

***Praeorbitolina claveli* n.sp. (benthic Foraminifera)  
from the Lower Aptian *sensu lato* (Bedoulian) of Central Iran**

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**Abstract:** The new orbitolinid foraminifer, *Praeorbitolina claveli* n.sp., is described from the Lower Aptian (Bedoulian) of Central Iran. It is characterized by an eccentric embryonic apparatus displaying both a subdivided subembryonic zone and a deuteroconch. The Barremian-Aptian orbitolinid association of this area has a typical northern Tethyan character (e.g., "association à *Valserina*" of CHERCHI and SCHROEDER, 1973).

**Key Words:** Foraminifera; orbitolinids; *Praeorbitolina*; *Mesorbitolina*; Lower Aptian; Bedoulian; Iran; palaeobiogeography.

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**Résumé :** *Praeorbitolina claveli* n.sp. (foraminifère benthique) de l'Aptien inférieur *sensu lato* (Bédoulien) du centre de l'Iran.- Un nouveau foraminifère orbitolinidé, *Praeorbitolina claveli* n.sp., est identifié dans l'Aptien inférieur (Bédoulien) de l'Iran central. Il se caractérise par un appareil embryonnaire constitué d'une zone subembryonnaire subdivisée ainsi que d'une deutéroconque. L'association d'orbitolinidés d'âge Barrémien-Aptien de cette région présente un caractère typiquement nord-téthysien (e.g., "association à *Valserina*" de CHERCHI et SCHROEDER, 1973).

**Mots-Clefs :** Foraminifère ; Orbitolinidae ; *Praeorbitolina* ; *Mesorbitolina* ; Aptien inférieur ; Bédoulien ; Iran ; paléobiogéographie.

## Introduction

Lower Cretaceous orbitolinid foraminifers were reported from different structural regions of Iran, e.g., the Zagros Zone in the south, Central Iran and the northern part (Kopet Dag, Alborz) (e.g., HENSON, 1948; SCHROEDER, 1965; GOLLESTANEH, 1965; SAMPÒ, 1969; MEHRNUSCH, 1973; SIMMONS *et al.*, 2000; SCHROEDER *et al.*,

2010; BABAZADEH *et al.*, 2010; YAZDI-MOGHADAM & AMIRI, 2010; SHIRAZI & ABEDI, 2013). Currently, several sections of Lower Cretaceous orbitolinid-bearing, shallow-water carbonates from Central Iran are being investigated with respect to their benthic foraminifers and calcareous algae. In the present contribution, a new species of orbitolinid foraminifer is described.

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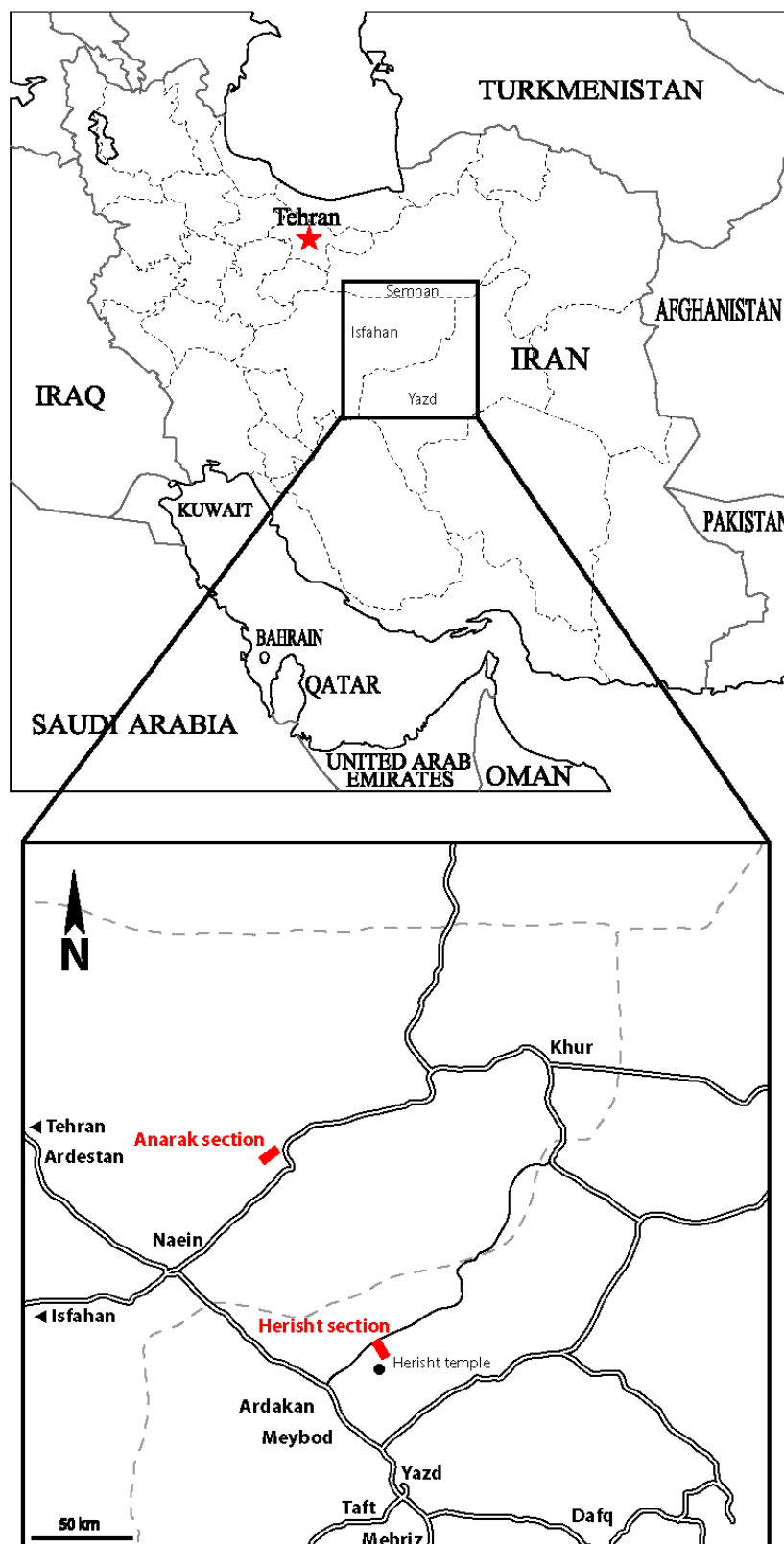
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## Geological setting

The mountainous region around Anarak is part of the Yazd Block of Central Iran (BERBERIAN & KING, 1981; AGHANABATI, 2004, for overviews). It is bounded northward by the Doruneh fault and towards the west by the Naien Baft ophiolite belt. Trangressive Lower Cretaceous shallow-water limestones overlie conglomerates and sandstones which in turn are underlain by the Late Paleozoic to Triassic Anarak metamorphic complex (e.g., TORABI, 2011; BUCHS *et al.*, 2013). The Lower Cretaceous carbonates of the Yazd Block that are generally assigned to the Barremian-Aptian interval were investigated with respect to microfacies, sedimentology and micropaleontology by BUCUR *et al.* (2012) and WILMSEN *et al.* (2013). Three sections of Lower Cretaceous, shallow-water carbonates are currently being studied in the area of Anarak-Naien-Ardakan (Fig. 1): the Anarak section near Anarak and two sections at Herisht (T and H) close to Ardakan. Orbitolinid foraminifers represent frequent constituents of the carbonates. As the first result of the ongoing studies, a new species is described as *Praeorbitolina clavelli* n.sp. herein.

► **Figure 1:** Location of the studied sections at Anarak and Herisht in Central Iran. The Herisht section is the type-locality of the new species *Praeorbitolina clavelli* n.sp. Anarak section: N 33°20'22.66", E 53°41'53.68"; Herisht section: N 32°25'37.61", E 54°6'54.11".



## Systematics

### Family Orbitolinidae

MARTIN, 1890

### Subfamily Orbitolininae

MARTIN, 1890

### Genus *Praeorbitolina*

SCHROEDER, 1964a

**Type-species:** *Praeorbitolina cormyi*  
SCHROEDER, 1964a

The new foraminifer is attributed to the genus *Praeorbitolina* SCHROEDER, 1964a, which is defined essentially by its embryonic apparatus composed of a protoconch, a deutoconch and the subembryonic zone situated in an eccentric position at the beginning of a small spire (SCHROEDER, 1964a, 1975; CHERCHI *et al.*, 1998; SCHROEDER *et al.*, 2010).

### *Praeorbitolina claveli* n.sp.

Pl. 1, figs. 1-17

#### Synonymy:

1973. *Praeorbitolina* sp. – MEHRNUSCH, Figs. 11-13.  
1992. *Praeorbitolina wienandsi* SCHROEDER – MASSE *et al.*, Pl. 2, fig. 11.

**Origin of the name:** Dedicated to Bernard CLAVEL for his numerous contributions to the stratigraphy and systematics of the orbitolinids.

**Holotype:** Pl. 1, fig. 4. Axial section, cut perpendicular to the median plane and passing through the embryonic apparatus; from the Herisht section, thin-section T 47 (number 23868), Lower Aptian (Bedoulian), *Praeorbitolina cormyi* orbitolinid zone of SCHROEDER *et al.* (2010; CHERCHI & SCHROEDER, 2013).

**Paratypes:** Specimens in Pl. 1, figs. 5, 9 (number 23867) and 16 (number 23871), lower Aptian (Bedoulian), *Praeorbitolina cormyi* orbitolinid zone of SCHROEDER *et al.* (2010; CHERCHI & SCHROEDER, 2013).

**Material studied:** About 40 specimens in 15 thin-sections from the Herisht section, deposited at the Babeş-Bolyai University, Cluj-Napoca, Romania, Department of Geology (collection I.I. BUCUR, under the inventory numbers: 23865 to 23880).

**Type locality:** The Herisht section (Esfahan area), located about 9 km northeast of Ardakan city, province of Yazd. Coordinates: N 32°25'37.61", E 54°6'54.11".

**Type level:** Lower Aptian (Bedoulian), *Praeorbitolina cormyi* zone (SCHROEDER *et al.*, 2010; CHERCHI & SCHROEDER, 2013).

**Diagnosis:** Representative of *Praeorbitolina* displaying subdivided subembryonic zone and deutoconch (two to three, up to 5 short plates).

**Description:** In the thin-sections that were studied, juvenile specimens predominate (e.g., Pl. 1, figs. 12, 14). These consist of the eccen-

tric embryonic apparatus and some curved chambers (up to 4-5) only, resulting in a biconvex test outline in axial sections (Pl. 1, figs. 6, 14). Later chambers successively build up in an annular plane resulting in the slightly convex to flat test bases (Pl. 1, figs. 3-5, 7). In adult specimens the chambers may increase progressively in width (Pl. 1, fig. 17). The marginal zone of the chamber layers is subdivided by one horizontal plate and vertical plates (= one rafter and beams *sensu* HOTTINGER, 2006). Chamberlets of the central zone alternate in position between successive chamber layers (Pl. 1, fig. 3).

The megalospheric embryonic apparatus, situated in an eccentric position at the beginning of the initial spire, consists of three parts: protoconch, deutoconch and subembryonic zone. The differentiation of the deutoconch and the protoconch is poorly pronounced and they may appear as a single subspherical chamber. In axial sections parallel to the median plane, the eccentric position of the embryonic apparatus is distinct and marked at the outer test surface by a small elevation (Pl. 1, figs. 5-6, 14). The deutoconch is subdivided by mostly two to three, rarely up to five short plates (or septules) (Pl. 1, figs. 3, 9, 16). In the subembryonic zone, two to three irregularly spaced partitions can be recognized. As the septules of the subembryonic zone are arranged parallel to the median plane, they are more easily seen in sections cut perpendicular to this plane (Pl. 1, figs. 3, 13). Axial sections cut parallel to the median plane often display areas without partition (Pl. 1, figs. 7, 11). In axial sections cut perpendicular to the median plane the embryonic apparatus may appear centered (Pl. 1, fig. 8) or inclined to one side (Pl. 1, figs. 4, 15).

#### Dimensions:

Measurements:	Minimum	Maximum
Height of test:	0.14 mm	0.75 mm
Diameter of test:	0.2 mm	1.2 mm
Diameter embryonic apparatus:	0.09 mm	0.19 mm
Number of chambers:	4	25
Height of chamber:	0.02 mm	0.04 mm

**Comparisons:** The new species was described as *Praeorbitolina* sp. by MEHRNUSCH (1973) from the Lower Aptian of the Esfahan region, Central Iran, who noted the subdivision of the deutoconch by short plates. *Praeorbitolina claveli* n.sp. differs from the type-species *Praeorbitolina cormyi* SCHROEDER, 1964a, and *Praeorbitolina wienandsi* SCHROEDER, 1964a, by the complexity of the embryonic apparatus. While the former shows an undivided subembryonic zone and undivided deutoconch, the latter exhibits a partitioned subembryonic zone (Pl. 2). *Praeorbitolina claveli* n.sp. is characterized by the presence of short plates (2 to 5) in the deutoconch and plates in the subembryonic zone. The latter may be scattered and irregularly spaced. Furthermore, the size of the embryonic apparatus is larger. According to SCHROEDER

(1975, p. 121), the average diameter of the embryonic apparatus is 0.07 mm (0.08 mm in CHERCHI & SCHROEDER, 2009) in *P. cormyi*, and 0.1 mm in *P. wienandsi* (0.13 mm in CHERCHI & SCHROEDER, 2009). In *P. claveli*, the embryonic apparatus ranges from 0.09 mm (MEHRNUSCH, 1973: 0.08 mm) to 0.19 mm (most values between 0.13 and 0.15 mm).

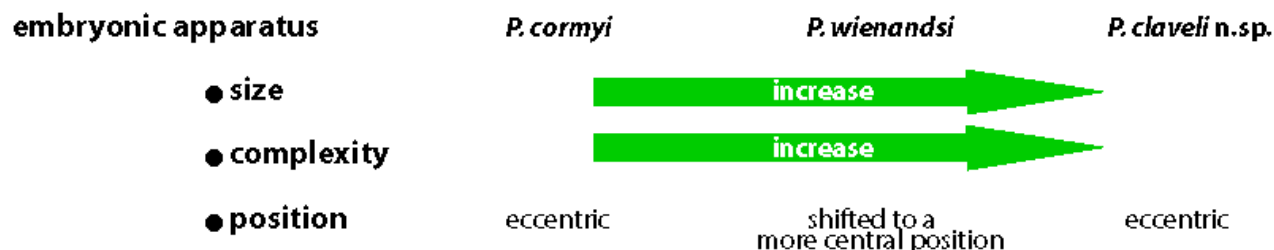
In the original description, the deuteroconch of *Praeorbitolina wienandsi* was defined as completely lacking any plates (see also Fig. B in SCHROEDER, 1964a). Later, a "first weak indication" of subdivision of the deuteroconch (= alveolar layer) was mentioned (SCHROEDER, 1975: p. 122). CHERCHI *et al.* (1998: p. 548) defined *P. wienandsi* as having "a deuteroconch sometimes showing one or two rudimentary septula in its uppermost part". The schematic drawing of the embryonic apparatus again was shown to lack septula in the deuteroconch (CHERCHI *et al.*, 1998: Fig. 3B). In fact, there are only few illustrations in the literature for such a feature. For example, BOSELLINI *et al.* (1999: Fig. 5g) illustrated an axial section (perpendicular to the median plane) of *P. wienandsi* showing a single short plate (or septula) in the deuteroconch. We interpret these specimens as transitional forms between *P. wienandsi* and *P. claveli* n.sp. It is worth mentioning that transitional forms between *P. cormyi* and *P. wienandsi* also exist (CHERCHI *et al.*, 1998: Pl. 4, figs. 2, 8). MATSUMARU (2005) described a new orbitolinid, *Praeorbitolinoides japonica* from the Japanese Lower Aptian, assigning it a new genus and species. This taxon has also been interpreted by CHERCHI & SCHROEDER (2009) as representing a transitional form between *Praeorbitolina cormyi* and *P. wienandsi*, a view later accepted by IBA *et al.* (2011).

**Remarks:** Orbitolinids display distinct phylogenetic evolutionary lineages within different species within a single genus or connecting one genus with another. Such lineages are known from both the Dictyoconinae (with simple embryonic apparatus) and the Orbitolininae (with complex embryonic apparatus). In the case of the Dictyoconinae, for instance, such lineages show an increasing complexity of the marginal zone (from forms without plates, to forms with horizontal plates, to forms with both horizontal and vertical plates) (e.g., SCHROEDER *et al.*,

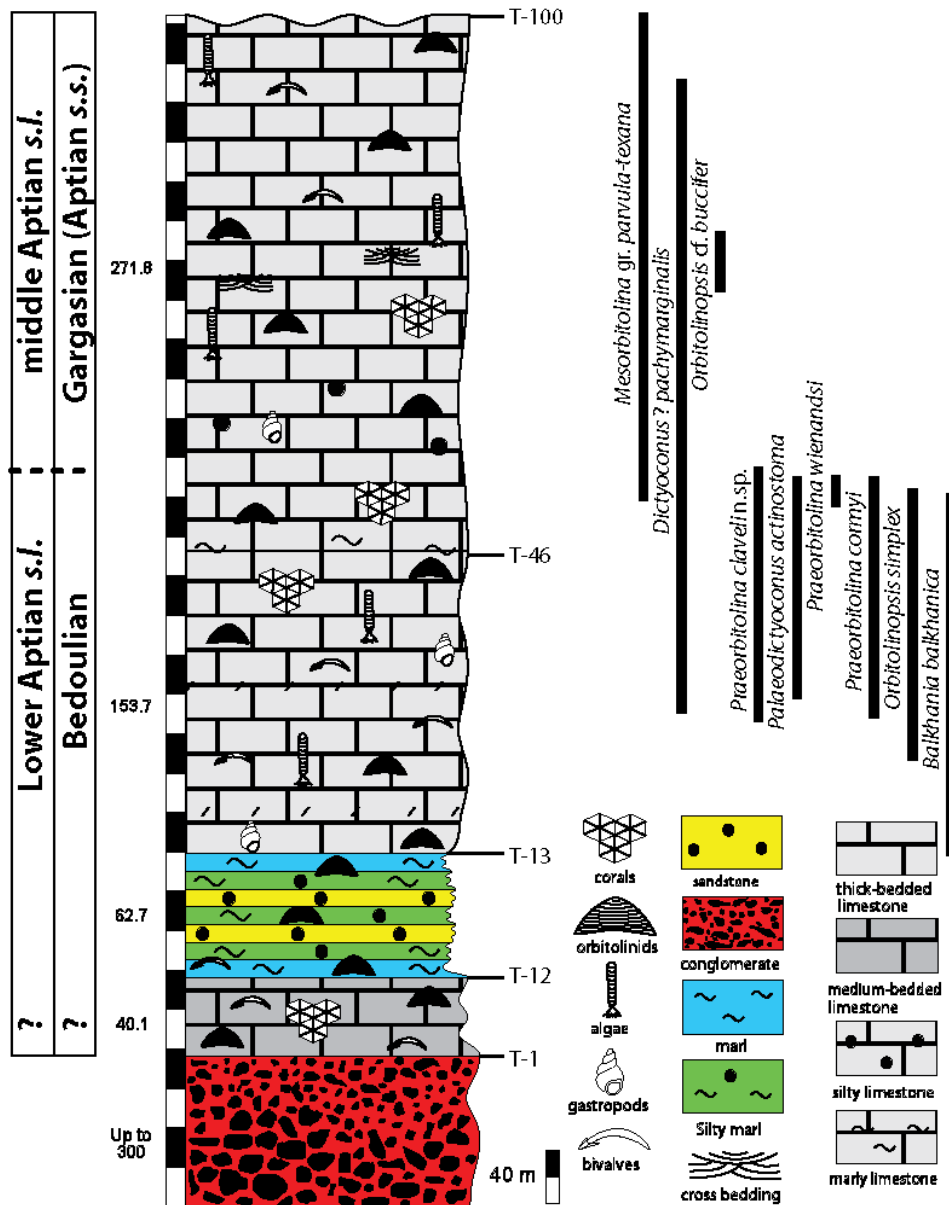
2002). Within the Orbitolininae such trends are exhibited by a continuous complexity of the embryonic zone along with an increasing size of the latter (e.g., SCHROEDER, 1975; SCHROEDER *et al.*, 2010).

The so-called *Praeorbitolina cormyi* – *Mesorbitolina* lineage is the longest of these trends ranging from the Lower Aptian to the Lower Cenomanian (e.g., SCHROEDER *et al.*, 2010). SCHROEDER (1964a) established the *Praeorbitolina* lineage with *P. cormyi* as the ancestor of *P. wienandsi*, the latter with a more complex embryonic apparatus that had also shifted to a more central position. This evolution leads to the most primitive representative of the genus *Mesorbitolina* SCHROEDER with *Mesorbitolina lotzei* appearing in the uppermost Bedoulian. This species is characterized by a centrally positioned embryonic apparatus showing an undivided deuteroconch (or with rare rudimentary plates) and a well partitioned subembryonic zone (SCHROEDER, 1964b; CHERCHI *et al.*, 1998; SCHROEDER *et al.*, 2010). Up to now, *P. wienandsi* has been considered the direct precursor of *Mesorbitolina lotzei*, that does not bear plates in its deuteroconch. *Praeorbitolina claveli* only partly fits into the scheme of increasing complexity of the embryonic apparatus, but the position of the embryonic apparatus (shifting from a clearly eccentric to a more central position) does not (Fig. 2). This leads to a conclusion that either the details of the transition from *Praeorbitolina* to *Mesorbitolina* must be reconsidered or that we are dealing with a separate parallel evolution.

**Stratigraphy:** The biostratigraphy of the Lower Cretaceous sections in Central Iran is based on orbitolinid foraminifers (Fig. 3). Some of the taxa observed in different sections under study are illustrated in plates 1 to 5. They include species that co-occur with *Praeorbitolina claveli* n.sp. as well as species from older strata, e.g., *Eopalorbitolina charollaisi* SCHROEDER (Pl. 4, figs. 5, 8), *Eopalorbitolina cf. transiens* (CHERCHI & SCHROEDER) (Pl. 4, fig. 12), *Eygalierina? turbinata* FOURY (Pl. 4, fig. 9) or *Valserina broennimanni* SCHROEDER (Pl. 5, figs. 1-6) from the Lower Barremian of the Anarak section. These taxa and others not illustrated here will be the subject of a separate contribution.



**Figure 2:** Comparison of the embryonic apparatus of representatives of *Praeorbitolina* SCHROEDER, 1964a (further details in the text).



◀ **Figure 3:** Lithostratigraphic column of the Herisht section (T numbers) with distribution (vertical range) of orbitolinids and *Balkhanina balkhanica* MAMONTOVA (for the palaeobiogeographic importance of this taxon, see TAHERPOUR KHALIL ABAD *et al.*, 2013).

SCHROEDER *et al.* (2010; CHERCHI & SCHROEDER, 2013) developed an orbitolinid biozonation for the Arabian plate shallow-water carbonates comprising the late Early Barremian – Middle Albian interval. For southeastern France and the Swiss Jura, a detailed biostratigraphic distribution of 39 orbitolinid taxa (based on ammonites) was recently presented by CLAVEL *et al.* (2013) comprising the Late Hauterivian – Bedoulian interval. Both zonations can be taken as a base for the stratigraphic setting of the sections studied. However, we note that SCHROEDER *et al.* (2010), ascribed the Furcata Zone to the Early Gargasian, whereas CLAVEL *et al.* (2013) ascribe it to the late Bedoulian. *Praeorbitolina claveli* spans the entire *Praeorbitolina cormyi* zone *sensu* SCHROEDER *et al.* (2010) and stratigraphically occurs also a little bit higher in the Herisht T section (see Fig. 3). It is not definitely proven whether this observation indeed

represents a longer range than *P. cormyi* or just reflects a lack of observation of the latter. To summarize, *P. claveli* is recorded from the *Praeorbitolina cormyi* zone (= *Deshayesites deshayesi* and *D. furcata* ammonite zones, SCHROEDER *et al.*, 2010, p. 67) that is late Bedoulian (Early Aptian) – early Gargasian (middle Aptian, or Aptian *sensu stricto* of MOULLADE *et al.*, 2011) in age. For a different concept of the Aptian stage (contrasting MOULLADE *et al.*, 2011), see also OGG & HINNOV (2012).

However, some of the orbitolinids from Central Iran, for example *Dictyoconus? Pachymarginalis* SCHROEDER (Pl. 3, figs. 6-7, 10-11), *Praeorbitolina* div. sp. (Pls. 1 - 2), *Dictyoconus? sp.* 1 and 2 (Pl. 3, figs. 5, 8), *Orbitolinopsis simplex* (HENSON) (Pl. 5, figs. 7-10), and *Mesorbitolina* div. sp. (Pl. 4, figs. 7, 10, 13) have not been recorded from the SW-French-Suisse Jura area (see CLAVEL *et al.*, 2013).

On the contrary, the stratigraphic ranges of the species *Palaeodictyoconus actinostoma* ARNAUD-VANNEAU & SCHROEDER (Pl. 4, figs. 3-4, 6) and *Orbitolinopsis* cf. *buccifer* ARNAUD-VANNEAU & THIEULOUY (Pl. 3, figs. 1-4) as indicated by CLAVEL *et al.* (2013) can be slightly increased to include younger strata where orbitolinids have not been found from southern France. This conclusion stems from the total ranges of both *Praeorbitolina cormyi* and *P. wienandsi* extending to the top of the Furcata Zone (SCHROEDER *et al.*, 2010, Fig. 10) and the distribution of the orbitolinids in the Herisht section (T section). However, in the absence of ammonite data, it is not possible to provide further specifications.

The stratigraphy of the still poorly-known species *Dictyoconus? pachymarginalis* needs further clarification. SCHROEDER (1965) described it from the upper Bedoulian-Gargasian strata of the Alborz Mountains, northern Iran. In south-east Spain, it is described as characteristic of the lower Gargasian, *i.e.*, the biozone of "*Dictyoconus pachymarginalis*, with the initial appearance of *Mesorbitolina minuta*" (MASSE *et al.*, 1992). Data from the Herisht T section show that this species co-occurs with *Mesorbitolina* gr. *texana* (ROEMER) at its upper range limit and is recorded throughout the whole *Praeorbitolina cormyi* zone.

The above also holds true for the stratigraphic distribution of *Orbitolinopsis simplex* described by HENSON (1948) as *Iraqia simplex* from the "Lower to middle Cretaceous" of Iraq and Iran (for generic affiliation of the species see SCHROEDER, 1963, 1964b). In the Urgonian of Spain (Teruel region), SCHROEDER (1964b) established the *Orbitolinopsis simplex* zone between the *Mesorbitolina lotzei* zone (below) and the *Mesorbitolina texana parva* zone (above). According to recent Lower Cretaceous orbitolinid zonation of the Arabian plate and adjacent regions (SCHROEDER *et al.*, 2010), this short term interval can be placed around the Bedoulian-Gargasian boundary. MASSE *et al.* (1992) place their "*Iraqia simplex* zone" below the *Praeorbitolina* zone. In the Herisht section, *O. simplex* spans the whole range of *Praeorbitolina cormyi* (Fig. 3).

**Microfacies and palaeoenvironment:** *Praeorbitolina claveli* n.sp. was observed in wackestones with orbitolinids and other benthic foraminifers such as *Maycina bulgarica* LAUG *et al.*, *Sabaudia minuta* (HOFKER), *Vercorsella* div. sp., *Everticyclammina hedbergi* (MAYNC) and others. Calcareous algae are represented by *Morelletpora turgida* (RADOIČIĆ), *Terquemella* sp., *Marinella lugeoni* PFENDER and others. The microfacies and associated microfossils indicate a quiet water inner platform-ramp depositional setting.

**Palaeobiogeography:** The taxa (or assemblage) reported from the Barremian-Aptian of Central Iran show the "European" character of

the orbitolinid fauna of Central Iran (CHERCHI *et al.*, 1981), namely the "*Valserina* association" *sensu* CHERCHI & SCHROEDER (1973). For example, *Orbitolinopsis simplex* is known from non-European areas NE Iraq (type-locality; HENSON, 1948), the Zagros Zone of Iran (HENSON, 1948), as well as from Spain (BASSOULLET & MOULLADE, 1962; SCHROEDER, 1963, 1964b; MASSE *et al.*, 1992). Its occurrence in Japan (MATSUMARU *et al.*, 2007) has so far not been verified (IBA *et al.*, 2011). Other forms like *Dictyoconus? Pachymarginalis* SCHROEDER are not palaeobiogeographically diagnostic and were reported from both northern (*e.g.*, MASSE *et al.*, 1992) and southern Tethyan carbonate platforms (MANCINELLI & CHIOCCHINI, 2006). The northern Tethyan margin affinity is also further substantiated by the larger benthic foraminifers *Balkhanian balkhanica* MAMONTOVA (TAHERPOUR KHALIL ABAD *et al.*, 2013), *Torreiroella hispanica* BRUN & CANÉROT and the dasycladalean algal assemblages (BUCUR *et al.*, 2012; HOSSEINI *et al.*, 2013). For the differences between the orbitolinid fauna of Central Iran and that from southern Iran (Zagros zone, eastern part of the Arabian Plate) see the species compilation in SCHROEDER *et al.* (2010).

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## Plates

### Plate 1:

*Praeorbitolina claveli* n.sp.

Herisht section, Bedoulian – *p.p.* Gargasian of Central Iran.

Fig. 1: Axial section. Thin-section T 36.

Fig. 2: Oblique transverse section through the embryonic apparatus. Thin-section T 47.

Fig. 3: Axial section. Thin-section T 77.

Fig. 4: Axial section, perpendicular to the median plane. Holotype specimen. Thin-section T 47

Fig. 5: Axial section. Thin-section T 36.

Fig. 6: Oblique axial section. Thin-section T 36.

Fig. 7: Axial section slightly oblique. Thin-section T 66.

Figs. 8, 15: Axial section, perpendicular to the median plane. Thin-section T 47.

Fig. 9: Axial section. Thin-section T 36.

Figs. 10, 13: Oblique section passing through the embryonic apparatus perpendicular to the median plane. Thin-sections T 47, T 36.

Figs. 11, 14: Axial section of a juvenile specimen. Thin-section T 36, T 47.

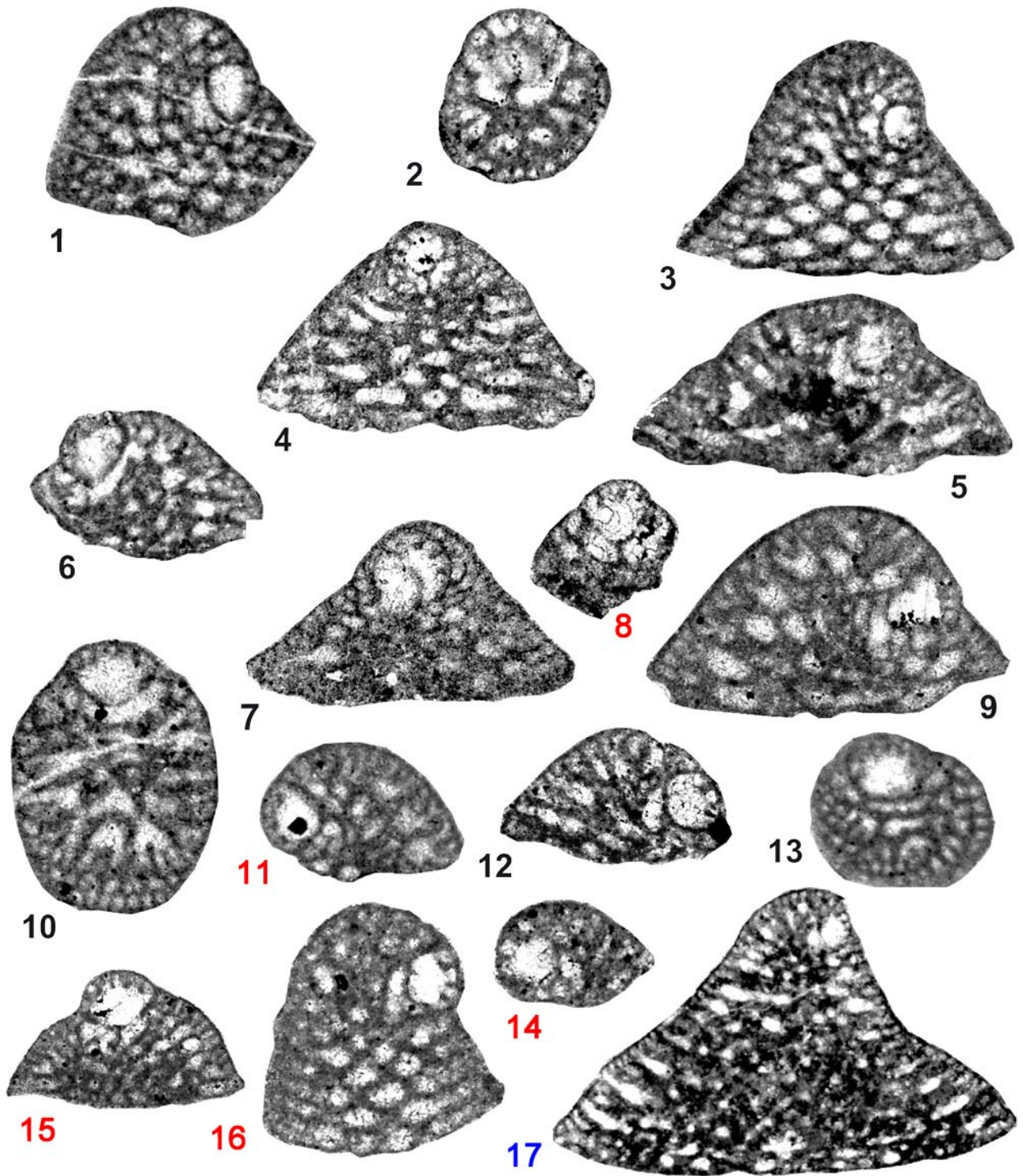
Fig. 12: Axial section. Thin-section T 36.

Fig. 16: Oblique axial section. Thin-section M 3.

Fig. 17: Axial section of an adult specimen. Thin-section T 50.

Abbreviations for all plates: AQ = Anarak section, north of Anarak, T = Herisht section, M = single sample taken NE of Anarak, G = single sample (see Fig. 1).





0.5 mm  
1-7, 9-10, 12-13

0.3 mm  
8, 11, 14-16

0.7 mm  
17

**Plate 2:**

*Praeorbitolina cormyi* SCHROEDER (1-8, 10-11), *Praeorbitolina wienandsi* SCHROEDER (9), Bedoulian of Central Iran

Fig. 1: Axial section of a large adult specimen. Thin-section T 47.

Fig. 2: Axial section. Thin-section T 47.

Fig. 3: Detail from fig. 2 showing embryonic apparatus. Note drop-like subembryonic zone.

Fig. 4: Oblique section. Thin-section T 73.

Fig. 5: Subaxial section, slightly oblique. Thin-section AQ 48B.

Fig. 6: Axial section. Thin-section T 67.

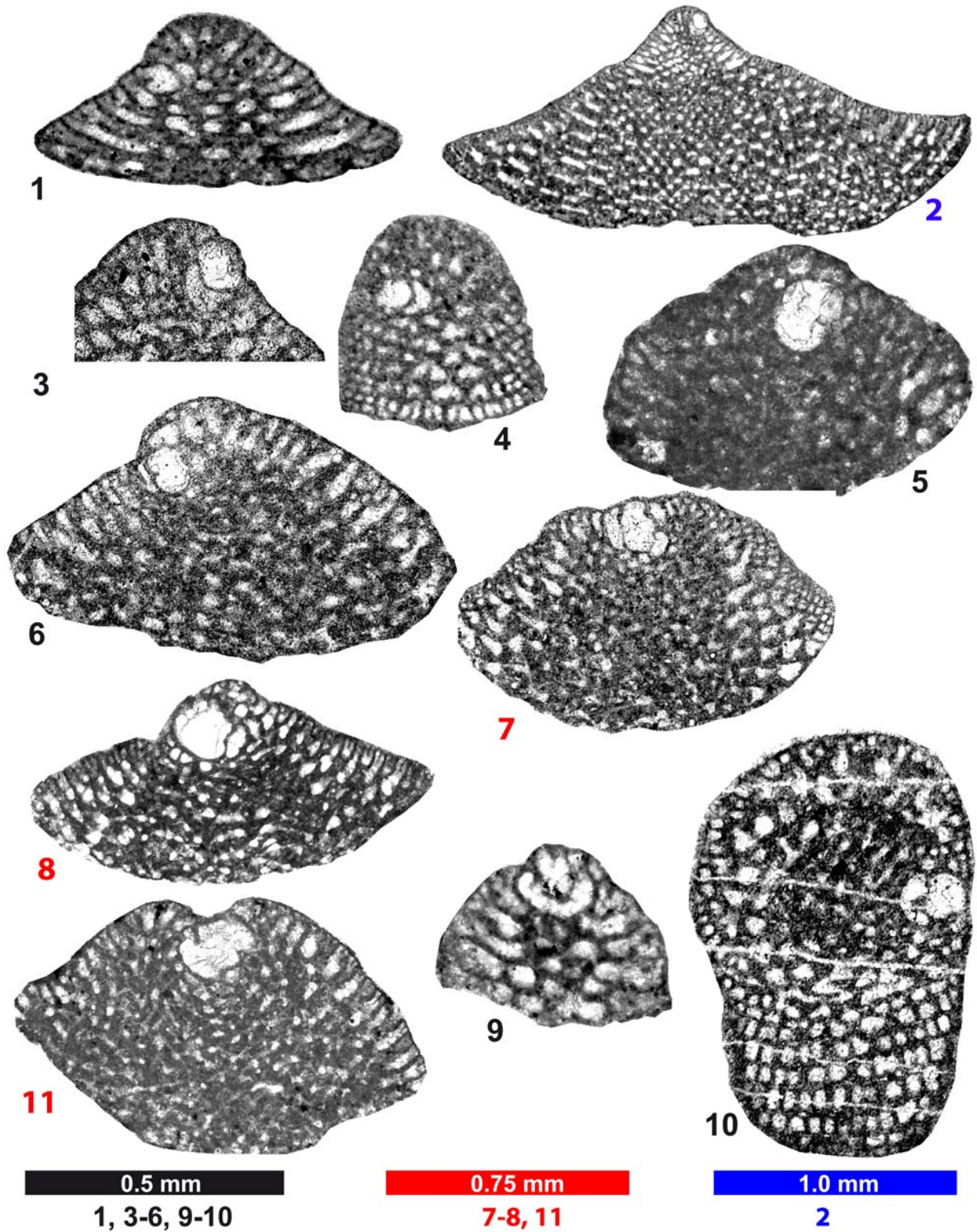
Fig. 7: Axial section, perpendicular to the median plane. Thin-section T 22.

Fig. 8: Axial section of a specimen exhibiting large embryonic apparatus. The specimen compares to Fig. 5c in BOSELLINI *et al.* (1999). Thin-section AQ 49.

Fig. 9: Axial section, perpendicular to median plane. Thin-section T 22.

Fig. 10: Oblique section. Thin-section T 49.

Fig. 11: Axial section, perpendicular to the median plane. Thin-section AQ 48.



**Plate 3:**

Orbitolinids from the Anarak (figs. 5, 12) and Herisht sections (all others), Central Iran

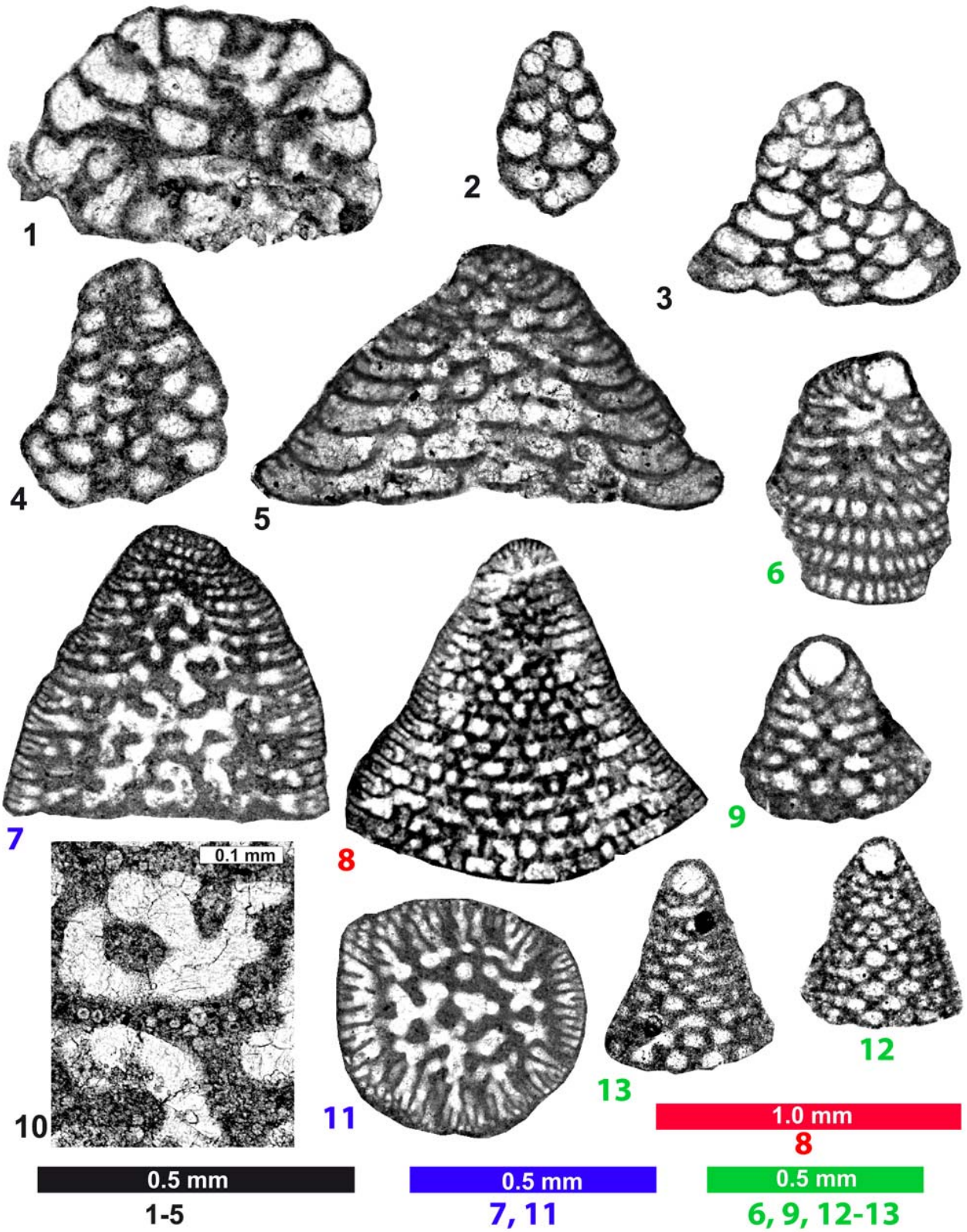
Figs. 1-4: *Orbitolinopsis* cf. *buccifer* ARNAUD-VANNEAU & THIEULOUY. Thin-sections T 72, T 86 (fig. 3).

Fig. 5: *Dictyoconus?* sp. 1. Thin-section AQ 24.

Figs. 6-7, 10-11: *Dictyoconus?* *pachymarginalis* SCHROEDER. Note the detail of the central zone of a specimen agglutinating nannoconids (see also SCHROEDER & CHERCHI, 1979; CHERCHI & SCHROEDER, 1999). Thin-sections T 58, T 86, T 74, T 94.

Fig. 8: *Dictyoconus?* sp. 2. Thin-section T 55.

Figs. 9, 12-13 *Orbitolinopsis* sp. Thin-section H 25, AQR 1big, H 43n.



**Plate 4:**

Orbitolinids from the Anarak (figs. 1-3, 5-7, 9, 10, 12-13) and Herisht sections (figs. 4, 7, 10, 13), Central Iran

Figs. 1-2: *Paleodictyoconus cuvillieri* (FOURY). Thin-sections AQ 7, AQ 18.

Figs. 3-4, 6: *Paleodictyoconus actinostoma* ARNAUD-VANNEAU & SCHROEDER. Thin-sections AQ 30, T 67, AQ 1.

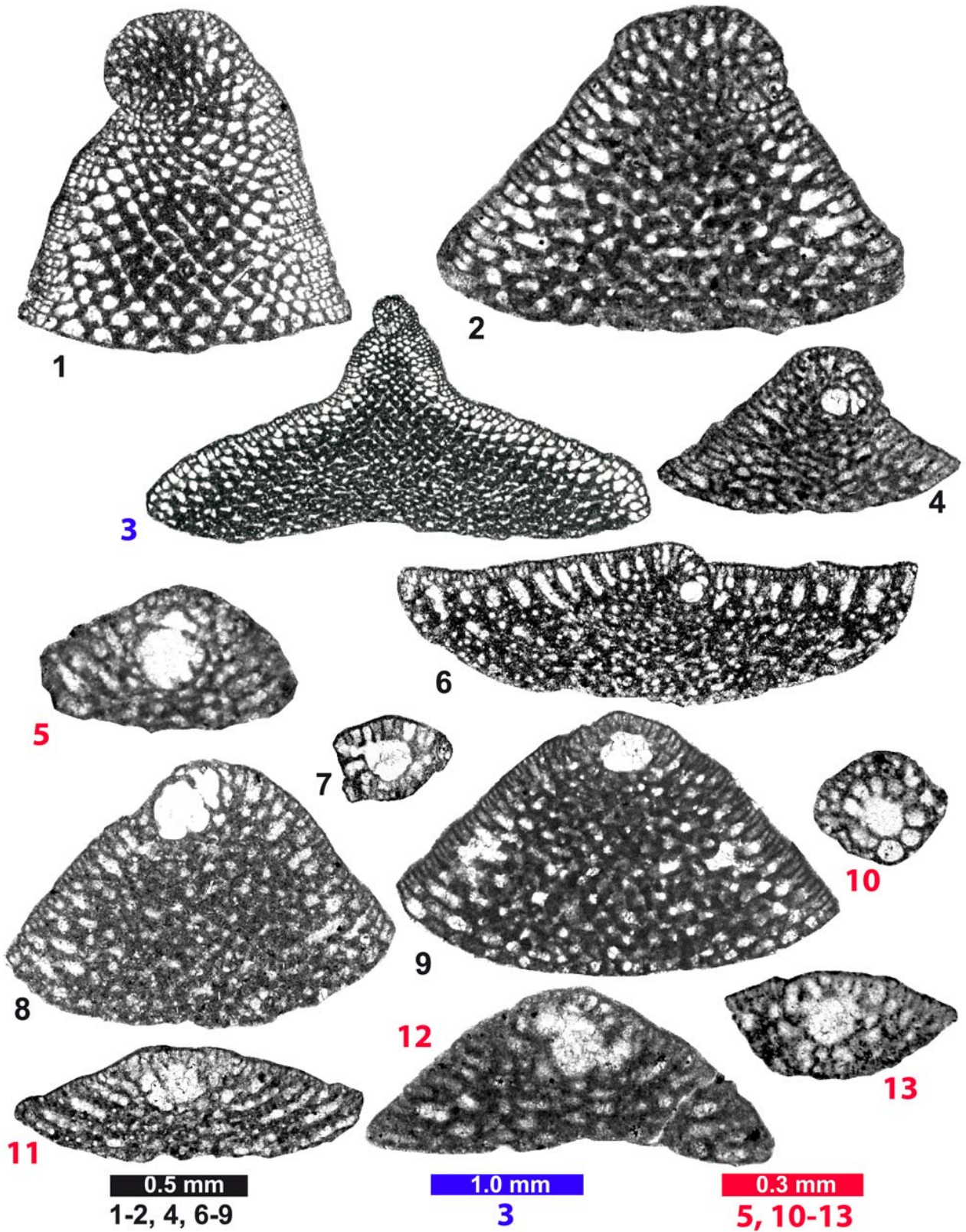
Figs. 5, 8: *Eopalorbitolina charollaisi* SCHROEDER. Thin-sections AQ 42, AQn 18.

Fig. 9: *Eygalierina? turbinata* FOURY. Thin-section AQ 49.

Figs. 7, 10, 13: *Mesorbitolina* gr. *texana* (ROEMER). Thin-sections T 48, T 78, T 65.

Fig. 11: *Palorbitolina* cf. *ultima* CHERCHI & SCHROEDER. Thin-section AQn 42-1.

Fig. 12: *Eopalorbitolina* cf. *transiens* (CHERCHI & SCHROEDER). Thin-section AQ 5.



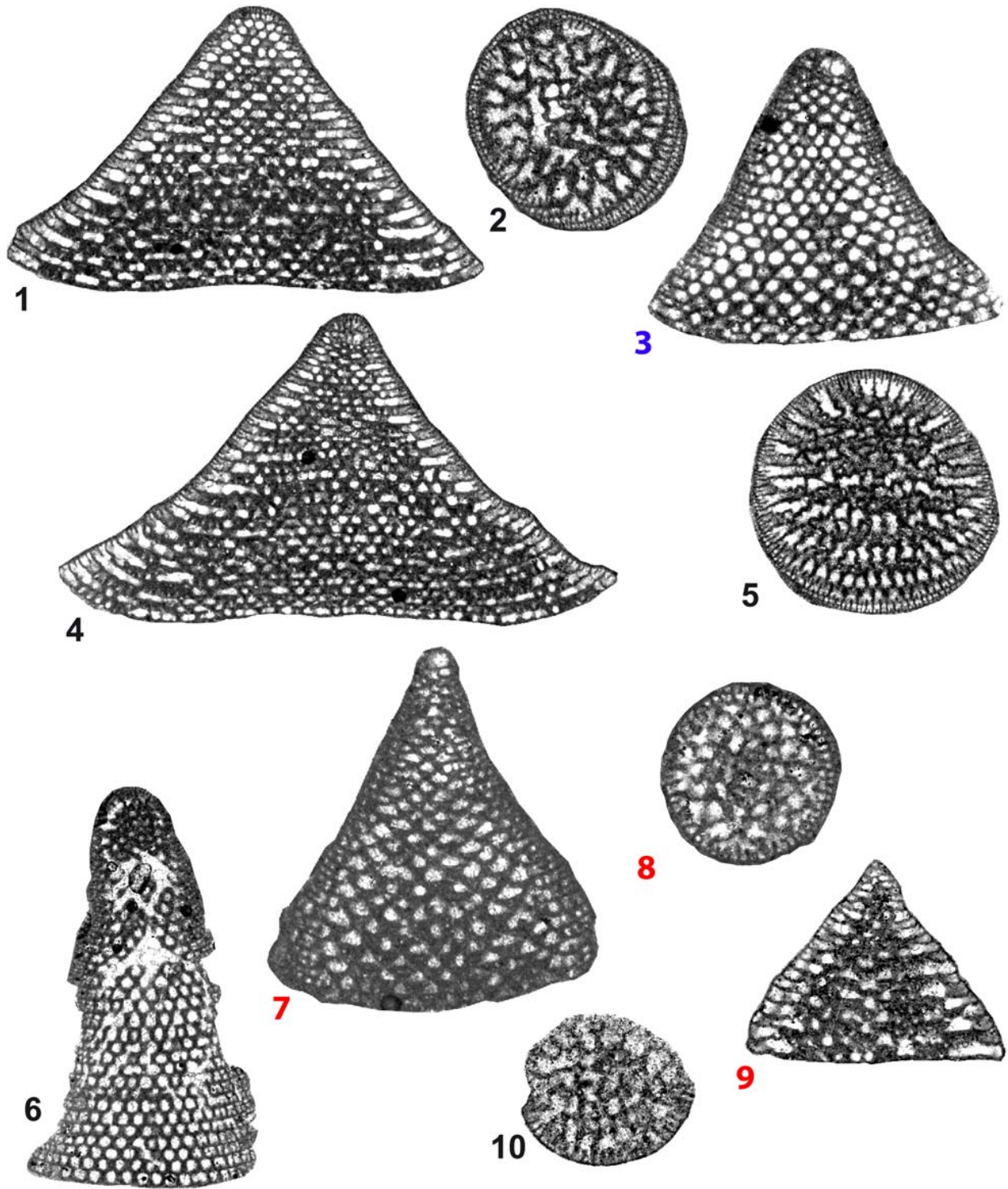
**Plate 5:**

Orbitolinids from the Anarak and Herisht sections (fig. 9), Central Iran

Figs. 1-6: *Valseolina broennimanni* SCHROEDER. Thin-sections AQ 8 (figs. 1, 4), AQ 2 (fig. 2), AQ 5 (figs. 3, 5), PA 24 (fig. 6).

Figs. 7-10: *Orbitolinopsis simplex* (HENSON). Thin-sections AQn 18, AQ 20, T 52, AQ 18.





1.0 mm  
1-2, 4-6, 10

1.0 mm  
3

0.5 mm  
7-9

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