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Decapoalina n. gen. (Miliolata, Milioliporidae; Late Triassic), a new foraminiferal genus for "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager & Ducret, 1982

Luka Gale, Roberto Rettori, Rossana Martini & Boštjan Rožič

L. Gale, Geological Survey of Slovenia, Department for Palaeontology and Stratigraphy, Dimičeva ul. 14, SI-1000 Ljubljana, Slovenia; luka.gale@geo-zs.si
R. Rettori, Università degli Studi di Perugia, Dipartimento di Scienze della Terra, Piazza Università, I-06123 Perugia, Italy; rrettori@unipg.it
R. Martini, University of Geneva, Earth and Environmental Sciences, Department of Geology and Palaeontology, 13 rue des Maraîchers, CH-1205 Geneva, Switzerland; rossana.martini@unige.ch
B. Rožič, Faculty of Natural Sciences and Engineering, Department for Geology, Privoz 11, SI-1000 Ljubljana, Slovenia; bostjan.rozic@ntf.uni-lj.si

KEY WORDS - Late Triassic, reef, Foraminifera, Decapoalina*, taxonomy, milioliporids.*

ABSTRACT - The wall of the type specimens of "Sigmoilina" schaeferae *Zaninetti, Altiner, Dager & Ducret, 1982, described from thin sections of the Norian-Rhaetian reef limestone of the Taurus Mountains (Turkey), originally interpreted to be porcelaneous imperforate, is micritized. In this study, the presence of coarse pseudopores is demonstrated in the specimens collected from the Rhaetian Dachstein-type reef limestone of Mt. Begunjščica (southern Karavanke Mts, northern Slovenia) and the new genus* Decapoalina *Gale, Rettori & Martini, is established to comprise this particular species.*

RIASSUNTO - [*Decapoalina* n. gen. (Miliolata, Milioliporidae; Triassico Superiore), un nuovo genere di foraminiferi per *"Sigmoilina" schaeferae* Zaninetti, Altiner, Dager & Ducret, 1982] - "Sigmoilina"schaeferae *è un foraminifero descritto per la prima volta nei sedimenti di età Norico-Retico dei Tauridi (Turchia), ma che comunemente si rinviene nei depositi recifali del Triassico Superiore. La parete è stata originariamente descritta come porcellanacea imperforata e la specie assegnata alla famiglia Miliolidae. Sulla base di nuovo materiale proveniente dalle Alpi sud-orientali (Slovenia) viene introdotto il nuovo genere* Decapoalina *Gale, Rettori & Martini, caratterizzato da una parete che possiede pseudo perforazioni. I caratteri principali di* Decapoalina *n. gen. sono l'organizzazione di tipo sigmoilino delle camere, l'avvolgimento involuto e la parete porcellanacea grossolanamente perforata.* Decapoalina schaeferae *n. comb. viene quindi riferita alla superfamiglia Milioliporoidea, che comprende generi tardo triassici a parete porcellanacea perforata. La funzione delle pseudo perforazioni nei milioliporidi rimane ancora irrisolta.*

INTRODUCTION

The superfamily Milioliporoidea comprises miliolid foraminifera with coarsely perforated porcelaneous wall (Brönnimann et al., 1971; Zaninetti et al., 1982; Senowbari-Daryan & Zaninetti, 1986; Loeblich & Tappan, 1987; Zaninetti et al., 1992; Gale et al., 2012a, b). Milioliporids are stratigraphically limited to the Late Triassic, disappearing at the Triassic-Jurassic boundary (Tappan & Loeblich, 1988; Gale et al., 2011, 2012c). The majority of milioliporids has been studied in thin sections, from which the morphology of some of the more complex forms could not be ascertained for a long time (see for example Senowbari-Daryan, 1983). Many features, such as the type of the aperture, still remain unobserved in several of the genera because of the inability to comprehend the entire range of possible shapes across different cross sections and the susceptibility of the wall to diagenetic alterations. With the constant income of new data and interpretations the taxonomy of the group has changed as well (e.g., Zaninetti, 1977; Zaninetti & Altiner, 1981; Zaninetti et al., 1982; Senowbari-Daryan, 1983; Senowbari-Daryan & Zaninetti, 1986; Loeblich & Tappan, 1987, 1992; Zaninetti & Martini, 1992; Zaninetti et al., 1992; Senowbari-Daryan, 1993; Gale et al., 2012a, b), which has resulted in a confusing array of junior synonyms and taxonomic groups, consisting of one or few genera (see recent review in Gale et al., 2012b). In this paper, we describe a new genus of the superfamily Milioliporoidea, namely *Decapoalina* n. gen. (type species "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager & Ducret, 1982) on the basis of thin sections of the Rhaetian Dachstein-type reef limestone from Mt. Begunjščica (Karavanke Mts, northern Slovenia) and the allodapic limestones from the Mt. Slatnik and Mt. Kobla sections (southern Julian Alps, western Slovenia), which contain reef-rimmed platform-derived grains.

GEOLOGICAL SETTING

The Late Triassic of the eastern Southern Alps is characterized by two large palaeogeographic units: the Slovenian Basin and the Julian Carbonate Platform (Buser, 1986, 1989; Ciarapica & Passeri, 1990; Ogorelec & Rothe, 1993; Buser, 1996; Sattler & Schlaf, 1999; Rožič et al., 2009). Although the latter is considered to be a generally shallow-water area, small-scale intraplatform basins existed and hemipelagites were reported from several localities in the Julian Alps (Buser et al., 1982; Kolar-Jurkovšek et al., 1983; Buser, 1996; Buser et al., 2008; Celarc & Kolar-Jurkovšek, 2008) and the Karavanke Mts (Kolar-Jurkovšek, 1994; Krystyn et al., 1994, 1999; Lein et al., 1995; Ogorelec et al., 1999). An equally complex palaeogeographic setting is reported from other localities of a large epeiric carbonate platform along the Neotethys

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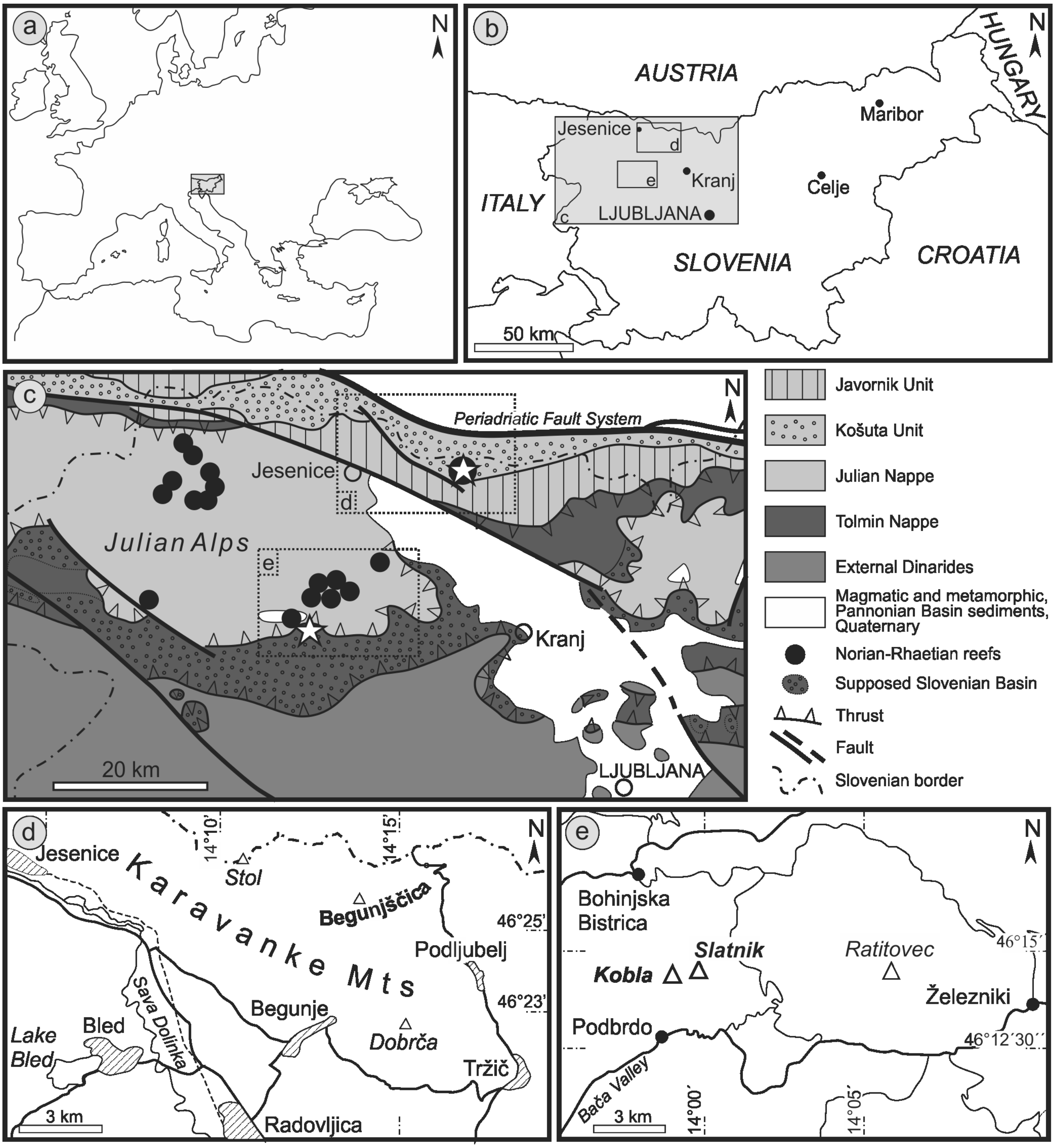


Fig. 1 - Geographic map of the localities studied. a) Location of Slovenia. b) Enlargement of the shaded area in Fig.1a; rectangles within the shaded area indicate location of maps in Figs 1d and 1e. c) Simplified structural map of the area shaded on Fig. 1b; white stars inside dotted rectangles indicate the location of Mt. Begunjščica and Slatnik and Kobla Mts. Modified after Turnšek (1997) and Placer (1999). d) Location of Mt. Begunjščica (lat. 46°25'18"; long. 14°13'47"). e) Location of Kobla (lat. 46°14'2"; long. 13°58'11") and Slatnik Mts (lat. 46°13'55"; long. 14°0'7").

Ocean (Michalík, 1993; Cozzi & Podda, 1998; Cozzi, 2002; Haas, 2002; Haas et al., 2007; Jadoul et al., 2007; Črne et al., 2011).

The Late Triassic successions of the Julian Carbonate Platform are dominated by peritidal Dachstein Limestone, whereas the transitions to intraplatform basins as well as the Slovenian Basin were characterized by extensive scleractinian coral reefs (Flügel & Ramovš, 1961; Buser et al., 1982; Turnšek et al., 1984; Turnšek & Ramovš, 1987; Turnšek & Buser, 1991; Turnšek, 1997). However, the continuous transitional zones from the platform to basins are not preserved because of the intense Tertiary poly-phase thrusting and neotectonic dextral strike-slip displacements (Placer, 1999, 2008; Vrabec & Fodor, 2006; Kastelic et al., 2008; Šmuc & Rožič, 2009). The studied foraminiferal material comes from different

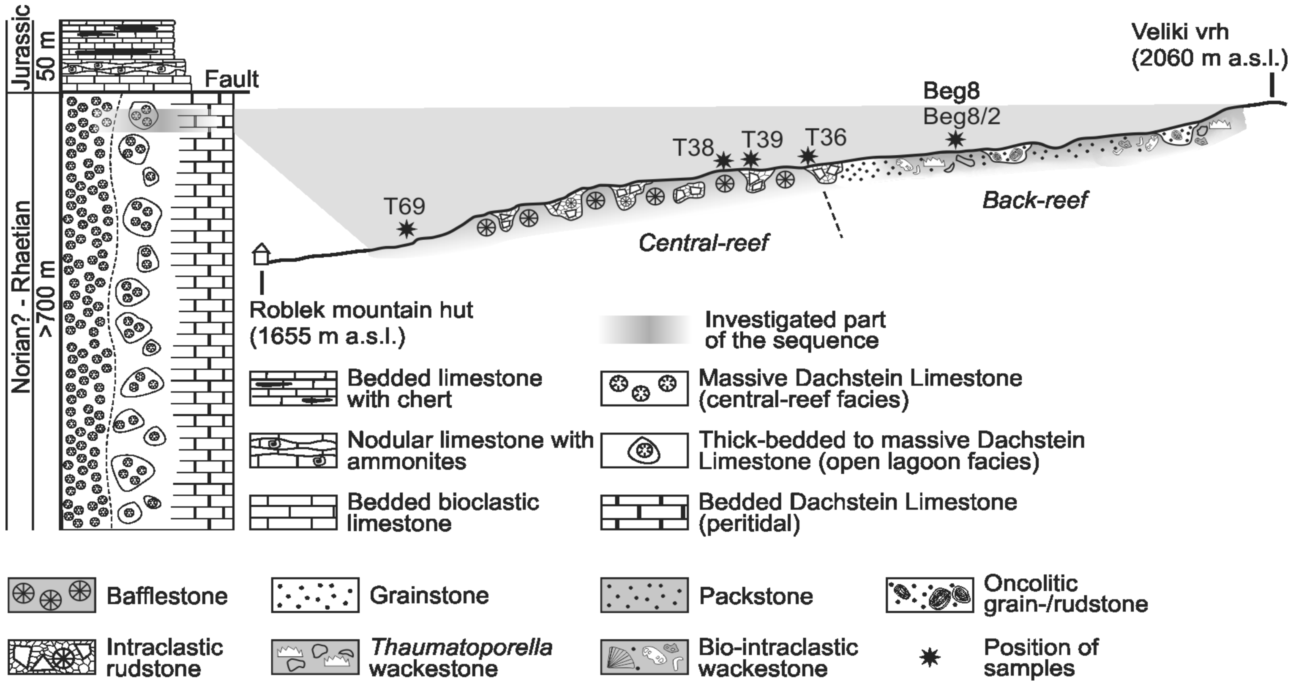


Fig. 2 - Schematic stratigraphical column and geological section across Mt. Begunjščica with the positions of the samples that yielded *Decapoalina schaeferae*. Modified after Gale et al. (2012b).

palaeogeographic units: 1) the reef-rimmed platform margin from Mt. Begunščica and 2) the allodapic limestone-dominated northern slope of the Slovenian Basin from Mt. Kobla and Mt. Slatnik.

Mt. Begunjščica (Fig. 1), presently situated in the Karavanke Mountain Ridge, belongs to the Košuta structural unit (Buser, 1980; Brenčič & Poltnig, 2008). The palaeogeographic location of the mountain was in the northernmost part of the Julian Carbonate Platform (Turnšek et al., 1984; Turnšek, 1997; Placer, 1999). The north-eastern part of the mountain consists of the Rhaetian bedded peritidal Dachstein Limestone that passes south-westward into the massive reef limestone. The Rhaetian age of the reef limestone is established on the basis of the reef-forming organisms (Flügel & Ramovš, 1961) and was recently confirmed by the finding of *Involutina turgida* Kristan, 1957 in association with several foraminifera of Norian-Rhaetian age (Gale, 2012; Gale et al., 2012b). Towards the south, a reverse fault separates the Triassic limestones from the Jurassic bedded bioclastic wackstones, nodular limestones with ammonites and bedded limestones with chert (Fig. 2) (Gale, 2012; Gale et al., 2012b). This contact is marked by a transgressive surface elsewhere in the Košuta Unit (Buser, 1980; Brenčič & Poltnig, 2008).

Mt. Kobla and Mt. Slatnik are located in the eastern part of the Bohinj Mountain Ridge that forms the southern orographic boundary of the Julian Alps (Fig. 1). These peaks structurally belong to the Tolmin Thrust, the lowermost subunit of the eastern Southern Alps (Placer, 1999, 2008; see also Rožič, 2009; Gale, 2010; Gale et al., 2011; Rožič & Šmuc, 2011; Goričan et al., 2012). The Tolmin Thrust comprises lithological units deposited in the Slovenian Basin (Buser, 1986). The studied successions originated on the northern slope of the basin and span the Norian "Bača Dolomite" and the uppermost Norian-Rhaetian Slatnik Formation (for details see Rožič et al., 2009; Gale, 2010). The age of these deposits is determined on the basis of conodont data (Rožič et al., 2009), which are supported by foraminiferal findings (Gale et al., 2012c). The Norian-Rhaetian boundary is placed at the lowest occurrence of the conodont *Misikella posthernsteini* Kozur & Mock, 1974.

The Triassic-Jurassic boundary is set at the highest occurrence of the conodonts and duostominid foraminifera (Rožič et al., 2009; Gale et al., 2011, 2012c; Goričan et al., 2012). The majority of information comes from the Slatnik Formation due to the strong dolomitisation of the "Bača Dolomite". The Slatnik Formation is characterized by alternating hemipelagic and allodapic limestones. The latter were redeposited from the Julian Carbonate Platform reef-dominated margin that is presently separated from the basinal successions by a prominent thrust. Although recorded at both localities, foraminifera-rich allodapic limestones are dominant especially in the more proximal Mt. Slatnik section (Fig. 3). The Slatnik Formation passes at both localities through the interval of thin-bedded hemipelagites into the Lower Jurassic Krikov Formation, which is characterized by allodapic limestones composed predominantly of peloids and ooids (Rožič, 2006, 2009; Rožič et al., 2009).

MATERIAL AND METHODS

Samples from Mt. Begunjščica virtually belong to the same stratigraphic level whose spatial changes can be followed along the foot path that links the Veliki vrh summit and the Roblek mountain hut (Fig. 2). Based on facies and foraminiferal associations (see Gale,

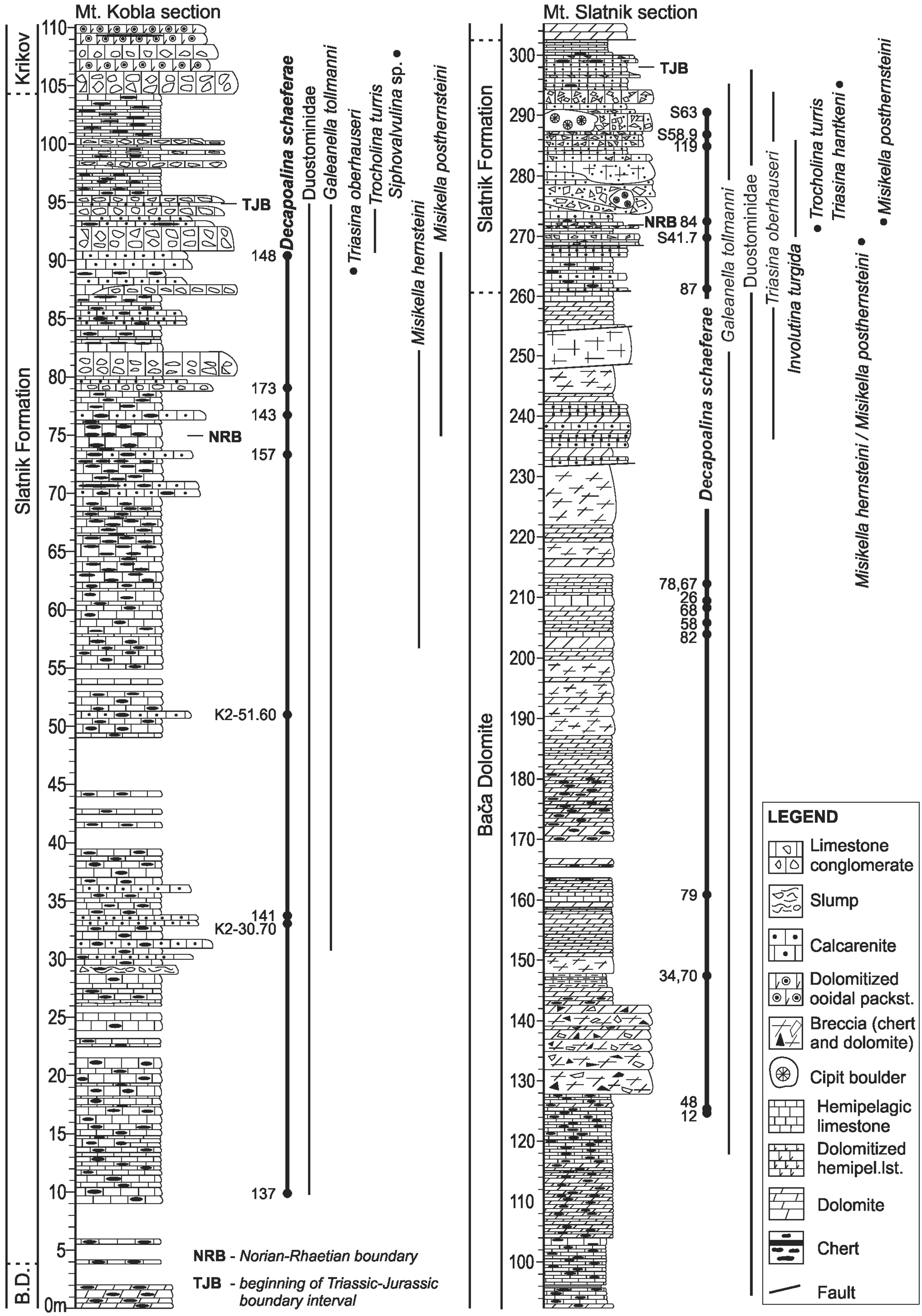


Fig. 3 - Simplified stratigraphical logs of Mt. Kobla and Mt. Slatnik sections with sampled levels yielding *Decapoalina schaeferae*. Note that the lowest occurrence of the conodont *Misikella posthernsteini* Kozur & Mock, 1974 here marks the position of the Norian-Rhaetian boundary (see discussion in Gale et al., 2012c). The beginning of the Triassic-Jurassic boundary interval is set at the highest occurrence of Duostominidae, coinciding with the highest occurrence of conodonts below the interval of platy limestones that mark the top of the Slatnik Formation (Gale et al., 2012c).

2012), the samples are deduced to originate from the central-reef (bioclastic rudstone supported by bioclastic grainstone with an abundance of abraded skeletal grains, interpreted as intra-reef breccia and corresponding to Standard Microfacies Type 6 in Flügel, 2004) and the immediate back-reef area (coarse-grained bioclastic grainstone with abraded skeletal grains corresponding to the Standard Microfacies Types 5 or 10 in Flügel, 2004). The foraminifera are considered to represent the in situ associations, or they were transported short distance away from their habitat. In contrast, the samples of allodapic limestones from the Mt. Kobla and Mt. Slatnik sections (Fig. 3) contain resedimented grains (Rožič et al., 2009; Gale, 2010). Most of the foraminifera derive from the adjacent Julian Carbonate Platform.

Decapoalina schaeferae n. gen. et n. comb. was observed in 14 thin sections from 11 samples taken at Mt. Begunjščica and in 27 thin sections, from 27 beds and samples of the Mt. Kobla and Mt. Slatnik sections (see Figs 2-3). The thin sections measure 47×28 mm and 75×49 mm in size and are stored at the Geological Survey of Slovenia (Dimičeva ul. 14, SI-1000 Ljubljana, Slovenia; repository numbers 69847-70910). Basic statistical calculations were performed with the software Microsoft Office Excel 2007.

SYSTEMATIC PALAEONTOLOGY (LG, RR, RM)

Subphylum Foraminifera d'Orbigny, 1826
nomen translat. Cavalier-Smith, 2003
Class Miliolata Lankester, 1885
nomen translat. Saidova, 1981 accord. Mikhalevich, 1998
Order Soritina Ehrenberg, 1839
Superfamily Milioliporoidea Brönnimann & Zaninetti, 1971 (in Brönnimann et al., 1971)
Family Milioliporidae Brönnimann & Zaninetti, 1971 (in Brönnimann et al., 1971)

Genus *Decapoalina* n. gen.

Type species - "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager & Ducret, 1982.

Etimology - In memory and honor of Prof. Paola De Capoa (Università degli Studi di Napoli), palaeontologist.

Diagnosis - The juvenile stage consists of a globular proloculus and a probable flexostyle channel. The channel is followed by several chambers in a sigmoiline arrangement. The coiling is involute throughout the ontogeny, leading to the lateral thickening of the test. The wall is porcelaneous, pseudo-perforated. No aperture is observed.

Comparison - *Decapoalina* is homeomorphic with the Eocene to Recent *Sigmoilina* Schlumberger, 1887 (type species *Planispirila sigmoidea* Brady, 1884). The former differs from the latter in having a perforated wall and most likely for the presence of a flexostyle channel. *Karaburunia* Langer, 1968 is another Triassic miliolid with a sigmoidal chamber arrangement. The type species, *Karaburunia rendeli* Langer, 1968, was described from a washed residue from the Upper Anisian beds of the Karaburun peninsula in Turkey (Langer, 1968). Haig & McCartain (2012) described another new species, *Karaburunia atsabensis*, from the Carnian or Norian beds of Timor. The wall of *Karaburunia* lacks pseudo-perforations. *Ophthalmipora* Zaninetti & Brönnimann, 1972, described from the Carnian beds of Italy (Zaninetti & Brönnimann, 1972), has a much less pronounced sigmoidal chamber arrangement, an evolute adult stage and a biconcave test outline. The wall of *Ophthalmipora* has coarse pseudo-pores typical of milioliporids. *Miliolipora* Brönnimann & Zaninetti in Brönnimann et al., 1971 resembles *Decapoalina* in having a perforated porcelaneous wall and a flexostyle (Pl. 1, fig. 8). Its chambers are in quinqueloculine arrangement, which may resemble a sygmoidal one of *Decapoalina*. However, the tests do not show lateral thickenings (see Pl. 2, fig. 7).

Remarks - The test morphology of *Decapoalina* is the same as that of *Sigmoilina*. Therefore, the two can be assumed to have a similar mode of life. However, the younger (true) *Sigmoilina* is considered to be a cosmopolitan genus (Loeblich & Tappan, 1987), whereas *Decapoalina* typically associates with reef-dwelling foraminifera (Schäfer & Senowbari-Daryan, 1978, 1981; Wurm, 1982; Zaninetti et al., 1982; Al-Shaibani et al., 1983; Bernecker, 1996; Martini et al., 2009; Senowbari-Daryan et al., 2010; Chablais et al., 2011; Gale, 2012). Currently, we cannot ascertain if the post-embryonic stage of *Decapoalina* is multichambered or tubular in nature. The regular increase in chamber lumen implies a single tube enrolled in a sigmoidal manner. However, septa are present in modern *Sigmoilina*, which has virtually the same equatorial transect as *Decapoalina* and our material implicates the presence of a flexostyle channel. The issue would be resolved by looking at the longitudinal sections - possible candidates are specimens determined by Salaj et al., 1983 as *Spiroloculina praecursor* Oberhauser, 1960 (Pl. 74, figs 10-11) and *Quinqueloculina nucleiformis* Kristan-Tollmann, 1964 (Pl. 75, fig. 5) - and by cutting of isolated specimens from the residue.

Decapoalina is currently a monospecific genus. *Sigmoilina*? *triadica* Langer, 1968 from the Late Anisian of the Karaburun peninsula (Turkey) is planispiral with a strong deviation of the coiling axis, rather than a sigmoidal chamber arrangement and it is therefore considered to be closer to the ophthalmidiid genera. *Sigmoilina*? *triadica* also lacks pseudo-perforations of the wall.

Decapoalina schaeferae (Zaninetti, Altiner, Dager & Ducret, 1982)
(Fig. 4; Pl. 1, figs 1-7; Pl. 2, figs 1-6)

1968 Miliolidae - Dimitrijević et al., Pl. 6, figs 7-8.
1978 "*Sigmoilina*" sp. - Schäfer & Senowbari-Daryan, p. 88, Pl. 1, fig. 4.
1982 "*Sigmoilina*" sp. - Wurm, p. 223, Pl. 32, fig. 20.
1982 "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager & Ducret, p. 110-111, Pl. 8, figs 3, 6, 9, 12-13.
1983 "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager and Ducret, 1982 - Al-Shaibani et al., p. 302, Pl. 2, figs 12-13, 20 [non Pl. 3, fig. 26?].
1983 *Sigmoilina schaeferae* Zaninetti, Altiner, Dager et Ducret, 1982 - Salaj et al., p. 114, Pl. 73, figs 1-11.

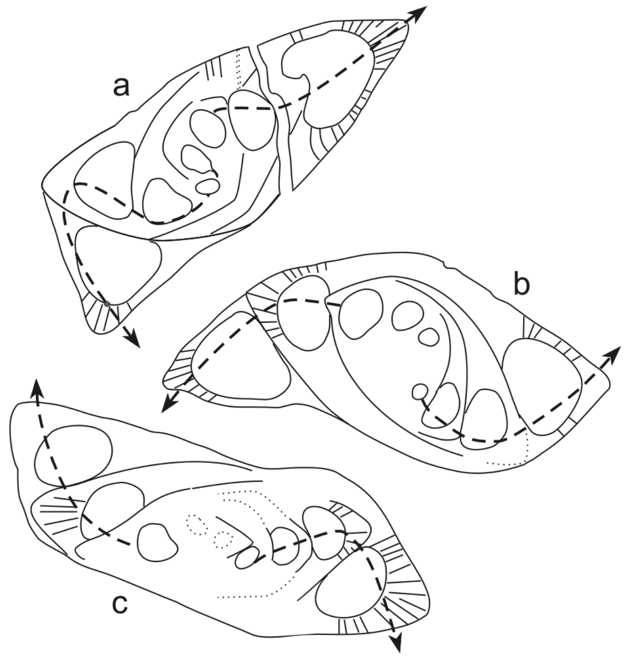


Fig. 4 - Hand-drawings of *Decapoalina schaeferae*. a) Based on the specimen from Pl. 1, fig. 5. b) Based on the specimen from Pl. 2, fig. 1. c) Based on the specimen from Pl. 2, fig. 2. Dashed arrowed lines indicate the direction of growth. Note the sharp turning points.

1983 *Sigmoilina multicarinata* Salaj et al., p. 114-115, Pl. 74, fig. 3 [non Pl. 74, fig. 4].
1983 *Paleomiliolina occulta* (Antonova, 1958) - Salaj et al., p. 114, Pl. 75, figs 7-8.
1986 *Sigmoilina* sp. - Matzner, Pl. 5, fig. 3.
1986 *Sigmoilina* sp.? - Matzner, Pl. 5, fig. 8.
1986 *Sigmoilina* aff. *schaeferae* Zaninetti, Altiner, Dager & Ducret - Matzner, Pl. 7, fig. 3.
1986 *Sigmoilina schaeferae* Zaninetti et al. - Matzner, Pl. 7, fig. 4.
1993 *Gsolbergella spiroloculiformis* (Oravecz-Scheffer, 1968) - Trifonova, Pl. 8, fig. 24.
1996 "*Sigmoilina schaeferae*" Zaninetti, Altiner, Dager & Ducret, 1982 - Bernecker, Pl. 17, fig. 11.
2009 "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager and Ducret, 1982 - Martini et al., Pl. 1, figs 24-25.
2010 "*Sigmoilina*" *schaeferae* Zaninetti et al., 1982b - Senowbari-Daryan et al., Figs 6p, 6r, 10k, 20j.
2011 "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager and Ducret - Chablais et al., Pl. 1, figs 34-38.
2012 "*Sigmoilina*" *schaeferae* Zaninetti, Altiner, Dager & Ducret, 1982 - Gale, p. 31, Pl. 3, fig. 11.

Material - 49 specimens attributed to microspheric generation and one megalospheric specimen. From Mt. Begunjščica (Rhaetian) (Fig. 2): samples T69 (thin sections 246, 247), T38 (thin sections 286A, 290A, 291B), T39 (thin sections 244A, 293), T36 (thin sections 245, 245A, 245B, 283, 284), Beg 8/2 (thin section 249), Beg 8 (thin section 186C).

From the Norian part of the Mt. Slatnik section (Fig. 3): samples A102.70-102.85 (thin section 12B), A102.36-102.42 (thin section 48), A81.0 (thin sections 34/2, 70A), A65.95-66.40 (thin section 79A), A23.9-24.0 (thin sections 82A, 82B), A22.2-22.25 (thin section 58), A19.24-19.27 (thin section 68A), A18.35-18.46 (thin sections 26A, 26B), A15.55-15.65 (thin section 78A), A15.40-15.55 (thin section 67), S32.20-32.25 (thin section 87), sample and thin section S41.7.

From the Rhaetian part of the Mt.Slatnik section (Fig. 3): samples S44.60-44.70 (thin section 84), S54.80-55.00 (thin section 119), samples and thin sections S58.9, S63.0.

From the Norian part of the Mt. Kobla section (Fig. 3): sample V-II (thin section 137), sample and thin section K2-30.70, sample V-VIIIA (thin section 141), sample and thin section K2-51.60, sample V70.60-70.80 (thin section 157).

From the Rhaetian part of the Mt. Kobla section (Fig. 3): samples V71.97-72.05 (thin section 143), V76.10-76.45 (thin section 173), V90.46-90.51 (thin section 148).

Description of new material - The test is overall lenticular in shape, stocky or elongated and inversely symmetrical. The globular proloculus is followed by a possible flexostyle channel (Pl. 1, fig. 3; Pl. 2, fig. 4). The channel is in turn followed by a tube or up to five pairs of chambers in a sigmoiline arrangement. The chamber lumen gradually increases in size and is semicircular in cross-section. The chamber wall often bears a well visible short, blunt keel on its outer surface. The keeled margin is present throughout the ontogeny (Fig. 4; Pl. 1, figs 5-6; Pl. 2, figs 1-2, 4). The wall of each successive chamber or coil covers previous chambers/coils, so that the test is involute, with a marked lateral thickening (Pl. 1, figs 5, 7; Pl. 2, figs 1-2, 4-6). The wall is thick, dark, originally most likely porcelaneous. Coarse pseudo-perforations are visible in all stages of growth and they also cross the keel. The aperture is not visible in our material. The megalospheric generation is marked by a reduced number of coils (three follow the flexostyle channel in the specimen on Pl. 1, fig. 3).

The larger diameter of the tests of the microspheric generation ($n = 49$) is 178-806 μm (mean 416 μm). The smaller diameter of the tests of the microspheric generation is 178-497 μm (mean 226 μm). The ratio between the larger and the smaller diameter (i.e., the shape of the test) is 1.14-3.11 (mean 1.88) for the microspheric generation. The proloculus measures 17-35 μm in diameter ($n = 4$; mean 22 μm).

The single specimen attributed to the megalospheric generation (Pl. 1, fig. 3) measures 290 μm and 136 μm in larger and smaller diameter, respectively. Its proloculus measures 43 μm in diameter.

The distribution of the test sizes is depicted in Fig. 5. Histogram of the ratios between the larger and smaller diameters is positively skewed (Fig. 6), but this skewness is due to the mechanical sorting of specimens from distal turbidity current deposits in the Slovenian Basin, which form the bulk of the measured specimens.

Remarks - The species *Decapoalina schaeferae* was introduced by Zaninetti et al. (1982) as "*Sigmoilina*" *schaeferae*. The type specimen, reproduced in Pl.1, fig.1, and the paratype (Pl. 1, fig. 2) were found in the Norian and/or Rhaetian reef limestone east of Kapezçuku in northern Antalya, Turkey (Taurus Mts). Zaninetti et al. (1982) recognised an initial quinqueloculine chamber arrangement in the microspheric forms, which is missing in megalospheric specimens. They assumed a miliolid-type of growth with two chambers added on opposite

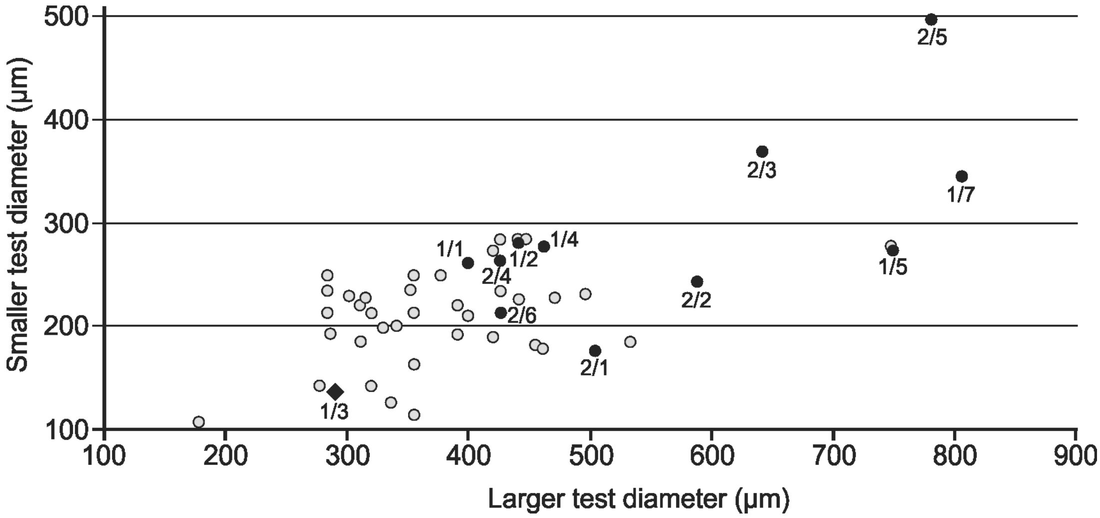


Fig. 5 - Diagram of the smaller versus larger diameter of the test. The position of the single megalospheric form on the diagram is indicated with a diamond symbol. Plain black circles indicate specimens depicted in the plates; they are identified by two numbers, i.e. 2/1 meaning specimen on Pl. 2, fig. 1. Note the position of the holotype and the paratype, figured on Pl. 1, figs 1 and 2, respectively.

sides of the test in a sigmoidal arrangement to be the most distinctive feature of the new species, besides the keeled margin of the last chambers. Longitudinal sections were not identified. The generic attribution was considered ambiguous because of the lack of information regarding the type of the aperture (thus the quotation marks in "*Sigmoilina*"). Micro- and megalospheric generations were distinguished on the basis of the difference in size of the proloculus (15 µm in the micro- and 50 µm in the megalospheric forms). We reject the presence of the initial quinqueloculine chamber arrangement and argue for the possible presence of the flexostyle channel instead.

Al-Shaibani et al. (1983) reported *D. schaeferae* (sensu this work) from the biolithite and grapestone facies of the reef limestone from the Rhaetian of Seram. The specimen on their pl. 3, fig. 26, however, is considered by us to be *Miliolipora cuvillieri* Brönnimann & Zaninetti, 1971(in Brönnimann et al., 1971), due to the quinqueloculine chamber arrangement and the smooth test outline.

Salaj et al. (1983) confusingly introduced the name *Sigmoilina bystrickyi* n. sp. in the figure captions, whereas in the text the same figures are named as *S. schaeferae* (see also Matzner, 1986). More important, poorly preserved pseudo-perforations can be observed in the walls of the specimens on their pl. 73, figs 6 and 9 and pl. 75, figs 7-8; the latter two specimens were named *Paleomiliolina occulta* (Antonova, 1958) by Salaj et al. (1983) and only a part of their material has a "keeled" margin. In addition, Salaj et al. (1983) introduced two new species of *Sigmoilina*. The first, *Sigmoilina multicarinata* was established on the basis of the smaller test size, fewer coils and more numerous costae. Gale et al. (2012b) placed the paratype of *S. multicarinata* in the synonymy of *Miliolipora tamarae* Gale, Rettori & Martini, 2012b. Consequently, the only remaining specimen of *S. multicarinata* is of the same size and has the same number of coils as *D. schaeferae*. We interpret the additional "costae" of *S. multicarinata* to be keels/costae of the older chamber of *D. schaeferae*. *Sigmoilina multicarinata* is thus considered a junior synonym of the latter species. The second new species introduced by Salaj et al. (1983), *Sigmoilina*? *excentrica*, is in our opinion a transverse section of *Planiinvoluta carinata* Leischner, 1961.

Matzner (1986) noticed that several specimens have more elongated (flattened) tests and named them *Sigmoilina* aff. *schaeferae*. He made an important observation on the clear presence of pseudo-perforations of the wall, which cannot be seen in the type material of *D. schaeferae* (sensu this work). Indeed, the pseudo-perforations are clearly visible on his pl. 5, fig. 3 and pl. 7, figs 3-4. As shown in our Fig. 5, the shape of *D. schaeferae* can vary greatly and the whole spectrum of shapes, from elliptical to highly elongated, is attributed to one species only. The histogram of the ratio between the larger and the smaller diameters for our specimens likewise has only

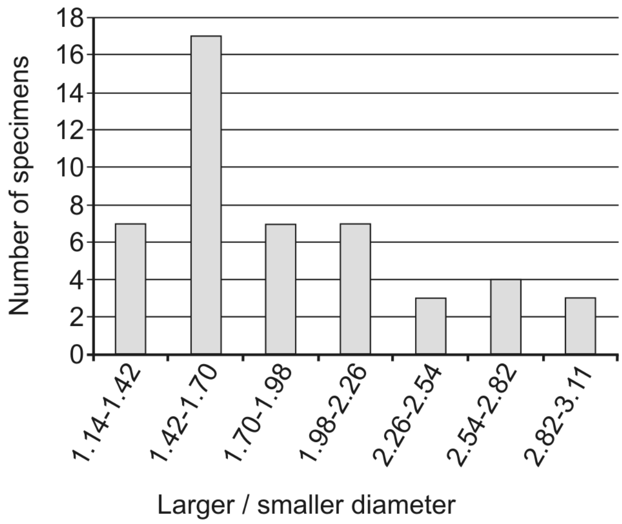


Fig. 6 - Histogram of larger/smaller test diameter ratios. The holotype and the paratype are excluded, but having a ratio of 1.53 and 1.57 respectively, they would fall near the mode. The megalospheric specimen is likewise not included. Note the positive skewness of the histogram.

one modus and therefore, it does not indicate the presence of two distinct populations (Fig. 6).

Comparison - The test of *Karaburunia rendeli* Langer, 1968 is more ovate than that of *D. schaeferae*, and *Karaburunia atsabensis* Haig & McCartain, 2012 has a more variable milioline coiling from quinqueloculine to almost spiroloculine. Both species lack surface ornamentation. *Sigmoilina*? *triadica* Langer, 1968 has an almost planispiral coil, a rounded chamber outline and it lacks pseudo-perforations.

Geographic distribution and stratigraphic range - Upper Triassic, Cyprus (Martini et al., 2009); Norian, Western Carpathians, Slovakia (Salaj et al., 1983); Norian, Bulgaria (Trifonova, 1993); Norian, Outer Dinarides, Bosnia and Herzegovina (Dimitrijević et al., 1968); Norian and/or Rhaetian, Taurus Mts, Turkey (Zaninetti et al.,

EXPLANATION OF PLATE 1

Decapoalina schaeferae (Zaninetti et al., 1982), n. gen. et n. comb. (Figs 1-7) and a milioliporid (Fig. 8). All material is deposited at the Geological Survey of Slovenia, except where indicated otherwise.

Figs 1-7 - *Decapoalina schaeferae*

1 - Holotype. Equatorial section. Type level e-BT-1054 (see Zaninetti et al., 1982), E of Kepezçukur, Antalya, Taurus Mts, Turkey. Norian/Rhaetian. Repository of the Museum d'Histoire naturelle de Genève (repository number of the holotype and paratypes MHNG 84-11).

2 - Paratype. Off-centered and slightly oblique section. Type level C-BT-1054 (see Zaninetti et al., 1982), E of Kepezçukur, Antalya, Taurus Mts, Turkey. Norian/Rhaetian. Repository of the Museum d'Histoire naturelle de Genève.

3 - Equatorial section of a megalospheric specimen. White arrow points at pseudo-perforations. Black arrows point at the possible flexostyle, preceeding the sigmoidal coiling. Mt. Begunjščica, Slovenia. Sample T69B, thin section 247. Rhaetian.

4 - Slightly off-centered and slightly oblique section. Arrow points at pseudo-perforations, visible in all stages of growth. Mt. Begunjščica, Slovenia. Sample T69B, thin section 247. Rhaetian.

5 - Equatorial section. Note the involute coiling, the deviation from the sigmoidal arrangement and that the keel is present already in the inner whorls (arrows). Specimen reproduced in Fig. 4a. Mt. Begunjščica, Slovenia. Sample T36, thin section 245B. Rhaetian.

6 - Detail of figure 5. White arrow points at the keel, while the black arrow points at pseudo-perforations.

7 - Equatorial section of a microspheric form. Arrow points at possible flexostyle, which is followed by a sigmoidal coiling. Mt. Begunjščica, Slovenia. Sample T36, thin section 283. Rhaetian.

Fig. 8 - Equatorial section of a milioliporid (*Miliolipora* or *Decapoalina*) showing the flexostyle channel (arrow) and damage of outer coils. Mt. Begunjščica, Slovenia. Sample T36, thin section 245A. Rhaetian.

Scale bar 50 µm (Fig. 6), 100 µm (Figs 3-4), 200 µm (Figs 1-2, 5, 7-8).

EXPLANATION OF PLATE 2

Decapoalina schaeferae (Zaninetti et al., 1982) (Figs 1-6) and *Miliolipora cuvillieri* Brönnimann & Zaninetti, 1971 (in Brönnimann et al., 1971) (Fig. 7). All material is deposited at the Geological Survey of Slovenia.

Figs 1-6 - *Decapoalina schaeferae*

1 - Off-centered equatorial section. Note the elongated shape of the test, the angular (keeled) margin of the tube, the pseudo-perforations (arrow) and the involute coiling. Specimen reproduced in Fig. 4b. Mt. Begunjščica, Slovenia. Sample T39, thin section 293. Rhaetian.

2 - Off-centered equatorial section. Same features as in figure 1. Specimen reproduced in Fig. 4c. Mt. Begunjščica, Slovenia. Sample T39, thin section 293. Rhaetian.

3 - Off-centered equatorial section. Mt. Begunjščica, Slovenia. Sample T36, thin section 245A. Rhaetian.

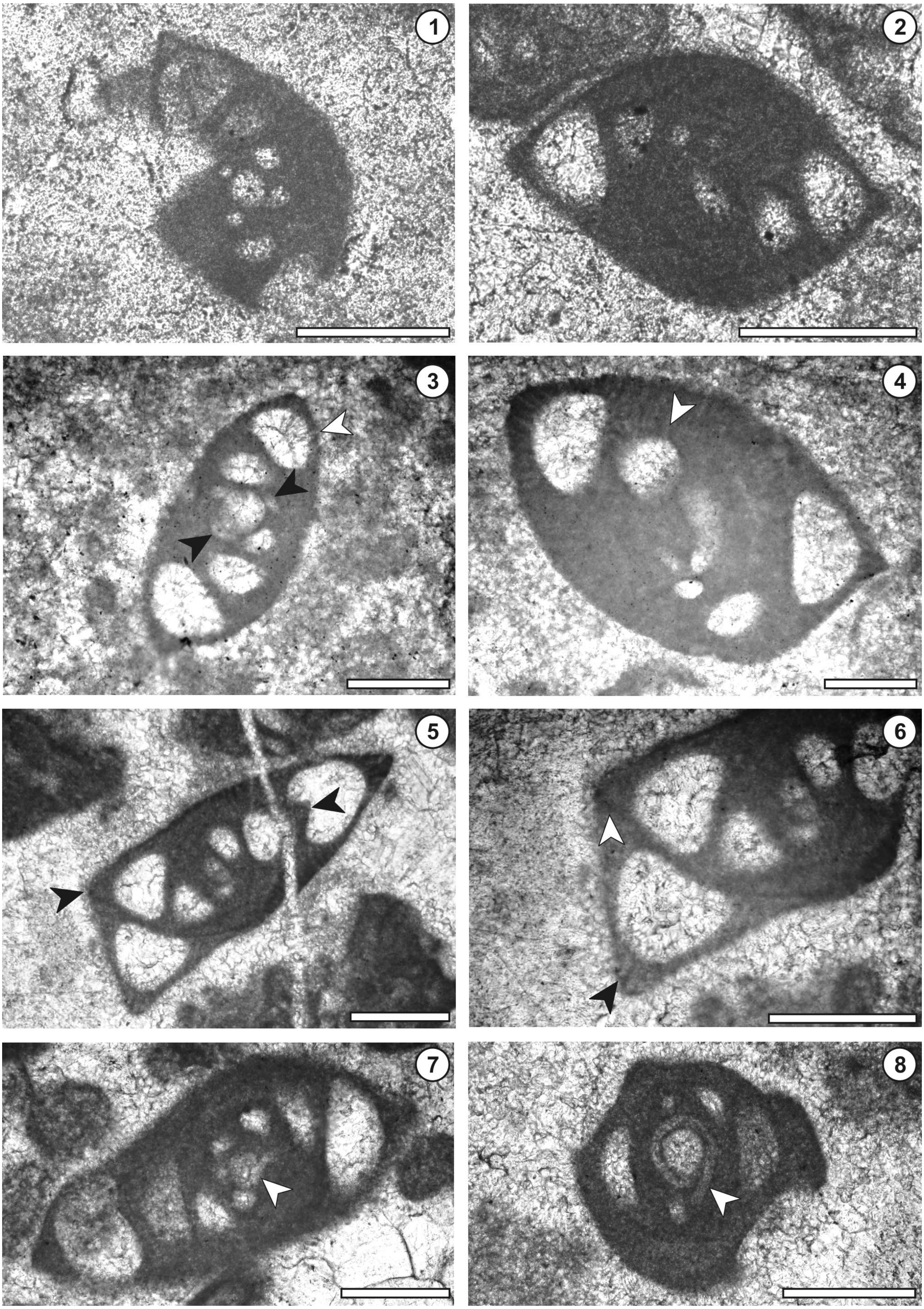
4 - Off-centered equatorial section. Note the flexostyle (arrow) and the involute coiling. Mt. Slatnik, Slovenia. Sample A15.40-15.55, thin section 67. Norian.

5 - Off-centered equatorial section. Mt. Kobla, Slovenia. Sample V76.10-76.45, thin section 173. Rhaetian.

6 - Off-centered and slightly oblique section. Mt. Begunjščica, Slovenia. Sample T39, thin section 293. Rhaetian.

Fig. 7 - *Miliolipora cuvillieri*. Equatorial section. Note the quinqueloculine arrangement of the chambers, the lack of keel and the absence of lateral thickening. Sample T69B, thin section 247. Rhaetian.

Scale bar 100 µm (Figs 4, 7), 200 µm (Figs 1-3, 5-6).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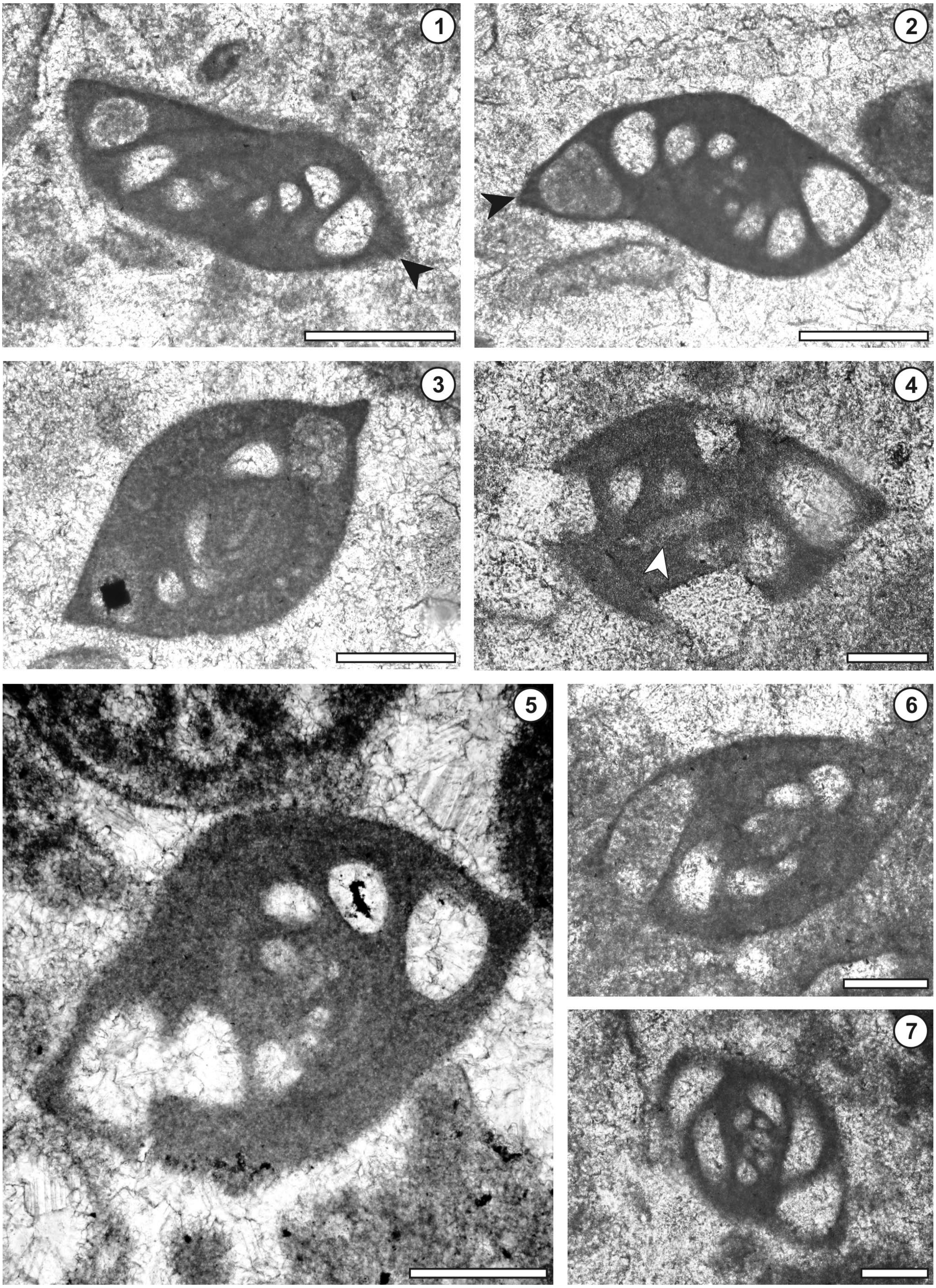
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1982); Norian and/or Rhaetian, Sambosan Accretionary Complex, Japan (Chablais et al., 2011); Norian and/or Rhaetian, Jabal Kawr and Jabal Wasa, Oman (Bernecker, 1996); Rhaetian, Iran (Senowbari-Daryan et al., 2010); Norian and Rhaetian, Julian Alps and Karavanke Mts, Slovenia (Gale et al., 2011, 2012b; Gale, 2012; this work); Rhaetian, Seram, Indonesia (Al-Shaibani et al., 1983), Rhaetian, Northern Calcareous Alps, Austria (Wurm, 1982; Matzner, 1986).

CONCLUSIONS

Decapoalina Gale, Rettori & Martini n. gen. is characterized by sigmoidally arranged post-embrionic chambers, an involute coiling, a keeled margin and a pseudo-perforated porcelaneous wall. *Decapoalina*, presently being monospecific, ranges from Norian to Rhaetian in age. It is commonly associated with reef facies.

Decapoalina is homeomorphic with Anisian to Carnian *Karaburunia* Langer, 1968 and with Eocene to Recent *Sigmoilina* Schlumberger, 1887. Yet, both of the latter genera lack pseudo-perforations. In addition, *Karaburunia* lacks a keeled margin. The Carnian genus *Ophthalmipora* Zaninetti & Brönnimann, 1972 has a less pronounced sigmoidal arrangement of chambers and an evolute coiling, though its wall is likewise perforated.

The pseudo-perforations and the porcelaneous wall of *Decapoalina* are sufficient criteria for its placement into the superfamily Milioliporoidea, family Milioliporidae.

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