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Foraminiferal assemblage in the coral-bearing limestones of the Vršatec area (Pieniny Klippen Belt, Western Carpathians, Slovakia)

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Abstract: The paper deals with benthic foraminifera occurring with the scleractinian corals in the Jurassic biohermal and peribiohermal coral-bearing limestones of the Vršatec area (Czorsztyn Succession, Slovak Pieniny Klippen Belt). The coral community is dominated by branching forms of the genus *Thecosmilia.* Co-occurring abundant benthic foraminifera belong to the species *Rumanolina seiboldi*, *R. elevata*, *Paalzowella turbinella* and *Troglotella incrustans.* The coral-bearing limestones were initially assigned to the Oxfordian on the basis of the microfacies analyses and bivalve and scleractinian faunas. In recent papers they are assigned to the Bajocian on the basis of ammonites found in the neptunic dykes and stratigraphic superimposition criteria. However, the stratigraphic distribution of the majority of the identified foraminifera indicates that like most scleractinian coral taxa they are not known earlier than in the Late Jurassic. The Late Jurassic age of these coral-bearing limestones is also suggested by an encrusting microproblematic organism *Iberopora bodeuri.*

Key words: Upper Jurassic, Pieniny Klippen Belt, Slovakia, Foraminifera, Scleractinia.

Introduction

Upper Jurassic scleractinian corals with about 20 species presented by Mišík (1979) and Morycowa & Mišík (2005), come from the biohermal limestones in the Vršatec Castle klippe area (Czorsztyn Succession) in the Slovak sector of the Pieniny Klippen Belt, Western Carpathians (Figs. 1A,B, 2). The stratigraphic span of the species given in the latter paper is limited to the Late Jurassic interval, with the exception of two species (*Atelophyllia* cf. *clermontei* Lathuilière and *Periseris elegantula* (d'Orbigny)), known only from the Middle Jurassic. These two species were considered by Morycowa & Mišík (2005) to represent surviving Bajocian-Callovian taxa.

The age of the biohermal coral limestones, accepted previously as the Oxfordian (cf. Mišík 1979) is assumed to correspond to the Bajocian (probably Early Bajocian) (i.a. Schlögl et al. 2006, 2009a,b) on the basis of the stratigraphic superimposition criteria and ammonite species *Nannolytoceras tripartitum* (Raspail) occurring in the neptunic dyke cutting the peribiohermal limestones (i.a. Schlögl et al. 2006, 2009a) and Bathonian-Callovian ammonites occurring in dykes in the uppermost part of the Vršatec limestone in the Vršatec-Castle Klippe (Schlögl et al. 2009b). However, other age bio-indicators and in particular the youngest indicator of the biohermal coral-bearing limestones and their equivalents, should also be considered.

The foraminifera co-occurring with the corals, derived from these limestones point rather to their Late Jurassic age (Table 1). Moreover, some *incertae sedis* encrusting micro-

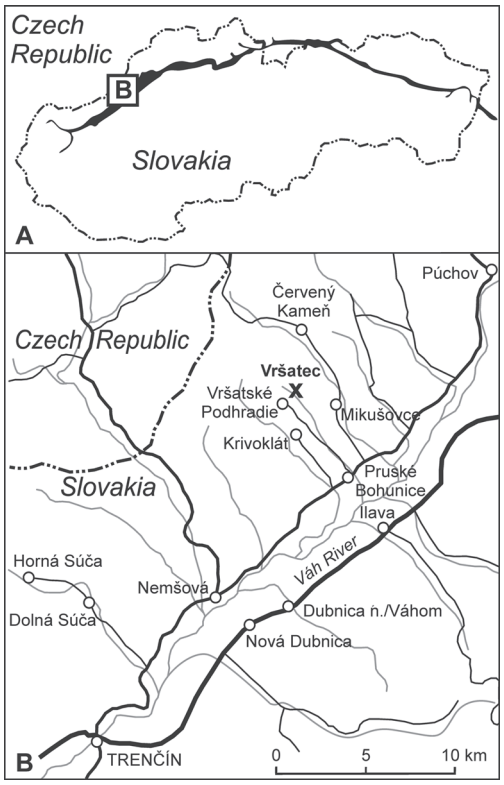

Fig. 1. A — Position of the Vršatec klippe (rectangle) relative to the Pieniny Klippen Belt (black irregular line). **B** — Topographic map of the Vah valley region (Western Slovakia) showing the location of the Vršatec klippe (x-shape). (After Morycowa & Mišík 2005, simplified.)

Fig. 2. Vršatec Castle klippe. Biohermal limestones occur in its higher part (left of the broken line — arrow) (After Morycowa & Mišík 2005).

fossils (Fig. 3.1,2) also appear to suggest this age. Therefore, our data based on the foraminifera and microproblematic fossils co-occurring with the corals association seem to be useful for the further discussion.

Material and methods

The corals from the Jurassic biohermal and peribiohermal limestones (cf. Mišík 1979; Morycowa & Mišík 2005) have been collected by professor Milan Mišík from the Vršatec area. Almost all specimens from biohermal facies come from Site 22, only two from Site 42 (see Morycowa & Mišík 2005: fig. 1C). The coral skeleton fragments from the reddish peribiohermal limestones (cf. Mišík 1979: fig. 1) come from Site 3 near the entrance to the Vršatec Castle.

The foraminifera analysed in this paper also come from Sites 22 and 3.

The investigations were carried out with the help of the binocular and petrographic microscopes.

The primary acronym of the specimens from the collection studied by Morycowa (Morycowa & Mišík 2005), was UJ 134P/1-n (Museum of the Institute of Geological Sciences of Jagiellonian University in Cracow), but this acronym and the numbers of the specimens were changed later and the specimens and thin sections are located in the Slovak National Museum in Bratislava (Morycowa & Mišík 2005: SNM Z 24183-24230/n). A few small fragments of these samples and about 10 thin sections (see Appendix 1) kept in the Museum of the Institute of Geological Sciences UJ, some of which were not included in previous works, are analysed here.

Discussion on foraminifera co-occurring with corals

The corals occur frequently in white biohermal limestones and sporadically in pinkish and grey peribiohermal limestones and reef breccias that were assigned by Mišík (1979) to the Oxfordian and by Schlögl et al. (2006, 2099a,b) to the Bajocian. Detailed lithological, microfacies and biostratigraphical characteristics of these sediments were presented by Mišík (1979). About 20 shallow-water scleractinian coral taxa were identified in these biohermal limestones (Sites 22 and 42; cf. Morycowa & Mišík 2005: fig. 1C). The most common taxa are pseudocolonial (phaceloid-dendroid) forms from the family Montlivaltiidae, genus *Thecosmilia*. Other families are rather poorly represented. The stratigraphic span of the coral species described in Morycowa & Mišík (2005) is limited to the Late Jurassic interval, with the exception of two species, known only from the Middle Jurassic (*Atelophyllia* cf. *clermontei* Lathuilière and *Periseris elegantula* (d'Orbigny)), considered by the authors mentioned above as representing surviving Bajocian-Callovian taxa. Moreover, some *incertae sedis* microfossils that encrust coral skeletons (Fig. 3.1,2) such as *Iberopora bodeuri* Granier & Berthou (Oxfordian–Berriasian), not known to date from the Middle Jurassic (cf. Schlagintweit 2004), also suggest this age.

The studied material did not reveal any index Jurassic foraminiferal species. The identified taxa (6 species and 1 identified as cf.; see Appendix 2) may be divided into two groups differing in the extent of their stratigraphic distribution. The more stratigraphically restricted species are: *Rumanolina seiboldi* (Lutze) — Oxfordian–Valanginian; *Rumanolina elevata* (Paalzow) — Oxfordian–Valanginian; *Paalzowella turbinella* Gümbel — Oxfordian–Early Kimmeridgian and *Troglotella incrustans* Wernli & Fookes — Oxfordian–Lower Cenomanian. The stratigraphic distribution (Table 1) of the mentioned species seems to indicate that the investigated strata are not older than the Late Jurassic. Taken as a whole the foraminiferal fauna of the material studied shows affinities with the assemblages known from the Upper Jurassic carbonate sediments of epicontinental and Tethyan facies.

Conclusions

The investigations of the thin sections of the coral-bearing biohermal and peribiohermal limestones from the Vršatec area show that they contain abundant foraminifera species of the genera *Rumanolina* Neagu, *Paalzowella* Cushman and *Troglotella* Wernli & Fookes. Their stratigraphic distribution, like that of most coral species, is characteristic of the Late Jurassic interval, in contrast to the inference where these limestones belong to the Middle Jurassic (Schlögl et al. 2006, 2009a,b). Moreover, some microfossils *incertae sedis* encrust-

Table 1: Occurrences and/or stratigraphic ranges of selected foraminifera species from the coral-bearing limestones of the Vršatec area (– – – – when the species were determined here or in the literature as affinis or conformis, as well as when the stratigraphic distribution of species is not certain).

Species \ Occurrence	Liassic	Bajocian	Batonian	Callovian	Oxfordian	Kimmeridgian	Tithonian	Berriasian	Valanginian	Authors
Rumanolina seiboldi (Lutze, 1960)										Lutze 1960; Barbulescu & Neagu 1970; Bielecka in Malinowska 1980; Neagu & Cirnaru 2001; Olszewska et al. 2011
Rumanolina feifeli (Paalzow, 1932)										Barbulescu & Neagu 1970; Bielecka & Geroch 1977; Holbourn & Kamiński 1997; Szydło 1997; Neagu & Cirnaru 2001; Olszewska 2005; Ivanova et al. 2008
Rumanolina elevata (Paalzow, 1932)										Barbulescu & Neagu 1970; Dragastan 1975; Bielecka in Malinowska 1980; Neagu & Cirnaru 2001
Paalzowella turbinella (Gümbel, 1862)										Bielecka in Malinowska 1980; Ivanova et al. 2008; Olszewska 2010; Olszewska et al. 2011
Redmondoides lugeoni (Septfontaine, 1977)										Septfontaine 1977; Soták 1987; Martini & Zaninetti 1995; Bassoulet 1997; Ivanova & Kołodziej 2004, 2010; Schlagintweit et al. 2005; BouDagher-Fadel 2008; Ivanova et al. 2008; Olszewska et al. 2011
Troglotella incrustans (Wernli & Fookes, 1992)										Wernli & Fookes 1992; Martini & Zaninetti 1995; Bucur et al. 1996; Schlagintweit & Ebli 1999; Moshammer & Schlagintweit 1999; Helm 2005; Krajewski & Olszewska 2007
Haghimashella cf. *arcuata* (Haeusler, 1890)										Neagu & Neagu 1995; Krajewski & Olszewska 2007; Ivanova & Kołodziej 2010 ("known range"); Olszewska 2010; Olszewska et al. 2011

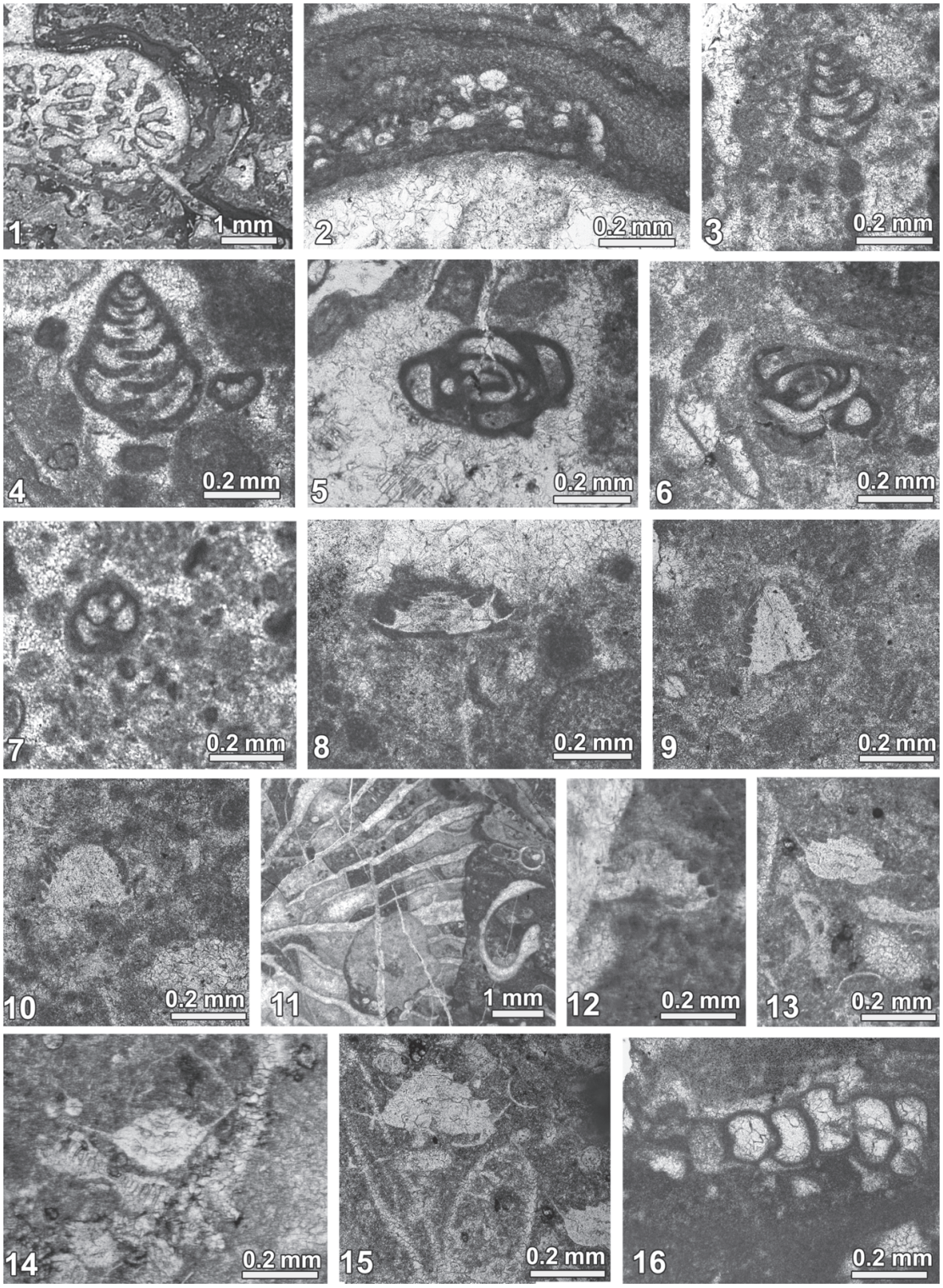

Fig. 3. Figs. 1–12 and 16 — thin section from the biohermal whitish scleractinian coral limestones (Site 22); figs. 13–15 — thin section from the reddish peribiohermal coral limestones (Site 3). **1–7** — Thin sections no. UJ 134P/4/3a: 1 — Scleractinian coral *Cladophyllia rollieri* (Koby) encrusted by microfossils *incertae sedis*; 2 — Enlarged fragment of coral and microencruster. The latter composed of *Iberopora bodeuri* Granier & Berthou accompanied by *Koskinobullina socialis* Cherchi & Schroeder; 3, 4 — *Redmondoides lugeoni* (Septfontaine); 5, 6 — Miliolidae; 7 — *Haghimashella* cf. *arcuata* (Haeusler). **8** — Thin section no. UJ 134P/3/5b: *Paalzowella turbinella* (Gümbel). **9** — Thin section no. UJ 134P/1/13c: *Paalzowella elevata* (Paalzow). **10** — Thin section no. UJ 134P/1/14a (not studied to date): *Rumanolina seiboldi* (Lutze). **11–12** — Thin section no. UJ 134P/2/4b: 11 — Skeletal fragment of *Thecosmilia dichotoma* Koby in transverse section; 12 — *Rumanolina feifeli* (Paalzow) occurring between skeletal coral elements. **13–15** — Thin section no. UJ 134P/12/1a: 13–14 — *Paalzowella turbinella* (Gümbel); 15 — *Rumanolina* aff. *feifeli* (Paalzow). **16** — Thin section no. UJ 134P/1/7b: *Troglotella incrustans* (Wernli & Fookes).

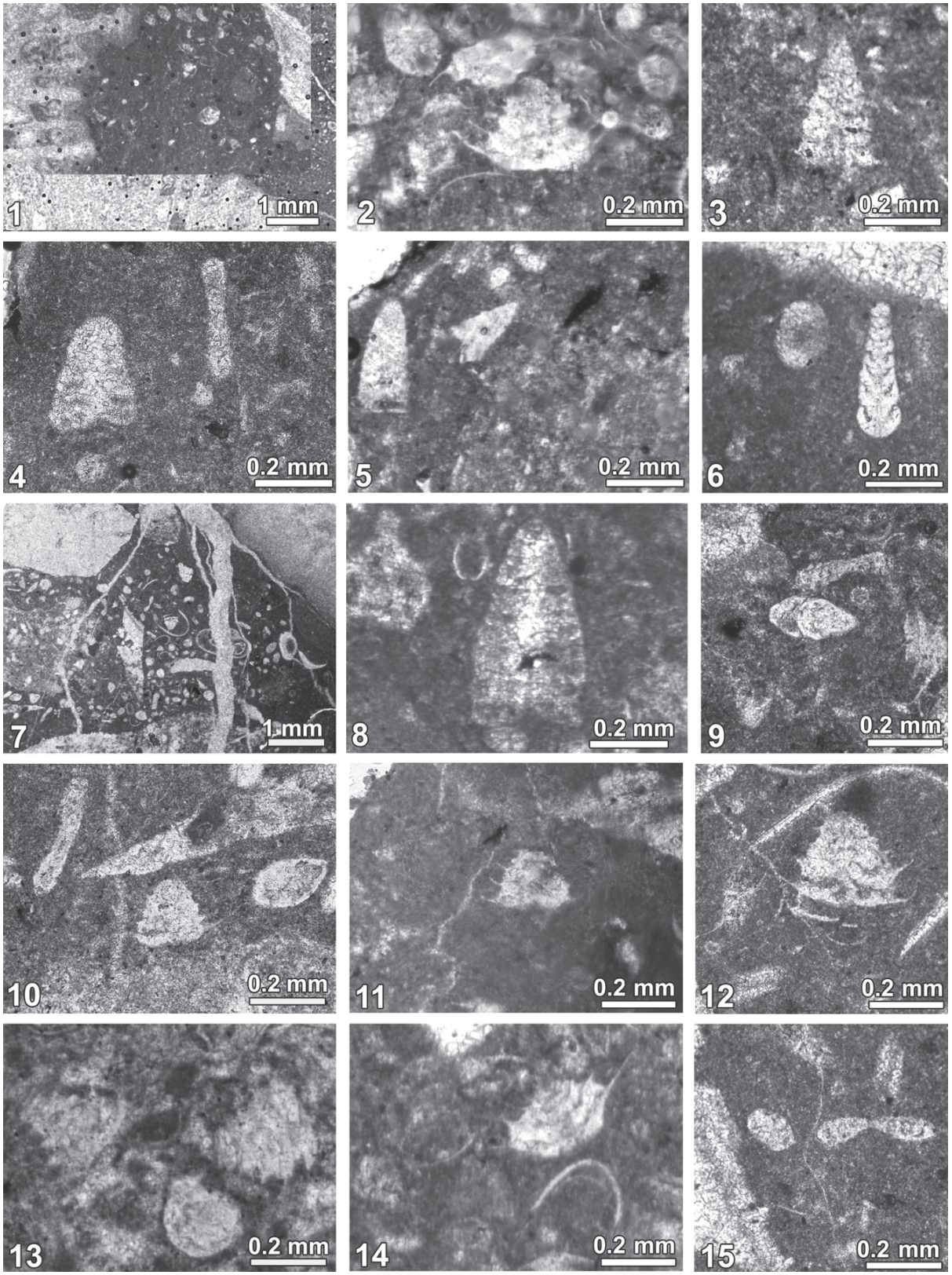

Fig. 4. Thin sections from the reddish peribiohermal coral limestones (Site 3). **1–5** — Thin section no. UJ 134P/12/2a. Limestone with fragment of scleractinian skeleton and rather rich foraminifera forms: 2 — *Rumanolina seiboldi* (Lutze); 3–5— *Rumanolina elevata* (Paalzow), with *Spirillina* sp. in Fig. 3.4. **6–15** — Thin section UJ 134P/12/3a: 6 — *Frondicularia* sp.; 7 — Biointramicrite with scleractinian skeleton fragment and microfossils such as radiolarians and foraminifera; 8 — ?*Rumanolina* sp.; 9 — *Spirillina* sp., *Rumanolina* sp. and Nodosariidae; 10–13 — *Rumanolina seiboldi* (Lutze), and *Spirillina* sp. in Fig. 10; 14 — *Paalzowella turbinella* (Paalzow); 15 — *Spirillina* sp.

ing coral skeletons, such as *Iberopora* Granier & Berthou, known to date only from the Oxfordian–Berriasian may also support their age as younger than Middle Jurassic.

The alternative explanation of the Late Jurassic age of the discussed coral and foraminifera taxa could be that their stratigraphic ranges and first appearance, given in the literature, are not sufficiently understood. On the other hand it is difficult to explain why so many taxa known to date from the Upper Jurassic appeared earlier and simultaneously in one region. Further studies of biohermal limestones based on richer material may resolve this problem.

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Appendix 1

Thin section UJ 134P/ 1/7 (specimen: SNM Z 24189). Biohermal white limestone (Site 22) with *Thecosmilia dichotoma* Koby.

Thin section UJ 134P/1/13 (specimen: SNM Z 24195). Biohermal white limestone (Site 22) with *Placophyllia* aff. *dianthus* (Goldfuss).

Thin section UJ 134P/1/14 (not studied to date). Biohermal white limestone (Site 22) with indet. thamnasterioid scleractinian coral. Thin section UJ 134P/2/4b (specimen: SNM Z 23205). Biohermal white limestone (Site 22) with *Thecosmilia* aff. *dichotoma* Koby.

Thin section UJ 134P/ 3/5 (specimen SNM Z 24210). Biohermal white limestone (Site 22) with *Thecosmilia dichotoma* Koby and *Cladophyllia* sp.

Thin section UJ 134P/ 4/3 (not studied to date). Biohermal white limestone (Site 22) with *Cladophyllia rolieri* (Koby) and *Thecosmilia dichotoma* Koby.

Thin section UJ 134P/ 12/1. Peribiohermal pinkish limestone (Site 3) with thamnasterioid coral fragment.

Thin section UJ 134P/12/2. Peribiohermal pinkish limestone (Site 3) with *Thecosmilia* cf. *dichotoma* Koby (Mišík 1979, p. 16, pl. 20, fig. 1).

Thin section UJ 134P/12/3. Biohermal pinkish limestone (Site 3) with coral skeleton fragments.

Appendix 2

Systematic positions of the studied foraminifera. (After: Loeblich & Tappan 1988, Neagu 2001, Kaminski 2004 and Schlagintweit 2012).

Family Placentulinidae Kasimova, Poroshina & Geodakchan, 1980,
Genus *Rumanolina* Neagu, 2001
Rumanolina seiboldi (Lutze, 1960)
Rumanolina feifeli (Paalzow,1932)
Rumanolina elevata (Paalzow,1932)
?*Rumanolina* sp.
Genus *Paalzowella* Cushman, 1933
Paalzowella turbinella (Gümbel, 1862)

Family Paravalvulinidae Banner, Simmone & Whittaker, 1991
Genus *Redmondoides* Banner, Simmons & Whittaker, 1991
Redmondoides lugeoni (Septfontaine, 1977)

Family Telamminidae Loeblich & Tappan 1985
Genus *Troglotella* Wernli & Fookes, 1992
Troglotella incrustans (Wernli & Fookes, 1992)

Family Textulariopsidae Loeblich & Tappan, 1982
Genus *Haghimashella* Neagu & Neagu, 1995
Haghimashella cf. *arcuata* (Haeusler, 1890)