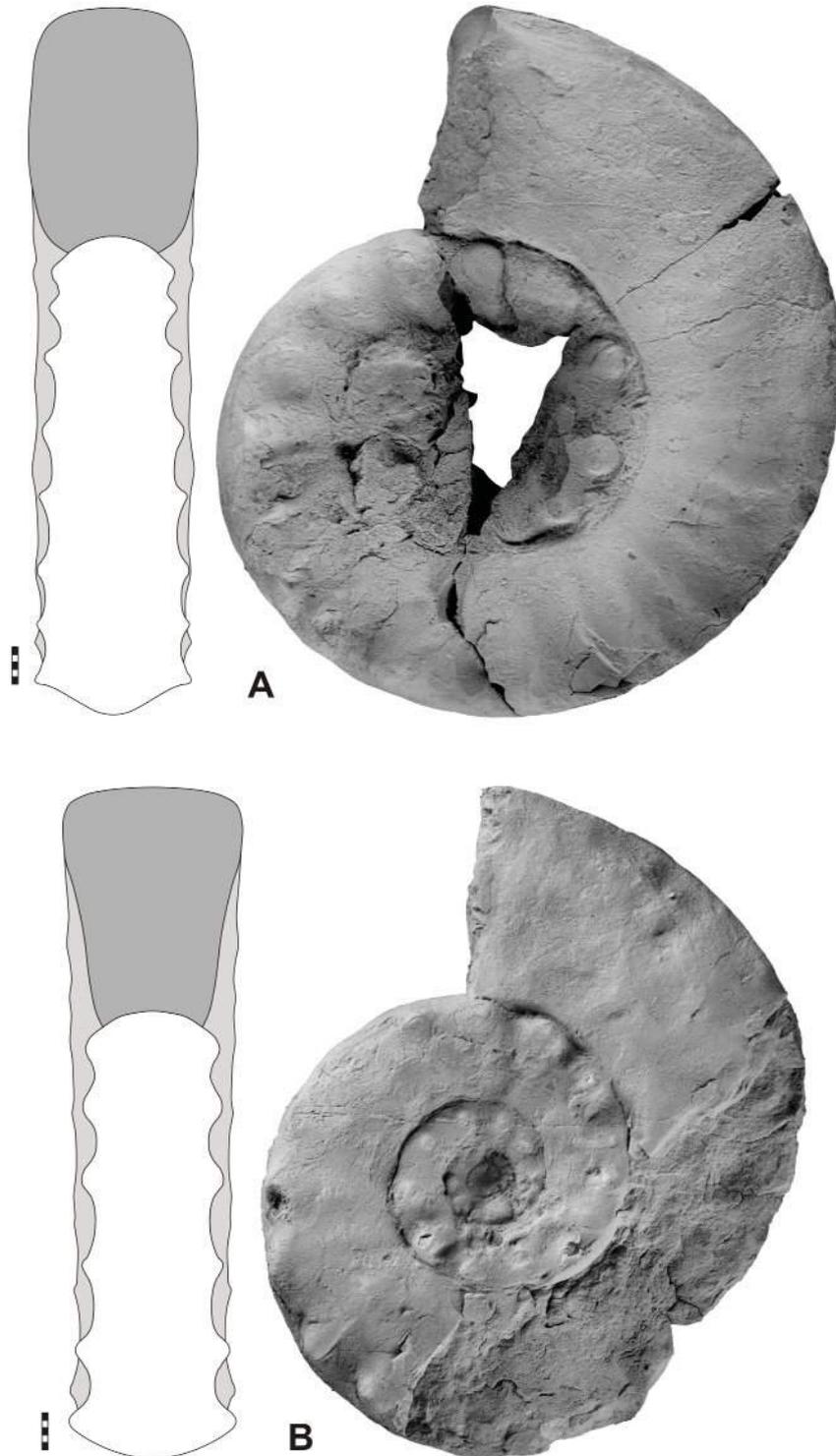


Fig. 34. *Paratirolites baghukensis* Korn & Hairapetian sp. nov. **A.** Paratype MB.C.29850, section 1, -2.70 m. **B.** Paratype MB.C.29874, section G, float. Scale bar units=1 mm.

Table 16. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites baghukensis* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29850	95.0	–	32.5	41.5	31.6	–	–	0.44	2.25	0.03
MB.C.29874	89.1	–	28.9	36.8	27.9	–	–	0.41	2.12	0.03
MB.C.29851	71.2	–	21.4	31.9	20.4	–	–	0.45	1.96	0.05
MB.C.29868	71.1	19.6	22.8	28.2	21.7	0.28	0.86	0.40	2.07	0.05
MB.C.29860	63.1	18.1	21.6	26.4	20.0	0.29	0.84	0.42	2.14	0.07
MB.C.29870	94.3	–	29.5	38.5	28.0	–	–	0.41	2.02	0.05
MB.C.29861	86.0	19.0	27.3	38.7	26.0	0.22	0.70	0.45	2.05	0.05
MB.C.29862	82.3	21.0	23.8	35.4	23.0	0.26	0.88	0.43	1.93	0.03
MB.C.29877	60.1	18.6	18.5	26.0	17.5	0.31	1.01	0.43	1.99	0.05

The suture line of holotype MB.C.29868 shows a slightly pouched external lobe with trifid, asymmetric prongs. The ventrolateral saddle is weakly inflated, the adventive and lateral lobes are flattened at the base and subdivided in five and four notches, respectively (Fig. 33C).

Paratype MB.C.29860 (Fig. 33B) is smaller with 61 mm conch diameter but confirms the description given for the holotype. It shows four whorls preserved and thus allows for the study of the sculpture of the inner volutions.

The two larger paratypes MB.C.29874 and MB.C.29850 (Fig. 34) show then the transformation into the weakly ornamented adult stage, in which a tendency towards a parallel-sided whorl profile is visible.

Remarks

Paratirolites baghukensis sp. nov. belongs to the slender species of the genus. It differs from the other species of the genus in the sharp ribs on the adult body chamber. *Paratirolites multiconus* also has a slender conch, but differs from *P. baghukensis* sp. nov. in the much more numerous ventrolateral nodes.

Stratigraphic range

Upper part of the Hambast Formation; 3.10 to 2.35 m below the extinction horizon (*Paratirolites kittli* Zone).

Paratirolites aduncus Korn & Hairapetian sp. nov.

urn:lsid:zoobank.org:act:86D671DC-3110-45AE-A379-2543EA8DEDD0

Figs 35–37; Table 17

Diagnosis

Species of *Paratirolites* with conch reaching 125 mm dm. Subadult stage with circular or weakly depressed whorl profile ($ww/wh=1.00-1.30$) and rounded venter; about 10 very coarse conical ventrolateral nodes per volution. Adult stage with weakly trapezoidal and weakly compressed whorl profile ($ww/wh=0.75-0.90$), flattened tectiform venter and subangular ventrolateral shoulder; about 10 hook-shaped ventrolateral nodes per half volution. Prongs of external lobe usually bifid but rarely trifid or multiply serrated; altogether 11–17 notches of E, A and L lobes.

Etymology

From the Latin '*aduncus*', meaning 'incurved', because of the curved ventrolateral nodes.

Material examined**Holotype**

IRAN • Esfahan Province, Baghuk Mountain B section; Hambast Formation; illustrated in Fig. 35A; MB.C.29894.

Paratypes

IRAN • 9 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29880 to MB.C.29888 • 5 specimens; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.29889 to MB.C.29893 • 1 specimen; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.29895 • 5 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29896 to MB.C.29900 • 17 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29901 to MB.C.29917 • 1 specimen; Esfahan Province, Baghuk Mountain F section; Hambast Formation; MB.C.29918 • 8 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29919 to MB.C.29926 • 1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29927 • 3 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.29928 to MB.C.29930.

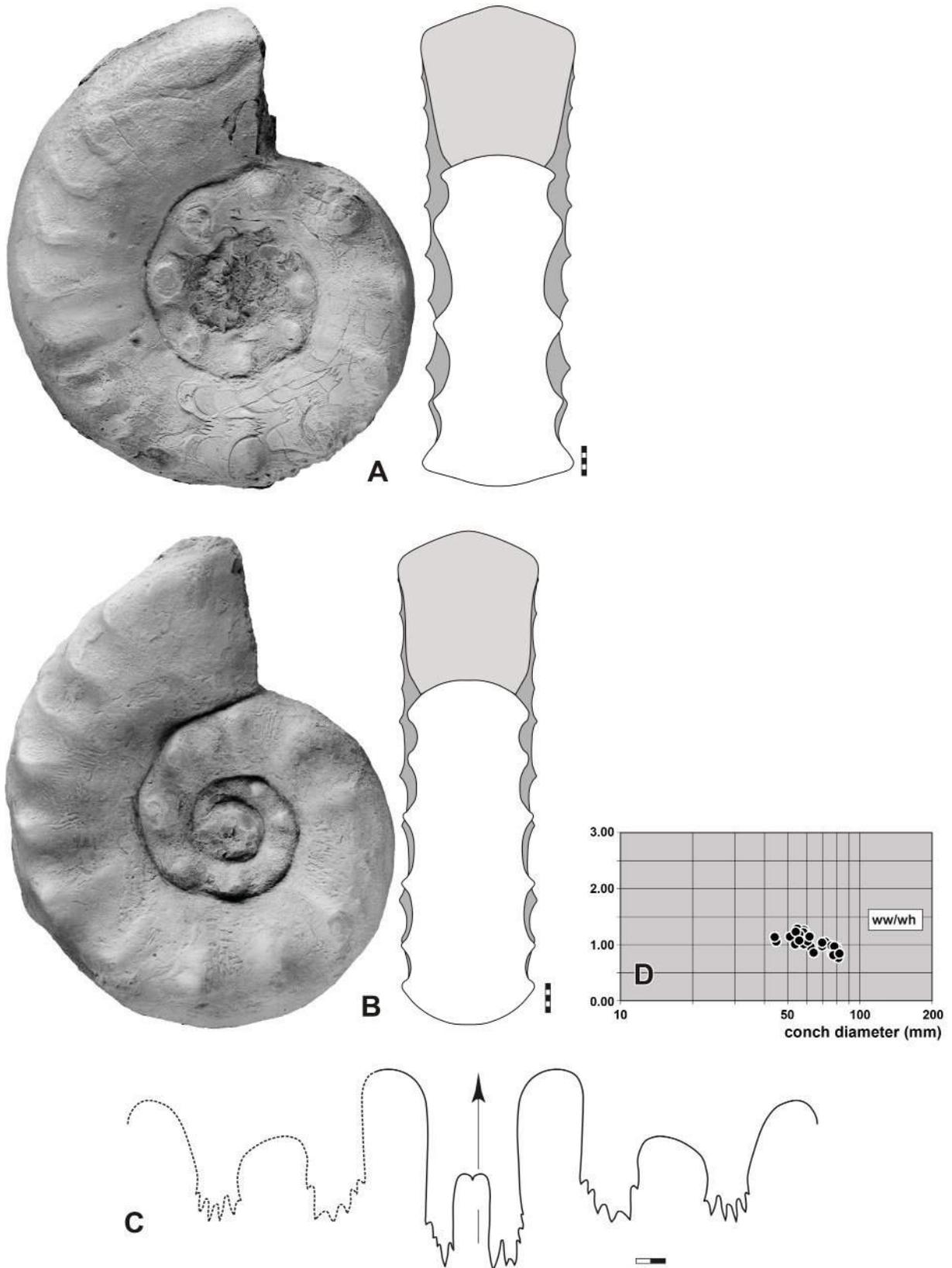
Description

Holotype MB.C.29894 (Fig. 35A) is a fairly well-preserved specimen with 80 mm conch diameter. It shows, at a conch diameter of 60 mm, three closely approximated septa, after which the terminal body chamber begins with a sudden weakening of the ventrolateral nodes. While these nodes are coarse and conical on the phragmocone, they almost spontaneously become elongated and hook-shaped on the body chamber.

The suture line of holotype MB.C.29894 shows a deep, parallel-sided external lobe with prongs multiply serrated asymmetrically (Fig. 35C). The ventrolateral saddle is nearly symmetric and inverted U-shaped, it is followed by an adventive lobe and a lateral lobe with six little notches each. Both lobes are semicircular at the base and slightly asymmetric.

Paratype MB.C.29880 has 83 mm conch diameter; half of the last volution belongs to the body chamber (Fig. 35B). It largely agrees, in conch shape and sculpture, with the holotype. The specimen allows for the study of two whorls, on which transformations in conch shape and sculpture can be observed. The phragmocone has a nearly circular whorl profile (ww/wh about 1.15 at 60 mm conch diameter) with nine coarse conical ventrolateral nodes on its last volution, which sometimes are developed as sharp spines. On the body chamber, the transformation into a weakly trapezoidal whorl profile can be observed; here the slightly concave flanks diverge towards the subangular ventrolateral shoulder that separates the flank from the flattened, weakly tectiform venter. On the body chamber occurs also a change in the sculpture towards more numerous (about 10 per half whorl) short ribs, which are restricted to the outer flank and ventrally end in hook-shaped, sharp nodes.

Paratype MB.C.29900 is a specimen of 104 mm conch diameter. It has a fairly well-preserved phragmocone but a weathered body chamber, of which a little more than half a volution is preserved (Fig. 36A). The shape of the body chamber whorl profile had to be reconstructed; it shows a trapezoidal shape with weakly diverging flanks, a rounded ventrolateral shoulder and a flattened tectiform venter. One volution earlier, the whorl profile is strongly trapezoidal with flat, diverging flanks and a flattened, broadly rounded venter. The sculpture is coarse on the phragmocone and weakens in strength significantly on the body chamber. The last volution of the phragmocone has 15 conical, spiny ventrolateral nodes,



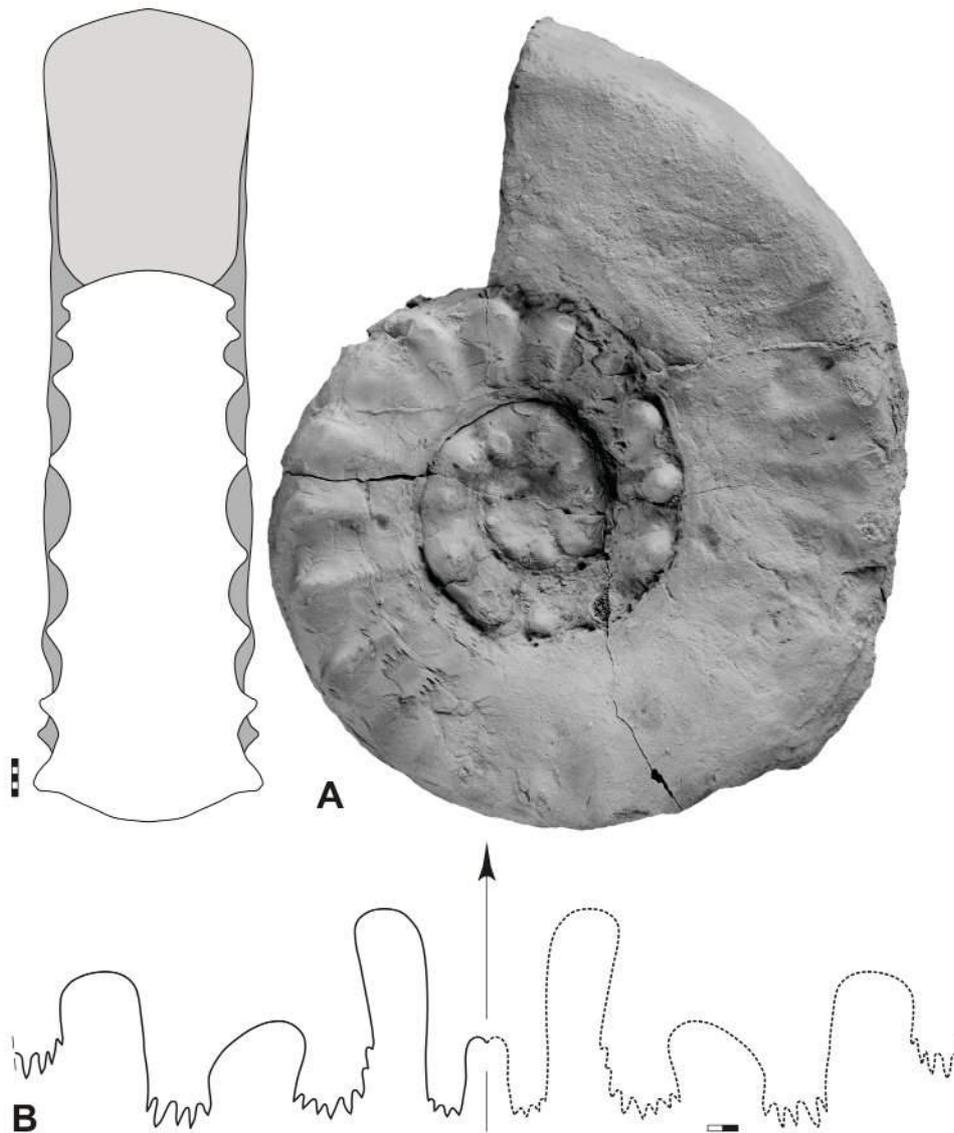


Fig. 36. *Paratirolites aduncus* Korn & Hairapetian sp. nov. **A.** Lateral and dorsal view, paratype MB.C.29900, section C, -2.45 m. **B.** Suture line, paratype MB.C.29900, at 30 mm ww, 16.0 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

which are first very coarse and conical but later elongate, weaker and more closely spaced. On the body chamber, weak and rounded ribs with concave course are visible on the outer flank.

The suture line of paratype MB.C.29900 shows a parallel-sided external lobe with parallel-sided prongs that are divided by four small notches. The very narrow ventrolateral saddle is weakly inclined towards the umbilicus. Following is a very asymmetric, weakly pouched adventive lobe with eight notches,

Fig. 35 (preceding page). *Paratirolites aduncus* Korn & Hairapetian sp. nov. **A–B.** Lateral and dorsal views. **A.** Holotype MB.C.29894, section B, float. **B.** Paratype MB.C.29880, section 1, -1.60 m. **C.** Suture line of holotype MB.C.29894, at 17.3 mm wh. **D.** Whorl profile proportions. Abbreviation: see Material and methods. Scale bar units = 1 mm.

Table 17. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites aduncus* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29922	81.9	22.0	28.9	34.2	26.0	0.27	0.76	0.42	2.15	0.10
MB.C.29880	81.8	23.1	27.1	32.6	25.6	0.28	0.85	0.40	2.12	0.06
MB.C.29894	80.3	24.9	26.1	33.9	25.1	0.31	0.95	0.42	2.12	0.04
MB.C.29881	77.1	21.4	25.5	33.3	24.8	0.28	0.84	0.43	2.17	0.03
MB.C.29884	73.2	23.1	23.1	30.3	23.0	0.32	1.00	0.41	2.13	0.00
MB.C.29901	72.2	20.4	19.5	33.3	18.8	0.28	1.05	0.46	1.83	0.04
MB.C.29885	62.9	–	20.5	27.7	18.6	–	–	0.44	2.02	0.09
MB.C.29899	62.6	22.0	23.0	24.9	20.5	0.35	0.96	0.40	2.22	0.11
MB.C.29924	60.9	21.0	19.9	25.9	19.4	0.34	1.06	0.43	2.15	0.03
MB.C.29917	82.8	22.0	26.3	31.7	25.0	0.27	0.84	0.38	2.05	0.05
MB.C.29898	78.8	25.8	26.7	34.1	25.2	0.33	0.97	0.43	2.16	0.06
MB.C.29903	78.0	23.0	28.4	32.2	26.4	0.29	0.81	0.41	2.29	0.07
MB.C.29897	76.5	24.8	25.4	30.6	24.0	0.32	0.98	0.40	2.12	0.06
MB.C.29907	70.0	22.6	22.0	29.3	20.9	0.32	1.03	0.42	2.03	0.05
MB.C.29912	70.0	22.3	23.0	30.2	22.0	0.32	0.97	0.43	2.13	0.04
MB.C.29886	70.0	23.0	22.3	29.0	21.0	0.33	1.03	0.41	2.04	0.06
MB.C.29920	64.5	20.2	23.7	25.0	22.0	0.31	0.85	0.39	2.30	0.07
MB.C.29921	62.0	21.6	19.0	26.0	18.0	0.35	1.14	0.42	1.99	0.05
MB.C.29902	54.3	22.0	18.0	25.0	17.0	0.41	1.22	0.46	2.12	0.06

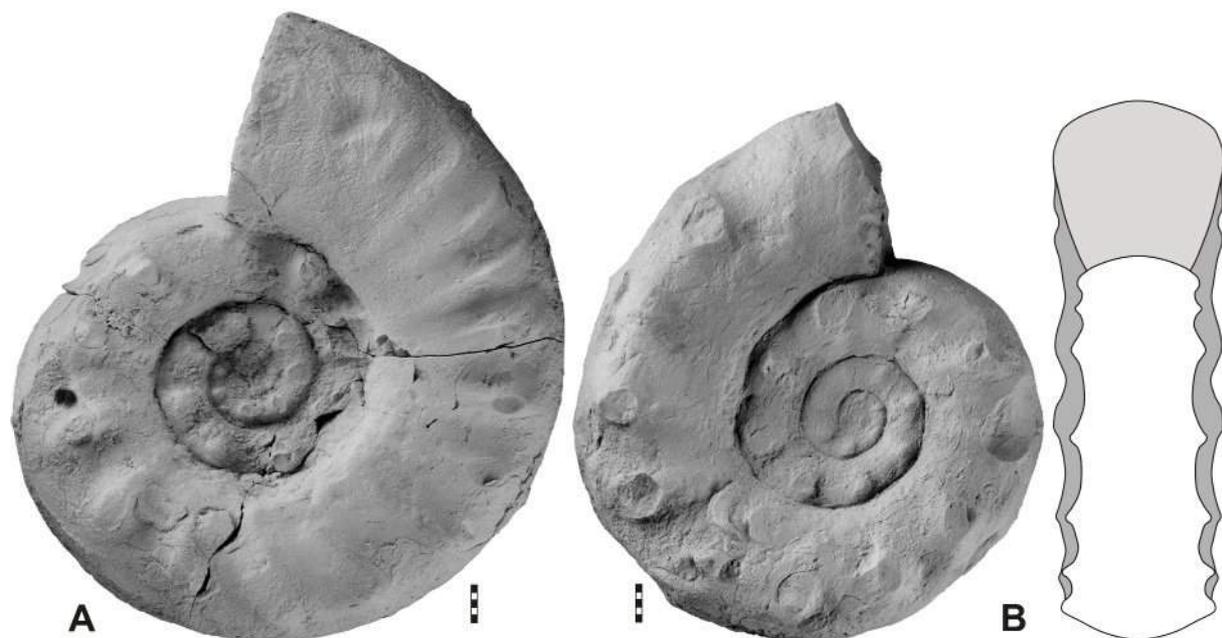


Fig. 37. *Paratirolites aduncus* Korn & Hairapetian sp. nov. **A.** Paratype MB.C.29922, section G, float. **B.** Paratype MB.C.29884, section 1, float. Scale bar units = 1 mm.

which are already climbing up the ventral side. The weakly inflated, asymmetric lateral saddle is low and the asymmetric lateral lobe with steep dorsal flank possesses five notches (Fig. 36B).

Remarks

Paratirolites aduncus sp. nov. differs from the other species of the genus in the presence of the hook-shaped ventrolateral nodes of the adult stage.

Stratigraphic range

Upper part of the Hambast Formation; 2.65 to 1.15 m below the extinction horizon (*Paratirolites kittli* Zone to *Lutites profundus* Zone).

Paratirolites quadratus Korn & Ghaderi in Korn *et al.*, 2016
Figs 38–39; Table 18

Paratirolites quadratus Korn & Ghaderi in Korn *et al.*, 2016: 866, text-fig. 25.

Diagnosis

Paratirolites with conch reaching 90 mm dm. Subadult stage with trapezoidal, weakly depressed whorl profile ($ww/wh = 1.35–1.60$) and broadly rounded venter; about 11–13 ribs ending in spiny ventrolateral nodes. Adult stage with weakly trapezoidal to nearly quadrate and weakly depressed whorl profile ($ww/wh = 1.00–1.20$), weakly concave venter and angular ventrolateral shoulder; coarse and shallow ribs on flanks. Prongs of external lobe multiply serrated; altogether about 14–17 notches of E, A and L lobes.

Material examined

Holotype

IRAN • 1 specimen; East Azerbaijan, Ali Bashi N section; *Paratirolites* Limestone, 1.70 m below the top; illustrated by Korn *et al.* (2016: text-fig. 25); MB.C.25296.

Additional material

IRAN • 3 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29331 to MB.C.29333.

Description

Specimen MB.C.29932 is a nicely preserved specimen of 72 mm conch diameter (Fig. 38A). It shows weak septal crowding at 48 mm diameter and thus half of the last volution belongs to the body chamber. The whorl profile shape changes from trapezoidal with convex flanks of the subadult stage to parallel-sided at the beginning of the body chamber; at the same time the shape of the venter changes from weakly convex to nearly totally flattened. The sculpture of the subadult stage possesses 13 conical ventrolateral nodes per volution; they originate from rounded radial ribs. On the body chamber the nodes are weaker and become radially elongated, they are connected with low, rounded dorsolateral ribs.

The suture line of specimen MB.C.29932 shows an asymmetric external lobe with weakly concave flanks, of which both prongs are trifid. Also on the venter follows the very narrow, weakly inflated ventrolateral saddle and the asymmetric adventive lobe (Fig. 38B).

Specimen MB.C.29933 is a larger specimen with 101 mm conch diameter (Fig. 39A). It shows similar conch and sculpture characteristics but differs from the preceding specimen in the coarser ventrolateral nodes and the larger phragmocone (62 mm dm). Its suture line has a parallel-sided external lobe with

Table 18. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites quadratus* Korn & Ghaderi in Korn *et al.* (2016) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29933	101.0	26.8	32.6	43.3	31.5	0.27	0.82	0.43	2.11	0.03
MB.C.29933	70.4	28.5	24.4	28.2	–	0.40	1.17	0.40	–	–
MB.C.29932	71.5	23.6	25.4	30.4	23.9	0.33	0.93	0.43	2.26	0.06
MB.C.29932	47.9	26.3	15.7	20.5	–	0.55	1.68	0.43	–	–
MB.C.29931	61.1	21.5	19.6	26.4	18.4	0.35	1.10	0.43	2.05	0.06

parallel-sided trifold prongs. The ventrolateral saddle is very narrow and the adventive lobe shows strong serration by small notches, which climb up the ventral flank to more than half of the lobe depth. The lateral saddle is weakly inflated and lower than the ventrolateral saddle and the lateral lobe is nearly parallel-sided and possesses five small notches (Fig. 39B).

Remarks

Paratirolites quadratus differs from the other species of *Paratirolites* in the slightly trapezoidal, nearly quadrate whorl profile in the adult conch and the very long, spiny ventrolateral nodes.

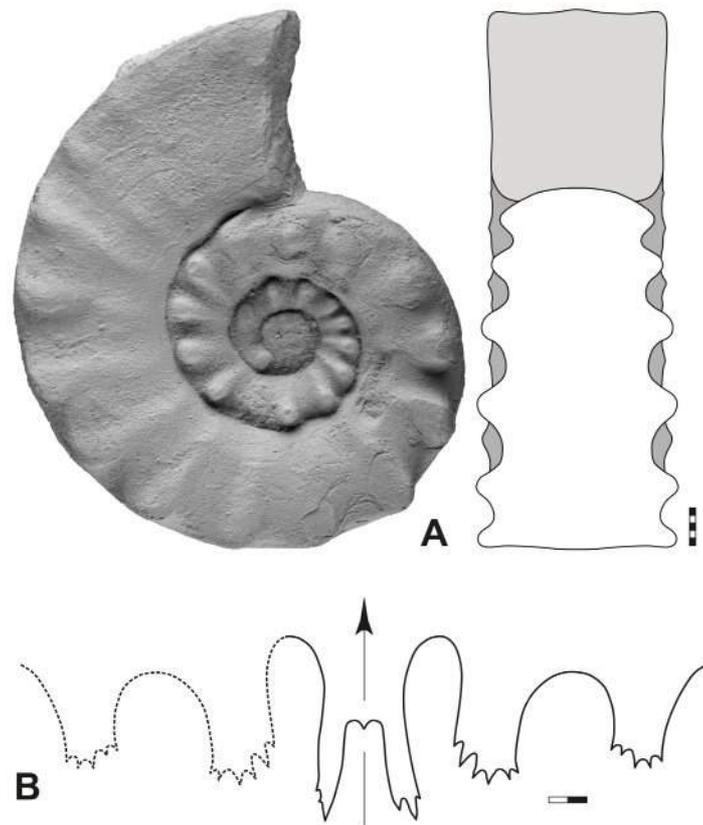


Fig. 38. *Paratirolites quadratus* Korn & Ghaderi, 2016. **A.** Lateral and dorsal view, specimen MB.C.29932, section E, float. **B.** Suture line, specimen MB.C.29932, at 13.5 mm wh. Abbreviation: see Material and methods. Scale bar units = 1 mm.

Stratigraphic range

At Baghuk Mountain only known from float from the upper part of the Hambast Formation; *Stoyanowites dieneri* Zone in the Julfa region.

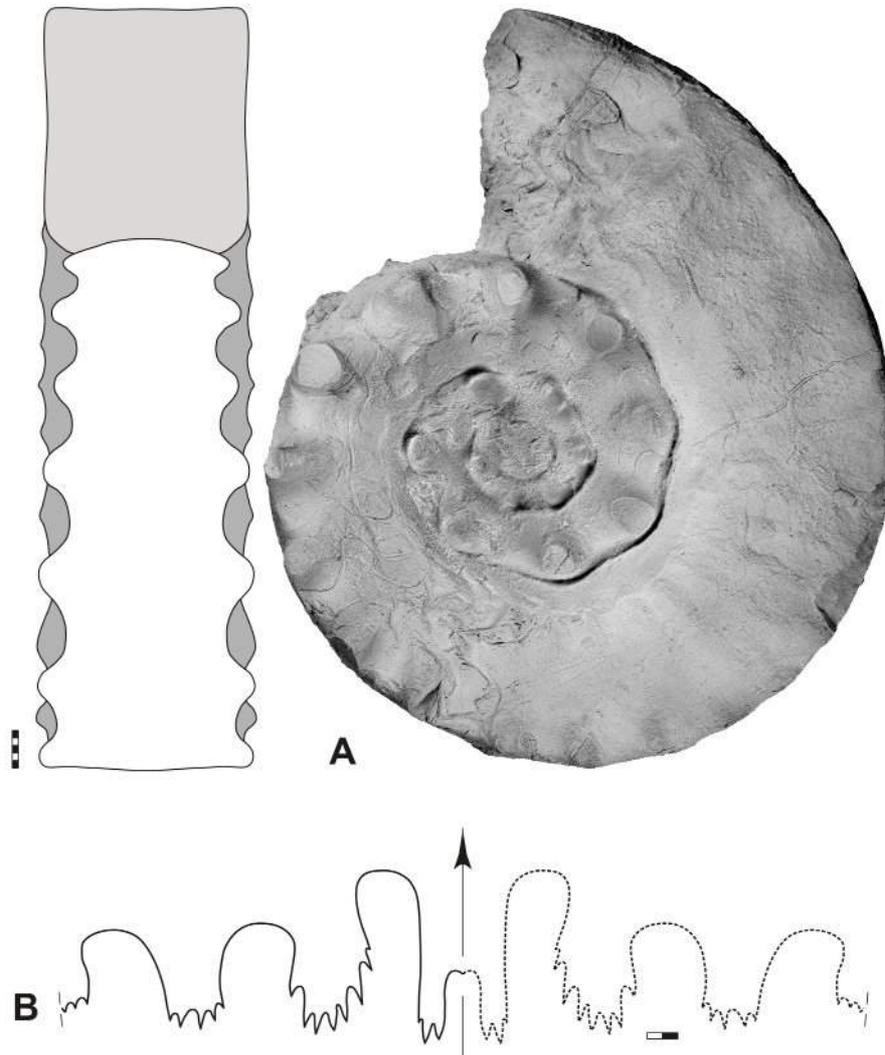


Fig. 39. *Paratirolites quadratus* Korn & Ghaderi, 2016. **A.** Lateral and dorsal view, specimen MB.C.29933, section E, float. **B.** Suture line, specimen MB.C.29933, at 29.0 mm ww, 17.0 mm wh. Abbreviations: see Material and methods. Scale bar units=1 mm.

Paratirolites serus Korn & Ghaderi in Korn *et al.*, 2016
Fig. 40; Table 19

Paratirolites serus Korn & Ghaderi in Korn *et al.*, 2016: 868, text-fig. 27.

Diagnosis

Paratirolites with conch reaching 80 mm dm. Subadult stage with weakly to strongly trapezoidal, depressed whorl profile ($ww/wh=1.40-1.80$) and broadly rounded venter; 12–14 coarse conical ventrolateral nodes. Adult stage with circular or slightly trapezoidal, weakly to moderately depressed

whorl profile ($ww/wh=1.20\text{--}1.60$), flattened venter and subangular to angular ventrolateral shoulder; numerous ribs on the flank. Prongs of external lobe simple; altogether 6–9 notches of E, A and L lobes.

Material examined

Holotype

IRAN • East Azerbaijan, Ali Bashi N section; *Paratirolites* Limestone, 0.65 m below the top; illustrated by Korn & Ghaderi in Korn *et al.* (2016: text-fig. 27a); MB.C.25300.

Additional material

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29934 • 2 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29935 to MB.C.29936 • 1 specimen; Esfahan Province, Baghuk Mountain F section; Hambast Formation; MB.C.29937.

Description

Specimen MB.C.29936 has 62 mm conch diameter and is the largest available specimen (Fig. 40A). It is corroded but still rather well preserved and allows the study of three whorls. A little more than half a volution belongs to the body chamber. The weakly depressed whorl profile ($ww/wh=1.05$) of the body

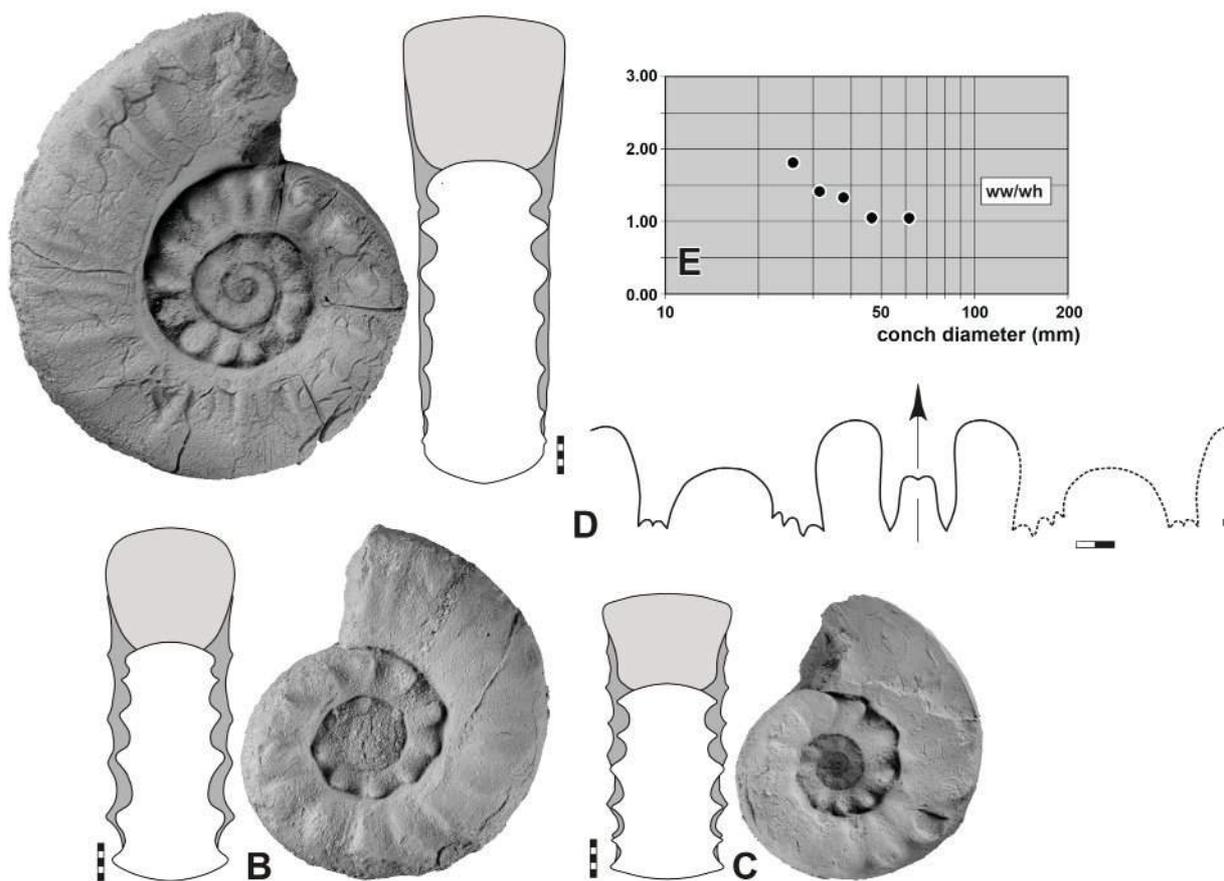


Fig. 40. *Paratirolites serus* Korn & Ghaderi, 2016. **A.** Lateral and dorsal view, specimen MB.C.29936, section E, float. **B.** Lateral and dorsal view, specimen MB.C.29934, section C, -0.60 m. **C.** Lateral and dorsal view, specimen MB.C.29937, section F, -0.75 m. **D.** Suture line, specimen MB.C.29934, at 16.0 mm ww, 10.3 mm wh. **E.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units=1 mm.

Table 19. Conch dimensions (partly estimated) and ratios of selected specimens of *Paratirolites serus* Korn & Ghaderi in Korn *et al.* (2016) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29936	61.8	21.3	20.5	26.2	19.7	0.34	1.04	0.42	2.15	0.04
MB.C.29934	46.7	16.9	16.2	20.2	15.2	0.36	1.04	0.43	2.20	0.06
MB.C.29937	37.8	16.9	12.8	15.7	12.0	0.45	1.32	0.42	2.15	0.06
MB.C.29935	36.7	14.7	13.6	15.0	12.7	0.40	1.08	0.41	2.34	0.07

chamber is trapezoidal with weakly diverging flanks and the flattened venter is separated from the flanks by a subangular ventrolateral shoulder. The sculpture changes, on the last portion of the phragmocone, from a subadult stage with 14 coarse ventrolateral nodes per volution to the adult stage with numerous weak radial ribs with weak ventrolateral nodes on the flank.

Specimen MB.C.29934 is a smaller individual with 48 mm conch diameter and is better preserved than the preceding one with half a volution of the body chamber preserved (Fig. 40B). It shows a weakly trapezoidal, weakly depressed body chamber whorl profile ($ww/wh=1.05$) with rounded ventrolateral shoulder and a broadly rounded venter, while the phragmocone has a more depressed whorl profile ($ww/wh=1.40$). The sculpture in the subadult stage has twelve coarse ventrolateral nodes, which become weaker and radially elongated on the body chamber, where they finally disappear and instead shallow radial dorsolateral ribs take place.

The suture line of specimen MB.C.29934 has an external lobe with nearly parallel flanks and unserrated, narrow lanceolate prongs. The ventrolateral saddle is weakly asymmetric and the adventive lobe is strongly asymmetric with a steep ventral flank, four little notches and an oblique dorsal side. The lateral lobe possesses only three small notches (Fig. 40D).

Remarks

Paratirolites serus is the stratigraphically youngest species of the genus in the Baghuk Mountain sections. It differs from the other by its small conch size and the simple suture line with unsubdivided prongs of the external lobe.

Subadult specimens of *P. serus* resemble some stratigraphically older species such as *P. kittli* and particularly *P. vediensis*. *Paratirolites serus* differs from these in the smaller conch diameter (40 mm maximum phragmocone diameter in contrast to 70–80 mm in *P. kittli* and *P. vediensis*) and a simpler suture line with unsubdivided prongs of the external lobe.

Stratigraphic range

Upper part of the Hambast Formation; 0.75 to 0.60 m below the extinction horizon (*Abichites stoyanowi* Zone).

Genus *Clivotirolites* Korn & Hairapetian gen. nov.

urn:lsid:zoobank.org:act:2F50EBFF-9384-40A5-84D9-573E68455DD2

Type species

Clivotirolites decoratus Korn & Hairapetian gen. et sp. nov., Baghuk Mountain.

Diagnosis

Representatives of the family Dzhulfitidae with large conch; maximum adult diameters are about 120 mm. Adult stage with trapezoidal whorl profile. Subadult stage with conical ventrolateral nodes, adult stage with weak ribs. Suture line protracted on the flanks, with deep external lobe; depths of external lobe and adventive lobe nearly identical.

Etymology

From the Latin ‘*clivus*’, meaning ‘oblique’, because of the suture line and the similarity with *Tirolites* and *Paratirolites*.

Included species

Clivotirolites decoratus Korn & Hairapetian gen. et sp. nov.; *Clivotirolites petilus* Korn & Hairapetian gen. et sp. nov.

Remarks

Clivotirolites gen. nov. differs from *Paratirolites* and related genera in the oblique protracting outline of the outer suture line.

Clivotirolites decoratus Korn & Hairapetian gen. et sp. nov.
urn:lsid:zoobank.org:act:0A7C7606-6D92-4630-BAF3-1A8E30B6486D
Figs 41–43; Table 20

Diagnosis

Species of *Clivotirolites* gen. nov. with conch reaching 110 mm dm. Subadult stage with trapezoidal, weakly depressed whorl profile ($ww/wh=1.10-1.20$) and slightly flattened venter; about 20–24 weak ventrolateral spines per volution. Adult stage with parallel or weakly diverging flanks and weakly compressed whorl profile ($ww/wh=0.70-0.80$), flattened, slightly tectiform venter and angular ventrolateral shoulder; numerous rounded ribs on flank ending in sharp ventrolateral nodes. Prongs of external lobe variable, simple to digitate; altogether 10–17 notches of E, A and L lobes.

Etymology

From the Latin ‘*decoratus*’, meaning ‘decorated’, because of the sculpture.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain C section; Hambast Formation, 1.35 m below the top; illustrated in Fig. 41A; MB.C.29941.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29938 • 2 specimens; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.29939 to MB.C.29940 • 14 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29942 to MB.C.29955 • 2 specimens; Esfahan Province, Baghuk Mountain F section; Hambast Formation; MB.C.29956 to MB.C.29957 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29958 to MB.C.29959 • 2 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29960 to MB.C.29961.

Description

Holotype MB.C.29941 is a rather well-preserved specimen of 64 mm conch diameter and shows all typical characters for the species (Fig. 41A). The specimen shows one and a half whorls preserved. It displays septal crowding and the end of the phragmocone appears at 38 mm diameter. About 210 degrees of the last volution belong to the body chamber, which shows a weakly trapezoidal whorl profile with weakly concave, weakly diverging flanks, a subangular ventrolateral shoulder and a flattened tectiform venter. The whorl belonging to the phragmocone has a more pronounced trapezoidal profile with convex, diverging flanks. The sculpture on the phragmocone part consists of rather small, pointed ventrolateral tubercles, 22 per volution. On the body chamber, these tubercles are connected with weak and rounded radial ribs, which are strongest on the inner flank.

Paratype MB.C.29946 is a similar specimen with 58 mm conch diameter and the last septum at 33 mm dm (Fig. 41B). It possesses a nearly quadrate whorl cross section of the body chamber but also shows that the profile is trapezoidal in an earlier growth stage. On the last volution of the phragmocone, 20 sharp ventrolateral nodes can be counted.

Larger paratypes such as MB.C.29947 (50 mm phragmocone diameter), MB.C.29944 (52 mm; Fig. 42B), MB.C.29938 (52 mm; Fig. 42A) and MB.C.29958 (53 mm; Fig. 43A) are generally similar but show stronger diverging flanks of the body chamber.

Suture lines were drawn from four specimens, all of them show principally similar outlines with some common characters (Fig. 43B–E). The external lobe is not as deep as the adventive lobe, it is wider at its base, from where the flanks converge towards the ventrolateral saddle. All four specimens show asymmetric notching of its prongs; usually there are three notches but also more intense serration is possible. The ventrolateral saddle is usually slightly inflated and the adventive lobe is parallel-sided with five or six notches at its base.

Remarks

Clivotiroilites decoratus gen. et sp. nov. differs in the large number (more than 20 per volution) of ventrolateral nodes from the species of *Clivotiroilites petilus* gen. et sp. nov. (about 15 nodes per volution).

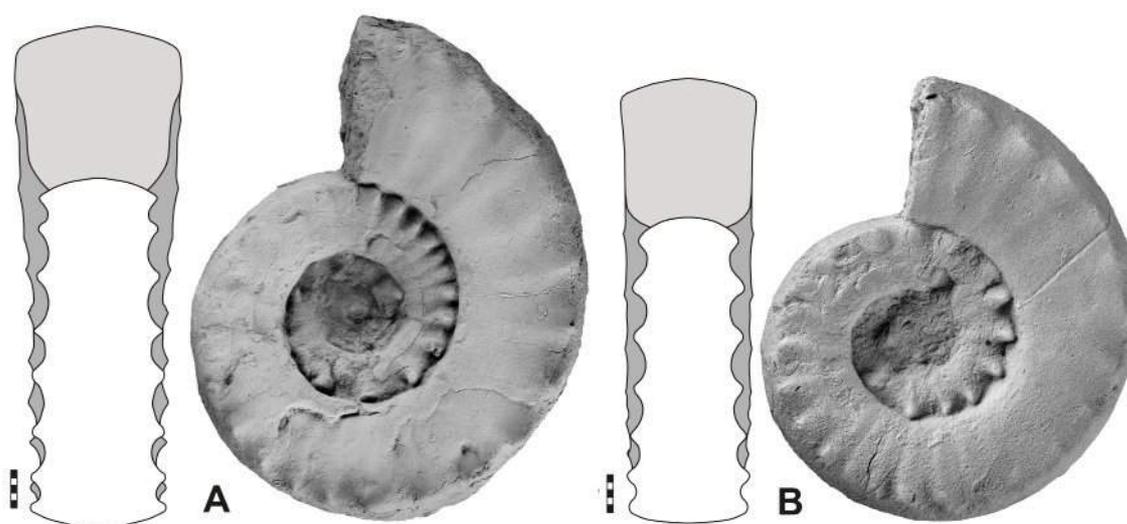


Fig. 41. *Clivotiroilites decoratus* Korn & Hairapetian gen. et sp. nov., lateral and dorsal views. **A.** Holotype MB.C.29941, section C, -1.35 m. **B.** Paratype MB.C.29946, section E, float. Scale bar units = 1 mm.

Stratigraphic range

Upper part of the Hambast Formation; 2.05 to 1.10 m below the extinction horizon (*Alinashites ferdowsii* Zone to *Abichites abichi* Zone).

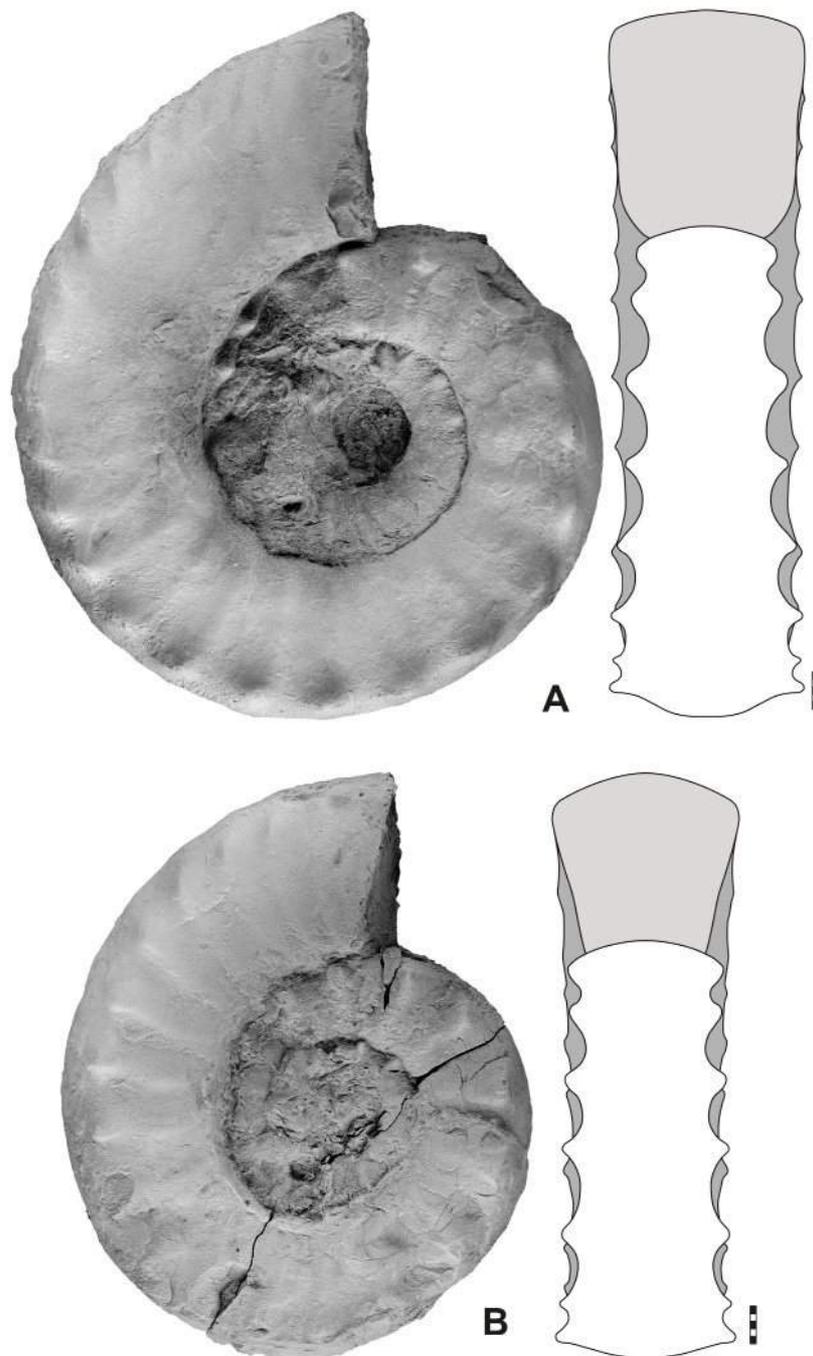


Fig. 42. *Clivotirolites decoratus* Korn & Hairapetian gen. et sp. nov., lateral and dorsal views. **A.** Paratype MB.C.29938, section 1, -1.50 m. **B.** Paratype MB.C.29944, section E, float. Scale bar units = 1 mm.

Table 20. Conch dimensions (partly estimated) and ratios of selected specimens of *Clivotirolites decoratus* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29958	91.4	–	29.2	39.8	28.1	–	–	0.44	2.08	0.04
MB.C.29938	88.7	24.4	28.6	41.2	27.0	0.28	0.85	0.46	2.07	0.06
MB.C.29947	78.2	–	24.5	33.8	23.6	–	–	0.43	2.05	0.04
MB.C.29944	77.3	24.5	24.4	33.8	22.8	0.32	1.00	0.44	2.01	0.07
MB.C.29941	66.3	21.9	21.7	28.8	20.5	0.33	1.01	0.43	2.10	0.06
MB.C.29961	63.2	21.8	21.3	27.2	19.4	0.34	1.02	0.43	2.08	0.09
MB.C.29946	58.8	17.8	19.7	25.7	18.1	0.30	0.90	0.44	2.09	0.08
MB.C.29942	89.6	23.1	29.8	40.0	28.8	0.26	0.78	0.45	2.17	0.03
MB.C.29948	86.4	20.5	29.0	37.5	27.5	0.24	0.71	0.43	2.15	0.05
MB.C.29939	84.5	24.0	27.7	38.0	26.7	0.28	0.87	0.45	2.14	0.04
MB.C.29959	84.4	21.0	27.5	38.6	26.0	0.25	0.76	0.46	2.09	0.05
MB.C.29941	83.6	21.0	27.0	37.2	26.0	0.25	0.78	0.44	2.11	0.04
MB.C.29953	79.9	19.9	26.8	35.9	26.0	0.25	0.74	0.45	2.20	0.03
MB.C.29951	77.8	19.1	26.4	33.0	26.0	0.25	0.72	0.42	2.26	0.02
MB.C.29943	73.2	22.6	26.5	31.1	25.0	0.31	0.85	0.42	2.31	0.06
MB.C.29952	69.0	20.2	24.6	29.7	24.0	0.29	0.82	0.43	2.35	0.02
MB.C.29954	61.4	16.2	21.2	27.4	20.2	0.26	0.76	0.45	2.22	0.05

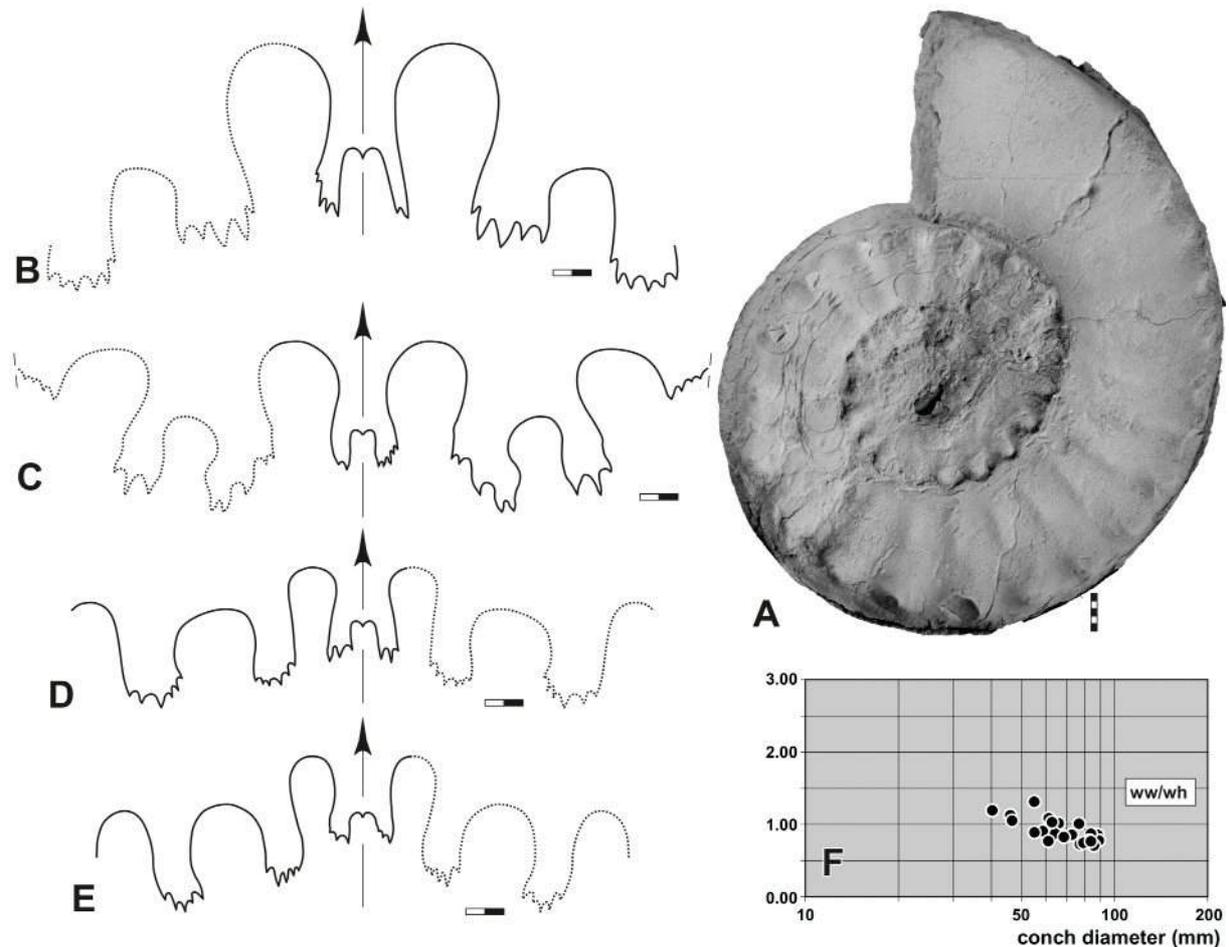


Fig. 43. *Clivotirolites decoratus* Korn & Hairapetian gen. et sp. nov. **A.** Lateral view, paratype MB.C.29958, section G, float. **B.** Suture line, paratype MB.C.29938, at 17.8 mm wh. **C.** Suture line, paratype MB.C.29944, at 15.6 mm wh. **D.** Suture line, holotype MB.C.29941, at 13.2 mm wh. **E.** Suture line, paratype MB.C.29946, at 13.0 mm ww, 11.2 mm wh. **F.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units=1 mm.

Clivotirolites petilus Korn & Hairapetian gen. et sp. nov.
urn:lsid:zoobank.org:act:6608C3B9-8B98-4E05-91E6-DA463119748F

Fig. 44; Table 21

Diagnosis

Species of *Clivotirolites* gen. nov. with conch reaching 120 mm dm. Subadult stage with trapezoidal, weakly compressed whorl profile (ww/wh=0.90) and flattened tectiform; 15 coarse ventrolateral nodes per revolution. Adult stage with trapezoidal, weakly compressed whorl profile (ww/wh=0.70), flat venter and angular ventrolateral shoulder; weak ribs and ventrolateral nodes. Prongs of external lobe bifid; altogether 16 notches of E, A and L lobes.

Etymology

From the Latin '*petilus*', meaning 'slim', because of the slender conch.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain E section; Hambast Formation; illustrated in Fig. 44A; MB.C.29962.

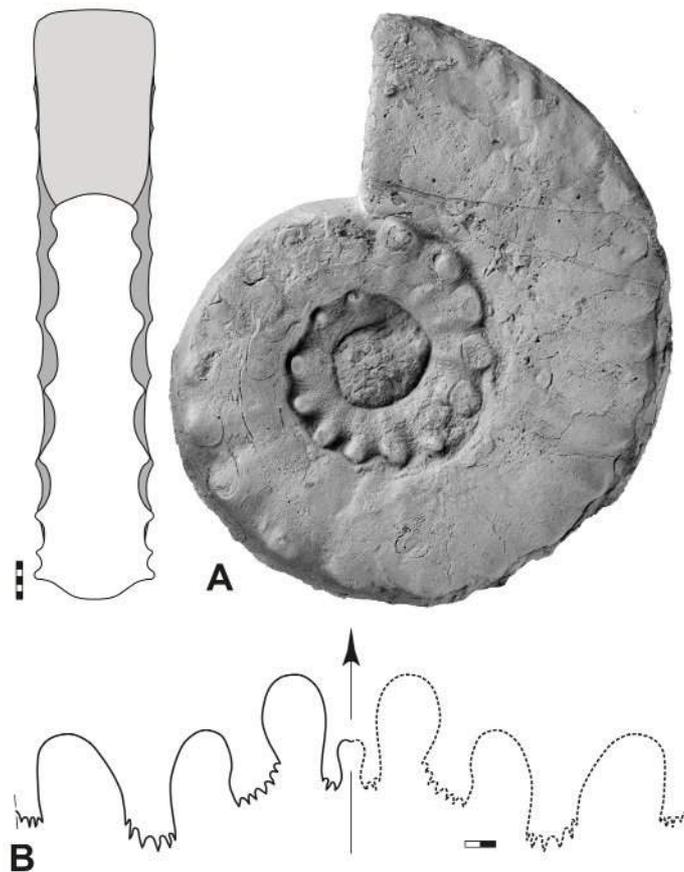


Fig. 44. *Clivotirolites petilus* Korn & Hairapetian gen. et sp. nov. **A.** Lateral and dorsal view, holotype MB.C.29962, section E, float. **B.** Suture line, holotype MB.C.29962, at 45.5 mm dm, 14.9 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 21. Conch dimensions (partly estimated) and ratios of selected specimens of *Clivotirolites petilus* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29962	79.9	16.5	28.0	33.2	24.9	0.21	0.59	0.42	2.11	0.11
MB.C.29962	56.4	15.5	17.8	25.0	–	0.27	0.87	0.44	–	–

Description

Holotype MB.C.29962 is a comparatively well-preserved individual with 80 mm conch diameter and allows the study of two whorls (Fig. 44A). Nearly three quarters of the last volution belong to the body chamber. The adult whorl profile is compressed ($ww/wh \sim 0.80$) and weakly trapezoidal with gently diverging flanks, a subangular ventrolateral shoulder and a flattened but still weakly rounded venter. The sculpture of the last phragmocone volution has 15 coarse ventrolateral nodes. With beginning of the terminal body chamber, these nodes become weaker and more numerous; at the end of the body chamber, ten faint nodes occur in a quarter of a volution.

The suture line of the holotype has an external lobe with weakly converging flanks. Its prongs are slightly pouched and possess three denticles. The ventrolateral saddle is inflated and followed by an asymmetric, pouched adventive lobe with oblique, weakly rounded base and seven small notches. The lateral lobe is generally V-shaped with weakly diverging flanks; it has six notches (Fig. 44B).

Remarks

Clivotirolites petilus gen. et sp. nov. differs in the lower number (about 15 per volution) of ventrolateral nodes from the species of *Clivotirolites decorates* gen. et sp. nov.

Stratigraphic range

The single specimen was collected from float of the upper part of the Hambast Formation.

Genus *Esfahanites* Korn & Hairapetian gen. nov.

urn:lsid:zoobank.org:act:61EDFE2C-1650-4303-BDC4-3E9F0434CDB8

Type species

Esfahanites armatus Korn & Hairapetian gen. et sp. nov., Baghuk Mountain.

Diagnosis

Representative of the family Dzhulfitidae with large conch; maximum adult diameters about 120 mm. Adult stage with trapezoidal whorl profile. Subadult stage with conical ventrolateral nodes, adult stage with weak ribs. Suture line with very small external lobe reaching only half the depth of adventive lobe.

Etymology

Named after the city of Esfahan.

Included species

Esfahanites armatus Korn & Hairapetian gen. et sp. nov.

Remarks

Esfahanites gen. nov. differs from *Paratirolites* and related genera in the very small external lobe.

Esfahanites armatus Korn & Hairapetian gen. et sp. nov.
urn:lsid:zoobank.org:act:DACEC5B2-4BE5-40D0-AA2B-578741DC349C
Figs 45–46; Table 22

? *Paratirolites* sp. Ghaedi *et al.*, 2009: pl. 2 figs 1, 4.

? *Paratirolites waageni* – Zakharov & Mussavi Abnavi 2013: text-fig. 12c.

Diagnosis

Species of *Esfahanites* gen. nov. with conch reaching 130 mm dm. Subadult stage with strongly trapezoidal, moderately depressed whorl profile ($w/w_h = 1.50–1.70$) and rounded to tectiform venter; about 12 coarse ventrolateral nodes per volution. Adult stage with trapezoidal and moderately depressed whorl profile ($w/w_h = 1.50–1.70$), flattened tectiform venter and angular ventrolateral shoulder; coarse rursiradiate ribs. Prongs of external lobe trifold or multiply serrated; altogether 15–21 notches of E, A and L lobes.

Etymology

From the Latin ‘*armatus*’, meaning ‘armed’, because of the coarse spiny sculpture.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain E section; Hambast Formation; illustrated in Fig. 45; MB.C.29964.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.29963 • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29965 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29966 • 2 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.29967 to MB.C.29968.

Description

Holotype MB.C.29964 is the best-preserved specimen; it has 106 mm conch diameter and allows the study of two whorls (Fig. 45A). The diameter of the phragmocone is 68 mm and the body chamber has a length of about 270 degrees. Throughout the last two preserved volutions, the whorl profile is trapezoidal, but with the flanks less strongly diverging at the end of growth. The venter is broadly rounded in the penultimate whorl and becomes more flattened on the terminal body chamber. The sculpture on the phragmocone has 14 coarse conical ventrolateral nodes on the last volution; these nodes show a rib-like elongation towards the umbilicus. The sculpture on the body chamber shows variably coarse, rounded ribs on the flank; they turn backward near the umbilicus and are strengthened in the ventrolateral area.

The suture line of holotype MB.C.29964 is remarkable because of its very small external lobe, which is wider at the base and is constricted in the upper part (Fig. 45B). The prongs are inclined ventrally and possess five little notches each. The ventrolateral saddle is small and inflated. The asymmetric adventive lobe is strongly serrated with little notches being developed on the ventral side up to half of the lobe depth. The lateral lobe is slightly less strongly serrated than the adventive lobe.

Paratype MB.C.29966 is an incomplete but otherwise rather well-preserved individual of 101 mm conch diameter; it allows the study of two and a half whorls (Fig. 46A). The body chamber begins at 60 mm conch diameter, meaning that the preserved part of the body chamber has a length of 270 degrees and

is nearly complete. Conch shape changes can be observed during the last whorl of the specimen. While the whorl profile is circular with rounded venter at the beginning of the last whorl, it changes to tectiform and has, at the end of growth, an almost flat venter, separated from the flat and diverging flanks by an angular ventrolateral shoulder. The sculpture of the phragmocone part of the specimen shows coarse conical nodes in the ventrolateral area, 12 on the last volution and 10 on the penultimate volution. At the beginning of the terminal body chamber, these nodes are transformed into elongate nodes and finally rounded ribs, which turn from the umbilicus in backward direction. Finally, at the end of the body chamber these ribs become weaker and only shallow rounded ribs and weak ventrolateral nodes can be seen.

The suture line of paratype MB.C.29966 shows a very small external lobe that has not half the depth of the adventive lobe (Fig. 46B). It is parallel-sided with parallel-sided prongs that possess three small

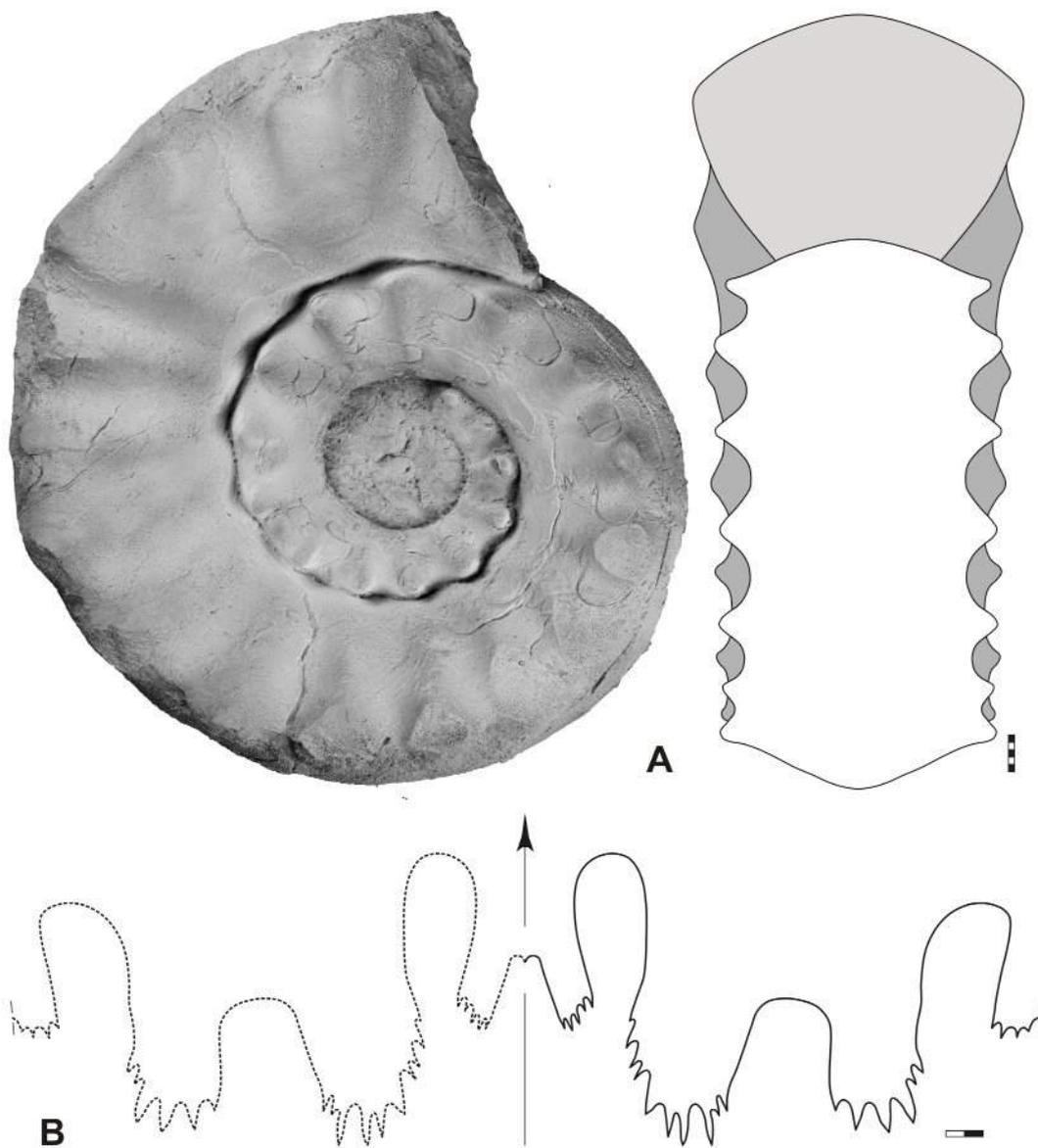


Fig. 45. *Esfahanites armatus* Korn & Hairapetian gen. et sp. nov., holotype MB.C.29964, section E, float. **A.** Lateral and dorsal view. **B.** Suture line, at 58.0 mm dm, 35.0 mm ww, 22.0 mm wh. Abbreviations: see Material and methods. Scale bar units=1 mm.

Table 22. Conch dimensions (partly estimated) and ratios of selected specimens of *Esfahanites armatus* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29964	105.8	51.6	32.0	46.3	29.5	0.49	1.61	0.44	1.92	0.08
MB.C.29964	78.1	42.0	26.0	31.6	–	0.54	1.62	0.40	–	–
MB.C.29966	101.2	–	34.0	43.9	32.9	–	–	0.43	2.20	0.03
MB.C.29966	67.3	34.5	21.3	30.5	–	0.51	1.62	0.45	–	–
MB.C.29965	96.5	–	32.5	38.5	30.5	–	–	0.40	2.14	0.06
MB.C.29965	69.5	33.5	22.0	28.0	–	0.48	1.52	0.40	–	–

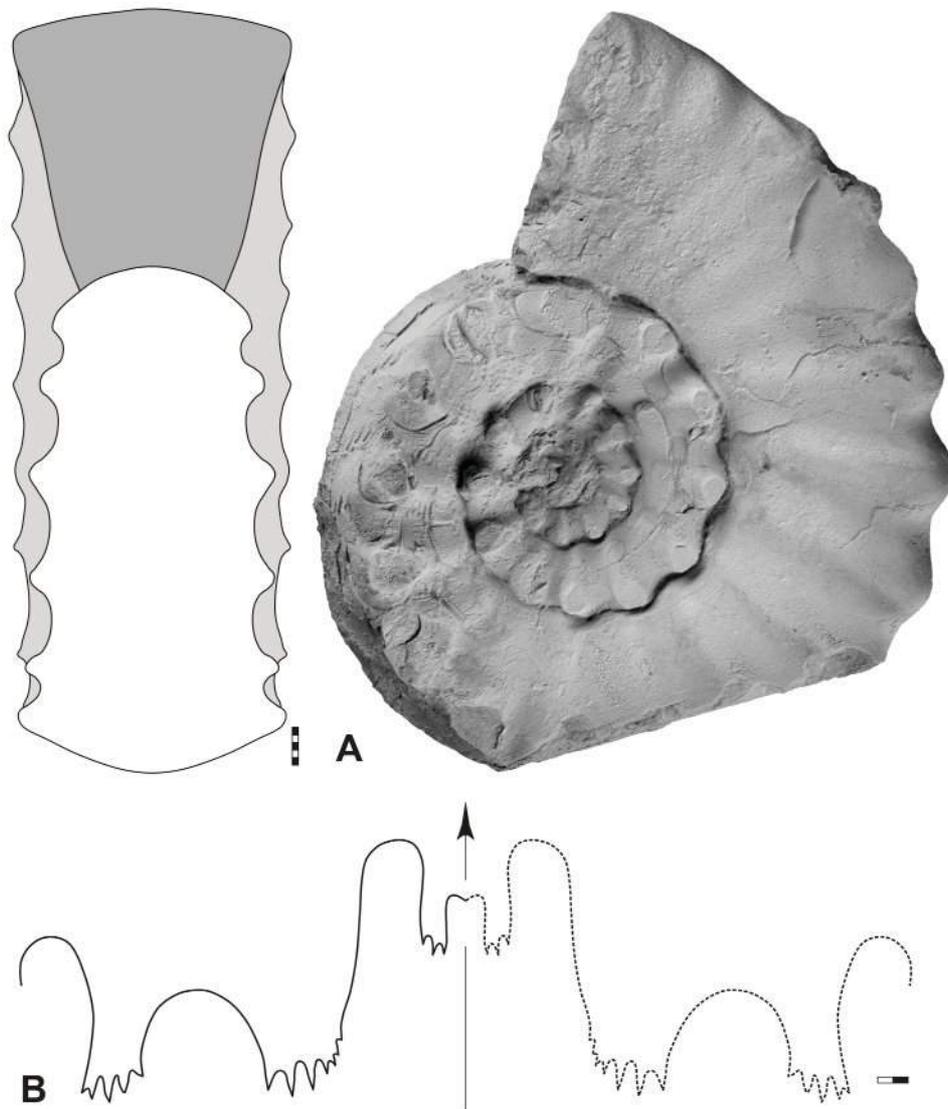


Fig. 46. *Esfahanites armatus* Korn & Hairapetian gen. et sp. nov., paratype MB.C.29966, section G, float. **A.** Lateral and dorsal view. **B.** Suture line, at 56.0 mm dm, 36.0 mm ww, 19.0 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

notches. The ventrolateral saddle is inverted U-shaped with a much longer dorsal flank. The adventive lobe has seven small notches and the lateral lobe five, both lobes are asymmetric and separated by a low semi-circular lateral saddle.

Remarks

Esfahanites armatus gen. et sp. nov. differs in the very small external lobe from all the species of *Paratirolites*. It can therefore not be confused with any other species.

Stratigraphic range

Upper part of the Hambast Formation; the only in situ collected specimen comes from 2.00 m below the extinction horizon (*Alibashites ferdowsii* Zone).

Genus *Alibashites* Korn & Ghaderi in Korn *et al.*, 2016

Type species

Xenodiscus (*Paratirolites*?) *Mojsisovicsi* Stoyanow, 1910, by original designation.

Included species

Alibashites ferdowsii Korn & Ghaderi in Korn *et al.*, 2016; *Xenodiscus* (*Paratirolites*?) *Mojsisovicsi* Stoyanow, 1910; *Alibashites uncinatus* Korn & Ghaderi in Korn *et al.*, 2016.

Diagnosis

Representatives of the family Dzhulfitidae with moderately large to large conch; maximum adult diameters 90 mm. Adult stage with subtrapezoidal or quadrate whorl profile. Subadult stage with large conical ventrolateral nodes, adult stage with weak ribs. Suture line with deep external lobe; depths of external lobe and adventive lobe nearly identical.

Remarks

Alibashites has an intermediate morphological position between *Paratirolites* and *Abichites*. It possesses the subadult sculpture with conical ventrolateral nodes of *Paratirolites* but lacks the trapezoidal whorl profile of that genus. *Abichites* has a similar adult conch morphology with a rectangular or subtrapezoidal whorl profile but does not possess the strong ventrolateral nodes developed in *Alibashites*.

Alibashites mojsisovicsi (Stoyanow, 1910)

Fig. 47; Table 23

Xenodiscus (*Paratirolites*?) *Mojsisovicsi* Stoyanow, 1910: 79, pl. 8 fig. 1.

Abichites mojsisovicsi – Shevyrev 1965: 180, pl. 23 fig. 4; 1968: 95, pl. 4 fig. 3. — Stepanov *et al.* 1969: pl. 13 fig. 4.

Alibashites mojsisovicsi – Korn & Ghaderi in Korn *et al.* 2016: 870, text-fig. 29.

Diagnosis

Alibashites with conch reaching 90 mm dm. Subadult stage with circular, weakly depressed whorl profile (ww/wh=1.00–1.20) and rounded venter; 13 coarse ventrolateral nodes per revolution. Adult stage with quadrate and weakly compressed whorl profile (ww/wh=0.95–1.00), almost flat venter and subangular

ventrolateral shoulder; low ribs on flanks, forming very weak dorsolateral and ventrolateral nodes. Prongs of external lobe variable, simple to trifid; 8–13 notches of E, A and L lobes.

Material examined

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29969 • 1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.299670 • 2 specimens; Esfahan Province, Baghuk Mountain; Hambast Formation; MB.C.299671 to MB.C.29972.

Description

Specimen MB.C.29969 has 55 mm conch diameter with a moderately well-preserved last volution of the phragmocone but a weathered body chamber (Fig. 47A). It possesses a nearly quadrate whorl profile with angular ventrolateral shoulder and weakly concave venter at its largest diameter. Half of a whorl earlier, the venter is nearly flat and another half of a whorl earlier, it is broadly convex. At this stage, the whorl profile is trapezoidal with strongly diverging flanks. The sculpture of the phragmocone shows about 20 ventrolateral nodes with a tendency to become weaker during growth of the conch.

The suture line of specimen MB.C.29969 shows a V-shaped external lobe with diverging flanks, a parallel-sided ventrolateral saddle with weak dorsal inclination and adventive and lateral lobes with moderate serration (Fig. 47B). They are separated by a rather low, symmetric lateral saddle.

Remarks

Alibashites ferdowsii also has coarse nodes in the subadult stage like *A. mojsisovicsi*, but this species shows a much wider whorl profile ($ww/wh=1.25–1.50$) than *A. mojsisovicsi* ($ww/wh=0.95–1.00$) in the adult stage. *A. mojsisovicsi* differs from the species of *Abichites*, which may develop a similar adult stage, in the coarse subadult ventrolateral nodes.

Stratigraphic range

Upper part of the Hambast Formation; 1.35 to 0.75 m below the extinction horizon (upper part of the *Lutites profundus* Zone to *Abichites stoyanowi* Zone).

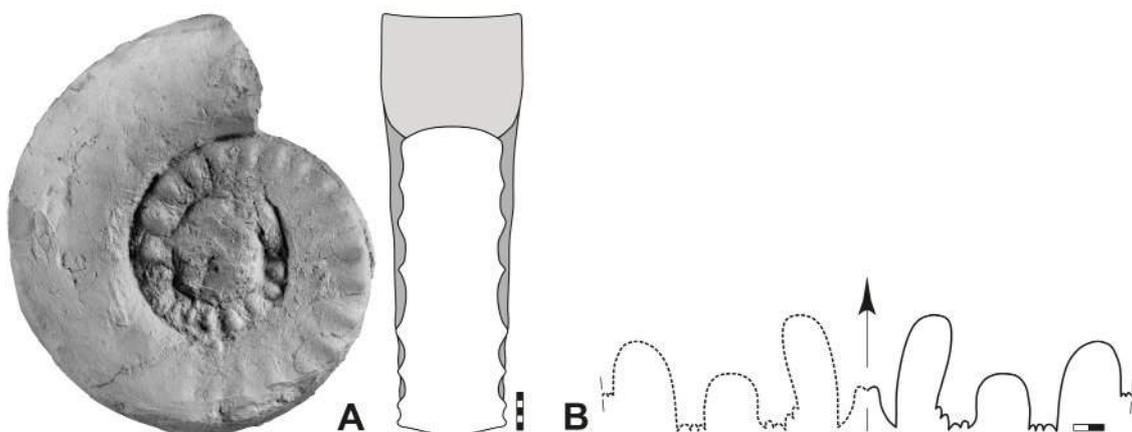


Fig. 47. *Alibashites mojsisovicsi* (Stoyanow, 1910) **A.** Lateral and dorsal view, specimen MB.C.29969, section C, -0.75 m. **B.** Suture line, specimen MB.C.29969, at 12.6 mm wh. Abbreviation: see Material and methods. Scale bar units = 1 mm.

Table 23. Conch dimensions (partly estimated) and ratios of selected specimens of *Alibashites mojsisovicsi* (Stoyanow, 1910) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29969	55.2		16.6	26.7	16.2	–	–	0.48	2.00	0.03
MB.C.29969	43.1	17.1	14.5	20.6	–	0.40	1.18	0.48	–	–
MB.C.29972	48.2	17.3	13.3	19.7	–	0.36	1.30	0.41	–	–
MB.C.29970	46.5	18.3	15.0	20.8	14.4	0.39	1.22	0.45	2.10	0.04

Alibashites ferdowsii Korn & Ghaderi in Korn *et al.*, 2016
Figs 48–49; Table 24

Alibashites ferdowsii Korn & Ghaderi in Korn *et al.*, 2016: 871, text-fig. 30.

Diagnosis

Species of *Alibashites* with conch reaching 100 mm dm. Subadult stage with circular to subtrapezoidal, weakly depressed whorl profile ($ww/wh=1.25\text{--}1.50$) and broadly rounded venter; 10–12 very coarse ventrolateral nodes. Adult stage with subtrapezoidal and weakly depressed whorl profile ($ww/wh=1.20\text{--}1.50$) with converging flanks, almost flat venter and angular ventrolateral shoulder; sharp ribs on flanks, forming short dorsolateral nodes and stronger ventrolateral nodes. Prongs of external lobe variable in shape, bifid to multiply serrated; altogether 15–18 notches of E, A and L lobes.

Material examined

Holotype

IRAN • West Azerbaijan, Aras Valley section; *Paratirolites* Limestone; illustrated by Korn & Ghaderi in Korn *et al.* (2016: text-fig. 30a); MB.C.25327.

Additional material

IRAN • 6 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29976 to MB.C.29978 • 1 specimen; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.29979 • 7 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29980 to MB.C.29986 • 2 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29987 to MB.C.29988 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29989 to MB.C.29990.

Description

Specimen MB.C.29974 is the largest available specimen with 59 mm conch diameter (Fig. 48A). Slightly less than half of a volution belongs to the body chamber. The profile of the aperture is characterised by a broadly rounded umbilical margin, weakly concave flanks, an angular ventrolateral shoulder and a broadly rounded but somehow flattened venter. The whorl profile in this stage is weakly depressed with a ww/wh ratio of 1.35. One volution earlier, the venter is more rounded and the flanks are widely curved, producing a depressed oval whorl profile. The sculpture changes from the subadult stage with coarse ventrolateral nodes per volution into the body chamber sculpture with sharp dorsolateral ribs, which are connected by low and rounded folds with weak ventrolateral nodes.

The suture line of specimen MB.C.29974 is characterised by a Y-shaped external lobe, of which the prongs are subdivided by four small notches of varying depth. The ventrolateral saddle is strikingly

asymmetric and dorsally inclined. It is followed by the asymmetric adventive lobe with seven small notches, the asymmetric parabolic lateral saddle and a lateral lobe with three notches (Fig. 49A).

Specimen MB.C.29987 is a specimen with 51 mm conch diameter. Its profile is subtrapezoidal at the aperture; it shows a convex and oblique umbilical wall and is widest in the dorsolateral portion of the

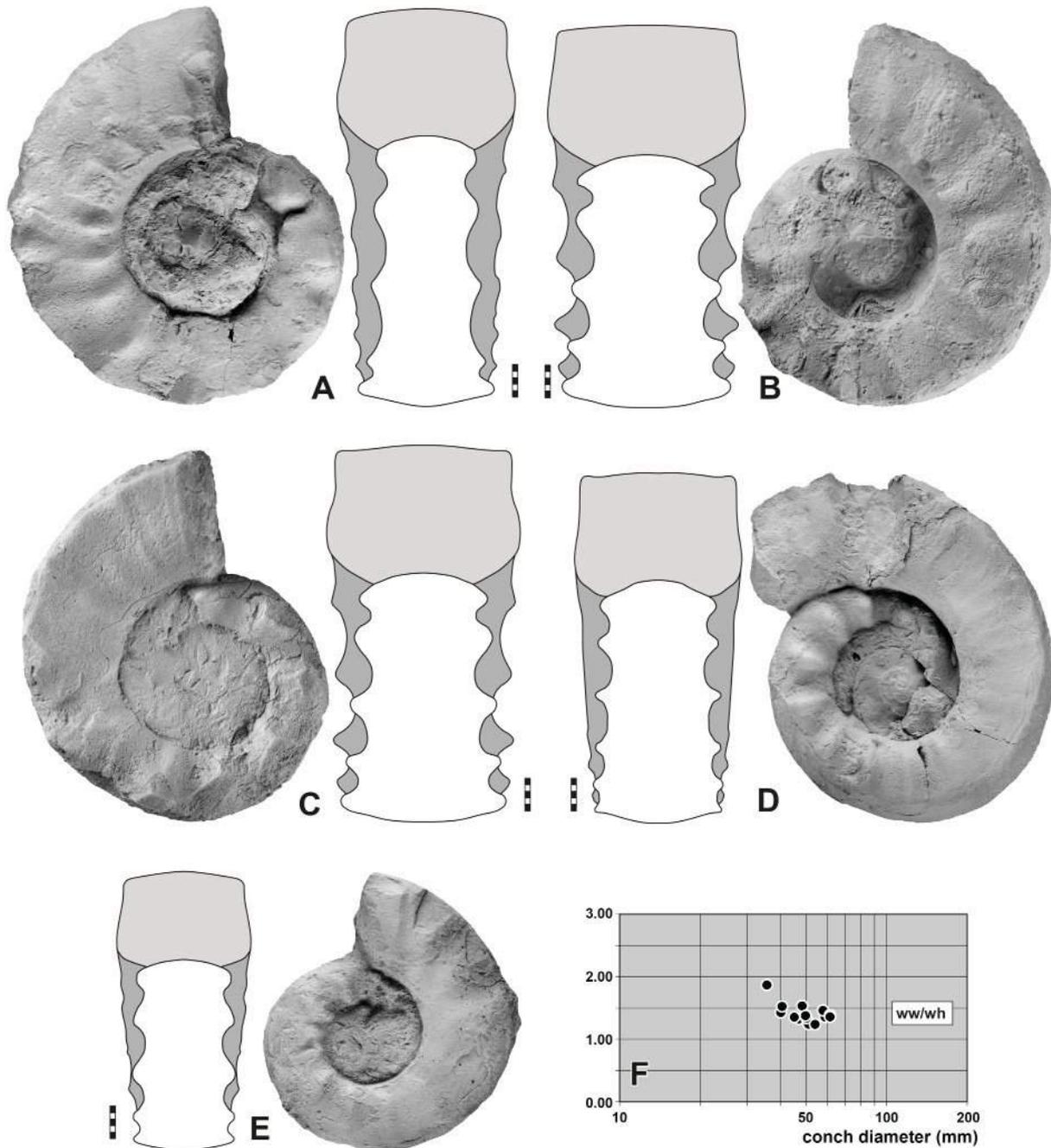


Fig. 48. *Alibashites ferdowsii* Korn & Ghaderi, 2016. **A.** Lateral and dorsal view, specimen MB.C.29974, section 1, -1.60 m. **B.** Lateral and dorsal view, specimen MB.C.29990, section G, float. **C.** Lateral and dorsal view, specimen MB.C.29987, section E, float. **D.** Lateral and dorsal view, specimen MB.C.29980, section C, -1.15 m. **E.** Lateral and dorsal view, specimen MB.C.29979, section B, float. **F.** Whorl profile proportions. Scale bar units = 1 mm.

flank and weakly concave in the outer flank area (Fig. 48C). The flattened venter is separated from the flank by an angular ventrolateral shoulder. One whorl earlier is the whorl profile trapezoidal with a rounded ventrolateral shoulder and a broadly rounded venter. The sculpture on the phragmocone consists of twelve coarse conical nodes; on the body chamber these nodes become weaker and are connected with elongate rounded dorsolateral ribs by shallow, rounded folds.

The suture line shows a slightly pouched external lobe with lanceolate, unsubdivided prongs. The ventrolateral saddle is turned U-shaped with nearly parallel flanks. Both flanks of the adventive lobe stand parallel, but its base is oblique and serrated into six little notches (Fig. 49D).

Remarks

The specimens from Baghuk Mountain are morphologically very similar to the material from the type area, and the sizes of the specimens are nearly identical. Differences occur in the degree of sutural subdivision; while the prongs of the external lobe in the material from Julfa are secondarily subdivided (two, three or four notches), many of the specimens from Baghuk Mountain show non-subdivided lanceolate prongs.

Alibashites ferdowsii shows an intermediate morphological position between the genera *Paratirolites* and *Abichites*. Characteristic for *Paratirolites* is the intermediate growth stage with trapezoidal whorl profile with the prominent conical ventrolateral nodes; similar to *Abichites* is the flat venter in the adult stage. The intermediate position of *A. ferdowsii* is also visible in the suture line; on the one side is the more complex external lobe in *Paratirolites* (with serrated prongs of the external lobe), and on the other side is *Abichites* (with a trend towards unserrated prongs of the external lobe).

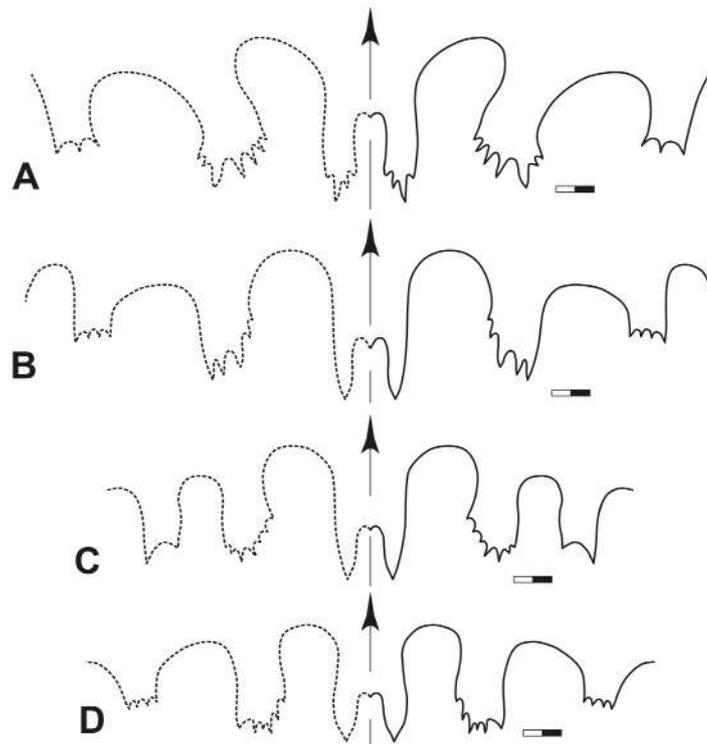


Fig. 49. *Alibashites ferdowsii* Korn & Ghaderi, 2016, suture lines. **A.** MB.C.29974, at 12.8 mm wh. **B.** MB.C.29980, at 10.9 mm wh. **C.** MB.C.29979, at 14.0 mm ww, 10.4 mm wh. **D.** MB.C.29987, at 10.3 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 24. Conch dimensions (partly estimated) and ratios of selected specimens of *Alibashites ferdowsii* Korn & Ghaderi in Korn *et al.*, 2016 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29974	59.2	26.1	19.4	25.6	19.0	0.44	1.35	0.43	2.17	0.02
MB.C.29990	58.1	28.0	19.3	25.1	19.2	0.48	1.45	0.43	2.23	0.01
MB.C.29987	51.3	21.2	17.2	22.2	16.5	0.41	1.23	0.43	2.17	0.04
MB.C.29980	48.5	22.5	14.8	20.7	14.2	0.46	1.52	0.43	2.00	0.04
MB.C.29979	40.2	19.7	13.9	16.6	13.3	0.49	1.42	0.41	2.23	0.04
MB.C.29983	61.8	26.5	19.2	26.0	18.5	0.43	1.38	0.42	2.04	0.04
MB.C.29988	54.3	20.4	16.6	25.0	16.0	0.38	1.23	0.46	2.01	0.04
MB.C.29981	50.4	21.5	16.2	21.5	15.4	0.43	1.33	0.43	2.07	0.05
MB.C.29984	50.0	24.2	17.7	20.9	17.0	0.48	1.37	0.42	2.30	0.04

Stratigraphic range

Upper part of the Hambast Formation; 2.25 to 0.70 m below the extinction horizon (*Alibashites ferdowsii* Zone to lower part of the *Abichites stoyanowi* Zone).

Genus *Lutites* Korn & Hairapetian gen. nov.

urn:lsid:zoobank.org:act:5B2AB929-F903-46B0-B108-A1C57458A1DA

Type species

Lutites lyriformis Korn & Hairapetian gen. et sp. nov., Baghuk Mountain.

Diagnosis

Genus of the family Dzhulfitidae with large conch; maximum adult diameters about 140 mm. Adult stage with compressed, subtrapezoidal whorl profile; flanks concave, venter flat or concave. Subadult stage with conical ventrolateral nodes, adult stage with weak ribs or delicate plications. Suture line with deep external lobe (deeper than adventive lobe), ventral prongs unsubdivided or notched.

Etymology

Named after the Lut Desert, which extends to the North-East of Baghuk Mountain.

Included species

Alibashites stepanovi Korn & Ghaderi in Korn *et al.*, 2016; *Lutites paucis* Korn & Hairapetian gen. et sp. nov.; *Lutites alius* Korn & Hairapetian gen. et sp. nov.; *Lutites profundus* Korn & Hairapetian gen. et sp. nov.; *Lutites lyriformis* Korn & Hairapetian gen. et sp. nov.; *Lutites plicatus* Korn & Hairapetian gen. et sp. nov.

Remarks

Lutites gen. nov. differs from *Paratirolites* and related genera in the compressed subtrapezoidal, pear-shaped whorl profile and in the very deep external lobe.

Lutites paucis Korn & Hairapetian gen. et sp. nov.

urn:lsid:zoobank.org:act:9C85D567-DA54-463F-8CE3-BFDBABD83928

Fig. 50; Table 25

Diagnosis

Species of *Lutites* gen. nov. with conch reaching 70 mm dm. Subadult stage with circular, slightly compressed whorl profile ($ww/wh=0.90-1.00$) and broadly rounded venter; very coarse conical ventrolateral nodes. Adult stage with subtrapezoidal, slightly compressed whorl profile ($ww/wh=0.80$), flattened venter and subangular ventrolateral shoulder; without ribs or nodes. Prongs of external lobe simple; altogether 11 notches of E, A and L lobes.

Etymology

From the Latin '*paucis*', meaning 'fewer', because of the low number of lobes and nodes.

Material examined**Holotype**

IRAN • Esfahan Province, Baghuk Mountain C section; Hambast Formation, 2.45 m below the top; illustrated in Fig. 50A; MB.C.29991.

Paratypes

IRAN • 2 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29992 to MB.C.29993.

Description

Holotype MB.C.29991 is a partly corroded specimen with 64 mm conch diameter with two thirds of the last volution belonging to the body chamber (Fig. 50A). At the end of the body chamber, the whorl profile is subtrapezoidal with a broadly rounded umbilical margin, converging flanks, a narrowly rounded ventrolateral shoulder and a flattened venter. By contrast, the whorl profile is trapezoidal at the beginning of the body chamber and subcircular in the last portion of the phragmocone. The sculpture of the phragmocone consists of very coarse conical ventrolateral nodes (eight per volution). The body chamber appears to be smooth.

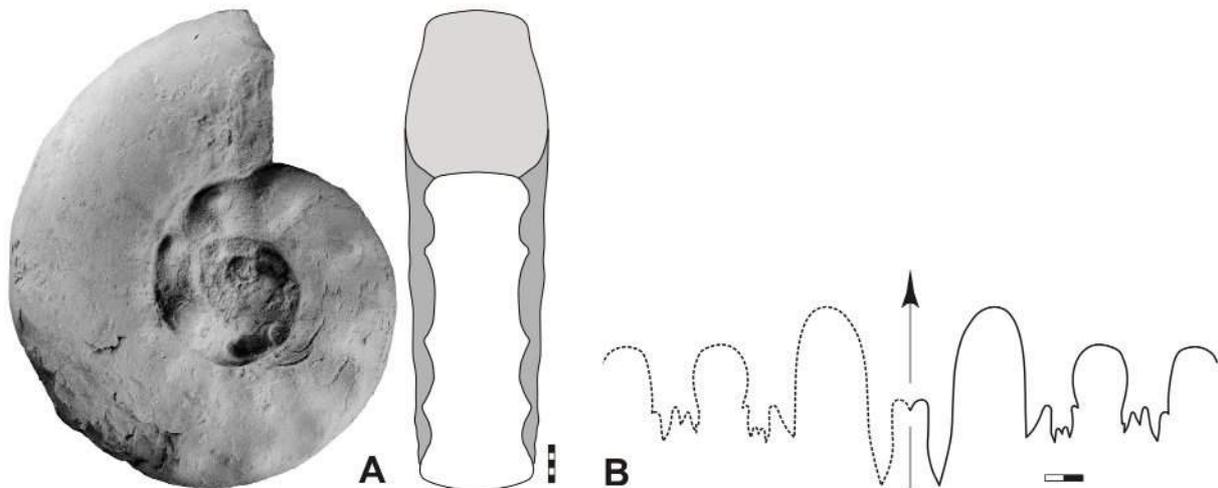


Fig. 50. *Lutites paucis* Korn & Hairapetian gen. et sp. nov. **A.** Lateral and dorsal view, holotype MB.C.29991, section C, -2.45 m. **B.** Suture line, holotype MB.C.29991, at 13.7 mm wh. Abbreviation: see Material and methods. Scale bar units = 1 mm.

Table 25. Conch dimensions (partly estimated) and ratios of the holotype of *Lutites paucis* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29991	64.3	18.8	23.5	24.1	22.8	0.29	0.80	0.37	2.40	0.03
MB.C.29991	44.3	15.9	16.7	16.9	–	0.36	0.95	0.38	–	–

The suture line of the holotype has a large external lobe with weakly diverging flanks and simple, narrow and lanceolate prongs. The ventrolateral saddle is narrowly rounded and the lateral saddle is weakly inflated. Both the adventive lobe and the lateral lobe are parallel-sided and both characterised by five notches that are very dissimilar in size (Fig. 50B).

Remarks

Lutites paucis gen. et sp. nov. differs from the other species of the genus in the stouter conch, the only weakly flattened venter and the lower number of conical nodes. The new species may represent an intermediate form between *Alibashites* and *Lutites* gen. nov.

Stratigraphic range

Upper part of the Hambast Formation; 2.45 m to 1.20 m below the extinction horizon (uppermost part of the *Paratirolites kittli* Zone to the *Lutites profundus* Zone).

Lutites lyriformis Korn & Hairapetian gen. et sp. nov.

urn:lsid:zoobank.org:act:3FC3DB4D-AA14-43A6-B982-0137ED22D6B7

Figs 51–52; Table 26

Diagnosis

Species of *Lutites* gen. nov. with conch reaching 140 mm dm. Subadult stage with parallel-sided, compressed whorl profile ($ww/wh=0.60–0.70$) and rounded venter; about 14 ventrolateral nodes per revolution. Adult stage with subtrapezoidal, compressed whorl profile ($ww/wh=0.50–0.60$), concave flanks, concave venter and angular ventrolateral shoulder; numerous weak and densely arranged ribs. Prongs of external lobe bifid to multiply serrated; altogether 13–22 notches of E, A and L lobes.

Etymology

From the Latin ‘*lyra*’, referring to the shape of the whorl profile.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain A section; Hambast Formation; illustrated in Fig. 51A; MB.C.29995.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.29994 • 2 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.29996 to MB.C.29997 • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.29998 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.29999 • 2 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.30000 to MB.C.30001.

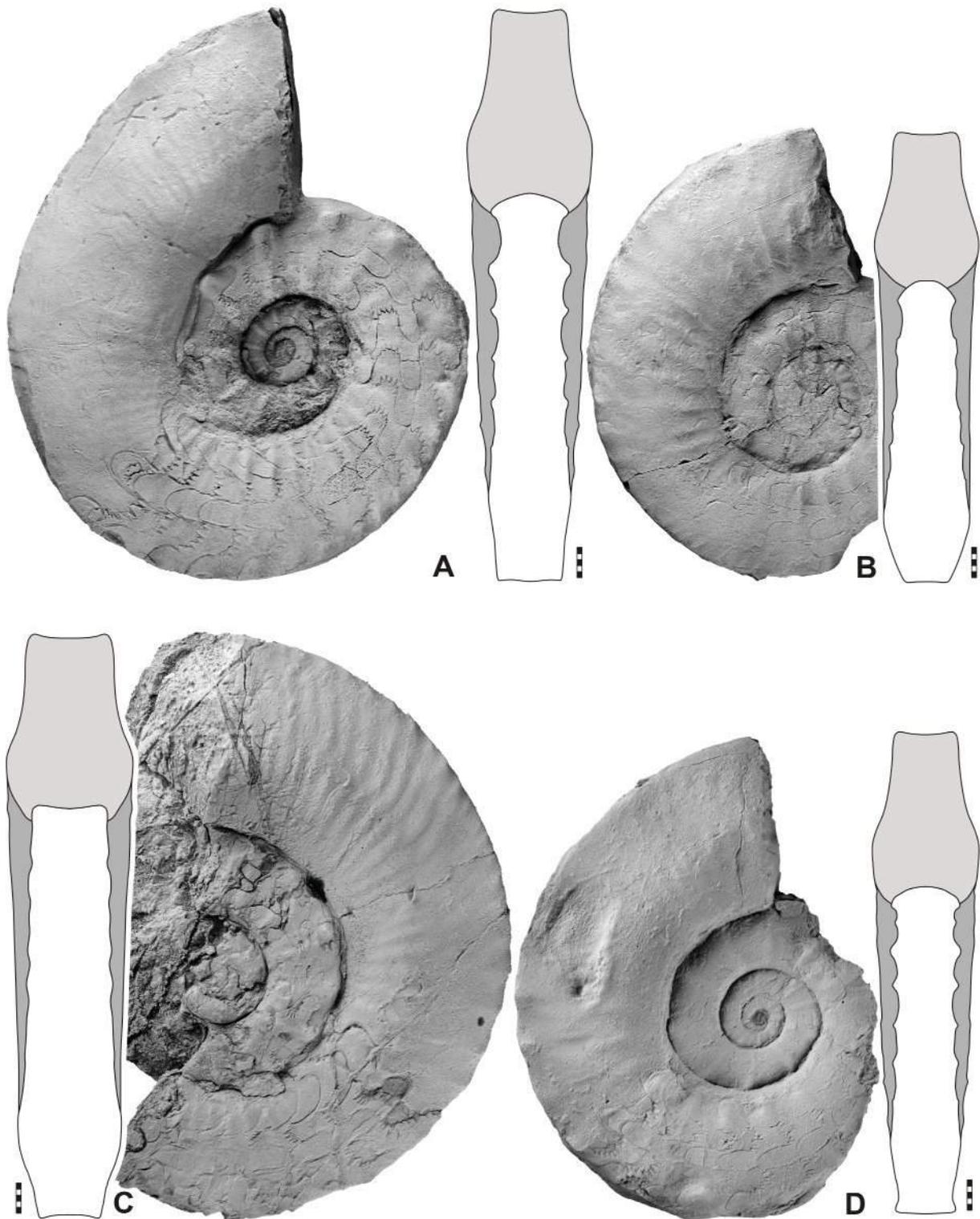


Fig. 51. *Lutites lyriformis* Korn & Hairapetian sp. nov., lateral and dorsal views. **A.** Holotype MB.C.29995, section A, float. **B.** Paratype MB.C.29997, section C, -1.00 m. **C.** Paratype MB.C.29996, section C, -1.45 m. **D.** Paratype MB.C.29999, section G, -1.20 m. Scale bar units = 1 mm.

Description

Holotype MB.C.29995 is a rather well-preserved specimen with 96 mm conch diameter (Fig. 51A). It allows the study of three and a half volutions, of which only one third of a volution belongs to the body chamber. Adulthood is indicated by the weak crowding of the last septa at 73 mm diameter. The whorl profile is, at the largest preserved conch diameter, subtrapezoidal with a broadly rounded umbilical margin and concave and converging flanks. The weakly concave venter is separated from the flanks by an angular ventrolateral shoulder. Half a volution earlier, the venter is plane and another half a volution back, the venter is broadly rounded. The sculpture shows significant ontogenetic changes from the subadult stage with 13 coarse and blunt ventrolateral nodes, which originate from weak and rounded radial ribs, per volution. They become weaker and more numerous in the last quarter volution of the phragmocone (about 12 weak ventrolateral nodes within this interval). The body chamber possesses a very weak sculpture consisting only of weak and rounded radial riblets in the inner flank area.

The suture line of the holotype possesses a parallel-sided external lobe with prongs being asymmetrically serrated by four and five small notches, respectively. The asymmetric ventrolateral saddle is nearly as wide as high; it is followed by an adventive lobe with oblique base serrated into seven small notches. The weakly asymmetric, inverted U-shaped lateral saddle is nearly as high as the ventrolateral saddle. Finally, the asymmetric lateral lobe has also seven small notches (Fig. 52A).

The smaller paratype MB.C.29997 has 74 mm conch diameter, of which the phragmocone has a diameter of 64 mm and one quarter of a whorl belongs to the body chamber (Fig. 51B). The whorl profile is subtrapezoidal with concave, converging flanks and the venter is weakly concave. The sculpture generally resembles the holotype, but the ribs and nodes are weaker. The same is true for the additional

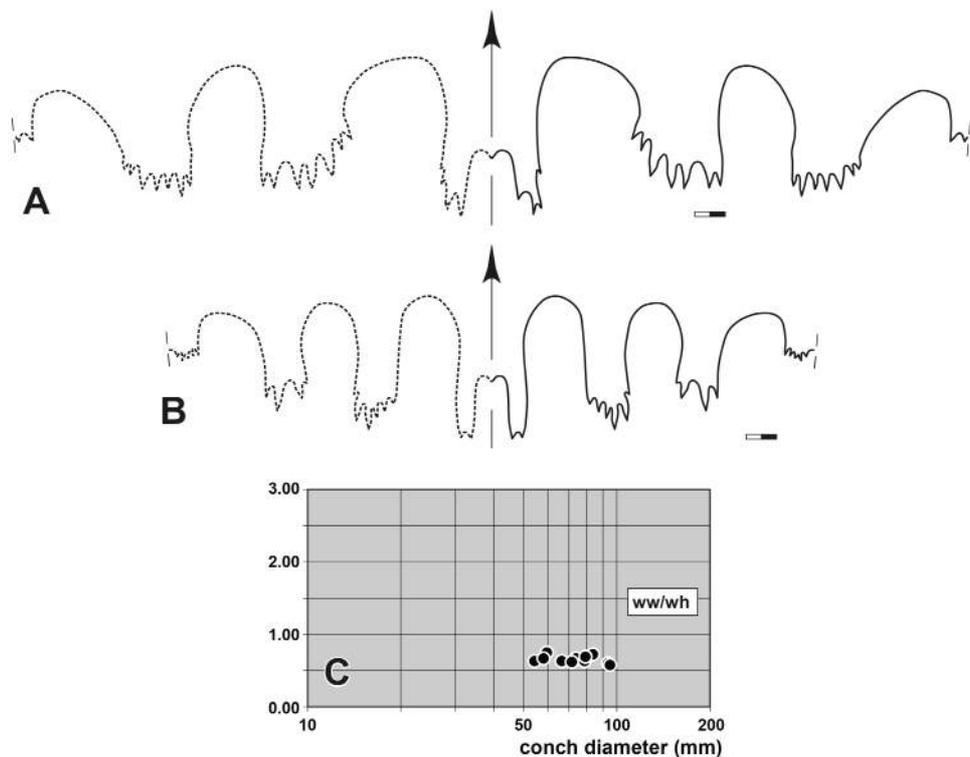


Fig. 52. *Lutites lyriformis* Korn & Hairapetian gen. et sp. nov. **A.** Suture line, holotype MB.C.29995, at 58.3 mm dm, 23.1 mm wh. **B.** Suture line, paratype MB.C.29997, at 53.8 mm dm, 19.0 mm wh. **C.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 26. Conch dimensions (partly estimated) and ratios of selected specimens of *Lutites lyriformis* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.29995	95.8	19.9	34.6	35.8	31.7	0.21	0.58	0.37	2.23	0.08
MB.C.29996	94.3	18.6	31.1	41.3	30.0	0.20	0.60	0.44	2.15	0.03
MB.C.29998	79.7	18.3	26.6	31.3	24.4	0.23	0.69	0.39	2.08	0.08
MB.C.29999	79.2	18.0	28.6	29.3	25.5	0.23	0.63	0.37	2.18	0.11
MB.C.29997	74.3	16.8	25.3	30.1	24.5	0.23	0.66	0.41	2.23	0.03
MB.C.29994	72.0	15.1	24.4	29.2	23.0	0.21	0.62	0.41	2.16	0.06
MB.C.29995	95.8	19.9	34.6	35.8	31.7	0.21	0.58	0.37	2.23	0.08

paratypes MB.C.29996 (Fig. 51C) and MB.C.29999 (Fig. 51D), which is the conch geometry are nearly identical with the holotype.

The suture line of paratype MB.C.29997 shows a parallel-sided external lobe that is deeper than the adventive lobe. The prongs are bifid and parallel-sided. All lobes and thus saddles are parallel-sided and all saddles have the same height. The adventive lobe and the lateral lobe possess six and four small notches (Fig. 52B).

Remarks

The new species differs in the coarse ventrolateral nodes of the subadult stage from most of the other species of *Lutites* gen. nov. with compressed whorl profile. *Lutites lyriformis* gen. et sp. nov. is similar to *L. profundus* gen. et sp. nov. but differs in the much weaker sculpture of the terminal body chamber, which shows only very weak ribs in *L. lyriformis* gen. et sp. nov. but ventrolateral nodes in *L. profundus* gen. et sp. nov.

Stratigraphic range

Upper part of the Hambast Formation; 1.45 to 1.00 m below the extinction horizon (*Lutites profundus* Zone to *Abichites abichi* Zone).

Lutites profundus Korn & Hairapetian gen. et sp. nov.
urn:lsid:zoobank.org:act:BB88C301-E69F-4E4B-8B25-F086D3BC6EEC
Fig. 53; Table 27

Diagnosis

Species of *Lutites* gen. nov. with conch reaching 125 mm dm. Subadult stage with subcircular, compressed whorl profile ($ww/wh=0.70-0.80$) and rounded venter; about 13 coarse ventrolateral nodes per revolution. Adult stage with subtrapezoidal, compressed whorl profile ($ww/wh=0.70-0.75$), flat or concave venter and angular ventrolateral shoulder; weak dorsolateral ribs and elongated ventrolateral nodes. Prongs of external lobe trifid; altogether about 19 notches of E, A and L lobes.

Etymology

From the Latin ‘*profundus*’, meaning ‘deep’, because of the deep external lobe.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain E section; Hambast Formation; illustrated in Fig. 53; MB.C.30003.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30002 • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30004 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30005 • 3 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.30006 to MB.C.30008.

Description

Holotype MB.C.30003 is a rather well-preserved specimen with 86 mm conch diameter, in which two whorls can be studied (Fig. 53A). One third of the last volution belongs to the body chamber and the last four septa of the phragmocone are crowded. In the adult stage, the compressed whorl profile ($ww/wh=0.75$) shows a broadly rounded umbilical margin with an oblique umbilical wall. The whorl profile is widest on the inner flank, from where the concave flanks converge towards the angular ventrolateral

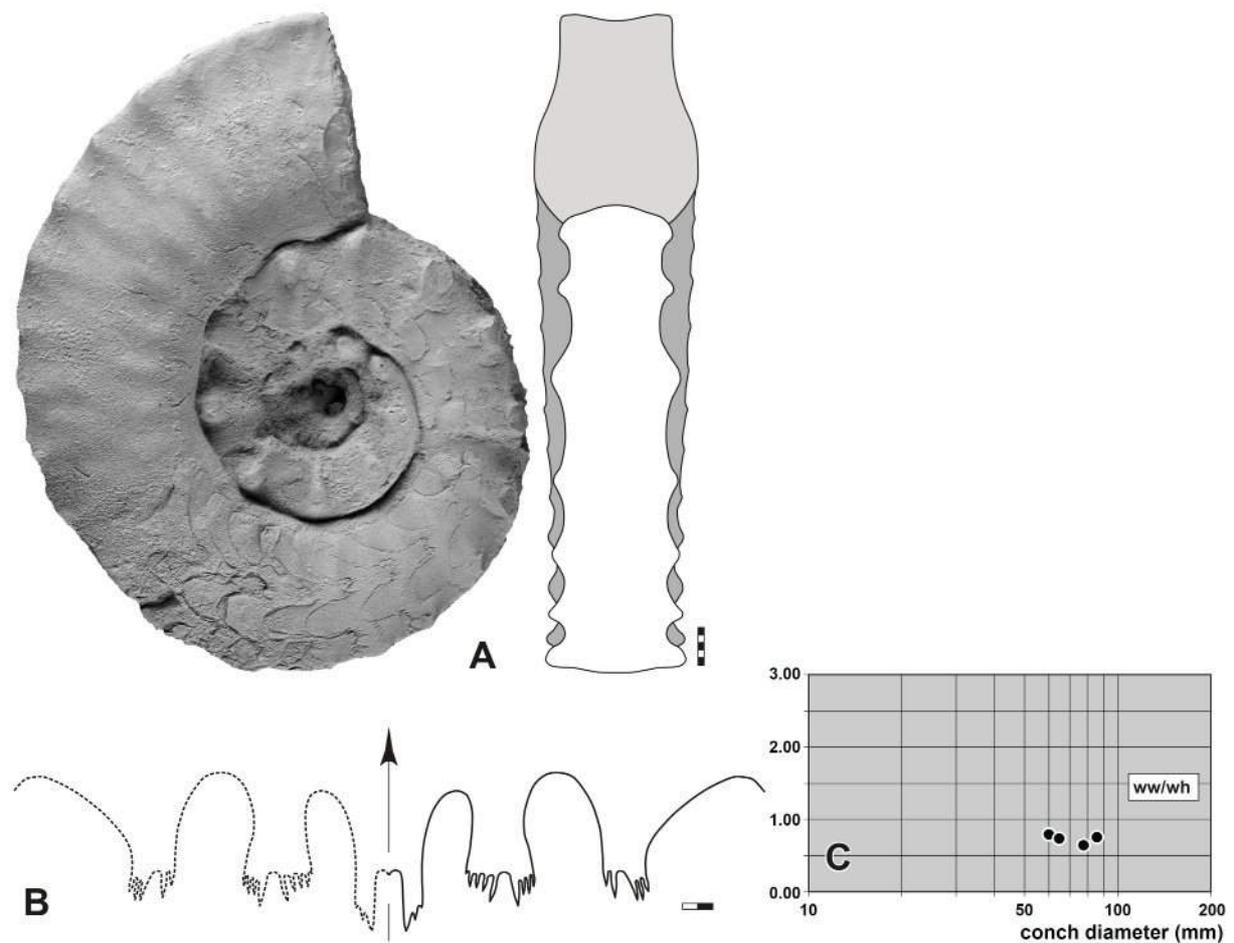


Fig. 53. *Lutites profundus* Korn & Hairapetian gen. et sp. nov. **A.** Lateral and dorsal view, holotype MB.C.30003, section E, float. **B.** Suture line, holotype MB.C.30003, at 60.0 mm dm, 19.6 mm wh. **C.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 27. Conch dimensions (partly estimated) and ratios of selected specimens of *Lutites profundus* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30005	95.0	–	32.0	40.4	30.5	–	–	0.43	2.17	0.05
MB.C.30005	65.0	16.5	22.5	27.3	–	0.25	0.73	0.42	–	–
MB.C.30003	86.2	21.2	28.2	37.8	27.7	0.25	0.75	0.44	2.17	0.02
MB.C.30003	60.2	16.2	20.5	24.8	–	0.27	0.79	0.41	–	–
MB.C.30002	78.0	18.0	28.0	33.0	–	0.23	0.64	0.42	–	–

shoulder. The venter is concave in this growth stage. Half a volution back the venter is flat and another half whorl back, a rounded venter can be seen belonging to a subcircular, compressed whorl section ($ww/wh=0.80$). The sculpture experiences a change in strength during the last volution. The penultimate volution has ten coarse ventrolateral nodes, which are connected with weak and rounded radial ribs. These nodes become weaker and more numerous at the end of the phragmocone, but they are still present on the body chamber (12 on a distance of 120 degrees). Here, they are elongate and alternate, in their positions, with low umbilical ribs.

The suture line of the holotype has a narrow and deep external lobe (deeper than the adventive lobe) with parallel flanks in the lower part. Its prongs are parallel-sided with asymmetric base and possesses three small notches. The ventrolateral saddle is narrow and asymmetric; it borders the adventive lobe that is widest near its base. It shows two groups of five very narrow notches. The nearly symmetric and inverted U-shaped lateral saddle is higher than the ventrolateral saddle. The asymmetric lateral lobe with less steep dorsal flank has also two groups of narrow notches, a ventral group with two and a dorsal group with three notches (Fig. 53B).

Remarks

Lutites profundus gen. et sp. nov. is similar to *L. lyriformis* gen. et sp. nov. but differs in the much coarser sculpture of the terminal body chamber, which shows only very weak ribs in the latter species but ventrolateral nodes in *L. profundus* gen. et sp. nov. All the other species of *Lutites* gen. nov. with a slender conch also show a much weaker sculpture.

Stratigraphic range

Upper part of the Hambast Formation; 1.60 to 1.20 m below the extinction horizon (*Lutites profundus* Zone).

Lutites alius Korn & Hairapetian gen. et sp. nov.

urn:lsid:zoobank.org:act:393BE629-C3CF-4FED-A221-1FFD673C8636

Fig. 54, Table 28

Diagnosis

Species of *Lutites* gen. nov. with conch reaching 130 mm dm. Subadult stage with oval, compressed whorl profile ($ww/wh=0.60-0.70$) and rounded venter; very weak, rounded ribs. Adult stage with subtrapezoidal, compressed whorl profile ($ww/wh=0.50-0.60$), flat or concave venter and angular ventrolateral shoulder; very weak ribs. Prongs of external lobe simple; altogether about 17 notches of E, A and L lobes.

Etymology

From the Latin ‘*alius*’, meaning ‘different’, because of the different notching degree of the external and adventive lobes.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain E section; Hambast Formation; illustrated in Fig. 54A; MB.C.30013.

Paratypes

IRAN • 2 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.30009 to MB.C.30010 • 1 specimen; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.30011 • 1 specimen; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.30012 • 2 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation;

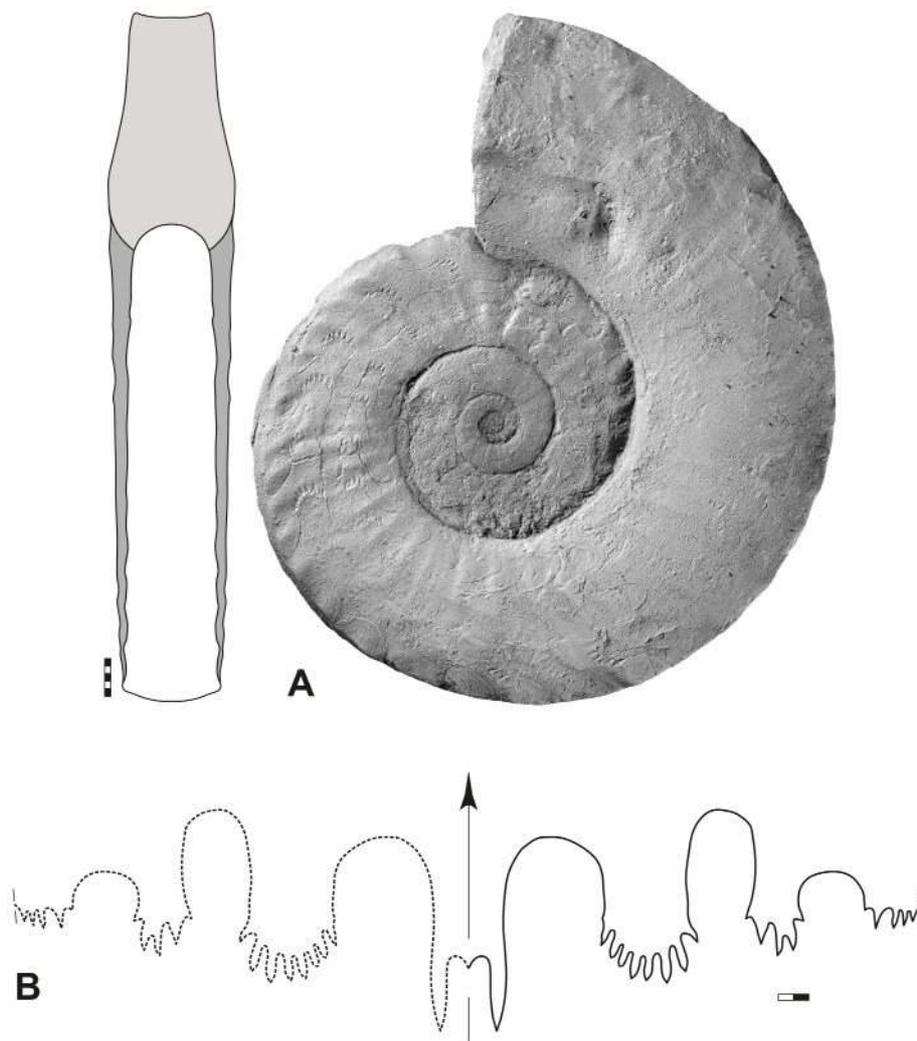


Fig. 54. *Lutites alius* Korn & Hairapetian gen. et sp. nov. **A.** Lateral and dorsal view, holotype specimen MB.C.30013, section E, float. **B.** Suture line, specimen MB.C.30013, at 64.3 mm dm, 13.5 mm ww, 22.6 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 28. Conch dimensions (partly estimated) and ratios of the holotype of *Lutites alius* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30013	90.5	17.0	30.5	36.5	28.4	0.19	0.56	0.40	2.12	0.07
MB.C.30013	64.4	15.0	22.5	25.1	–	0.23	0.67	0.39	–	–

MB.C.30014 to MB.C.30015 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30016 to MB.C.30017.

Description

Holotype MB.C.30013 has a conch diameter of 90 mm and allows the study of three and a half volutions (Fig. 54A). Less than half of the last whorl belongs to the body chamber. The conch is very slender ($ww/dm=0.19$) with a compressed whorl profile ($ww/wh=0.55$) that shows a concave venter bordered by an angular ventrolateral shoulder from the concave, converging flanks. One volution back, the compressed whorl profile is oval with rounded venter. The shell ornament does not change significantly during the last three volutions. It consists of fine, weakly sigmoidal ribs that are best visible on the inner flank and the ventrolateral margin, where they develop into weak nodes. These nodes disappear on the terminal body chamber.

The suture line of the holotype has a very narrow, parallel-sided and very deep (1.5 times of the adventive lobe) external lobe with very narrow, lanceolate and unsubdivided prongs. Both flanks of the inverted U-shaped ventrolateral saddle are parallel, and also the adventive and lateral lobes are parallel-sided. The adventive lobe has a semicircular base with eight small notches and the lateral lobe bears five notches (Fig. 54B).

Remarks

Lutites alius gen. et sp. nov. differs in the simple (non-subdivided prongs) and very deep external lobe from the other species of the genus. Furthermore, it lacks coarse ornament and possesses a very slender conch, which make a separation from other species easy.

Stratigraphic range

Upper part of the Hambast Formation; 1.70 to 1.20 m below the extinction horizon (*Lutites profundus* Zone).

Lutites plicatus Korn & Hairapetian gen. et sp. nov.

urn:lsid:zoobank.org:act:1713B70A-3C3C-4FCD-9827-BBBA6F989797

Fig. 55; Table 29

Diagnosis

Species of *Lutites* gen. nov. with conch reaching 120 mm dm. Subadult stage with oval, compressed whorl profile ($ww/wh=0.75$) and rounded venter; about 12 radial plications per volution. Adult stage with subtrapezoidal, compressed whorl profile ($ww/wh=0.72$), weakly concave flanks, flattened venter and subangular ventrolateral shoulder; numerous weak and densely arranged plications and small ventrolateral nodes. Prongs of external lobe multiply serrated; altogether 20 notches of E, A and L lobes.

Etymology

From the Latin '*plicatus*', meaning 'corrugated', referring to the dense ribbing.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain E section; Hambast Formation; illustrated in Fig. 55A; MB.C.30018.

Description

Holotype MB.C.30018 is a specimen with 84 mm diameter, of which the last 120 degrees belong to the body chamber (Fig. 55A). Nearly one volution of the phragmocone can be studied; at this stage the whorl profile is oval and compressed with a rounded venter. The ornament consists of nearly 20 faint radial plications, which are coarsest near the umbilicus and in the ventrolateral area, where they form weak nodes. The ornament is weaker on the body chamber, where the plications are more numerous. The whorl profile is subtrapezoidal and compressed ($ww/wh=0.72$) in the adult stage with a rounded umbilical margin, weakly concave flanks and a flattened venter.

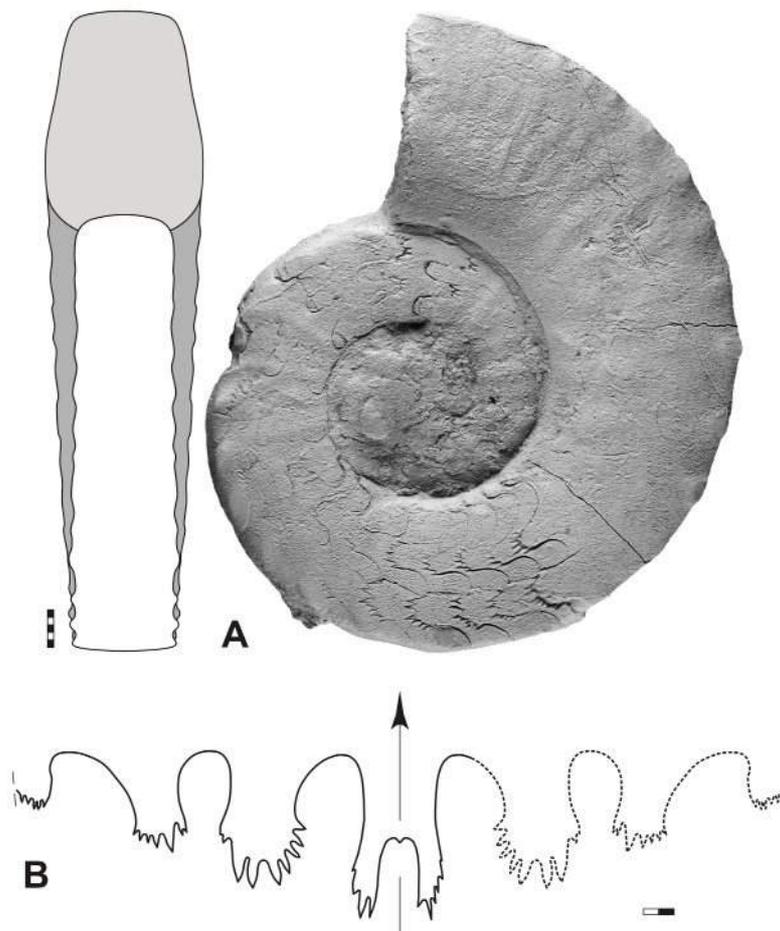


Fig. 55. *Lutites plicatus* Korn & Hairapetian gen. et sp. nov. **A.** Lateral and dorsal view, holotype MB.C.30018, section E, float. **B.** Suture line, holotype MB.C.30018, 13.7 mm ww, 18.6 mm wh. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Table 29. Conch dimensions (partly estimated) and ratios of the holotype of *Lutites plicatus* Korn & Hairapetian gen. et sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30018	84.3	20.7	28.7	34.5	26.7	0.25	0.72	0.41	2.14	0.07
MB.C.30018	59.7	15.3	20.5	23.2	–	0.26	0.75	0.39	–	–

The suture line of the holotype has a narrow external lobe with asymmetric, multiply serrated prongs (four and six small notches), an asymmetric and inflated ventrolateral saddle and multiply serrated adventive and lateral lobes (Fig. 55B). Both lobes show notches of various size.

Remarks

Lutites plicatus gen. et sp. nov. differs in the shape of the flattened, but convex venter from most of the other species of the genus (*L. lyriformis* gen. et sp. nov., *L. profundus* gen. et sp. nov., *L. alius* gen. et sp. nov.), which possess a completely flat or even concave venter.

Stratigraphic range

Upper part of the Hambast Formation; horizon unknown.

Genus *Abichites* Shevyrev, 1965

Type species

Kashmirites? stoyanowi Kiparisova in Voinova *et al.*, 1947, by original designation.

Included species

Abichites abichi Shevyrev, 1965; *Abichites alibashiensis* Korn & Ghaderi in Korn *et al.*, 2016; *Abichites ariaeii* Korn & Ghaderi in Korn *et al.*, 2016; *Abichites paucinodus* Korn & Ghaderi in Korn *et al.*, 2016; *Abichites shahriari* Korn & Ghaderi in Korn *et al.*, 2016; *Kashmirites? stoyanowi* Kiparisova in Voinova *et al.*, 1947; *Abichites subtrapezoidalis* Korn & Ghaderi in Korn *et al.*, 2016; *Abichites terminalis* Korn & Ghaderi in Korn *et al.*, 2016; *Abichites ovalis* Korn & Hairapetian sp. nov.; *Abichites infirmus* Korn & Hairapetian sp. nov.

Diagnosis

Genus of the family Dzhulfitidae with small to moderately large conch; maximum adult diameters are between 30 and 90 mm. Adult stage with quadrate, rectangular or oval whorl profile. Subadult stage with weak to moderately strong lateral ribs; adult stage with weak ornament. Suture line with deep external lobe; the depths of external lobe and adventive lobe are nearly identical.

Remarks

The morphological range of the genus *Abichites* was discussed by Korn & Ghaderi (in Korn *et al.* 2016).

Abichites abichi Shevyrev, 1965

Fig. 56; Table 30

Abichites abichi Shevyrev, 1965: 181, pl. 24 fig. 4.

Xenodiscus aff. *kapila* – Stoyanow 1910: 87, pl. 9 fig. 3.

Abichites abichi – Shevyrev 1968: 96, pl. 4 fig. 4. — Korn & Ghaderi in Korn *et al.* 2016: 878, text-fig. 35.

Diagnosis

Species of *Abichites* with conch reaching 75 mm dm. Subadult stage with subquadrate, weakly depressed to compressed whorl profile ($ww/wh=1.20$) and slightly flattened venter; with 15 rounded straight ribs on the flanks. Adult stage with quadrate whorl profile ($ww/wh=1.00$), parallel flanks and flattened venter; with weak rounded ribs on the flanks. Prongs of external lobe usually simple; 7–12 notches of E, A and L lobes.

Type material

Holotype

AZERBAIJAN • Nakhichevan Province, Dorasham 2 section; *Paratirolites* Limestone; illustrated by Shevyrev (1965: pl. 24 fig. 4); PIN 1252/137.

Material examined

IRAN • 4 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.30019 to MB.C.30022 • 1 specimen; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.30023 • 5 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30024 to MB.C.30028 • 6 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30029 to MB.C.30034 • 4 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30035 to MB.C.30038 • 2 specimens; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.30039 to MB.C.30040.

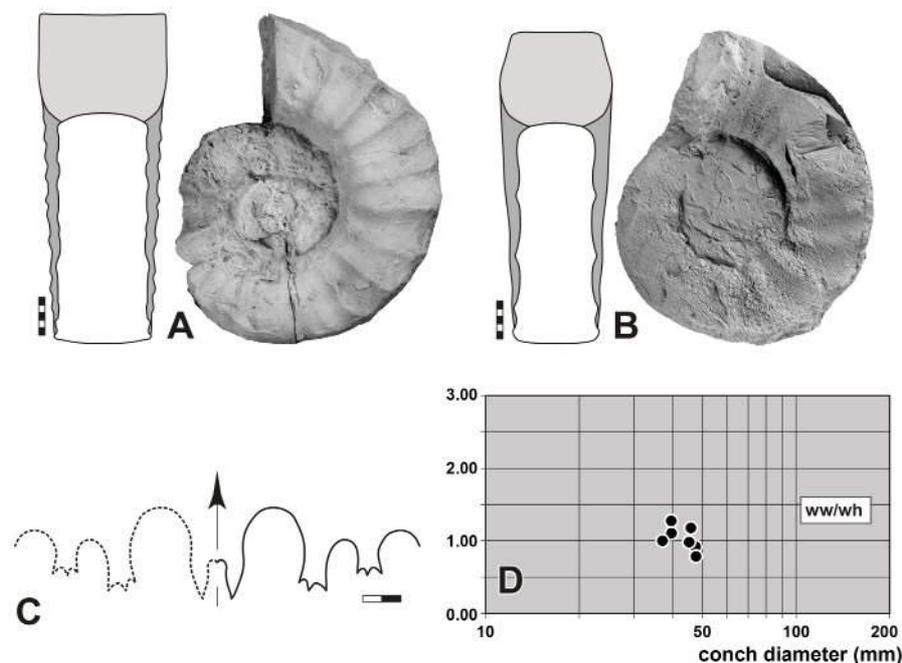


Fig. 56. *Abichites abichi* Shevyrev, 1965. **A.** Lateral and dorsal view, specimen MB.C.30039, section H, -1.30 m. **B.** Lateral and dorsal view, specimen MB.C.30019, section 1, -0.90 m. **C.** Suture line, specimen MB.C.30019, at 7.7 mm wh. **D.** Whorl profile proportions. Abbreviation: see Material and methods. Scale bar units=1 mm.

Table 30. Conch dimensions (partly estimated) and ratios of the holotype of *Abichites abichi* Shevyrev, 1965 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30019	39.8	14.4	13.1	16.3	12.7	0.36	1.10	0.41	2.16	0.03
MB.C.30028	47.7	12.2	15.6	20.0	15.0	0.26	0.78	0.42	2.13	0.04
MB.C.30027	47.6	15.7	17.2	19.7	16.5	0.33	0.91	0.41	2.34	0.04
MB.C.30023	46.0	18.9	16.2	20.2	15.2	0.41	1.17	0.44	2.23	0.06
MB.C.30038	45.4	14.6	15.0	18.9	14.0	0.32	0.97	0.42	2.09	0.07
MB.C.30036	37.2	12.3	12.4	15.7	11.6	0.33	0.99	0.42	2.11	0.06

Description

Specimen MB.C.30039 has 44 mm diameter and is a fragment of half a volution (Fig. 56A). However, it allows the study of the conch shape with a nearly quadrate whorl profile. On half of a volution there are twelve sharp radial ribs, which are coarsest in the outer flank.

Specimen MB.C.30019 has 40 mm conch diameter and allows the study of only one volution (Fig. 56B). The whorl profile is subtrapezoidal with broadly rounded umbilical margin, weakly converging flanks, a subangular ventrolateral shoulder and a flat venter. The sculpture is weaker than in the first specimen and the ribs are coarsest on the inner flank.

The suture line of specimen MB.C.30019 is characterised by a large external lobe, of which the flanks stand parallel in the middle part. Its prongs are narrowly V-shaped and non-serrated. After a ventrolateral saddle that is as wide as the external lobe follow a small, nearly parallel-sided adventive lobe with three notches, a small lateral saddle and a small parallel-sided lateral lobe with three notches (Fig. 56C).

Remarks

Abichites abichi differs from the otherwise similar species *A. subtrapezoidalis* in the quadrate adult whorl profile (subtrapezoidal in *A. subtrapezoidalis*). The body chamber of *A. abichi* has stronger ribs than *A. subtrapezoidalis* does. *A. alibashiensis* has a similar body chamber, but differs from *A. abichi* in the coarse ventrolateral nodes of the subadult stage.

Stratigraphic range

Upper part of the Hambast Formation; 1.20 to 0.05 m below the extinction horizon (*Abichites abichi* Zone to *Arasella minuta* Zone).

Abichites alibashiensis Korn & Ghaderi in Korn *et al.*, 2016

Fig. 57; Table 31

Abichites alibashiensis Korn & Ghaderi in Korn *et al.*, 2016: 879, text-fig. 36.

Diagnosis

Species of *Abichites* with conch reaching 85 mm dm. Subadult stage with broadly oval, weakly depressed whorl profile ($ww/wh=1.10-1.30$) and rounded venter; 12–15 ventrolateral nodes per volution. Adult stage with quadrate of weakly subtrapezoidal, weakly compressed whorl profile ($ww/wh=0.80-1.25$),

flattened venter and subangular to angular ventrolateral shoulder; sharp ribs. Prongs of external lobe simple or bifid; altogether 7–11 notches of E, A and L lobes.

Material examined

Holotype

IRAN • East Azerbaijan, Ali Bashi N section; *Paratirolites* Limestone, 1.40 m below the top; illustrated by Korn & Ghaderi in Korn *et al.* (2016: text-fig. 36a); MB.C.25399.

Additional material

IRAN • 2 specimens; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.30041 to MB.C.30042 • 3 specimens; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.30043 to MB.C.30045 • 3 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30046 to MB.C.30048 • 5 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30049 to MB.C.30053 • 1 specimen; Esfahan Province, Baghuk Mountain F section; Hambast Formation; MB.C.30054 • 4 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30055 to MB.C.30058.

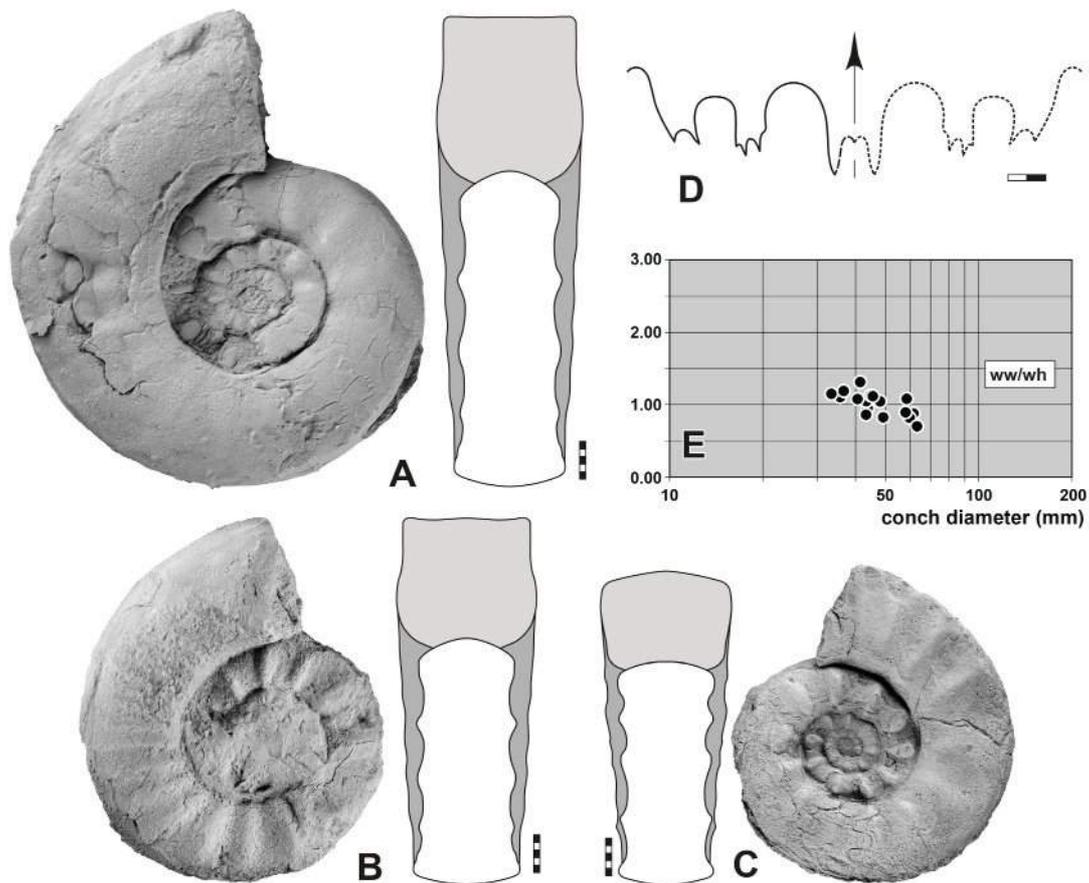


Fig. 57. *Abichites alibashiensis* Korn & Ghaderi, 2016. **A.** Lateral and dorsal view, specimen MB.C.30051, section E, float. **B.** Lateral and dorsal view, specimen MB.C.30046, section C, -0.50 m. **C.** Lateral and dorsal view, specimen MB.C.30045, section B, float. **D.** Suture line, specimen MB.C.30046, at 10.1 mm wh. **E.** Whorl profile proportions. Abbreviation: see Material and methods. Scale bar units = 1 mm.

Table 31. Conch dimensions (partly estimated) and ratios of selected specimens of *Abichites alibashiensis* Korn & Ghaderi in Korn *et al.* (2016) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30051	61.9	18.8	21.5	25.6	20.2	0.30	0.87	0.41	2.20	0.06
MB.C.30046	48.2	17.2	16.6	19.4	15.9	0.36	1.04	0.40	2.23	0.04
MB.C.30049	43.5	15.3	14.7	17.2	14.0	0.35	1.04	0.40	2.17	0.05
MB.C.30045	41.5	17.1	13.2	17.3	12.8	0.41	1.30	0.42	2.09	0.03
MB.C.30048	36.7	14.4	12.2	16.5	11.8	0.39	1.18	0.45	2.17	0.03
MB.C.30047	63.5	15.8	22.6	24.4	21.8	0.25	0.70	0.38	2.32	0.04
MB.C.30057	60.1	18.0	22.1	22.5	20.9	0.30	0.81	0.37	2.35	0.05
MB.C.30058	58.8	20.4	19.0	24.2	18.8	0.35	1.07	0.41	2.16	0.01
MB.C.30041	58.3	15.8	17.8	24.2	16.8	0.27	0.89	0.42	1.97	0.06
MB.C.30050	45.7	17.4	15.7	18.9	15.0	0.38	1.11	0.41	2.22	0.04
MB.C.30052	43.4	13.0	15.2	18.5	14.5	0.30	0.86	0.43	2.26	0.05
MB.C.30043	33.5	14.6	12.8	15.2	12.1	0.44	1.14	0.45	2.45	0.05

Description

Specimen MB.C.30051 has 62 mm conch diameter and is rather well preserved with about 190 degrees of the body chamber visible (Fig. 57A). The whorl profile of the terminal body chamber has a broadly rounded umbilical margin, weakly concave flanks that are gently converging towards the flat venter, which is delimited by an angular ventrolateral shoulder. In the phragmocone, the whorl profile is oval with a broadly rounded venter. The change of the sculpture from the subadult stage with coarse ventrolateral nodes (12 per volution) towards the adult stage with only weak ribs on the flank happens already before the beginning of the terminal body chamber.

Specimen MB.C.30046 is smaller (48 mm dm) and shows the transformation from the subadult stage with rounded ventrolateral margin to the adult stage with quadrate whorl profile, in which the venter is flat and separated from the flanks by an angular margin (Fig. 57B). The sculpture of the subadult stage possesses prominent ribs (about 13 per volution), which weaken out on the terminal body chamber. The suture line of specimen MB.C.30046 shows a simply subdivided external lobe with narrow, V-shaped prongs, a broadly rounded parabolic ventrolateral saddle and asymmetric, weakly serrated adventive and lateral lobes (Fig. 57D).

Remarks

Abichites alibashiensis differs from *A. abichi*, *A. stoyanowi* and *A. subtrapezoidalis* in the sharp ribs, which tend to end in ventrolateral nodes, in the subadult stage. Species of *Alibashites* possess subadult ribs but also ventrolateral nodes; these are *A. mojsisovicsi* (with very weak adult ribs) and *A. ferdowsii* (with a much more depressed whorl profile).

Stratigraphic range

Upper part of the Hambast Formation; 1.15 to 0.40 m below the extinction horizon (*Abichites abichi* Zone to lowest part of the *Arasella minuta* Zone).

Abichites ovalis Korn & Hairapetian sp. nov.

urn:lsid:zoobank.org:act:983F405A-033F-49EB-8D75-E5F917F23D86

Fig. 58; Table 32

Diagnosis

Species of *Abichites* with conch reaching 85 mm dm. Subadult stage with subcircular, weakly compressed whorl profile ($ww/wh=0.80-1.00$) and rounded venter; about 12 shallow and rounded radial ribs. Adult stage with parallel sided or weakly trapezoidal, weakly compressed whorl profile ($ww/wh=0.80-1.00$), rounded venter and narrowly rounded ventrolateral shoulder; shallow wide ribs on the flank. Prongs of external lobe simple; altogether 7–11 notches of E, A and L lobes.

Etymology

From the Latin ‘*ovalis*’, meaning ‘oval’, because of the oval whorl profile in the subadult stage.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain B section; Hambast Formation; illustrated in Fig. 58A; MB.C.30059.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain B section; Hambast Formation; MB.C.30060 • 3 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30061 to MB.C.30063 • 6 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30064 to MB.C.30069 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30070 to MB.C.30071 • 1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.30072.

Description

Holotype MB.C.30059 is a rather well-preserved specimen with 62 mm conch diameter; the phragmocone diameter is 44 mm and 190 degrees of the body chamber are preserved (Fig. 58A). The adult whorl profile is weakly trapezoidal with gently diverging, slightly concave flanks, a rounded ventrolateral shoulder and a slightly flattened but broadly rounded venter. One volution earlier, the whorl profile is subcircular and weakly compressed ($ww/wh=0.90$). The sculpture on the phragmocone consists of 12 shallow and rounded radial ribs per volution. They become weaker on the body chamber but develop to elongate, rather sharp nodes on the outer flank.

The suture line of holotype MB.C.30059 shows an external lobe with flanks standing parallel in the lower part and diverging in the upper part. The prongs are very narrow, lanceolate and not secondarily serrated. On the outer flank lies the symmetric adventive lobe with semicircular, strongly serrated base; it is followed by a rather high lateral saddle and a parallel-sided lateral lobe with five small notches (Fig. 58C).

Paratype MB.C.30071 has 60 mm conch diameter and is, with its weakly trapezoidal whorl profile and the general conch shape very similar to the previous one but has a more slender conch ($ww/wh=0.85$). It shows, in the inner whorls, weak ventrolateral nodes connected to the shallow radial ribs (Fig. 58B).

Remarks

Abichites ovalis sp. nov. closely resembles *A. paucinodum*, but differs in the whorl profile (diverging flanks in *A. ovalis* sp. nov. but converging in *A. paucinodum*), the wider umbilicus in *A. ovalis* sp. nov. and in the rounded venter in *A. ovalis* sp. nov. (flat in *A. paucinodum*).

Table 32. Conch dimensions (partly estimated) and ratios of selected specimens of *Abichites ovalis* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30059	61.8	18.1	20.4	26.0	19.5	0.29	0.89	0.42	2.13	0.04
MB.C.30071	59.5	16.3	19.7	25.5	18.7	0.27	0.83	0.43	2.13	0.05
MB.C.30061	42.8	14.1	14.7	16.5	14.1	0.33	0.95	0.39	2.22	0.04
MB.C.30060	48.8	14.5	18.1	19.4	17.0	0.30	0.80	0.40	2.35	0.06
MB.C.30065	42.7	10.7	15.0	17.0	14.0	0.25	0.71	0.40	2.21	0.07
MB.C.30064	42.4	13.4	15.4	17.0	14.5	0.32	0.87	0.40	2.31	0.06
MB.C.30070	39.3	12.7	13.8	14.6	13.0	0.32	0.92	0.37	2.23	0.06

Stratigraphic range

Upper part of the Hambast Formation; 0.75 to 0.40 m below the extinction horizon (*Abichites stoyanowi* Zone to lowest part of the *Arasella minuta* Zone).

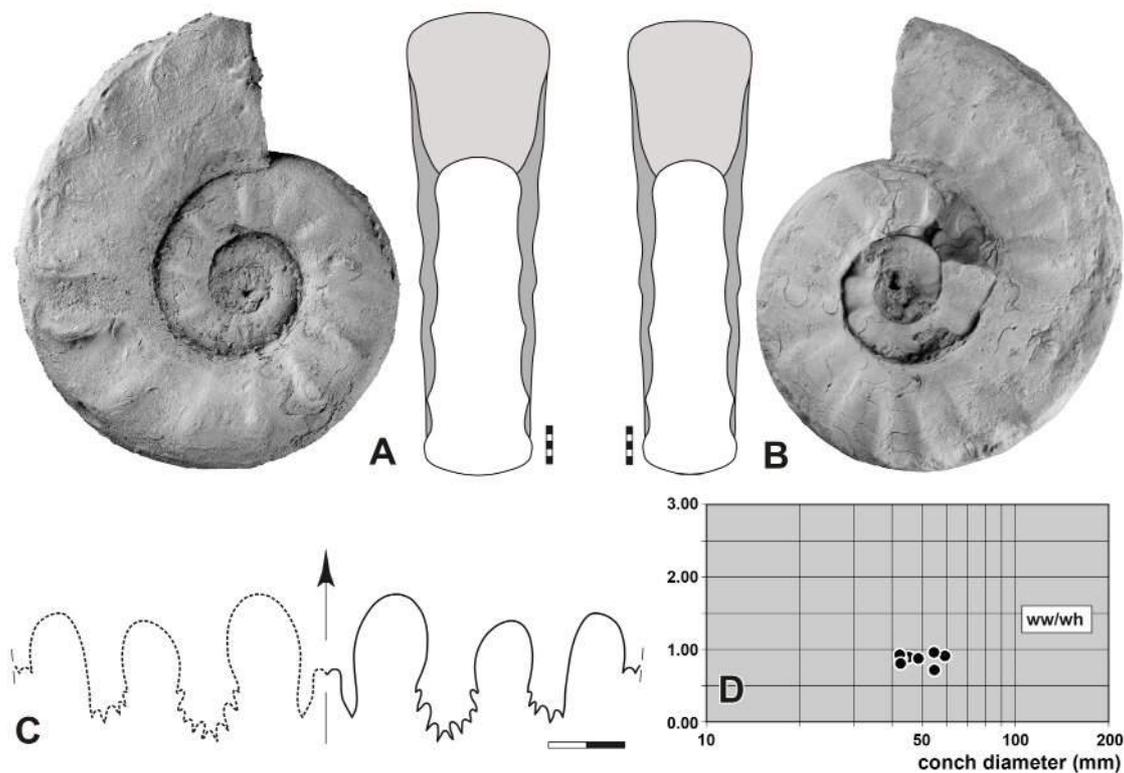


Fig. 58. *Abichites ovalis* Korn & Hairapetian sp. nov. **A.** Lateral and dorsal view, holotype MB.C.30059, section B, float. **B.** Lateral and dorsal view, paratype MB.C.30071, section G, -0.40 m. **C.** Suture line, holotype MB.C.30059, at 14.2 mm wh. **D.** Whorl profile proportions. Abbreviation: see Material and methods. Scale bar units = 1 mm.

Abichites stoyanowi (Kiparisova in Voinova *et al.*, 1947)
Fig. 59; Table 33

Kashmirites? *stoyanowi* Kiparisova in Voinova *et al.*, 1947: 149, pl. 35 fig. 1.

Xenodiscus radians – Stoyanow 1910: 86, pl. 9 fig. 5.

Xenodiscus sp. indet. Stoyanow 1910: 87, pl. 9 fig. 6.

Abichites stoyanowi – Shevyrev 1965: 179, pl. 24 figs 2–3; 1968: 94, pl. 3 fig. 5, pl. 4 fig. 2. — Korn in Ghaderi *et al.* 2014: text-fig. 7h. — Korn & Ghaderi in Korn *et al.* 2016: 881, text-fig. 38.

Diagnosis

Species of *Abichites* with conch reaching 70 mm dm. Subadult stage with circular, weakly compressed whorl profile ($ww/wh=0.75-1.00$) and rounded venter; 16–20 moderately weak ribs per volution. Adult stage with quadrate and weakly compressed whorl profile ($ww/wh=0.90-1.00$), flat venter and subangular to angular ventrolateral shoulder; altogether 12–14 sharp concavo-convex ribs per half volution on flanks. Prongs of external lobe simple or bifid; 6–11 notches of E, A and L lobes.

Material examined

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.30073 • 2 specimens; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30074 to MB.C.30075 • 3 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30076 to MB.C.30078 • 1 specimen; Esfahan Province, Baghuk Mountain F section; Hambast Formation; MB.C.30079 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30080 to MB.C.30081 • 1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.30082.

Description

Specimen MB.C.30078 has 62 mm conch diameter and is rather well-preserved with the last half volution belonging to the body chamber (Fig. 59A). This has a subtrapezoidal, weakly compressed whorl profile ($ww/wh=0.90$) with a broadly rounded umbilical margin, weakly concave converging flanks, an angular ventrolateral shoulder and a weakly concave venter. Two stages of the ornament are visible; the subadult stage has coarse node-like ribs on the flank, which in the adult stage become increasingly weaker and more numerous (15 per half volution at the beginning of the body chamber).

The suture line of specimen MB.C.30078 has a large external lobe with weakly diverging flanks and unsubdivided lanceolate prongs. The inverted U-shaped ventrolateral saddle is dorsally inclined and is followed by the pouched adventive lobe that has a very oblique base subdivided into three very shallow blunt notches. In contrast, the three notches of the parallel-sided lateral lobe are pointed denticles (Fig. 59E).

The two smaller specimens MB.C.30074 (31 mm dm; Fig. 59D) and MB.C.30081 (34 mm dm; Fig. 59B) have similar conch shapes and proportions; they differ in the somewhat weaker sculpture.

Remarks

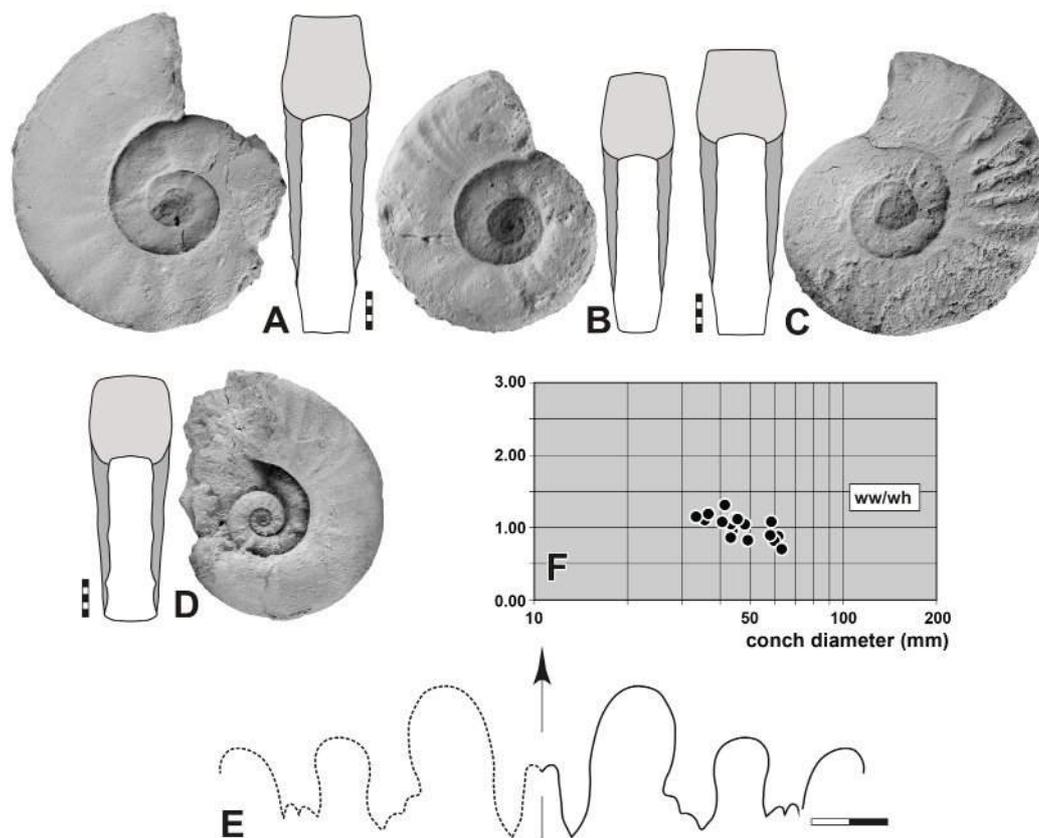
Abichites stoyanowi differs from *A. abichi*, which is another similar species with moderately coarse sculpture, in the much weaker ribs. *Abichites subtrapezoidalis* has a similar whorl profile, but only very weak riblets around the umbilicus on the adult body chamber.

Stratigraphic range

Upper part of the Hambast Formation; 0.80 to 0.05 m below the extinction horizon (*Abichites stoyanowi* Zone to lowest part of the *Arasella minuta* Zone).

Table 33. Conch dimensions (partly estimated) and ratios of selected specimens of *Abichites stoyanowi* (Kiparisova in Voinova *et al.*, 1947) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30078	41.1	11.8	14.6	17.8	13.4	0.29	0.81	0.43	2.20	0.08
MB.C.30079	37.7	12.4	13.3	14.8	12.2	0.33	0.93	0.39	2.19	0.08
MB.C.30081	33.8	9.7	13.1	13.6	11.2	0.29	0.74	0.40	2.24	0.15
MB.C.30074	30.9	9.9	11.6	11.7	10.6	0.32	0.86	0.38	2.31	0.09
MB.C.30077	46.3	13.1	15.8	18.9	15.0	0.28	0.83	0.41	2.19	0.05
MB.C.30076	41.0	10.6	12.8	16.7	12.2	0.26	0.83	0.41	2.03	0.05

**Fig. 59.** *Abichites stoyanowi* (Kiparisova, 1947). **A.** Lateral and dorsal view, specimen MB.C.30078, section G, -0.40 m. **B.** Lateral and dorsal view, specimen MB.C.30081, section G, -0.05 m. **C.** Lateral and dorsal view, specimen MB.C.30079, section F, -0.75 m. **D.** Lateral and dorsal view, specimen MB.C.30074, section C, -0.50 m. **E.** Suture line, specimen MB.C.30078, at 7.2 mm ww, 7.4 mm wh. **F.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units = 1 mm.

Abichites infirmis Korn & Hairapetian sp. nov.

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Fig. 60; Table 34

Diagnosis

Species of *Abichites* with conch reaching 50 mm dm. Subadult stage with oval, weakly compressed whorl profile (ww/wh=0.60–0.80) and rounded venter; very weak, rounded nodes. Adult stage with weakly subtrapezoidal, weakly compressed whorl profile (ww/wh=0.60–0.80) with weakly converging flat flanks, weakly flattened venter and narrowly subangular ventrolateral shoulder. Sculpture with faint plications. Prongs of external lobe simple; altogether 5–6 notches of E, A and L lobes.

Etymology

From the Latin ‘*infirmis*’, meaning ‘barely visible’, because of the weak sculpture.

Material examined

Holotype

IRAN • Esfahan Province, Baghuk Mountain G section; Hambast Formation, 0.40 m below the top; illustrated in Fig. 60A; MB.C.30086.

Paratypes

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain 1 section; Hambast Formation; MB.C.30083 • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30084 • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30085 • 2 specimens; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30087 to MB.C.30088.

Description

Holotype MB.C.30086 is a rather well-preserved specimen with 42 mm conch diameter (Fig. 60A). The whorl profile of the body chamber is subtrapezoidal with a narrowly rounded umbilical margin, flat and weakly converging flanks, a subangular ventrolateral shoulder and a flattened but still broadly rounded venter. Its ww/wh ratio is 0.70 and the whorl embraces the preceding one only weakly. The shell appears to be smooth except for very faint plications.

The suture line of the holotype has a parallel-sided external lobe that has a width/depth ratio of ~ 0.75. It is deeper than the adventive lobe and possesses unsubdivided lanceolate prongs. The ventrolateral

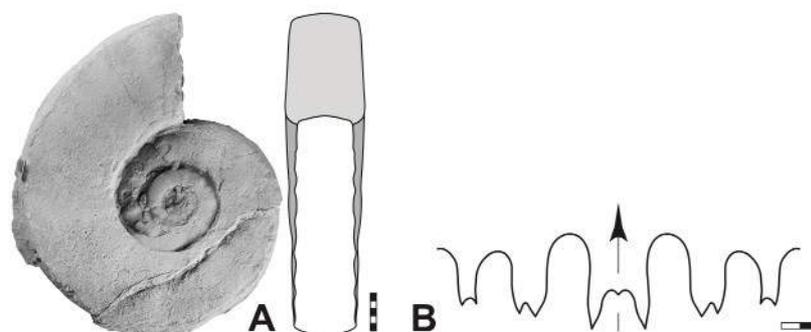


Fig. 60. *Abichites infirmis* Korn & Hairapetian sp. nov. **A.** Lateral and dorsal view, holotype MB.C.30086, section G, -0.40 m. **B.** Suture line, holotype MB.C.30086, at 21.5 mm dm, 9.1 mm wh. Abbreviations: see Material and methods. Scale bar units=1 mm.

Table 34. Conch dimensions (partly estimated) and ratios of selected specimens of *Abichites infirmis* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30086	41.6	10.4	14.7	15.5	13.6	0.25	0.71	0.37	2.21	0.07
MB.C.30088	36.9	8.8	13.2	13.6	12.3	0.24	0.67	0.37	2.25	0.07
MB.C.30087	33.6	7.7	12.4	12.6	11.4	0.23	0.62	0.38	2.29	0.08
MB.C.30083	33.1	9.4	12.4	13.3	11.3	0.28	0.76	0.40	2.31	0.09

saddle is inverted U-shaped and symmetric and the weakly asymmetric, parallel-sided adventive lobe is subdivided into two secondary notches. The narrow lateral saddle is also inverted U-shaped and followed by a parallel-sided lateral lobe with two notches (Fig. 60B).

Remarks

Abichites infirmis differs from most of the species of the genus in the lack of coarse ribs or nodes. Similar species are *A. paucinodus* (which possesses few coarse nodes on the flanks) and *A. terminalis* (with an oval whorl profile).

Stratigraphic range

Upper part of the Hambast Formation; 0.40 to 0.05 m below the extinction horizon (*Arasella minuta* Zone).

Genus *Stoyanowites* Korn in Ghaderi *et al.*, 2014

Type species

Paratirolites dieneri Stoyanow, 1910, by original designation

Included species

Stoyanowites aspinosus Korn & Ghaderi in Korn *et al.*, 2016; *Paratirolites dieneri* Stoyanow, 1910; *Stoyanowites parallelus* Korn & Hairapetian sp. nov.

Diagnosis

Genus of the family Dzhulfitidae with moderately large conch; maximum adult diameters are between 80 and 95 mm. Subadult and adult stages with rectangular and compressed whorl profile. Subadult stage with weak to moderately strong lateral ribs; adult stage with weak ornament. Suture line with an external lobe that is much shorter than the adventive lobe.

Remarks

Stoyanowites is separated from most of the other genera of the family Dzhulfitidae by the short external lobe, which does not reach the depth of the adventive and lateral lobes. Only *Dzhulfites* is similar in this respect, but this genus is characterised by coarse ventrolateral nodes absent in *Stoyanowites*.

Stoyanowites dieneri (Stoyanow, 1910)

Fig. 61, Table 35

Paratirolites Dieneri Stoyanow, 1910: 83, pl. 8 fig. 2.

Paratirolites dieneri – Spath 1934: 366, text-fig. 125e. — Shevryev 1965: 178, pl. 23 figs 2–3; 1968: 93, pl. 3 figs 2–3.

Stoyanowites dieneri – Korn in Ghaderi *et al.* 2014: text-fig. 7F. — Korn & Ghaderi in Korn *et al.* 2016: 884, text-fig. 42.

Paratirolites mojsisovicsi – Teichert & Kummel in Teichert *et al.* 1973: pl. 7 fig. 1.

Diagnosis

Species of *Stoyanowites* with conch reaching 120 mm dm. Subadult stage with oval, weakly compressed whorl profile ($ww/wh=0.70-0.80$) and rounded venter; 16 fine ribs forming weak and rounded dorsolateral and ventrolateral nodes. Adult stage with parallel flanks and weakly compressed whorl profile ($ww/wh=0.60-0.70$), rounded venter and subangular ventrolateral shoulder; weak dorsolateral nodes. Prongs of external lobe bifid; altogether 10–16 notches of E, A and L lobes; external lobe shorter than adventive lobe.

Material examined

IRAN • 3 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30089 to MB.C.30091 • 1 specimen; Esfahan Province, Baghuk Mountain H section; Hambast Formation; MB.C.30092 • 4 specimens; Esfahan Province, Baghuk Mountain section; Hambast Formation; MB.C.30093 to MB.C.30096.

Description

Specimen MB.C.30090 has 74 mm conch diameter and is fairly well preserved if partly crushed and weathered (Fig. 61A). Nearly half of the last volution belongs to the body chamber. At the end of the preserved part of the body chamber, the whorl profile is compressed ($ww/wh=0.70$) and has nearly parallel, only weakly converging flanks, a subangular ventrolateral shoulder and a flat venter. One volution earlier, the whorl profile is oval with rounded venter. The sculpture on the body chamber consists of faint radial riblets and pronounced isolated ventrolateral spines, ten per half volution. The penultimate volution is corroded, but it appears that the sculpture is weaker than on the terminal body chamber.

The suture line of specimen MB.C.30090 has the characteristic short external lobe with bifid, nearly parallel-sided prongs (Fig. 61C). Both the adventive lobe and the lateral lobe are also nearly parallel-sided, they show four small notches.

The smaller specimen MB.C.30089 has a weaker sculpture than the preceding specimen (Fig. 61B). It shows weak ventrolateral spines and weak radial plications on the flank. Its suture line has a weakly pouched, short external lobe with bifid prongs; the pouched adventive lobe and the parallel-sided lateral lobes are trifold (Fig. 61D).

Remarks

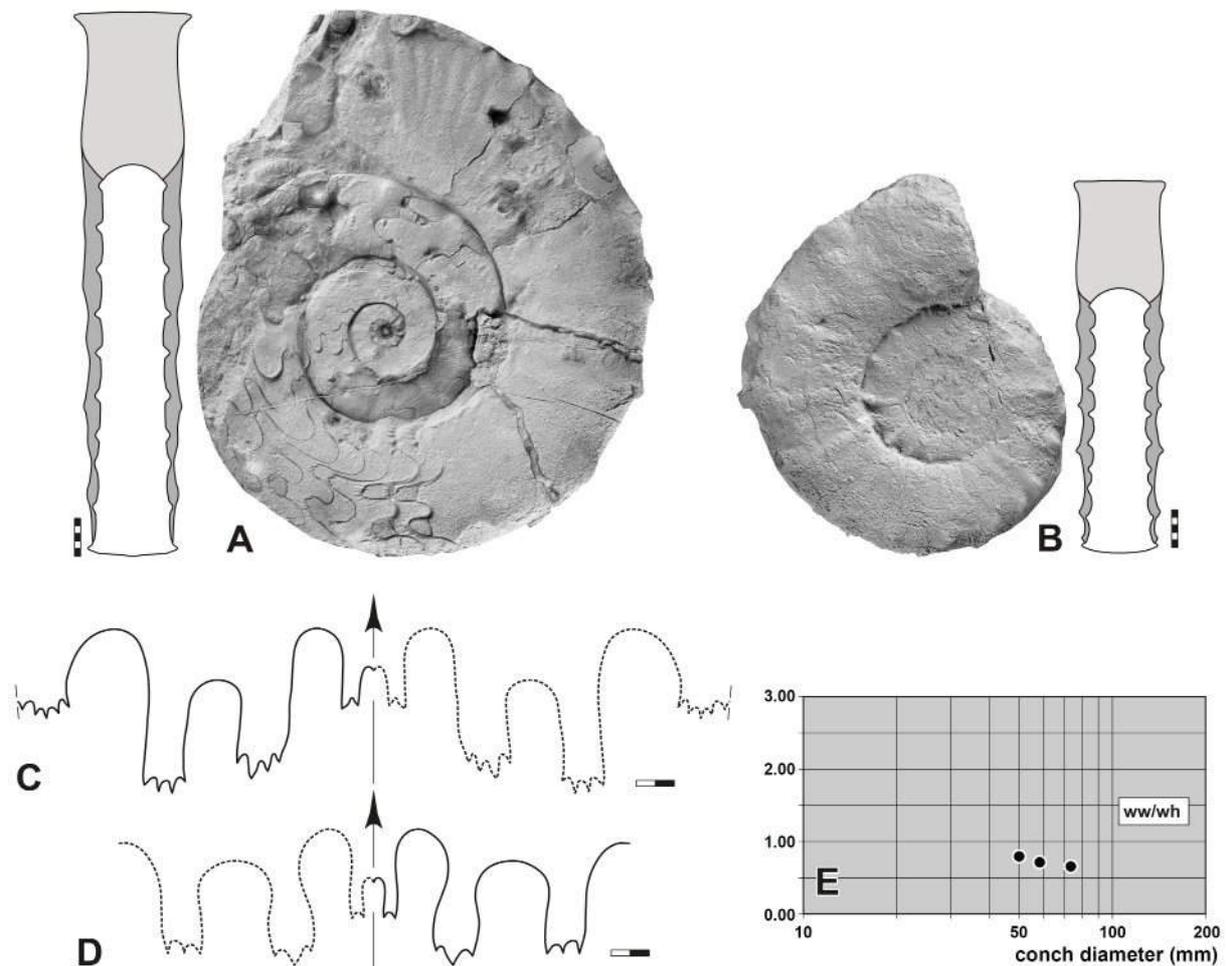
Stoyanowites dieneri differs from *S. aspinosus*, which is clearly separated from *S. dieneri* because of its wider umbilicus and the lack of spines. *Stoyanowites parallelus* sp. nov. differs in the flat venter and the more numerous ribs and ventrolateral spines.

Stratigraphic range

Upper part of the Hambast Formation; the only one in situ collected specimen comes from 1.80 m below the extinction horizon (*Alibashites ferdowsii* Zone).

Table 35. Conch dimensions (partly estimated) and ratios of selected specimens of *Stoyanowites dieneri* (Stoyanow, 1910) from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30090	74.0	14.8	23.3	32.4	22.6	0.20	0.64	0.44	2.07	0.03
MB.C.30090	58.8	13.3	19.1	28.2	–	0.23	0.70	0.48	–	–
MB.C.30089	49.8	13.0	17.5	21.5	15.8	0.26	0.74	0.43	2.15	0.10
MB.C.30093	79.4	–	25.0	34.8	24.0	–	–	0.44	2.05	0.04
MB.C.30091	60.6	–	18.8	27.6	18.0	–	–	0.46	2.02	0.04
MB.C.30096	47.5	–	15.7	20.7	15.0	–	–	0.44	2.14	0.04

**Fig. 61.** *Stoyanowites dieneri* (Stoyanow, 1910). **A.** Lateral and dorsal view, specimen MB.C.30090, section E, float. **B.** Lateral and dorsal view, specimen MB.C.30089, section E, float. **C.** Suture line, specimen MB.C.30090, at 12.4 mm ww, 17.4 mm wh. **D.** Suture line, specimen MB.C.30089, at 14.4 mm wh. **E.** Whorl profile proportions. Abbreviations: see Material and methods. Scale bar units=1 mm.

Stoyanowites aspinosus Korn & Ghaderi in Korn *et al.*, 2016

Fig. 62; Table 36

Stoyanowites aspinosus Korn & Ghaderi in Korn *et al.*, 2016: 885, text-fig. 43.

Diagnosis

Species of *Stoyanowites* with conch reaching 100 mm dm. Subadult stage with oval, weakly compressed whorl profile (ww/wh=0.70) and rounded venter; 15 narrow and rounded ribs on the flanks. Adult stage with oval and weakly compressed whorl profile (ww/wh=0.60–0.70) and moderately wide to wide umbilicus (uw/dm=0.40–0.50), rounded venter and rounded ventrolateral shoulder; very weak ribs on the flanks, coarsest in ventrolateral area. Prongs of external lobe bifid; 8–9 notches of E, A and L lobes.

Material examined

Holotype

IRAN • West Azerbaijan, Aras Valley section; *Paratirolites* Limestone, 0.95 m below the top; illustrated by Korn & Ghaderi in Korn *et al.* (2016: text-fig. 43a); MB.C.25458.

Additional material

IRAN • 1 specimen; Esfahan Province, Baghuk Mountain I section; Hambast Formation; MB.C.300978 • 2 specimens; Esfahan Province, Baghuk Mountain A section; Hambast Formation; MB.C.30098 to MB.C.30099 • 1 specimen; Esfahan Province, Baghuk Mountain C section; Hambast Formation; MB.C.30100 • 1 specimen; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30101.

Description

Specimen MB.C.30100 is a fragmentary specimen with 72 mm diameter and shows the wide umbilicus (uw/dm=0.50), the nearly parallel-sided whorl profile and the rounded venter. The ornament of the last half volution consists of numerous (about 25) rather sharp ribbles, which extend with a shallow sinus across the flanks and turn forward in the ventrolateral area, where they become coarser and form a hook-like rib (Fig. 62A). The venter is smooth.

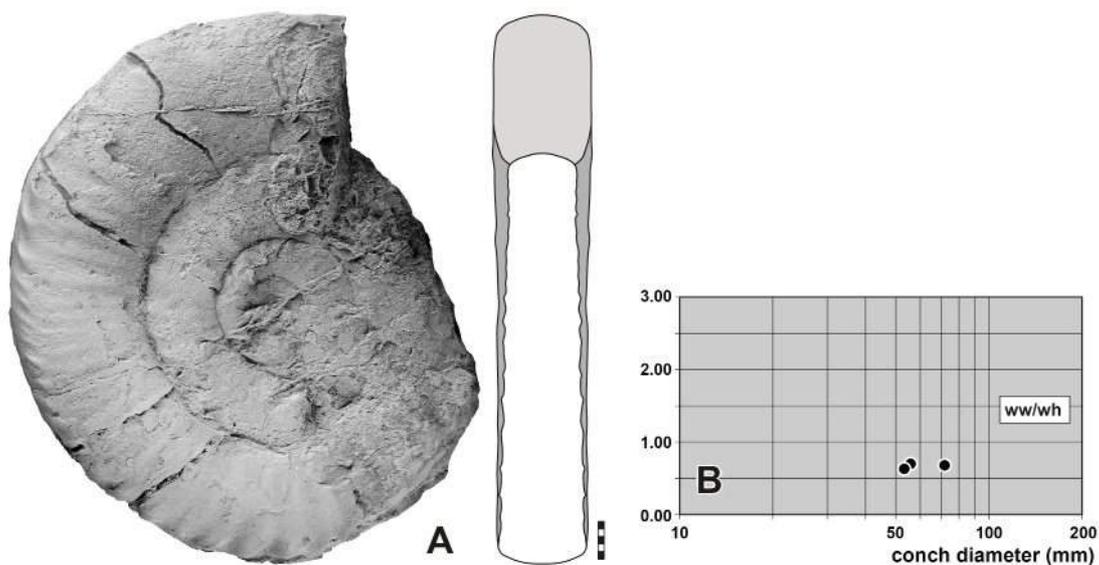


Fig. 62. *Stoyanowites aspinosus* Korn & Ghaderi, 2016. **A.** Lateral and dorsal view, specimen MB.C.30100, section C, -1.60 m. **B.** Whorl profile proportions. Scale bar units=1 mm.

Table 36. Conch dimensions (partly estimated) and ratios of selected specimens of *Stoyanowites aspinosus* Korn & Ghaderi in Korn *et al.*, 2016 from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30100	71.7	13.8	20.4	37.3	19.8	0.19	0.68	0.52	1.91	0.03
MB.C.30100	56.1	10.8	15.5	27.1	–	0.19	0.70	0.48	–	–
MB.C.30097	56.0	–	16.2	26.7	15.7	–	–	0.48	1.93	0.03
MB.C.30099	53.5	11.6	18.4	24.0	16.7	0.22	0.63	0.45	2.11	0.09
MB.C.30098	58.2	12.7	19.1	25.3	18.1	0.22	0.66	0.43	2.11	0.05

Remarks

Stoyanowites aspinosus differs from *S. dieneri* in the absence of dorsolateral nodes and the presence of densely spaced curved riblets on the body chamber. *Stoyanowites parallelus* sp. nov. differs in the flat venter.

Stratigraphic range

Upper part of the Hambast Formation; 1.80 to 1.60 m below the extinction horizon (*Alibashites ferdowsii* Zone).

Stoyanowites parallelus Korn & Hairapetian sp. nov.

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Fig. 63; Table 37

Diagnosis

Species of *Stoyanowites* with conch reaching 100 mm dm. Subadult stage with rectangular, compressed whorl profile ($ww/wh=0.70$), subangular ventrolateral shoulder and flattened venter; 10 rather coarse ventrolateral spines per half volution. Adult stage with parallel-sided, compressed whorl profile ($ww/wh=0.60$), flat venter and angular ventrolateral shoulder; 15 ventrolateral spines per half volution. Prongs of external lobe simple; altogether 13 notches of E, A and L lobes.

Etymology

Named after the parallel flanks of the whorl profile.

Material examined**Holotype**

IRAN • Esfahan Province, Baghuk Mountain C section; Hambast Formation, 1.70 m below the top; illustrated in Fig. 63A; MB.C.30102.

Paratypes

IRAN • 2 specimens; Esfahan Province, Baghuk Mountain E section; Hambast Formation; MB.C.30103 to MB.C.30104 • 1 specimen; Esfahan Province, Baghuk Mountain G section; Hambast Formation; MB.C.30105.

Description

Holotype MB.C.30102 is an incomplete specimen of 72 mm diameter; it allows the study of conch shape, ornament and suture line. The conch is extremely discoidal ($ww/dm=0.19$) with a wide umbilicus ($uw/$

Table 37. Conch dimensions (partly estimated) and ratios of the holotype of *Stoyanowites parallelus* Korn & Hairapetian sp. nov. from Baghuk Mountain.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.30102	72.2	13.7	22.5	33.7	21.8	0.19	0.61	0.47	2.05	0.03

dm=0.47) and a compressed whorl profile (ww/wh=0.61). It has nearly parallel, slightly concave flanks, a prominent subangular ventrolateral shoulder and a weakly concave venter at the largest diameter (Fig. 63A). The sculpture is dominated by coarse ventrolateral spines, which become weaker towards the end of growth, but of which are still 15 are present on half a volution of the body chamber. They are not always connected with short ribs on the inner flank.

The suture line of holotype MB.C.30102 shows the short external lobe, which has simple, weakly pouched prongs. The ventrolateral saddle is rather narrow; the adventive and lateral lobes possess six notches (Fig. 63B).

Remarks

Stoyanowites parallelus sp. nov. differs from *S. dieneri* and *S. aspinosus* in the flat venter and the numerous sharp ventrolateral nodes in the adult stage.

Stratigraphic range

Upper part of the Hambast Formation; 1.70 m below the extinction horizon (*Alibashites ferdowsii* Zone).

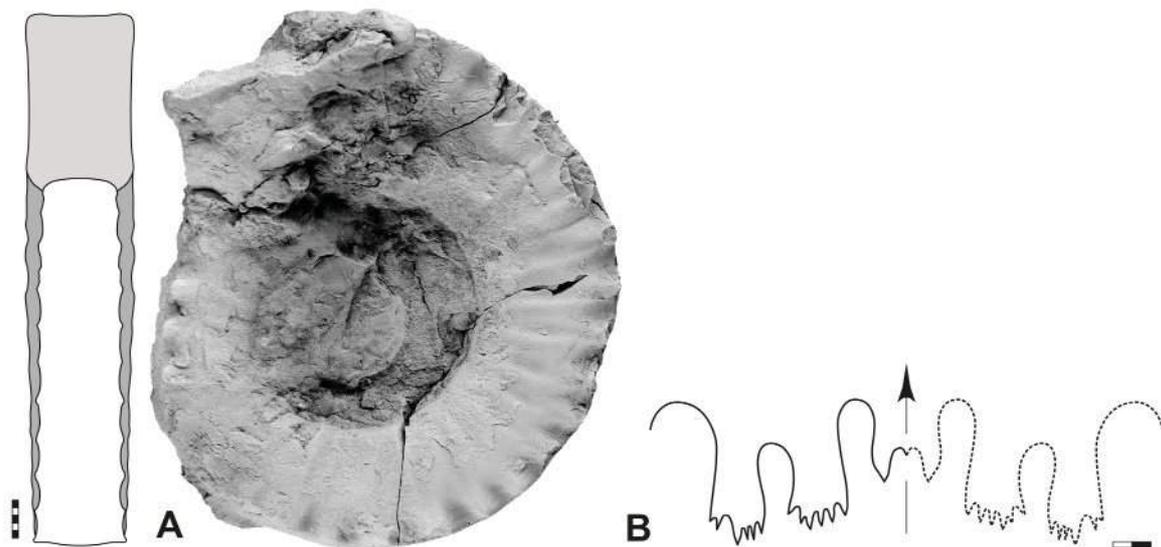


Fig. 63. *Stoyanowites parallelus* Korn & Hairapetian sp. nov. **A.** Lateral and dorsal view, holotype MB.C.30102, section C, -1.70 m. **B.** Suture line, holotype MB.C.30102, at 17.5 mm wh. Abbreviation: see Material and methods. Scale bar units=1 mm.

Discussion

Baghuk Mountain (Central Iran) is the world's most diverse locality for Late Permian ammonoids. The sections have so far yielded eleven genera (*Pseudogastrioceras*, *Shevyrevites*, *Arasella*, *Dzhulfites*, *Paratirolites*, *Clivotirolites* gen. nov., *Esfahanites* gen. nov., *Alibashites*, *Lutites* gen. nov., *Abichites* and *Stoyanowites*) and 37 species of ammonoids from the Changhsingian. The succession of ammonoid species allows for a subdivision of the rock unit into biozones, which largely correspond with the occurrences in north-western Iran.

Three new genera, *Clivotirolites*, *Esfahanites* and *Lutites*, as well as 19 new species are described: *Shevyrevites corrugatus* Korn & Hairapetian sp. nov., *Arasella falcata* Korn & Hairapetian sp. nov., *Dzhulfites brevisellatus* Korn & Hairapetian sp. nov., *Paratirolites rubens* Korn & Hairapetian sp. nov., *Paratirolites lanceolobatus* Korn & Hairapetian sp. nov., *Paratirolites robustus* Korn & Hairapetian sp. nov., *Paratirolites baghukensis* Korn & Hairapetian sp. nov., *Paratirolites aduncus* Korn & Hairapetian sp. nov., *Clivotirolites decoratus* Korn & Hairapetian gen. et sp. nov., *Clivotirolites petilus* Korn & Hairapetian gen. et sp. nov., *Esfahanites armatus* Korn & Hairapetian gen. et sp. nov., *Lutites paucis* Korn & Hairapetian gen. et sp. nov., *Lutites lyriformis* Korn & Hairapetian gen. et sp. nov., *Lutites profundus* Korn & Hairapetian gen. et sp. nov., *Lutites alius* Korn & Hairapetian gen. et sp. nov., *Lutites plicatus* Korn & Hairapetian gen. et sp. nov., *Abichites ovalis* Korn & Hairapetian sp. nov., *Abichites infirmus* Korn & Hairapetian sp. nov. and *Stoyanowites parallelus* Korn & Hairapetian sp. nov. The other 18 species are already known from localities in the Transcaucasus (Armenia, Azerbaijan) and north-western Iran.

Acknowledgements

We are indebted to the Islamic Azad University for the support of the field sessions at Baghuk Mountain. We greatly acknowledge Evelin Stenzel and Markus Brinkmann (Berlin) for the preparation as well as Jonas Jahn, Sebastian Sladeczek and Jenny Huang (Berlin) for the photography of the specimens. The Deutsche Forschungsgemeinschaft (DFG) provided financial support for the project (projects Ko1829/12-1, Ko1829/15-1, Ko1829/18-1 and FOR2332). We greatly acknowledge the reviews by Arnaud Brayard (Dijon) and an anonymous reviewer.

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Manuscript received: 30 May 2021

Manuscript accepted: 13 August 2021

Published on: 27 October 2021

Topic editor: Christian de Muizon

Desk editor: Kristiaan Hoedemakers

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