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# Ammonites from Bathonian and Callovian (Middle Jurassic) North of Damghan, Eastern Alborz, North Iran

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Zitteliana 89, 253–270.

## Abstract

The following Middle Jurassic ammonite families (subfamilies) are described from the Dalichai Formation north of Damghan (eastern Alborz), some of them for the first time: Phylloceratidae, Lytoceratidae, Oppeliidae (Hecticoceratinae), Stephanoceratidae (Cadomitinae), Tulitidae and Reineckeiidae. The fauna is typically Northwest-Tethyan and closely related to Central Europe (Subboreal – Submediterranean Provinces).

**Key words:** Ammonites, Dalichai Formation, Middle Jurassic, Alborz, Iran

## Zusammenfassung

Aus der Dalichai Formation nördlich von Damghan (Ostalborz) werden einige mitteljurassische Ammoniten, teils zum ersten Mal, beschrieben. Folgende Familien und Unterfamilien sind vertreten: Phylloceratidae, Lytoceratidae, Oppeliidae (Hecticoceratinae), Stephanoceratidae (Cadomitinae), Tulitidae und Reineckeiidae. Die Fauna ist typisch für die Nordwest-Tethys und zeigt enge Beziehungen zu Zentraleuropa (Subboreale und Submediterrane Faunenprovinz).

**Schlüsselwörter:** Ammoniten, Dalichai Formation, Mittlerer Jura, Alborz, Iran

## Introduction

The present study is a continuation of a larger research project on the ammonite fauna of the Dalichai and Lar formations in eastern Alborz and Binalud Range. The ammonites of the Dalichai Formation were studied largely by Seyed-Emami et al. (1985, 1989, 1995), Schairer et al. (1991) and in recent years by Majidifard (2003), Seyed-Emami & Schairer (2010, 2011a, b), Seyed-Emami et al. (2013), Raoufian (2014), Raoufian et al. (2011, 2014), Dietze et al. (2014), Parent et al. (2014) and Seyed-Emami et al. (2015). The studied ammonites come - except of one specimen - from the Parikhan section west of Shahrud (Seyed-Emami et al. 2013, fig. 3B) and are exclusively from the Dalichai Formation at Talu, north of Damghan (Fig. 1). At Talu as elsewhere in the Alborz Range, the Dalichai Formation is a sequence of greyish limestones and marlstones, overlying disconformably the Shemshak Group (Norian–Early Bajocian; Fürsich et al. 2009). It is followed gradually by the light and cliff building carbonates of the Lar Formation (Upper Jurassic). The outcrop at Talu was studied by Behfar (2009) and Behfar et al. (2012) in the frame of a MSc. thesis. For the present study, a new section nearby was chosen and collections were made by A. Raoufian (2015).

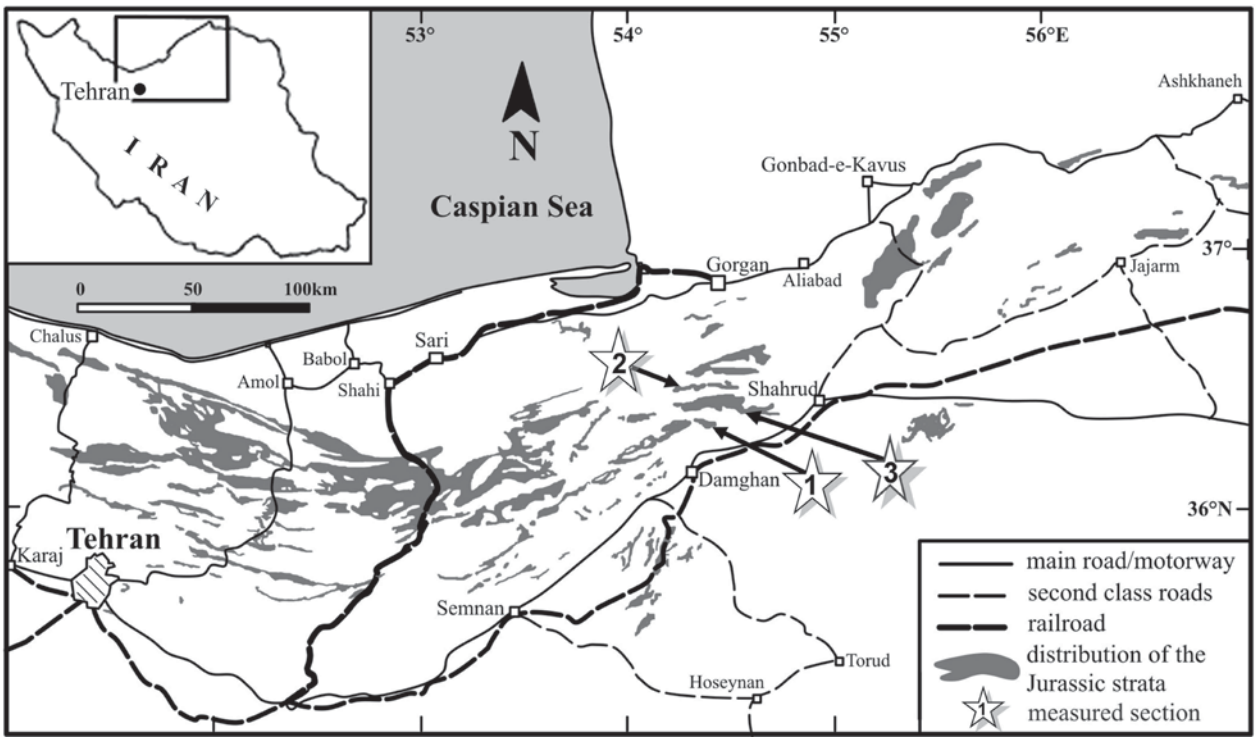
The greater part of the Morphoceratidae from Talu and Kelariz (Fig. 1) were previously studied by Dietze et al. (2014) and the Macrocephalitidae by Seyed-Emami et al. (2015).

## 2. Geological setting and specimen repository

### 2.1 Geological setting

The section Talu is located ca 19 km north of Damghan, E 54° 26’ 04”, N 36° 19’ 06” (see geological map of Damghan 1: 100,000 prepared by Alavi-Naini & Salehi Rad 1975).

The ammonites described in this study come from the upper part of the Dalichai Formation at Talu and are of Callovian age, except of a few specimens which have a Bathonian age. The new measured section at Talu (Fig. 2) has a thickness of 152 m and can be subdivided roughly into four members (from base to top):




**Textfigure 1:** Geographic map of central and east Alborz Mountains with location of the sections; 1= Talu, 2 = Kelariz, 3 = Parikhan.

**Member 1**: 15.5 m of brownish, sandy to fine-conglomeratic limestone with intercalation of marlstone.

**Member 2**: 60 m of greyish-green, argillaceous and very soft marlstone, with intercalation of marly limestone in the upper part. This unit contains few fragments of sponges, pelecypods, gastropods, crinoid ossicles and belemnites.

**Member 3**: 70 m of an alternation of greyish marly limestone and marlstone, with varying content of ammonites. Within this member, there are three distinct succeeding stratigraphic levels, consisting of few meters of condensed, reddish, nodular limestone and marls in "Ammonitico Rosso" facies:

**Red Bed I:** begins ca 95 m above the base of the section and is 1.5 m thick. It contains Late Bajocian ammonites (*Oxycerites*, *Parkinsonia*, Perisphinctidae etc.).

**Red Bed II:** begins ca 120 m above the base and is 2 m thick. It contains Early Bathonian ammonites (*Oxycerites*, *Cadomites*, *Parkinsonia*, Morphoceratidae and Perisphinctidae).

**Red Bed III:** begins ca 140 m above the base and is ca 4 m thick. It contains Callovian ammonites (Hecticoceratinae, Reineckeidae, Perisphinctidae, etc.). About 2 meters below this bed, there is a bed with fairly rich Macrocephalitinae.

The red beds are the most prominent features within the Dalichai Formation along the eastern Alborz and Binalud Mountains (Seyed-Emami et al. 2013). They represent condensation horizons of red nodular limestone and marls with iron coating and hardened surfaces. This lithology is widespread in the Alpine-Mediterranean Jurassic.

**Member 4:** 27 m, alternation of light-grey limestone and marlstone with intercalation of cherty limestones in the upper part. It contains Upper Callovian to Lower Oxfordian ammonites.

### 2.2 Specimen repository

The ammonites studied herein are deposited in the collections of the "Bayerische Staatssammlung für Paläontologie und Geologie" in Munich, Germany under the numbers SNSB-BSPG 2013 XX1V 40–62.

### 2.3 Measured parameters and abbreviations

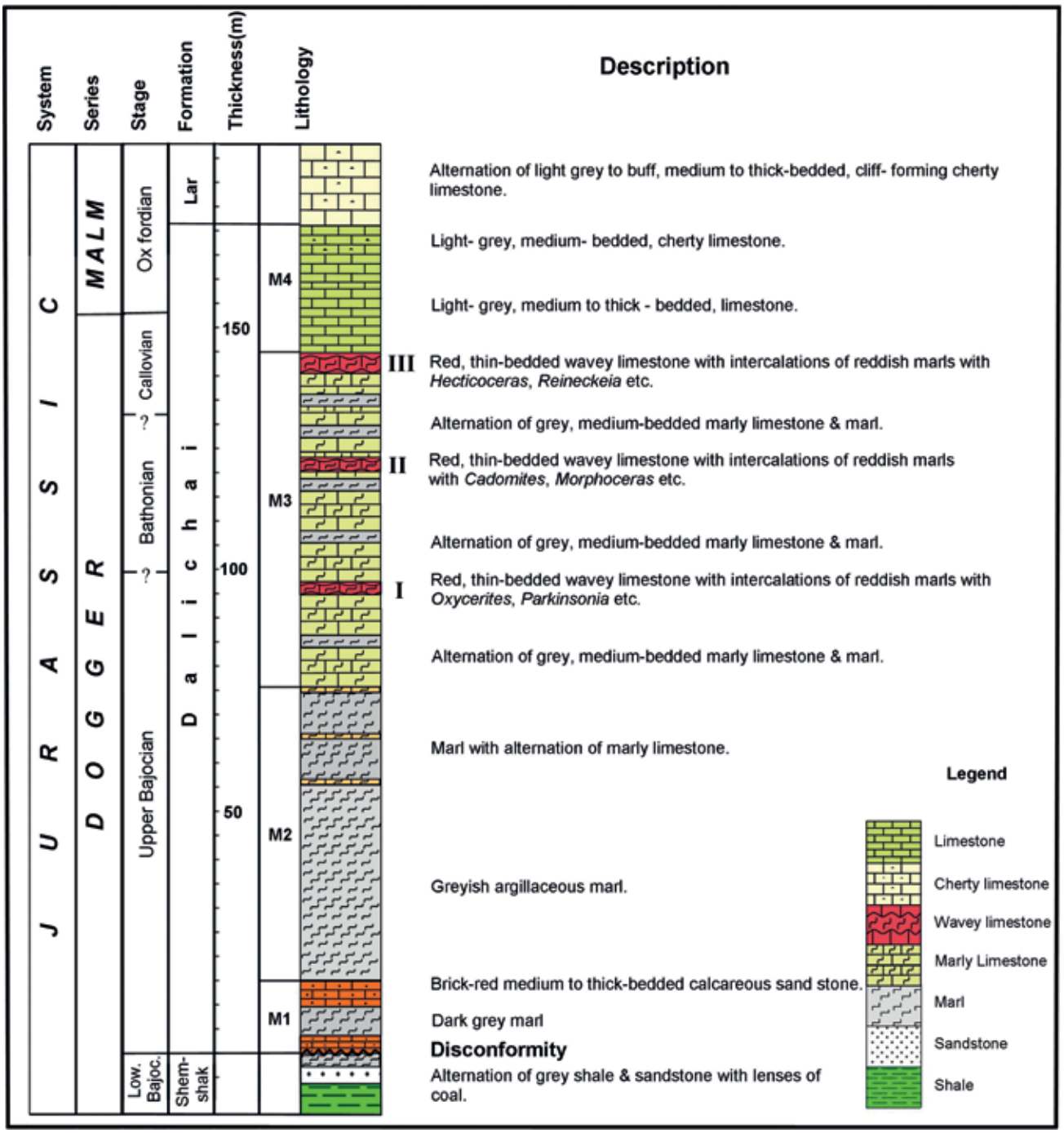
As far as possible, the following parameters are given: diameter (D) in mm; umbilical width (U), whorl height (H), whorl width (W) (all in % of diameter); number of primary ribs (PR) on a whorl, (SR) number of secondary ribs on a whorl; [m] = microconch, [M] = macroconch. All figures are in natural size, if not otherwise indicated.

## 3. Systematics

Family Phylloceratidae Zittel, 1884
Subfamily Phylloceratinae Zittel, 1884

Genus *Adabofoloceras* Joly, 1977

*Adabofoloceras* aff. *adabofolense* (Collignon, 1958)
Pl. 1, Fig. 1a, b




**Textfigure 2:** Stratigraphic log of the Talu section.

aff. 1958 *Adabofoloceras adabofolense* – Collignon, pl. 12, figs 63, 63a–b.

aff. 1976 *Adabofoloceras adabofolense* (Collignon) – Joly, p. 119, pl. 1, figs 1, 7; pl. 2, figs 1a–c, 3a–b, 4a–b, 6a–b, 10; pl. 38, figs 1a–b, 8–10, 11a–b; pl. 39, figs 10–12; 43, figs 7–9.

Material: One phragmocone from Talu (Col. Raoufian): SNSB-BSPG 2013 XXIV 40.

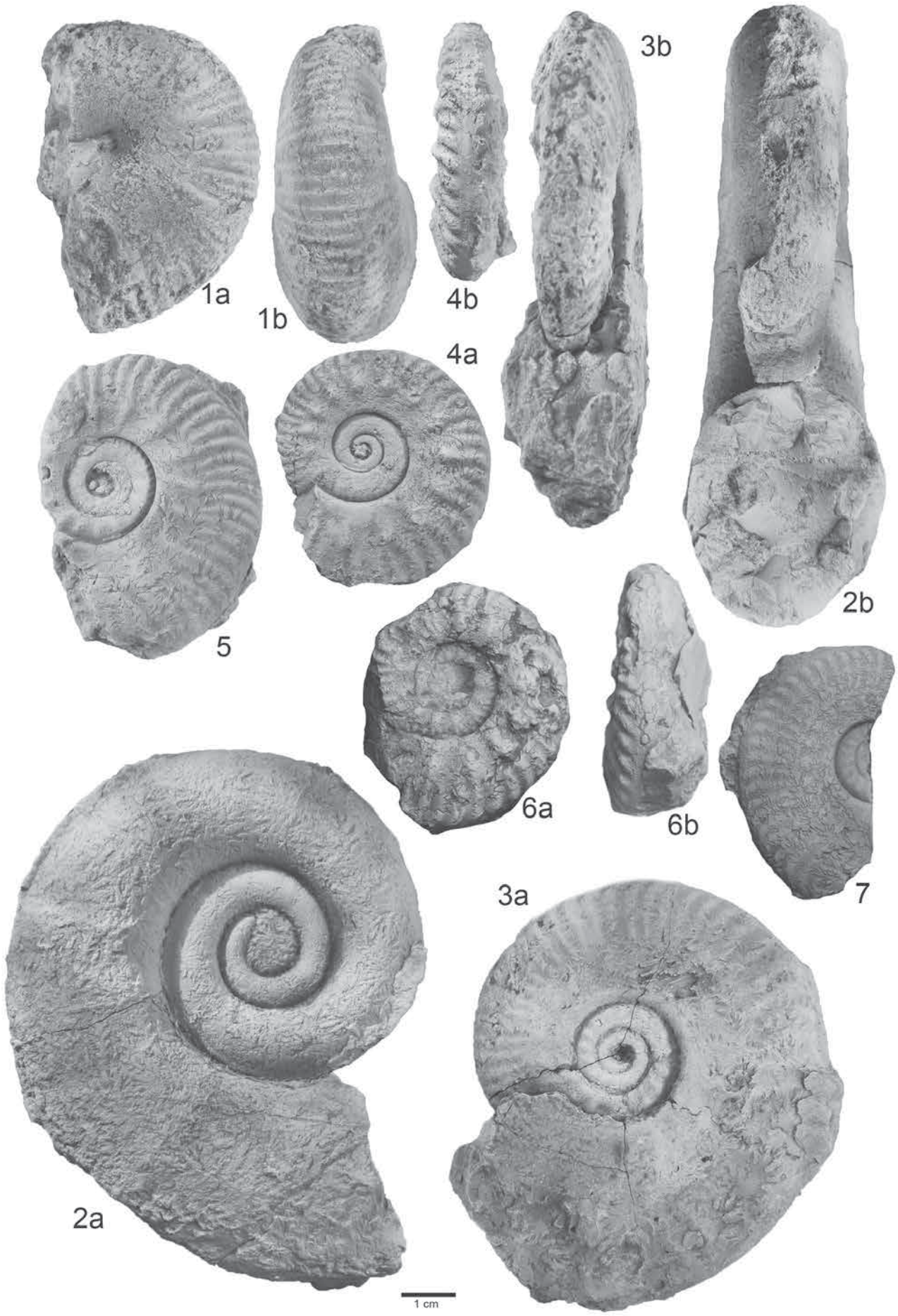
| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV56 | 54 | 7 | 55 | 45 |

Description: Highly involute Phylloceratidae with high-oval whorl section and an arched venter. The greatest whorl width is near to the mid-flank, from where the flank falls towards venter and umbilicus. The umbilicus is closed and funnel-shaped. The ribs are nearly rectiradiate and begin faintly within the inner flank. Towards the venter the ribs become distinctly coarser and bifurcate usually around the mid-flank, occassionally with intercalatory ribs. Suture line is not visible.

Discussion: Our specimen can be well compared to the holotype of Collignon (1958, pl. 12, figs 63, 63 a–b) being reproducted by Joly (1977: p. 119, pl. 1, fig. 1, pl. 38, figs a–b), from the Lower Callovian of Madagascar.


**Textfigure 3:** Field aspects of the Dalichai Formation north of Talu. **(a)** Postion of the Dalichai Formation between Shemshak and Lar formations. **(b)** Sharp contact between Shemshak and Dalichai formations with paleosoil (Mid-Cimmerian Event). **(c)** Position of the first, second and third Red Beds within the Dalichai Formation. **(d)** Aspect of Red Bed III at Talu. **(e)** *Reineckeia* in situ within the Red Bed III.

**Plate 1: (1)** *Adabofoloceras* aff. *adabofolense* (Collignon, 1958); Red Bed III, Talu, SNSB-BSPG 2013 XXIV 40. **(2)** *Lytoceras* sp.; Talu, SNSB-BSPG 2013XXIV 41. **(3–6)** *Hecticoceras* gr. *metomphalum* Bonarelli, 1894; Red Bed III, Talu. **(3)** SNSB-BSPG 2013 XXIV 42. **(4)** SNSB-BSPG 2013 XXIV 43. **(5)** SNSB-BSPG 2013 XXIV 44. **(6)** SNSB-BSPG 2013 XXIV 46. **(7)** *Hecticoceras (Lunuloceras)* sp.; Red Bed III, Talu, SNSB-BSPG 2013 XXIV 47.


1a
1b
4b
3b
4a
2b
5
6a
6b
7
2a
3a
1 cm

Occurrence: From Red Bed III.

Family Lytoceratidae Neumayr, 1875
Subfamily Lytoceratinae Neumayr, 1875
*Lytoceras* sp.
Pl. 1, Fig. 2a, b

Material: One fully septated internal mould from Talu: SNSB-BSPG 2013 XXIV 41.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013XXIV 41 | 99 | 41 | 37 | 32 |

Description: The rather strongly eroded phragmocone has a diameter of nearly 100 mm. It is a serpenticone and evolute Lytoceratidae with circular to high oval, slightly higher than wide whorl section. Because of the strong erosion the ribbing is not well recognizable. So far visible, very faint radial and distant ribs can be recognized.

Age: Late Early to Middle Callovian (Red Bed III).

Family Oppeliidae Bonarelli, 1894
Subfamily Hecticoceratinae Spath, 1925

Genus *Hecticoceras* Bonarelli, 1894

*Hecticoceras* gr. *metomphalum* Bonarelli, 1894
Pl. 1, Figs 3a, b, 4a, b, 5, 6a, b;
Pl. 2, Figs 1a, b, 2a, b

1894 *Hecticoceras* (*Lunuloceras*) *metomphalum* n. f. – Bonarelli, p. 90.
1956 *Hecticoceras* (*Rossiensiceras*) *metomphalum metomphalum* (Bonarelli) – Zeiss, p. 54, pl. 2, fig. 4 (with synonymy).
2000 *Hecticoceras* (*Rossiensiceras*) *metomphalum* Bonarelli – Schairer et al., p. 55, fig. 14.
2000 *Hecticoceras metomphalum metomphalum* Bonarelli, 1894 – Besnosov & Mitta, p. 53, pl. 19, figs 3–5.
2003 *Hecticoceras* (*Putealiceras*) *metomphalum* (Bonarelli) – Majidifard, pl. 4, figs 1, 4.
2009 *Hecticoceras* (*Lunuloceras*) gr. *metomphalum* (Bonarelli, 1894) – Schlögl et al., p. 66, figs 5.9–11, 6.4–5.
2011b *Hecticoceras* (*Rossiensiceras*) aff. *metomphalum* (Bonarelli, 1894) – Seyed-Emami & Schairer, p. 376, fig. 3A.
2013 *Hecticoceras* (*Rossiensiceras*) gr. *metomphalum* (Bonarelli, 1894) – Seyed-Emami et al., p. 50, fig. 5f.
2014 *Hecticoceras metomphalum* Bonarelli, 1893 – Parent et al., pl. 2, figs 2–3.

Material: Six one-side preserved internal moulds from the third red-bed at Talu: SNSB- BSPG 2013 XXIV 42–46, 48.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV 43 | 43 | 36 | 40 | - |
| BSPG 2013 XXIV 46 | 48 | 40 | 38 | - |
| BSPG 2013 XXIV 48 | at ca 55 | ca 25 | ca 46 | ca 27 |
| BSPG 2013 XXIV 45 | 58 | 26 | 47 | - |
| BSPG 2013 XXIV 42 | 78 | 27 | 42 | - |

Description: Within the present collection we can distinguish roughly two morphotypes: Fairly involute and rather compressed forms with little to moderately coarse ornamentation (morphotype 1) and relatively depressed and evolute forms with coarse ornamentation (morphotype 2). We assign both morphotypes to a single taxon *H.* gr. *metomphalum*.

Discussion: The systematics of Hecticoceratinae is still a persistant problem and they are subdivided into many unnecessary and probably synonymous taxa. Particularly the metomphalum-group shows apparently a large intraspecific variability, as emphasized already by Schlögl et al. (2009: 66), Seyed-Emami & Schairer (2011b: 4) and Dietl (2013).

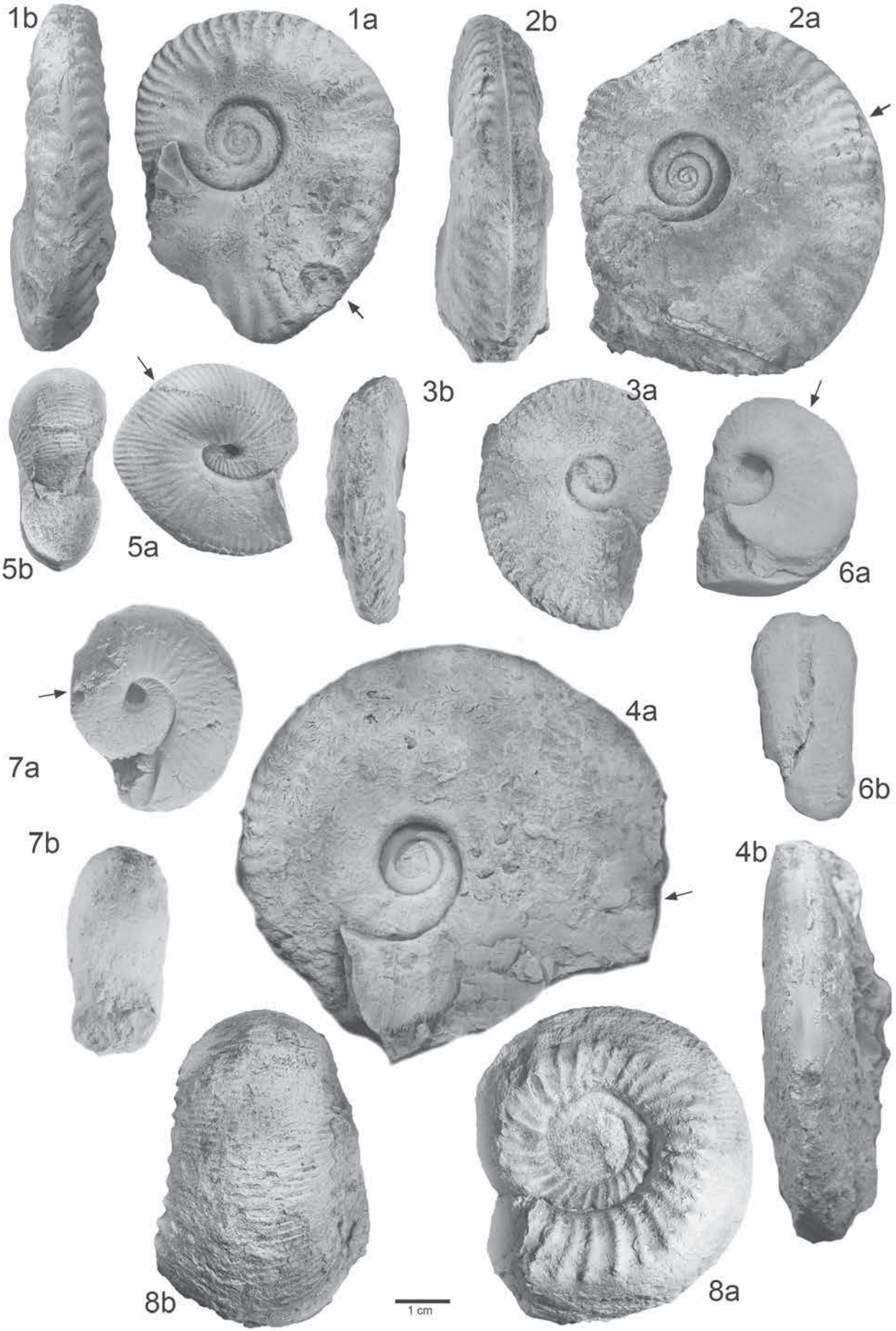
**Morphotype 1.** Rather involute and compressed forms with semi-coarse ornamentation: SNSB-BSPG 2013 XXIV 42, 48 (Pl. 1, Fig. 3 a, b; Pl. 2, Figs 2 a, b):

In specimen SNSB-BSPG 2013 XXIV48 (Pl. 2, Fig. 2 a, b) only one side is preserved. It is a partially eroded internal mould with a diameter over 65 mm. The body chamber begins at D = 53 mm. It is relatively involute with high-oval, slightly shouldered whorl cross-section and a sharp, low and narrow keel. The nearly smooth inner flank falls gently towards the rather sharp umbilical margin and is slightly concave. The umbilical wall is low and vertical. Ribbing is up to a diameter of 40 mm relatively fine, but later it becomes coarser. On the last half whorl of the phragmocone there are about 7–8 flat and blunt peri-umbilical tubercles, giving way to 3 to 4 blunt and concave outer ribs. On the body chamber the tubercles almost cease and the inner flank becomes smooth. On the outer flank there are still faint and distant ribs. Specimen SNSB-BSPG 2013 XXIV 42 is a large phragmocone with a diameter of nearly 80 mm. These forms can be attributed to the group of *Hecticoceras metomphalum metomphalum*.

**Morphotype 2.** Rather evolute and depressed forms with coarse ornamentation: SNSB-BSPG 2013 XXIV 43, 44, 45, 46 (Pl. 1, Figs 4a, b, 5, 6a, b; Pl. 2, Fig. 1a, b.). These forms can be best compared with the group of *Hecticoceras metomphalum multicostatum* Tsytovich, 1911.

SNSB-BSPG 2013 XXIV43 (Pl. 1, Fig. 4a, b) is a phragmocone with only one-side preserved. It is fairly evolute with a low keel and a smooth inner flank gently falling towards the low umbilicus. The umbili-

**Plate 2: (1, 2)** *Hecticoceras* gr. *metomphalum* Bonarelli, 1894; Talu. **(1)** SNSB-BSPG 2013 XXIV 45. **(2)** SNSB-BSPG 2013 XXIV 48. **(3)** *Hecticoceras* aff. *paulowi* (de Tsytovitch, 1911); Talu, SNSB-BSPG 2013 XXIV 49. **(4)** *Hecticoceras* (*Lunuloceras*) sp. nov.? [M]; Red Bed III, Talu, SNSB-BSPG 2013 XXIV 50. **(5)** *Bullatimorphites* (*Bomburites*) *microstoma* (Orbigny, 1846) [m]; Talu, SNSB-BSPG 2013 XXIV 55. **(6, 7)** *Bullatimorphites (Bomburites)* aff. *suevicus* (Roemer, 1911) [m]; Red Bed III, Talu. **(6)** SNSB-BSPG 2013 XXIV 56. **(7)** Parikhan (from scree): SNSB-BSPG 2013 XXIV 62. **(8)** *Cadomites* (*Cadomites*) cf. *costidensum* (Imlay, 1953), Talu (from scree), SNSB-BSPG 2013 XXIV 52.


1b
1a
2b
2a
5b
5a
3b
3a
6a
7a
4a
6b
7b
4b
8b
1 cm
8a

cal wall is low and vertical. The ribbing is coarse with slightly elongated prorsiradiate peri-umbilical tubercles (9 on a half-whorl). From the tubercles radiate mostly two concave outer ribs with occassionally an intercalate rib.

SNSB-BSPG 2013 XXIV 45 (Pl. 2, Fig. 1a, b) is a fairly involute phragmocone with a small fragment of the body chamber, which begins at D = 58 mm. The umbilical margin is rather sharp, with a low and steep umbilical wall. Whorl section is high oval with a low keel. The ribbing is rather coarse with prorsiradiate elongated peri-umbilical tubercles (8–9 on a half whorl), which give way to three concave external ribs above the mid-flank; occasionally with intercalated ribs.

Discussion: The different morphotypes of the group of *Hecticoceras metomphalum* are relatively frequent in the Dalichai Formation. Because of the condensation, it cannot be determined whether these are only morphotypes of a single species or different taxa of different age.

Age: Zeiss (1956: 45) recorded *H. metomphalum* from the Anceps to the Lamberti zone, Schlögl et al. (2009: 66) from the Middle Callovian (Coronatum Zone) and Dietl (2013) from the Middle Callovian (upper Jason Zone). Our specimens come from the Red Bed III at Talu. Considering the stratigraphic position of Macrocephalitidae from the same section (Seyed-Emami et al., 2015, p. 6, table 1), which occur ca 2 meters below the Red Bed III, the age of the herein described Hecticoceratinae is most probably late Early Callovian (Gracilis Chron) to early Middle Callovian (Anceps Chron).

*Hecticoceras* aff. *paulowi* (de Tsytovitch, 1911)
Pl. 2, Fig. 3a, b

| | |
|---|---|
| aff. 1911 | *Hecticoceras Paulowi* n. sp. – de Tsytovitch, p. 69, pl. 7, figs 8–12, pl. 8, figs 2–3. |
| aff. 1956 | *Hecticoceras* (*Lunuloceras*) *paulowi* (de Tsytovitch) – Zeiss, p. 44, pl. 1, fig. 11 (with synonymy). |
| aff. 2009 | *Hecticoceras* (*Lunuloceras*) *paulowi* cf. (de Tsytovitch, 1911) – Schlögl et al., p. 66, figs 5.4, 6.6. |
| aff. 2013 | *Hecticoceras* (*Lunuloceras*) *paulowi* (de Tsytovitch) – Seyed-Emami et al., p. 50, figs 5 c–e. |

Material: One eroded internal mould from Talu: SNSB-BSPG 2013 XXIV 49.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV 49 | 46 | 22 | 46 | - |

Description: Specimen (SNSB-BSPG 2013 XXIV49) is a partially eroded phragmocone with only one side preserved. It is relatively involute with high-oval whorl section and a sharp, low and narrow keel. The nearly smooth inner flank falls gently towards the umbilical margin. The umbilical wall is low and steep. The ribbing is up to a diameter of ca 35 mm relatively fine and seemingly limited to the outer flank, but later it becomes slightly coarser. The inner part of the flank is up to a diameter of 35 mm almost smooth, but later indistinct, distant and thickened inner ribs appear.

Discussion: Concerning the rather smooth inner flank and the relatively narrow umbilicus the present specimen can be best compared with *H. paulowi*. "*Orbignyceras paulowi*" from the Upper Callovian of Herznach (Switzerland) as reported by Jeannet (1951, pl. 9, fig. 12) is very similar. It also can be compared with involute and smoothly ribbed morphotypes of the *H. metomphalum* group.

Age: Zeiss (1956: 45) and Fortwengler et al. (2012: 120) reported *H. paulowi* from the Upper Callovian (Lamberti Zone). Schlögl et al. (2009) reported it from the Middle Callovian (Coronatum Zone). The present specimen comes from the Red Bed III indicating a late Early to Middle Callovian age.

*Hecticoceras* (*Lunuloceras*) sp.
Pl. 1, Fig. 7

Material: An eroded half of a phragmocone from Talu: SNSB-BSPG 2013 XXIV 47.

Description: The half-preserved phragmocone has a diameter of nearly 50 mm. It is a discoidal, moderately evolute, carinate and slightly shouldered *Hecticoceras* with high-oval cross section. The umbilical margin is sharp, the umbilical wall vertical. The flank is slightly convex and falls from the tubercles slightly towards the umbilicus and the venter. The ribbing is rather fine and consists of short and prorsiradiate inner ribs which end shortly above the umbilicus at small and rounded tubercles. On a half-whorl, at a diameter of ca 50 mm, there are 12 to 13 tubercles. Two concave outer ribs radiate almost regularly from the tubercles. On the shoulder the ribs bend forward and end at the keel.

Discussion: The present form cannot be attributed to any known Hecticoceratinae yet. So far the best comparable taxon is *Hecticoceras pseudopunctatum* (Lahusen, 1883) in Jeannet (1951, p. 43, pl. 9, fig. 11) and Zeiss (1956, p. 40, fig. 4, 9).

Occurrence: Red Bed III.

*Hecticoceras* sp. nov.? [M]
Pl. 2, Fig. 4a, b

Material: A one-side preserved internal mould from Talu: SNSB-BSPG 2013 XXIV 50.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV 50 | 80 | 19 | 51 | - |

Description: The strongly eroded specimen has a diameter of more than 80 mm. Apart from a small portion of the body chamber the greater part of the last whorl belongs to the phragmocone. A slight

egression at a diameter of ca 80 mm indicates the beginning of the body chamber. It is a discoidal, carinate and involute *Hecticoceras* with high-oval, slightly shouldered whorl section and a low keel. The umbilical margin is rather sharp, with a vertical umbilical wall. The flank is slightly convex and falls from the mid-flank gently towards the umbilicus and the venter. The ribbing is falcoid. Probably due to erosion, the ribbing on the inner flank is somewhat obscure, but still some flat, broad and widely spaced ribs can be recognized. At about the mid-flank, the ribs give way to two or three slightly concave outer ribs, occasionally with an intercalate rib. Towards the venter the ribs become stronger and broader and somewhat scale-like. On the shoulder the ribs bend forward and reach up to the faint keel.

Discussion: The present specimen is characterized by its large size. Among the known taxa of *Hecticoceras* our specimen can be best compared to *H. paulowi*, especially to some specimens illustrated by Jeannet (1951, pl. 10, figs 1–3). After Jeannet (1951, p. 45) the taxon can reach a size of up to 90 mm. Another partially similar taxon is *H. lunuloides* (Kilian) in Lemoine (1932, pl. 13, fig. 9) and in Parent et al. (2014, pl. 2, fig. 5a–c) from the Binalud Mountains, northeast Iran. Most probably it represents a new species.

Age: Late Early to Middle Callovian (Red Bed III).

Family Stephanoceratidae Neumayr, 1875
Subfamily Cadomitinae Westermann, 1956

Genus *Cadomites* (*Cadomites*) Munier-Chalmas, 1892

*Cadomites bremeri* Tsereteli, 1968
Pl. 3, Fig. 2a–c

| | |
|---|---|
| 1968 | *Cadomites bremeri* Tsereteli s. nov. – Tsereteli, p. 80, pl. 12, figs 1 (holotype), 2–4. |
| 1974 | *Cadomites* (*Cadomites*) *bremeri* Tsereteli, 1968 – Kopik, p. 22, pl. 3, fig. 3, pl. 4, figs 1a–c, pl. 5, figs 1a–c, pl. 6, figs 1a–b, pl. 7, figs 1a–b. |
| 1997 | *Cadomites* (*Cadomites*) *bremeri* Tser. – Mangold & Rioult, p. 59, pl. 16, fig. 1. |
| 2007 | *Cadomites bremeri* Tsereteli – Dietze et al., p. 114, fig. 8c. |
| 2010 | *Cadomites bremeri* Tsereteli, 1968 [M] – Zaton, p. 125, pl. 2C–H, Textfigs 6–7C–F (with synonymy). |
| 2016 | *Cadomites* (*Cadomites*) bremeri Tsereteli [M] – Sandoval, p. 239, pl. 7b. |

Material: One one-side preserved phragmocone from Talu: SNSB-BSPG 2013 XXIV 51

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV51 | 59 | 28 | 39 | - |

Description: A still fully septated and moderately involute (semi-evolute) *Cadomites* with cadicone, broad-trapezoid whorl section. The flank falls steeply towards the umbilicus and merges gradually into the vertical umbilical wall. The umbilicus is deep and funnel-like. The ribbing is fine and dense. The slightly prorsiradiate inner ribs begin at the seam and end into relatively tiny tubercles at the ventro-lateral margin (the greatest whorl width). Mostly three to four fine and bundled ventral ribs radiate from the tubercles; they cross the arched venter. At a diameter of 32 mm there are 35 tubercles per whorl, at 50 mm there are 39.

Discussion: The present specimen matches best the specimen illustrated in Mangold & Rioult (1997, pl. 16, fig. 1). The similar *Cadomites rectelobatus* (Hauer) is more depressed and has a larger whorl width. Further similar taxa are *Cadomites* (*C.*) *orbignyi* (Grossovre) and *Cadomites* (*C.*) *daubenyi* (Gemmellaro). For a detailed discussion see Zaton (2010: 126).

Age: *Cadomites bremeri* is a widely distributed taxon and the index ammonite of the Bremeri Zone (Top Middle Bathonian) (Mangold & Rioult, 1997: 59; Sandoval, 2016, p. 238). At Talu it was collected loosely from the scree below Red Bed III.

*Cadomites* (*Cadomites*) cf. *costidensum* (Imlay, 1953)

Pl. 2, Fig. 8a, b; Pl. 3, Fig. 3a–c

| | |
|---|---|
| cf. 1953 | *Gowericeras costidensum* – Imlay, pl. 22, fig. 10–13 |
| 1974 | *Cadomites (Cadomites) stegeus* (Buckman 1922) – Kopik, p. 17, pl. II, figs 2a, b, 3. |
| aff. 1989 | *Cadomites* aff. *stegeus* (Buckman, 1922) – Seyed-Emami et al., p. 83, pl. 2, figs 1, 2. |

Material: Two incomplete and one-side preserved internal moulds from Talu: SNSB-BSPG 2013 XXIV 52, 53.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV 52 | 56 | 36 | 36 | ca 57 |

Description: Specimen pl. 2, fig. 8a, b is a fully septated, rather evolute phragmocone with cadicone to broad trapezoid whorl cross-section. The flank falls steeply towards the umbilicus and merges gradually into the short and vertical umbilical wall. The ornamentation consists of relatively coarse, slightly prorsiradiate and concave inner ribs, which end ventrolaterally into semi-coarse tubercles. From the tubercles radiate 3–4 fine and slightly convex ventral ribs. At a diameter of 56 mm there are 30 tubercles per whorl.

Discussion: Because of their lesser rib density the two specimens stand between *C. bremeri* and *C. oppitzi/altispinosus*. In Europe, we know little about *Ca-*

*domites* in the Retrocostatum Zone. Only Kopik described a few microconchs and his *C. stegeus* (p. 17, pl. II, figs 2a, b, 3) seems to be the same species as the Iranian specimen. Imlay (1953) desrcibed many species of *Cadomites* as *„Gowericeras“* from Canada of which *C. costidensum* is very close to the two specimens illustrated here; they also come from a similar stratigraphic level (lower part of Upper Bathonian).

*Cadomites rectelobatus* (Hauer) is much more inflated and has much wider whorls. *Cadomites* cf. *stegeus* (Buckman) in Pavia et al. (2008, pl.1, figs 6–7) is less broad and has coarser and less dense ribbing. In comparison with the very similar taxon *Cadomites daubenyi* (Gemmellaro, 1877) in Galácz et al. (2008, p. 58, pl. 2, fig. 8, pl. 4, fig. 3) and Pavia & Cresta (2002, p. 236, figs 161 a-d) our specimens are distinguished by a wider umbilicus and coarser ribbing. For further differences towards other similar species see Kopik (1974: 19).

Age*:* The type of *C. costidensum* comes from the Western Interior (USA). After Callomon (1984) this horizon corresponds to the Cranocephaloide Zone in the Boreal Realm, which represents the upper part of the Bremeri Zone in Europe. Our specimens were collected loosely from the scree above the Red Bed II and below Red Bed III.

Family Tulitidae Buckman, 1921

Genus *Bullatimorphites* Buckman, 1921

*Bullatimorphites* (?*Kheraiceras*) sp. [M]
Pl. 3, Fig. 1a, b

cf. 1983 *Bullatimorphites (Bullatimorphites) costatus* (Arkell) – Sandoval, p. 556, pl. 69, figs 1, 2, pl. 71, fig. 2.
cf. 1988 *Bullatimorphites (Bullatimorphites)* cf. *costatus* (Arkell) – Westermann & Callomon 1988, p. 81, pl. 17, fig. 5a, b.
1991 *Bullatimorphites* aff. *ymir* (Oppel) – Seyed-Emami et al., p. 72, pl. 3, fig. 1–4
2006 *Bullatimorphites (Bullatimorphites) perisphinctoides* Arkell – Topchishvili et al., pl. 33, fig. 1, pl. 34, fig. 1 (= *Bullatimorphites suevicus* Tsereteli, 1968)

Material: One incomplete and strongly eroded specimen from Talu: SNSB-BSPG 2013 XXIV 54.

Description: An incomplete specimen with a diameter of ca 103 mm. It comprises parts of the body chamber, indicated by a distinct eggression and simultaneous contraction of the whorl at about D = ca 80 mm. The phragmocone is fairly involute and depressed. The ribbing is little coarse on the phragmocone. Towards the body chamber it becomes coarser and ribs are more distant.

Discussion: In the upper part of the Bremeri Zone (*fortecostatum* horizon) there occur species that stand between the *bullatimorphus-costatus* group and *B. hannoveranus*. But they have a narrower umbilicus (as *B*. *costatus*), the ribbing is somewhat coarser and they are slightly smaller (110–140 mm). Typical specimens have already been illustrated under different names (see synonym list). On the internet there is a manuscript name: “*B. sandovali”,* for *Bullatimorphites novo* sp. 1 Sandoval, 1983. A similar, but older taxon is *B. latecentratus* (Quenstedt), designated and refigurd by Hahn (1971, p. 97, pl. 6, fig. 3a, b) and refigured by Arkell (1954, P. 109, fig. 35) and Schlegelmilch (1985, p. 134, pl. 52, fig. 2). Another similar taxon is *B. hermi* Seyed-Emami et al. (1998, p. 123, pl. 2, fig. 1, textfig. 3) which is very close to *B. hannoveranus* (Roemer).

Age: Bremeri Zone, upper part. The Iranian specimen is collected loosely from the scree above Red Bed II at Talu and may be little younger.

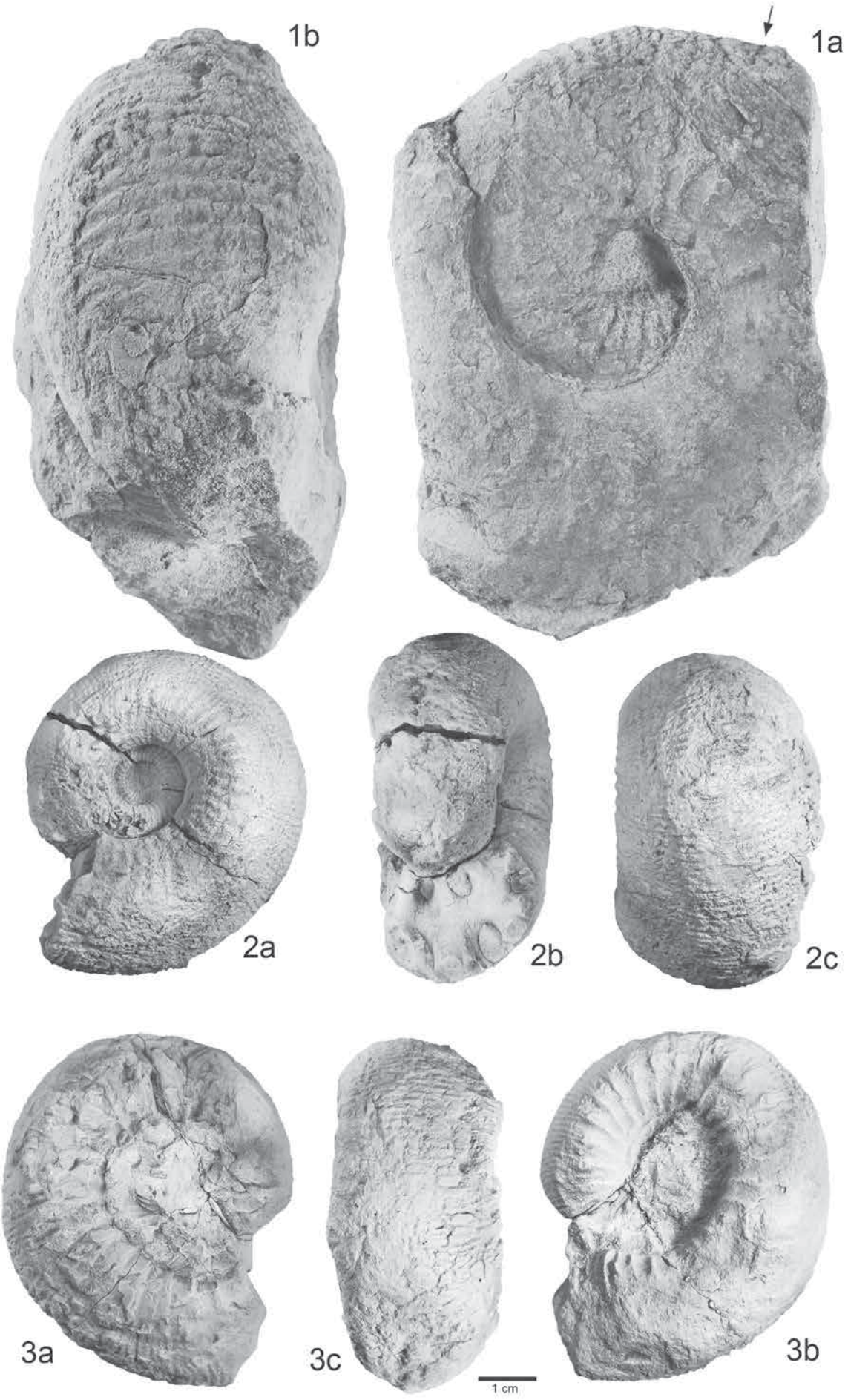
*Bullatimorphites* (*Bomburites*) *microstoma*
(Orbigny, 1846) [m]
Pl. 2, Fig. 5a, b

1939 *Sphaeroceras microstoma* d´Orb. – Kuhn, p. 472, pl. 6, fig. 3.
1954 *Ammonites microstoma* D´Orbigny sp. – Arkell, p. 108, fig. 35 (refiguration of the lectotype).
1971 *Bullatimorphites* (*Bomburites*) *microstoma* (d´Orbigny) – Hahn, p. 108, pl. 7, figs 5, 6; pl. 9, fig. 8.
aff. 1972 *Treptoceras microstoma* (D´Orbigny) – Krystyn, p. 291, pl. 20, fig. 3; textfig. 28.
1994 *Bullatimorphites bullatus* forme microconque *microstoma* (d´Orbigny, 1846) – Thierry et al., p. 132, pl. 56, figs 2a–c (refiguration of the holotype), 3a, b.
1995 *Bullatimorphites* (*Bomburites*) *microstoma* (d´Orbigny, 1846) – Mönnig, p. 71, pl. 10, fig. 1.
2003 *Bullatimorphite* (*Bomburites*) cf. *microstoma* (d´Orbigny) – Majidifard, p. 98, pl. 4, fig. 12.
2009 *Bullatimorphites* aff. (*Bomburites*) *suevicus* (Roemer) – Behfar et al., pl. 1, fig. 6.
2012 *Bullatimorphites* (*Bomburites*) aff. *microstoma* (Orbigny, 1846) – Behfar et al., pl. 1, fig. 6.
2016 *Kheraiceras* (*Bomburites*) *microstoma* (d´Orbigny) – Sandoval, p. 241, fig. 9c.

Material: One slightly distorted specimen, with a part of the body chamber from Talu: SNSB-BSPG 2013 XXIV 55.

Description: The slightly deformed specimen has a diameter of ca 38 mm. About half of the last whorl belongs to the body chamber, which is indicated by a clear egression and simultaneous contraction of the whorl and a distinct crinkle. The crinkle at the beginning of the body chamber may be strengthened by distortion. The phragmocone is ellipticone, involute, and moderately inflated. The ribbing is on the

**Plate 3**: **(1)** *Bullatimorphites* (*?Kheraiceras*) sp. [M]; Talu (from scree), SNSB-BSPG 2013 XXIV 54. **(2)** *Cadomites bremeri* Tsereteli, 1968; Talu, SNSB-BSPG 2013 XXIV 51. **(3)** *Cadomites* (*Cadomites*) cf. *costidensum* (Imlay, 1953); Talu (from scree), SNSB-BSPG 2013 XXIV 53.


1b
1a
2a
2b
2c
3a
3c
3b
1 cm

phragmocone fine, dense and slightly prorsiradiate, single or irregularly bifurcating above the umbilicus and higher up. On the body chamber the ribbing becomes slightly coarser and more widely spaced; the inner ribs are short, slightly thickened and bifurcate often irregularly on the flank.

Discussion: Arkell (1954: p. 108) could not observe any lappet on d'Orbigny's specimens and considered them rather to be small *Bullatimorphites*. But Thierry et al. (1994: p. 133) mentioned a short lappet, which can be seen on the figured specimen (pl. 56, fig. 2) and stated that the specimens were found together with *B. bullatus* and can be considered as microconch forms of the latter.

The present specimen, though a little smaller, can be well compared to *B. microstoma* in Thierry et al. (1994: pl. 56, fig. 2a, b), Kuhn (1939, pl. 6, fig. 3) and Hahn (1971, pl. 7, fig. 6). The very similar specimen *Bullatimorphites* (*Bomburites*) *suevicus* (Roemer) from the upper Bathonian (Hahn 1971, p. 106, pl. 8, figs 5, 6, 8, 10; Dietl 1994, p. 19, pl. 2, fig. 1) is more depressed and has a greater size.

Age: *Bullatimorphus* (*Bomburites*) *microstoma* is usually reported from the lower Callovian (Hahn 1971, p. 108; Kuhn 1939, p. 472; Thierry et al. 1994, p. 133) and Sandoval (2016, p. 242). The present specimen comes from the beds with *Macrocephalites*, ca 2 m below the Red Bed III, which corresponds also to Lower Callovian (Bullatus Zone) see Seyed-Emami et al. (2015, p. 19).

*Bullatimorphites* (*Bomburites*) aff. *suevicus*
(Roemer, 1911) [m]
Pl. 2, Figs 6a, b, 7a, b

aff. 1971 *Bullatimorphites* (*Bomburites*) *suevicus* (J. Roemer) – Hahn, p. 106, pl. 8, figs 5, 6, 8, 10.
aff. 1985 *Bullatimorphites* (*Bomburites*) *suevicus* (Roemer, 1911) – Schlegelmilch, p. 135, pl. 52, fig. 7.
2005 *Bullatimorphites* (*Kheraiceras*) *bullatus* (Orbigny) – Shafeizad & Seyed-Emami, pl. 1, fig. 18.
aff. 2015 *Bullatimorphites* (*Bomburites*) *suevicus* (Roemer, 1911) – Martin & Mangold, p. 55, pl. 22, figs 1–9 (with synonymy).

Material: One nearly complete internal mould from Parikhan (west Shahrud, col. Shafeizad): SNSB-BSPG 2013 XXIV 62 and a strongly eroded, incomplete specimen with a portion of the body chamber from Talu (col. Behfar): SNSB-BSPG 2013 XXIV 56.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV62 (end of PH) | 38 | 31 | 31 | ca 40 |

Description: SNSB-BSPG 2013 XXIV 62: The phragmocone is ellipticone, inflated and nearly sphaerocone with a tight umbilicus. About ¾ of the last whorl belongs to the body chamber. The beginning of the body chamber, at a diameter of ca 22 mm, is indicated by a distinct eggression and simultaneous contraction of the whorl. At the beginning of the peristome there is a deep prorsiradiate constriction, delimited by a distinct bulge. A small part of the lappet is preserved at the end of the peristome. The ribbing is similar to *B.* (*B.*) *microstoma*. On the phragmocone it is fine and prorsiradiate, single or bifurcating irregularly within the inner flank. On the body chamber the ribs become slightly coarser and more widely spaced. The ribs cross the arched venter without interruption.

Discussion: The specimen from Parikhan unites both properties of *B.* (*B.*) *microstoma*, as well as *B.* (*B.*) *suevicus*, so that it could be assigned to both taxa. Compared to the lectotype of *B. (B.) suevicus*, designated by Hahn (1971: p. 107) and illustrated by Arkell (1954, fig. 36 left) and Schlegelmilch (1985: pl. 52, fig. 7) it is somewhat smaller and less inflated. In this respect it resembles *B. (B.) uhligi* (Popovici-Hatzeg), see Martin & Mangold (2015, p. 57).

Another similar taxon is *Bullatimorphites weigelti* Kuhn (1939, pl. 7, fig. 3), refigured by Schlegelmilch (1985, pl. 52, fig. 3).

Age: Our specimen was collected loosely from the locality Parikhan (west Shahrud) by M. Shafeizad (Seyed-Emami et al. 2013, fig. 3b). Fernandez-Lopez (2001) reported the taxon from the Upper Bathonian (Retrocostatum Zone). *Bullatimorphites* (*B.*) *suevicus* is usually recorded from the uppermost Bathonian.

Family Reineckeiidae Hyatt, 1900

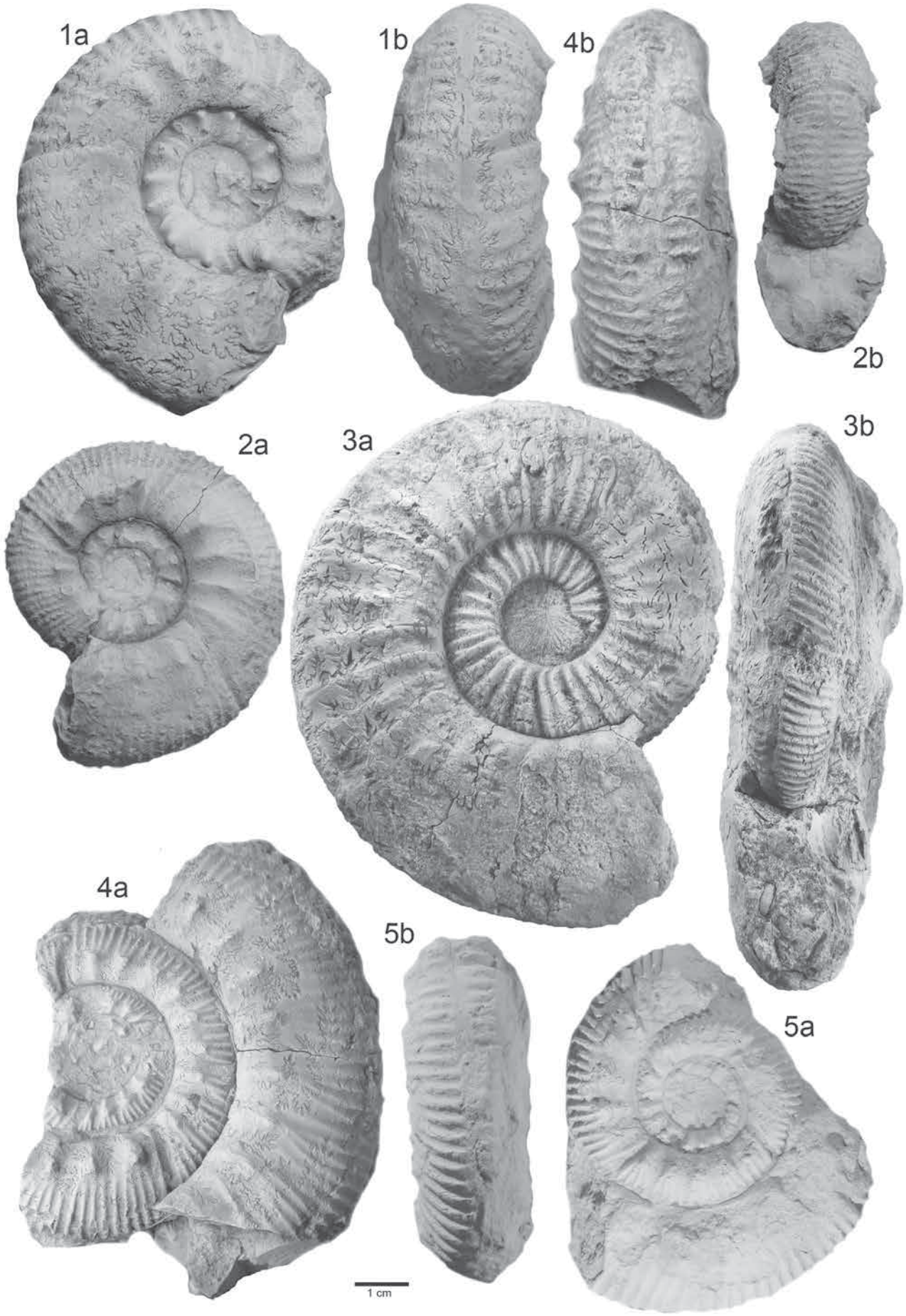
Remarks on Reineckeiidae from Talu: In Talu, Reineckeiidae are most abundant next to the Perisphinctidae as is usual within the Dalichai Formation in North Iran. Of more than hundred specimens, only few examples are considered here, because of nomenclatural problems regarding this ammonite family.

Genus *Reineckeia* Bayle, 1878

*Reineckeia* (*Reineckeia*) gr. *stuebeli*
(Steinmann, 1881) (M)
Pl. 4, Figs 4a, b, 5a, b

1984 *Reineckeia* (*Reineckeia) stuebeli* Steinmann, 1881 – Cariou, p. 264, pl. 40, figs 1–4a–c, 5, pl. 41, figs 2a–b, 3, 6a–b; textfigs 131–132, 146–149, 152, 159–160 (with synonymy).

**Plate 4: (1)** *Reineckeia* (*Reineckeia*) ex gr. *anceps* (Reinecke, 1818); Red Bed III, Talu, SNSB-BSPG 2013 XXIV 60. **(2)** *Reineckeia* sp.; Red Bed III, Talu, SNSB-BSPG 2013 XXIV 61. **(3)** *Alborzites binaludensis* Seyed-Emami (2013); Red Bed III, Talu, SNSB-BSPG 2013 XXXIV 57. **(4, 5)** *Reineckeia* (*Reineckeia*) gr. *stuebeli* (Steinmann, 1881) [M]; Red Bed III, Talu. **(4)** SNSB-BSPG 2013 XXIV 58. **(5)** SNSB-BSPG 2013 XXIV 59.


1a
1b
4b
2b
2a
3a
3b
4a
5b
5a
1 cm

Material: Two on one side preserved phragmocones from Talu: SNSB-BSPG 2013 XXIV 58, 59.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV 58 | 65 | 47 | 31 | 38 |
| BSPG 2013 XXIV 59 | 65 | 52 | 29 | - |

Description: Specimen SNSB-BSPG 2013 XXIV 58 is a fragment of a larger, fully septated and very evolute Reineckeiidae. In the inner whorls the whorl section is broad trapezoid-oval, but becomes later ovate and slightly higher than wide. The umbilicus is wide and shallow with rounded umbilical margin and steep umbilical wall. The ribbing consists of short, distant, nearly radiate and fairly coarse primary ribs, which start at the seam and end shortly above the umbilicus into fairly strong and sharp (spinose) tubercles. There are 11 tubercles on a half whorl at a diameter of 65 mm. Mostly four slightly prorsiradiate secondary ribs radiate from the tubercles with occasionally intercalated ribs. The ribs end vertically at a distinct ventral furrow. At a diameter of 65 mm there are two deep, prorsiradiate constrictions per half whorl.

Discussion: Regarding the wide umbilicus and the pattern of ribbing our specimens can be fairly well compared to the macroconch forms of *R. stuebeli* (Steinmann, 1881) as reported by Cariou (1984, p. 264,), especially the specimens illustrated on plate 40. A rather similar taxon is *Rehmannia* (*Loczyceras*) *reissi* (Steinmann) in Cariou & Krishna (1988, p. 156, pl. 1, fig. 1) from the Anceps Zone of Cutch, India.

Age: After Cariou (1984: p. 278) and Crariou (1994: p. 150) *R. suebeli* is a frequent taxon in the lower Middle Callovian (Anceps Zone) of Europe, being also known from the South Tethyan Realm (North Africa, India (Cutch) and Madagaskar). At Talu, the specimens come from Red Bed III.

*Reineckeia* (*Reineckeia)* ex gr. *anceps*
(Reinecke, 1818)
Pl. 4, Fig. 1a, b

1984 *Reineckeia (Reineckeia*) *anceps anceps* (Reinecke) – Cariou, p. 220, pl. 33, figs 4, 5a– b; pl. 34, figs 1, 2, 5a–b; pl. 35, figs 1, 4, 5a–b; textfigs 123, 126, 137, 155, 156 (with synonymy).
1988 *Reineckeia* (*Reineckeia*) *anceps* (Reinecke 1818) – Cariou & Krishna, p. 160, pl. 2, figs 2a–b; pl. 3, figs 1a–b (with synonymy).
2002 *Reineckeia* (*Reineckeia*) *anceps* (Reinecke, 1818) – Seyed-Emami et al., p. 185, figs 2–2–4.

Material: One phragmocone from Talu: SNSB-BSPG 2013 XXIV 60.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV 60 | 75 | 41 | 37 | - |

Description: A fully septated, fairly evolute and rather depressed *Reineckeia* with a diameter of 76 mm. The whorl section is, at the end of the last preserved whorl, rounded to oval and nearly as high as wide. The ribbing on the inner whorl consists of short, radiate, distant and coarse primaries, beginning at the seam. These end alternately into coarse, conical and spinose tubercles. Towards the last preserved whorl, the tubercles weaken. On the last portion of the whorl the ribbing consists of coarse and distant primaries, which often trifurcate above the mid-flank. Only one constriction can be recognized on the last whorl.

Discussion: The holotype of *R. anceps* (Reinecke 1818, p. 82, pl. 7, fig. 61) is lost and so far no neotype is established. Therefore, there is a lot of confusion regarding this taxon. Considering the numerous topotypes the taxon has to be re-studied. After E. Mönnig (pers. com. 2016) “the holotye comes from a little creek E of Uetzing in Franconia and probably from the upper Jason Zone (Dietl & Mönnig, in press). Similar species are also known from the upper Jason Zone of Swabia (Dietl 2013)“. Our specimen can be well compared to depressed morphotypes of the *R. anceps* group as reported by Cariou (1984), especially to *R. anceps elmii* Bourquin, 1968 in Cariou (pl. 37, fig. 2a, b). Concerning the broad whorl section and the coarse ribbing it shows also similarity with *Reineckeia* (*R.*) *nodosa* (Till, 1907).

Age: After Dietl (2013) *Reineckeia anceps* occurs in the upper part of the Jason Zone, which corresponds to the Upper Anceps Zone (Tyranniformis Subzone) in the Submediterranean Province. Our specimen comes from Red Bed III at Talu.

*Reineckeia* sp.
Pl. 4, Fig. 2a, b

Material: One phragmocone from Talu: SNSB-BSPG 2013 XXIV 61.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXIV 61 | 60 | 38 | 38 | 38 |

Description: Fairly evolute and slightly depressed *Reineckeia* with a rounded to oval whorl section. The ribbing consists of slightly proverse and distant primaries which end within the inner third of the flank into conical (spinose?) tubercles. Three or four rather fine, dense and partly polygrate secondaries bundle from the tubercles. Two or three intercalated ribs occur irregularly. There are three prorsiradiate and rather deep constrictions on the last whorl.

Age: early Middle Callovian, Red Bed III.

Genus *Alborzites* Schairer,
Seyed-Emami & Zeiss, 1991

*Alborzites binaludensis* Seyed-Emami, 2013
Pl. 4 Fig. 3a, b

2013 *Alborzites binaludensis* Seyed-Emami nov. sp. – Seyed-Emami et al., p. 57, figs 8e–h, m–o.
2014 *Alborzites binaludensis* Seyed Emami, 2012 – Parent et al., p. 11, pl. 5, figs 3–4, pl. 6, fig. 3, pl. 8, fig. 4, pl. 20, fig. 3.

Material: One fully septated and one-sided preserved specimen from Red Bed III at Talu: SNSB-BSPG 2013 XXXIV 57.

| Dimensions: | *D* | *U* | *H* | *W* |
|---|---|---|---|---|
| BSPG 2013 XXXIV 57 | 90 | 38 | 36 | - |

Description: The present specimen is a fully septated phragmocone with a diameter of 90 mm. For a detailed description see Seyed-Emami et al. (2013, p. 57).

Discussion: Hitherto only few specimens of the new genus *Alborzites* have been found in eastern Alborz. However, apparently it is not a rare taxon. Parent et al. (2014) reported several specimens from the Binalud Mountains (East Alborz).

Age: Red Bed III, early Middle Callovian.

## 4. Discussion

The Dalichai Formation (Late Bajocian–Oxfordian) is a sequence of greyish limestone and marlstone, being widely distributed along the Alborz Range and its eastern continuation Binalud Mountains. It contains locally a rather rich ammonite fauna, being often concentrated in few condensed beds. The studied ammonites come mostly from the upper part of the Dalichai Formation at Talu, north of Damghan. At Talu the ammonites are mostly accumulated within three few meter thick beds of condensed, red, nodular limestones and marls (Red Beds I–III). The red nodular limestone beds are the most prominent features within the Dalichai Formation along the eastern Alborz and Binalud Mountains (Seyed-Emami et al. 2013), representing condensation horizons being deposited on pelagic swells of a swell-trough system (Sandoval 2016, p. 245). This facies is widespread in the Alpine-Mediterranean Jurassic (e.g. Elmi 1981; Farinacci et al. 1981a, b; Martire 1988, 1989; Böhm et al. 1999; Rais et al. 2007; Jenkyns 1974, 2009; Baraboshkin et al. 2010; Sandoval 2016).

Within the red beds the ammonites are preserved mostly as one-sided internal moulds with iron impregnation and crusts without shell. This indicates strong dissolution, presence of oceanic currents and probably deeper-water environments. The deeper environmental deposition of the Dalichai Formation is also indicated by sedimentary structures such as slumpings, trace fossils, the great number of Phylloceratidae and the relatively great numbers of Lytoceratidae (Behfar et al. 2012).

At Talu, the bulk of the ammonite fauna consists of Perisphinctidae (ca 30%), Phylloceratidae (ca 20%) and Reineckeidae (ca 18%) as is usual for the Dalichai Formation (Seyed-Emami et al. 2013). The relativey high number of Lytoceratinae (ca 4%) and Macrocephalitidae (ca 6.5%) is especially remarkable, as they are rather rare elements within the Dalichai Formation. On the other hand, the nearly complete absence of Reineckeiidae and Macrocephalitidae in the section near Kelariz nearby Talu is remarkable (Seyed-Emami et al., 2015), although both sections are separated by a few kilometres only. Usually Reineckeiidae are amongst the most frequent ammonite taxa within the Dalichai Formation.

Paleobiogeographically the ammonite fauna of the Dalichai Formation is typically north-west Tethyan, with relations to the subboreal/submediterranean provinces (Seyed-Emami et al. 2013; Dietze et al. 2014).

## 5. Age of the Red Bed III

Red Bed III lies about two meters above the beds with Macrocephalitinae which belong to the Bullatus and Prahecquense zones of the Lower Callovian (Seyed-Emami et al. 2015). Consequently, regarding the stratigraphic position and the faunal composition, the age of the Red Bed III is late Early to Middle Callovian (Gracilis to Coronatum chrones). At Talu the first Macrocephalitinae appear in the Bullatus Zone, in which the Reineckeiidae are still absent. The first Reineckeiidae appear in the Gracilis Zone. It is remarkable that in southeast Spain the first Macrocephalitidae also appear in the Bullatus Zone, in which the Reineckeiidae are still absent and the first Reineckeiidae appear in the Gracilis Zone (Sandoval, 2016, p. 240).

## Acknowledgements

I dedicate this article to Dr. Winfried Werner on the occasion of his 65th birthday as a token of our long time friendship and his kind and steady support of my research activities in Munich in all the years and wish your family and you health, happiness and joy in the coming years. We would like to thank E. Mönnig (Coburg) for his constuctive review and additional informations. The present study is part of a research program supported by the Alexander von Humboldt Foundation. K.S.E. thanks G. Wörheide and W. Werner (both Munich) for providing research facilities during his stay (2016) at the BSPG in Munich. Our thank goes also to E. Lang, U. Projahn, S. Sónyi for preparation of the fossils and M. Schellenberger for production of photographs. We thank also Alexander Nützel (Munich) for his valuable editing

work and preparation of fossils to be photographed.

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