Early Berriasian ammonites from Shal, Talesh region (NW Alborz Mountains, Iran)

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1. Introduction

Neocomian ammonites from northern Iran are poorly known (Seyed-Emami et al., 1972). Bogdanowitch (1890) and Rivière (1934) recorded from this area the occurrence of ammonite species indicative of the early Berriasian, but originally assigned to the late Tithonian. Seyed-Emami (1975) considered these records doubtful and recorded Middle Jurassic to early Barremian ammonites, including taxa confined to the Berriasian, from a succession exposed near the village of Shal (Talesh region, northwest Alborz Mountains). These ammonites have never been described in detail, nor illustrated.

The present paper provides the first taxonomic description of early Berriasian ammonites from northern Iran. K. Seyed-Emami and B. Hamzepour made a first collection in 1970 but new fieldwork carried out in 2005 on Jurassic-Lower Cretaceous successions of the Shal Basin supplemented earlier sampling and provided a detailed stratigraphic framework.

A detailed description of the stratigraphical, sedimentological and micropalaeontological context and content of the Shal and Kolur formations will be the subject of a subsequent paper.

2. Geological setting

The section studied crops out a few hundreds metres north of the village of Shal (co-ordinates: N 37° 20’ 11”; E 48° 44’ 53”) (Fig. 1). At the base are Middle Jurassic rocks that conformably overlie the Shemshak Formation (Upper Triassic-Middle Jurassic). Davies et al. (1972) studied this section during the baseline geological mapping of the Masuleh area (geological map Masuleh 1/100 000), and designated it as the type section of the Shal Formation.

Based on data collected during our fieldwork, this formation reaches a thickness of 51 m and consists of bioclastic glauconitic sandstones and limestones with numerous fossiliferous beds (Fig. 2). The Shal Formation can be roughly subdivided into an ? upper Bajocian to Callovian-lower Kimmeridgian part, characterized by glauconitic sandstones, sandy limestones and limestones with frequent intercalations of bioclastic material. The first beds of the upper part of the section comprise 1.4 m of nodular, glauconitic,
sandy limestone with abundant ammonites, dated as early late Kimmeridgian. Starting from this layer, glauconitic sandy limestones characterise the sedimentary sequence. Our layer 45, a 1.4 m-thick reddish limestone, corresponds to ‘Layer 8’ of Davies et al. (1972, p. 61). Layer 45 yields ammonites of the genus Haploceras, indicative of a Tithonian age (Olóriz, 1978; Enay and Cecca, 1986). The find of specimens of the calpionellid Chitinoiodella in layer 47 indicates the base of the upper Tithonian (Benzaggagh et al., 2010). Layers 46 to 54 comprise fine-grained, glauconitic limestones. In the middle part of layer 51, the calpionellids Calpionella alpina Lorenz, 1902 and Crassicollaria parvula Remane, 1962 indicate the base of the Berriasian (Remane et al., 1986; Benzaggagh et al., 2010). Casts of large, unidentified ammonites have been observed on the top of bedding planes in layers 46 and 52. Layer 53 contains the rich ammonite fauna described in the present paper. The section ends at layer 54, which is overlain by 4–4.5 m of limestones that grade into the overlying Kolor Formation.

3. Stratigraphic position of early Berriasian ammonites in the Shal formation

The ammonites mentioned in the present paper were collected from layer 53, which consists of several distinct beds. Only two of these yielded ammonites (Fig. 2). In the field the lower bed was designated 53* and the upper bed, which contains fragments of ammonites, was referred to as 53g. These beds crop out both along a cliff, where we measured and sampled the section, and also along the road (which is almost 30 m away from the cliff face) where the beds have been referred to as 53'I and 53'bis. The ammonites collected in 1970 by K. Seyed-Emami and B. Hamzepour, and subsequently reported on by Seyed-Emami in 1975

3.2. Road exposure

Bed 53*, L. liebigi (1 specimen), H. carachtheis morph elimatum (1 specimen, macroconch; see Fig. 5j) and morph carachtheis (1 specimen, microconch; see Fig. 5G, H), Berriasella (B.) oppeli (Kilian, 1889) (1 specimen), B. (B.) sabatasi (1 specimen), Pseudosubplanites lorioli (von Zittel, 1868) (2 specimens), P. cf. lorioli (2 specimens), T. fuersichi nov. gen., nov. sp. (1 specimen).

3.3. Ammonites collected from layer 53 along the road by K. Seyed-Emami in 1975

Mablosiceras sp. (1 specimen), T. fuersichi nov. gen., nov. sp. (4 specimens) and Berriasella div. spp. (6 specimens).

4. Biostratigraphy

All species identified from the Shal section are from the Berriasella jacobi and Pseudosubplanites grandis zones sensu Le Hégarat (1973). These two biostratigraphic units were included as subzones by Hoedemaeker (1982) in the Pseudosubplanites euxinus Zone. Following a proposal by Tavera (1985), the vertical range of the jacobi Subzone has been enlarged to encompass the euxinus Zone, which means that the first ammonite zone of the Berriasian is the jacobi Zone sensu Tavera (1985). This solution, which was accepted by the Working Group on Lower Cretaceous Cephalopods in 1992 (Hoedemaeker and Company, 1993), is adopted in the present paper. The current Lower Cretaceous Ammonite Working Group (the ‘Kilian Group’) subsequently confirmed the jacobi Zone as the first ammonite zone of the Berriasian Stage (Reboulet and Hoedemaeker, 2006; Reboulet and Klein, 2009). In conclusion, all
Fig. 2. Log of the Middle Jurassic-lower Berriasian Shal Formation as exposed in the section near the village of Shal, and closeup of layers 46 to 54 (right column): A. view of the section; B. top bedding plane of Bed 53; C. exposure of the section from the top of layer 46 to layer 53.
ammonite species identified from beds 53 and 54 in the Shal section (Fig. 2) belong to the jacobi Zone sensu Tavera.

Calpionellids support this age assignment. The occurrence in layer 51 of *C. parvula* Remane, 1962 and *C. alpina* (Lorenz, 1902) (Fig. 3) indicates the lower portion of the standard calpionellid Zone B (Remane et al., 1986), namely Subzone B1 (Benzaggagh and Atrops, 1995; Benzaggagh et al., 2010). The base of this Zone B coincides with that of the jacobi Zone (Enay and Geyssant, 1975; Cecca et al., 1989; Benzaggagh et al., 2010). Calpionellids from both the Shal and Kolur formations will be described in detail in a forthcoming paper.

Seyed-Emami (1975) assigned the fauna collected by him (see above) to the late Tithonian, according to the definition of the Jurassic/Cretaceous boundary that was further modified (Zakharov et al., 1996) in agreement with recommendations made at the 1973 ‘Colloque sur la limite Jurassique-Crétacé’ at Lyon-Neuchâtel.

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**Fig. 3.** Calpionellids from layers 47 and 51 of the Shal section: A. Chitinoidella bermudezi (Furrazola-Bermudez, 1965), top of Bed 47; B. Chitinoidella boneti Doben, 1963, top of Bed 47; C. Crassicollaria parvula Remane, 1962, middle of Bed 51; D. Calpionella alpina Lorenz, 1902, middle of Bed 51.

**Fig. 4.** Abbreviations of dimensional parameters used in the systematic descriptions, and nomenclature of some shell characters. *D* — maximum diameter; *d* — lower diameter; *Uw* — umbilical width; *Wh* — whorl height; *Wb* — whorl breadth.
According to these recommendations, which are currently followed in the Mediterranean areas, the Jurassic/Cretaceous boundary is drawn at the base of the jacobi Zone. Thus, the ammonites of layer 53 belong to the early Berriasian jacobi Zone.

5. Systematic palaeontology (FC and KS-E)

Here we describe only representatives of the subfamily Berriasellinae Spath, 1922 taxonomically. The standard dimensions for normally coiled ammonites are given in millimetres and as percentages of total diameter. With regard to shell parameters, the following abbreviations (Fig. 4) are used: $D =$ maximum diameter; $d =$ diameter at which measurements were taken when less than $D$; $Wh =$ whorl height; $Uw =$ umbilical width; $Wb =$ whorl breadth; the ratio $Wb/Wh$ expresses the degree of whorl compression; $K =$ number of ribs per half a whorl; $Ph =$ diameter of the end of phragmocone (‘$n$’ signifies that the specimen is wholly septate).

We follow the terminology introduced by Zeiss (1968) in his seminal work on Tithonian perisphinctids in our description of ribbing types. This nomenclature has been widely accepted by
Remarks. The subfamily has been thoroughly monographed by Mazenot (1939), Le Hégarat (1973), Nikolov (1982) and Tavera (1985). Additional relevant data can be found in papers by Retowski (1893) and, in part, in the recent revision of species-level taxonomy of the genus Pseudosubplanites from Crimea by Bogdanova and Arkadiev (2005). Several specimens from Shal are assigned to the latter genus.

Genus Pseudosubplanites Le Hégarat, 1973

Type species: Pseudosubplanites berriasensis Le Hégarat, 1973

Remarks. Le Hégarat (1973) placed this genus in the family Perisphinctidae Steinnann, 1880. However, Tavera (1985) proposed to include it in the subfamily Berriasellinae, as a subgenus of Berriasella Uhlig (1905). We concur with Tavera (1985) in retaining Pseudosubplanites as a distinct berriasellinid genus.

Pseudosubplanites lorioli (von Zittel, 1868)

Description. Species characterised by small size (40–50 mm), of moderately evolute coiling; ornament consisting mostly of biplicate ribs, whose posterior branch is slightly rursiradiate. A polygyrate rib is seen in BSPG 2010 XVI 9 (Fig. 5A). Simple ribs are rare.

Remarks. The present example suggests its assignment to Pseudosubplanites berriasensis, Pseudosubplanites euxinus (Retowski, 1893), considered by Bogdanova and Arkadiev (2005) to be synonymous with Pseudosubplanites lorioli, has a relatively higher number of polygyrate ribs. In addition, smaller and more involute shells characterise the latter species, or morphotype of lorioli.

Geographical and stratigraphical distribution. P. ponticus has been recorded from southeast France, Switzerland, southern Spain, Poland, Romania, the Czech Republic, Bulgaria, Crimea (Ukraine), northern Caucasus and Tunisia (Le Hégarat, 1973; Patrulius and Avram, 1976; Nikolov, 1982; Tavera, 1985; Bogdanova and Arkadiev, 2005), from stratigraphical horizons equivalent to the jacobi Zone sensu Tavera (1985).

Pseudosubplanites cf. ponticus (Retowski, 1893)

Material. BSPG 2010 XVI 16.

Description. We assign, with a query, a fragment of an ammonite shell that probably reached a diameter of at least 60 mm to this species. Half of the final whorl is preserved; half of the preserved portion of this is body chamber. Ribs are biplicate and polygyrate, flexuous and relatively numerous. Two polygyrate ribs occur in the last part of the phragmocone and two others on the preserved portion of the body chamber. Inner whorls are partially and poorly preserved.

Remarks. Although the number of polygyrate ribs seems to be higher than in specimens figured in the literature, the ribbing of the present example suggests its assignment to Pseudosubplanites ponticus. Pseudosubplanites euxinus (Retowski, 1893), considered by Bogdanova and Arkadiev (2005) to be synonymous with Pseudosubplanites lorioli, has a relatively higher number of polygyrate ribs. In addition, smaller and more involute shells characterise the latter species, or morphotype of lorioli.

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Pseudosubplanites cf. crymensis Bogdanova and Arkadiev, 2005

Material. BSPG 2010 XVI 5.

Description. A specimen of an ammonite that reached a diameter of almost 70 mm is tentatively assigned to this species. The ribs on the visible portion of the venter cross this uninterrupted, thus justifying the assignment to Pseudosubplanites. Ribs are strong, biplicate and, rarely, simple. Secondary ribs are slightly prorsiradiate, but do not project towards the shell aperture, the posterior branch being slightly rursiradiate.

Remarks. Pseudosubplanites crymensis is characterised by the absence of polygyrate ribs; such are probably also lacking in our specimen, although only half is preserved. Pseudosubplanites combesi Le Hégarat, 1973 is similar to the present example, but develops polygyrate ribs, while P. berriasensis Le Hégarat, 1973 has numerous polygyrate ribs. The secondary ribs in P. grandis (Mazenot, 1939) have a characteristic projection towards the aperture; this is not developed in our specimen.

Geographical and stratigraphical distribution. To date, Pseudosubplanites crymensis has been described from Crimea (Bogdanova and Arkadiev, 2005), where it occurs in the jacobi Zone.

Genus Berriasella Uhlig, 1905

Type species: Ammonites privasensis Pictet, 1867

Berriasella oppeli (Kilian, 1889)

Figure 5I
1868 Ammonites callisto d’Orbigny; von Zittel, p. 100 (pars), pl. 20, figs 1–4, non fig. 5. 1889 Perisphinctes oppellii Kilian, p. 662.
1985 Berriasella (Berriasella) oppellii (Kilian); Tavera, p. 252, text-fig. 19K; pl. 35, figs 3–5 (with additional synonymy).


Description. The specimen assigned to this species shows evolute coiling, an ovate whorl section, with slightly convex flanks. The umbilical margin is rounded. Ribs are biplicate, with the exception of a single simple rib at the end of the last whorl, slightly prosiradiate and interrupted on the venter by a smooth band. On the body chamber ribs are slightly thickened, forming tiny tubercles on both sides of this ventral smooth band.

Remarks. The specimen from Shal is of a smaller size than the holotype of the species (von Zittel, 1868, pl. 20, fig. 1; plaster cast photographed by Mazenot, 1939, pl. 3, fig. 1), to which it is otherwise closely similar.

Dimensions

<table>
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<tr>
<th>Specimen</th>
<th>D Wh</th>
<th>Wb Uw</th>
<th>Wh/Wb</th>
<th>K Ph</th>
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<td>42</td>
<td>~16.5 (0.39)</td>
<td>~15 (0.36)</td>
<td>22</td>
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Geographical and stratigraphical distribution. This species has been recorded from southeast France, southern Spain, Romania, the Czech Republic, Bulgaria and Tunisia (von Zittel, 1868; Le Hégarat, 1973; Patruilus and Auram, 1976; Nikolov, 1982; Tavera, 1985), from stratigraphic horizons equivalent to the jacobi Zone sensu Tavera (1985).

Berriasella sabatasi Le Hégarat, 1973

Fig. 5E

1939 Berriasella moreti Mazenot, p. 61 (pars), pl. 5, fig. 1, non figs 2, 3
1973 Berriasella (Berriasella) sabatasi Le Hégarat, p. 63, pl. 6, fig. 7; pl. 38, fig. 10.
1985 Berriasella (Berriasella) sabatasi Le Hégarat; Tavera, p. 251, text-fig. 19J; pl. 35, figs 1, 2.

Material. BSPG 2010 XVI 3.

Description. Berriasellid macroconch characterised by slightly convex flanks, almost flat venter, rounded umbilical edge and a relatively steeply inclined umbilical wall. The ornament consists of fluous, biplicate ribs with secondary ribs that are weaker than primary ones; shallow constrictions occur. The second specimen, BSPG 2010 XVI 1, identified as B. cf. sabatasi, shows denser ribbing.

Remarks. Both specimens assigned here are wholly septate; the one figured is slightly deformed but clearly shows the characters of the holotype, illustrated both by Mazenot (1939, pl. 5, fig. 1) and Le Hégarat (1973, pl. 38, fig. 10).

Geographical and stratigraphical distribution. This species has been recorded from southeast France (Le Hégarat, 1973), from stratigraphic horizons equivalent to the jacobi Zone and from southern Spain from beds assigned to the jacobi Zone and the base of the andrussowi Zone (Tavera, 1985).

Genus Malbosiceras Grigorieva, 1938

Type species: Ammonites malboisi Pictet, 1867

Remarks. Our interpretation of this genus follows Tavera (1985), who considered Mazenoticeras, Pomeliceras and some of the species included by Le Hégarat (1973) in Delphinella to be synonyms of Malbosiceras.

Malbosiceras sp.

Fig. 5D


Description. A near-completely septate fragment of a large specimen characterised by a compressed whorl section with parallel flanks that, starting from a height that coincides with the location of the lateral row of tubercles, converge towards the rounded ventral area. The umbilical wall is low and the umbilical margin rounded (note that the umbilical wall at the end of the last preserved whorl is free from the matrix plug of matrix that covers this portion of the shell). The ornament consists of strong, elevated ribs that branch near mid-flank. Two secondary ribs arise from a prominent, rounded tubercle located at the point of branching. One or two intercalated ribs occur between biplicate ribs. Although the venter is poorly preserved, the main ribs do not develop tubercles and are simply thickened on the ventral margin.

Remarks. It is impossible to assign this specimen to any of the species described in the literature, because the body chamber is not preserved. It is worth noting that our specimen is almost wholly septate and that species included in Malbosiceras mostly develop umbilical tubercles in the adult body chamber. Assignment of BSPG 2010 XVI 21 to Malbosiceras is questionable, because it does not show clear umbilical tubercles. The genus Retowskiceras does develop a row of lateral tubercles but shows a different ribbing pattern with biplicate or rare trifurcate ribs, arising from the tubercles, plus rare intercalated ribs.

Genus Taleshites nov.

Type species (by monotypy): Taleshites fuersichi nov. sp.

Diagnosis. Evolute shells with a high, ovate whorl section. Phragmocone ornament consists of biplicate and simple ribs; while on the body chamber ribs become flexuous and more widely spaced; constrictions are deep; intercalated and fasciculate ribs are developed.

Comparisons. T. fuersichi nov. sp. cannot be confused with any berriasellid, in view of its peculiar ontogenetic change in ornament characters. Species of the genus Berriasella do not develop the fasciculate ribs and rib spacing observed on the adult body chamber of T. fuersichi nov. gen., nov. sp. The absence of tubercles precludes comparison with other berriasellids such as Malbosiceras, Fauriella, Jabronella, Retowskiceras and Tiroveta. Pseudosubplanites includes species with the closest morphological resemblance to this new form. However, T. fuersichi nov. gen., nov. sp. shows a characteristic ribbing change in the body chamber which is not observed in Pseudosubplanites. Furthermore, according to Bogdanova and Arkadiiev (2005, p. 490), the latter genus develops dichotomous ribs; such are lacking in our taxon. The change in ornament in the final growth stage and the continuity of ribs on the venter in the mature body chamber of T. fuersichi nov. gen., nov. sp. suggest closer affinities with late Tithonian perisphinctids rather than with berriasellids. Le Hégarat (1973) noted the morphological similarities of Parapallasiceras busnardoi Le Hégarat, 1973 and P. bochianensis Le Hégarat, 1973 to certain Tithonian perisphinctids. However, these two species, for which Tavera (1985, p. 236) erected Busnardoiceras (as a subgenus of Berriasella) develop virgatotome ribs, a feature not seen in ammonites here included in Taleshites nov. gen.
Taleshites fuersichi nov. gen., nov. sp.

Derivation of name. The species is dedicated to Prof. Franz Fürsich.

Types. Holotype is BSPG 2010 XVI 18; paratypes are BSPG 2010 XVI 2, 7, 8, 11 and 17.

Additional material: BSPG 2010 XVI 19 and 20 (T. cf. fuersichi); BSPG 2010 XVI 6 (Taleshites cf. fuersichi).

Type locality. Shal, Talesh region, northwest Iran.

Stratigraphical horizon. Berriasella jacobi Zone, early Berriasian.

Diagnosis. As for genus (see above).

Description. Evolute shell, with flat flanks that converge towards the venter. On the inner whorls (up to $d = 50$ mm), the venter is rounded and the whorl section ovate. Then the venter widens, while remaining rounded, and flanks tend to become flattened. The umbilical wall is wide and oblique, the umbilical edge rounded on the phragmocone and tends to disappear in the adult body chamber.

On the inner whorls ribbing is dense, up to the end of the phragmocone and its disappearance at $d = 37$ mm. On the phragmocone, although on one specimen (see Fig. 6C), a fasciculate rib, made up of a biciplicate rib and an oblique simple rib on the adapical side of a shallow constriction, at $d = 32$ mm, mimics a polygyrate rib. Two fasciculate ribs of this kind are also developed at $d = 26–29$ mm in BSPG 2010 XVI 8 (Fig. 6H). Ribs cross the venter without interruption (BSPG 2010 XVI 2; see Fig. 6B), from at least $d = 37$ mm. This can be seen in BSPG 2010 XVI 11 (see Fig. 6C), which is an individual that did not reach maturity. Here a shallow ventral smooth band is visible following the end of the phragmocone, up to $d = 37$ mm, where it disappears (BSPG 2010 XVI 11; see Fig. 6D, E).

On the body chamber ribbing becomes irregular and dissimilar to that on the phragmocone. The end of the phragmocone may be marked by a constriction but this is not always the case (i.e., BSPG 2010 XVI 17; see Fig. 6C). Ribs become biciplicate: the lower, simple half of the rib is prorsiradiate, the upper half, which bifurcates, gently rursiradiate. Constrictions are deep and relatively frequent at this stage; thickened ribs on the adoral or in the adapical side mark them. Rib interspaces become larger (compare the last third of the ultimate whorl of the holotype, BSPG 2010 XVI 18 [see Fig. 6F] with the equivalent second half of the last whorl in BSPG 2010 XVI 8 [see Fig. 6H]). Biciplicate ribs are still developed at this stage, but
intercalated ribs (Fig. 6F–H), and even fasciculate ones (one simple one, united to a biplicate rib in the lower third of the flank) occur.

Remarks. Ornament characters unknown in coeval taxa characterise the new taxon. Bipicate ribbing, and the absence of genuine polypyriform ribs, would suggest affinities with the genera Pseudosubplanites and Hegaretella, which have no ventral interruption of the ribs. However, in the adult body chamber of these genera, a combination of rib spacing with fasciculate ribs, frequent contractions and simple ribs is not observed.

**Dimensions**

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6. Conclusions

The majority of early Berrisanian ammonite species identified from the Shal section have previously been recorded from numerous well-studied localities in Europe and North Africa. This, together with the occurrence of calpionellids, allows good correlation with biozones established at the classic sections in southeast France. The presence of lytoceratids and Haploceras is indicative of a connection with open oceanic environments (Westermann, 1996).

According to recent palaeogeographical reconstructions, the Talesh area was part of the northern margin of Tethys (Barrier and Vrielynck, 2008; Wilmsen et al., 2010). The Shal Basin was situated along the northern margin of the Lar platform, to the south of the oceanic South Caspian Basin and connected with Tethys to the west. The affinity of the Shal Basin fauna with early Berrisanian assemblages from southeast France, southern Spain, Morocco, Tunisia, Bulgaria and Crimea is in agreement with this palaeogeographical reconstruction. The sole faunal element that provisionally appears to be endemic is Taleshitės furraziensis nov. gen., nov. sp., but whether or not it is a genuine endemic can only be tested by further fieldwork and re-examination of previously made collections from elsewhere.

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