



Middle and Late Jurassic ammonites from the Dalichai Formation west of Shahrud (East Alborz, North Iran)

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With 10 figures

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Abstract: The following ammonite families are reported from the Dalichai Formation west of Shahrud (eastern Alborz, North Iran): Phylloceratidae, Haploceratidae, Oppeliidae, Sphaeroceratidae, Stephanoceratidae, Otoitidae, Tullitidae, Macrocephalitidae, Perisphinctidae, Ataxioceratidae, Aspidoceratidae and Reineckeidae, the latter with the newly introduced taxon *Alborzites binaludensis* SEYED-EMAMI nov. sp. The fauna comprises 23 species, most of them recorded from Iran for the first time. The described ammonites range from early Late Bajocian (late Early Bajocian?) to Middle Oxfordian. The ammonites are commonly concentrated in red, nodular limestones (“Ammonitico Rosso” facies). Palaeobiogeographically the ammonite fauna is closely related to those from the Sub-mediterranean Province of the northwestern Tethys.

Key words: Ammonites, Middle/Upper Jurassic, Dalichai Formation, Alborz, Binalud, Iran.

1. Introduction

Jurassic strata are well developed and widely distributed in the mountains north and west of Shahrud, eastern Alborz (VAZIRI & MAJIDIFARD 2000) (Fig. 1). In the study area, as common in the Alborz Range, the Late Triassic-Jurassic strata comprise three well distinguishable lithostratigraphic units beginning with the dark, siliciclastic and coal bearing Shemshak Formation (Group) (Norian – Lower Bajocian), followed disconformably by an alternation of greyish marls and limestone of the Dalichai Formation (Upper Bajocian – Oxfordian) and on the top the light cliff-forming carbonates of the Lar Formation (Upper Jurassic).

The here described ammonites are selected from a

larger number of ammonites, collected by K. SEYED-EMAMI and M.R. MAJIDIFARD during several visits to the sections west of Shahrud in the years 1996 to 2003. Few further specimens come from Takht-Kuh (ca. 25 km south of Bojnurd on the road to Esfarayen), Baghi (northwest of Neyshapur, Binalud Mountains) (Fig. 2), Tazareh (ca. 15 km northeast of Damghan) and Emamzadeh-Hashem in central Alborz (Fig. 1).

The sections west of Shahrud were studied by SHAFEIZAD (2001) within a MS Thesis; the results of this thesis were summarized in SHAFEIZAD & SEYED-EMAMI (2005). The same sections were again measured and resampled by RAOUFIAN (2011). The geological map 1: 100000 of the Shahrud area has been prepared by VAZIRI & MAJIDIFARD (2000).

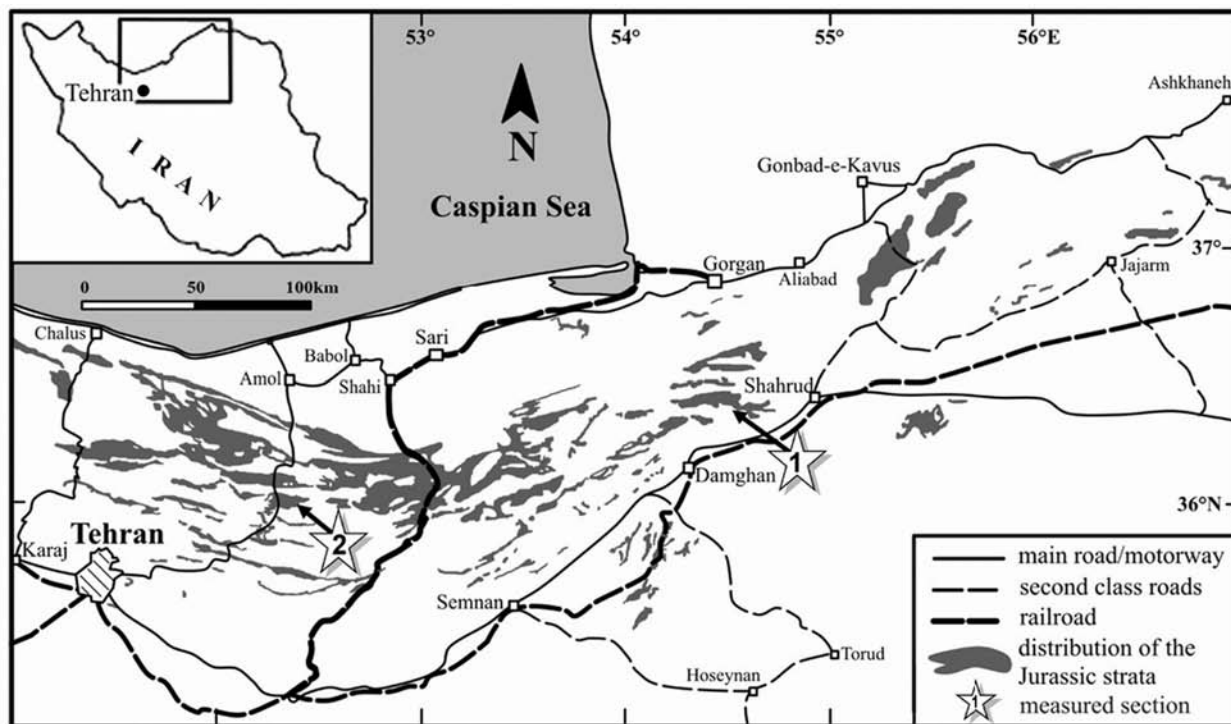


Fig. 1. Geographic map of central and east Alborz and western Koppeh Dagh, North Iran. 1 = location of sections west of Shahrud (Parikhan and Kuhe-Tapal); 2 = Emamzadeh-Hashem, central Alborz.

2. Geological setting

The bulk of the described ammonites come from two sections west of Shahrud: Parikhan ca. 11 km west of Shahrud (N 36°23'31", E 54°49'21") and Kuhe-Tapal ca. 21 km west of Shahrud (N 36°23'2", E 54°44'18") (Fig. 1). Additional specimens come from red, nodular limestones and marls at Takht-Kuh (ca. 25 km south of Bojnourd) and few specimens from Baghi, ca. 60 km northwest of Neyshapur (E 58°42'1", N 36°35'37") (Figs. 2-3). According to A. RAOUFIAN (pers. comm.) the Dalichai Formation at Baghi section has a thickness of 706 m and ranges from Upper Bajocian to Kimmeridgian. In the sections west of Shahrud the Dalichai Formation consists largely of an alternation of bluish-grey marls and limestone. At both sections the Dalichai Formation follows discontinuously on the dark, siliciclastic and coal bearing Shemshak Formation and is overlain gradationally by the light and cliff-forming carbonates of the Lar Formation.

At Kuhe-Tapal (thickness: 256 m), as well as at Parikhan (thickness: 324.5 m) (Fig. 3) the Dalichai Formation begins with several meters of red-brown, len-

ticular and sandy to fine-conglomeratic limestone with abundant crinoid fragments. At Parikhan it yielded few fragments of stephanoceratid ammonites of (late Early?) to early Late Bajocian age. Concerning the clastic nature of these beds these ammonites may be reworked from the underlying Shemshak Formation. This is followed by several ten of meters of greyish-green, argillaceous and very soft marls, with intercalated limestone beds in its upper part. The lower part of this unit yielded representatives of *Spiroceras* and *Garantiana* of Late Bajocian age as well as few small and pyritized sponges, bivalves, gastropods and belemnites (SHAFEIZAD 2001; SHAFEIZAD & SEYED-EMAMI 2005). The upper part of the Dalichai Formation consists largely of an alternation of greyish limestone and marls with varying content of ammonites. The bulk of the ammonites are accumulated in a few meters thick of pink nodular limestone and marls in "Ammonitico Rosso" facies. There are two red nodular and condensed beds in the sections Parikhan and Kuhe-Tapal (Fig. 3). The lower bed contains Late Bajocian to Bathonian and the upper one Middle and Late? Callovian ammonites.

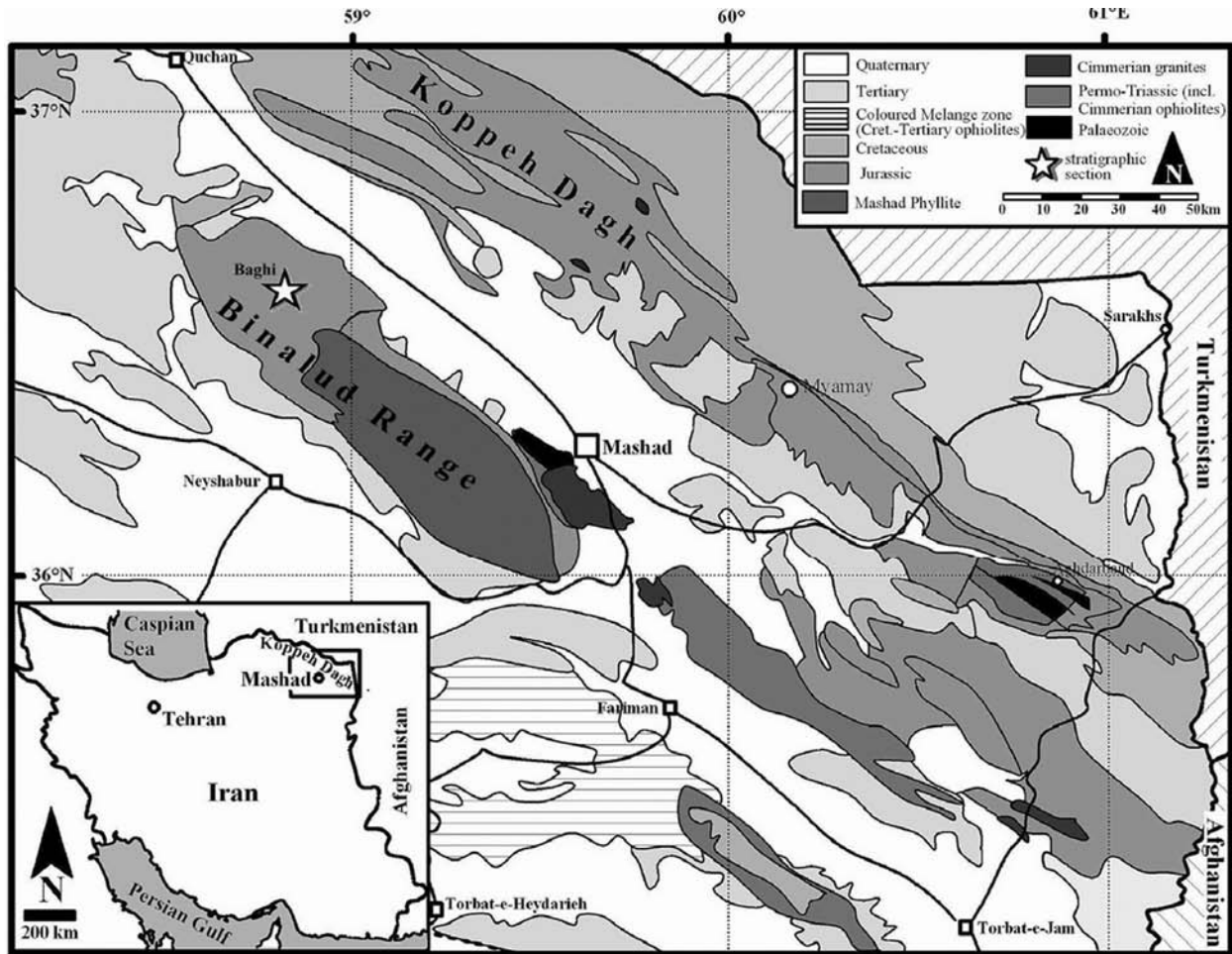


Fig. 2. Geographic map of the Binalud Mountains and eastern Koppeh-Dagh, with location of the Baghi section (modified from original, prepared by M. WILMSEN, Dresden).

3. Systematic palaeontology

The herein studied ammonite fauna is deposited in the collections of the “Bayerische Staatssammlung für Paläontologie und Geologie” (BSPG 2011 XXVII) in Munich, Germany.

As far as the preservation of the specimens allows 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; number of secondary ribs (SR) on a whorl; [m] = microconch, [M] = macroconch. All figures are natural size, otherwise indicated.

Order Ammonoidea ZITTEL, 1884
 Suborder Phylloceratina ARKELL, 1950
 Family Phylloceratidae ZITTEL, 1884
 Genus *Holcophylloceras* SPATH, 1927

Holcophylloceras zignodianum (D’ORBIGNY, 1848)

Fig. 4a-b

- *1848 *Ammonites zignodianus* D’ORBIGNY, p. 493, pl. 182, figs. 1-5.
- 2000 *Holcophylloceras zignodianum* (D’ORBIGNY, 1848). – JOLY, p. 107, pl. 26, fig. 8a-b; pl. 27, figs. 1-4a-b; text-figs. 219-226 (with synonymy).
- 2011 *Holcophylloceras zignodianum* (D’ORBIGNY, 1848). – RAOUFIAN et al., p. 77, pl. 2, figs. 1 a-c, 2a-c.

Material: Three corroded, one-side preserved phragmocones from Kuhe-Tapal: 2011 XXVII 1, 2, 3.

Dimensions:	D	U	H	W
2011 XXVII 1	98	10	55	–

Description: Fairly involute Phylloceratidae with high ovate whorl section and arched venter. The flanks are

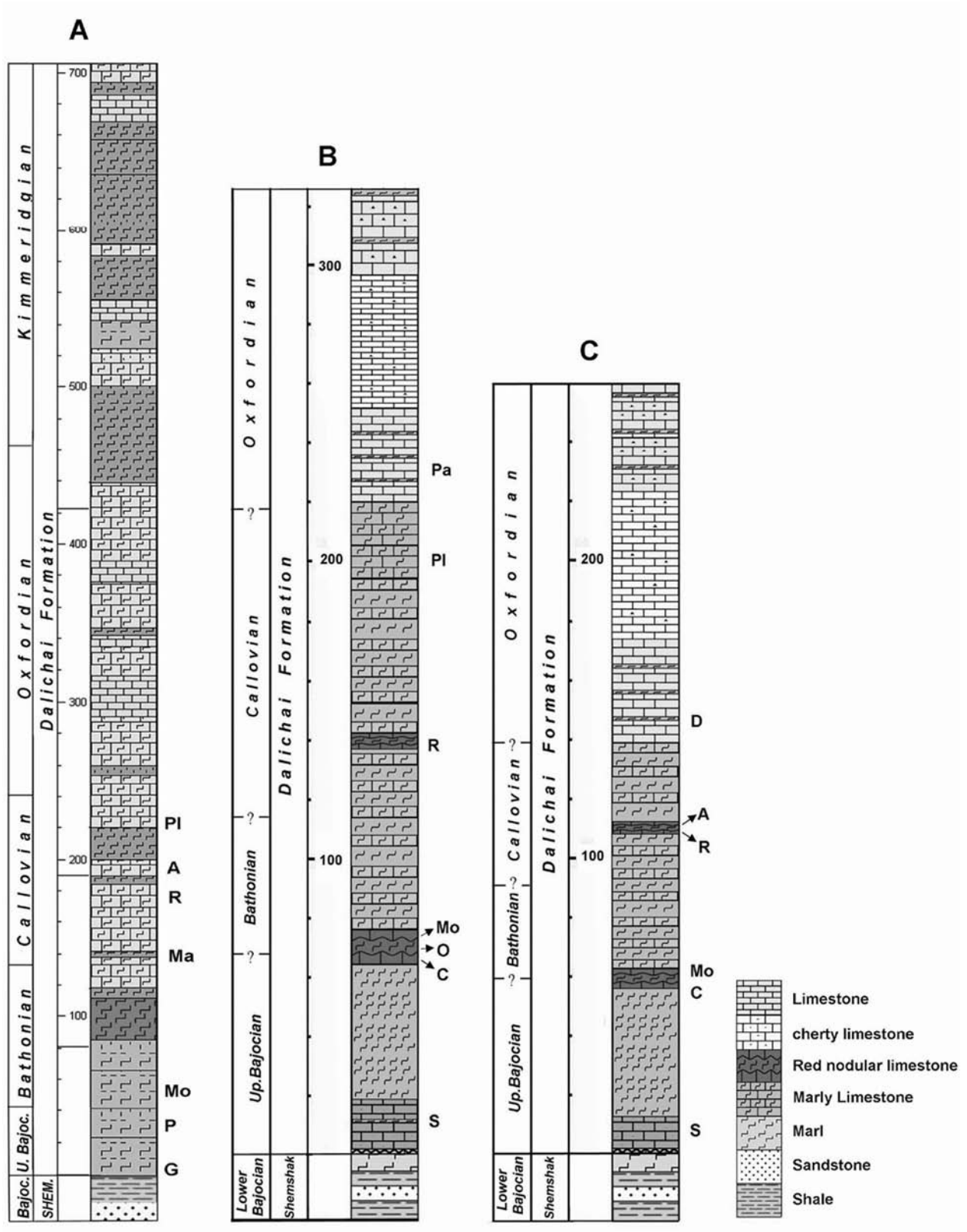


Fig. 3.

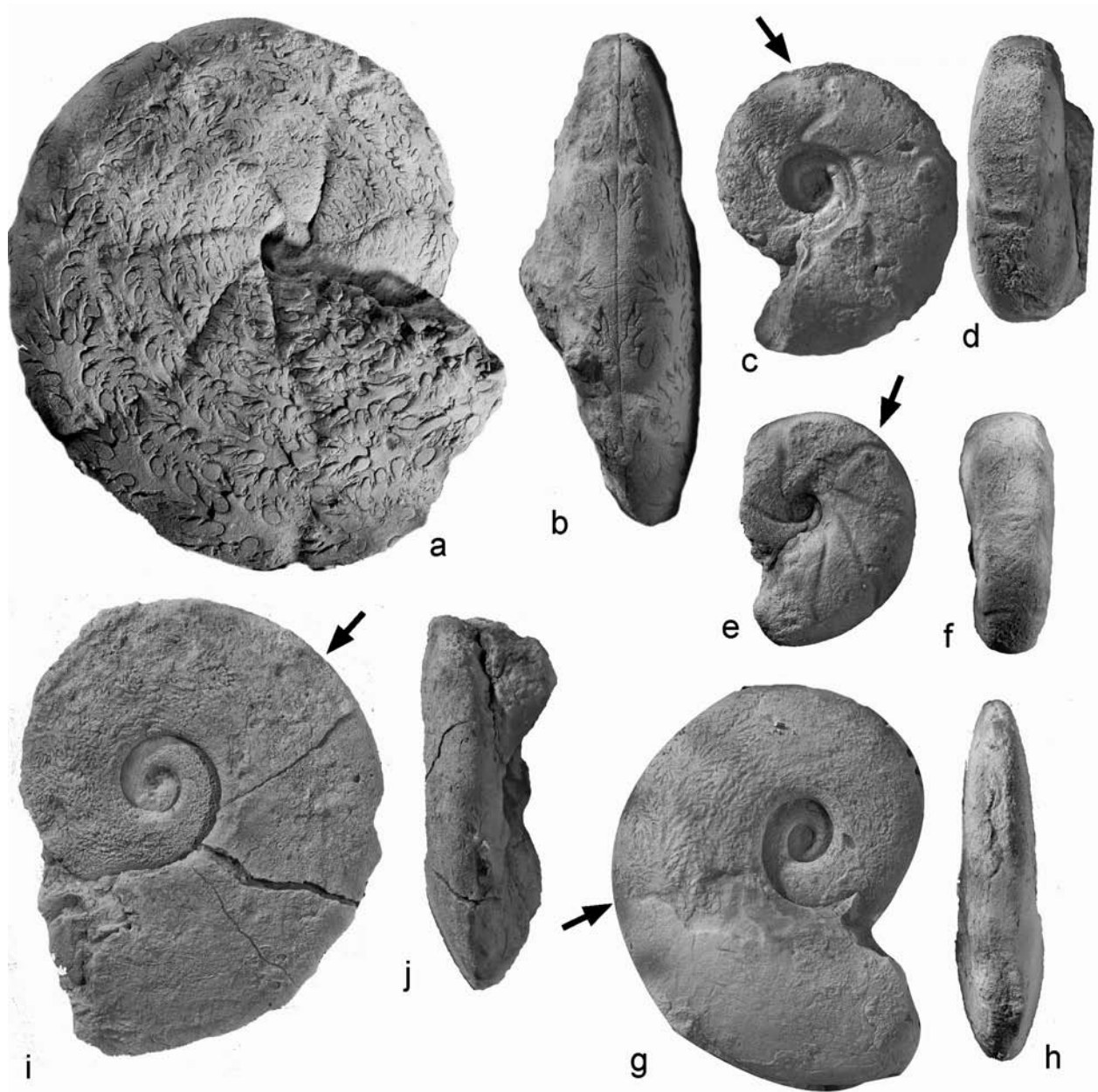


Fig. 4. a-b – *Holcophylloceras zignodianum* (D'ORBIGNY, 1848) x 80%, Kuhe-Tapal, BSPG 2011 XXVII 1; c-d – *Sowerbyceras tortisulcatum* (D'ORBIGNY, 1841) x 80%, Kuhe-Tapal, BSPG 2011 XXVII 4; e-f – *Sowerbyceras* aff. *subtortisulcatum* (POMPECKI, 1893) x 80%, Kuhe-Tapal, BSPG 2011 XXVII 7; g-h – *Lissoceras vouttense* (OPPEL, 1865) x 80%, Kuhe-Tapal, BSPG 2011 XXVII 8; i-j – *Lissoceras vouttense* (OPPEL, 1865) x1, south Bojnurd, 2001 XXVII 10.

Fig. 3. Stratigraphical logs of the studied sections: A. Baghi, B. Parikhan, C. Kuhe-Tapal. A = *Alborzites*, C = *Cadomites*, D = *Dichotomoceras*, G = *Garantiana*, Ma = *Macrocephalites*, Mo = *Morphoceras*, O = *Oxycerites*, P = *Parkinsonia*, Pa = *Parawedekindia*, Pl = *Peltoceras*, R = *Reineckeia*, S = *Sphaeroceras*.

slightly convex with greatest width about the mid-flank. Umbilical border is rather sharp, umbilical wall steep. The illustrated specimen shows seven fairly deep and sigmoidal constrictions, which curve acutely forward above the mid-flank and cross the venter.

Remarks: *H. zignodianum* is distinguished by its deep, sigmoidal constrictions, curving acutely forward on the outer mid-flank. From the very similar *H. indicum* (LEMOINE) it is distinguished by having a much narrower umbilicus (JOLY 2000:108).

Age: *H. zignodianum* has a long stratigraphic range from Late Bajocian to Oxfordian (JOLY 2000: 108).

Genus *Sowerbyceras* PARONA & BONARELLI, 1895

Sowerbyceras tortisulcatum (D'ORBIGNY, 1841)

Fig. 4c-d

- 2000 *Sowerbyceras tortisulcatum* (D'ORBIGNY, 1841). – JOLY, p. 114, pl. 28, figs. 4a-b, 5a-c; text-figs.236-242 (with synonymy).
 2010 *Sowerbyceras tortisulcatum* (D'ORBIGNY, 1841). – SEYED-EMAMI & SCHAIRER, p. 271, fig. 6a, b.
 2011 *Sowerbyceras tortisulcatum* (D'ORBIGNY, 1841). – SEYED-EMAMI & SCHAIRER, p. 12, fig. 4A, B.
 2011 *Sowerbyceras tortisulcatum* (D'ORBIGNY, 1841). – RAOUFIAN et al., p. 79, pl. 3, fig. 5a-c.

Material: One internal mould with a part of the body chamber from south Bojnurd: 2011 XXVII 4.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>
2011 XXVII 4	51	27	43	37

Description: Half of the last whorl of the present specimen belongs to the body chamber, beginning at ca. *D* = 34 mm. It is a rather evolute form with flattened sides and venter and a broad rectangular whorl cross section. Umbilical border is rather sharp, umbilical wall steep and slightly concave. On the last whorl there are five deep, strongly sigmoidal constrictions, being flared on the venter.

Remarks: *Sowerbyceras tortisulcatum* is a very common element in the Middle and Late Jurassic strata of North Iran. From the very similar *Sowerbyceras subtortisulcatum* (POMPECKJ, 1893) it is distinguished by a wider umbilicus and apparently fewer constrictions.

Age: Late Callovian to Oxfordian, after JOLY (2000: 116).

Sowerbyceras cf. *subtortisulcatum* (POMPECKJ, 1893)

Fig. 4e-f

- aff. 2000 *Sowerbyceras subtortisulcatum* (POMPECKJ, 1893). – JOLY, p. 114, pl. 28, fig. 3a, b; text-figs. 234-235 (with synonymy).

Material: Three internal moulds from Kuhe-Tapal: 2011 XXVII 5, 6, 7.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>
2011 XXVII 7	42	17	49	39

Description: Half of the outer whorl of the illustrated specimen (Fig. 4e-f) belongs to the body chamber, beginning at *D*=32 mm. It is a smooth and fairly involute *Sowerbyceras* with flattened flanks and nearly rectangular whorl section. Umbilical border is rounded, umbilical wall steep. The greatest whorl width is near the venter, from where the flanks fall slightly towards the umbilicus. There are six to seven proverse and sigmoidal constrictions. Near the shoulder the constrictions bend strongly forward and cross transversely the rather flat venter.

Remarks: Our specimens are slightly more involute than *S. subtortisulcatum*. *S. tortisulcatum* (D'ORBIGNY) is also similar but has a wider umbilicus and apparently fewer constrictions.

Age: Late Callovian, after JOLY (2000: 113).

Suborder Ammonitina HYATT, 1889

Family Haploceratidae ZITTEL, 1884

Genus *Lissoceras* BAYLE, 1879

Lissoceras vouttense (OPPEL, 1865)

Fig. 4g-j

- 1865 *Ammonites vouttensis*. – OPPEL, p. 319.
 2009 *Lissoceras vouttense* (OPPEL, 1865). – SCHLÖGL et al., p. 63, figs. 5.1, 5.2, 6.1 (with synonymy).

Material: Two slightly compressed and partly corroded internal moulds with parts of the body chamber from Kuhe-Tapal (2011 XXVII 8, 9) and three further specimens from Takht Kuh, south of Bojnourd (2011 XXVII 10, 11, 12).

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>
2011 XXVII 8	55	24	47	ca. 25
		70	27	44 ca. 25
2011 XXVII 11	44	24	48	27

Description: Discoidal, fairly evolute and slender *Lissoceras* with high oval whorl section and rounded ventral side. The greatest width is near to the umbilical margin, from where the flanks converge towards the venter. Umbilical border is rounded, umbilical wall steep. The beginning of the body chamber is marked by a slight uncoiling.

Remarks: Our specimens closely resemble *L. vouttense* in ROMAN (1924: 47, pl. 2, fig. 1, 1a, pl. 8, figs. 7-8) and SCHLÖGL et al. (2009: figs. 5.1, 5.2, 6.1). As already emphasized by SCHLÖGL et al. (2009: 64), *L. jullieni* from the Callovian of Herznach (N Switzerland) figured by JEANNET (1951: pl. 31, figs. 1-2, text-figs. 233-234) is probably a *L. vouttense*. *L.*

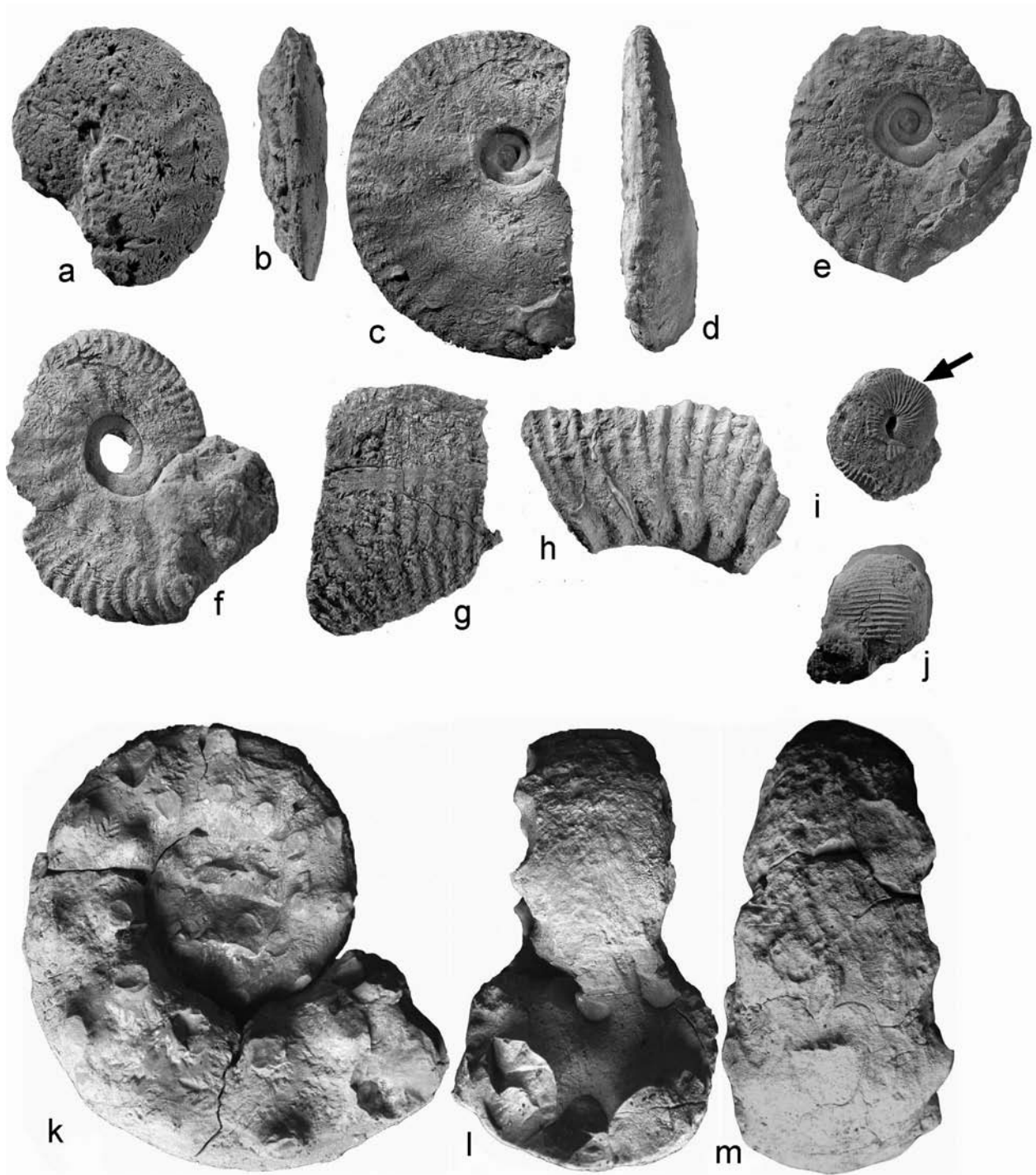


Fig. 5. **a-b** – *Oxycerites yeovilensis* (ROLLIER, 1911) x 80%, Kuhe-Tapal, BSPG 2001 XXVII 13; **c-d** – *Hecticoceras* (*Lunuloceras*) cf. *paulowi* (DE TSYTOVITCH, 1911) x 80%, Kuhe-Tapal, BSPG 2001 XXVII 14; **e** – *Hecticoceras* (*Lunuloceras*) cf. *paulowi* (DE TSYTOVITCH, 1911) x 80%, Kuhe-Tapal, BSPG 2001 XXVII 15; **f** – *Hecticoceras* (*Rossienceras*) gr. *metomphalum* BONARELLI, 1894 x 80%, Kuhe-Tapal, BSPG 2001 XXVII 18; **g** – *Emileia?* sp. x 80%, Parikhan, BSPG 2001 XXVII 25; **h** – *Stephanoceras?* sp. x 80%, Parikhan, BSPG 2001 XXVII 23; **i-j** – *Sphaeroceras brongniarti* (SOWERBY, 1818), Parikhan, BSPG 2001 XXVII 21; **k-m**. *Peltoceras* sp. ex gr. *Peltoceras athleta* (PHILLIPS, 1829) x 60%, Parikhan, BSPG 2011 XXVII 54.

voultense was also reported from the Lower-Middle Callovian “Ammonitico Rosso Facies” in eastern Crimea by BARABOSHKIN et al. (2010). Another similar taxon which also occurs in Iran is *L. psilodiscus* (SCHLOENBACH, 1865) from the lower Bathonian (SEYED-EMAMI et al. 1991: 69, pl. 1, figs. 9-10; SHAFIZAD & SEYED-EMAMI 2005: fig. 10.10).

Age: Lower to Middle Callovian, after SCHLÖGL et al. (2009). In Alborz it was found in the upper condensed beds within the Dalichai Formation.

Family Opeleidae BONARELLI, 1894
Subfamily Opeleinae BONARELLI, 1894
Genus *Oxyerites* ROLLIER, 1909

Oxyerites yeovilensis (ROLLIER, 1911)
Fig. 5a-b

Material: One fully septated and strongly corroded specimen with $D = 45$ mm from the condensed red beds at Kuhe-Tapal: 2011 XXVII 13.

Description: See SEYED-EMAMI et al. (1985: 62, 1989: 82, 1991: 69).

Age: Lower Bathonian.

Subfamily Hecticoceratinae SPATH, 1925
Genus *Hecticoceras* BONARELLI, 1894
Subgenus *Lunuloceras* BONARELLI, 1894

Hecticoceras (Lunuloceras) cf. paulowi (DE TSYTOVITCH, 1911)
Fig. 5c-e

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).

Material: Four fragmentary and corroded specimens from Kuhe-Tapal 2011 XXVII 14 - 17.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>
2011 XXVII 14	60	16	53	–
2011 XXVII 15	39	26	46	–

Description: The specimen (Fig. 5c-d) is a fairly involute Hecticoceratinae with high oval whorl cross section and a rather broad venter and a narrow low keel. The flanks are slightly convex, with the greatest whorl section width at about the lower third of the flank. Umbilical margin is rather sharp, with a vertical umbilical wall. The ribs are falcoid, bi- or trifurcated. The primary ribs are prorsiradiate and divide at about the mid-flank into two or three rursiradiate

and slightly concave secondary ribs. From a diameter of ca. 40 mm the primary ribs become more distant, somewhat flat and broad, looking like broad wrinkles. The specimen illustrated in Fig. 5e is distinctly more evolute.

Remarks: Specimen Fig. 5c-d is probably a macroconch form, being at $D = 60$ mm still fully septated. It can be best compared with *H. (L.) paulowi* (DE TSYTOVITCH, 1911: 69, pl. 7, fig. 10). This specimen is slightly more involute than the lectotype (DE TSYTOVITCH, 1911: pl. 7, fig. 10) designated by ZEISS (1956: 44). SCHLÖGL et al. (2009: figs. 5.4, 6.6) reported a coarser ribbed specimen as *H. (L.) cf. paulowi*.

Age: Late Callovian Lamberti Zone, According to ZEISS (1956: 45) and FORTWENGLER et al. (2012: 120, fig. 5). SCHLÖGL et al. (2009: 66) reported it from the Middle Callovian.

Sugenus *Rossienceras* GÉRARD & CONTAULT, 1936

Hecticoceras (Rossienceras) gr. metomphalum BONARELLI, 1894
Fig. 5f

Material: 3 fragmentary specimens from Kuhe-Tapal: 2011 XXVII 18-20.

Description: Specimen 2011 XXVII 18 (Fig. 5f) is a one-side preserved, compressed phragmocone with $D = 50$ mm and belongs with certainty to the very variable *H. (L.) metomphalum* group. For more details see SEYED-EMAMI & SCHAIRER (2011: 376).

Age: This polymorphic species is known from Anceps to Lamberti zones (ZEISS, 1956).

Family Sphaeroceratinae BUCKMAN, 1920
Genus *Sphaeroceras* BAYLE, 1878

Sphaeroceras brongniarti (SOWERBY, 1818)
Fig. 5i-j

*1818 *Ammonites Brongniarti* SOWERBY, p. 190, pl. A, fig. 2.
1951 *Sphaeroceras brongniarti* (J. SOW.). – ARKELL, p. 77, text-fig. 20, 2a, b (refiguration of the holotype from Bayeaux, Normandy, France).

1956 *Sphaeroceras brongniarti* (J. DE SOWERBY, 1818). – WESTERMANN, p. 28, pl. 14, figs. 1-7.

1994 *Sphaeroceras brongniarti* (J. SOWERBY, 1817). – GAUTIER & RIOULT, p. 130, pl. 46, fig. 3 a-c.

1994 *Sphaeroceras brongniarti* (SOWERBY, 1818). – SEYED-EMAMI et al., p. 149, pl. 1, fig. 2.

Material: Two fragmentary specimens from Parikhan, ca. 11 km west of Shahrud. The larger specimen has a diameter of 23 mm, the smaller one 11 mm (specimen 2011 XXVII 21, 22).

Description: On the figured specimen (Fig. 5i-j) parts of the original test is still preserved. It is a globular and tightly-coiled *Sphaeroceras* ($D=23$ mm), which begins to uncoil at the beginning of the last whorl, indicating the beginning of the adult body chamber. At a diameter of ca. 23 mm the ratio of the whorl width to diameter is ca 78%. The ribbing is fine and sharp. The primary ribs are slightly prorsiradiate and bifurcate frequently about the inner third of the flank. Few intercalatory ribs are present. The secondary ribs are very fine, densely spaced and cross the rounded venter almost transversely.

Remarks: The present specimen has a larger diameter and is slightly more depressed than the holotype which was re-figured by ARKELL (1951: 77, text-fig. 20, 2a-b). According to WESTERMANN (1956: 29) *S. brongniarti* shows wide variation in all of its features, especially in diameter. Another similar specimen was figured by FISCHER (1994, pl. 46, fig. 3a-c).

Age: In Europe *S. brongniarti* is known from the Humphriesianum to Subfurcatum zones (late Early Bajocian to early Late Bajocian). In Iran it was found together with fragments of a few oppeliids and stephanoceratids (*Stephanoceras*, *Emileia*) in the basal beds of the Dalichai Formation, just below the marls with *Strenoceras* and *Garantiana*, indicating the Humphriesianum? Zone. The clastic nature of the sediments, being partly fine-conglomeratic, may indicate that these fossils were possibly reworked from the underlying Shemshak Formation.

Family Stephanoceratidae NEUMAYR, 1875
Genus *Stephanoceras* WAAGEN, 1869

Stephanoceras? sp.
Fig. 5h

Material: Several small fragments from Parikhan, west of Shahroud: 2011 XXVII 23, 24.

Description: The fragmentary specimens are evolute with rounded whorl section. The ribbing is coarse with closely spaced subradial primary ribs which begin at the umbilical seam. At about the inner third of the flank the ribs end into rounded tubercles and bifurcate, alternating with some intercalatory ribs.

Age: Late Early Bajocian, Humphriesianum? Zone.

Family Otoitidae MASCKE, 1907
Genus *Emileia* BUCKMAN, 1898

Emileia? sp.
Fig. 5g

Material: A fragment from the basal beds at Parikhan: 2011 XXVII 25.

Description: The single fragmentary specimen is strongly depressed, broad-sphaerocone, with arched venter and fairly dense ribbing, showing the features of *Emileia*.

Age: Late Early Bajocian.

Family Tulitidae BUCKMAN, 1921
Genus *Morrisiceras* BUCKMAN, 1920

Morrisiceras morrisi (OPPEL, 1857) [M]
Fig. 6a-d

2008 *Morrisiceras morrisi* (OPPEL, 1857) [M&m]. – ZATOŃ, p. 701, figs. 2, 5-6 (with synonymy).

Material: One corroded specimen with a part of the body chamber from the red condensed beds at Kuhe-Tapal (2011 XXVII 26, Fig. 6a-b) and a one-side preserved phragmocone from the red nodular limestones south of Bojnurd (2011 XXVII 27, Fig. 6c-d).

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>
2011 XXVII 27	47	ca. 8	55	ca. 42
2011 XXVII 26 [M]	105	ca.16	ca. 47	ca. 38

Description: Fig. 6a-b (2011 XXVII 26) shows a fully grown, compressed sphaerocone *Morrisiceras*, with nearly one third of the last whorl of the broken body chamber. At the termination of the phragmocone it is rather involute, with deep umbilicus and vertical umbilical wall. At the beginning of the body chamber a distinct uncoiling occurs and the whorl cross section is rather high ovate-triangular. The greatest whorl width is shortly above the umbilicus, from where the flanks converge towards the narrow venter. The ribbing is, as far as visible, fairly coarse, slightly prorsiradiate and confined to the outer half of the flank. The smaller specimen (Fig. 6c-d; 2011 XXVII 27) is a one-side and relatively well-preserved phragmocone. It is a compressed sphaerocone, involute, with broad high-oval whorl cross section, slightly rounded flank and an arched venter. The greatest width lies near to the umbilical margin, from where it converges towards the venter. Umbilicus is deep, umbilical margin rounded, umbilical wall nearly vertical. The ribbing is slightly rursiradiate, rather dense and restricted to the outer part of the flank.

Remarks: A thorough analysis and description of *Morrisiceras* was given by ZATOŃ (2008). He used a wide definition of the taxon and united almost all the existing and diverse nominal species under the single taxon *M. morrisi* (OPPEL). Our specimen can be best compared with the more compressed and slim forms as “*Lycetticeras lycetti* ARKELL” in ARKELL (1954: 127, pl. 15, figs. 3, 9; text-fig. 41), KOPIK (2006: 22, pl. 20, fig. 1; pl. 21, fig. 1) and “*Lycetticeras sknipum*” (BUCKMAN) in ZATOŃ (2008: 702, figs. 2-9). The smaller specimen (2011 XXVII 27) recalls some ribbed Phylloceratidae (*Adabofoloceras*), but the suture-line, as far as recognizable, is without doubt not phylloceratid.



Fig. 6

Age: Middle Bathonian, Morrissi Zone. After ZATOŃ (2008, 2010) the taxon is paleobiogeographically restricted to the northern hemisphere (northwest and central Europe). Isolated occurrences are known from Turkmenistan/Uzbekistan (BESNOZOV & MITTA 1993). This is the first record of the taxon from Iran and a strong indication of the Middle Bathonian.

Family Macrocephalitidae BUCKMAN, 1922
Genus *Macrocephalites* ZITTEL, 1884

Macrocephalites cf. *compressus* (QUENSTEDT, 1846)
Fig. 6e-f

Material: One internal mould from Tazareh coals mine, northeast of Damghan (ca. 40 km west of Shahrud): 2011 XXVII 28.

Description: Rather large ($D = 115$ mm), slender and moderately involute *Macrocephalites*. The inner part of the last whorl is compressed, but the outer part seems not to be affected. It is not possible to see whether part of the body chamber is present or not. The ribbing is fine, dense, slightly prorsiradiate, bifurcating within the inner part of the flank, with sporadic intercalatory ribs.

Remarks: Concerning the rather little inflated and high oval whorls and the fine ribbing our specimen can be best compared with *M. compressus*. Similar forms are *M. macrocephalus* (SCHLOTHEIM) and *M. semilaewis* (WAAGEN). As outlined by PAGE (2008: 41) most of the existing nominal *Macrocephalites* species probably belong to a single variable biological species.

Age: *Macrocephalites* shows a world wide distribution, ranging from Late Bathonian to Early Callovian.

Family Perisphinctidae STEINMANN, 1890
Subfamily Pseudoperisphinctinae SCHINDEWOLF, 1925
Genus *Binatisphinctes* BUCKMAN, 1921

Binatisphinctes binatus (LECKENBY, 1859) [M]
Fig. 7a-d

1921 *Binatisphinctes binatus* BEAN-LECKENBY sp. – BUCKMAN, pl. 261A-B.

1988 *Binatisphinctes?* *binatus* (LECKENBY, 1859). – COX, p. 47, pl. 21, figs. 1-2, 4-5 (with synonymy).

1991 *Binatisphinctes* sp. – SCHAIRER et al., p. 60, pl. 3, fig. 2.

Material: Five partly compressed and one-side preserved phragmocones from Kuhe- Tapal: 2011 XXVII 29-33.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>	<i>PR/2</i>	<i>SR/2</i>
2011 XXVII 32	59	48	30	–	16	–
2011 XXVII 33	62	40	34	–	12	36
2011 XXVII 29	71	48	31	–	15	35
2011 XXVII 30	72	43	33	–	14	34
2011 XXVII 31	108	42	33	–	17	–

Description: Specimen 2011 XXVII 29 (Fig. 7a-b) is a fully septate, very evolute perisphinctid ammonite with fairly ovate, slightly higher than wide whorl section at the end of the last preserved whorl. The inner whorls are more depressed with a nearly quadratic whorl section. The umbilicus is shallow and wide with rounded border. The ribs are rather coarse and slightly prorsiradiate. Primary ribs are rather strong, and bifurcate usually on the outer half of the flank. Few intercalatory and simple ribs occur. On the inner whorls the ribbing is fairly densely spaced. On the venter the ribs become slightly rursiradiate. Few weakly developed constrictions and parabolic ribs are present. A smooth ventral band exists throughout the outer whorl.

Remarks: Two of the present specimens (2011 XXVII 29 and 32) closely resemble the illustrated specimen in COX (1988, pl. 21, fig. 5a-c); however, the ribbing is somewhat coarser in the present specimens. The other three existing specimens (2011 XXVII 30, 31 and 33) are clearly more involute, rather compressed and the whorl section is on the outer whorls clearly higher than wide. From the very similar *B. hamulatus* (BUCKMAN) our specimens are distinguished by slightly less coarse ribbing and perhaps a larger end-size. The similarity of the latter to *Pseudopeltoceras* is already stressed by COX (1988: 47).

Age: Upper Callovian, Athleta-Lamberti zones in Great Britain, France and Germany.

Binatisphinctes aff. *hamulatus* (BUCKMAN, 1921) [m?]
Fig. 7e-f

aff. 1921 *Hamulisphinctes hamulatus*, nov. – BUCKMAN, pl. 262, fig. A-B.

aff. 1988 *Binatisphinctes hamulatus* (BUCKMAN, 1921). – COX, p. 46, pl. 18, figs. 2-6, pl. 19, fig. 1 (with synonymy).

Material: A corroded internal mould, with a small portion of the body chamber from Kuhe- Tapal: 2011 XXVII 34.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>	<i>PR/2</i>	<i>SR</i>
2011 XXVII 34	49	49	31	31	14	–

Fig. 6. a-b – *Morrisiceras morrissi* (OPPEL, 1857) x 86%, Kuhe-Tapal, BSPG 2011 XXVII 26; **c-d** – *Morrisiceras morrissi* (OPPEL, 1857) x 86%, south Bojnurd, BSPG 2011 XXVII 27; **e-f** – *Macrocephalites* aff. *compressus* (QUENSTEDT, 1846) x 90%, Tazareh, BSPG 2011 XXVII 28.

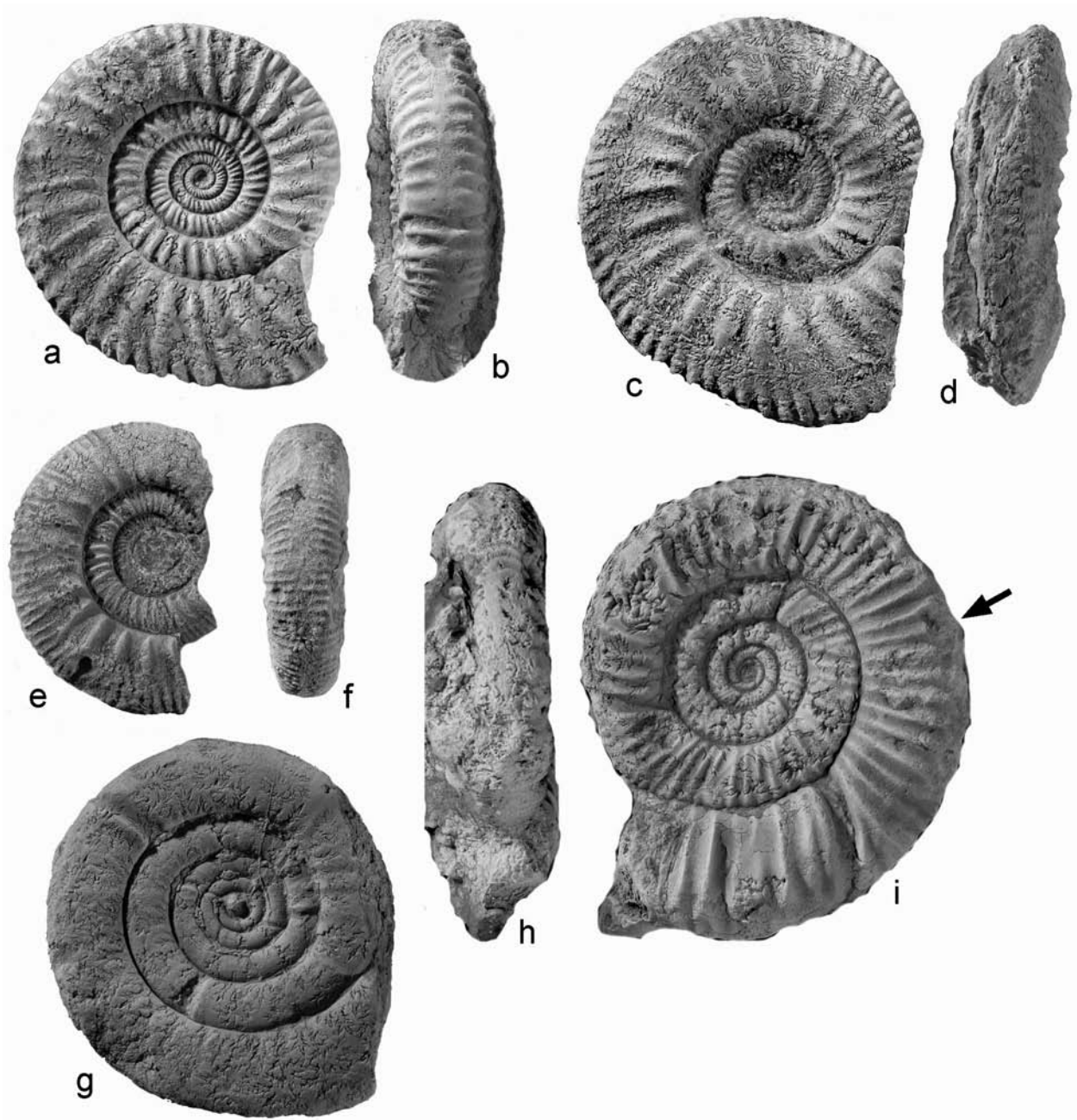


Fig. 7. a-b – *Binatisphinctes binatus* (LECKENBY, 1859) x 80%, Kuhe-Tapal, BSPG 2011 XXVII 29; c-d – *Binatisphinctes binatus* (LECKENBY, 1859) x 86%, Kuhe-Tapal, BSPG 2011 XXVII 30; e-f – *Binatisphinctes* aff. *hamulatus* (BUCKMAN, 1921) x 86%, Kuhe-Tapal, BSPG 2011 XXVII 34; h-i – *Orthosphinctes?* sp. x 86%, south Bojnurd, BSPG 2011 XXVII 35; g, *Passendorferia (Enayites) rozaki* MELENDEZ, 1989 x 86%, Kuhe-Tapal, BSPG 2011 XXVII 36.

Remarks: Very evolute Perisphinctidae, with quadrate whorl section and a smooth ventral band. The ornamentation is very similar to that of *B. binatus*. From the latter it is distinguished by a slightly coarser ribbing, a more de-

pressed and quadrate whorl section.

Age: Late Callovian.

Subfamily Passendorferiinae MELÉNDEZ, 1989
 Genus *Passendorferia* BROCHWICZ-LEWINSKI, 1973
 Subgenus *Enayites* BROCHWICZ-LEWINSKI & ROZAK,
 1976

Passendorferia (Enayites) rozaki MELÉNDEZ, 1989
 Fig. 7g

1989 *Passendorferia (Enayites) rozaki* sp. nov. – MELÉNDEZ, p. 174, pl. 13, figs. 10-15; text-fig. 34.

Material: A single specimen found isolated in scree, from Kuhe-Tapal: 2011 XXVII 36.

Description: The figured specimen is a strongly corroded phragmocone. It is a serpenticone and extremely evolute ammonite with rounded whorls. The ribbing is rather coarse and biplicate with intercalatory ribs. The dividing point is very high on the flank near to the venter. There are about two deep constrictions per whorl.

Remarks: Our specimen can be best compared with *P. rozaki* from the Bimammatum Zone. From the existing species of *Passendorferia* it is distinguished by its extremely wide umbilicus and the rather coarse ribbing. A very similar form is *Passendorferia uptonioides* (ENAY) described from northeastern Alborz (PARENT et al. 2012: 137, fig. 3) MELÉNDEZ et al. (2002) consider *Passendorferia* as a typical tethyan taxon common in the Submediterranean Province.

Age: Late Oxfordian, Bimammatum Zone. This specimen was collected from the scree and comes most probably from the overlying Lar Formation.

Family Ataxioceratidae BUCKMAN, 1921
 Subfamily Ataxioceratinae BUCKMAN, 1921
 Genus *Orthosphinctes* SCHINDEWOLF, 1925

Orthosphinctes? sp.
 Fig. 7h-i

Material: A one-side preserved internal mould with parts of the body chamber from south Bojnurd: 2011 XXVII 35.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>	<i>PR/2</i>	<i>SR/2</i>
2011 XXVII 35	80	51	27	–	21	–
	62	51	28	–	21	–

Description: Evolute Perisphinctidae, with rounded to subrectangular whorl section with slightly arched venter. The ribbing consists of rather coarse and prorsiradiate primary ribs, bifurcating very high on the flank into two secondary ribs. Shortly after the beginning of the body whorl at *D* = 62 mm and after a deep and strong constriction the primary ribs become coarser and more distant. There are two deep and relatively broad constrictions on the last whorl. In addition few parabolic ribs are present.

Remarks: The present specimen differs from typical *Orthosphinctes* by having a constant number of primary ribs on the succeeding whorls. In contrast, in typical *Orthosphinctes* the number of the ribs increases towards the outer whorls and bifurcation points are rather lower on the flank.

Age: Oxfordian.

Family Reineckeidae HYATT, 1900
 Genus *Reineckeia* BAYLE 1878
 Subgenus *Reineckeia* BAYLE, 1878

Reineckeia (Reineckeia) nodosa TILL, 1907
 Fig. 8k-l

1984 *Reineckeia (Reineckeia) nodosa* TILL, 1907. – CARIU, p. 246, pl.37, figs. 5-6.

1991 *Reineckeia (Reineckeia)* sp. – SCHAIRER et al., p. 56, pl. 2, fig. 3.

Material: A single specimen from Kuhe-Tapal: 2011 XXVII 40.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>
2011 XXVII 40	56	43	27	56

Description: The fairly well preserved phragmocone is evolute with a broad-oval whorl section. The ribbing is coarse with 12 coarse tubercles on the last whorl. In the higher part of the flank the primary ribs divide into three or four relatively coarse secondary ribs.

Remarks: The present Iranian specimen differs from the specimens illustrated by CARIU (1984: pl. 37, figs. 5-6) in having coarser secondary ribs.

Age: *R. nodosa* ranges according to CARIU (1984: 264) from late Middle Callovian (upper Coronatum Zone) to early Upper Callovian (Collotiformis Subzone).

Genus *Alborzites* SCHAIRER, SEYED-EMAMI & ZEISS,
 1991

Supplementary remarks on the diagnosis of *Alborzites*: The original diagnosis was based on the single fragmentary specimen of *A. semnanensis* from the Dalichai Formation (Callovian) at Kuhe-Sharaf, SE Alborz (SCHAIRER et al. 1991: 58). New collections from south Bojnurd, Kuhe-Tapal and Binalud Mountains allow enhancing the diagnosis. Polygyrate ribs occur only on the inner whorls of the specimens 2011 XXVII 41 and 2011 XXVII 42 from Bojnurd. However on the specimens from Kuhe-Tapal no polygyrate ribs can be observed, moreover the ribbing is clearly coarser and the tubercles at the dividing point of the ribs fade gradually on the body whorl.

So far common features for *Alborzites* are: Relatively small Reineckeidae (max. *D* ca. 100 mm), moderately involute, with rather fine and rounded tubercles. At the begin-

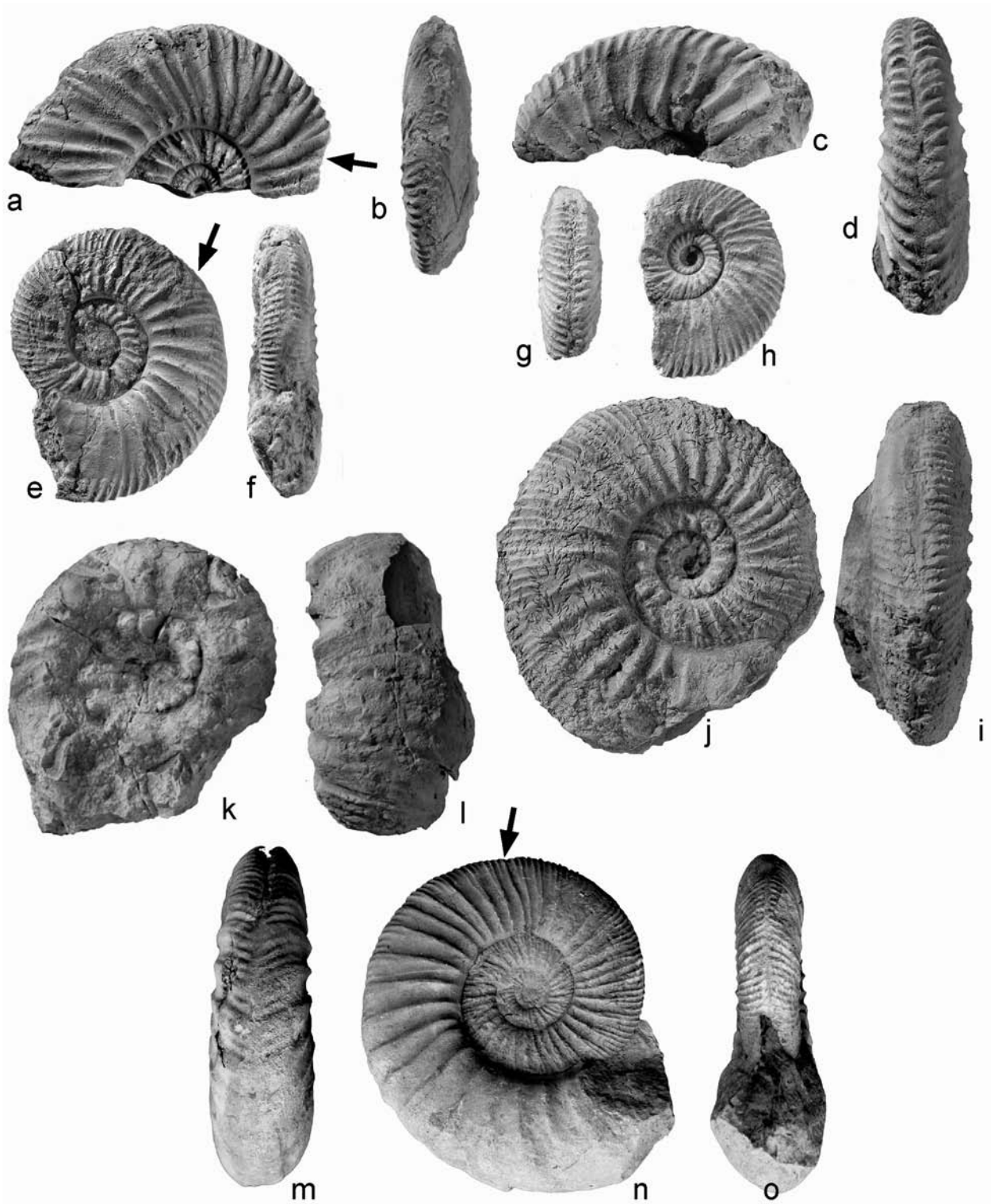


Fig. 8. a-b – *Alborzites semnanensis* SCHAIRER, SEYED-EMAMI & ZEISS, 1991 x 80%, Kuhe Tapal, BSPG 2011 XXVII 43; c-d – *Alborzites semnanensis* SCHAIRER, SEYED-EMAMI & ZEISS, 1991 x 80%, Kuhe-Tapal, BSPG 2011 XXVII 44; e-f – *Alborzites binaludensis* SEYED-EMAMI nov. sp. [Paratype x 80%], south Bojnurd, BSPG 2011 XXVII 41; g-h – *Alborzites binaludensis* SEYED-EMAMI nov. sp. x 80%, south Bojnurd, BSPG 2011 XXVII 42; i-j – *Rehmannia (Loczyceras)* aff. *reissi* (STEINMANN, 1881) x 80%, Kuhe-Tapal, BSPG 2011 XXVII 37; k-l – *Reineckeia (Reineckeia) nodosa* TILL, 1907 x 80%, Kuhe-Tapal, BSPG 2011 XXVII 40; m-o – *Alborzites binaludensis* SEYED-EMAMI nov. sp. [Holotype] x 60%, Baghi, BSPG 2011 XXVII 56.

ning of the body chamber the tubercles fade gradually and the dividing point of the ribs moves higher up to the outer part of the flank. The most significant feature of *Alborzites* is the forward projection of the ribs on the venter, contrary to all other known Reineckeidae. So far polygyrate ribbing seems to be only significant at species level.

Alborzites semnanensis SCHAIRER, SEYED-EMAMI &
ZEISS, 1991
Fig. 8a-d

*1991 *Alborzites semnanensis* nov. sp. – SCHAIRER et al., p. 58, pl. 2, fig. 7.

Material: Two fragmentary specimens from Kuhe-Tapal: 2011 XXVII 43, 44.

Description: Specimen 2011 XXVII 43 (Fig. 8a-b) is a half preserved specimen with a diameter of ca. 60 mm. On the inner whorls the ribs are not clearly recognizable. On the outer whorl, still representing the phragmocone, the ribs are bi- to triplicate with the dividing point at about the mid-flank. At the dividing point there are tiny rounded tubercles. A single constriction can be observed. On the last whorl (body chamber) the ribs are biplicate with varying dividing points on the upper half of the flank. On the venter, the ribs curve faintly forward, ending at a narrow band. Specimen 2011 XXVII 44 (Fig. 8 c-d) is also a fragment, nearly as large as the other one, with a high oval to trapezoidal whorl section. The ribbing is coarse and mainly triplicate with the dividing point relatively high above the mid-flank. One constriction can be observed. On the venter the ribs curve clearly, ending at a narrow band.

Remarks: The present fragmentary specimens match fairly well with the holotype of *A. semnanensis* (SCHAIRER et al. 1991: 58, pl. 2, fig. 7).

Age: Middle Callovian.

Alborzites binaludensis SEYED-EMAMI nov. sp.
Fig. 8e-h, m-o

Etymology: Named after the Binalud Mountains, which are the eastern extension of the Alborz Range (from Bojnurd to Mashhad).

Types: Holotype is the specimen 2011 XXVII 56 [M?] from the Baghi section, eastern Binalud Mountains; paratypes are the specimens 2011 XXVII 41 and 2011 XXVII 42 from the red Beds south of Bojnurd, western Binalud Mountains. Additional material: two specimens from Baghi, Binalud Mountains: 2011 XXVII 57, 58.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>	<i>PR/2</i>	<i>SR/2</i>
2011 XXVII 42	36	35	38	30	15	37

2011 XXVII 41	60	33	33	ca. 23	15	ca. 40
2011 XXVII 56	92	39	38	30	15	–
(end of phragmocone)	ca. 62	ca. 36	ca. 35	ca. 28	17	42

Type locality: Baghi, ca. 90 km northwest of Neyshapour, Binalud Mountains, northeast Iran (E 58° 42' 1", N 36° 35' 37") (Fig. 2).

Type horizon: Middle Callovian (Coronatum? Zone) (Fig. 3).

Diagnosis: Fairly evolute with high oval whorl section and a narrow ventral band. The ribbing on the inner whorls is rather dense and fine with tiny tubercles at about the mid-flank and dividing into three or rarely two secondary ribs, which bend forward on the venter, ending at a narrow band, few polygyrate ribs occur; on the body chamber, the ribs become distinctly coarser, more widely spaced and the dividing point moves higher up on the flank.

Description: The holotype (2011 XXVII 56; fig. 8m-o) is a nearly complete adult specimen (*D* = 95 mm). It is a fairly evolute reineckeiid with high ovate whorl cross section and a narrow ventral groove. The umbilical margin is rounded, with nearly steep umbilical wall. The ribbing is rather dense and fine. The slightly prorsiradiate primary ribs begin at the seam and end rather irregularly in tiny tubercles just below the mid-flank. From the tubercles, usually three or infrequently two secondary ribs radiate, occasionally with intercalatory ribs. The secondary ribs are rather fine, bend on the venter slightly forward and end at a narrow band. Few polygyrate ribs occur. The body chamber begins at *D* = 62 mm and comprises almost $\frac{3}{4}$ of the ultimate whorl. At the beginning of the body chamber begins a slight uncoiling, the ribs become distinctly coarser, more distant and the dividing point moves higher up on the flank.

One of the paratypes is also a nearly complete individual (2011 XXVII 41; Fig. 8e-f) from south Bojnurd. This is a small and probably microconch reineckeiid with a diameter of ca. 60 mm, with the body chamber beginning at a diameter of 37 mm. It is fairly evolute, with high oval, clearly higher than wide whorl section and a narrow band on the venter. The umbilical margin is rounded, with a low and nearly straight umbilical wall. The ribbing is on the phragmocone rather prorsiradiate with tiny and rounded tubercles within the inner half of the flank. Usually two secondary ribs initiate from the tubercles with occasional intercalatory ribs. On the body chamber the ribbing becomes coarser, less dense and slightly concave, the tubercles fade away and the dividing point moves higher up, within the outer half of the flank. The ribs are usually biplicate with intercalatory ribs. Few polygyrate ribs and some inconspicuous constrictions occur. On the venter the ribs bend clearly forward and end at a narrow smooth band.

The second paratype (specimen 2011 XXVII 42; Fig. 8g-h) is still septate at *D* = 37 mm. On the inner whorls up to *D* = 17 mm there are regularly tiny and rounded tubercles at the division point. Later the tubercles are slightly coarser and occur at irregular intervals. The ribs are usually triplicate with the dividing point within the inner flank half. On the last whorl there are 5-6 inconspicuous constrictions.

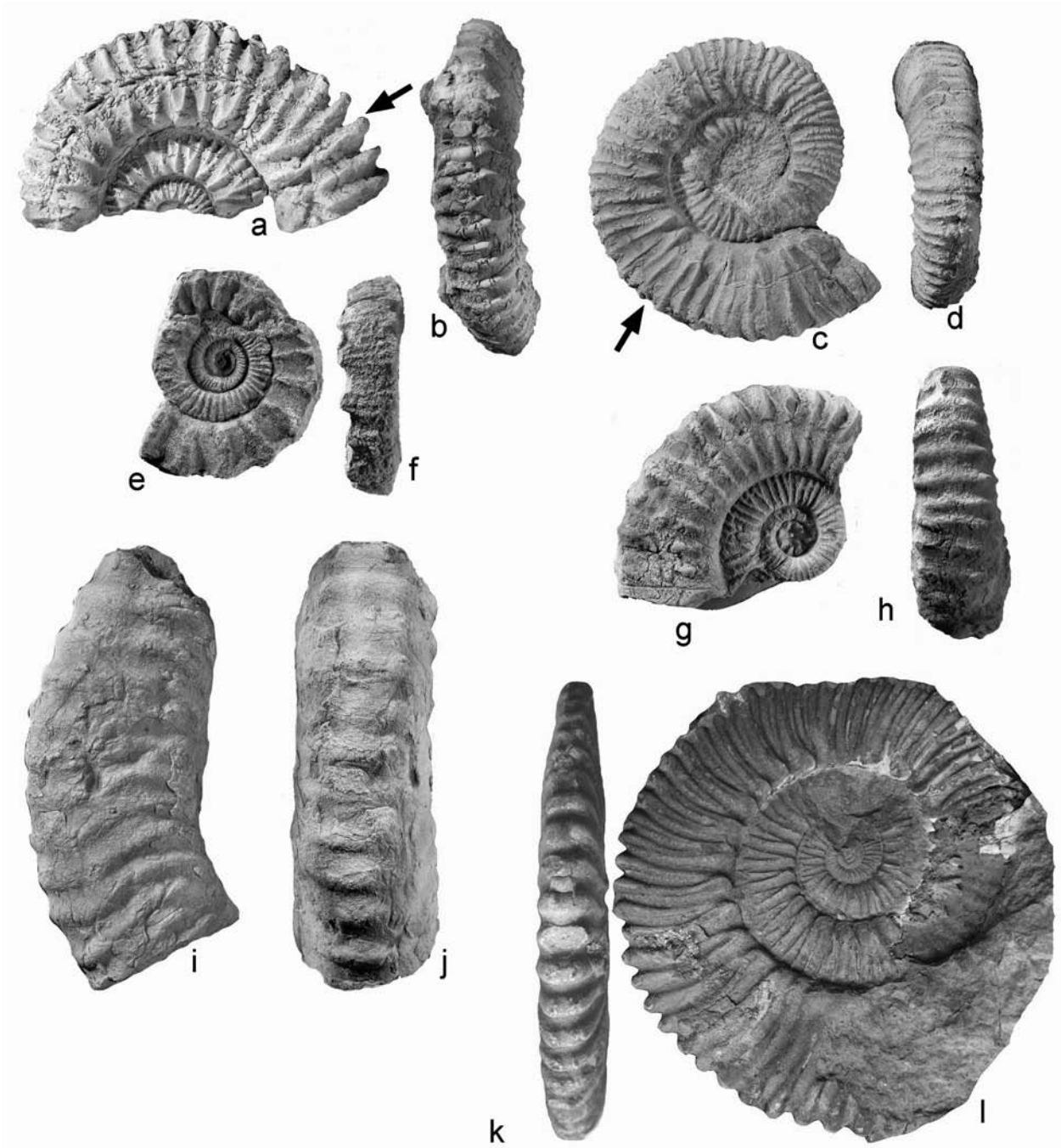


Fig. 9. a-b – *Peltoceratoides* (*Parawedekindia*) aff. *arduennensis* (D'ORBIGNY, 1848) x 84%, south Bojnurd, BSPG 2011 XXVII 48; c-d. *Peltoceratoides* (*Parawedekindia*) aff. *pseudoconstantii* PRIESER, 1937 x 84%, Kuhe-Tapal, BSPG 2011 XXVII 47; e-f – *Peltoceras* (*Peltoceras*) *berckhemeri* PRIESER, 1937 x 84%, Kuhe-Tapal, BSPG 2011 XXVII 45; g-h – *Peltoceratoides* sp. x 84%, Emamzadeh-Hashem, BSPG 2011 XXVII 46; i-j – *Gregoryceras* sp. x 84%, Kuhe-Tapal, BSPG 2011 XXVII 52; k-l. *Peltoceratoides* (*Parawedekindia*) *arduennensis* (D'ORBIGNY, 1848), Parikhan x 74%, BSPG 2011 XXVII 55.

Few inconspicuous polygyrate ribs occur. On the venter the ribs bend forward and end at a narrow band.

Remarks: The new species differs from *A. semnanensis* in having weaker ribs which are distinctly less coarse and more densely spaced.

Age: Probably Middle Callovian (Coronatum?Zone). A more precise age is not possible, because the specimens come from condensed beds.

Genus *Rehmannia* SCHIRARDIN, 1956
Subgenus *Loczyceras* BOURQUIN, 1968

Rehmannia (Loczyceras) aff. reissi (STEINMANN, 1881)
Fig. 8i-j

aff. 1984 *Rehmannia (Loczyceras) reissi* (STEINMANN, 1881). – CARIOU, p. 86, pl. 10, figs. 1, 3, 4a-c; pl. 11, figs. 1a-b, 3, 4 a-c; text-figs. 31, 37, 55-56, 97.

Material: Three corroded phragmocones from Kuhe-Tapal: 2011 XXVII 37-39.

Dimensions:	D	U	H	W
2011 XXVII 37	66	36	37	–
2011 XXVII 39	58	43	35	–
2011 XXVII 38	53	35	39	36

Description: The figured specimen (2011 XXVII 37, Fig. 8i-j) is a fairly evolute phragmocone with high-ovate whorl section. The umbilical margin is rounded and the umbilical wall is nearly vertical. The ribbing is rather dense and perisphinctoid. On the inner whorls, the primary ribs are short and form rather sharp tubercles just above the umbilicus. On the last preserved whorl, the primary ribs are slightly prorsiradiate, ending into tiny tubercles within the inner third of the flank and mostly trifurcate into rather fine and dense secondary ribs; intercalatory ribs occur. On the venter the ribs form nearly a right angle to the narrow band.

Remarks: Our specimens are characterized by their dense and perisphinctoid-like ribbing and a rather narrow umbilicus. The present specimens are more evolute than *R. (L.) reissi* and the dividing points are higher on the flank. Another similar specimen is *R. (L.) aff. discrepans* (BOURQUIN) in SCHAIRER et al. (1991: 56, pl. 2, fig. 2).

Age: Middle Callovian.

Family Aspidoceratidae ZITTEL, 1895
Subfamily Peltoceratinae SPATH, 1924
Genus *Peltoceras* WAAGEN, 1871
Subgenus *Peltoceras* WAAGEN, 1871

Peltoceras sp. ex gr. *Peltoceras (Peltoceras) athleta*

(PHILLIPS, 1829)
Fig. 5k-m

cf. 1931 *Peltoceras athleta* (PHIL.). – SPATH, pl. 103, fig. 6; pl. 106, fig. 3 (neotype); pl. 107, fig. 3.

cf. 1993 *Peltoceras athleta* (PHILLIPS) morphe *athleta* (PHILLIPS) (M). – BONNOT, p. 154, pl. 4, figs. 1-4.

cf. 1995 *Peltoceras athleta* (PHILLIPS, 1829) morphe *athleta* [M]. – BONNOT, p. 198, pl. 1, figs. 1, 2a-b (with synonymy on p. 212).

Dimensions:	D	U	H	W	PR/2	SR/2
2011 XXVII 54	90	38	42	ca. 52	6	6

Material: One strongly corroded phragmocone ($D = 125$ mm), from Parikhan, 2011 XXVII 54.

Description: Rather depressed and evolute Peltoceratinae with broad subrectangular whorl section and broad, slightly arched venter. Umbilical wall is steep. On the last preserved whorl the ornamentation consists of pairs of strong and spiny umbilical and ventrolateral tubercles (bituberculate). The ornamentation of the inner whorls up to $D = 50$ mm is not visible.

Discussion: *P. (P.) athleta* is a very variable taxon so that BONNOT (1995) distinguished several morphotypes. Our specimen is rather incomplete, strongly corroded and the inner whorls are not visible, it is difficult to determine it specifically. So far it can be best compared with *P. (P.) athleta* morphe *athleta*, but it differs by having a smaller umbilicus, a slightly convex venter, a broad-rectangular whorl section and fewer tubercles per whorl. After A. BONNOT (pers. comm.) this specimen, specially the bituberculate stage, resembles much some *Euaspidoceras*. To distinguish both taxa with a high level of certainty we need to see the early ornamentation. Contrary to *Peltoceras*, *Euaspidoceras* has always parabolic ribs on the inner whorls.

Age: *P. (P.) athleta* is widely distributed in Europe and occurs after BONNOT (1995: 214) in the early Late Callovian (Athleta Zone) The stratigraphic position of the Iranian specimen within the studied section indicates also a Late Callovian age.

Peltoceras (Peltoceras) aff. berckhemeri PRIESER,
1937
Fig. 9e-f

aff. 1937 *Peltoceras berckhemeri* n. sp. – PRIESER, p. 16, pl. 1, fig. 1a-c; text-fig. 3A-C.

aff. 1985 *Peltoceras (Peltoceras) berckhemeri* PRIESER, 1937. – SCHLEGELMILCH, p. 144, pl. 58, fig. 2.

Material: A one-side preserved phragmocone from Kuhe-Tapal, collected by M. SHAFIZAD: 2011 XXVII 45.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>
2011 XXVII 45	38	ca. 52	26	–

Description: Very evolute Peltoceratinae with shallow umbilicus. The cross section of the inner whorl is seemingly broadly quadratic, becoming distinctly broader on the last preserved whorl. The venter is nearly flat. On the inner whorls (up to 22 mm in diameter) the ornamentation consists of fine, dense, sharp and radiate ribs, bifurcating on the outer part of the flank, just below the ventrolateral shoulder. From ca. *D* = 22 mm onwards, the ribs become noticeably coarser and more distant. On the last preserved whorl the ribs are coarse, distant with umbilical and much coarser ventrolateral tubercles and trifurcate primaries, crossing the venter in a straight line.

Remarks: The specimen is slightly more evolute than the otherwise very similar *P. berckhemeri*. Moreover, our specimen has a finer ribbing on the inner whorls. Concerning the fine and dense inner whorls ribbing the Iranian specimen can be best compared to *P. berckhemeri* var. *neidlingenense* PRIESER (1937: 18, pl. 1, figs. 4-5). However the coarsening of the ribs occurs somewhat later in our specimen. Further similar specimens are *P. cf. berckhemeri* in JEANNET (1951, p. 166, pl. 72, fig. 3a-c) and a juvenile specimen from Yorkshire figured by SPATH (1931: 561, pl. 103, fig. 6a-b). BONNOT (1993:154, 1995: 212) considers *P. berckhemeri* synonymous to *Peltoceras athleta*, morphe athleta.

Age: Late Callovian?

Genus *Peltoceratoides* SPATH, 1924
Peltoceratoides sp.
Fig. 9g-h

Material: One fully septate internal mould from Gardaneh Emamzadeh-Hashem (Central Alborz), collected by Mrs. B. TUTOUNCHI, 2011 XXVII 46.

Description: Evolute Peltoceratidae with quadratic-trapezoidal whorl section. The greatest width lies just above the umbilicus, sloping gently towards the venter. The umbilical border is rounded; the umbilical wall steep. The ribbing on the inner whorl is rather dense and fine, bifurcating shortly above the umbilicus, with few simple ribs. On the last preserved whorl the ribbing is slightly rursiradiate, mostly simple and rather coarse and distant. On the mid-flank the ribs become fainter, swelling ventrolaterally into tubercles. The ribs cross in straight-line the slightly arched venter.

Remarks: The most characteristic feature of the present specimen is the slightly rursiradiate and simple ribbing on the last preserved whorl, looking somewhat alike *Prieserites* sp. A and *P.* sp. in JEANNET (1951: 189-190, pl. 79, figs. 2-3).

Age: *Peltoceratoides* has a wide distribution, occurring on both sides of the Tethys in Early Oxfordian (ALBERTI et al. 2011: 12).

Subgenus *Parawedekindia* SCHINDEWOLF, 1925 [m]

Peltoceratoides (Parawedekindia) aff. pseudoconstantii PRIESER, 1937 [m]
Fig. 9c-d

aff. 1937 *Peltoceratoides pseudoconstantii* n. sp. – PRIESER, p. 90, pl. 7, fig. 4; pl. 9, figs. 1, 3, 8; text-fig. 10H.

aff. 1994 *P. (P.) pseudoconstantii* PRIESER, 1937. – SCHLEGELMILCH, p. 117, pl. 61, fig. 3.

Material: A one-side preserved specimen with a portion of the body chamber (beginning at *D* = 48 mm) from Gardaneh Emamzadeh-Hashem (Central Alborz); collected by B. TUTOUNCHI: 2011 XXVII 47.

Dimensions:	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>	<i>PR/2</i>	<i>SR/2</i>
2011 XXVII 47	48	47	31	29	17	29
	56	45	32	29	15	31

Description: Medium-sized, evolute Peltoceratidae with a quadratic-subrectangular, slightly higher than wide whorl cross section. Flanks are flat, descending gently towards the tabulate venter. Umbilical wall is low and vertical. The ornamentation consists of rather sharp and slightly rursiradiate ribs, beginning at the umbilical seam. The primary ribs are slightly bullate and bifurcate usually shortly above the umbilicus. Trifurcation and simple ribs rarely occur. Ventrolaterally, the ribs bend slightly forward and cross the venter without interruption and with a slight forward flexure. Few tiny tubercles occur sporadically at the ventrolateral edge. On the body chamber the ribbing becomes somewhat coarser and more widely spaced.

Remarks: Except slightly denser ribbing on the inner whorls, our specimen closely resembles *P. pseudoconstantii* PRIESER, especially the specimen on pl. 9, fig. 8, being later refigured by SCHLEGELMILCH (1994: 117, pl. 61, fig. 3). Another similar specimen is *P. (P.) eugenii* morphe *capri-anum* PRIESER (in BONNOT et al. 1997: 664, figs. 13.4-13.5; especially fig. 13.5.). Nevertheless, the whorl section of our specimen is more angular and the ribbing is slightly less coarse and flexuous. The present specimen is also very similar to *P. (P.) arduennensis*. However, it is distinguished only by a wider umbilicus and slightly denser ribbing. ALBERTI et al. (2011) considered *Parawedekindia* as microconchs of *Peltoceratoides*.

Age: According to SCHLEGELMILCH (1994: 117): Early Oxfordian.

Peltoceratoides (Parawedekindia) arduennensis
(D'ORBIGNY, 1848) [m]
Fig. 9k-l

*1848 *Ammonites arduennensis* sp. nov. – D'ORBIGNY, p. 500, pl. 185, figs 4-7.

- 1994 *Parawedekindia arduennensis* (D'ORBIGNY). – MARCHAND et al., p. 164, pl. 69, figs. 5, 6a-c, 7.
 2011 *Peltoceratoides (Parawedekindia) arduennensis* (D'ORBIGNY, 1848) [m]. – ALBERTI et al., p. 8, figs. 10A-E; 11A-E, J-M; 12; table 5 (with synonymy).

Lectotype: The specimen figured by D'ORBIGNY (1848, pl. 185, figs. 4-5) designated and refigured by MARCHAND et al. (1994: 164, pl. 69, fig. 5).

Material: One compressed specimen from Parikhan: 2011 XXVII 55.

Description: A strongly compressed internal mould with ca $D = 95$ mm. The beginning of the body chamber cannot be determined. It is an evolute *Peltoceratoides* with a shallow umbilicus, parallel flanks and a tabulate venter. On the inner whorls, the ribbing is rather dense with short and radiate primary ribs, beginning at the umbilical seam and bifurcating rather regularly within the inner third of the flank. Few simple ribs exist. On the outer whorl, the primary ribs become slightly bullate, move to the umbilical shoulder and bifurcate or rarely trifurcate. Ventrolaterally the ribs become thicker, slightly bullate at the ventrolateral margin.

Discussion: Our specimen closely resembles the specimens from the Oxfordian of Kachchh (India) as figured by ALBERTI et al. (2011).

Age: According to ALBERTI et al. (2011) *P. (P.) arduennensis* has a world-wide distribution during the Early Oxfordian (Mariae to Cordatum zones).

Peltoceratoides (Parawedekindia) aff. arduennensis
 (D'ORBIGNY, 1848) [m]
 Fig. 9a-b

Material: Four fragmentary specimens from Takht-Kuh, south of Bojnurd: 2011 XXVII 48-51.

Dimensions:

	<i>D</i>	<i>U</i>	<i>H</i>	<i>W</i>	<i>PR/2</i>	<i>SR/2</i>
2011 XXVII 48	63	ca. 47	ca. 32	–	15	24

Description: The figured specimen (2011 XXVII 48) is a one-side preserved specimen with a small part of the body chamber. It is evolute with subrectangular whorl section. Inner whorls are rather depressed with nearly quadratic whorl cross section. The ribbing is fairly coarse with short, slightly prorsiradiate and bullate primary rib; they begin at the umbilical seam and bifurcate shortly above the umbilical border. Few simple intercalated ribs occur. On the flank the ribs bend slightly backwards, become ventrolaterally coarser and cross the tabulate venter in straight line.

Remarks: Except a coarser ribbing, our specimens compare fairly well to *P. (P.) arduennensis*. Similar specimens, but with slightly coarser ribbing, were illustrated by ALBERTI et al (2011, fig. 10D, 10G and 10H) as *P. (P.) cf. arduennensis* from Kachchh (India).

Age: Lower Oxfordian (Mariae to Cordatum zones).

Gregoryceras sp.
 Fig. 9i-j

Material: Two corroded fragments from Kuhe-Tapal, NW Shahroud: 2011 XXVII 52, 53.

Description: The illustrated specimen (2011 XXVII 52, Fig. 9i-j) has a coarse and apparently simple, prorsiradiate ribbing on the inner flank but becomes strongly rursiradiate on the outer part of the flank. Ventrolaterally the ribs become slightly bullate and cross the venter without interruption.

Remarks: *Gregoryceras* is a rather rare taxon in the Upper Jurassic of Iran. So far the only previous records are *G. cf. fouquei* (KILIAN) from the eastern Tabas Block in eastern Central Iran (SCHAIRER et al. 2002) and from eastern Alborz (MAJIDIFARD 2003).

Age: The genus ranges from the late Middle to early Late Oxfordian (BERT et al. 2009).

4. Conclusions

The bulk of the described ammonites are selected from a larger collection of more than 2,000 specimens, from two sections west of Shahrud (eastern Alborz). Some of the present ammonites were already described from various parts of the Alborz Mountains (SEYED-EMAMI et al. 1985, 1989, 1991, 1994, 1995; SCHAIRER et al. 1991; MAJIDIFARD 2003, 2008). The described ammonite fauna comprises taxa from the early Late Bajocian (late Early Bajocian?) to Middle Oxfordian. Following families are present: Phylloceratidae, Lytoceratidae, Spiroceratidae, Haploceratidae, Oppeliidae, Stephanoceratidae, Sphaeroceratidae, Macrocephalitidae, Parkinsoniidae, Morphoceratidae, Reineckeidae, Perisphinctidae, Ataxioceratidae, Aspidoceratidae. The percentage of the most frequent ammonite families is as following: Phylloceratidae (30%), Reineckeidae (30%), Perisphinctidae (27%), Oppeliidae (5%) and others less than (5%) (see SHAFEIZAD 2001; SHAFEIZAD & SEYED-EMAMI 2005). The relatively high number of Lytoceratidae (13 specimens 0,7%) is remarkable. Lytoceratidae are contrary to Phylloceratidae very rare elements within the Jurassic ammonite faunas of northern Iran (SEYED-EMAMI & SCHAIRER 2010, 2011a; SHAFEIZAD & SEYED-EMAMI 2005).

From the total fauna, 23 species were chosen for this study, especially those which have been less known or have not been described hitherto. The oldest taxa collected from the base of the Dalichai Formation

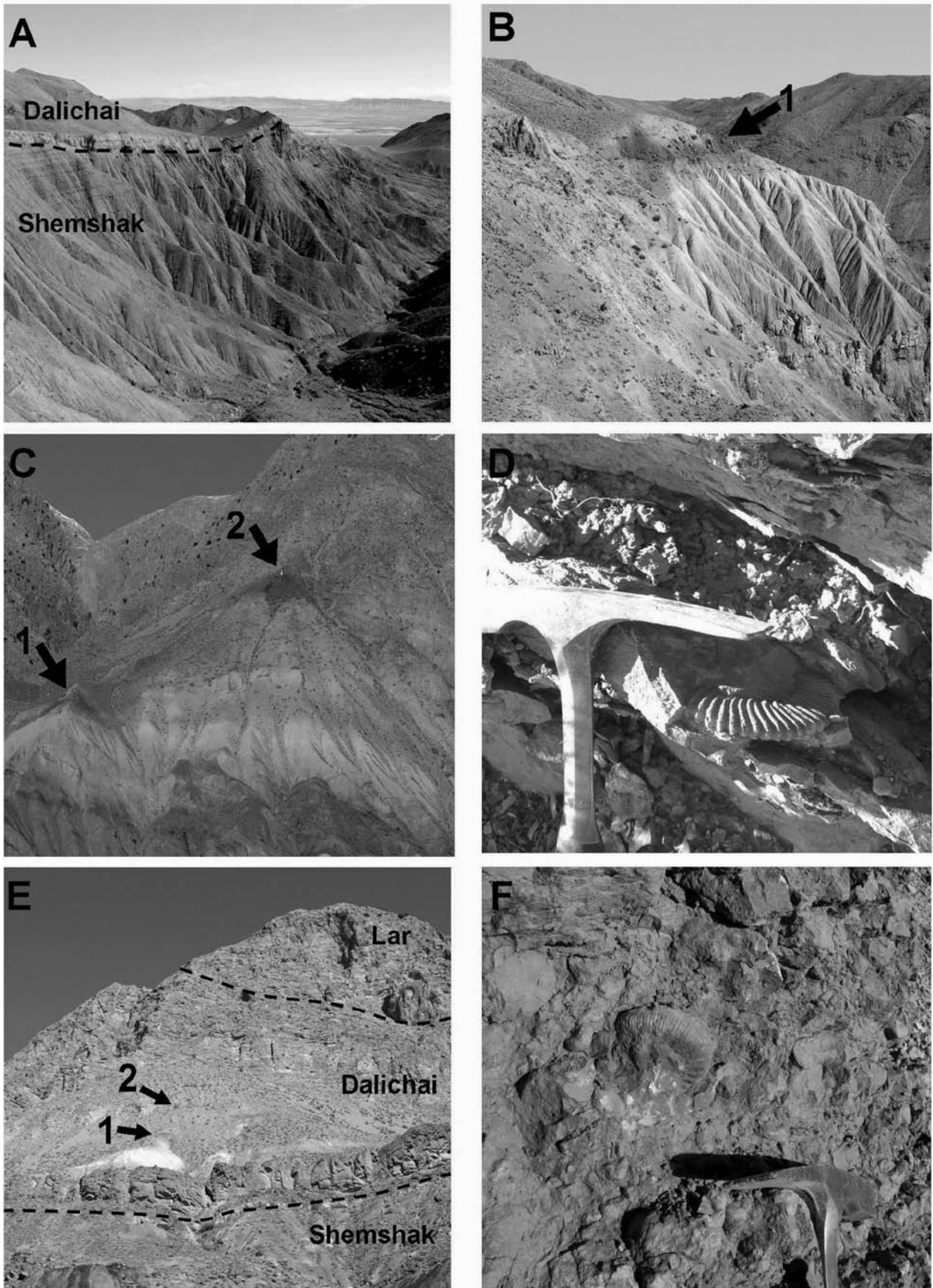


Fig. 10.

west of Shahrud are few fragmentary Stephanoceratidae and Sphaeroceratidae of late Early to early Late Bajocian age, followed by few Spiroceratidae and Parkinsoniidae of the Late Bajocian. The Early Bathonian is documented, besides *Oxycerites*, in particular by Morphoceratidae. Of great interest is the first record of *Morrisiceras* indicating the Middle Bathonian. After ZATON (2008, 2010) this taxon seems to be restricted palaeobiogeographically to the northern hemisphere (northwest and central Europe); however, isolated occurrences are known from Italy and Turkmenistan/Uzbekistan. This is the first record of *Morrisiceras* from Iran and so far the first solid proof of the Middle Bathonian represented within the Dalichai Formation.

Latest Bathonian and Early Callovian are indicated by the presence of *Macrocephalites*, which is a rather rare taxon in Alborz and occurs usually in small numbers. Higher up in the section in the late Early and Middle Callovian, besides Phylloceratidae, Perisphinctidae, Hecticoceratinae and Reineckeidae occur. As usual in the Alborz Range the typical Mediterranean Reineckeidae (PAGE 2008; SCHLÖGL et al. 2009; SEYED-EMAMI & SCHAIRER 2011b) appear in large numbers and high diversity. This may be related to the worldwide Middle Callovian transgression (HALLAM 2001: 29) which is seemingly also the most extensive transgression phase within the Jurassic of North Iran. In the Late Callovian the number and also the diversity of ammonoids decreases considerably, indicating a sea level fall. Besides Perisphinctidae (*Binatisphinctes*) the Aspidoceratidae (Peltoceratinae) appear. In Early Oxfordian the number and diversity of the ammonites increase slowly again.

The number, diversity and palaeobiogeographic relationship of the ammonite fauna at different levels of the Dalichai Formation is apparently closely related to transgressive and regressive phases, caused by global sea-level fluctuations. As evidences of glaciations are lacking during the Jurassic period (HALLAM 2001; WI-

ERZBOWSKI & ROGOV 2011), the fluctuations of the sea-level are rather related to plate tectonics (tectono-eustatic) (HALLAM 2001: 32).

Other factors may be palaeoceanographic conditions such as temperature and opening of new migration ways (CECCA et al. 2005; RAIS et al. 2007; SCHLÖGL et al. 2009; ZATOŃ 2011; WIERZBOWSKI & ROGOV 2011).

The presence of condensed beds in “Ammonitico Rosso” facies represents one of the most prominent features of the Dalichai Formation in the eastern Alborz Mountains (Fig. 10). It represents condensation horizons with red nodular limestone and marls and occurs in different stratigraphic levels and embodies various time spans. This lithology is also wide-spread in the Alpine-Mediterranean Jurassic (e. g., RAIS et al. 2007; JENKYN 2009). At the sections west of Shahrud (Parikhan and Kuhe-Tapal) there are two reddish condensation horizons, an older one of Late Bajocian to Bathonian age and a younger one of Middle to Late Callovian age.

The ammonite fauna of the Dalichai Formation is typically Northwest-Tethyan and belongs to the Sub-mediterranean Province with episodic Mediterranean and Subboreal affinities. Typical Boreal ammonites like Kosmoceratidae are almost missing.

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Fig. 10. Field aspects of the Dalichai Formation west of Shahrud. **A** – Sharp contact of the Dalichai and Shemshak formations at Parikhan. **B** – Lower marl member of the Dalichai Formation followed by the first red, condensed nodular limestone (arrow) at Parikhan. **C** – Position of the first and second red condensed beds (arrows) at Parikhan. **D** – *Parawedekindia* in situ, about 230m above the base of the Dalichai Formation at Parikhan. **E** – Sharp contact of the Dalichai and Shemshak formations, with the basal siliciclastic limestone and the position of the first and second red condensed beds (arrows) at Kuhe-Tapal. **F** – Close-up view of the second condensed bed at Kuhe-Tapal.

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