GEOLOGIJA 57/2, 119-146, Ljubljana 2014

doi:10.5474/geologija.2014.011

# Lower Jurassic foraminiferal biostratigraphy of Podpeč Limestone (External Dinarides, Slovenia)

## Spodnjejurske foraminifere podpeškega apnenca (Zunanji Dinaridi, Slovenija)

Luka GALE

Department for Geology, Faculty of Natural Sciences and Engineering University of Ljubljana, Privoz 11, SI–1000 Ljubljana, Slovenia; e-mail: luka.gale@ntf.uni-lj.si
Geological Survey of Slovenia, Dimičeva ul. 14, SI–1000 Ljubljana; e-mail: luka.gale@geo-zs.si

Prejeto / Received 24. 10. 2014; Sprejeto / Accepted 10. 11. 2014

*Key words*: taxonomy, biostratigraphy, foraminifera, Dinaric Carbonate Platform, Sinemurian, Pliensbachian, lithiotid limestone
*Ključne besede*: taksonomija, biostratigrafija, foraminifere, Dinarska karbonatna platforma, sinemurij, pliensbachij, litiotidni apnenec

**Abstract**

The "Podpeč limestone" outcropping south of Ljubljana (Central Slovenia), deposited at the northern edge of the Dinaric Carbonate Platform, comprises mostly dark grey and black thick bedded oolitic limestone, and is renowned for several horizons of lithiotid bivalves. Foraminifera, especially *Orbitopsella* spp., are rather frequent, but no detailed distribution of foraminiferal taxa was given. Furthermore, documentation of foraminiferal species is scarce, with few photographs. In order to give a comprehensive picture of foraminiferal assemblage of the "Podpeč limestone" and its distribution, three sections were measured in detail and sampled. The foraminiferal assemblage consists of 17 species, described in detail. On the basis of foraminifera, the investigated part of the "Podpeč limestone" belongs to the *Lituosepta recoarensis* and *Orbitopsella praecursor* biozones of early Late Sinemurian and Early Pliensbachian age, respectively.

**Izvleček**

Temno sivi in črni plastnati ooidni "podpeški apnenec", ki ga najdemo južno od Ljubljane (osrednja Slovenija), je nastajal na severnem robu Dinarske karbonatne platforme in je znan po več horizontih litiotidnih školjk. Poleg ostale makrofavne, so v njem dokaj pogoste tudi foraminifere, posebno *Orbitopsella* spp. Žal so ta poročila slikovno slabo dokumentirana in ponavadi brez natančne stratigrafske umestitve. Da bi proučili celotno foraminiferno združbo in razpon posameznih taksonov, sem posnel tri detajlne sedimentološke profile. Na podlagi presekov v zbruskih sem določil 17 vrst bentoških foraminifer in ugotovili, da raziskani del združbe "podpeškega apnenca" pripada *Lituosepta recoarensis* in *Orbitopsella praecursor* bioconama zgodnje poznesinemurijske in zgodnjepliensbachijske starosti.

### Introduction

Following the devastating effects of the alleged biocalcification crisis at the Triassic-Jurassic boundary in the Neotethys area (e.g., Hautmann et al., 2008; Črne et al., 2011), the Early Jurassic saw a gradual reestablishment of shallow water benthic communities, in which agglutinated large benthic foraminifera played a prominent role (Septfontaine, 1988; Bassoullet, 1997; Mancinelli et al., 2005; BouDagher-Fadel & Bosence, 2007; Velić, 2007; BouDagher-Fadel, 2008). Transition from poorly diversified Hettangian fauna with small involutinids and pfenderinids into Sinemurian *Siphovalvulina*- and *Textularia*-dominated assemblages, and further from simple into internally complicated lituolids of the Pliensbachian is well recorded (BouDagher-Fadel, 2008), and provides a useful tool in biostratigraphic studies throughout the present-Mediterranean area (e.g., Septfontaine, 1984, 1988; Bassoullet, 1997; Mancinelli et al., 2005; BouDagher-Fadel & Bosence, 2007).

Biostratigraphic division of Jurassic shallow water carbonates of the central Dinaric Carbonate Platform has been given by Radoičić (1966) and recently by Velić (2007). The key to a detailed subdivision of Lower Jurassic strata elsewhere in the Karst Dinarides is thus at hand.

The aim of this paper is to give a systematic account of foraminifera in the lithiotid bivalves-rich "Podpeč limestone", an informal Pliensbachian stratigraphic unit of central Slovenia, and to present their distribution in three

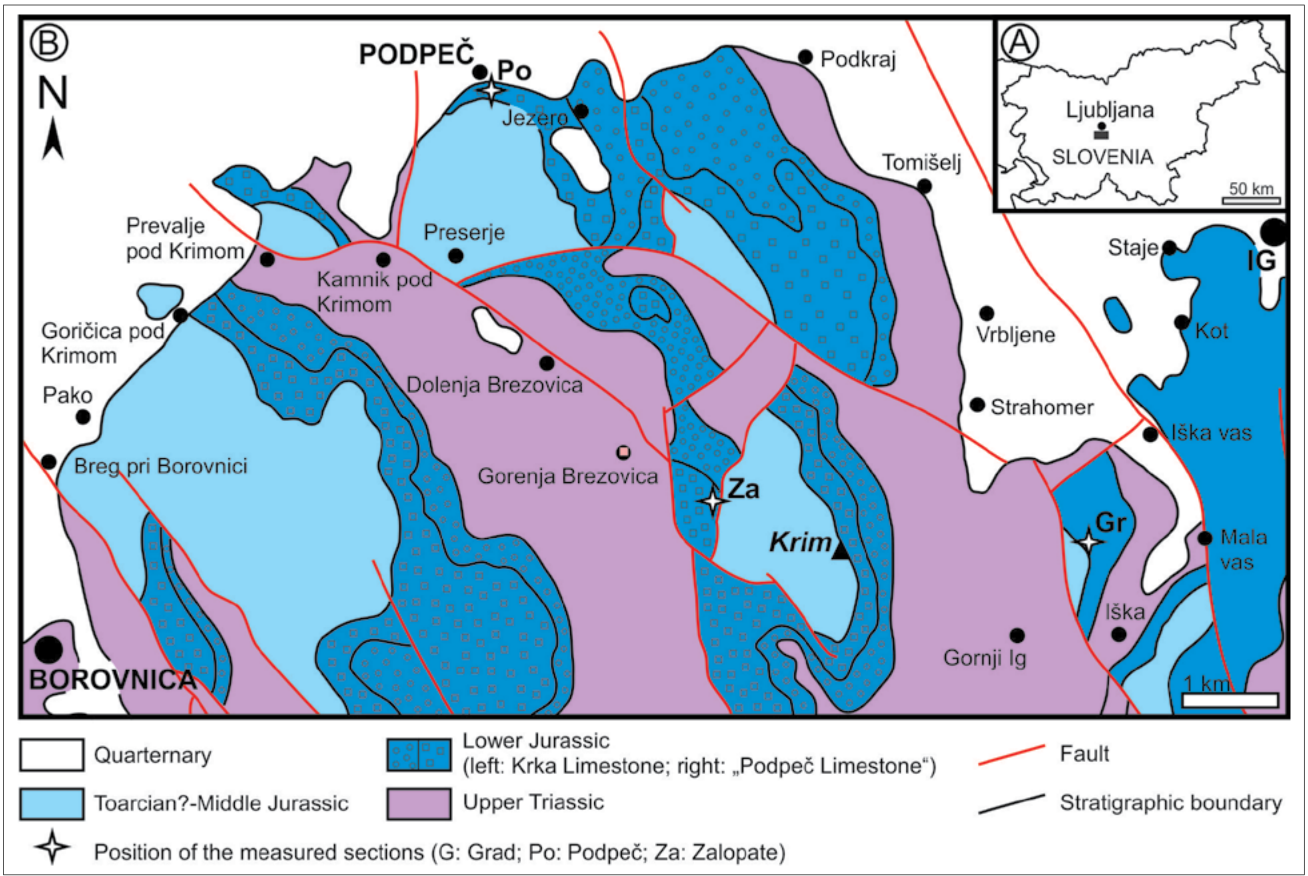



Fig. 1. Geological map of the Mt. Krim area with the position of the measured sections. Redrawn and modified after Buser et al. (1967) and Buser (1968).

Sl. 1. Geološ ka karta območja Krima in položaj posnetih profilov. Prerisano in prirejeno po Buser et al. (1967) in Buser (1968).

detailed sedimentological sections from the Mt. Krim area: the classical locality of the Podpeč quarry, supplemented by data from Zalopate and Grad sections (Fig. 1).

## Previous research

The stratigraphic succession of the Krim Mountain area was more extensively described by Pleničar (1970), Buser (1974), and recently by Miler and Pavšič (2008). As an informal lithostratigraphic unit, the Pliensbachian "Podpeč limestone", characterized by lithiotid bivalves, attracted the most attention due to its architectural value (Ramovš, 1961, 2000) and due to the local abundance of fossil brachiopods and molluscs, most notable lithiotid bivalves (Buser, 1965; Buser & Debeljak, 1996; Debeljak & Buser, 1997; Ramovš, 2000; Miler & Pavšič, 2008). Coral patches can also occur locally (Turnšek, 1997; Turnšek & Košir, 2000; Miler & Pavšič, 2008).

Shallow-water carbonates with lithiotid bivalves can be followed over the area of Slovenia in an over 100 km long belt (Buser & Debeljak, 1996). Locally, Dozet and Strohmenger (2000) introduced a Lower Jurassic Podbukovje Formation, or Predole Beds with five members (Dozet, 2009). The correlation of the "Podpeč limestone" with these units is unclear, due to the lack of definitions and biostratigraphic studies of the lower and upper boundaries of the "Podpeč limestone". Furthermore, no type sections for the Podbukovje/Predole Formations and their members were selected either, and a more detailed description and definitions of lithostratigraphic boundaries are missing as well. The "Podpeč limestone" may thus correspond to one, two or all of the three successive middle members of the Podbukovje/Predole Formations, i.e. *Orbitopsella* limestone, *Lithiotis* limestone and Oolitic limestone sensu Dozet (2009).

Foraminifera were first recognized in the "Podpeč limestone" by Ramovš (1961) and Buser (1965, 1974). Scattered reports on other species of foraminifera from the "Podpeč limestone" or from equivalent units are also given by Šribar (1966), Strohmenger and Dozet (1991), Dozet (1992, 1996), Dozet and Strohmenger (2000), Turnšek et al. (2003), Miler and Pavšič (2008), and Dozet (2009).

According to Dozet (2009), "*Orbitopsella* limestone" contains *Orbitopsella praecursor*, *Lituosepta recoarensis* Cati, *Planisepta compressa*, *Involutina farinacciae*, *Haurania deserta*, *Agerina martana*, *Glomospira* sp., *Aeolisaccus dunningtoni*, *Amijiella amiji* (mentioned in figure, not in the text), *Paleomayncina termieri*, *Pseudocyclammina liassica* (names are spelled as written in Dozet, 2009). In the "*Lithiotis* limestone", the following taxa were determined (Dozet, 2009): *A. amiji*, *P. liassica*, *P. termieri* (mentioned only in figure). In addition, from the middle Early Jurassic *Orbitopsella praecursor* subzone of the Early Jurassic *Palaeodasycladus mediterraneus* cenozone, Dozet (1996) mentiones *O. praecursor*, *Orbitopsella* cf. *dubari*, *Mayncina termieri*, *Haurania amiji*, *H. deserta*, *L. recoarensis*, *Vidalina martana*, *Neoangulodiscus leischneri*, *Involutina turris* and *Permodiscus sinuosus* (all names as in original).

All these reports lack a detailed sedimentological section and the details of foraminiferal distribution.

## Methods of study

In order to investigate foraminifera from the "Podpeč limestone", three sedimentological sections were measured bed-by-bed in the wider Mt. Krim area (Fig. 1). Samples were collected from 55 beds, and 62 thin sections made, in which foraminifera were determined. Foraminiferal systematics follows BouDagher-Fadel (2008). Terminology follows Hottinger (2006) and Basi et al. (2006). The positions of thin sections and the distribution of foraminifera are given in Figures 2–4.

## Geological setting

Geological mapping of the Mt. Krim area was performed by Lipold (1858), Kramer (1905), Vetters (1933), Buser et al. (1967), Buser (1968), and Miler and Pavšič (2008). The area structurally belongs to the External Dinarides (Placer, 1999, 2008). The Lower Jurassic succession consists of shallow-water carbonates, deposited at the northern margin of the Dinaric Carbonate Platform, facing the Slovenian Basin to the present north (Buser, 1989, 1996). At the time, the opening of the Piemont-Liguria Ocean on the far west caused a gradual deepening of the Slovenian Basin (Rožič, 2009), and a partial disintegration of the Dinaric Carbonate Platform margin (Miler & Pavšič, 2008). The latter, however, remained relatively stable until the end of the Cretaceous (Buser, 1989, 1996). The Lower Jurassic succession comprises: Hettangian and Sinemurian (?) coarse-grained dolomite, micritic and subordinately fine-grained oolitic limestone, locally dolomitic breccia (Buser, 1965; Miler & Pavšič, 2008; Ogorelec, 2009), Pliensbachian oolitic limestone and lithiotid limestone ("Podpeč limestone"; Pleničar, 1970; Buser, 1974; Miler & Pavšič, 2008), and Toarcian thin bedded micritic limestone (A. Košir, pers. com., see also Dozet, 2009). The age of these units is determined on the basis of superposition, or fossils determined from individual levels within the stratigraphic units (Miler & Pavšič, 2008).

## Description of measured sections

The Zalopate section (see position on Fig. 1) is located at approximate coordinates 45°56´09´´ latitude and 14°27´21´´ longitude, a few meters above the road. The section starts with micritic limestone, which may be banded (straight dark and white, 5 mm thick lamina). Black fine-grained oolite soon appears and then represents the dominant lithology. Accumulations of bivalves, brachiopods, intraclasts and oncoides are locally present at the base of oolite. Irregular reddish bedding planes are interpreted as short-time emersion levels (see Martinuš et al., 2012). Grading, parallel lamination, occasional scour structures and ripples are present.

The Podpeč 1 section (45°58´22´´ lat., 14°25´16´´ long.; Fig. 3 left) spans the "classical" locality with lithiotid bivalves (see Buser & Debeljak, 1996) at the eastern side of the now abandoned quarry (Fig. 1). The Podpeč 2 section (Fig. 3 right) starts with the outcrop in a private garden some meters further towards the east and overlaps with the Podpeč 1 section. The dominant lithology is medium- to very thick bedded gray oolite. Various amounts of mm- to cm-sized intraclasts and oncoids are locally present, as well as fragmented or complete fossil bivalves, gastropods and terebratulid brachiopods, sometimes forming floatstone or rudstone textures. At least nine lithiotid horizons were counted. Lithiotid shells are embedded in limestone or red claystone matrix and form coquinas, sometimes in lens-like bodies, which laterally thin-out. Though not in life position, shells are probably preserved in situ as testified by the presence of unseparated and unbroken valves. Wackestone and black mudstone are subordinate and bedding thin- to medium-thick. Irregular bedding planes and red clayey surfaces are frequent. They were interpreted as emersion levels (Buser & Debeljak, 1996). Parallel lamination and grading are common. Cross-lamination was found in an outcrop located outside the quarry.

The Grad section (45°55´46´´ lat., 14°30´14´´ long.) is the shortest of the measured sections (Fig. 4). Thick to very thick bedded oolite predominates. Lithiotid bivalves are present in two oolite levels, but are not in life position. Concentrations of broken mollusc shells are common.

## Systematic palaeontology

Order Foraminiferea J. J. Lee, 1990

Suborder Textulariina Delage & Hérouard, 1896
Superfamily Verneulinacea Cushman, 1911
Family Verneulinidae Cushman, 1911
Subfamily Verneulinoidinae Suleymanov, 1973
Genus *Duotaxis* Kristan, 1957
(type species: *Duotaxis metula* Kristan, 1957)

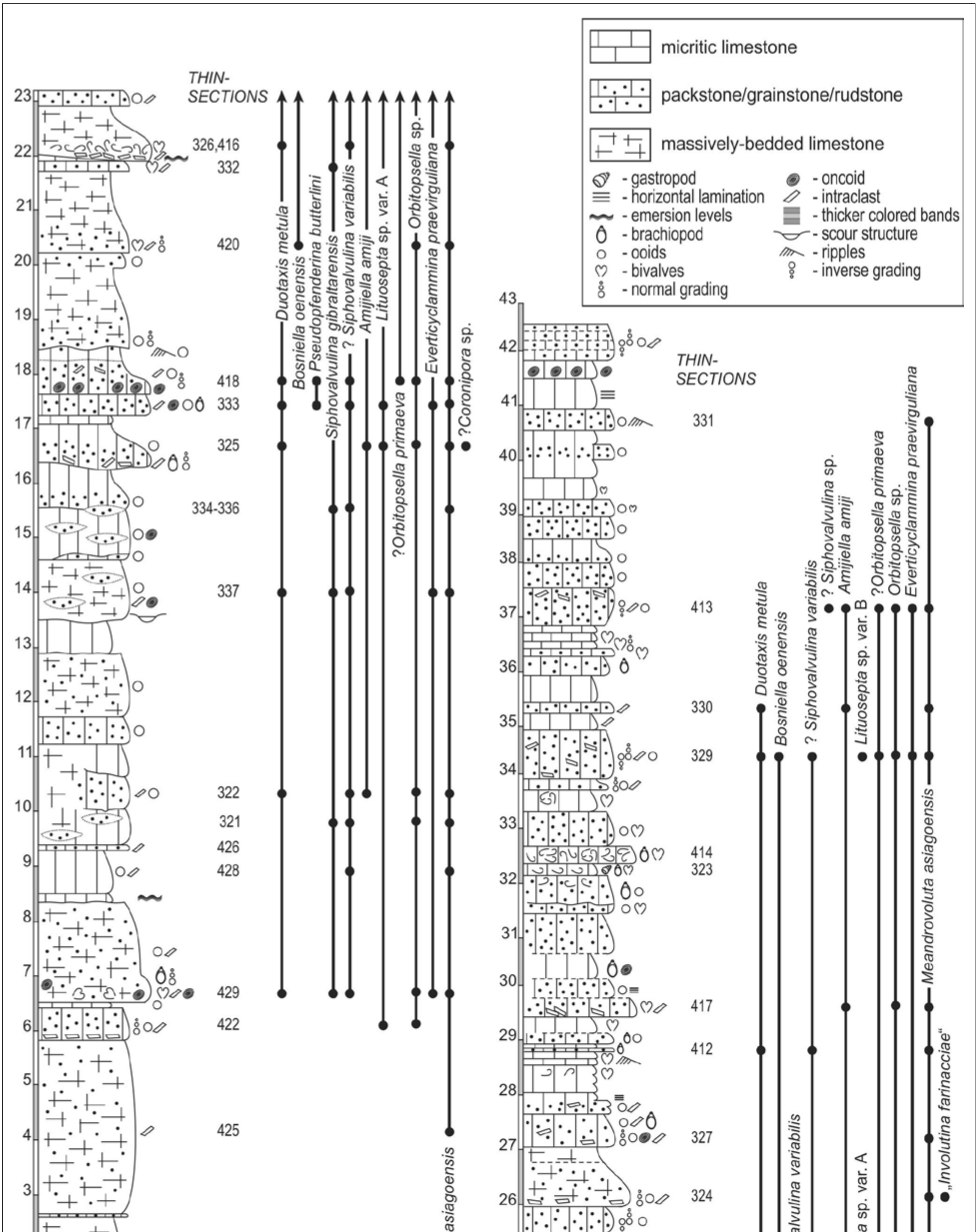



Fig. 2. Zalopate section with distribution of foraminifera.

Sl. 2. Profil Zalopate z razporeditvijo foraminifer.

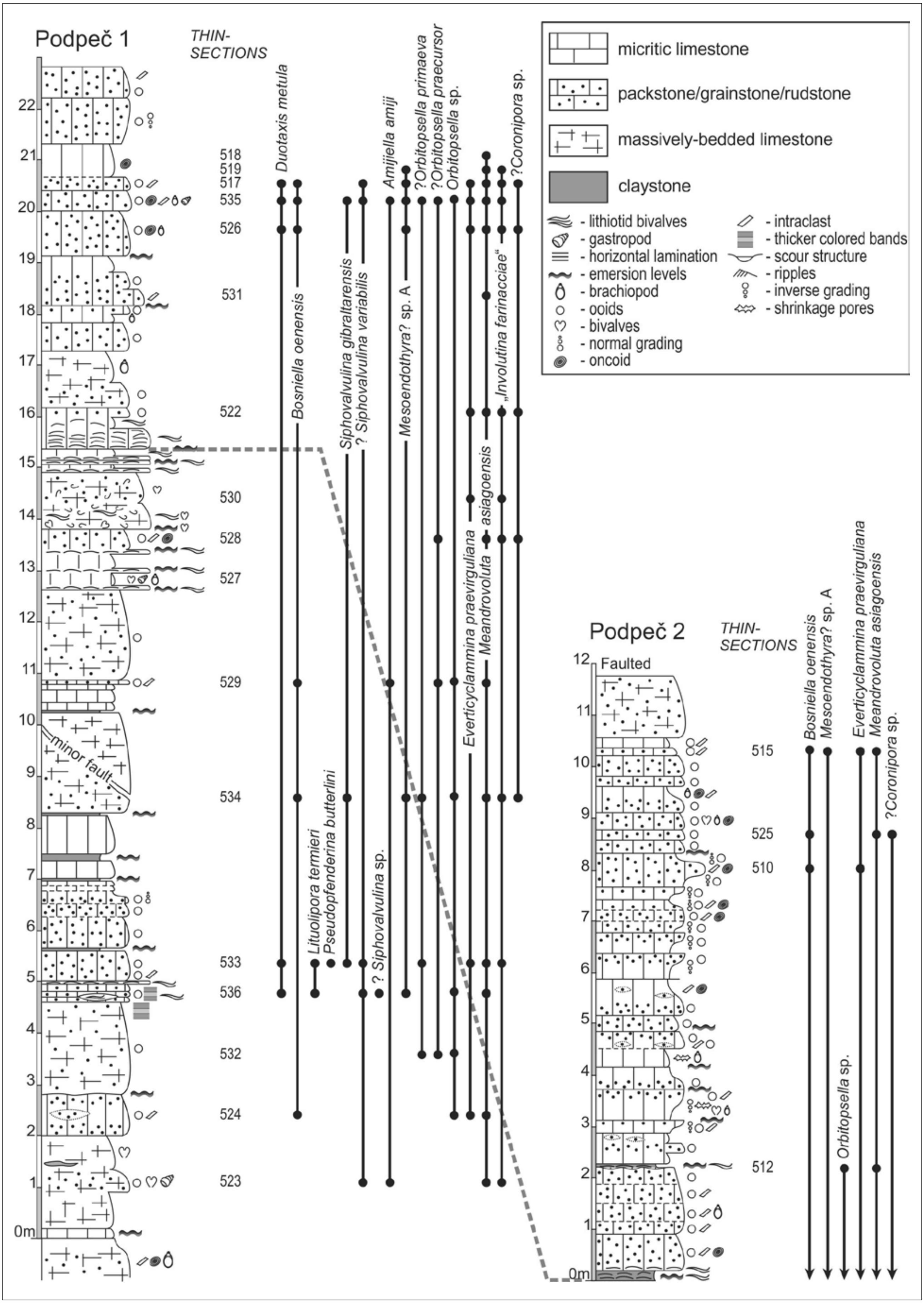



Fig. 3. Podpeč sections with distribution of foraminifera.

Sl. 3. Profila Podpeč z razporeditvijo foraminifer.

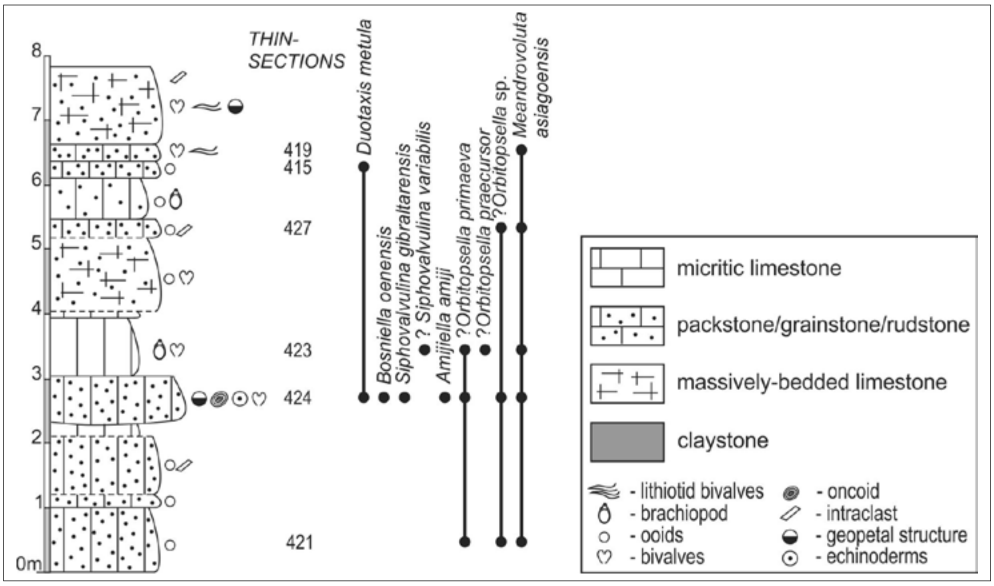



Fig. 4. Grad section with distribution of foraminifera.
Sl. 4. Profil Grad z razporeditvijo foraminifer.

*Duotaxis metula* Kristan, 1957
(Pl. 1, figs. 1-2; Pl. 2, fig. 5)

*1957 *Duotaxis metula* nov. gen. nov. spec. – Kristan, p. 295, Pl. 27, figs. 5a-d, 6.
1996 *Duotaxis metula* Kristan, 1957 – Fugagnoli, p. 388, Pl. 1, figs. 1-5; Fig. 2a-h.
1999 *Duotaxis metula* Kristan, 1957 – Bassoullet et al., p. 226, Pl. 4, fig. 8.
2001 *Duotaxis metula* Kristan, 1957 – BouDagher-Fadel et al., p. 606, Pl. 2, figs. 1-4.

**Material:** Thin sections 322, 325, 326, 328, 329, 330, 333, 337, 412, 415, 418, 424a, 424b, 429a, 517, ?526, 533, 535, 535b, 536.

**Description:** The test is 0.27-0.51 mm high, and 0.29-0.54 mm wide, with the ratio between height and width 0.86-1.00. A simple proloculus is followed by chambers in a trochospiral arrangement. Most specimens have 4 or 5 trochospiral coils, but the largest bears 8 coils. No endoskeletal elements are present. The test wall is simple, agglutinated.

**Geographic distribution and stratigraphic range:** The type specimen of *D. metula* was described from Rhaetian of Northern Calcareous Alps (Kristan, 1957). Early Jurassic examples are cited from Southern Alps (Fugagnoli, 1996, 1998; Fugagnoli & Loriga Broglio, 1998), Sinemurian of Gibraltar (BouDagher-Fadel et al., 2001), Pliensbachian of Middle Atlas, Morocco (Bassoullet et al., 1999). According to Velić (2007), this species lasts until the end of Pliensbachian in the Karst Dinarides of Croatia.

Superfamily Biokovinoidea Gušić, 1977
Family Biokovinidae Gušić, 1977
Genus *Bosniella* Gušić, 1977
(type species: *Bosniella oenensis* Gušić, 1977)

*Bosniella oenensis* Gušić, 1977
(Pl. 1, figs. 3-9)

* 1977 *Bosniella oenensis* n. gen., n. sp. – Gušić, p. 13, Pl. 11, figs. 1-2; Pl. 12, figs. 1-4; Pl. 13.
1998 *Bosniella oenensis* Gusic, 1977 – Fugagnoli, p. 173-175, Pl. 19, figs. 1-9; Pl. 20, figs. 1-2.
1998 *Bosniella oenensis* Gušić, 1977 – Fugagnoli & Loriga Broglio, p. 63, Figs. 10.1-5.
2007 *Bosniella oenensis* Gušić 1977 – BouDagher-Fadel & Bosence, p. 8, Pl. 5, figs. 4, 6; Pl. 7, figs. 3-4; Pl. 8, fig. 6.

***Material:*** Thin sections ?329, 420, 424b, 510, 513, 515, 517, 524, 525, 526, 529, 534, 535, 535b. One specimen is possibly of microspheric generation, 49 specimens of megalospheric generation.

**Description:** Most of the material is identified as tests of megalospheric generation. The majority of specimens has only planispirally coiled part of the test. In a few cases the planispiral part is followed by uniserial part of the test. Protoconch is complex (bilocular cf. Gušić, 1977), 0.11-0.19 mm in diameter. It is followed by 1-2 planispiral coils, amounting to the outer test diameter of 0.56-1.00 mm. Chambers (3-5?) are hardly discernibly in the first coil. The second coil comprises 6-9 reniform chambers, separated by thick, short and obliquely positioned septa. The uniserial part of the test is 0.61-1.11 mm high, consisting of 3-8 chambers. The height of these chambers remains approximately constant (lumen height 0.13-0.14 mm), whereas the chamber width may stay unchanged or slightly increases (lumen width 0.42-0.61 mm). The aperture is initially simple basal, towards the end of the second coil becoming centrally situated, and in the uniserial part multiple/cribrate. Stolons are 0.04-0.07 mm in width, widely separated. The outer test wall and the septa near the outer wall (the gradual loss of perforations in septa was commented also in Gušić & Velić, 1978) are agglutinated, riddled with large and densely packed pseudopores (alveoles in BouDagher-Fadel & Bosence, 2007), i.e., in the literature called a keriothecal wall (e.g. Septfontaine, 1988; Bassoullet, 1994; Tasli, 2001; Schlagintweit & Velić, 2011). The outer wall and the septa are

0.06-0.08 mm thick. In the axial section the coiled part of the test appears biumbilical or with parallel, slightly compressed sides, 0.42 mm wide. The periphery of the test is widely rounded. The degree of chamber overlap is not distinctly visible.

**Remarks:** According to Gušić (1977), the planispiral part of the *Bosniella oenensis* comprises 2-3 (megalospheric) or 3-4 (microspheric test) coils. Megalospheric tests with 1-1.5 coils, however, were described also by Fugagnoli (1998).

The wall was originally described as having bifurcating alveoles (Gušić, 1977). It was later mostly described as keriothecal (Bassoullet, 1994; Fugagnoli, 1998; Tasli, 2001; Schlagintweit & Velić, 2011). The original distinction from *Mesoendothyra* Dain was based on the different wall texture (simple microgranular in *Mesoendothyra* vs. complex in *Bosniella*). However, Septfontaine (1988) considered *Bosniella* a junior synonym of *Mesoendothyra*. Because *M. croatica* differs from the type species of *Mesoendothyra*, Bassoullet (1994) later considered *Bosniella* a valid Jurassic genus, comprising *B. oenensis*, *B. fontainei* and *B. croatica*. Fugagnoli (1998) also considered both genera distinct, but due to the lack of revision of the type material of *Mesoendothyra*. Tasli (2001) acknowledged both possibilities by considering *Bosniella* a junior synonym of *Mesoendothyra* or, alternatively, placing *M. croatica* into the valid genus *Bosniella*. I prefer the latter option, due to the presence of specimens referred to *Mesoendothyra* sp., which probably has a simple microgranular wall.

*Bosniella fontainei* Bassoullet from Middle Jurassic of Thailand has slighly smaller megalospheric tests, larger microspheric tests, less globular chambers and strongly inclined septa (Bassoullet, 1994). It is safe to add that *B. fontanei* has more numerous chambers (9-10 or 10-11) in the last whorl of megalo- and microspheric tests, respectively.

*Bosniella croatica* Gušić is smaller (mostly 0.5-0.6 mm in diameter), is more globular, with shorter, wider and involute chambers (cf. Bassoullet, 1994).

*Bosniella bassoulleti* Schlagintweit & Velić from Late Aalenian to Early Bajocian (?) is of the same size as *B. oenensis*. It has, however, 11-14 chambers in the last whorl (compared to 7-9 in *B. oenensis*), thinner septa (0.04-0.08 mm, compared to 0.12-0.13 mm for *B. oenensis*), and a well developed uniserial part with chambers retaining constant size or becoming only slightly wider, whereas these progressively increase in *B. oenensis* (Schlagintweit & Velić, 2011).

**Geographic distribution and stratigraphic range:** Sinemurian-Pliensbachian of Karst Dinarides, Bosnia (Gušić, 1977); Sinemurian – Early Pliensbachian of Betic Cordillera, Spain, and Sinemurian – Pliensbachian of High Atlas, Morocco (BouDagher-Fadel & Bosence, 2007); Sinemurian-Pliensbachian of Southern Alps, northern Italy (Fugagnoli, 1998; Fugagnoli & Loriga Broglio, 1998). Late Sinemurian – Pliensbachian according to Bassoullet (1997).

Genus *Lituolipora* Gušić & Velić, 1978
(type species: *Lituolipora polymorpha* Gušić & Velić, 1978)

*Lituolipora termieri* (Hottinger, 1967)
(Pl. 1, figs. 10-12)

* 1967 *Mayncina termieri* n. sp. – Hottinger, p. 31, Pl. 3, figs. 4-10; Fig. 14.
1978 *Lituolipora polymorpha* n. gen., n. sp. – Gušić & Velić, p. 74, Pl. 1, figs. 1-4; Pl. 2, figs. 1-5; Pl. 3, figs. 1-3; Pl. 4, figs. 1-6; Pl. 5, figs. 1-5; Pl. 6, figs. 1-6, pars 7; Pl. 7, figs. 1-4; Pl. 8, figs. 1-6; Pl. 9, figs. 1-11; Pl. 10, figs. 3, 4, 6.
1986 "*Mayncina*" *termieri* – Septfontaine, Pl. 2, fig. 1.
1998 *Paleomayncina termieri* (Hottinger), 1967 – Fugagnoli, p. 153, Pl. 7, figs. 1-5.
1998 *Paleomayncina termieri* (Hottinger), 1967 – Fugagnoli & Loriga Broglio, p. 58, Figs. 8.1-8.2.
1999 *Paleomayncina termieri* (Hottinger) – Bassoullet et al., p. 222, Pl. 4, figs. 1-3.
?2003 *Paleomayncina termieri* (Hottinger, 1967) – Azerêdo et al., Pl. 10, fig. 8.
2003 *Lituolipora termieri* (Hottinger, 1967) – Kabal & Tasli, p. 345, Pl. 1, figs. 1-20.
2005 *Lituolipora termieri* (Hottinger) – Cai et al., Pl. 4, figs. 13-21.

**Material:** Thin sections 533, 536. Three specimens; one certainly belonging to microspheric generation.

**Description:** Specimens likely belong to a microspheric generation. The initial, irregularly coiled part consists of few chambers. It is followed by a planispiral part, approximately in two coils. The last whorl has 9-11 chambers, separated by obliquely set septa of thickness approximately equal to the wall. The total diameter of the coiled part is 0.40-0.54 mm. The uncoiled part of the test is short, not well developed, with only 1-2 free chambers. They are 0.04-0.05 mm high (lumen) and 0.2-0.26 mm wide, of boxwork shape. The aperture is at first a single opening, later becoming multiple (see Pl. 1, fig. 10). The outer test wall is coarsely alveolar, 0.04-0.08 mm thick.

**Remarks:** *Lituolipora termieri* was described from the Lower Jurassic of Morocco as *Mayncina termieri* with a simple finely agglutinated wall (Hottinger, 1967). Gušić and Velić (1978) later introduced a new genus and species, *Lituolipora polymorpha*, from the Lower Jurassic of Croatia. The new genus was established on the basis of coarsely perforated wall. Gušić and Velić (1978) were aware of the close similarity with *M. termieri*, but they came to a conclusion that the wall of *M. termieri* is not diagenetically altered. Septfontaine (1988) later decided for the contrary, and introduced a new genus *Paleomayncina* with the type species *M. termieri*. Kabal and Tasli (2003) proposed to retain *Lituolipora* as a valid genus name for the sake of priority over *Paleomayncina*, and recognized *L. polymorpha* to be a junior synonym of *L. termieri*. Their opinion is followed in this paper. Kabal and Tasli (2003) further documented the variability of the species and recognized three morphotypes, two corresponding to different onthogenetic stages of the megalospheric generation and one to microspheric tests (Kabal & Tasli, 2003). Septfontaine (1988) and Kabal and Tasli (2003) describe the wall as coarse keriothecal with polygonal canaliculi, though Gušić and Velić (1978) argued for the inapropriate use of the term keriothecal. The open perforations in Gušić and Velić (1978) specimens were interpreted as result of test abrasion (Septfontaine, 1988).

The specimen in Azerêdo et al. (2003) is considered doubtful, as only uniserial part is shown, though with a cribrate (or multiple?) aperture and flat chambers.

**Geographic distribution and stratigraphic range:** Sinemurian-Pliensbachian of southern Tibet, China (Cai et al., 2005); Late Sinemurian – Pliensbachian of Southern Alps, northern Italy (Fugagnoli, 1998; Fugagnoli & Loriga Broglio, 1998); Late Sinemurian – Pliensbachian of Karst Dinarides, Croatia (Gušić & Velić, 1978; Velić, 2007); Pliensbachian of Atlas, Morocco (Hottinger, 1967; Septfontaine, 1986; Bassoullet et al., 1999); Late Sinemurian – Toarcian of Central Taurides, Turkey (Kabal & Tasli, 2003). Latest Sinemurian – Pliensbachian according to Bassoullet (1997).

Superfamily Pfenderinoidea Smouth & Sugden, 1962
Family Pfenderinidae Smouth & Sugden, 1962
Subfamily Pseudopfenderininae Septfontaine, 1988
Genus *Pseudopfenderina* Hottinger, 1967
(type species: *Pfenderina butterlini* Brun, 1962)

*Pseudopfenderina butterlini* (Brun, 1962)
(Pl. 1, figs. 13-14)

*1962 *Pfenderina butterlini* – Brun, p. 188, Pl. 1, figs. 3-9; Pl. 2, fig. 3.
1967 *Pseudopfenderina butterlini* (Brun) 1962 – Hottinger, p. 87, Pl. 19, figs. 7-22; Fig. 44.
1967 *Pseudopfenderina* nov. spec. – Hottinger, p. 89, Pl. 19, figs. 1-6.
1996 *Pseudopfenderina* aff. *butterlini* (Brun) – Zambetakis-Lekkas et al., Pl. 1, figs. 4-6.
1998 *Pseudopfenderina* cf. *butterlini* – Fugagnoli, p. 156, Pl. 7, figs. 7-9.
2003 *Pseudopfenderina buterllini*? (Brum, 1962) [sic] – Azerêdo et al., Pl. 10, figs. 5-6.
pp. 2007 *Pseudopfenderina* cf. *butterlini* (Brun 1962) – BouDagher-Fadel & Bosence, p. 3, Pl. 7, fig. 2 [non Pl. 10, fig. 6].

**Material:** Thin sections 333, 418, 533, 533b. Specimens are in basal sections (perpendicular to the coiling axis, one in slightly oblique section.

**Description:** The test is free, roughly elliptical in outline. Test wall is dark, agglutinated and undifferentiated, simple. The outline of the test is continuous, without obvious sutures. Septa are of the same thickness as the outer test wall, and appear perpendicular or slighly oblique to the outer test wall. They divide the interior of the test in 5-10 chambers per whorl. A single solid micritic mass of circular outline (columella) occupies the center of the test. Columella is bordered by large, resorbed foramina (cf. Bassi et al., 2006).

Test diameter ranges from 0.11 to 0.54, with larger tests having greater chamber number.

**Remarks:** According to literature descriptions (e.g., Hottinger, 1967) *Pseudopfenderina* has a high trochospiral form, which, however, cannot be visible in the observed material due to the lack of axial sections. The genus is distinguished from similar genera posessing axial columella in its lack of complicated wall structure (subepidermal reticular network in *Kurnubia* Henson; primitive hypodermal network in *Praekurnubia* Redmond) or in the absence of subcameral tunnel, which is present in *Pfenderina* Henson and *Paleopfenderina* Septfontaine (Hottinger, 1967; Septfontaine, 1988; Loeblich & Tappan, 1987). The columella of *Pseudopfenderina* consists of pillars and secondary (?) carbonate deposits, forming a solid structure (Hottinger, 1967). As pillars are sometimes not visible, some authors prefer determination as *Pseudopfenderina* cf. *butterlini* (e.g., Fugagnoli, 1998; BouDagher-Fadel & Bosence, 2007). Part of the material in BouDagher-Fadel and Bosence (2007) is attributed to *Duotaxis metula* Kristan in basal section, as no columella is visible and the umbilicus appears unfilled.

Hottinger (1967) distinguished two-times smaller specimens with fewer chambers per whorl (5-7 compared to 7-9 of *P. butterlini*) as an unnamed new species. His opinion was later followed by Fugagnoli (1998), who counted 5-6 chambers per coil in material from the Southern Alps. However, Hottinger's (1967) figures show 8-9 chambers per coil, and the size difference is here argued to derive from the different position of sections according to test's height (even though the test has fairly parallel sides in the later stage of growth). Larger equatorial sections have more chambers than smaller ones.

**Geographic distribution and stratigraphic range:** Sinemurian – Pliensbachian of High Atlas, Morocco; Sibillini Mountains, central Italy; Dorsales Range, Tunisia; Iberian Basin, Spain (BouDagher-Fadel & Bosence, 2007); Late Sinemurian of Southern Alps, northern Italy (Fugagnoli, 1998); Late Sinemurian of Algarve Basin, South Portugal (Azerêdo et al., 2003); Sinemurian – Early Pliensbachian of

Tripolitza platform, Greece (Zambetakis-Lekkas et al., 1996). Latest Sinemurian to Early Pliensbachian according to Bassoullet (1997).

Genus *Siphovalvulina* Septfontaine, 1988
(type species: *Siphovalvulina variabilis* Septfontaine, 1988)

*Siphovalvulina gibraltarensis* BouDagher-Fadel, Rose, Bosence & Lord, 2001
(Pl. 1, figs. 15-16)

p.p. 1998 *Siphovalvulina variabilis* Septfontaine, 1988 – Fugagnoli, p. 157, Pl. 8, fig. 8.
p.p. 1998 *Siphovalvulina variabilis* Septfontaine – Fugagnoli & Loriga Broglio, p. 60, Fig. 9.2.
2001 *Siphovalvulina gibraltarensis* sp. nov. – BouDagher-Fadel et al., p. 605, Pl. 1, figs. 6-11.
2007 *Siphovalvulina gibraltarensis* BouDagher-Fadel, Rose, Bosence & Lord 2001 – BouDagher-Fadel & Bosence, p. 9, Pl. 2, figs. 1-2; Pl. 4, fig. 2; Pl. 6, figs. 3-5; Pl. 9, fig. 6; Pl. 11, figs. 1, 5.

**Material:** Thin sections 321, 328, 332, 335, 337, 424b, 429b, 533, 534, 535.

**Description:** Test is trochospirally coiled, with an apical angle 90-130°. The spire comprises up to 5 coils. The test is 0.18-0.44 mm high, 0.16-0.46 mm wide. The test wall is simple, microagglutinated. The umbilical opening is wide, continuing into a wide, twisted umbilical canal. Apertural faces of chambers are well rounded.

**Remarks:** The high apical angle is a distinctive mark of this species (see BouDagher-Fadel et al., 2001).

**Geographic distribution and stratigraphic range:** Sinemurian of Gibraltar; Sinemurian – Early Pliensbachian of Betic Cordillera, Spain; Sinemurian of Iberian Range, Spain; Sinemurian – Pliensbachian of High Atlas, Morocco; Sinemurian of Dorsales Range, Tunisia; Sinemurian – Pliensbachian of Sibillini Mountains, central Italy; Sinemurian – Pliensachian of Evvia, Greece (BouDagher-Fadel & Bosence, 2007); Early Jurassic of Southern Alps, northern Italy (Fugagnoli, 1998); Sinemurian – Toarcian of Karst Dinarides, Croatia (Velić, 2007).

? *Siphovalvulina variabilis* Septfontaine, 1988
(Pl. 1, figs. 17-18; Pl. 2, figs. 1-2)

nom. nudum 1980 “*Siphovalvulina*” – Septfontaine, Pl. 2, fig. 10.
L 1988 *Siphovalvulina* n. gen. – Septfontaine, p. 244.
p.p. 1998 *Siphovalvulina variabilis* Septfontaine, 1988 – Fugagnoli, p. 157, Pl. 8, figs. 1-2, 4-5.
p.p. 1998 *Siphovalvulina variabilis* Septfontaine – Fugagnoli & Loriga Broglio, p. 60, Fig. 9.1.
2001 *Siphovalvulina colomi* sp. nov. – BouDagher-Fadel et al., p. 605, Pl. 1, figs. 1-4.
2003 *Siphovalvulina variabilis* Septfontaine, 1988 – Azerêdo et al., Pl. 10, fig. 7.
2003 *Siphovalvulina* sp. – Kabal & Tasli, Pl. 4, figs. 9-10.
p.p. 2007 *Siphovalvulina colomi* BouDagher-Fadel, Rose, Bosence & Lord 2001 – BouDagher-Fadel & Bosence, p. 8, Pl. 9, fig. 4; Pl. 10, fig. 1; Pl. 11, figs. 4-5.

**Material:** Thin sections 321, 322, 326, 329b, 333, 412, 418, 423, 428, 429a, ?335, 337, 513, 517, 523, 533, 535b, 536.

**Description:** The test is trochospiral, with an apical angle 45-75° and up to 6 coils. Three chambers are visible in basal section of the last coil. The total test height is 0.25-0.77 mm, the width 0.20-0.51 mm. The twisted umbilical canal is clearly visible, indented on the inner side of the chambers. The chamber lumen is rounded to reniform. The wall is simple, microagglutinated.

**Remarks:** The specimens ascribed here to *S. variabilis* differ from *S. gibraltarensis* in having a narrower apical angle. The holotype of *S. variabilis* was figured by Septfontaine (1980) and described in Septfontaine (1988) as having a very variable morphology. At the time, *Siphovalvulina* was considered a monospecific genus, ranging from Hettangian to the Cretaceous. BouDagher-Fadel et al. (2001) later described *Siphovalvulina colomi* from Lower Jurassic strata. The later author considered *S. colomi* and *S. gibraltarensis* the only Early Jurassic species of this genus. *Siphovalvulina colomi* in their opinion differs from *S. variabilis* in having a more compact test, less visible sutures and smoothly convex septa, which are not highly arched and oblique to the main axis. Some of the specimens figured by the same author (e.g. BouDagher-Fadel & Bosence, 2007, Pl. 9, fig. 4; Pl. 11, fig. 4), including the holotype of *S. colomi* (BouDagher-Fadel et al., 2001, Pl. 1, fig. 1) in my opinion fail to meet this criteria. I thus consider *S. colomi* a probable junior synonym of *S. variabilis*.

**Geographic distribution and stratigraphic range:** Early Jurassic specimens derive from: Sinemurian of Gibraltar; Sinemurian – Early Pliensbachian of betic Cordillera, Spain; Sinemurian of Dorsales Range, Tunisia; Sinemurian – Pliensbachian of Sibillini Mountains, central Italy; Sinemurian – Pliensbachian of Evvia, Greece (BouDagher-Fadel et al., 2001); Early Jurassic of Southern Alps, northern Italy (Fugagnoli, 1998); Late Sinemurian of Algarve, Portugal (Azerêdo et al., 2003); Pliensbachian – Toarcian? of Central Taurides, Turkey (Kabal & Tasli, 2003).

Septfontaine (1988) considered *S. variabilis* as Hettangian to Early (also Late?) Cretaceous in age. According to Velić (2007), this species in the Karst Dinarides first appears at the end of the Hettangian.

? *Siphovalvulina* sp. A
(Pl. 2, fig. 4)

p.p. 2007 *Siphovalvulina colomi* BouDagher-Fadel, Rose, Bosence & Lord 2001 – BouDagher-Fadel & Bosence, p. 8, Pl. 6, fig. 6; Pl. 9, fig. 5.

**Material:** Thin sections 413, 536.

**Description:** A high trochospiral test with remiform to rounded trapezoidal chambers in 6 coils measures 0.68 mm in height and 0.36 mm in width. The apical angle is 45°. The siphonal canal is relatively narrow.

**Remarks:** These specimens differ from *S. variabilis* in more flattened chambers. More specimens, however, would be needed to confirm the difference. The specimens resemble part of the material figured by BouDagher-Fadel and Bosence (2007) as *Siphovalvulina colomi.*

**Geographic distribution and stratigraphic range:** Similar specimens have been figured from Sinemurian – Pliensbachian of Sibillini Mountains, Italy and from Sinemurian of Dorsales Range, Tunisia by BouDagher-Fadel and Bosence (2007).

Superfamily Lituoloidea de Blainville, 1827
Family Hauraniidae Septfontaine, 1988
Subfamily Amijiellinae Septfontaine, 1988
Genus *Amijiella* Loeblich & Tappan, 1985
(type species: *Haurania amiji* Henson, 1948)

*Amijiella amiji* (Henson, 1948)
(Pl. 2, figs. 6-10)

1948 *Haurania amiji* – Henson, p. 12, Pl. 15, figs. 5-10.
1966 Lituolidés – Radoičić, Pl. 23, fig. 1 pars.
1967 *Haurania amiji* Henson 1948 – Hottinger, p. 52, Pl. 8, figs. 1-6, 20-21; Fig. 25.
1977 *Haurania amiji* Henson – Velić, Pl. 2, figs. 6-8.
1981 *Haurania amiji* Henson 1948 – Baloge, p. 130, Fig. 2, Pl. 1, figs. 1-7; Pl. 2, figs. 1-3, 5-7, 11-12.
1994 *Amijiella amiji* (Henson) – Chiocchini et al., Pl. 2, fig. 14; Pl. 27, figs. 2-4.
1997 *Amijiella amiji* (Henson) – Banner et al., Pl. 1, fig. 8;
1998 *Amijiella amiji* (Henson, 1948) – Fugagnoli, p. 161, Pl. 12, figs. 1-9.
1998 *Amijiella amiji* (Henson), 1948 – Fugagnoli & Loriga Broglio, p. 53, Figs. 7.5, 6.
1999 *Amijiella* sp. – Bassoullet et al., p. 217, Pl. 4, fig. 4.
2000 *Amijiella amiji* (Henson) 1948 – Perelis Grossowicz et al., Pl. 1, fig. 2.
2003 *Amijiella amiji* (Henson) – Kabal & Tasli, Pl. 4, figs. 1-6.
2005 *Amijiella amiji* (Henson) – Cai et al., Pl. 4, figs. 1-7
2007 *Amijiella amiji* (Henson 1948) – BouDagher-Fadel & Bosence, p. 7, Pl. 1, fig. 5; Pl. 3, fig. 5, Pl. 7, fig. 1; Pl. 8, fig. 1.
2008 *Amijiella amiji* (Henson) – Al-Saad, Pl. 2, fig. 1.

**Material:** Thin sections 322, ?325, ?330, 413, 417, 424b, 513, 523, 529, 535. Two specimens of megalospheric generation and ten microspheric tests, all in longitudinal sections. Two transverse sections.

**Description:** The test is elongated, with pronounced dimorphism, expressed in the development of the planispiral part, followed by chambers in uniserial rectilinear or curvilinear arrangement. The aperture is not clearly visible; it could be multiple or circular. In some specimens, a single central opening is observed. The uniserial part of the test is circular in cross-section. Thick radial beams of the exoskeleton are pronounced, reaching far towards the centre of chamber. The wall is of variable thickness (0.04-0.06 mm).

*Type 1:* The test is uniserial throughout, or perhaps with a very small coiled initial part, which is not discernible. The number of chambers in uniserial part ranges from 4 to 8. They are fairly constant in height (lumen around 0.04-0.06 mm) and width, resulting in a test with roughly parallel sides, 0.65-1.00 mm long and 0.32-0.39 mm wide.

*Type 2*: The initial part of the test is planispiral, 0.19-0.34 mm in diameter. The number of coils is not clearly visible (2?). The coiled part is followed by 4 uniserial chambers in total length of 0.48 mm. Individual chambers are 0.05-0.06 mm high (lumen), maintaining approximately constant width.

**Remarks:** A reconstruction of *A. amiji* is given by Baloge (1981). Radial partially developed beams (incipient septula?) are clearly visible in sections perpendicular to the axis of growth. Rafters are also depictured. BouDagher-Fadel and Bosence (2007) interpreted aperture as multiple, later reduced to a single central opening. Loeblich and Tappan (1987) and Septfontaine (1988) write about cribrate aperture. Smaller (1.2 mm) specimens with planispiral initial part were originally interpreted as microspheric tests, and the specimens lacking planispiral part as megalospheric. Hottinger (1967), however, could not confirm this. Fugagnoli (1998) on the basis of the literature survey allowed for a possibility that both generations could possess a planispiral part.

**Geographic distribution and stratigraphic range:** Middle Liassic of Dinarides, Montenegro (Radoičić, 1966); Middle Liassic of Central Apennines, central Italy (Chiocchini et al., 1994); latest Hettangian to end of Pliensbachian of Dinarides, Croatia (Velić, 1977); Sinemurian – Early Pliensbachian of Betic Cordillera, Spain; Sinemurian – Pliensbachian of High Atlas, Morocco (BouDagher-Fadel & Bosence, 2007); Late Sinemurian - Pliensbachian of Southern Alps, northern Italy (Fugagnoli, 1998; Fugagnoli & Loriga Broglio, 1998); Late Sinemurian of Poitou, France (Baloge, 1981); Pliensbachian of Middle Atlas, Morocco (Bassoulet et al., 1999); Middle Liassic and Toarcian of southern Tibet, China (Cai et al., 2005); Late Sinemurian to Late Pliensbachian-Toarcian(?) of Central Taurides, Turkey (Kabal & Tasli, 2003); Toarcian of Middle East (Banner et al., 1997); Late Sinemurian to Bathonian of Israel (Perelis Grossowicz et al., 2000); Early Bajocian of Quatar (Al-Saad, 2008). According to Bassoullet (1997) and Banner et al. (1997) the species ranges from Late Sinemurian to end of Bathonian.

Family Mesoendothyridae Voloshinova, 1958
Subfamily Mesoendothyrinae Voloshinova, 1958
?Genus *Mesoendothyra* Dain, in Bykova et al., 1958
(type species: *Mesoendothyra izumijana* Dain, in Bykova et al., 1958)

*Mesoendothyra*? sp. A
(Pl. 2, figs. 11-13)

1998 *Mesoendothyra* sp. – Fugagnoli, p. 155, Pl. 23, figs. 4-5.
2000 “*Mesoendothyra*” sp. – Perelis Grossowicz et al., Pl. 1, fig. 7.
2007 *Mesoendothyra* sp. – Velić, Pl. 2, figs. 1-4.

**Material:** Thin sections 515, 517, 519, 526, 534, 535b, 536.

**Description:** The test is mostly circular in equatorial section; planispiral coils are rarely followed by the uniserial part of the test. The outer test wall is microagglutinated. A keriothecal structure is suggested, but not clearly visible. The wall is 0.02-0.03 mm thick. Septa are approximately of the same thickness, situated slightly oblique. The aperture is simple basal, in the uncoiled part multiple.

*Microspheric (?) test*: The proloculus is not distinguishable. The planispiral part consists of (2?) 2.5-3 coils. Counting from the aperture backwards, the last coil comprises 7-10 chambers. The uniserial part is present in only one of the specimens, consisting of 4 chambers. Chambers are approximately as high as they are wide. The planispiral part of the test measures 0.22-0.43 mm in diameter. The total test length of the test with the uniserial part is 0.69 mm. The higher number of planispiral coils suggests these tests belong to the microsphaeric generation.

*Megalospheric test*: The proloculus is circular, 0.03-0.04 mm in diameter. It is followed by 1.5-2.5 planispiral coils, with 9 chambers in total (6 are counted in the last whorl). The entire spiral part is 0.26-0.39 mm in diameter.

**Remarks:** The shape of the test and the test size correspond to *Mesoendothyra* sp. described by Fugagnoli (1998), Perelis Grossowicz et al. (2000), and Velić (2007). The wall was determined by Fugagnoli (1998) as simple, without exoskeletal structure. If this is the case, then it is appropriate to place this species into genus *Mesoendothyra* (although the stratigraphic gap between this and later species of this genus is not considered). However, the simple structure may be the product of diagenetic alteration of keriothecal wall, and the species should be assigned into genus *Bosniella*. The specimens presented here do not offer reliable evidence for this. The uniserial part in some specimens figured by Velić (2007) bears much flatter chambers.

**Geographic distribution and stratigraphic range:** Early Jurassic of Southern Alps, northern Italy (Fugagnoli, 1998); Sinemurian – Pliensbachian of Karst Dinarides of Croatia (Velić, 2007); Toarcian-Early Bajocian (undiffirentiated) of Israel (Perelis Grossowicz et al., 2000).

Subfamily Orbitopsellinae Höttinger & Caus, 1982
Genus *Lituosepta* Cati, 1959
(type species: *Lituosepta recoarensis* Cati, 1959)

*Lituosepta* sp. var. A
(Pl. 2, figs. 14-16)

Cf. 1959 *Lituosepta recoarensis* n. gen. n. sp. – Cati, p. 104, Pl. 1, figs. 1-14, Fig. 1.
Cf. 1962 *Lituosepta recoarensis* Cati – Sartoni & Crescenti, p. 274, Pl. 13, fig. 2; Pl. 47, fig. 7.
pars 1977 *Labyrinthina recoarensis* (Cati) – Velić, Pl. 2, figs. 3, 5 [non Pl. 2, figs. 1, 2, 4].
pars 1994 *Lituosepta recoarensis* Cati – Chiocchini et al., Pl. 2, fig. 7 [? Pl. 2, fig. 15].
1998 *Lituosepta recoarensis* – Fugagnoli, p. 150-152, Pl. 5, figs. 1-8.
2000 *Planisepta compressa* (Hottinger) 1967 – Perelis Grossowicz et al., Pl. 1, fig. 4.
2003 *Lituosepta recoarensis* Cati, 1959 – Azêredo et al., Pl. 10, figs. 1, 2, 9.
pars 2003 *Lituosepta recoarensis* Cati – Kabal & Tasli, Pl. 2, figs. 1-3, 5-7 (non Pl. 2, fig. 4).
2007 *Lituosepta recoarensis* Cati 1959 – BouDagher-Fadel & Bosence, p. 7, Pl. 1, fig. 3; Pl. 2, fig. 3.
2007 *Lituosepta compressa* (Höttinger 1967) [sic]– BouDagher-Fadel & Bosence, p. 7, Pl. 1, fig. 6; Pl. 3, figs. 2, 4.
2007 *Lituosepta recoarensis* Cati – Velić, Pl. 2, figs. 5-8.

**Material:** Thin sections 325, 328, 333, 422. Megalospheric tests.

**Description:** The total length of the test is 0.46-1.00 mm. A simple megalospheric proloculus measures 0.08-0.09 mm in diameter (the exception is specimen from thin section 333 with diameter of 0.07 mm). A planispiral part in 1.5 coils follows. Six to nine chambers are visible in the last coil, whereas the chambers are poorly visible in the initial part of the spire. The total diameter of the coiled part is 0.28-0.42 mm. In most of the specimens a uniserial part consisting of up to 12 chambers follows. Chambers are flat, 0.04-0.05 mm high (lumen) and separated by septa 0.03-0.05 mm thick (never thicker than the chamber lumen). Scattered endoskeletal pillars are visible crossing the chamber lumen. The wall appears undifferentiated, microagglutinated. The aperture is multiple in the uncoiled part, not visible in the planispiral one.

**Remarks:** The specimens figured herein correspond best to *Lituosepta recoarensis*, originally described by Cati (1959) from the Lower Jurassic of Southern Alps. Hottinger (1967) later refigured some of Cati's (1959) specimens, adding some new specimens from High Atlas of Morocco, as well as a wealth of specimens, which he attributed to a new species, *Lituosepta compressa*. According to Hottinger (1967), the new species differs from *L. recoarensis* in having smaller test, a more pronounced flattening, a better developed pillars in the endoskeleton, a tighter coiling and a smaller proloculus in megalospheric forms (0.06-0.08 mm compared to 0.08-0.10 for *L. recoarensis*). In his opinion, transverse sections of *L. recoarensis* in Cati (1959) possibly belong to *Haurania*. Both species of *Lituosepta* should thus be laterally compressed. In contrary to Hottinger, Septfontaine (1984) believed Cati was right about *L. recoarensis* having circular cross section, and he subsequently established a new genus, *Planisepta*, to comprise flattened ex *L. compressa* (Septfontaine, 1988). Furthermore, Septfontaine (1984) regarded specimens designated by Hottinger (1967) as *L. recoarensis* as belonging to *P. compressa*. Fugagnoli (1998) and Fugagnoli and Loriga Broglio (1998) later accepted Hottinger's (1967) interpretation, disregarding validity of genus *Planisepta*. Loeblich and Tappan (1987) considered *Lituosepta* as a junior synonym of *Labyrinthina* Weynschenk. According to Septfontaine (1988), the initial coiled stage is more pronounced in the latter (3 coils compared to 1.5 coild in *Lituosepta*), whereas BouDagher-Fadel (2008) mentiones also a fan-shaped flabelliform test and a canalicular wall in *Lituosepta*.

In my opinion, the distinction between the two species is not well established. The size difference proves to be irrelevant (see specimens in Fugagnoli, 1998, and BouDagher-Fadel & Bosence, 2007). In fact, the only useful quantitative parameter seems to be the size of the proloculus, but the latter overlap at 0.08 mm. Based on the material figured by Cati (1959) and Hottinger (1967), the difference may be in the tightness of coiling, i.e. the planispiral part of the megalospheric form opens after 1.5 coils in *L. recoarensis* and after 2 in *L. compressa*, and in the number of endoskeletal pillars, which are better developed (more numerous) in the latter species. It is also true, that Cati's microsphaeric specimen does not show a pronouncely fan-shaped uncoiled part. Thus, I agree with Septfontaine's opinion and regard Hottinger's specimens as belonging to *L. compressa* only. However, as the type material of *L. recoarensis* needs to be re-examined, I refrain from species designation. Regarding the genus name, I agree with Fugagnoli (1998) and Fugagnoli and Loriga Broglio (1998) that the degree of flattening is not a generic criterion. The name *Planisepta* is thus regarded as a junior synonym of *Lituosepta*, especially since there is no equivocal proof of the *L. recoarensis* cross section.

One of the specimens, figured by Chiocchini et al. (1994), does not show endoskeletal pillars. Its determination is thus considered doubtful.

*Lituosepta* differs from *Orbitopsella* Munier-Chalmas in having a simple megalospheric proloculus, and from *Haurania* Henson in a simple exoskeleton and in a laterally flattened test (Hottinger, 1967; Loeblich & Tappan, 1987).

**Geographic distribution and stratigraphic range:** Bassoullet (1997) regards *L. recoarensis* and *L. compressa* as stratigraphically very useful species, as the former is of Sinemurian and the latter of Pliensbachian age. However, due to taxonomic uncertainties regarding the distinction of both species, a careful re-examination of material is needed. The specimens from the synonymy list were collected in: middle Early Jurassic of Apennines, central Italy (Cati, 1959; Sartoni & Crescenti, 1962; Chiocchini et al., 1994); Late Sinemurian of Central Taurides, Turkey (Kabal & Tasli, 2003); Late Sinemurian of Algarve Basin, Portugal (Azerêdo et al., 2003); Late Sinemurian – Early Pliensbachian of Karst Dinarides (Velić, 2007); Pliensbachian of Israel (Perelis Grossowicz et al., 2000); Sinemurian – Early Pliensbachian of Betic Cordillera, Spain; Sinemurian – Pliensbachian of High Atlas, Morocco; Sinemurian – Pliensbachian of Evvia, Greece (BouDagher-Fadel & Bosence, 2007); and Pliensbachian of Southern Alps, northern Italy (Fugagnoli, 1998).

*Lituosepta* sp. var. B
(Pl. 2, fig. 18)

Cf. 1967 *Lituosepta compressa* n. sp. – Hottinger, p. 36-38, Pl. 4, figs. 1-13; Figs. 17-18.

**Material:** Thin sections 329, 329b. Microspheric test.

**Description:** A relatively small coiled (planispiral?) part of the test, 0.43 mm in diameter, is not clearly visible, so the number of coils (possibly 2) is poorly defined. In the outer part, however, more than 12 chambers can be counted, prior to the following uniserial part. In the latter, chambers, while retaining a constant height of 0.05 mm, become increasingly wider, producing a flaring test of total length of 2.07 mm. The uniserial part consists of 26 chambers. Septa and the outer test wall are 0.03 mm thick. Chamber lumen is crossed by numerous pillars. The wall is presumably simple in structure, microagglutinated. The aperture is multiple in the last part of the coiled and in the uniserial part at least.

**Remarks:** Tests of distinct fan shaped planispiral part are here described separately from the rest of the *Lituosepta* material, as they better correspond to Hottinger's (1967) specimens, which he regarded as belonging to *L. recoarensis*, but which, according to Septfontaine (1984), belong to *L. compressa* instead. Radoičić (1966; Pl. 144, fig. 2; Pl. 145, fig. 1) shows microspheric tests of supposedly *L. recoarensis* from middle Lower Jurassic of Karst Dinarides (Žumberak, Croatia), which have fewer chambers than specimens figured herein.

Genus *Orbitopsella* Munier-Chalmas, 1902
(type species: *Orbitolites praecursor* Gümbel, 1872)

?*Orbitopsella primaeva* Henson, 1948
(Pl. 2, fig. 18; Pl. 3, figs. 1-5)

*1948 *Coskinolinopsis primaevus* Henson – Henson, p. 27, Pl. 10, figs. 4-5.
1967 *Orbitopsella primaeva* (Henson) – Hottinger, p. 46, Pl. 4, figs. 17-18; Figs. 23k-s.
1998 *Orbitopsella primaeva* (Henson, 1948) – Fugagnoli, p. 147, Pl. 1, figs. 1-9; Pl. 2, figs. 1-10.
1998 *Orbitopsella primaeva* (Henson), 1948 – Fugagnoli & Loriga Broglio, p. 50, Figs. 6.1-5.
2000 *Orbitopsella primaeva* (Henson) – Perelis Grossowicz et al., Pl. 1, figs. 8, 9, 10.
2003 *Orbitopsella primaeva* (Henson) – Kabal & Tasli, Pl. 3, figs. 1-3.
2007 *Orbitopsella primaeva* (Henson 1948) – BouDagher-Fadel & Bosence, p. 6, Pl. 1, figs. 1, 2 , 4; Pl. 2, fig. 4.
?2007 *Haurania deserta* Henson, 1948 – BouDagher-Fadel & Bosence, Pl. 8, figs. 2-5.
2007 *Orbitopsella primaeva* (Henson) – Velić, Pl. 2, figs. 9-11; Pl. 3, figs. 1-4.

**Material:** Thin sections ?329b, 413, 418, 421, 424a, 424b, 513, 532, 533, 534, 535b.

**Description:** Dimorphism is strongly pronounced.

*Megalospheric test*: In equatorial view the test appears fan shaped, semicircular, whereas in axial view the test is strongly elongated with parallel sides. Protoconch is complex, though the wall separating the proloculus from the deuteroloculus is usually not preserved. The size of the protoconch (lumen) is 0.18-0.31 mm. A short planispiral part follows with up to 12 chambers, and in the last stage of growth numerous uniserially arranged strongly arched chambers. These maintain constant height while gradually becoming wider. The total diameter of the test amounts to 2.14-2.35 mm.

The outer wall and the septa are 0.03 mm thick. A notable difference among specimens is in the size of agglutinated grains: while some specimens have uniformly thick wall, in others incorporated grain size exceeds the basic wall thickness by as much as 6.4-times. The exoskeleton is simple, with poorly visible beams. The endoskeleton consists of widely spaced and few pillars. Four to five stolon planes are visible.

*Microspheric test*: The test is in »axial« section flat, with parallel sides, or with a gradually higher periphery, becoming biconcave. The total test diameter is 2.50-6.22 mm. The protoconch and the initial spiral part were not observed. The exoskeletal and endoskeletal features are as described above.

**Remarks:** Despite the large number of specimens attributed to *Orbitopsella* only a few were determined to the species level. The criteria used in distinguishing *O. primaeva* from *O. praecursor* (Gümbel) and *O. dubari* Hottinger are: protoconch size and the test size (both smaller in *O. primaeva*) in megalospheric tests, and fewer stolon planes and much microspheric smaller test for *O. primaeva* (see Hottinger, 1967). The number of spiral chambers could not be observed due to insuitable orientation of specimens. Compared to specimens in Hottinger (1967), the megalospheric specimens from the Krim area belong to A1 generation. The difference in coarseness of the wall is considered a phenotypic character (Fugagnoli, 1998).

**Geographic distribution and stratigraphic range:** Sinemurian – Early Pliensbachian of Betic Cordillera, Spain (BouDagher-Fadel & Bosence, 2007); Late Sinemurian – Early Pliensbachian of Southern Alps, northern Italy (Fugagnoli, 1998; Fugagnoli & Loriga Broglio, 1998); Late Sinemurian – Early Pliensbachian of Karst Dinarides, Croatia (Velić, 2007); Pliensbachian of High Atlas, Morocco (Hottinger, 1967); Early Pliensbachian of Israel (Perelis Grossowicz et al., 2000); Early Pliensbachian of Central Taurides, Turkey (Kabal & Tasli, 2003). Latest Sinemurian and Early Pliensbachian according to Bassoullet (1997).

?*Orbitopsella praecursor* (Gümbel, 1872)
(Pl. 3, figs. 6-8)

1962 *Orbitopsella praecursor* (Gümbel) – Sartoni & Crescenti, p. 274, Pl. 47, fig. 1.
1966 *Orbitopsella praecursor* (Gümbel) – Radoičić, Pl. 20, figs. 1-2; Pl. 72, figs. 1-2.
1967 *Orbitopsella praecursor* (Gumbel) 1872 – Hottinger, p. 40, Pl. 5, figs. 1-12; Fig. 20.
1977 *Orbitopsella praecursor* (Guembel) – Velić, Pl. 1, figs. 1-5
1987 *Orbitopsella praecursor* (Gümbel) - Ulcigrai et al., Figs. 5-7.
1994 *Orbitopsella praecursor* Gümbel – Chiocchini et al., Pl. 2, figs. 12-13; Pl. 27, fig. 10.
1998 *Orbitopsella praecursor* (Gümbel), 1872 – Fugagnoli & Loriga Broglio, p. 52, Figs. 6.6-9.
1998 *Orbitopsella praecursor* (Gümbel, 1872) – Fugagnoli, p. 148, Pl. 3, figs. 1-9.
1999 *Orbitopsella praecursor* (Gümbel), 1872 – Bassoullet et al., p. 224, Pl. 1, figs. 1-8.
2003 *Orbitopsella praecursor* (Gümbel) – Kabal & Tasli, Pl. 3, figs. 4-11.
2005 *Orbitopsella praecursor* (Gümbel) – Cai et al., Pl. 3, figs. 17-25.

2007 *Orbitopsella praecursor* (Gümbel 1872) – BouDagher-Fadel & Bosence, p. 7, Pl. 3, fig. 3.
2007 *Orbitopsella praecursor* (Gümbel) – Velić, Pl. 3, figs. 5-6; Pl. 4, figs. 1-4.

**Material:** Thin sections 427, 528, 529, 532, 535b.

**Description:** Few specimens are in appropriate section to allow for the recognition of this species. The endoskeletal pillars are few and widely spaced. The wall structure is not visible. The wall thickness is around 0.04 mm. The protoconch of megalospheric forms measures 0.44 mm in diameter and the total test diameter is 1.46-1.75 mm. The initial part of the test is often wider than the rest of the test. The microspheric form measures 10.71 mm in diameter. The initial spiral part consists of 14 chambers.

**Remarks:** According to Hottinger (1967), Fugagnoli (1998) and Bassoullet et al. (1999), *O. circumvolata* probably represents a junior synoynm of *O. praecursor*. Hottinger (1967) retained it as a special morphotype.

**Geographic distribution and stratigraphic age:** Middle Early Jurassic of Apennines, central Italy (Sartoni & Crescenti, 1962; Chiocchini et al., 1994); middle Early Jurassic of southern Tibet, China (Cai et al., 2005); Sinemurian – Early Pliensbachian of Betic Cordillera, Spain; Sinemurian – Pliensbachian of High Atlas, Morocco (BouDagher-Fadel & Bosence, 2007); Late Sinemurian – Pliensbachian of Southern Alps, northern Italy (Ulcigrai et al., 1987; Fugagnoli, 1998; Fugagnoli & Loriga Broglio, 1998); Pliensbachian of Middle Atlas, Morocco (Bassoullet et al., 1999); Early Pliensbachian of Central Taurides, Turkey (Kabal & Tasli, 2003); Early to Middle Pliensbachian of Karst Dinarides, Croatia (Velić, 2007). Middle part of Pliensbachian according to Bassoullet (1997).

Suborder Loftusiina Kaminski & Mikhalevich, in Kaminski, 2004
Superfamily Loftusiacea Brady, 1884
Family Everticyclamminidae Septfontaine, 1988
Genus *Everticyclammina* Redmond, 1964
(type species: *Everticyclammina hensoni* Redmond, 1964)

*Everticyclammina praevirguliana* Fugagnoli, 2000
(Pl. 3, figs. 9-15)

* 2000 *Everticyclammina praevirguliana* n. sp. – Fugagnoli, p. 127, Pl. 1, figs. 1-9; Pl. 2, figs. 1-10; Pl. 3, figs. 1-8.
2001 *Everticyclammina praevirguliana* Fugagnoli, 2000 – BouDagher-Fadel et al., p. 611, Pl. 2, fig. 12.
2007 *Evertyciclammina praevirguliana* Fugagnoli 2000 – BouDagher-Fadel & Bosence, p. 3, Pl. 3, fig. 6; Pl. 4, figs. 1, 5; Pl. 5, fig. 3; Pl. 9, figs. 2-3.
? 2011 *Everticyclammina praevirguliana* Fugagnoli, 2000 – Schlagintweit & Velić, p. 96, Figs. 15a-d.

**Material:** Thin sections 328, 329, 329B, 333, 337, 413, 429B, 510, 513, 515, 517, 522, 524, 526, 530, 533, 535, 535b. Specimens of megalo- and microspheric generation. One specimen in axial section, 10 specimens in equatorial section.

**Description:** Fairly large specimens have thick, finely agglutinated alveolar wall with widely spaced alveolae. Both generations (micro- and megalospheric) usually comprise well developed planispirally coiled initial part, followed by few uniserially arranged chambers. Chambers of the coiled part appear remiform, whereas chambers are triangular in shape in the uncoiled part of the test, tapering towards distal end. Aperture is a simple, large, centrally situated opening. Septa are of the same thickness (0.03 to 0.10 mm) as the outer test wall. The thickness of both, however, varies largely even in the same specimen.

*Microspheric test:* The coiled part of the test comprises 2-2.5 coils; the first is very small, with an indistinguishable number of chambers. The second coil consists of 3-4 chambers. The diameter of the coiled part is 0.16-0.41 mm. The rectilinear or curvilinear uniserial part, 0.5-0.67 mm long, consists of 2-5 chambers. The width of these in some sections appears equal to diameter of the initial coiled part. The maximum height of chambers (lumen, measured to the top of aperture, i.e. with septa thickness included) in the uncoiled part is 0.11-0.23 mm. A proloculus is too small to be measured.

*Megalospheric test*: The initial part measures 0.26-0.48 mm in diameter and has 2 coils with 3 (?) and 5-7 chambers, respectively. The uncoiled part, 0.35-0.75 mm long, consists of 3-4 chambers, which are up to 0.11-0.28 mm high and 0.17-0.42 mm wide. A simple spheric proloculus measures 0.03-0.11 mm in diameter. In axial section, the initial coiled part appears biconcave, with chambers of the last whorl by 1/2 wider than the first whorl. The periphery is rounded, yet with box-like outline.

**Remarks:** According to BouDagher-Fadel et al. (2001) and BouDagher-Fadel and Bosence (2007), *E. praevirguliana* represents the only species of *Everticyclammina* from the Early Jurassic. Based on the original diagnosis of the species (Fugagnoli, 2000), it seems difficult to distinguish *E. praevirguliana* from other species of this genus. Fugagnoli (2000) mentiones a smaller test size and a more uniform chamber growth in *E. praevirguliana* in comparisson to *Everticyclammina virguliana* (Koechlin), the next species in phylogeny. The biumbilical axial section and the triangular, tapering chambers (compared to rounded chambers of *E. virguliana*) of the uniserial part of the test might provide a better distinguishing character, but the range of chamber shape from triangular to semi-circular is present also in the original material of Fugagnoli (2000). The two species may thus be synonyms, but a further discussion is needed. Schlagintweit and Velić (2011) described specimens of the genus *Everticyclammina* from Aalenian of the Dinarides in Croatia as *E. praevirguliana*, extending the stratigraphic range of this species into younger strata. Due to the similarity between the two species, their species might also be determined as *E. virguliana*. Alternatively, the two species may have coexisted for some time.

**Geographic distribution and stratigraphic range:** Latest Hettangian to end of Toarcian of Karst Dinarides, Croatia (Velić, 2007); Sinemurian of Gibraltar (BouDagher-Fadel et al., 2001; BouDagher-Fadel & Bosence, 2007); Late Sinemurian-Pliensbachian of Southern Alps, northern Italy (Fugagnoli, 2000); Sinemurian – Early Pliensbachian of Betic Cordillera, Spain; Sinemurian of High Atlas, Morocco; Sinemurian – Pliensbachian of Dorsales Range, Tunisia; Sinemurian – Pliensbachian of Sibillini Mountains, central Italy; Sinemurian – Pliensbachian of Evvia, Grece (BouDagher-Fadel & Bosence, 2007).

Suborder Miliolina Delage & Hérouard, 1896
Superfamily Cornuspiracea Schultze, 1854
Family Cornuspiridae Schultze, 1854
Subfamily Meandrospirinae Saidova, 1981
Genus *Meandrovoluta* Fugagnoli & Rettori, 2003
(type species: *Meandrovoluta asiagoensis* Fugagnoli & Rettori, 2003)

*Meandrovoluta asiagoensis* Fugagnoli & Rettori, 2003
(Pl. 3, figs. 16-18)

1966 *Glomospira* sp. – Radoičić, Pl. 92, fig. 2; Pl. 111, fig. 2; Pl. 124, fig. 2 pars; Pl. 125, figs. 1-2 pars.
1994 *Glomospira* sp. – Chiocchini et al., Pl. 2, figs. 19, 21; Pl. 27, fig. 7.
p.p. 1998 *Glomospira* sp. Rzehak, 1885 – Fugagnoli & Loriga Broglio, p. 66-68, Fig. 9.12 [non Figs. 9.10-9.11].
1999 *Meandrospiranella* sp. ? – Bassoullet et al., p. 228, Pl. 4, figs. 12-13.
1999 *Hoyenella* sp. ? – Bassoullet et al., p. 228, Pl. 4, figs. 14-17.
*2003 *Meandrovoluta asiagoensis* Fugagnoli & Rettori gen. et sp. nov. – Fugagnoli et al., p. 45, Pl. 1, figs. 1-12; Pl. 2, figs. 1-16.
?2005 *Glomispira tingriensis* sp. nov. – Cai et al., p. 45, Pl. 1, figs. 27-32.

**Material:** Thin sections 321, 322, 324, 325, 326, 327, 328, 329, 329B, 330, 331, 333, 335, 337, 412, 413, 415, 417, 418, 419, 420, 421, 423, 424a, 424b, 425, 427, 428, 429a, 429b, 429c, 512, 515, 517, 518, 519, 522, 523, 524, 525, 526, 528, 529, 531, 533, 534, 535, 535b, 536.

**Description:** Specimens are morphologically very variable. A globular proloculus is followed by an undivided second chamber, which coils mostly in irregular fashion, or at some stage remaining close to one plane, producing roughly globular or disc-like test. The test wall dark and dense, sometimes brownish in appearance. The size of the measured specimens (a few of the total number) is 0.17-0.36 mm. The lumen hight in the outermost preserved deuteroloculus is 0.03-0.05 mm. Up to 11 coils were counted on either side of the proloculus. The microspheric and megalospheric generations are currently not distinguished due to the lack of centered sections.

**Remarks:** *Meandrovoluta* is among the most common benthic foraminifera in Early Jurassic carbonates, often described as *Glomospira* sp. The distinction from the latter, however, is in its wall structure, which is porcelaneous in *Meandrovoluta* and finely agglutinated in *Glomospira* Rzehak (Fugagnoli et al., 2003). Its morphological variability, its presence in a variety of facies and assemblages, and a locally high abundance in low-diversity assemblages (personal observation in resediments of Perbla Formation, depositiory of B. Rožič, University of Ljubljana) suggest it is an opportunistic species (see Dodd & Stanton, 1990, p. 288). A somewhat similar Triassic genus *Hoyenella* Rettori has an initial mioliod coiling and a regularly developed last planispiral stage (Rettori, 1994, 1995).

Finally, Cai et al. (2005) described three new species from the Middle? Jurassic of Tibet: *Glomospira wolongensis*, *Glomospira tingriensis* and *Glomospirella minuscula*. The latter has a pronounced planispiral stage, and *G. wolongensis* appears smaller and with fewer coils, but *G. tingriensis* may prove to be a junior synonym of *M. asiagoensis*.

**Geographic distribution and stratigraphic range:** The specimens cited in the synonymy list belong to Sinemurian – Toarcian of Southern Alps, northern Italy (Fugagnoli, 1998; Fugagnoli et al., 2003); Sinemurian – Toarcian of Karst Dinarides, Croatia (Velić, 2007), and Bosnia (Radoičić, 1966); middle Early Jurassic of Apennines, central Italy (Chiocchini et al., 1994), Pliensbachian of Middle Atlas, Morocco (Bassoullet et al., 1999).

Suborder Involutinina Hohenegger & Piller, 1977
Superfamily Involutinoidea Bütschi, 1880
Family Involutinidae Bütschli, 1880
Subfamily Involutininae Bütschli, 1880
Genus *Involutina* Terquem, 1862
(type species: *Nummulites liassicus* Jones, in Brodie, 1853)

"*Involutina farinacciae* Brönnimann & Koehn-Zaninetti, 1969"
(Pl. 4, figs. 1-3)

*1969 *Involutina farinacciae*, n. sp. – Brönnimann & Koehn-Zaninetti, p. 76, Figs. 1c, 2a-g.
pars 2011 *Involutina farinacciae* Bronnimann & Koehn-Zaninetti – Radoičić & Jovanović, Pl. 1, figs. 3-5; Pl. 2, figs. 1-4; Pl. 3, figs. 1-6; Pl. 4, figs. 1-6, 8-9.

**Material:** Thin sections 324, 517, 519, 522, 523, 526, 528, 530, 533, 534, 535, 535b.

**Description:** Tests are small, recrystallized into spar (originally aragonitic), mostly overgrown by ooid or micritic coatings. All specimens identified with confidence are in axial section. A planispiral coil is visible. Only lumen of a few last coils is visible; the total number of coils is probably around 5. The umbilical part is strongly thickened on both sides, being biconvex and bearing numerous papillae. The last 1-2 coils are evolute. The test diameter is 0.15-0.27 mm.

**Remarks:** Based on the original description, "*Involutina farinacciae*" differs from other species of this genus by its small size and the shape of the chamber lumen. However, Rigaud et al. (in press) say there is no reliable criterion to separate "*I. farinacciae*" from *Involutina liassica* (Jones), due to the large variability of the species.

**Geographic distribution and stratigraphic range:** The type material derives from early Early Jurassic of Monte Lacerone, Italy (Brönnimann & Koehn-Zaninetti, 1969). Radoičić and Jovanović (2011) add numerous localities in Inner Dinarides, Karst Dinarides, Budva Basin and from Avroman Range area in Iraq, advocating "*I. farinacciae*" as a marker of middle Early Jurassic. The Podpeč quarry is among the listed localities.

Family Trocholinidae Kristan-Tollmann, 1963, emend. Rigaud et al., 2013
? Subfamily Lamelliconinae Zaninetti et al., 1987, emend. Rigaud et al., 2013
? Genus *Coronipora* Kristan, 1958
(type species: *Coronella austriaca* Kristan, 1957)

? *Coronipora* sp.
(Pl. 4, figs. 4?-5?, 6-17)

?Cf. 1957 *Semiinvoluta clari* nov. gen. nov. spec. – Kristan, p. 276, Pl. 22, figs. 11a-c, 12-15, 16a-c, 17.
Cf. 1957 *Coronella austriaca* nov. gen. nov. spec. – Kristan, p. 281, Pl. 23, figs. 10a-c, 11-13.
Cf. 1966 *Lasiodiscus* (?) *etruscus* n. sp. – Pirini, p. 91, Pl. 1, figs. 1-3
Cf. 1966 *Lasiodiscus* (?) sp. – Pirini, p. 92, Pl. 1, figs. 4-9.
?Cf. 1986 *Semiinvoluta clari* Kristan – Kristan-Tollmann, Fig. 1.6.
Cf. 1986 *Coronipora austriaca* (Kristan) – Kristan-Tollmann, Fig. 1.7-1.8.
Cf. 1975 *Semiinvoluta* sp. 1 (cf. *S. clari* Kristan) – Gušić, p. 30-31, Pl. 10, figs. 1-10; Pl. 11, figs. 8?-9?, 11?-12?.
Cf. 1975 *Semiinvoluta* sp. 3 – Gušić, p. 31, Pl. 11, figs. 4-7, ?10.
Cf. 1975 *Semiinvoluta* sp. 4 – Gušić, p. 31, Pl. 10, fig. 12.
Cf. 1975 Genus cf. *Coronipora* Kristan – Gušić, p. 33, Pl. 12, figs. 1-7, ?8; Pl. 13, figs. 1?-8?.
Cf. 1978 *Semiinvoluta* ? sp. – Piller, p. 88, Pl. 21, figs. 6-8.
Cf. 1987a *Coronipora etrusca* (Pirini, 1966) – Blau, p. 503, Pl. 4, figs. 2-6.
Cf. 1987a *Coronipora deminuta* n. sp. – Blau, p. 504, Pl. 4, figs. 7-9.
Cf. 1987b *Coronipora etrusca* (Pirini, 1966) – Blau, p. 9, Pl. 5, figs. 1-9.
Cf. 1987b *Coronipora gusici* n. sp. – Blau, p. 9, Pl. 3, figs. 10-13.
Cf. 1987b *Coronipora* sp. 1 cf. *austriaca* (Kristan, 1957) – Blau, p. 10, Pl. 4, figs. 8-11; Fig. 1e.
Cf. 1987b *Semiinvoluta violae* n. sp. – Blau, p. 10, Pl. 2, figs. 1-8.
Cf. 1991 *Coronipora* sp. 1 cf. *austriaca* (Kristan 1957) – Blau & Haas, p. 18, Figs. 7a-e.
2013 *Coronipora* Kristan – Rigaud et al., Figs. 6.2-6.4.

**Material:** Thin sections 325, 517, 522, 525, 526, 528, 534.

**Description:** The test is in low trochospiral, consisting of circular proloculus (0.03 mm in diameter) and undivided second chamber coiling in 4-6 coils (in one specimen 7 coils or more are visible). Calcareous material is added (?) from the outer coil towards umbilicus, leaving a shallow umbilical depression. In tangential or transverse sections, the lower side thus appears flat and completely filled, whereas a depression is seen in the axial plane. The upper side of the test is more or less convex, without secondary thickening. The chamber lumen is open towards the spiral (upper) side through wide perforations (canals?). The total test diameter is 0.24-0.40 mm (mostly around 0.31 mm), and the test height 0.08-0.17 mm (mostly 0.12 mm).

The wall is recrystallized into spar, originally aragonitic.

**Remarks:** The determination of this species is problematic at the genus and species level.

Kristan (1957) introduced two new genera: *Semiinvoluta* and *Coronella*. *Semiinvoluta* was described as planispiral, evolute and with sutural canals on one side and coated with secondary material on the other side. Its type species, *S. clari* Kristan, has diameter of 0.62 mm and 5-9 coils. Some of the figures draw by hand, show a very low trochospiral coil. The description of *Coronella* is practically the same as of *Semiinvoluta*, except that the test is evolute on the coated side also. The type species, *C. austriaca*, measures 0.93 mm in diameter has 5 coils. Later, Kristan (1958) substituted *Coronella* with *Coronipora* Kristan.

Gušić (1975) later changed the orientation of *Semiinvoluta* and reminded of the lack of appropriate comparative material for this "aberrant" group of involutinids. He emphasised that the type material was shown by hand-drawings only. His specimens were thus left in open nomenclature and species distinguished on the basis of different contour of the test, and the thickness of calcite deposits.

Piller (1978) defined *Coronipora* as having one evolute side and the other coved by lamellae; the coiling is plani- to trochospiral. He hinted at the synonymy with *Planispirillina* Bermudez, but due to the lack of observation of the lamination in the latter, left both species valid. The distinction between *Coronipora* and *Semiinvoluta* was likevise questioned.

Rigaud et al. (2013) greatly revised the Trocholinidae family. The genus *Coronipora* was redefined as having ridge-like lamellae and large perforations or short canals on the spiral side, and interfingering lamellae on the umbilical side, while *Semiinvoluta* possesses papillae on the umbilical side, shortened lamellae on the apical side and a depressed apical thickening. According to Rigaud et al. (2013), "*Coronipora*" *serraforma* Senowbari-Daryan et al. is a junior synonym of *S. clari*.

According to the emendation of *Coronipora* and *Semiinvoluta* (Rigaud et al., 2013), the specimens figured herein should belong to *Coronipora*, as no apical lamellae are visible. This distinction, however, is not obvious in the type material figured by Kristan (1957), and I consider this interpretation doubtful.

The species determination is likewise tentative. Considering a wide variety in size, *Coronipora austriaca* (Kristan), *Semiinvoluta clari* Kristan and *Coronipora etrusca* (Pirini) are likely candidates. The distinction from similar species is mostly lacking in the first description of these species, and the thorough revision seems necessary.

**Geographic distribution and stratigraphic range:** Poorly defined due to the unclarity of determination. The stratigraphic range is probably Rhaetian (?) – Early Jurassic.

## Biostratigraphy

Several biostratigraphic schemes based on foraminifera exist for the Early Jurassic, and only a few more recent are discussed herein.

Kabal and Tasli (2003) named three zones in the Early Jurassic of Central Taurides. Late Sinemurian *Lituosepta recoarensis* lineage zone (1) starts with the first occurence of *L. recoarensis*, and ends with the first occurence of *Orbitopsella primaeva*. *Amijiella amiji* is also present, and *Lituolipora termieri* and *Lituosepta compressa* occur for the first time. The latest Sinemurian – Early Pliensbachian *Orbitopsella* lineage zone (2) starts with the first occurence of *O. primaeva* and ends with the last occurence of *O. praecursor*. Algae *Palaeodasycladus mediterraneous* Pia is present. The *Lituolipora termieri* interval zone (3) begins with the last occurrence of *Orbitopsella*. This zone also represents the acme of *L. termieri*. The upper boundary is poorly defined and the zone may reach into the Toarcian, below the early Middle Jurassic *Bosniella croatica* zone.

From the Apennines, Mancinelli et al. (2005) described three Early Jurassic zones. The *Thaumatoporella parvovesiculifera* (Reineri) interval zone (1) is Hettangian – Early Sinemurian in age. The lower boundary is the last occurrence of *Triasina hantkeni* Majzon, and the upper the first occurrence of *P. mediterraneus*. *Duotaxis metula* and *Siphovalvulina variabilis* first occur in the upper part of this zone. The Late Sinemurian *P. mediterraneus* local taxon range zone (2) starts with the first occurrence of its nominal species, and ends with its last occurrence. The Pliensbachian *Orbitopsella* local taxon range zone (3) follows.

BouDagher-Fadel and Bosence (2007) described five foraminiferal biozones for the Hettangian – Early Pliensbachian interval based on investigation of several complete sections in the Mediterranean area. In the Hettangian *Siphovalvulina gibraltarensis* zone (1) only a few foraminifera are present. *Textularia* and *Siphovalvulina* dominate. *Involutina liassica* first appears in this zone. Foraminifera remain rare also in the Early – Middle Sinemurian *Siphovalvulina colomi* zone (2), but biodiversity somewhat increases. *Pseudopfenderina butterlini* appears in this zone for the first time. *Duotaxis metula* is a Late Triassic Lazarus species. The first appearance of *Everticyclammina praevirguliana* marks the beginning of Middle Sinemurian *E. praevirguliana* zone (3). The Late Sinemurian is recognized by the *Lituosepta recoarensis* and *Orbitopsella* spp. Zone (4). *Lituosepta recoarensis* and *Orbitopsella praecursor* appear for the first time, along with *Amijiella amiji*, *Haurania deserta*, and *Bosniella oenensis*. The following Early Pliensbachian *Lituosepta compressa* biozone is marked by the first appearance of its nominal species. *Pseudocyclammina* sp., *Orbitopsella circumvulvata*, and *Buccicrenata* first appear in this zone.

Finally, the biostratigraphic scheme for the Karst Dinarides was devised by Velić (2007). The Late Rhaetian (?) – Early Sinemurian is marked by the *Triasina hantkeni – Mesoendothyra* sp. interval zone (1). Only small valvulinids and lituolids (i.e., *D. metula*, *A. amiji*, *S. variabilis*, *E. praevirguliana*) are present. The first occurrence of *Mesoendothyra* sp. marks the beginning of its Early – Late Sinemurian lineage zone (2). The upper boundary is marked by the first occurrence of *L. recoarensis*. *Lituolipora termieri* is an important taxon of this zone. The early Late Sinemurian *L. recoarensis* lineage zone (3) ends with the first occurrence of *O. primaeva*. The *O. primaeva* lineage zone (4) ranges from Late Sinemurian to the early Early Pliensbachian. It ends with the first occurrence of *O. praecursor*. Velić (2007) divided this zone into Late Sinemurian – earliest Early Pliensbachian *O. primaeva – L. recoarensis* concurrent-range subzone, ranging from the first occurrence of *O. primaeva* to the last occurrence of *L. recoarensis*, and into Early Pliensbachian *L. recoarensis – O. praecursor* interval subzone. The following *O. praecursor* taxon-range zone (5) marks the Early Pliensbachian. *Orbitopsella* is represented

| | Septfontaine (1984) | Kabal & Tasli (2000) | Mancinelli et al. (2005) | Velić (2007; pers.com. 2014) | BouDagher-Fadel & Bosence (2007) |
|---|---|---|---|---|---|
| Toarcian | | | | *P.liassica-G.cayeuxi* i.z. | |
| Late Pliensbachian | *L.termieri* & *L.compressa* | *L.termieri* | *Orbitopsella* | *P.liassica* t.r.z.; *O.praecursor-P.liassica* i.z. | |
| Early Pliensbachian | *Orbitopsella*: *O.praecursor* | *Orbitopsella*: *O.praecursor* | | *O.praecursor* t.-r.z. sbz.2, sbz.1 | *L.compressa* |
| | *Orbitopsella*: *O.primaeva* & *P.butterlini* | *Orbitopsella*: *O.primaeva* | | *O.primaeva* l.z. sbz.2, sbz.1 | |
| Late Sinemurian | *L.recoarensis* | *L.recoarensis* | *P.mediterraneus* | *L.recoarensis* l.z. | *L.recoarensis* & *Orbitopsella* spp. |
| Middle Sinemurian | | | | *Mesoendothyra* l.z. | *E.praevirguliana* |
| Lower-Middle Sinemurian | | | | | *S.colomi* |
| Hettangian | *Siphovalvulina* & *Mesoendothyra* | | *T.parvovesiculifera* | *T.hantkeni-Mesoendothyra* i.z. | *S.gibraltarensis* |
| Rhaetian | | | | | |

Fig. 5. A schaematic comparisson between foraminiferal (foraminiferal-green algae) biostratigraphic schemes for Early Jurassic as proposed by Septfontaine (1984), Kabal and Tasli (2000), Mancinelli et al. (2005), Velić (2007) and BouDagher-Fadel & Bosence (2007). Not to scale.

i.z.: interval zone; l.z.: lineage zone; sbz.: subzone; t.-r.z.: taxon-range zone.

Sl. 5. Shematska primerjava foraminifernih (foraminiferno-algnih) biostratigrafskih shem za zgodnjo juro po Septfontaine (1984), Kabal in Tasli (2000), Mancinelli et al. (2005), Velić (2007) in BouDagher-Fadel in Bosence (2007). Ni v razmerju.

i.z.: intervalna cona; l.z.: evolucijska cona; sbz.: podcona; t.-r.z.: razponska cona

by *O. primaeva*, as well as *O. praecursor*. In the late Early Pliensbachian *O. praecursor* – *O. primaeva* concurrent-range subzone (from the first occurrence of *O. praecursor* to the last occurrence of *O. primaeva*), *Biokovina gradacensis* (Gušić) and *Bosniella oenensis* also occur. The *O. praecursor* abundance subzone is late Early Pliensbachian to early Late Pliensbachian in age. The following *O. praecursor* – *Pseudocyclammina liassica* Hottinger interval zone (6) starts with the last occurrence of *O. praecursor* and ends with the first occurrence of *P. liassica*. It is Late Pliensbachian in age, but perhaps includes also the beginning of Toarcian. The *P. liassica* taxon-range zone (7) marks the late Late Pliensbachian. The Early Jurassic then ends with the *P. liassica* – *Gutnicella cayeuxi* interval zone (8), ranging from the last occurrence of *P. liassica* to the first occurrence of *G. cayeuxi*. *Bosniella croatica* is present. This zone is Toarcian – Earyl Aalenian in age (Velić, 2007).

According to biostratigraphic scheme of Velić (2007), the Podpeč and the Grad sections belong to *Orbitopsella praecursor* taxon range zone of the Early Pliensbachian. The highest occurrence of *Orbitopsella* is at the top of Podpeč 1 section, or at the 2nd metre of the lateral Podpeč 2 section, so there is a possibility that the uppermost part of the measured

**PLATE 1**

1–2 *Duotaxis metula* Kristan. 1: Thin section 337. 2: Thin section 412.

3–9 *Bosniella oenensis* Gušić. 3-8: Thin section 510. Multiple aperture is indicated with arrowhead in figure 6. 9: Note clearly visible keriothecal structure of the wall (white arrowhead) and *Meandrovoluta* incorporated into the wall (black arrowhead). Thin section 526.

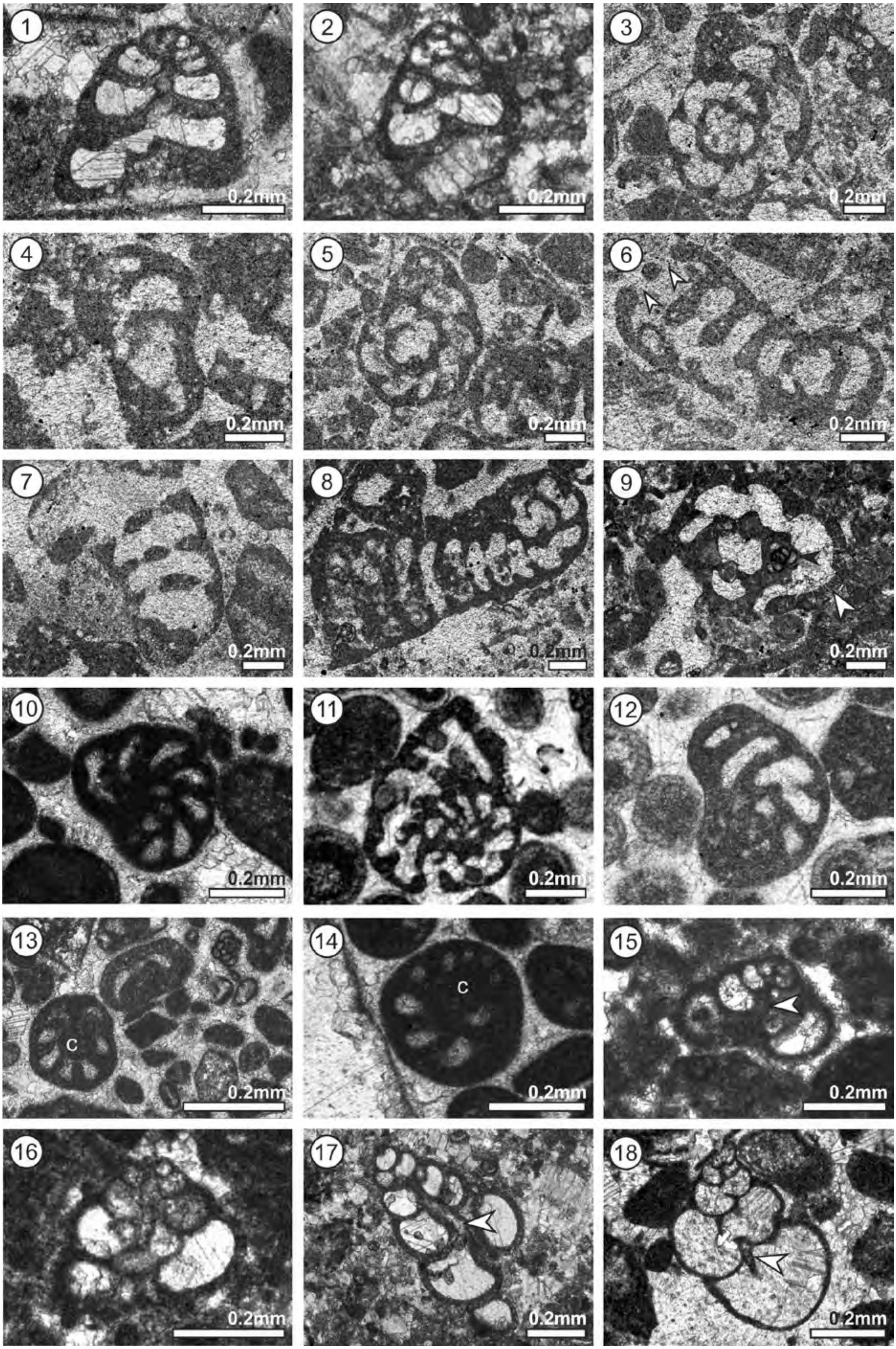
10–12 *Lituolipora termieri* (Hottinger). 10: Thin section 533. 11–12: Thin section 536.

13–14 *Pseudopfenderina butterlini* (Brun). Columella (C). 13: Thin section 418. 14: Thin section 533.

15–16 *Siphovalvulina gibraltarensis* BouDagher-Fadel et al.. Note the siphonal canal (arrowhead). 15: Thin section 328. 16: Thin section 321.

17–18 ?*Siphovalvulina variabilis* Septfontaine. Note the siphonal canal (arrowhead). 17: Thin section 412. 18: Thin section 525.

**PLATE 1**


1
0.2mm
2
0.2mm
3
0.2mm
4
0.2mm
5
0.2mm
6
0.2mm
7
0.2mm
8
0.2mm
9
0.2mm
10
0.2mm
11
0.2mm
12
0.2mm
13
C
0.2mm
14
C
0.2mm
15
0.2mm
16
0.2mm
17
0.2mm
18
0.2mm

section reaches the early Late Pliensbachian (the start of *P. liassica* zone). However, no index taxa of *P. liassica* zone were found to support this possibility. The Pliensbachian age of these three sections is in agreement with the previous determination of age on the basis of lithiotid bivalves (e.g., Buser & Debeljak, 1996), although lithiotid bivalves are known also from Toarcian (Debeljak & Buser, 1998; Sabatino et al., 2013).

On the other hand, the Zalopate section, at least from the 6th meter up, to the 34th meter belongs to the early Late Sinemurian *L. recoarensis* zone sensu Velić (2007), marked by the presence of *L. recoarensis* and absence of *Orbitopsella*. The section from the 34th meter up could belong to the next, *O. primaeva* lineage zone of Late Sinemurian age. It has to be noted here, that no lithiotid bivalves were recorded in the Zalopate section and that the attribution to the "Podpeč limestone" lies solely on lithological similarity and the geological map. The lack of a proper, lithostratigraphic definition of this unit is here obvious, and we would either have to correct the geological map, using a more strictly defined "Podpeč limestone", or extend the stratigraphic span of the "Podpeč limestone" to the Late Sinemurian. The Late Sinemurian – Pliensbachian age is also established for the Rotzo Member of the Calcari Grigi Formation of the Trento Plateau in Italy (Fugagnoli & Loriga Broglio 1998; Masetti et al., 1998; Fugagnoli et al., 2003), which lithologically corresponds to the "Podpeč limestone" (Buser & Debeljak, 1996).

## Conclusions

The foraminiferal assemblage of the "Podpeč limestone" was investigated in three sections located in the wider Mt. Krim area, south of Ljubljana.

The Zalopate section spans the lower part of the "Podpeč limestone". No lithiotid bivalves were found. *Orbitopsella* first occurs 34 meters from the base of the section. Based on the presence of its nominal taxon, this part of the section belongs to the *Lituosepta recoarensis* zone of early Late Sinemurian age. The upper part of the section, marked by the presence of *Orbitopsella primaeva*, belongs to Late Sinemurian *O. primaeva* lineage zone. The Podpeč 1 and Podpeč 2 sections sample the classical locality of the "Podpeč limestone". Numerous lithiotid bivalve coquinas are present. The presence of *Orbitopsella praecursor* and *Bosniella oenensis* indicate Early Pliensbachian *Orbitopsella praecursor* taxon range zone. The same zone was determined in the Grad section.

The results of this study thus confirm the Pliensbachian age of the "Podpeč limestone" at its classical locality. The lower boundary of the "Podpeč limestone" is now extended to the Late Sinemurian.

## Acknowledgements

This study was financially supported by the Slovenian Research Agency (program number P1-0011). Thin sections were prepared by M. Štumergar from the Geological Survey of Slovenia. Sections were investigated with the help of students Primož Oprčkal and Maša Jamnik. The thanks are extended to three reviewers, whose constructive suggestions greatly improved this paper.

## References

Al-Saad, H. 2008: Stratigraphic distribution of the Middle Jurassic foraminifera in the Middle East. Rev. Paléobiol., 27: 1–13.

Azerêdo, A. C., Manuppella, G. & Ramalho, M. M. 2003: The Late Sinemurian carbonate platform and microfossils with Tethyan affinities of the Algarve Basin (south Portugal). Facies, 48: 49–60, doi:10.1007/BF02667529.

Baloge, P.-A. 1981: Sur la présence du genre *Haurania* Henson, dans le Lias inférieur de la région de Saint-Maixent, Poitou, France. Rev. Micropal., 24: 127–137.

Banner, F. T., Whittaker, J. E., BouDagher-Fadel, M. K. & Samuel, A. 1997: *Socotraina*, a new hauraniid genus from the Upper Lias of the Middle East (Foraminifera, Textulariina). Rev. Micropal., 40: 115–124.

## PLATE 2

1–2 ?*Siphovalvulina variabilis* Septfontaine. Arrowhead is pointing at twisted siphonal canal. 1: Thin section 329b. 2: Thin section 337.

3 *Siphvalvulina* sp., transverse section. Note the siphonal canal (arrowhead). Thin section 519.

4 ?*Siphovalvulina* sp. A. Thin section 536.

5–8 ?9, 10: *Amijiella amiji* (Henson). 5: Thin section 424b. Arrowhead pointing at Duotaxis metula. 6: Thin section 413. 7: Thin section 513. 8: Thin section 424b. 9: Radial beams are indicated by the arrowhead. Thin section 330. 10: Thin section 535b.

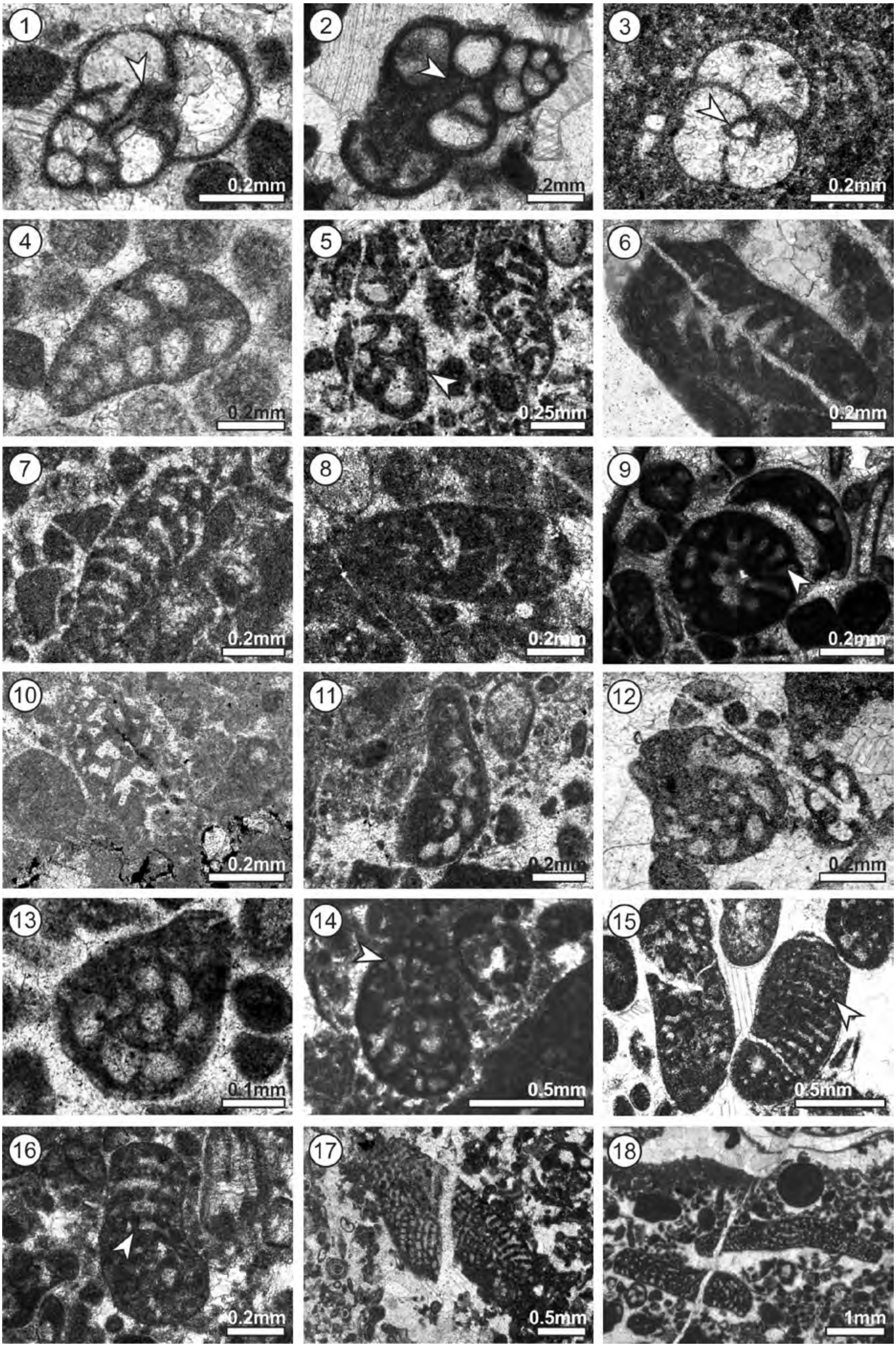
11–13 *Mesoendothyra*? sp. A. 11: Thin section 515. 12: Thin section 517. 13: Thin section 534.

14–16 *Lituosepta* sp. var. A. Note the endoskeletal pillars (arrowheads). 14: Thin section 328. 15 Thin section 422. 16: Thin section 333.

17 *Lituosepta* sp. var. B. Thin section 329.

18 ?*Orbitopsella primaeva* Henson. Thin section 413.

**PLATE 2**


1
0.2mm
2
2mm
3
0.2mm
4
0.2mm
5
0.25mm
6
0.2mm
7
0.2mm
8
0.2mm
9
0.2mm
10
0.2mm
11
0.2mm
12
0.2mm
13
0.1mm
14
0.5mm
15
0.5mm
16
0.2mm
17
0.5mm
18
1mm

Bassi, D., Fugagnolli, A. & Hottinger, L. 2006: Foraminiferal shell structures – 1st part. Ann. Uni. Studi Ferrara, Sez. Museol. Sci. Natur., 2.

Bassoullet, J. P. 1994: *Bosniella fontainei* nov.sp, (Foraminifera, Biokovinidae) from the Middle Jurassic of Thailand. Geobios, 27: 403–411, doi: 0.1016/S0016-6995(09)900-18-3.

Bassoullet, J.-P. 1997: Les grands foraminifères. In: Cariou, E. & Hantzpergue, P. (coord.): Biostratigraphie du Jurassique ouest-européen et Méditerranéen: zonations paralléles et distribution et microfossiles. Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, Mém., 17: 293–304.

Bassoullet, J. P., Boutakiout, M., Echarfaoui, H. 1999: Two new genera: *Palaeocyclammina* n.gen. and *Ijdranella* n.gen., Foraminiferida (Textulariina) from a *Orbitopsella praecursor* (Gümbel) liassic bed from Middle Atlas (Morocco). Rev. Micropal., 42: 213–230., doi:10.1016/S0035-1598(99)90012-0.

Blau, J. 1987a: Neue Foraminiferen aus dem Lias der Lienzer Dolomiten. Teil I: Die Foraminiferenfauna einer roten Spaltenfüllung in Oberrhätkalken. Jb. Geol. B.-A., 129: 495–523.

Blau, J. 1987b: Neue Foraminiferen aus dem Lias der Lienzer Dolomiten. Teil II (Schluss): Foraminiferen (Involutinina, Spirillinina) aus der Lavanter Breccie (Lienzer Dolomiten) und den Nördlichen Kalkalpen. Jb. Geol. B.-A., 130: 5–23.

Blau, J. & Haas, J. 1991: Lower Liassic involutinids (foraminifera) from the Transdanubian Central Range, Hungary. Paläont. Z., 65: 7–23, doi:10.1007/BF02985771.

BouDagher-Fadel, M. K. 2008: Evolution and geological significance of larger benthic foraminifera. In: Wignall, P. B. (ed.): Developments in Palaeontology and Stratigraphy. Elsevier, Amsterdam: 540 p.

BouDagher-Fadel, M. & Bosence, D. W. J. 2007: Early Jurassic benthic foraminiferal diversification and biozones in shallow-marine carbonates of western Tethys. Senck. Lethaea, 87: 1–39, doi:10.1007/BF03043906.

BouDagher-Fadel, M. K., Rose, E. P. F., Bosence, D. W. J. & Lord, A. R. 2001: Lower Jurassic foraminifera and calcified microflora from Gibraltar, western Mediterranean. Palaeontology, 44: 601–621, doi:10.111/1475-4983.00193.

Brady, H.B. 1884: Report on the foraminifera dredged by H. M. S. Challenger, during the years 1873-1876. In: Report on the Scientific Results of the Voyage of the H. M. S. Challenger during the years 1873–1876. Zoology 9.

Brodie, P.B. 1853: Remarks on the Lias at Fertherne near Newnham, and Purton near Sharpness; with an account of some new foraminifera discovered there; and on certain Pleistocene deposits in the Vale of Cloucester. Ann. Mag. Nat. Hist. ser. 2, 12: 272–277.

Brönnimann, P. & Koehn-Zaninetti, L. 1969: *Involutina hungarica* Sido et *Involutina farinacciae*, n. sp., deux Involutines post-triasiques, et remarque sur *Trocholina minima* Henson. Paläont. Z., 43: 72–80.

Brun, L. 1962: Note sur le genre *Pfenderina* Hensonm 1948; description d'une nouvelle espèce (*Pfenderina butterlini*) dans le Domérien du Maroc. Rev. Micropal., 5: 185–190.

Buser, S. 1965: Stratigraphic development of Jurassic strata in southern Primorje, Notranjska and western Dolenjska regions (dissertation). Univerza v Ljubljani, Fakulteta za naravoslovje in tehnologijo, Katedra za mineralogijo in geologijo, Ljubljana: 101 p. (in Slovenian)

Buser, S. 1968: Basic Geological Map SFRY 1 : 100.000, Sheet Ribnica, L 33-78. Zvezni geološki zavod Beograd.

Buser, S. 1974: Explanatory book of Sheet Ribnica, L 33-78, Basic Geological Map SFRY 1:100.000. Zvezni geološki zavod, Beograd: 60 p. (in Slovenian with English summary)

Buser, S. 1989: Development of the Dinaric and the Julian carbonate platforms and of the intermediate Slovenian Basin (NW Yugoslavia). Boll. Soc. Geol. Ital., 40: 313–320.

Buser, S. 1996: Geology of Western Slovenia and its paleogeographic evolution. In: Drobne, K., Goričan, Š. & Kotnik, B. (eds.): International workshop Postojna, 96: The role of impact processes and biological evolution of planet Earth. ZRC SAZU (Ljubljana): 111-123.

Buser, S. & Debeljak, I. 1996: Lower Jurassic beds with bivalves in South Slovenia. Geologija, 37/38(1995): 23-62, doi:10.5474/geologija.1995.001.

Buser, S., Grad, K. & Pleničar, M. 1967: Basic Geological Map SFRY 1 : 100.000, Sheet Postojna, L 33-77. Zvezni geološki zavod Beograd.

## PLATE 3

1–5 ?*Orbitopsella primaeva* Henson. One of the stolon axis is indicated by an arrowhead.

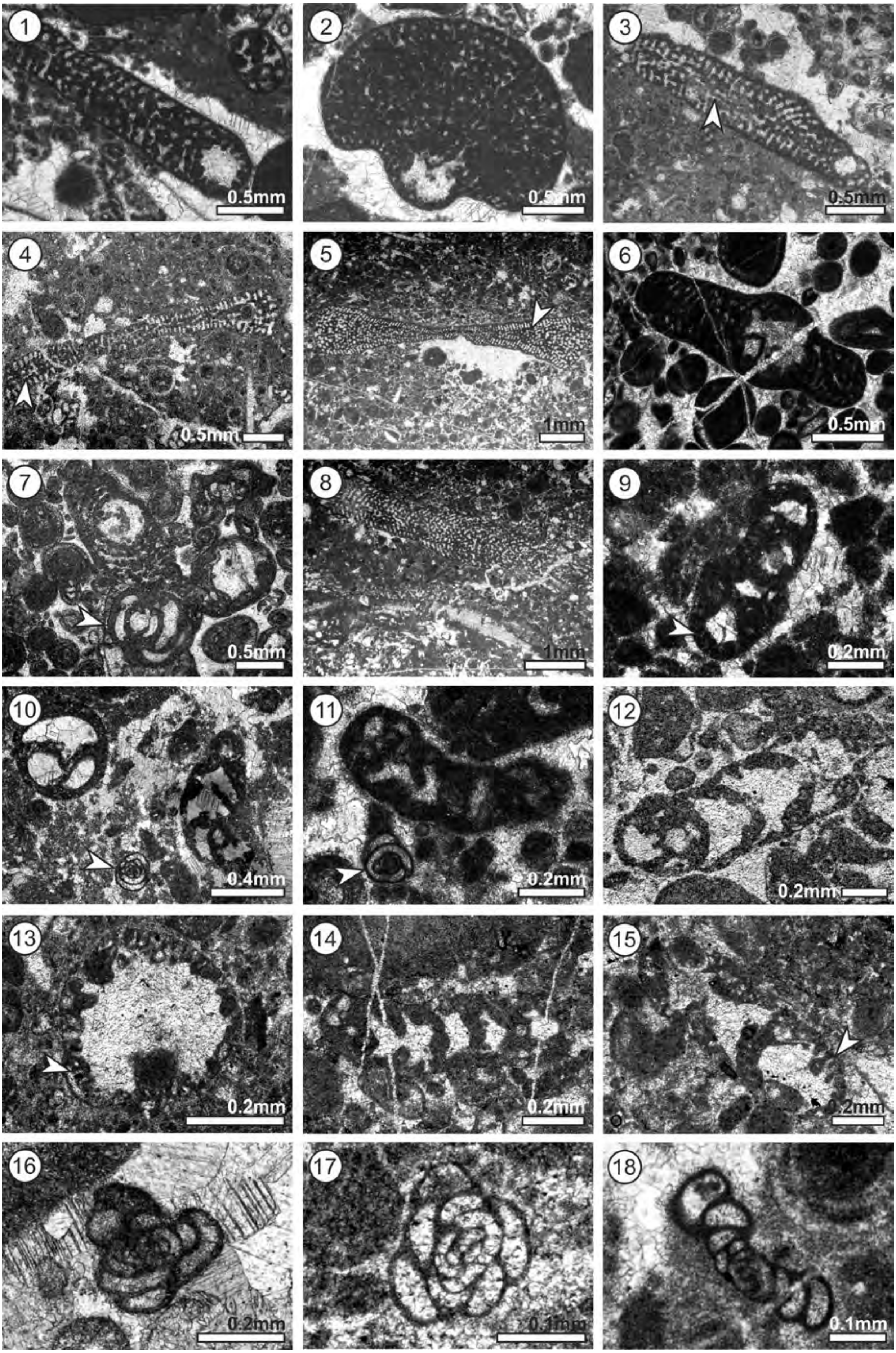
1–2 hin section 413. 3-4: Thin section 532. 5: Thin section 535b.

6–8 ?*Orbitopsella praecursor* (Gümbel). 6: Thin section 427. 7: Arrow pointing at *Bosniella oenensis*. Thin section 529. 8: Thin section 535b.

9–15 *Everticyclammina praevirguliana* Fugagnoli. Note the wide alveolae (arrowheads). 9: Axial section. Thin section 328. 10: Arrow pointing at *Meandrovoluta asiagoensis*. Thin section 328. 11: Arrow pointing at *Meandrovoluta asiagoensis*. Thin section 413. 12: Thin section 510. 13: Thin section 515. 14-15: Thin section 526.

16–18 *Meandrovoluta asiagoensis* Fugagnoli & Rettori. 16: Thin section 330. 17: Thin section 535b. 18: Thin section 415.

**PLATE 3**


1
0.5mm
2
0.5mm
3
0.5mm
4
0.5mm
5
1mm
6
0.5mm
7
0.5mm
8
1mm
9
0.2mm
10
0.4mm
11
0.2mm
12
0.2mm
13
0.2mm
14
0.2mm
15
0.2mm
16
0.2mm
17
0.1mm
18
0.1mm

Bütschli, O. 1880: Erster Band. Protozoa. In: Bronn, H.G. (Ed.): Klassen und Ordnungen des Their-Reichs, I Band, I Abtheilung. C.F. Winter, Leipzig: 1-224.

Bykova, N.K., Balakhmatova, V.T., Vasilenko, V.P., Voloshinova, N.A., Grigelis, A., Dain, L.G., Ivanova, L.V., Kuzina, V.I., Kuznetzova, Z.V., Kozyreva, V.F., Morozova, V.G., Myatlyuk, E.V. & Subbotina, N.N. 1958: New genera and species of foraminifera. Trudy Vsesoyuznogo Neft-yanopo Nauchno-issledovatel'skogo Geologorazvedochnogo Instituta (VNIGRI) 115: 4–81.

Cai, H.-W., Li, J.-G. & Zhang, B.-G. 2005: Early and Middle Jurassic foraminifera from Tingri and Nyalam regions of southern Tibet, China. Acta Paleontol. Sin., 45: 437–452.

Cati, F. 1959: Nuovo lituolide nei Calcari Grigi liassici del Vicentino. Giorn. Geol., 27: 103–112

Chiocchini, M., Farinacci, A., Mancinelli, A., Molinari, V. & Potetti, M. 1994. Biostratigrafia a foraminiferi, dasicladali e calpionelle delle successioni carbonatiche Mesozoiche dell'Appennino Centrale (Italia). In: Biostratigrafia dell'Italia centrale. Studi Geol. Camerti, 9–130.

Cushman, J.A. 1911: A monograph of the foraminifera of the North Pacific Ocean. Pt. 2. Textulariidae. U. S. Nati. Mus. Bull. 71: 1–108.

Črne, A. E., Weissert, H. J., Goričan, Š. & Bernasconi, S. M. 2011: A biocalcification crisis at the Triassic-Jurassic boundary recorded in the Budva Basin (Dinarides, Montenegro). Geol. Soc. Am. Bull., 123: 40–50.

Debeljak, I. & Buser, S. 1997: Lithiotid bivalves in Slovenia and their mode of life. Geologija, 40: 11–64, doi:10.5474/geologija.1997.001.

De Blainville, H.M.D. 1827: Manuel de malacologie et de conchyliologie (1825). F.G. Levrault, Paris: 670 p.

Delage, Y. & Hérouard, E. 1896: Traité de Zoologie Concrète. Vol. 1, La Cellule et les Protozoaires. Schleicher Frères (Paris.)

Dodd, J. R. & Stanton, R. J. Jr. 1990: Paleoecology: concepts and applications. John Wiley & Sons, Toronto: 502 p.

Dozet, S. 1992: Lithostratigraphic units and significant microfacies of the Kočevje Jurassic. RMZ, 39: 287–305. (in Slovenian with English abstract)

Dozet, S. 1996: Foraminiferal and algal biostratigraphy of the Jurassic beds in southeastern Slovenia. RMZ, 43: 3–10.

Dozet, S. 2009: Lower Jurassic carbonate succession between Predole and Mlačevo, Central Slovenia. RMZ, 56: 164–193. (in Slovenian with English abstract)

Dozet, S. & Strohmenger, C. 2000: Podbukovje Formation, central Slovenia. Geologija, 43/2: 197–212, doi:10.5474/geologija.2000.014. (in Slovenian with English abstract)

Fugagnoli, A. 1996: On the occurrence of *Duotaxis metula* Kristan (Foraminifera) in the Lower Jurassic (Calcari Grigi, Venetian Prealps, Italy). Rev. Paleob., 15: 285–392.

Fugagnoli, A. 1998: Le associazioni a foraminiferi bentonici del Giurassico inferior della Piattaforma di Trento (Calcari Grigi-Liassico). Sistematica, biostratigrafia e paleoecologia (disertacija). Dipartimento di Scienze Geologiche e Paleontologiche dell'Università degli Studi di Ferrara, Ferrara: 206 p.

Fugagnoli, A. 1999: *Cymbriaella*, a new foraminiferal genus (Textulariina) from the Early Jurassic of the Venetian Prealps (Northeastern Italy). Rev. Micropal., 42: 99–110., doi:10.1014/S0035-1598(99)90102-2.

Fugagnoli, A. 2000: First record of *Everticyclammina* Redmond 1964 (*E. praevirguliana* n. sp.; Foraminifera) from the Early Jurassic of the Venetian Prealps (Calcari Grigi, Trento Platform, northern Italy). J. Foram. Res., 30: 126–134, doi:10.2113/0300126.

Fugagnoli, A., Loriga Broglio, C. 1998: Revised biostratigraphy of Lower Jurassic shallow water carbonates from the Venetian Prealps (Calcari Grigi, Trento Platform, Northern Italy). Studi Trentini Sci. Natur. Acta Geol., 73: 35–73.

Fugagnoli, A., Giannetti, A. & Rettori, R. 2003: A new foraminiferal genus (Miliolina) from the Early Jurassic of the Southern Alps (Calcari Grigi Formation, Northeastern Italy). Rev. Espan. Micropal., 35: 43–50.

Gümbel, C.W. von 1872: Ueber zwei jurassische Vorläufer des Foraminiferen-Geschlechtes Nummulina und Orbitulites. N. Jb. Min. Geol. Paläont., 241–260.

Gušić, I. 1975: Upper Triassic and Liassic Foraminiferida of Mt. Medvednica, Northern Croatia (families: Involutinidae, Nubeculariidae). Palaeont. Jugoslavica, 15: 7–45.

Gušić, I. 1977: A new foraminiferal family, Biokovinidae, from the Jurassic of the Dinarids and its phylogenetic relationships. Palaeont. Jugoslavica, 18: 1–29.

Gušić, I. & Velić, I. 1978: *Lituolipora polymorpha* n. gen., n. sp. (Foraminiferida, Lituolacea?) from the Middle Liassic of the Outer Dinarids in Croatia and the establishment of a new family, Lituoliporidae. Geol. Vjesnik, 30: 73–93.

**PLATE 4**

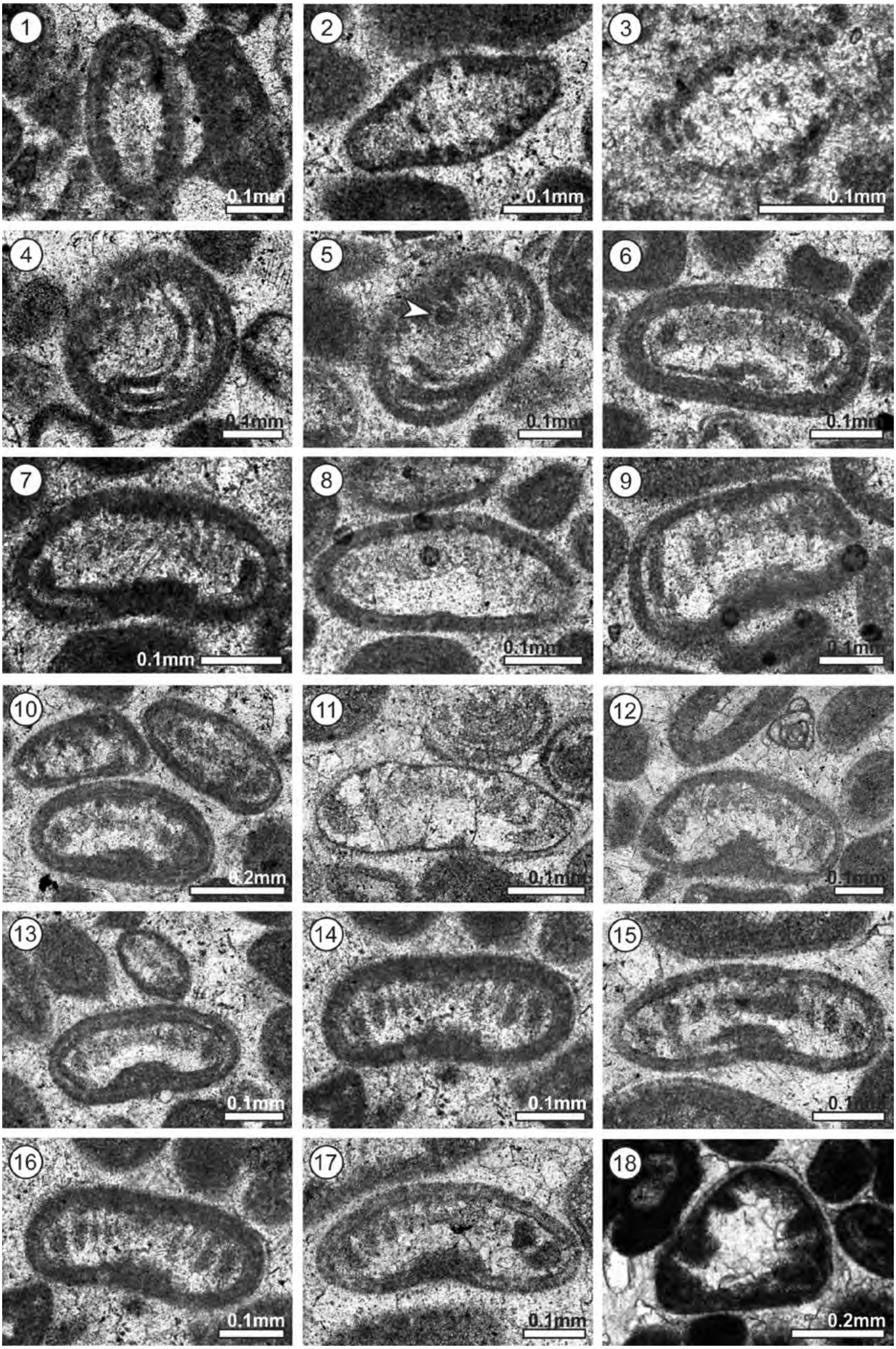
1–3 "*Involutina farinacciae* Brönnimann & Koehn-Zaninetti". 1: Thin section 526. 2: Thin section 528. 3: Thin section 535b.

4–5 ?*Coronipora* sp. or oblique section of "*Involutina farinacciae*".

6–17 ?*Coronipora* sp. Thin section 528. Arrowhead in figure 5 is pointing at proloculus.

18 ?*Trocholina* sp. Thin section 325.

**PLATE 4**


1
0.1mm
2
0.1mm
3
0.1mm
4
5
0.1mm
6
7
0.1mm
8
9
10
0.2mm
11
12
13
0.1mm
14
0.1mm
15
16
0.1mm
17
18
0.2mm

Hautmann, M., Benton, M. J. & Tomašových, A. 2008: Catastrophic ocean acidification at the Triassic-Jurassic boundary. N. Jb. Geol. Paläont. Abh., 249: 119–127.

Henson, F.R.S. 1948: Larger imperforate foraminifera of south-western Asia. British Museum (Natural History), London: 127 p.

Hohenegger, J. & Piller, W. 1977: Die Stellung der Involutinidae Bütschli und Spirillinidae Reuss im System der Foraminiferen. N. Jb. Geol. Paläont. Monatshefte, 7: 407–418.

Hottinger, L. 1967: Foraminifères imperforés du Mésozoïque marocain. Notes Mem. Serv. Geolog., 209: 1–129.

Hottinger, L. & Caus, E. 1982: Marginoporiform structure in *Ilerdorbis decussatus* n. gen. n. sp., a Senonian agglutinated, discoidal foraminifer. Eclogae Geol. Helv., 75: 807–819.

Hottinger, L. 2006: Illustrated glossary of terms used in foraminiferal research. Carnets Géol. [Notebooks on Geology] (Brest), Memoir 2006/02 (CG2006_M02). Dostopno na: paleopolis.rediris.es/cg.

Kabal, Y. & Tasli, K. 2003: Biostratigraphy of the Lower Jurassic carbonates from the Aydinick area (Central Taurides, S. Turkey) and morphological analysis of *Lituolipora termieri* (Hottinger, 1967). J. Foram. Res., 33: 338–351.

Kaminski, M.A. 2004: The year 2000 classification of the agglutinated foraminifera. In: Bubík, M. & Kaminski, M.A. (Eds.): Proceedings of the Sixth International Workshop on Agglutinated Foraminifera. Grzybowski Foundation Spec. Publ., 8: 237–255.

Kramer, E. 1905: Das Laibacher Moor. Kleinmayr & Fed. Bamberg, Ljubljana: 205 p.

Kristan, E. 1957: Ophthalmidiidae und Tetrataxinae (Foraminifera) aus dem Rhät der Hohen Wand in Nieder-Österreich. Jb. Geol. B.-A., 100: 269–298.

Kristan, E. 1958: Neue Namen für zwei Foraminiferengattungen aus dem Rhät. Verh. Geol. B.-A., Wien: 144 p.

Kristan-Tollmann, E. 1963: Entwicklungsreihen der Trias-Foraminiferen. Paläont. Z., 37: 147–154.

Kristan-Tollmann, E. 1986: Beobachtungen zur Trias am Südostende der Tethys – Papua/ Neuguinea, Australien, Neuseeland. N. Jb. Geol. Paläont. Mitt., 4: 201–222.

Lee, J.J. 1990: Phylum Granuloreticulosa (Foraminifera). In: Margulis, L. Corliss, J.O., Melkonian, M. & Chapman, D.J. (Eds.): Handbook of Protoctista: the structure, cultivation, habitats and life histories of the eukaryotic microorganisms and their descendants exclusive of animans, plants and fungi: A guide to the algae, ciliates, foraminifera, sporozoa, water molds and the other protoctists. Jones & Bartlett Publ. (Boston): 524–548.

Lipold, M. V. 1858: Bericht über die geologische Aufnahme in Unter-Krain im Jahre 1857. Jb. Geol. R.-A., 9: 257–276.

Loeblich, A.R.Jr. & Tappan, H. 1985: Some new and redefined genera and families of agglutinated foraminifera I. J. Foram. Res., 15: 91–104.

Loeblich, A. R. & Tappan, H. 1987 [z letnico 1988]: Foraminiferal genera and their classification. Van Nostrand Reinhold Company, New York): 970 p.

Mancinelli, A., Chiocchini, M., Chiocchini, R. A. & Romano, A. 2005: Biostratigraphy of Upper Triassic-Lower Jurassic carbonate platform sediments of the central-southern Apennines (Italy). Riv. Ital. Paleont. Strat., 111: 271–283.

Martinuš, M., Bucković, D. & Kukoć, D. 2012: Discontinuity surfaces recorded in shallow-marine platform carbonates: an example from the Early Jurassic of the Velebit Mt. (Croatia). Facies, 58: 649–669, doi:10.1007/s10347-011-0288-7.

Masetti, D., Claps, M., Giacometti A., Lodi, P. & Pignatti, P. 1998: I Calcari Grigi della piattaforma di Trento (lias inferiore e medio, Prealpi Venete). Atti Tic. Sc. Terra, 40: 139–183.

Miler, M. & Pavšič, J. 2008: Triassic and Jurassic beds in Krim Mountain area (Slovenija). Geologija, 51/1: 87–99, doi:10.5474/geologija.2008.010.

Munier-Chalmas, E. 1902: Sur les foraminifères ayant un résau de mailles polygonales. Bull. Soc. Geol. France, 2: 349–351.

Ogorelec, B. 2009: Spodnje jurske plasti v Preserju pri Borovnici. Geologija, 52/2: 193–204, doi:10.5474/geologija.2009.019.

Perelis Grossowicz, L., Bassoullet, J.-P., Hirsch, F. & Peri, M. 2000: Jurassic large foraminifera from Israel. GSI Curr. Res., 12: 132–144.

Piller, W. 1978: Involutinacea (Foraminifera) der Trias und des Lias. Beitr. Paläont. Österr., 5: 1–164.

Pirini, C. 1966: Alcuni Foraminiferi dei calcari liassici di Montemerano – Grosseto. Palaeontogr. Ital., 60: 89–98.

Placer, L. 1999: Contribution to the macrotectonic subdivision of the border region between Southern Alps and External Dinarides. Geologija, 41: 223–255, doi:10.5474/geologija.1998.013.

Placer, L. 2008: Principles of the tectonic subdivision of Slovenia. Geologija, 51/2: 205–217, doi:10.5474/geologija.2008.021.

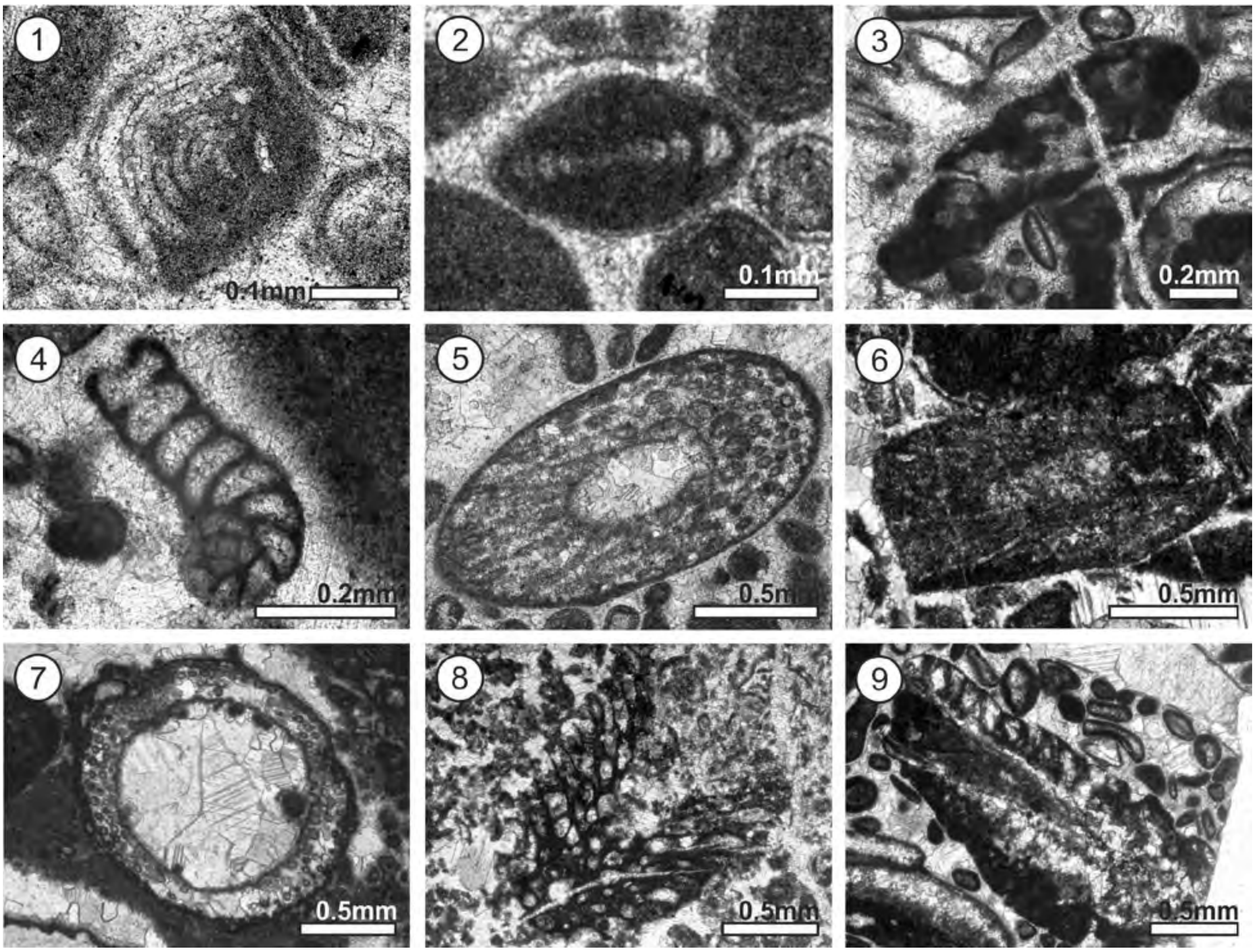
Pleničar, M. 1970: Explanatory book of Sheet Postojna, L 33-77, Basic Geological Map SFRY 1:100.000. Zvezni geološki zavod, Beograd: 62 p. (in Slovenian with English summary)

Radoičić, R. 1966: Microfacies du jurassiques des Dinarides externes de la Yugoslavie. Geologija, 9: 5–337.

Radoičić, R. & Jovanović, D. 2011: *Involutina farinacciae* Bronnimann & Koehn-Zaninetti 1969, a marker for the Middle Liassic in basinal and some platform facies of Mediterranean and near east areas; the discussion concerning the paleogeography of Montenegro-Albania border region (the Scutari-Peć Lineament). Ann. Géol. Pénins. Balkanique, 72: 47–61, doi: 0.2298/GABP11720047R.

Ramovš, A. 1961: Geological excursions in the surroundings of Ljubljana. Mladi geolog 3: 47–58. (in Slovenian)

**PLATE 5**




1–2 *Ophthalmidium* sp. 1: Thin section 522. 2: Thin section 528.

3 *Reophax* sp. Thin section 429.

4 *Ammobaculites* sp. Thin section 324.

5–9 Dasycladales. 5: Thin section 325. 6: Thin section 420. 7: Thin section 413. 8: Thin section 428. 9: Thin section 324.

Ramovš, A. 2000: Podpeč limestone, black and colorful Lesno Brdo limestone through time. Mineral, Ljubljana: 115 p. (in Slovenian)

Redmond, C.D. 1964: Lituolid foraminifera from the Jurassic and Cretaceous of Saudi Arabia. Micropaleontology, 10: 405–414.

Rettori, R. 1994: Replacement name *Hoyenella*, gen. n. (Triassic Foraminiferida, Miliolina) for *Glomospira sinensis* Ho, 1959. Boll. Soc. Paleont. Ital., 33: 341–343.

Rettori, R. 1995: Foraminiferi del Trias inferiore e medio della Tetide: revisione tassonomica, stratigrafia ed interpretazione filogenetica. Uni. Geneve, Publ. Dép. Géol. Paléont., 18: 1–107.

Rigaud, S., Blau, J., Martini, R. & Rettori, R. 2013: Taxonomy and phylogeny of the Trocholinidae (Involutinina). J. Foram. Res., 43: 317–339, doi:10.2113/gsjfr.43.4.317.

Rigaud, S., Blau, J., Martini, R. & Rettori, R. in press: Taxonomy, phylogeny, and functional morphology of the foraminiferal genus *Involutina*. Acta Palaeont. Polonica (Warszawa).

Rožič, B. 2009: Perbla and Tolmin formations: revised Toarcian to Tithonian stratigraphy of the Tolmin Basin (NW Slovenia) and regional correlations. Bull. Soc. Geol. France, 180/5: 411–430, doi:10.2113/gssgfbull.180.5.411.

Sabatino, N., Vlahović, I., Jenkyns, H.C., Scopelliti, G., Neri, R., Prtoljan, B. & Velić, I. 2013: Carbon-isotope record and palaeoenvironmental changes during the Early Toarcian oceanic anoxic event in shallow-marine carbonates of the Adriatic Carbonate Platform in Croatia. Geol. Mag., 150: 1085–1102, doi:10.1017/S0016756813000083.

Saidova, Kh.M. 1981: On an up-to-date system of supraspecific taxonomy of Cenozoic benthonic foraminifera. Institut Okeanologii P. P. Shirshova, Akademiya Nauk SSSR, Moscow: 73 p. [in Russian]

Sartoni, S. & Crescenti, U. 1962: Ricerche biostratigrafiche nel Mesozoico dell'Appennino Meridionale. Estratto Giorn. Geol., Ann. Museo Geol. Bologna, 29: 161–335.

Schlagintweit, S. & Velić, I. 2011: New and poorly known Middle Jurassic larger benthic foraminifera from the Karst Dinarides of Croatia. Geol. Croatica, 64: 81–99, doi:10.4154/GC.2011.08.

Schultze, M.S. 1854: Über den Organismus der Polythalamien (Foraminiferen), nebst Bermerkungen über die Rhizopoden im Allgemeinen. Wilhelm Engelmann, Leipzig: 68 p.

Septfontaine, M. 1980: Les Foraminifères imperforés des milieux de plate-forme au Mésozoique: détermination pratique, interprétation phylogénetique et utilisation biostratigraphique. Rev. Micropaléont., 23: 169–203.

Septfontaine, M. 1984: Biozonation (a l'aide des Foraminifères imperforés) de la plate-forme interne carbonatée liasique du Haut Atlas (Maroc). Rev. Micropaléont., 27: 209–229.

Septfontaine, M. 1986: Milieux de dépôt et foraminifères (Lituolidés) de la plate-forme carbonatée du Lias moyen du Maroc. Rev. Micropaléontol., 28: 265–289.

Septfontaine, M. 1988: Vers une classifation evolutive des Lituolides (Foraminiferes) Jurassiques en milieu de plate-forme carbonate. Rev. Paléob., spec. 2 (Benthos ´86): 229–256.

Smout, A.H. & Sugden, W. 1962: New information on the foraminiferal genus *Pfenderina*. Palaeontology, 4: 581–591.

Strohmenger, C. & Dozet, S. 1991: Stratigraphy and geochemistry of Jurassic carbonate rocks from Suha krajina and Mala gora mountain (Southern Slovenija). Geologija, 33(1990): 315–351,doi:10.5474/geologija.1990.008 (in Slovenian).

Suleymanov, I.S. 1973: Some questions on the systematics of the family Verneuilinidae Cushman 1927 in connection with conditions of the habitat. Dokladari Uzbekiston SSR, Fanlar Akademiyasining, 8: 35–36. (in Russian)

Šribar, L. 1966: Jurassic sediments between the villages Zagradec and Randol in Krka Valley. Geologija, 9: 379–384. (in Slovenian with English summary)

Tasli, K. 2001: Benthic foraminifera of the Upper Jurassic platform carbonate sequence in the Aydincik (Icel) Area, Central Taurides, S Turkey. Geol. Croatica, 54: 1–13.

Terquem, O. 1862: Recherches sur les foraminifères de l'etage moyen et de l'etage inférieur du Lias. Mem. Acad. Imper. Metz, 42: 415–466.

Turnšek, D. 1997: Mesozoic corals of Slovenia. ZRC SAZU, Ljubljana: 512 p.

Turnšek, D. & Košir, A. 2000: Early Jurassic corals from Krim Mountain, Slovenia. Razprave, 41: 81–113.

Turnšek, D., Buser, S. & Debeljak, I. 2003: Liassic coral patch reef above the "lithiotid limestone" on Trnovski gozd plateau, west Slovenia. Razprave, 44: 285–331.

Ulcigrai, F., Pugliese, N. & Pirini Radrizzani, C. 1987: Il livelo ad Orbitopselle nella successione liassica del Monte Lefre (Trentino orientale). Studi Trentini Sci. Natur. – Acta Geol., 64: 9–24.

Velić, I. 1977: Jurassic and Lower Cretaceous assemblage-zones in Mt. Velika Kapela, central Croatia. Acta Geol., Prirodoslovna istraživanja, 42: 15–37.

Velić, I. 2007: Stratigraphy and palaeobiogeography of Mesozoic benthic Foraminifera of the Karst Dinarides (SE Europe). Geol. Croatica, 60: 1–113.

Vetters, H. 1933: Geologische Manuskriptkarte Radmannsdorf 1:75.000. Nach Originalaufnahmen von Teller, Kossmat, Härtel und Ampferee zusammengestellt von H. Vetters.

Voloshinova, N.A. 1958: On new systematics of the Nonionidae. Trudy Vsesoyuznogo Neftyanogo Nauchno-issledovatel'skogo Geologo-razwedochnogo Instituta, 115: 117–191.

Zambetakis-Lekkas, A., Pomoni-Papaioannou, F. & Alexopoulos, A. 1996: Biostratigraphy and sedimentology of Liassic carbonate sediments of Tripolitza platform in central Crete. Rev. Paléobiol., 15, 393–399.