

Reineckeiidae (Ammonoidae) Family of the Dalichai Formation in Damghan Area (East Alborz), Iran

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Abstract

The present study is concerning the systematic descriptions of the Middle Jurassic (Callovian) ammonite fauna from the Damghan Area (eastern Alborz) and contains a rather rich ammonite fauna. The described ammonites come from the Middle part of the Dalichai Formation, consisting of an alternation of green marl, grey limestone and marly limestone. In this research, the biostratigraphy of these rocks is discussed with special emphasis on the abundant ammonite fauna (Reineckeiidae family). Altogether, 74 specimens of ammonites belonging to 14 species, 3 genera, 3 sub genera from Reineckeiidae family are described. Palaeobiogeographically the ammonite fauna is closely related to that of the sub-Mediterranean Province of the northwestern Tethys. The ammonites represent four zones, i.e. *Rehmannia* (*Loczyceras*) cf. *segestena* (Anceps Zone), *Rehmannia* (*Loczyceras*) *reissi* (Anceps Zone), *Rehmannia* (*Loczyceras*) *rehmanni* (Anceps Zone), *Rehmannia* (*Loczyceras*) *sequanica* *densicostata* (Coronatum Zone), *Reineckeia* (*Tyrannites*) *convexa* (Gracilis Zone), *Reineckeia* (*Tyrannites*) *pictava* (Gracilis Zone), *Reineckeia* (*Reineckeia*) *anceps anceps* (Anceps Zone), *Reineckeia* (*Reineckeia*) *anceps elmii* (Anceps Zone), *Reineckeia* (*Reineckeia*) cf. *fehlmani* (Anceps Zone), *Reineckeia* (*Reineckeia*) *nodosa* (Athleta Zone), *Collotia* cf. *multicostata* (Anceps Zone), *Collotia* cf. *gailliardi* (Coronatum Zone), *Collotia* cf. *oxyptychoides* (Athleta Zone), *Collotia* cf. *collotiformis* (Athleta Zone).

Keywords

Jurassic, Reineckeiidae, Palaeobiogeographically, Dalichai Formation, Alborz

1. Introduction

The type section of this formation consists of 107 m of light-grey to bluish-grey

limestone with thin intercalations of marl. According to Steiger [1], the thickness of the formation is about 50 to 120 m (average: 100 m, reaching more than 300 m in the eastern Alborz). The lower boundary of the Dalichai Formation is an unconformity due to the Mid-Cimmerian tectonic event (the marine transgression of the Dalichai Formation over the Shemshak Formation is diachronous). In many areas, the upper boundary of the Dalichai Formation is, however, gradational. In a few areas, it is continuous but sharp and followed by the Lar Formation. The sedimentary environments, in which this formation was deposited, are the lower shelf to continental slope. The Dalichai Formation is rich in ammonites, which were studied by different palaeontologists (e.g. Seyed-Emami *et al.* [2] [3] [4] [5] [6], Schairer *et al.* [7], Majidifard [8] [9], Vaziri *et al.* [10] [11], Shams *et al.* [12], Behfar *et al.* [13], Sarbandi Farahani *et al.* [14], Dietze *et al.* [15]), one of important ammonite families (with high frequency) of the Dalichai Formation in Alborz, is Reineckeiidae (e.g. Seyed-Emami *et al.* [16]). This family is assumed as one of the index Callovian ammonite fauna. In this research from studied sections, 74 Reineckeiidae with frequency (17.2%) (**Chart 1**), were collected that belong to the Callovian.

2. Material and Methods

2.1. Locality of Sections

Absharaf section: 60 km northwest of Damghan (co-ordinates: 35°56'25.7"N, 53°47'21.4"E) (**Figure 1(a)**). The Dalichai Formation at the Absharaf was measured northwest of Damghan with a total thickness of 618 m. It ranges from the Upper Bajocian to Kimmeridgian and can be subdivided, from bottom to top, into six members (**Figure 2**).

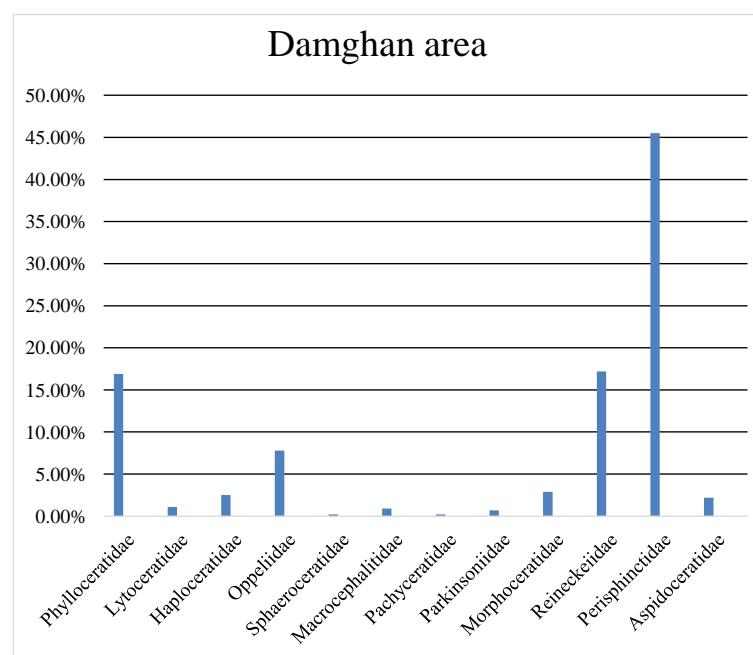
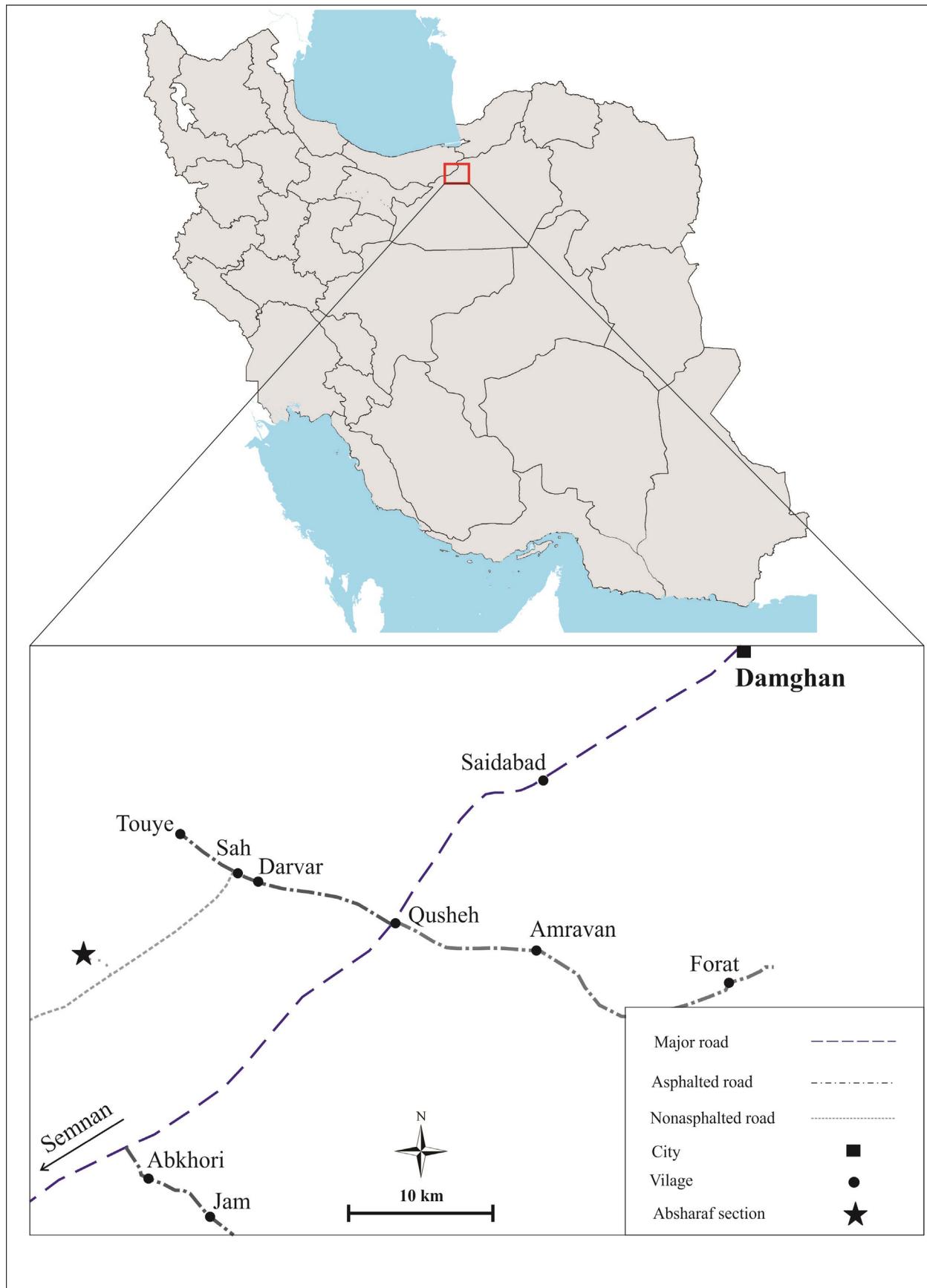
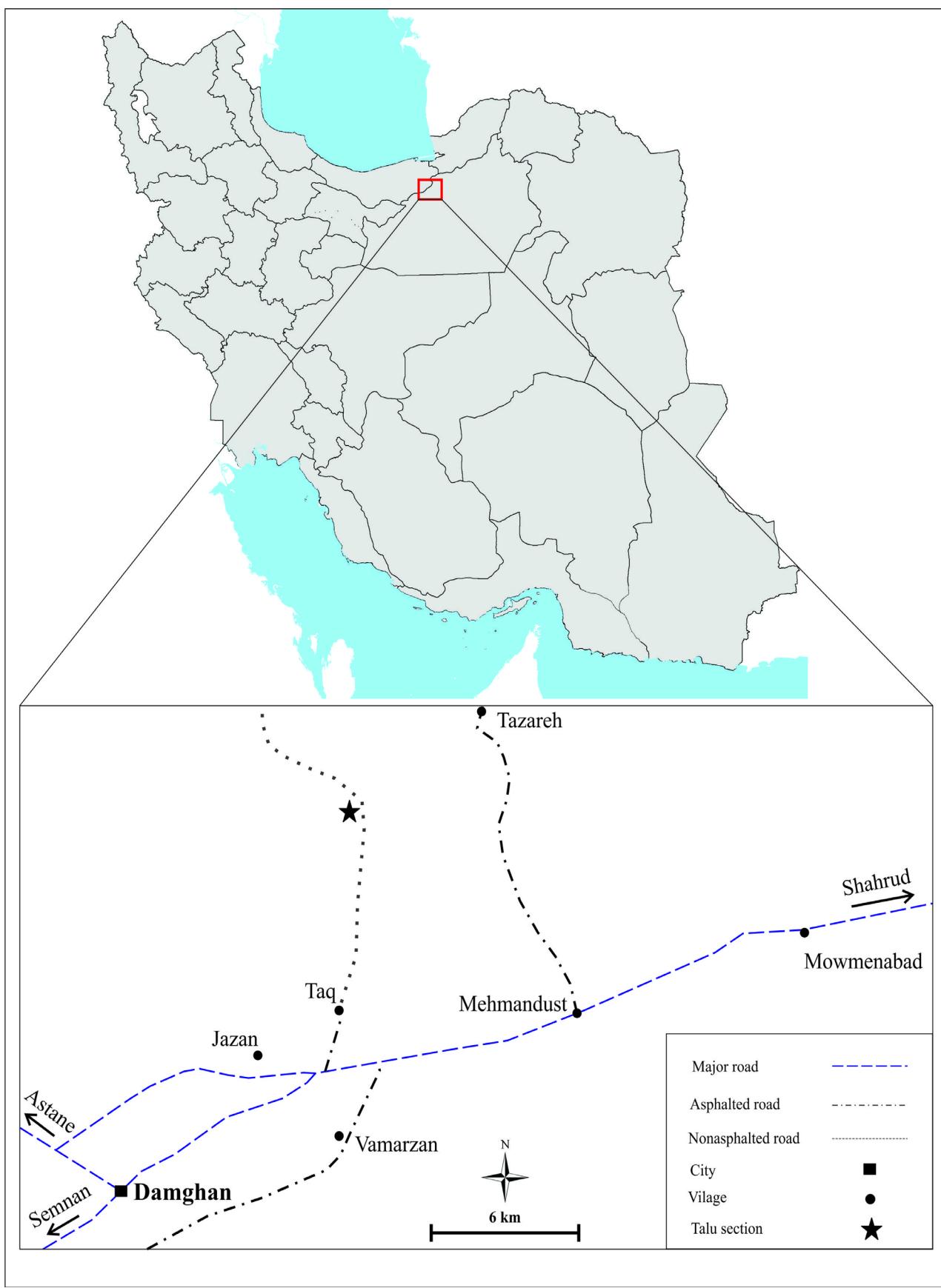
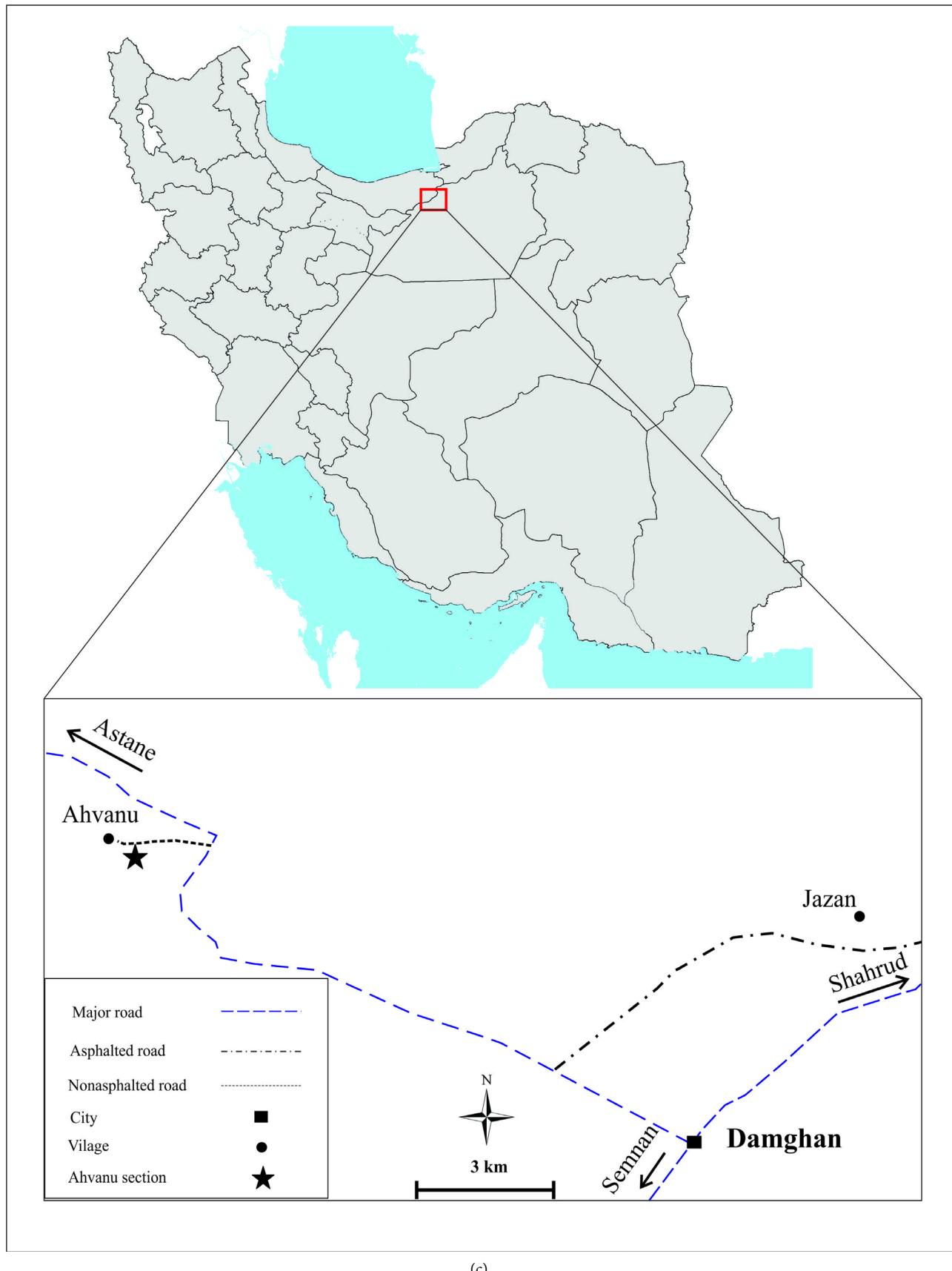


Chart 1. Relative abundances of ammonite families at the studied sections from the Damghan Area.



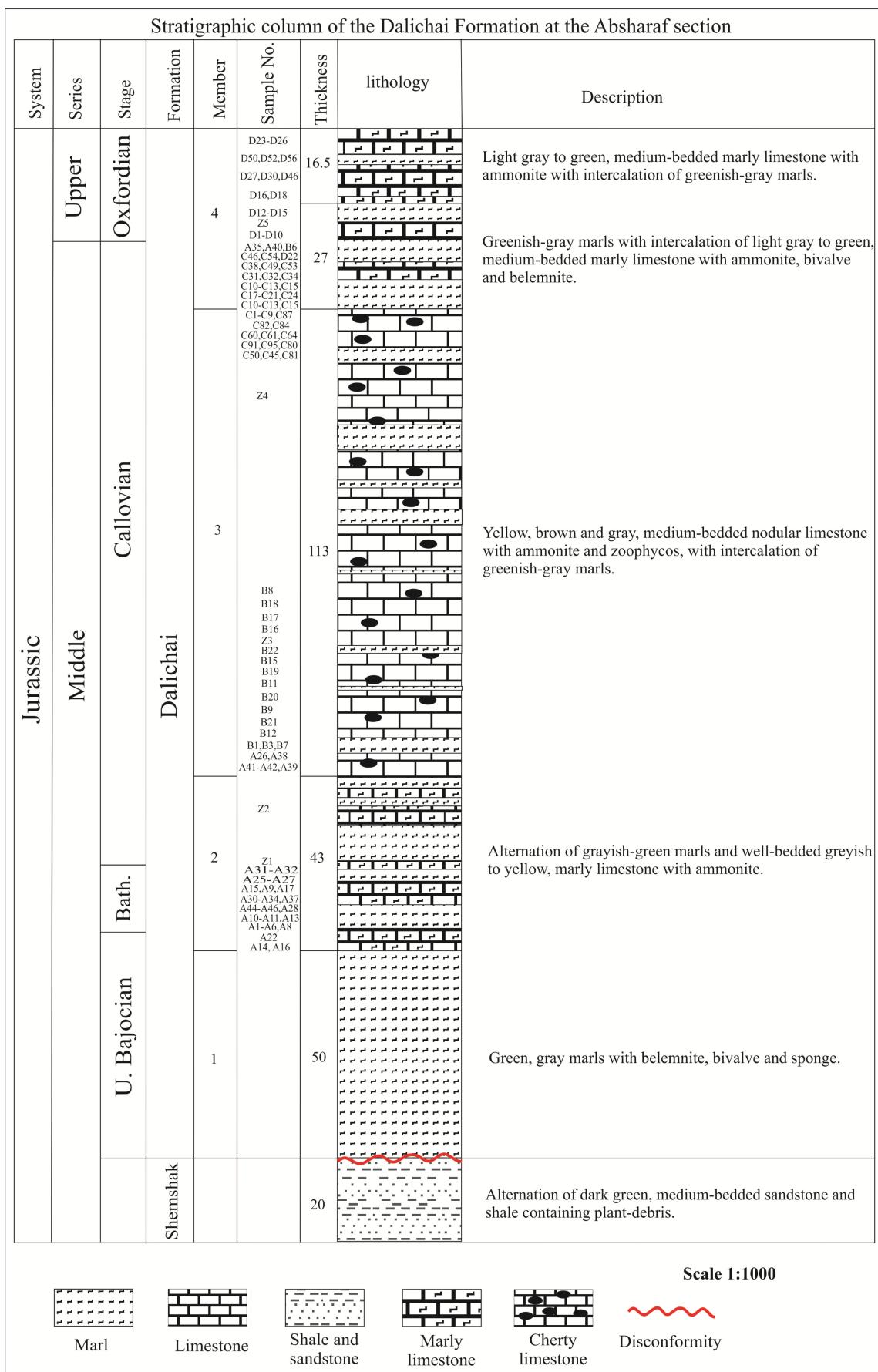
(a)



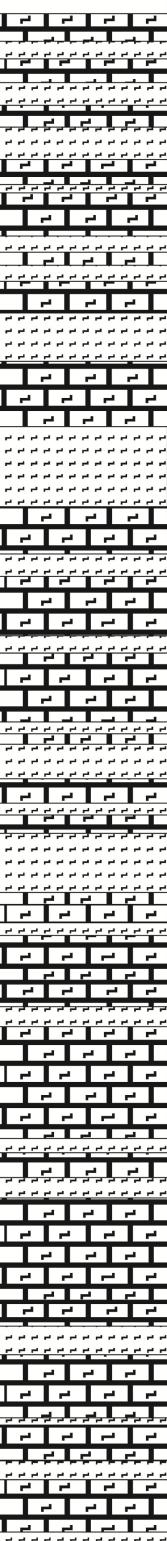


(c)

Figure 1. Position of the Absharaf (a), Talu (b) and Ahvanu (c), sections of the Dalichai Formation in the Alborz of north Iran.



Stratigraphic column of the Dalichai Formation at the Absharaf section

System	Series	Stage	Formation	Member	Sample No.	Thickness	lithology	Description
Jurassic	Upper	Kimeridgian	Dalichai	5	Z45 L4 L14,L24 Z44 L10,L12 Z43 L1,L5 Z42 K3 K1,K27 K12 K5 K37 K33 Z41 Z40 K9,K11 K4,K8 Z39 Z38 Z37 J3 J5 J2 Z35,Z36 Z34 I9 Z33 I5,I7 I3,I4 Z32 I17 Z31 I2 Z29,Z30 Z28 H13 Z27 H2 Z26 H10 H3,H7,H11 Z25 H1,H9 Z23,Z24 G19 G16 Z22 G13 Z21 G8 Z20 G1-G4,G6 Z19 G5,G14,G20 Z18 G12 Z16,Z17 Z15 Z14 Z13 Z12 Z11 Z10 E18,E25 E15-E17 E10-E14 Z8 E8,E9 E7 E6 Z7 E5 E1-E4 Z6	19.5 66.5 37.5 32 97 16		Alternation of grayish-green marls and well-bedded greyish to yellow, marly limestone with ammonite. Greenish-gray marls with intercalation of light gray to green, medium-bedded marly limestone with ammonite. Light gray to green, medium-bedded marly limestone with ammonite with intercalation of greenish-gray marls. Greenish-gray marls with intercalation of light gray to green, medium-bedded marly limestone with ammonite. Alternation of greenish-gray marls and light gray to green, marly limestone with ammonite. Light gray to green, medium-bedded marly limestone with ammonite with intercalation of greenish-gray marls.
Oxfordian	4							

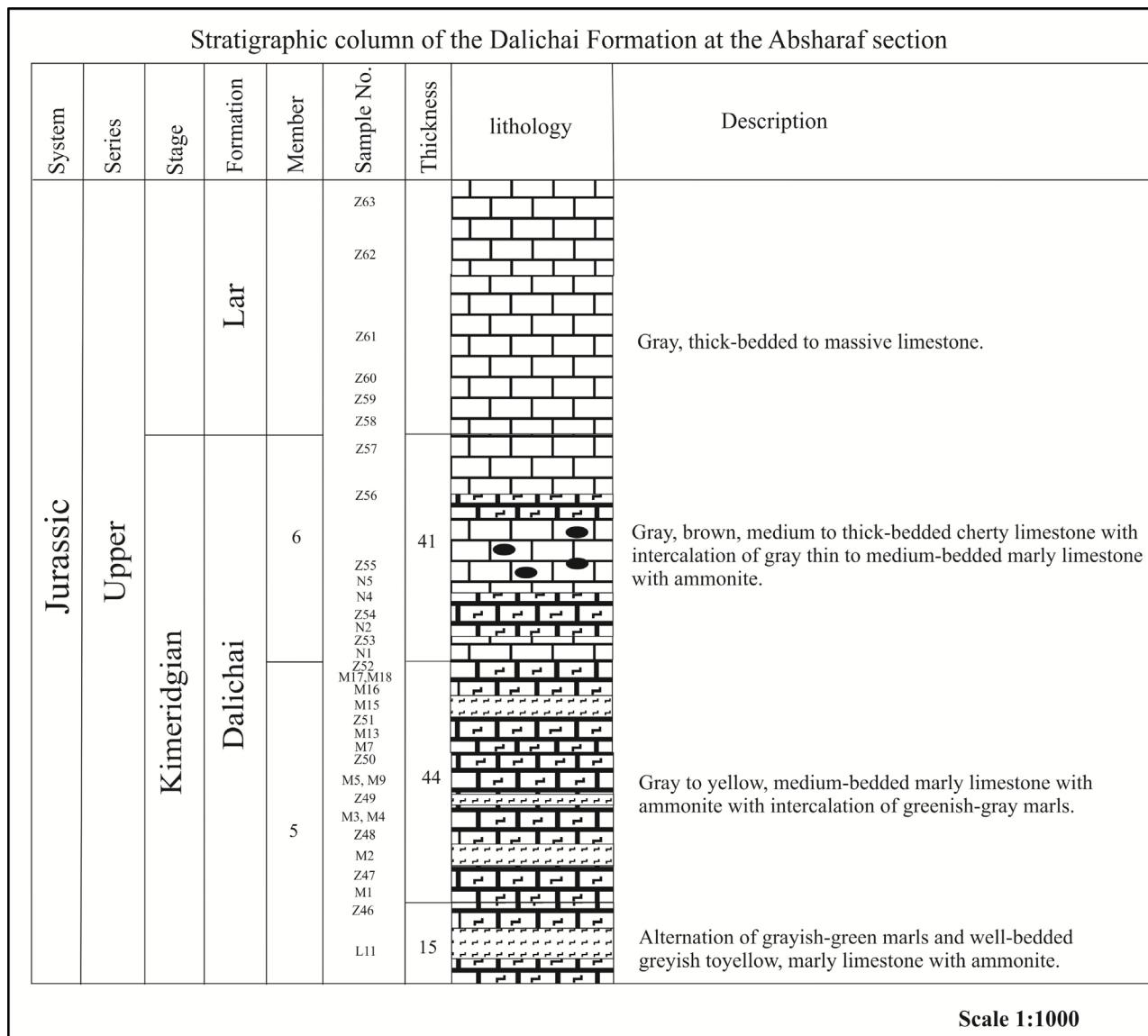


Figure 2. Stratigraphic column of Dalichai Formation in Absharaf section.

Talu section: 10 km northeast of Damghan (co-ordinates: $36^{\circ}19'3.3''N$, $54^{\circ}26'7.7''E$) (**Figure 1(b)**). The Dalichai Formation at the Talu was measured northeast of Damghan with a total thickness of 207.5 m. It ranges from the Upper Bajocian to the Oxfordian and can be subdivided, from bottom to top, into five members (**Figure 3**).

Ahvanu section: 10 km north of Damghan (co-ordinates: $36^{\circ}13'29.9''N$, $54^{\circ}11'13.0''E$) (**Figure 1(c)**). The Dalichai Formation at the Ahvanu was measured north of Damghan with a total thickness of 153.5 m. It ranges from the Upper Bajocian to the Callovian and can be subdivided, from bottom to top, into four members (**Figure 4**).

2.2. Ammonites

Since the main part of the thesis deals with ammonites, numerous ammonites

Stratigraphic column of the Dalichai Formation at the Talu section

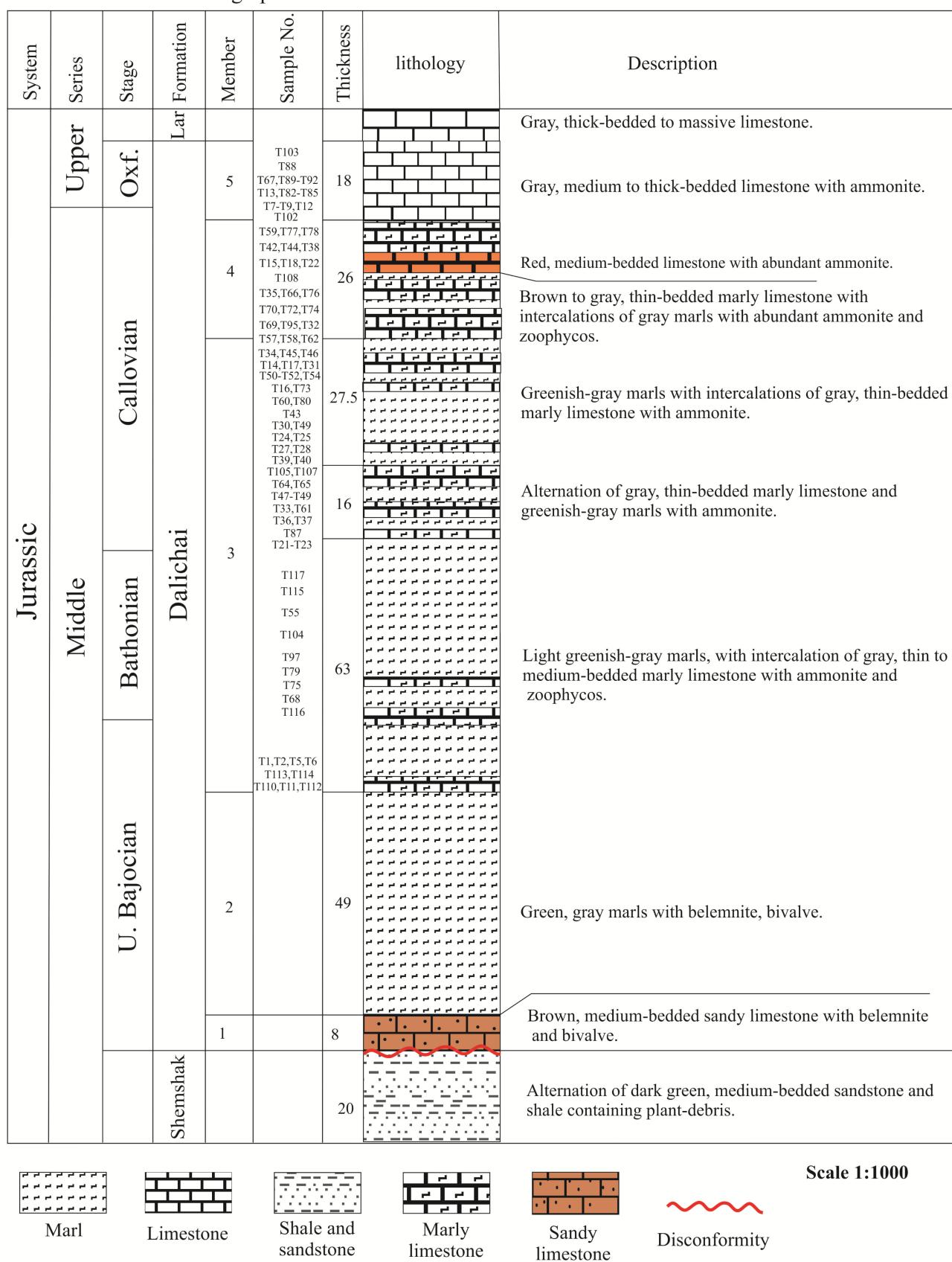
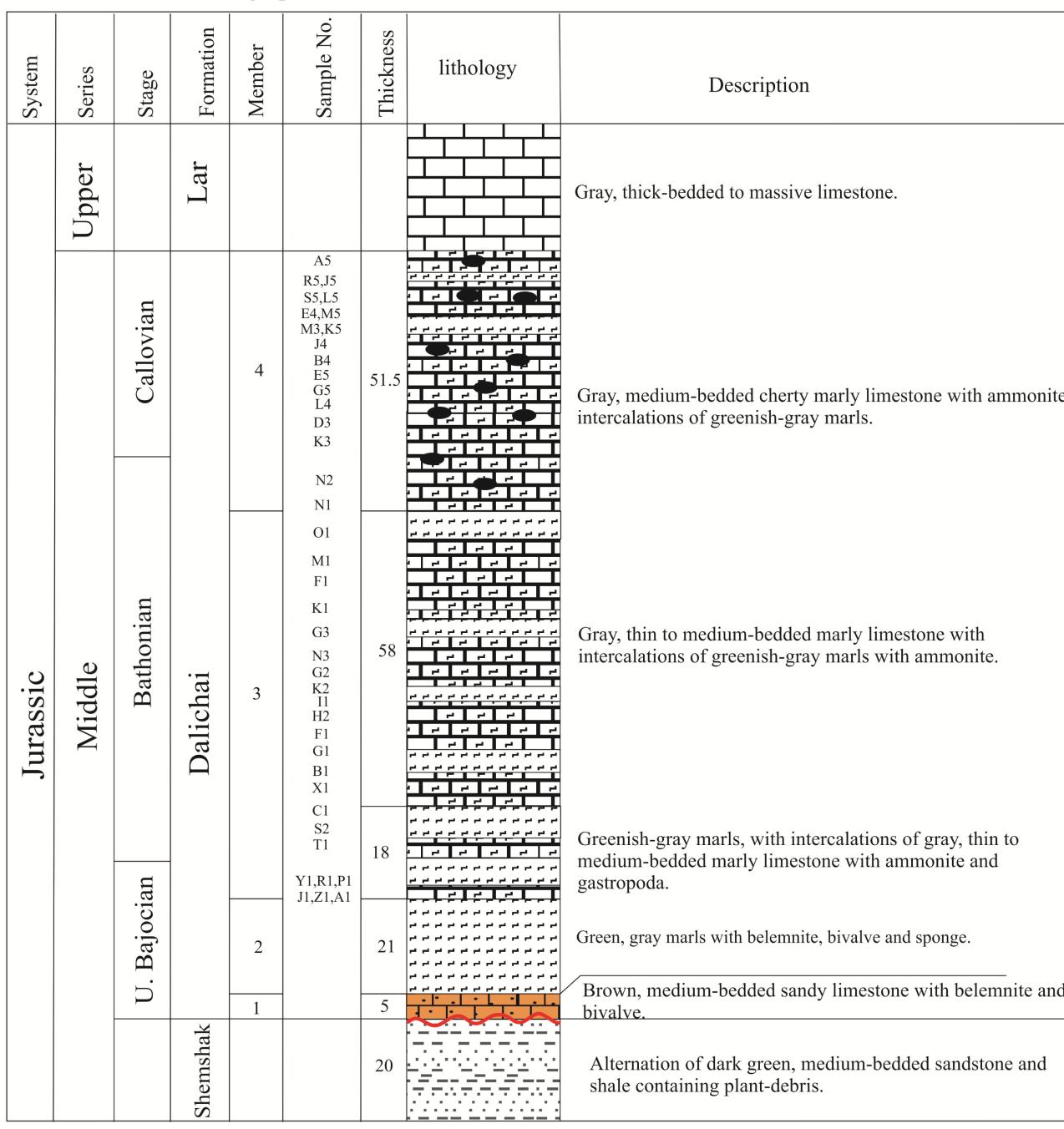


Figure 3. Stratigraphic column of Dalichai Formation in Talu section.

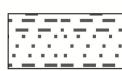
Stratigraphic column of the Dalichai Formation at the Ahvanu section



Scale 1:1000



Marl



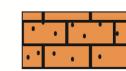
Shale and sandstone



Marly limestone



Cherty limestone



Sandy limestone



Disconformity

Figure 4. Stratigraphic column of Dalichai Formation in Ahvanu section.

were collected from the sections. After identification they were described and used to define the international Standard Zones. The ammonite zonation is based on Cariou & Hantzpergue [17].

3. Lithostratigraphy of Sections

Shemshak Formation: The Dalichai Formation is underlain by the Shemshak Formation, which consists of alternations of dark-green shales and medium-bedded, dark, fine-grained sandstones containing plant remains (**Figure 5** and **Figure 6**).

Dalichai Formation: The base of the Dalichai Formation consists of medium-bedded, brown weathering sandy limestone (grainstone), green-grey silty marls, alternations of greyish-green marls, well-bedded greyish to yellow marly limestones and limestones and alternations of medium-bedded, grey limestones (mudstone to packstone) with cherts, green-grey marls (**Figure 6** and **Figure 7**).

Lar Formation: The Lar Formation is represented by thick-bedded, cliff-forming, grey dolomitic limestones to limestones that, when weathered, are cream-coloured to yellowish (**Figure 6** and **Figure 8**).

4. Systematic Palaeontology

As far as permitted by the preservation of the specimens, measurements of the following parameters are given: diameter (D) in mm, umbilical width (U), whorl height (H), whorl width (W), the latter all in % of diameter; whorl round height



Figure 5. Silt coal of the Shemshak Formation at the Talu section.



Figure 6. Position of Dalichai Formation between Shemshak (below) and Lar (above) formations in the Talu section.



Figure 7. Alternations of greyish-green marls and well-bedded greyish to yellow marly limestones of the Dalichai Formation at the Absharaf section.

to whorl round width (Q), numbers of primary ribs per whorl (PR) and secondary ribs (SR). The specimens have been numbered according to sections (SH: Absharf section; T: Talu section; A: Ahvanu section).



Figure 8. Contacts of the Dalichai and Lar formations at the Absharaf section.

Fmally Rienekeiidae HYATT, 1900 [18].

Genus *Rehmannia* SCHIRADIN, 1956 [19].

Subgenus *Loczyceras* BOURQUIN, 1968 [20].

Rehmannia (Loczyceras) cf. segestana (GEMMELLARO, 1872) [21].

Pl. 2, Figures 3a-b

1872 *Perisphinctes segestana* sp. nov.-GEMMELLARO: p. 246, Pl. 13, Figures 1-3.

1984 *Rehmannia (Loczyceras) segestana* (GEMMELLARO).-CARIOU: p. 72, Pl. 7, Figure 3 and Figure 4, Pl. 8, Figure 1.

2003 *Rehmannia (Loczyceras) segestana* (GEMMELLARO).-MAJIDIFARD: Pl. 9, Figure 1.

Material: 1 specimen from Absharaf section (SH-B18) and 3 specimens and 1 fragment from Talu section (T-T45, 95, 118, 119) and 1 fragmentary specimen from Ahvanu section (A-D3), (**Table 1**).

Description: Umbilical wall low and steep, whorl cross-section nearly ellipsoidal. The ribbing is relatively coarse and distant. The bullate and radiate primary ribs end at prominent and pyramidal lateral tubercles at one-third of flank height, from where they bifurcate or trifurcate with some intercalatory ribs. The rectiradiate secondary ribs terminate at ventral furrow. The secondary ribs are

fainter and denser than the primaries. Some of the primary ribs do not divide.

Remarks: The present specimens are very similar to the specimen described and figured by CARIOU (1984: Pl. 7, Figure 3 and Figure 4).

Stratigraphic distribution: Middle Callovian, Anceps Zone.

Rehmannia (Loczyceras) reissi (STEINM, 1881) [22].

Pl. 1, Figures 5a-c

1984 *Rehmannia (Loczyceras) reissi* (STEINM).-CARIOU: Pl. 10, Figures 1-4, Pl. 11, Figures 1-5.

Material: 7 specimens from Talu section (T-T46-50-57-62-120-121-122), (**Table 2**).

Description: Umbilical wall steep, whorl cross-section ovate. Ribbing relatively coarse, the slightly bullate and radiate primary ribs end at prominent and pyramidal lateral tubercles at one-third of flank height, from where they bifurcate or trifurcate with some intercalatory ribs. The secondary ribs terminate at a ventral furrow. There are prorsiradiate constrictions per whorl.

Remarks: The present specimens are similar to the specimen described and figured by CARIOU (1984: Pl. 10, Figure 3 and Figure 4).

Stratigraphic distribution: Middle Callovian, Anceps Zone.

Rehmannia (Loczyceras) rehmanni (OPP, 1856) [23].

Pl. 2, Figure 2

1984 *Rehmannia (Loczyceras) cf. rehmanni* (OPP).-CARIOU: Pl. 3, Figure 2, Pl. 4, Figures 1-5, Figure 7, Pl. 5, Figures 1-3.

Material: 1 fragmentary specimen from Talu section (T-T40) and 1 fragmentary specimen from Ahvanu section (A-B3), (**Table 3**).

Description: Umbilical wall low and steep, whorl cross-section oval. The bullate, distant and prorsiradiate primary ribs end mostly at conical, sharp tubercles at around one-third of flank height. The slightly prorsiradiate secondaries

Table 1. Dimensions (in mm) of *Rehmannia (Loczyceras) cf. segestana*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
SH-3-B18	7.8	14.1	33.3	23	1.4	14	-
T-3-T45	6.3	17.4	31.7	-	-	14	42
T-4-T95	5	1.8	34	-	-	14	-
T-4-T119	5.4	1.6	31.4	24	1.3	-	-

Table 2. Dimensions (in mm) of *Rehmannia (Loczyceras) reissi*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
T-3-T46	6	25	35	30	1.1	-	-
T-3-T50	4.5	-	33.3	33.3	1	13	45
T-4-T57	3.6	-	38.8	36.1	1	12	33
T-4-T62	5.1	1.7	37.2	29.4	1.2	-	-
T-3-T120	5.1	23.5	39.2	33.3	1.1	13	-
T-3-T121	5.6	1.6	37.5	-	-	-	-
T-3-T122	4.6	-	36.9	30.4	1.2	-	-

are bifurcating or trifurcating with some intercalatory ribs, ending at a smooth ventral band. Some of the primary ribs do not divide.

Remarks: The present specimens are very similar to the specimen described and figured by CARIOU (1984: Pl. 4, Figure 3 and Figure 6).

Stratigraphic distribution: Middle Callovian, Anceps Zone.

Rehmannia (Loczyceras) sequanica densicostata (BOURQUIN, 1968) [20].

Pl. 2, Figures 1a-c

1968 *Rehmannia (Loczyceras) sequanica* sp. nov.-BOURQUIN: Pl. 24, Figure 3.

1984 *Rehmannia (Loczyceras) sequanica densicostata* nov. subsp.-CARIOU: p. 172, Pl. 24, Figure 4 and Figure 5.

2003 *Rehmannia (Loczyceras) sequanica* (BOURQUIN).-MAJIDIFARD: Pl. 9, Figure 2.

Material: 1 specimen from Talu section (T-T32), (**Table 4**).

Description: Umbilical wall steep, whorl cross-section nearly rectangular. The bullate and radiate primary ribs end at faint lateral tubercles at around one-third of flank height, from where they bifurcate or quadrifurcate with some intercalatory ribs. The rectiradiate secondary ribs terminate at ventral furrow. The secondary ribs are fainter and denser than the primaries. Some of the primary ribs do not divide.

Remarks: *Rehmannia (Loczyceras) sequanica densicostata* is similar to *Rehmannia (Loczyceras) segestana* (GEMMELLARO), but in having fainter and thinner ribs and tubercles and in possessing quadrifurcating secondaries.

Stratigraphic distribution: Middle Callovian, Coronatum Zone.

Genus *Reineckeia* BAYLE, 1878 [24].

Subgenus *Tyrannites* CARIOU, 1984 [25].

Reineckeia (Tyrannites) pictava (BOURQ, 1967) [20].

Pl. 3, Figures 1a-b

1984 *Reineckeia (Tyrannites) pictava* (BOURQIN) f. *Savarensis*.-CARIOU: Pl. 27, Figure 3 and Figure 4.

Material: 8 specimens and 1 fragment from Talu section (T-T37, 47, 51, 48, 61, 105, 107, 123, 124), (**Table 5**).

Description: Umbilical wall low and steep, whorl cross-section ovate. The bullate and radiate primary ribs end at faint lateral tubercles at around one-third of flank height, from where they bifurcate or trifurcate with some intercalatory

Table 3. Dimensions (in mm) of *Rehmannia (Loczyceras) rehmanni*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
T-3-T40	-	-	-	-	-	10	30
A-3-B3	7	24.2	30	22.8	1.3	20	32

Table 4. Dimensions (in mm) of *Rehmannia (Loczyceras) sequanica densicostata*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
T-4-T32	6.1	16.3	36	26.2	1.3	12	39

ribs. The rectiradiate secondary ribs terminate at ventral furrow. The secondary ribs are denser than the primaries. Some of the primary ribs do not divide.

Stratigraphic distribution: Lower Callovian, Gracilis Zone.

Reineckeia (Tyrannites) convexa (CARIOU, 1984) [25].

Pl. 3, Figures 4a-b

1984 *Reineckeia (Tyrannites) convexa* sp. nov.-CARIOU: p. 197, Pl. 28, Figure 3 and Figure 4, Pl. 29, Figures 1-4.

2003 *Reineckeia (Tyrannites) convexa* CARIOU, 1984.-MAJIDIFARD: Pl. 8, Figure 2.

Material: 2 specimens from Talu section (T-T33, 36), (**Table 6**).

Description: Umbilical wall steep, whorl cross-section rectangular, venter rounded to broad. The bullate and distant primary ribs end mostly at conical sharp tubercles at around one-third of flank height. The rectiradiate secondaries are bifurcating or trifurcating with single intercalatory ribs, all ending at a ventral furrow. The secondary ribs are denser than the primaries, rarely, primary ribs do not divide.

Remarks: The blunt, coarse and strong ribs distinguish this species from other species.

Stratigraphic distribution: Lower Callovian, Gracilis Zone.

Subgenus *Reineckeia* CARIOU, 1984 [25].

Reineckeia (Reineckeia) cf. fehlmanni (JEANNET, 1951) [26].

Pl. 3, Figures 3a-b

1984 *Reineckeia (Reineckeia) fehlmanni* JEANNET.-CARIOU: p. 278 Pl. 42, Figures 1-3.

1986 *Reineckeia (Reineckeia) fehlmanni* JEANNET.-SEQUEIROS et al.: Pl. 2, Figure 8.

Table 5. Dimensions (in mm) of *Reineckeia (Tyrannites) pictava*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
T-3-T37	6.8	23.5	35.2	29.4	1.1	19	-
T-3-T47	2.2	1.8	3.1	3.6	0.8	-	-
T-3-T51	2.1	1.9	3.8	3.3	1.1	17	-
T-3-T48	4.5	1.7	44.4	37.7	1.1	-	-
T-3-T61	4.1	-	41.4	39	1	-	-
T-3-T105	3	36.6	40	36.6	1	16	-
T-3-T107	2.9	-	37.9	44.8	0.8	-	-
T-4-T123	2.4	3.3	41.6	3.3	12	-	-
T-4-T124	3.3	-	39.3	30.3	1.2	-	-

Table 6. Dimensions (in mm) of *Reineckeia (Tyrannites) convexa*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
T-3-T33	7	35.7	38.5	28.5	1.3	14	42
T-3-T36	6.3	36.5	39.6	25.3	1.5	14	42

Material: 1 specimen from Absharaf section (SH-C45), (**Table 7**).

Description: Umbilical wall low and steep, whorl cross-section broad-ovate to rectangular, venter broad. Nearly all of the bullate and distant primary ribs end at pyramidal, sharp tubercles at around one-third of flank height. The bullate secondaries are bifurcate or trifurcate with single intercalatory ribs, ending at a smooth ventral band. The ribs are inner part in the last visible whorl are rectiradiate and on the outer part prorsiradiate.

Stratigraphic distribution: Middle Callovian, Anceps Zone.

Reineckeia (Reineckeia) anceps anceps (REINECKE, 1818) [27].

Pl. 2, Figures 5a-c

1818 *Nautilus anceps*-REINECKE: p. 82, Pl. 7, Figure 61.

1951 *Reineckeia anceps* REINECKE.-JEANNET: p. 127, Pl. 48, Figure 2 and Figure 3.

1984 *Reineckeia (Reineckeia) anceps anceps* (REINECKE).-CARIOU: p. 220, Pl. 33, Figure 4 and Figure 5, Pl. 34, Figure 1, Figure 2 and Figure 5, Pl. 35, Figure 1, Figure 4 and Figure 5.

1988 *Reineckeia (Reineckeia) anceps* (REINECKE).-CARIOU & KRISHNA: p. 160, Pl. 2, Figure 2 and Figure 3, Pl. 3, Figure 1.

1995 *Reineckeia (Reineckeia)* sp. ex gr. *R(R.) anceps* (REINECKE).-SEYEDE-EMAMI *et al.*: p. 43, Pl. 2, Figure 1.

2002 *Reineckeia (Reineckeia) anceps* (REINECKE).-SEYEDE-EMAMI *et al.*: 185, Figures 2-4.

2003 *Reineckeia (Reineckeia) anceps* (REINECKE).-MAJIDIFARD: p. 114, Pl. 7, Figure 4, Figure 5 and Figure 7.

2003 *Reineckeia (Reineckeia) anceps* (REINECKE).-CARRASCO-Ramirz: Figure 9 and Figures 10(a)-(d).

Material: 2 fragments from Absharaf section (SH-B9,15), and 1 specimen from Talu section (T-T34), (**Table 8**).

Description: Moderately evolute, coronate *Reineckeia* with broad-oval to broad rectangular whorl cross-section. Umbilical wall low and vertical, umbilical shoulder distinct. Ribbing relatively coarse. The slightly bullate and somewhat prorsiradiate primary ribs end at prominent and pyramidal lateral tubercles at one-third of flank height, from where they bifurcate in a somewhat prorsiradiate manner seldom they quadrifurcate with some intercalatory ribs. The slightly incurved secondary ribs terminate at a smooth ventral band. There are four prorsiradiate constrictions per whorl.

Table 7. Dimensions (in mm) of *Reineckeia (Reineckeia) cf. fehlmanni*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
SH-3-C45	7.3	1.2	35.6	27.3	1.3	11	27

Table 8. Dimensions (in mm) of *Reineckeia (Reineckeia) anceps anceps*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
T-3-T34	7	21.4	44.2	30	1.4	13	29

Remarks: The present specimens are very similar to the specimen described and figured by MAJIDIFARD (2003: Pl. 7, Figure 7).

Stratigraphic distribution: Middle Callovian, Anceps Zone.

Reineckeia (Reineckeia) anceps elmii (BOURQUIN, 1968) [20].

Pl. 2, Figures 4a-c

1984 *Reineckeia (Reineckeia) anceps elmii* (BOURQ).-CARIOU: Pl. 36, Figures 1-3, Pl. 37, Figures 1-2.

Material: 1 specimen from Absharaf section (SH-C50), and 1 specimen from Talu section (T-T31), (**Table 9**).

Description: Umbilical wall vertical, whorl cross-section broad-oval. The bullate primary ribs end at prominent, conical, and sharp lateral tubercles near the umbilical margin, from where they form trifurcate seldom quadrifurcate bundles. The rectiradiate secondary ribs terminate at a ventral furrow. There are deep and prorsiradiate constrictions on the last visible whorl.

Stratigraphic distribution: Middle Callovian, Anceps Zone.

Reineckeia (Reineckeia) nodosa (TILL, 1907) [28].

Pl. 3, Figures 2a-c

1907 *Reineckeia (Reineckeia) nodosa* n. sp.-TILL: p. 124.

1939 *Reineckeia (Reineckeia) nodosa* TILL.-KUHN: p. 34, Pl. 2, Figure 14.

1984 *Reineckeia (Reineckeia) nodosa* TILL.-CARIOU: p. 246, Pl. 37, Figure 5, Figure 6 and Figure 7.

2003 *Reineckeia (Reineckeia) nodosa* TILL.-MAJIDIFARD: p. 124, Pl. 9, Figure 4.

2013 *Reineckeia (Reineckeia) nodosa* TILL.-SEYED-EMAMI et al.: p. 56, Figures 8k-1.

Material: 1 specimen from Absharaf section (SH-C54), and 4 specimens from Talu section (T-T29, 42, 38, 44), (**Table 10**).

Description: Whorl cross-section oval, venter rounded and broad. The bullate and distant primary ribs end at prominent and sharp tubercles at around mid-flank, from where they usually form quadrifurcate bundles. The secondary ribs terminate at a ventral furrow. There are three deep and prorsiradiate constrictions on the last visible whorl.

Remarks: The present specimens resemble the holotype (KUHN 1939: Pl. 2, Figure 14), and the material figured by CARIOU (1984: Pl. 37, Figure 5, Figure 6 and Figure 7).

Stratigraphic distribution: Upper Callovian, Athleta Zone.

Table 9. Dimensions (in mm) of *Reineckeia (Reineckeia) anceps elmii*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
SH-3-C50	4.9	32.6	34.6	24.4	1.42	12	-
T-3-T31	3.3	2.7	36.3	57.5	0.63	10	-

Genus *Collotia* (DE GROSSOUVRE, 1917) [29].

Collotia cf. *multicostata* (PETITC, 1915) [30].

Pl. 1, Figures 3a-b

1984 *Collotia multicostata* (PETITEC).-CARIOU: Pl. 48, Figures 1-7, Pl. 47, Figure 3 and Figure 4.

Material: 2 specimens from Absharaf section (SH-C42, 47), and 3 specimens and 1 fragment from Talu section (T-T52, 58, 69, 125), (**Table 11**).

Description: Umbilical wall steep, whorl cross-section elongated ellipse to rectangular. The ribbing is relatively coarse, strong and distant. Primary ribs on the inner flank slightly bullate, terminating at around one-third of flank height in small and weak tubercles. From where they bifurcate or trifurcate with some intercalatory ribs, the secondaries have intercalatory ribs and end at the ventral furrow. The secondaries are denser than the primaries.

Remarks: The present specimens are similar to the specimen described and figured by CARIOU (1984: Pl. 48, Figure 1 and Figure 4).

Stratigraphic distribution: Middle Callovian, Anceps Zone.

Collotia cf. *gaillardi* (ROMAN, 1930) [31].

Pl. 1, Figures 2a-b

1984 *Collotia gaillardi* (ROMAN).-CARIOU: Pl. 54, Figures 2-5, Pl. 55, Figures 1-3, Pl. 56, Figures 1(a)-(c).

Material: 3 specimens from Talu section (T-T35, 76, 126), (**Table 12**).

Description: Shell evolute, umbilical wall low and steep, whorl cross-section elongated ellipse. There are completely conical and elongated tubercles at the umbilical margin and separated there from within the half (50%) distance of two secondary and forwarding ribs. The secondaries are denser than the primaries. Some of the primary ribs do not divide.

Remarks: The present specimens are similar to the specimen described and figured by CARIOU (1984: Pl. 54, Figure 2 and Figure 5).

Stratigraphic distribution: Middle Callovian, Coronatum Zone.

Table 10. Dimensions (in mm) of *Reineckeia* (*Reineckeia*) *nodosa*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
SH-4-C54	4.5	1.5	28.8	44.4	0.6	6	-
T-3-T29	4	1.5	35	45	0.7	11	-
T-4-T42	2.8	39.2	39.2	53.5	0.7	8	-
T-4-T38	6.7	25.3	34.2	28.3	1.2	15	32
T-4-T44	5.1	-	37.2	35.2	1	8	14

Table 11. Dimensions (in mm) of *Collotia* cf. *multicostata*.

Specimen	D	U%	W%	H%	Q	PR2	SR/2
SH-3-C47	7	1.1	35.7	28.5	1.2	19	-
SH-3-C42	6.7	1	41.7	25.3	1.6	19	-
T-3-T52	5.7	-	24.5	22.8	1	-	-
T-4-T69	5.6	23.2	35.7	26.7	1.3	-	-
T-4-T125	3.6	2.2	41.6	31.6	1.1	16	-

Collotia cf. *oxyptychooides* (SPATH, 1927) [32].

Pl. 1, Figures 4a-c

1984 *Collotia* cf. *oxyptychooides* (SPATH).-CARIOU: Pl. 61, Figures 1-3, Pl. 62, Figures 1-3, Pl. 63, Figures 1-4.

Material: 1 specimen from Talu section (T-T59), (**Table 13**).

Description: Umbilical wall low and steep, whorl cross-section broad-oval to broad rectangular. The primary ribs start at faint and regular nodes near the umbilical margin and divide mainly into two and three secondary ribs at about one-third of flank height. The secondary ribs are fainter and denser than the primaries. Some of the primary ribs do not divide.

Remarks: The present specimen is similar to the specimen described and figured by CARIOU (1984: Pl. 63, Figure 3).

Stratigraphic distribution: Upper Callovian, Athleta Zone.

Collotia cf. *collotiformis* (JEANNET, 1951) [26].

Pl. 1, Figures 1a-b

1984 *Collotia collotiformis* (JEANNET).-CARIOU: Pl. 59, Figures 1-3, Pl. 60, Figure 1.

Material: 1 specimen from Absharaf section (SH-C46), (**Table 14**).

Description: Umbilical wall low and vertical, whorl cross-section ovate. The primary ribs start from umbilicus margin at one-third of round width with thick elongated tubercles. At this area, the primary ribs are divided into two and three secondary and forward ribs. The secondary ribs are fainter and denser than the primaries. Some of the primary ribs do not divide.

Remarks: The present specimen is similar to the specimen described and figured by CARIOU (1984: Pl. 60, Figure 1).

Stratigraphic distribution: Upper Callovian, Athleta Zone.

5. Conclusions

Follwing Reineckeide family have been collected from the middle part of the Dalichai Formation at the sections:

Table 12. Dimensions (in mm) of *Collotia* cf. *gailliardi*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
T-4-T35	7.1	15.4	32.3	25.3	1.2	16	-
T-4-T76	6.4	1	32.8	32.8	1	19	-
T-4-T126	6.6	-	24.2	22.7	1	-	-

Table 13. Dimensions (in mm) of *Collotia* cf. *oxyptychooides*.

Specimen	D	U%	H%	W%	Q%	PR/2	SR/2
T-4-T59	3.9	30.7	41	-	-	-	-

Table 14. Dimensions (in mm) of *Collotia* cf. *collotiformis*.

Specimen	D	U%	H%	W%	Q	PR/2	SR/2
SH-4-C46	6	0.8	36.6	21.6	1.6	15	-

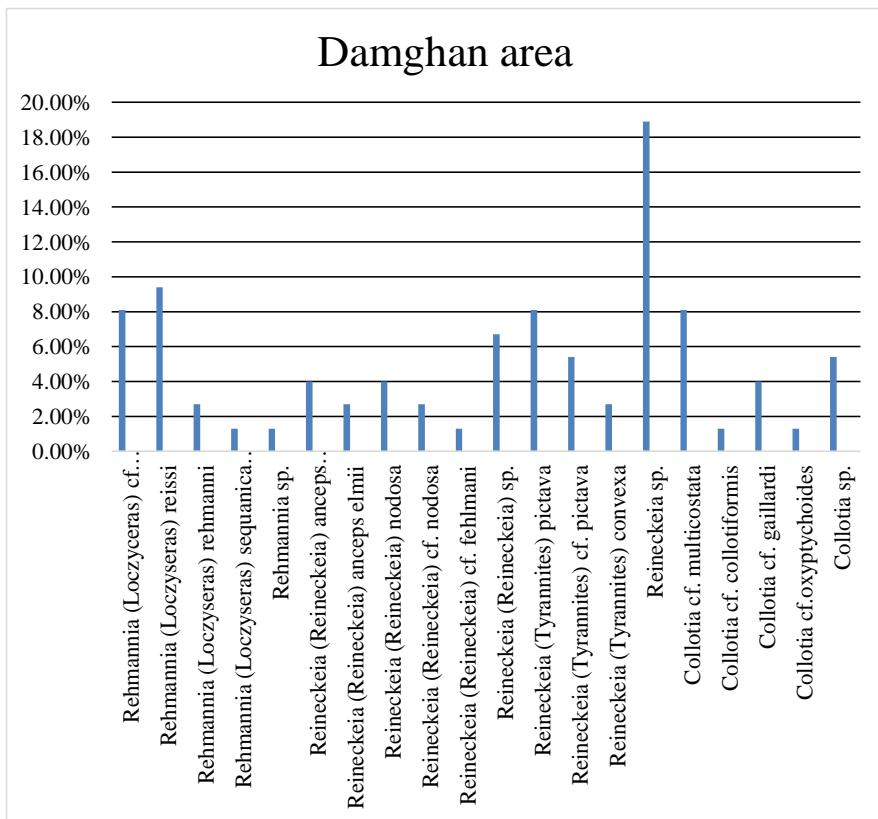


Chart 2. Percentage frequency species of Reineckiidae family in Damghan area.

Rehmannia (Loczyceras) cf. segestena (8.1%), *Rehmannia (Loczyseras) reissi* (9.4%), *Rehmannia (Loczyseras) rehmanni* (2.7%), *Rehmannia (Loczyseras) sequanica densicostata* (1.3%), *Reineckeia (Reineckeia) anceps anceps* (4%), *Reineckeia (Reineckeia) anceps elmii* (2.7%), *Reineckeia (Reineckeia) nodosa* (4%), *Reineckeia (Reineckeia) cf. nodosa* (2.7%), *Reineckeia (Reineckeia) cf. fehlmani* (1.3%), *Reineckeia (Tyrannites) pictava* (8.1%), *Reineckeia (Tyrannites) cf. pictava* (5.4%), *Reineckeia (Tyrannites) convexa* (2.7%), *Collotia cf. multicostata* (8.1%), *Collotia cf. collotiformis* (1.3%), *Collotia cf. gaillardi* (4%), *Collotia cf. oxyptychoides* (1.3%), *Collotia sp.* (5.4%) (**Chart 2**).

74 specimens of Reineckeidae family from the Dalichai Formations belonging to 3 genera, 3 sub genera and 14 species are described.

The identified species of the Delichai Formation in the studied sections show following zones:

Gracilic from Early Callovian, Anceps, Coronatum from Middle Callovian, Athleta from Late Callovian.

Moreover, palaeogeographic reconstructions show the geographic position of the Iranian plate (North and Central Iran) during the Middle Jurassic time, at the southern margin of Eurasia at a latitude around 30°N which rather corresponds to European areas (Enay & Cariou [33], Wilmsen et al. [34]).

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Appendix Plates

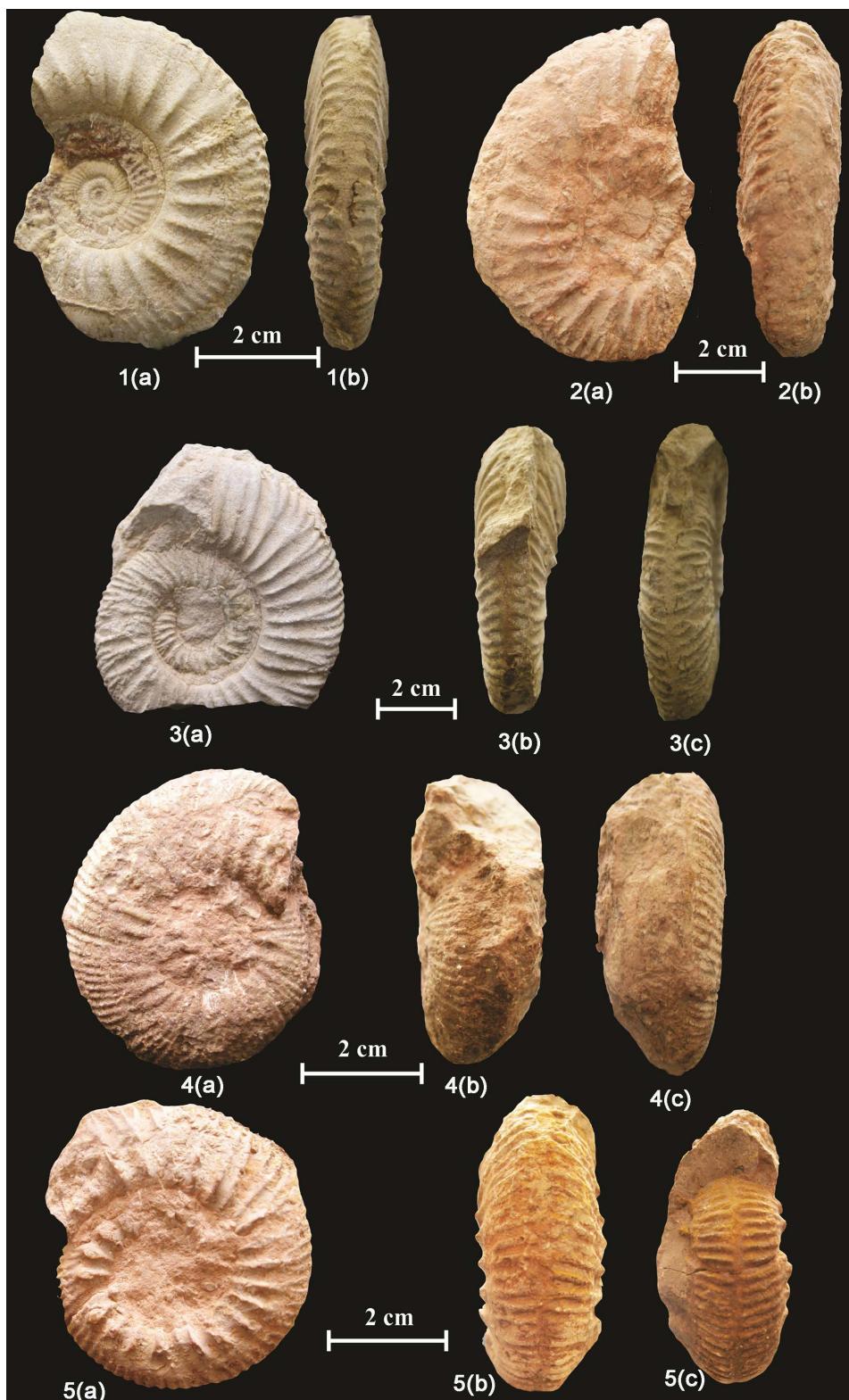


Plate 1. 1(a), 1(b): *Collotia* cf. *collotiformis* (JEANNET), Absharaf section, 2(a), 2(b): *Collotia* cf. *gailliardi* (ROMAN), Talu section, 3(a)-(c): *Collotia* cf. *multicostata* (PETITEC), Absharaf section, 4(a)-(c): *Collotia* cf. *oxyptychoides* (SPATH), Talu section, 5(a)-(c): *Rehmannia* (*Locyceras*) *reissi* (STEINM), Talu section.

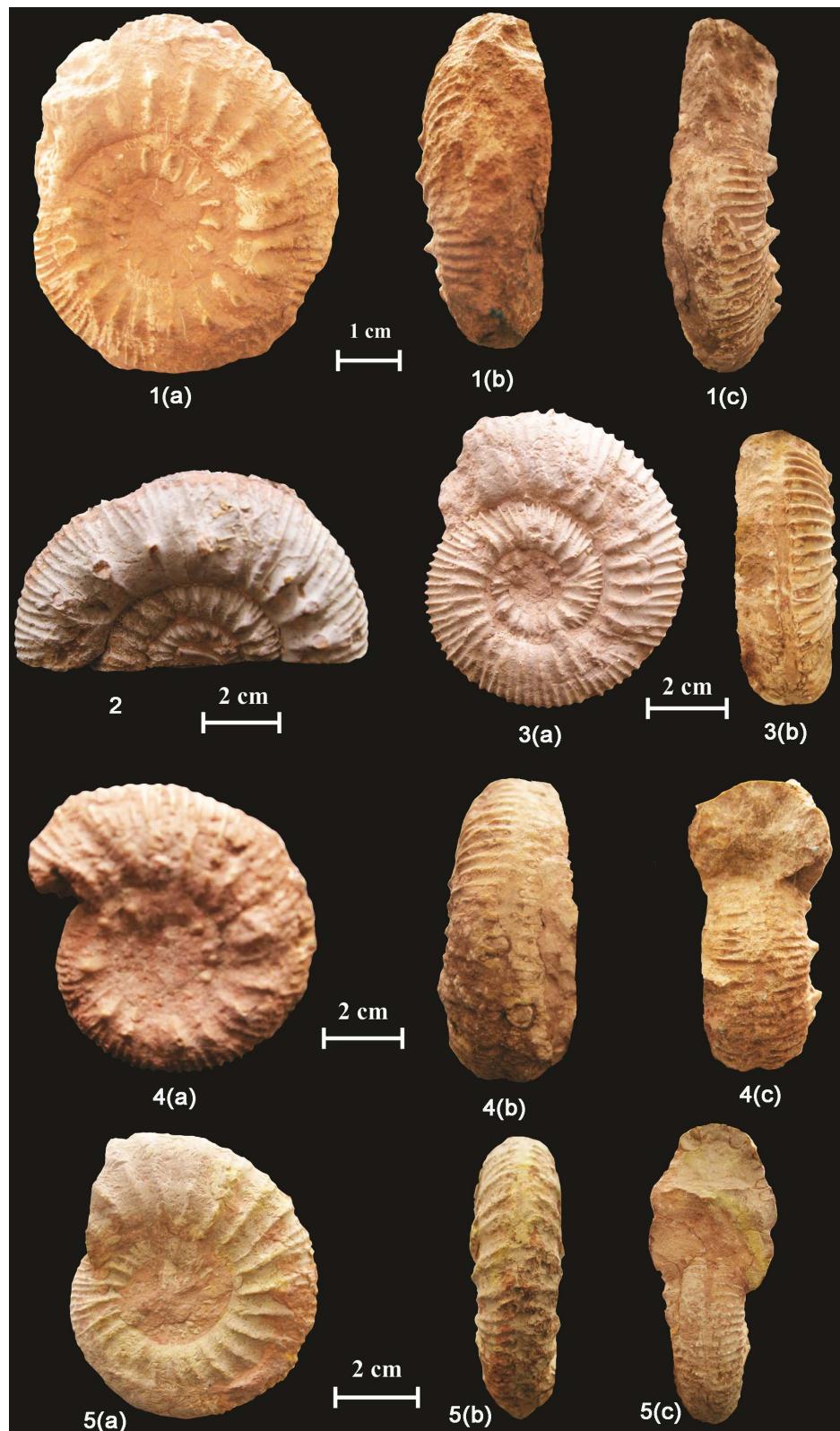


Plate 2. 1(a)-(c): *Rehmannia (Loczyceras) sequanica densicostata* (BOURQUIN), Talu section, 2: *Rehmannia (Loczyceras) rehmanni* (OPP), Talu section, 3(a), 3(b): *Rehmannia (Loczyceras) cf. segestena* (GEMMELLARO), Talu section, 4(a)-(c): *Reineckeia (Reineckeia) anceps elmii* (BOURQ), Talu section, 5(a)-(c): *Reineckeia (Reineckeia) anceps anceps* (REINECKE), Talu section.

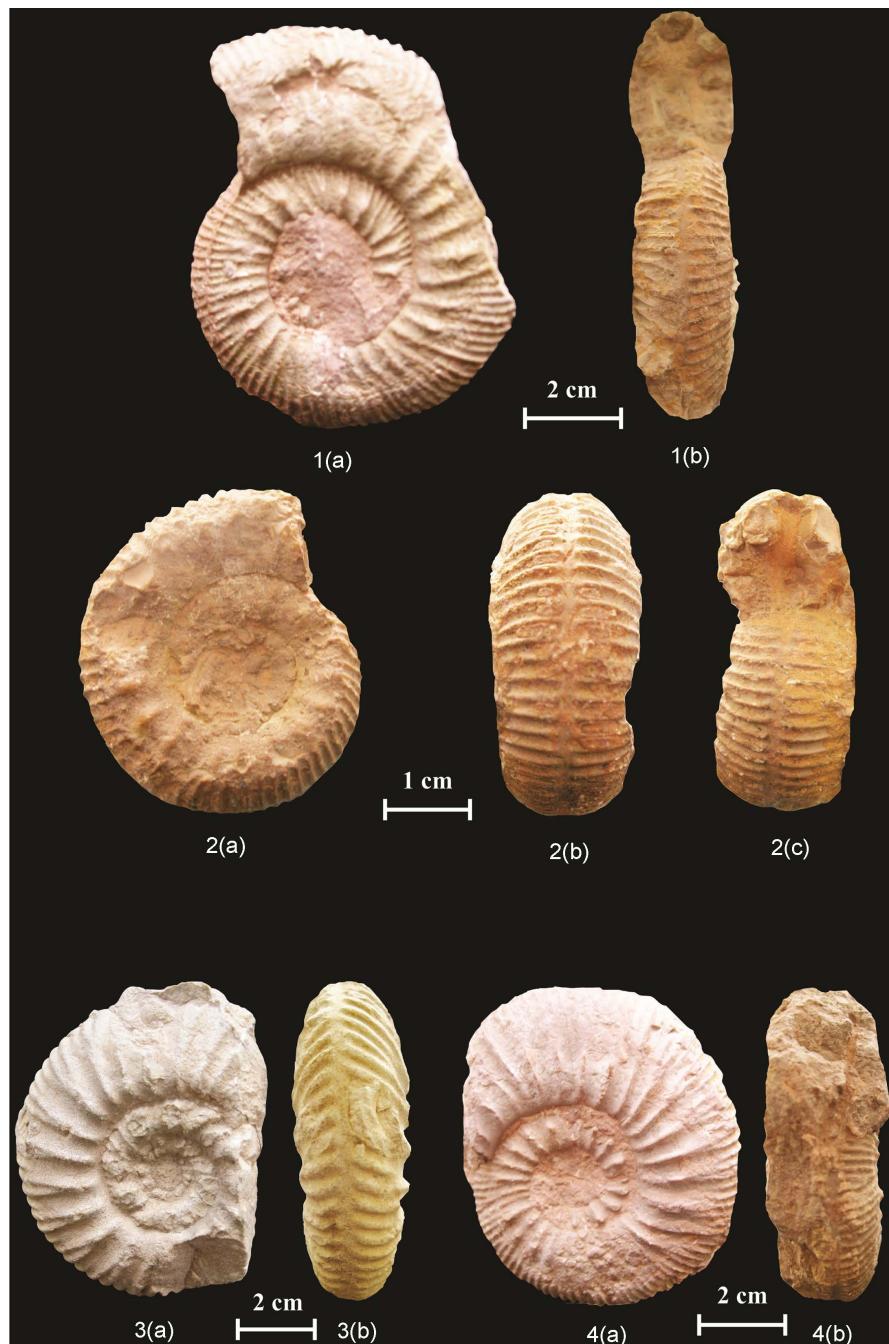


Plate 3. 1(a), 1(b): *Reineckeia* (*Tyrannites*) *pictava* (BOURQIN), Talu section, 2(a)-(c): *Reineckeia* (*Reineckeia*) *nodosa* (TILL), Talu section, 3(a), 3(b): *Reineckeia* (*Reineckeia*) cf. *fehlmanni* (JEANNET), Absharaf section, 4(a), 4(b): *Reineckeia* (*Tyrannites*) *convexa* (CARIOU), Talu section.



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