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Most abundant Middle Miocene rotaliinas (suborder Rotaliina, Foraminifera) of Kozjansko (Eastern Slovenia)

Najpogostejše srednjemiocenske rotaliine (podred Rotaliina, Foraminifera) Kozjanskega (vzhodna Slovenija)

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Abstract

This research presents the most numerous Middle Miocene foraminifera of the suborder Rotaliina from the Planina syncline in Kozjansko. 85 species and 2 subspecies have been identified. The species that show abundance in samples are: *Angulogerina angulosa, Trifarina bradyi, Sphaeroidina bulloides, Cibicidoides ungerianus, Nonion commune, Melonis pompilioides, Pullenia bulloides, Heterolepa dutemplei, Hansenisca soldanii* and *Hanzawaia boueana*.

Izvleček

V nalogi so predstavljene najpogostejše srednjemiocenske foraminifere podreda Rotaliina iz Planinske sinklinale na Kozjanskem. Izmed 85 določenih rotaliinskih vrst in 2 podvrst so po številu vzorcev, v katerih se pojavljajo, in po deležu hišic znotraj večine teh vzorcev najštevilčnejše naslednje vrste: *Angulogerina angulosa, Trifarina bradyi, Sphaeroidina bulloides, Cibicidoides ungerianus, Nonion commune, Melonis pompilioides, Pullenia bulloides, Heterolepa dutemplei, Hansenisca soldanii* in *Hanzawaia boueana*.

Introduction

The foraminiferal suborder Rotaliina was established in 1896 by Delage & Herouard as the suborder Rotalidae (renamed in Rotaliina in 1961 by Loeblich and Tappan) (Loeblich & Tappan, 1987). It represents the second largest foraminiferal suborder, comprising 628 genera according to Loeblich & Tappan (1987). The suborder includes benthic foraminifera with multilocular tests that have a perforated hyaline calcite wall of a lamellar structure. Other test characteristics show great variety; test is typically spiral or may be reduced to triserial, biserial and uniserial growth. Chambers can be simple or subdivided by septulae. The surface can be smooth, costate, striate, cancellate or papillate. The aperture can be simple or contain internal toothplate or other structures (Loeblich & Tappan, 1987). A simple to very complex internal canal system may be developed (Billman et al., 1980).

Rotaliinas show a wide tolerance to environment parameters: substrates, water depth, temperature, salinity and availability of food. They also show great variety in their mode of life, being either infaunal, semi-infaunal or epifaunal. In the case of an epifaunal mode they are either sessile attaching to hard substrates or completely mobile on the substrates surface. The strength of the wave action being important, in high-energy environments there is a preference for attachment to hard substrates. Their depth habitat has been shown to range from the shelf (< 180 m) to the abyssal plane (> 4000 m). They are found in water with temperatures ranging from cold to warm. They are euryhaline with specimens being found in brackish (< 32‰), marine (32-37‰) or hypersaline (> 37‰). They exhibit a range of trophic mechanisms: passive suspension feeding, herbivore, detritivore and rarely parasitic (Murray, 1991), in shallow nutrient poor waters symbiosis with diatoms has also been identified (Billman et al., 1980; Murray, 1991).

Foraminifera of the suborder Rotaliina have existed from the Triassic (Loeblich & Tappan, 1987). Due to the great diversity, fossil and recent species are recognized globally.

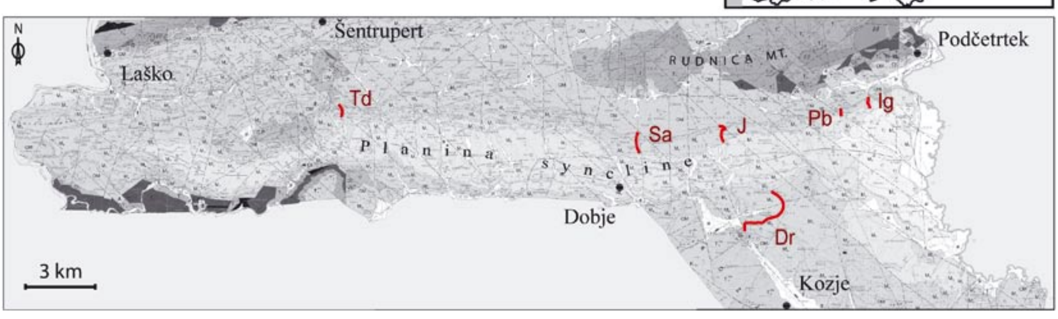
In this research, rotaliinas were studied from six sections; Imenska Gorca, Plohov breg, Javoršica, Sveta Ana, Trobni Dol and Drensko Rebro (Fig. 1). The investigated area is located mostly on the northern flank of the Planina syncline, only the Drensko Rebro section lies on its southern flank (Buser, 1977, 1979; Aničić & Juriša, 1984, 1985; Aničić & Ogorelec, 1994/95, 1996; Aničić et al.; 2002, 2004). Results show that rotaliinas have great diversity and abundance in the Planina syncline. Previous researches have shown that rotaliinas are numerous also in other Slovenian Middle Miocene sedimentary sequences. Although they represent a significant proportion of foraminiferal assemblages, they have not been described and mostly not imaged in the Slovenian literature previously.

Methods

Six sections within the Planina syncline were selected for the micropalaeontological research: Imenska Gorca, Plohov breg, Javoršica, Sveta Ana, Trobni Dol and Drensko Rebro (Fig. 1). One hundred and fifty nine samples, consisting of marly calcarenite and marl, were taken. The samples range from the Early Lower Badenian to Early Sarmatian. According to Oblak (2006), the following foraminiferal biozones are involved in this stratigraphic range: the Lower Badenian Lower Lagenidae and Upper Lagenidae Zones, the Middle Badenian *Pseudotriplasia robusta* Zone and *Uvigerina* cf. *pygmea* Zone, the Upper Badenian *Bolivina dilatata* Zone and *Virgulinella pertusa* Zone and the Sarmatian *Anomalinoides dividens* Zone and *Elphidium hauerinum* Zone (Tab. 1). The younger Sarmatian *Elphidium hauerinum* Zone lacks rotaliinas. One hundred and sixteen benthic species were described and classified according to Loeblich & Tappan foraminiferal classification (1987). Electron images of spiral, umbilical and side views were taken using the Jeol T330A scanning electron microscope at the Ivan Rakovec Institute of Palaeontology, ZRC SAZU.

Figure 1. Location map of studied sections in the Planina syncline (modified after Geological Map of Kozjansko (Slovenia), 1:50 000, Aničić et al., 2004): Td (Trobni Dol), Sa (Sveta Ana), J (Javoršica), Pb (Plohov breg), Ig (Imenska Gorca) and Dr (Drensko Rebro).

Slika 1. Položaj obravnavanih profilov v Planinski sinkinali (prirejeno po Geološki karti Kozjanskega (Slovenija), 1:50 000, Aničić et al., 2004): Td (Trobni Dol), Sa (Sveta Ana), J (Javoršica), Pb (Plohov breg), Ig (Imenska Gorca) and Dr (Drensko Rebro).



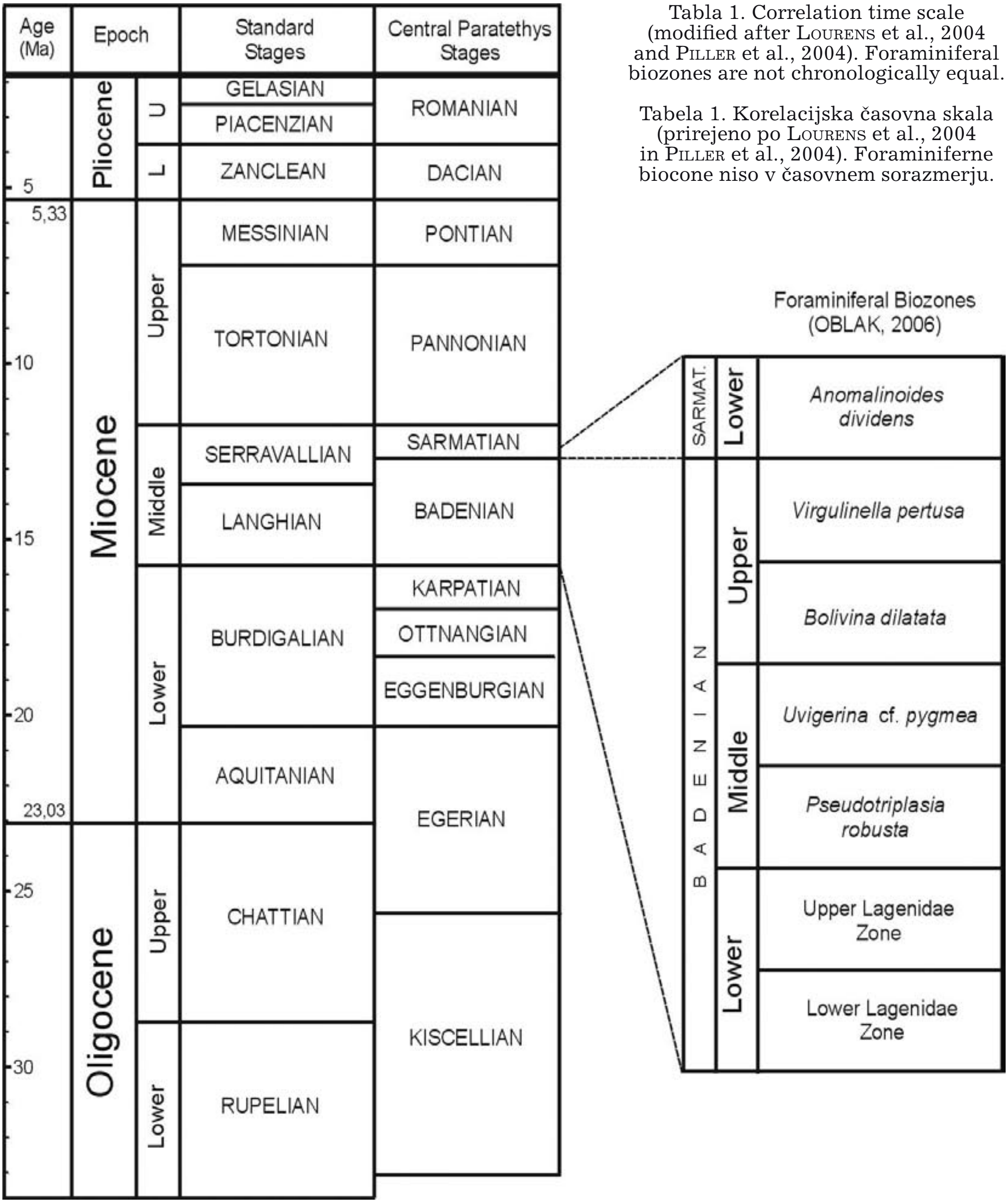


Tabla 1. Correlation time scale (modified after Lourens et al., 2004 and Piller et al., 2004). Foraminiferal biozones are not chronologically equal.

Tabela 1. Korelacijska časovna skala (prirejeno po Lourens et al., 2004 in Piller et al., 2004). Foraminiferne biocone niso v časovnem sorazmerju.

Results

Rotaliinas of the investigated area

From 159 Middle Miocene samples taken from all sections, eighty five species and two subspecies of the foraminiferal suborder Rotaliina have been determined:

Bolivina antiqua d'Orbigny,
Bolivina crenulata Cushman
Bolivina dilatata dilatata Reuss
Bolivina dilatata maxima Cicha & Zapletalová
Bolivina hebes Macfadyen
Bolivina pokornyi Cicha & Zapletalová
Bolivina viennensis Marks

Lapugyina schmidi Popescu
Loxostomoides zsigmondyi (Hantken)
Cassidulina laevigata d'Orbigny
Globocassidulina oblonga (Reuss)
Globocassidulina subglobosa (Brady)
Ehrenbergina serrata Reuss
Hopkinsina bononiensis (Fornasini)
Bitubulogenerina reticulata Cushman
Bulimina buchiana d'Orbigny
Globobulimina pupoides (d'Orbigny)
Globobulimina pyrula (d'Orbigny)
Pappina neudorfensis (Toula)
Uvigerina aculeata d'Orbigny
Uvigerina acuminata Hosius
Uvigerina bellicostata Łuczkowska
Uvigerina brunnensis Karrer
Uvigerina macrocarinata Papp & Turnovsky
Uvigerina cf. *pygmea* d'Orbigny
Uvigerina pygmoides Papp & Turnovsky
Uvigerina semiornata d'Orbigny
Uvigerina venusta Franzenau
Angulogerina angulosa (Williamson)
Trifarina bradyi Cushman
Reussella spinulosa (Reuss)
Coryphostoma digitalis (d'Orbigny)
Fursenkoina acuta (d'Orbigny)
Sigmavirgulina tortuosa (Brady)
Virgulinella pertusa (Reuss)
Caucasina elongata (d'Orbigny)
Caucasina gutsulica (Livental)
Caucasina subulata (Cushman & Parker)
Nodosarella rotundata (d'Orbigny)
Pleurostomella alternans Schwager
Myllostomella recta (Palmer & Bermúdez)
Neugeborina longiscata (d'Orbigny)
Orthomorphina dina (Venglinski)
Orthomorphina pupoides (Silvestri)
Siphonodosaria consobrina (d'Orbigny)
Siphonodosaria scripta (d'Orbigny)
Siphonodosaria verneuilii (d'Orbigny)
Stilostomella adolphina (d'Orbigny)
Baggina dentata Hagn
Cancris auriculus (Fichtel & Moll)
Valvulineria complanata (d'Orbigny)
Neoeponides schreibersii (d'Orbigny)
Rosalina obtusa d'Orbigny
Sphaeroidina bulloides d'Orbigny
Conorbella patelliformis (Brady)
Heronallenia sp.
Schackoinella imperatoria (d'Orbigny)
Siphonina reticulata (Czjzek)
Cibicidoides pseudoungerianus (Cushman)
Cibicidoides ungerianus (d'Orbigny)
Fontbotia wuellerstorfi (Schwager)
Lobatula lobatula (Walker & Jacob)
Planorbulina mediterranensis d'Orbigny
Nonion commune (d'Orbigny)
Nonionella turgida (Williamson)
Astrononion stelligerum (d'Orbigny)
Melonis pompilioides (Fichtel & Moll)
Pullenia bulloides (d'Orbigny)
Pullenia quinqueloba (Reuss)
Allomorphina trigona Reuss
Chilostomella oolina Schwager
Chilostomella ovoidea Reuss
Quadrimorphina petrolei (Andreae)
Oridorsalis umbonatus (Reuss)
Anomalinoides badenensis (d'Orbigny)
Heterolepa dutemplei (d'Orbigny)
Hansenisca soldanii (d'Orbigny)
Hanzawaia boueana (d'Orbigny)
Riminopsis boueanus (d'Orbigny)
Pararotalia aculeata (d'Orbigny)
Ammonia beccarii (Linnaeus)
Elphidiella sp.
Elphidium aculeatum (d'Orbigny)
Elphidium crispum (Linnaeus)
Elphidium fichtellianum (d'Orbigny)
Elphidium hauerinum (d'Orbigny)
Elphidium josephinum (d'Orbigny)
Elphidium reginum (d'Orbigny)
Porosononion granosum (d'Orbigny)

The following ten species were recognized to be particularly abundant through the sections: *Angulogerina angulosa, Trifarina bradyi, Sphaeroidina bulloides, Cibicidoides ungerianus, Nonion commune, Melonis pompilioides, Pullenia bulloides, Heterolepa dutemplei, Hansenisca soldanii* and *Hanzawaia boueana*. They occur in samples of the Lower Badenian Lower Lagenidae Zone to the Upper Badenian *Virgulinella pertusa* Zone, a few range up to the Lower Sarmatian *Anomalinoides dividens* Zone (Oblak, 2006). Beside a great stratigraphic range, these species show high abundance inside particular samples (Tab. 2).

Taxonomy of most abundant rotaliinas of the investigated area

Ordo Foraminiferida Eichwald, 1830
Subordo Rotaliina Delage & Herouard, 1896
Superfamilia Buliminacea Jones, 1875
Familia Uvigerinidae Haeckel, 1894
Subfamilia Angulogerininae Galloway, 1933
Genus *Angulogerina* Cushman, 1927

Angulogerina angulosa (Williamson, 1858)
(Pl. 1, figs. 1a–b)

1858 *Uvigerina angulosa* – Williamson, 67, pl. 5, fig. 140.
1960 *Angulogerina angulosa* (Williamson) – Barker, 154, pl. 74, figs. 15–16.
1979 *Trifarina angulosa* (Williamson) – Popescu, 36, pl. XXI, fig. 6.
1982 *Trifarina angulosa* (Williamson) – Dondi & Barbieri, tav. XXXVII, fig. 3.
1986 *Trifarina angulosa* (Williamson) – Belanger & Berggren, 336, pl. 3, fig. 4.
1987 *Angulogerina angulosa* (Williamson) – Loeblich & Tappan, pl. 574, figs. 5-9.
1987 *Trifarina angulosa* (Williamson) – Wenger, 282, Taf. 9, Fig. 21-22.
1991 *Angulogerina angulosa* (Williamson) – Cimerman & Langer, 63, pl. 66, figs. 3–4.
1993 *Angulogerina angulosa* (Williamson) – Hottinger et al., 100, pl. 126, figs. 1–7.
1993 *Angulogerina angulosa* (Williamson) – Sgarrella & Moncharmont Zei, 215, pl. 16, fig. 8.
1996 *Trifarina angulosa* (Williamson) – Violanti, 46, pl. 9, figs. 11–12.
1998 *Angulogerina angulosa* (Williamson) – Cicha et al., 80, pl. 54, figs. 5–6.
1998 *Angulogerina angulosa* (Williamson) – Rögl, 137, Taf. 4, Fig. 8.
2003 *Trifarina angulosa* (Williamson) – Murray, 26, pl. 51, fig. 1–6.
2003 *Angulogerina angulosa* (Williamson) – Rögl & Spezzaferri, pl. 6, fig. 2.

Material: Numerous tests in samples from six sections (Tab. 2).

Description: Small elongated test is triserial in its early part but later a tendency toward uniserial growth appears. Transverse section is circular in an initial triserial stage, and triangular in the main later stage. Test is thickest at the half of the length. It is about 2–2.5 times as long as thick. Chambers are slightly inflated and enlarge gradually as added. They are arranged in about five whorls. Sides of the test are convex due to chamber inflatedness. The three angles of the test are carinate, more intensively toward the aperture. Sutures are curved and depressed. Wall is calcareous and optically radial. It is finely perforated. The surface is ornamented by fine longitudinal costae that are usually not continuous over the sutures. Aperture is terminal; it is developed at the end of a short neck and it is bordered by a lip. It is provided with a toothplate.

Remark: In this study, specimens show a variety of ornamentation and flatness of angels. Specimens with more carinate angels are usually less ornamented; such tests are in literature cited also as *Angulogerina carinata* Cushman (Barker, 1960). Specimens of this study show intermediate forms therefore they are all determined as the species *Angulogerina angulosa*.

Size: Test length is 0.26 mm and thickness about 0.1 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Early Upper Badenian (*Bolivina dilatata* Zone).

Occurrence: The species was first described on recent specimens from Great Britain. In Australia, it is known from the Upper Oligocene to Lower Miocene (Li & McGowran, 2000), in Italy from the Oligocene (Poignant, 1983) to Pleistocene (Dondi & Barbieri, 1982: Langhian to Pleistocene, Dieci, 1959: Miocene to Pleistocene, Giannini & Tavani, 1960: Miocene, Pliocene), in the North Atlantic from the Miocene and Pliocene (Belanger & Berggren, 1986), and in Germany and Scandinavian from Pleistocene (Wiegank, 1972).

The species is extant; it is known from the North and South Atlantic, Indian Ocean, North and South Pacific (Longinelli, 1956; Wiegank, 1972; Dieci, 1959: Pacific, Barker, 1960: South Pacific, Loeblich & Tappan, 1987; Debenay & Konate, 1987; Debenay et al., 1987; Murray, 2003: North Atlantic), it is common from the Antarctica and Sub Antarctica (Violanti, 1996). It is noted also from the Mediterranean Sea (Parisi, 1981; Debenay et al., 1987; Sgarrella & Moncharmont Zei, 1993) and the Adriatic Sea (Cimerman & Langer, 1991).

In the Central Paratethys, it exists from the Lower Kiscellian to the end of the Badenian (Cicha et al., 1998). In Bavaria, it is noted from the Kiscellian to Ottnangian (Reiser, 1987: Lower Rupelian – Lower Egerian, Wenger, 1987: Upper Egerian – Middle Ottnangian), in Austria from the Karpatian (Rögl, 1998) and Early Lower Badenian (Rögl & Spezzaferri, 2003), and in Romania from the Upper Badenian (Popescu, 1979).

In Slovenia, the fossil specimens of the species have not been determined yet. The species is described and imaged only on recent specimens of the Adriatic Sea (Cimerman & Langer, 1991).

Ecology and palaeoecology: Miocene specimens from Romania are recorded from the pelitic facies (Popescu, 1979). The extant species prefers sandy sediments of the outer shelf and uppermost bathyal (continental slope), influenced by strong bottom currents (Violanti, 1996; after Mackensen et al., 1990). The species is reported from 18 to 3000 m (inner sublittoral to bathyal), of temperature range from 0 to 16°C (sub-arctic to temperate-cold) (Wiegank, 1972). It is a euhaline species (Wiegank, 1972: salinity above 34‰, Rögl, 1998). In the North Atlantic, the species is reported from the shore down to 2900 m, in the South Atlantic from 180 to 1800 m, in the India Ocean down to 2000 m, in the North Pacific down to 720 m and in the South Pacific from 15 to 2450 m (Dieci, 1959). In the Mediterranean, the species is extant in the circalittoral and particularly in the bathyal, in the Northern Adriatic Sea also in the infralitoral. The deepest occurrence is noted at 2860 m in the Tyrrhenian Sea (Sgarrella & Moncharmont Zei, 1993). In the Adriatic Sea, it was noticed also in detritus from cliff face at 35 m (Cimerman & Langer, 1991).

Genus *Trifarina* Cushman, 1923

Trifarina bradyi Cushman, 1923
(Pl. 1, figs. 2a–b)

1923 *Trifarina bradyi* – Cushman, U. S. Nat. Mus., Bull., 104(4), 99, pl. 22, figs. 3a–9b (Ellis & Messina, 1940).
1959 *Trifarina bradyi* Cushman – Dieci, 75, tav. VI, fig. 16.
1960 *Trifarina bradyi* Cushman – Premoli Silva, 569, tav. LVI, fig. 2.
1975 *Trifarina bradyi* Cushman – Popescu, 79, pl. LXXX, figs. 1a, b.
1982 *Trifarina bradyi* Cushman – Dondi & Barbieri, tav. XXXVII, fig. 5.
1987 *Trifarina bradyi* Cushman – Loeblich & Tappan, pl. 574, figs. 10–13.
1987 *Trifarina bradyi* Cushman – Wenger, 283, Taf. 9, Fig. 25–26.
1994 *Trifarina bradyi* Cushman – Bolli et al., 358, fig. 80.32.
1998 *Trifarina bradyi* Cushman – Cicha et al., 132, pl. 54, figs. 13–15.

Material: Numerous tests in samples from five sections (Tab. 2).

Description: Test is small, elongated and regularly triangular in transverse section. It is thickest in the upper third of the length. It is about twice times as long as thick. Sides of the test are flush or slightly concave. The early stage is triserial; later the test becomes uniserial and usually slightly twisted. Up to seven chambers that enlarge gradually are visible on each side. The three angles of the test are distinctly carinate in the whole length; from the initial part of the test up to the end of the neck. Sutures are thickened, curved and flush or depressed. Wall is calcareous, optically radial and finely perforated. The surface is smooth. Terminal aperture is developed at the end of a short neck. It is bordered by a lip and provided with a toothplate.

Size: Test length is 0.28 mm and thickness 0.12 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Late Middle Badenian (*Uvigerina* cf. *pygmea* Zone).

Occurrence: The species was first described on recent specimens from the Caribbean Sea. It appears for the first time in the Oligocene (Giannini & Tavani, 1960). In Australia, it is known from the Upper Oligocene to the end of Miocene (Li & McGowran, 2000), in Italy from the Aquitanian to Pleistocene, it is numerous particularly in the Pliocene (Dondi & Barbieri, 1982, Premoli Silva, 1960: Langhian, Dieci, 1959: Tortonian to Pleistocene, Giannini & Tavani, 1960: Miocene, Pliocene), in South America from the Lower and Middle Miocene (Bolli et al. 1994), and in Algeria from the Messinian (Poignant & Moissette, 1992).

The species is extant. It is known from the North and South Atlantic, Pacific (Longinelli, 1956; Barker, 1960: Pacific) and according to Dieci (1959), also from the Mediterranean. In view of Sgarrella & Moncharmont Zei (1993), the tests found on the Mediterranean bottom are most likely reworked from the Pliocene and Pleistocene sediments; the species is not extent any more in the Mediterranean.

In the Central Paratethys, it is known from the Upper Eocene to the end of the Badenian (Cicha et al., 1998); e.g. in Bavaria from the Kiscellian to Ottnangian

(Reiser, 1987: Lower Rupelian – Lower Egerian, Wenger, 1987: Eggenburgian – Middle Ottnangian), and in Romania from the Lower and Middle Miocene (Popescu, 1975).

In Slovenia, the fossil species has not been determined yet.

Ecology and palaeoecology: The genus *Trifarina* is infaunal and characteristically found in temperate to cold marine environments of depths ranging from 0 to 400 m; from the shelf to upper bathyal (Murray, 1991). Karpatian specimens from the Central Paratethys are reported mostly from the euhaline assemblages (Cicha & Zapletalová, 1967). Extant specimens occur in the depth-range from 700 to 2450 m in the North Atlantic, from 630 to 1210 m in the South Atlantic (Dieci, 1959), and from 22 to 500 m in the South Pacific (Longinelli, 1956).

Superfamilia Discorbacea Ehrenberg, 1838
Familia Sphaeroidinidae Cushman, 1927
Genus *Sphaeroidina* d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny, 1826
(Pl. 2, figs. 1a–b)

1826 *Sphaeroidina bulloides* – d'Orbigny, 101.
1956 *Sphaeroidina bulloides* d'Orbigny – Longinelli, 175, tav. X, fig. 1.
1959 *Sphaeroidina bulloides* d'Orbigny – Dieci, 87, tav. VII, figg. 18–19.
1960 *Sphaeroidina bulloides* d'Orbigny – Premoli Silva, 560, tav. LVI, figg. 1a–b.
1975 *Sphaeroidina bulloides* d'Orbigny – Popescu, 72, pl. XLIX, figs. 10a–b.
1985 *Sphaeroidina bulloides* d'Orbigny – Papp & Schmid, 96, Taf. 90, Fig. 7–12.
1986 *Sphaeroidina bulloides* d'Orbigny – Belanger & Berggren, 332, pl. 1, fig. 18.
1987 *Sphaeroidina bulloides* d'Orbigny – Wenger, 302, Taf. 14, Fig. 11–12.
1993 *Sphaeroidina bulloides* d'Orbigny – hottinger et al., 113, pl. 147, figs. 4–11.
1995 *Sphaeroidina bulloides* d'Orbigny – Yassini & Jones, 160, figs. 936–937.
1998 *Sphaeroidina bulloides* d'Orbigny – Cicha et al., 127, pl. 60, fig. 4.
1998 *Sphaeroidina bulloides* d'Orbigny – Robertson, 196, pl. 74, figs. 4a–c.
2003 *Sphaeroidina bulloides* d'Orbigny – Rögl & Spezzaferri, pl. 6, Fig. 24.

Material: Numerous tests in samples from all six sections (Tab. 2).

Description: Test is subglobular and involute. It is built of tightly embracing hemispherical chambers that enlarge rapidly in size. There are four chambers in the last whorl. Periphery is broadly rounded. Sutures are flush or slightly depressed and hardly visible. Wall is calcareous and optically radial. Surface is smooth and very finely perforate. Interiomarginal narrow crescentic aperture is developed near the junction of last three chambers. It is bordered by a lip and it is provided with an apertural plate.

Remark: In this study, tests are mostly subglobular, although rare more lobed forms may be present. Similar lobed tests are classified in the species *Sphaeroidina bulloides* also in the literature (Wenger, 1987).

Size: Test height is 0.35 mm and thickness 0.3 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Late Upper Badenian (*Virgulinella pertusa* Zone). Rare reworked tests were found also in the Lower Sarmatian samples (*Anomalinoides dividens* Zone).

Occurrence: Recent specimens from the Adriatic Sea (Italy) and fossil specimens from Sienna (Italy) are noted by the first description of the species (d'Orbigny, 1826). According to Papp and Schmid (1985), the species first appeared in the Eocene; while Bartolini (1966) gives an earlier first occurrence, placing it in the Cretaceous. In Middle America, the species is noted from the Lower Oligocene to Lower Pliocene (Robertson, 1998), in Italy from the Lower Oligocene to Pleistocene (Dondi & Barbieri, 1982; Barbieri & d'Onofrio, 1984: Middle Miocene, Giannini & Tavani, 1960: Miocene, Pliocene), in Australia from the Upper Oligocene to the end of Miocene (Li & McGowran, 2000), in the North Atlantic from the Middle Miocene to Pliocene (Belanger & Berggren, 1986), in Algeria from the Messinian (Poignant & Moissette, 1992), in South America from the Miocene (Hasson & Fischer, 1986), in Spain and California from the Pliocene (Longinelli, 1956), in the Indian Ocean from the Pliocene and

Pleistocene (Basov & Krasheninnikov, 1995), and in the Arabian Sea from the Quaternary (den Dulk et al., 1998).

The species is extant and is cosmopolitan (Papp & Schmid, 1985; Robertson, 1998; Barker, 1960: North Atlantic and Pacific; Hottinger et al. 1993: Red Sea). It is noted also from the Mediterranean Sea (Sgarrella & Moncharmont Zei, 1993).

In the Central Paratethys, it appears from the Lower Kiscellian to the end of the Badenian (Cicha et al., 1998) and it is numerous in the Badenian (Cicha & Zapletalová, 1967). In Romania, it is known from the Oligocene to Middle Miocene (Popescu, 1975), in Croatia (Šikić, 1985) and Hungary (Sztràkos, 1979) from the Upper Kiscellian, in Bavaria from the Kiscellian to Ottnangian (Reiser, 1987: Lower Rupelian – Lower Egerian, Wenger, 1987: Upper Egerian – Middle Ottnangian), in Austria from the Karpatian (Rögl, 1998) and Early Lower Badenian (Rögl & Spezzaferri, 2003), and in Poland from the Badenian (Szczechura, 2000)

In Slovenia, the species has not been described and imaged yet. It is only noted from Lower Egerian to Upper Badenian sediments. It is mentioned from Lower Egerian of the Laško syncline (Petrica et al., 1995; Dozet et al., 1999; Rijavec, 1976a, 1984) and Planina syncline (Rijavec, 1977), from the Upper Egerian of the Laško syncline (Rijavec, 1984; Dozet & Rijavec, 1994; Dozet et al., 1996; 1999) and Planina syncline (Rijavec, 1977; Rijavec & Dozet, 1996), from the Eggenburgian of the Laško syncline (Rijavec, 1984), from the Lower Badenian of the Celje syncline (Rijavec, 1978a), Laško syncline (Rijavec, 1976a, 1984; Dozet & Rijavec, 1994; Dozet et al., 1999), Planina syncline between Trobni Dol and Rudnica mountain (Rijavec & Dozet, 1996) and by Virštanj (Rijavec, 1977), and of the Bizeljsko syncline (Dozet et al., 1998). It is known also from the Middle Badenian of the Celje syncline (Rijavec, 1975, 1978a), Laško syncline (Rijavec, 1976a, 1984), Planina syncline by Planina pri Sevnici (Rijavec, 1977), and of the Bizeljsko syncline (Dozet et al., 1998). From the Upper Badenian, it appears in Slovenske gorice (Rijavec, 1974), Laško syncline (Rijavec, 1976a, 1984) and Senovo syncline (Dozet et al., 1998).

Ecology and palaeoecology: Fossil specimens from the Central Paratethys are characteristically found in sediments from the outer shelf (deepest neritic) to bathyal (Cicha & Zapletalová, 1967). Extant specimens prefer cool bottom waters (Rögl & Spezzaferri, 2003) and is a suboxic indicator (den Dulk et al., 1998). They occur deeper than 100 m (Wenger, 1987: after Phleger 1960). In the North Atlantic, it occurs in the depth-range from 160 to 3100 m, in the South Atlantic from 760 to 4200, in the North Pacific from 180 to 3700 m, and in the South Pacific from 70 to 2500 (Dieci, 1959). On the Australian coast, it is reported from the outer shelf and bathyal (continental slope) (Yassini & Jones, 1995). In the Mediterranean, it is characteristic for muds of the circalittoral and bathyal; it appears down to 1300 m (Sgarrella & Moncharmont Zei, 1993).

Superfamilia Discorbinellacea Sigal, 1952
Familia Parrelloididae Hofker, 1956
Genus *Cibicidoides* Thalmann, 1939

Cibicidoides ungerianus (d'Orbigny, 1846)
(Pl. 2, figs. 2a–c)

1846 *Rotalina ungeriana* – d'Orbigny, 157, Tab. VIII, fig. 16–18.
1959 *Cibicides ungerianus* (d'Orbigny) – Dieci, 102, tav. VIII, fig. 17.
1960 *Cibicides ungerianus* (d'Orbigny) – Giannini & Tavani, 56, tav. IX, fig. 2–4.
1967 *Cibicides ungerianus* (d'Orbigny) – Cicha & Zapletalová, 142, Taf. 13A, Fig. 1a–c.
1975 *Cibicidoides ungerianus* (d'Orbigny) – Popescu, 104, pl. LXXXV, figs. 1a–c.
1979 *Cibicidoides ungerianus* (d'Orbigny) – Sztràkos, pl. 30, figs. 4a–b.
1985 *Cibicides ungerianus* (d'Orbigny) – Papp & Schmid, 60, Taf. 51, Fig. 7–11.
1998 *Cibicidoides ungerianus ungerianus* (d'Orbigny) – Cicha et al., 91, pl. 61, figs. 15–17.
2003 *Cibicidoides ungerianus* (d'Orbigny) – Rögl & Spezzaferri, pl. 6, figs. 26–29.

Material: Numerous tests in samples from all six sections (Tab. 2).

Description: Biconvex biumbonate test is very low trochospiral. Spiral side is evolute and umbilical side involute. Test is nearly circular in equatorial section. There are two and a half to three whorls that enlarge rapidly in size. Last whorl consists of 10–13 chambers. Chambers are low, crescentic in shape and enlarge gradually. Sutures of both sides are curved backward; more distinctly on the spiral side. Whorl suture is flush but hardly visible due to granular ornamentation. Periphery is angular and very slightly lobate in outline. Wall is calcareous and optically radial. It is coarsely perforated on the spiral side and finely perforated on the umbilical side. Surface is smooth apart for typical granular ornamentation, which is developed around the umbo of the spiral side. Narrow arched aperture is interiomarginal and equatorial; it is bordered by a thin lip.

Remark: Reiser (1987) and Cicha et al. (1998) divide the species *Cibicidoides ungerianus* into subspecies *C. ungerianus ungerianus* (d'Orbigny) with weaker ornamentation and *C. ungerianus filicosta* (Hagn) with stronger ornamentation. Specimens from this study correspond to the subspecies *C. ungerianus ungerianus* (d'Orbigny).

Size: Test diameter is 0.58 – 0.6 mm and thickness 0.2 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Early Upper Badenian (*Bolivina dilatata* Zone). Rare reworked tests were found also in the Lower Sarmatian samples (*Anomalinoides dividens* Zone).

Occurrence: The species was first described from the Late Lower Badenian. There is no data about the type locality by the first description (d'Orbigny, 1846). The species appeared in the Oligocene according to Giannini & Tavani (1960), or in the Upper Eocene according to Ascoli (1956) and Gohrbandt (1961). In Italy, it is known from the Upper Eocene (Ascoli, 1956) to Pleistocene (Dondi & Barbieri, 1982: Serravallian to Pleistocene, Dieci, 1959: Miocene, Pliocene), but becomes the most abundant in the Tortonian (Dondi & Barbieri, 1982: Po Valley). In Middle America, it is noted from the Middle Oligocene (Bolli et al., 1994), in the Mediterranean from the Oligocene, and in the Arabian Sea from the Quaternary (den Dulk et al., 1998).

The species is extant (Giannini & Tavani, 1960). It is noted from the Arabian Sea (den Dulk et al., 1998).

In the Central Paratethys, it is known from the Upper Eocene to the Lower Sarmatian (Cicha et al., 1998). In Austria, it is noted from the Upper Eocene (Gohrbandt, 1961) and Early Lower Badenian (Rögl & Spezzaferri, 2003); in the Vienna Basin, it is especially abundant in the whole Lower Badenian (Papp & Schmid, 1985). In Hungary, it is known from the Upper Kiscellian (Sztràkos, 1979), in Bavaria from the Kiscellian and Lower Egerian (Reiser, 1987: Lower Rupelian – Lower Egerian), in Croatia from the Kiscellian (Šikić, 1985) and Upper Badenian (Bajraktarević, 1979, Pikija et al., 1984), in Romania from the Lower and Middle Miocene (Popescu, 1975), and in Poland from the Badenian (Szczechura, 2000)

In Slovenia, the species has not been described yet. It was only imaged from the Upper Eocene (Priabonian) of Socka –Dobrna area (northern of Celje; Cimerman et al., 2006). It is also noted from the Kiscellian to Middle Badenian sediments. It is mentioned from the Kiscellian of Zasavje (Kolar, 1978), from the Lower Egerian of the Laško syncline (Rijavec, 1984; Dozet & Rijavec, 1994; Petrica et al., 1995; Dozet et al., 1999), Planina syncline (Rijavec, 1977; Rijavec & Dozet, 1996) and Senovo syncline (Dozet et al., 1998), from the Upper Egerian of the Celje syncline (Rijavec, 1984), Laško syncline (Rijavec, 1977, 1984; Dozet & Rijavec, 1994; Dozet et al., 1996, 1999) and Planina syncline (Rijavec & Dozet, 1996), from the Lower Badenian of Slovenske gorice (Rijavec, 1976b), Dravinjske gorice (Rijavec, 1975), Celje syncline (Rijavec, 1978a), Laško syncline (Rijavec, 1976a, 1977, 1984; Dozet & Rijavec, 1994; Dozet et al., 1999), Planina syncline between Trobni Dol and Rudnica mountain (Rijavec & Dozet, 1996), by Virštanj and Plohov breg (Rijavec, 1977), and of the Bizeljsko syncline (Dozet et al., 1998). It is noted also from the Middle Badenian of Dravinjske gorice (Rijavec, 1975), Celje syncline (Rijavec, 1978a), Laško syncline (Rijavec, 1976a, 1984; Dozet & Rijavec, 1994), Planina syncline by Trobni Dol (Petrica et al., 1995), between Trobni Dol and Rudnica mountain (Rijavec & Dozet, 1996) and by Planina pri Sevnici (Rijavec, 1977), and of the Bizeljsko syncline (Dozet et al., 1998).

Ecology and palaeoecology: The genus *Cibicidoides* is epifaunal and is believed to attach itself to hard substrates. It is characteristic for cold marine environments of the shelf and bathyal (Murray, 1991). It is an oxic indicator (Rögl & Spezzaferri, 2003). Fossil Badenian specimens of the species *C. ungerianus* from the Central Paratethys are reported from sediments of the shelf (sublittoral to shallow neritic) (Cicha & Zapletalová, 1967).

Superfamilia Nonionacea Schultze, 1854
Familia Nonionidae Schultze, 1854
Subfamilia Nonioninae Schultze, 1854
Genus *Nonion* de Montfort, 1808

Nonion commune (d'Orbigny, 1846)
(Pl. 3, figs. 1a–b)

1846 *Nonionina communis* – d'Orbigny, 106, Tab. V, fig. 7–8.
1959 *Nonion commune* (d'Orbigny) – Dieci, 53, tav. IV, fig. 25a–b.
1967 *Florilus communis* (d'Orbigny) – Cicha & Zapletalová, 136.
1979 *Florilus communis* (d'Orbigny) – Popescu, 46, pl. XXVII, figs. 8a–b.
1985 *Nonion commune* (d'Orbigny) – Papp & Schmid, 45, Taf. 34, Fig. 1–5.
1987 *Florilus communis* (d'Orbigny) – Wenger, 298, Taf. 13, Fig. 15, 19.
1997 *Nonion commune* (d'Orbigny) – Filipescu & Girbacea, pl. VI, fig. 4.
1998 *Nonion commune* (d'Orbigny) – Cicha et al., 113, pl. 66, figs. 1–2.
2003 *Nonion commune* (d'Orbigny) – Rögl & Spezzaferri, pl. 6, fig. 35.
2007 *Nonion commune* (d'Orbigny) – Schütz et al., 457, Taf. 5, Fig. 3a-b.

Material: Numerous tests in samples from all six sections (Tab. 2).

Description: Planispirally enrolled test is involute. It is ovate in outline. Whorls enlarge rapidly in size. There are 9–12 low triangular low chambers in the last whorl. Sutures of both sides are curved backward. Umbilicus is narrow. Periphery is slightly compressed and smooth in outline. Calcareous optically granular wall is very finely perforated. The surface is smooth; except for the umbilical, sutural and apertural regions where numerous distinct pustules are developed. Sutures are curved and depressed. Narrow slitlike aperture is interiomarginal and equatorial. Triangular apertural face is typically well developed.

Size: Test length is 0.4–0.6 mm, width 0.3–0.4 mm and thickness 0.25–0.3 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Early Upper Badenian (*Bolivina dilatata* Zone).

Occurrence: The species was first described from the Tertiary of the Vienna basin. In Algeria, it is known from the Messinian (Poignant & Moissette, 1992).

The species is extant; it is known from the Atlantic (Dieci, 1959; Debenay & Konate, 1987), also from the Adriatic Sea (Dieci, 1959).

In the Central Paratethys, it appears from the Upper Eocene to the end of the Sarmatian (Cicha et al., 1998); e.g. in Hungary, it is known from the Upper Kiscellian (Sztràkos, 1979), in Bavaria from the Kiscellian to Ottnangian (Reiser, 1987: Lower Rupelian – Lower Egerian, Wenger, 1987: Upper Egerian – Middle Ottnangian), in Austria from the Karpatian, Badenian (Papp & Schmid, 1985; Rögl & Spezzaferri, 2003: Early Lower Badenian) and Lower Sarmatian (Schütz et al., 2007), in Romania from the Late Lower Badenian (Filipescu & Girbacea, 1997) and Upper Badenian (Popescu, 1979), and in Croatia from the Upper Badenian (Bajraktarević, 1978).

In Slovenia, the species hasn't been described yet; it was only imaged from the Badenian of the Celje syncline (Rijavec, 1978a). It is also noted from Kiscellian to Middle Badenian sediments. It is mentioned as *Nonion communis* from the Kiscellian of Zasavje (Kolar, 1978). As *Florilus communis*, it is noted from the Upper Egerian of the Celje syncline (Rijavec, 1984), from the Eggenburgian of the Laško syncline (Petrica et al., 1995; Rijavec & Dozet, 1996), from the Lower Badenian of Dravinjske gorice (Rijavec, 1975), of the Celje syncline (Rijavec, 1978a), Laško syncline (Rijavec, 1976a, 1977, 1984; Dozet & Rijavec, 1994; Dozet et al., 1999), Planina syncline between Trobni Dol and Rudnica mountain (Rijavec & Dozet, 1996), by Virštanj and Plohov breg (Rijavec, 1977), and of the Bizeljsko syncline (Dozet et al., 1998). It appears in the Middle Badenian of the Celje syncline (Rijavec, 1978a), Laško syncline (Rijavec, 1976a, 1977, 1984; Dozet et al., 1996), Planina syncline by Planina pri Sevnici and Plohov breg (Rijavec, 1977), and of the Bizeljsko syncline (Dozet et al., 1998).

Ecology and palaeoecology: The genus *Nonion* is infaunal and characteristic for muddy and silty sediments. It occurs in cold to warm waters of the shelf zone from 10 to 180 m (Murray, 1991). Fossil specimens of the species *N. commune* from the Central Paratethys are recorded from sediments of the shelf (deep sublittoral) to bathyal; they are most frequent in sediments of the neritic (Cicha & Zapletalová, 1967). The extant species is characteristic for the shelf of a depth-range from 0 to 180 m (Rögl & Spezzaferri, 2003). It may occur also in brackish waters (Wenger 1987).

Subfamilia Pulleniinae Schwager, 1877
Genus *Melonis* de Montfort, 1808

Melonis pompilioides (Fichtel & Moll, 1798)
(Pl. 3, figs. 2a–b)

1798 *Nautilus pompilioides* – Fichtel & Moll, Test. Micro. Arg. Naut., 31, pl. 2, figs. a–c (Ellis & Messina, 1940).
1956 *Nonion pompilioides* (Fichtel & Moll) – Longinelli, 143, tav. XI, figg. 12a–b.
1959 *Nonion pompilioides* (Fichtel & Moll) – Dieci, 55, tav. IV, figg. 27a–b.
1960 *Nonion pompilioides* (Fichtel & Moll) – Giannini & Tavani, 23, tav. VI, fig. 5.
1969 *Nonion pompilioides* (Fichtel & Moll) – Rögl, 101, Taf. 4, Fig. 11a–b.
1979 *Melonis pompilioides* (Fichtel & Moll) – Popescu, 48, pl. XXVIII, fig. 7a–b.
1985 *Melonis pompilioides* (Fichtel & Moll) – Papp & Schmid, 46, Taf. 36, Fig. 1–5.
1987 *Melonis pompilioides* (Fichtel & Moll) – Wenger, 300, Taf. 13, Fig. 23–24.
1991 *Melonis pompilioides* (Fichtel & Moll) – Cimerman & Langer, 74, pl. 85, figs. 1–4.
1998 *Melonis pompilioides* (Fichtel & Moll) – Cicha et al., 111, pl. 66, figs. 14–15.
1998 *Melonis pompilioides* (Fichtel & Moll) – Robertson, 228, pl. 91, figs. 4a–b.
2003 *Melonis pompilioides* (Fichtel & Moll) – Rögl & Spezzaferri, pl. 7, fig. 9–10.

Material: Numerous tests in samples from all six sections (Tab. 2).

Description: Planispiral test is involute and biumbilicate. It is circular in outline. Last whorl consists of 9–10, rarely of 11 chambers that enlarge gradually as added. Chambers are low and triangular in a side view. Sutures are radial, flush and straight to slightly curved backward; they are hardly visible. In the earlier part of the last whorl they may be thickened. Umbilici of both sides are wide and deep. Periphery is broadly rounded and smooth in outline. Toward the earliest part of the last whorl it can become slightly compressed. Wall is calcareous and optically granular. It is coarsely perforate. Surface is smooth. Apertural face is broad and smooth. Interiomarginal equatorial aperture extends laterally toward the umbilici. It is boarded by a lip.

Size: Test diameter is 0.4 mm and thickness 0.25 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Early Upper Badenian (*Bolivina dilatata* Zone).

Occurrence: There is no data about the type locality and type level in the catalogue (Ellis & Messina, 1940). In South America, it occurs from the Oligocene to Miocene (Robertson, 1998), in Middle America, in the Lower Miocene (Bolli et al., 1994) and Pliocene (Hasson & Fischer, 1986), in Italy from the Tortonian to Pleistocene (Dieci, 1959; Barbieri & d'Onofrio, 1984: Middle Miocene), in Egypt in the Middle Miocene (Cherif et al., 1994), in Algeria in the Messinian (Poignant & Moissette, 1992), and in the Atlantic in the Pleistocene (Lévy et al., 1998).

The species is extant; it is known from the Pacific and Atlantic (Robertson, 1998; Barker, 1960: Eastern Atlantic). It is noted also from the Mediterranean and Adriatic Sea (Cimerman & Langer, 1991).

In the Central Paratethys, it is known from the Upper Eocene to the end of the Badenian (Cicha et al., 1998), according to Papp & Schmid (1985) to the Sarmatian. In Bavaria, it appears from the Kiscellian to Ottnangian (Reiser, 1987: Upper Rupelian – Lower Egerian, Wenger, 1987: Upper Egerian – Middle Ottnangian), in Austria in the Karpatian (Rögl, 1969) and Early Lower Badenian (Rögl & Spezzaferri, 2003), in Romania in the Upper Badenian (Popescu, 1979), and in Poland in the Badenian (Szczechura, 2000).

In Slovenia, the species has not been described and imaged yet. It is only noted from the Karpatian of Slovenske gorice (JELEN & RIFELJ, 2003), and from the Lower Badenian of the Celje syncline (RIJAVEC, 1984) and Bizeljsko syncline (DOZET et al., 1998).

Ecology and palaeoecology: The genus *Melonis* is infaunal and occurs on the muddy and silty bottom of the shelf and bathyal zones. It is characteristic for cold marine waters (temperature below 10°C) (MURRAY, 1991). Fossil specimens of the species *Melonis pompilioides* from Upper Egerian to Ottnangian of Bavaria are most frequent recorded above the shelf/bathyal boundary (neritic/bathyal, WENGER, 1987). The extant species occurs in the depth-range from 50 to 4000 m (RÖGL & SPEZZAFERRI, 2003), and is typical in the range from 1000 to 3000 m (WENGER, 1987). According to older literature, the maximum depth of occurrence has moved downward; in the Atlantic down to 4900 m (LONGINELLI, 1956), in the North Pacific down to 5000 m and in the South Pacific down to 4400 m (DIECI, 1959). In the Tyrrhenian Sea, the tests were found in soft sediments at 130 m, and in the Adriatic Sea in detrital sands at 55 m (CIMERMAN & LANGER, 1991).

Genus *Pullenia* PARKER & JONES, 1862

Pullenia bulloides (D'ORBIGNY, 1846)
(Pl. 4, figs. 1a–b)

1846 *Nonionina bulloides* – D'ORBIGNY, 107, Tab. V, fig. 9–10.
1956 *Pullenia sphaeroides* D'ORBIGNY – LONGINELLI, 174, tav. X, figg. 2–3.
1959 *Pullenia bulloides* (D'ORBIGNY) – DIECI, 87, tav. VII, figg. 16a–b.
1967 *Pullenia bulloides* (D'ORBIGNY) – CICHA & ZAPLETALOVÁ, 137, Taf. 6A, Fig. 8a–b.
1971 *Pullenia bulloides* (D'ORBIGNY) – CICHA et al., 281–282, Taf. 11, Fig. 2-3.
1975 *Pullenia bulloides* (D'ORBIGNY) – POPESCU, 101, pl. LXXXIII, figs. 1a–b.
1982 *Pullenia bulloides* (D'ORBIGNY) – DONDI & BARBIERI, tav. XLIV, fig. 8.
1985 *Pullenia bulloides* (D'ORBIGNY) – PAPP & SCHMID, 45, Taf. 34, Fig. 6–9.
1986 *Pullenia bulloides* (D'ORBIGNY) – BELANGER & BERGGREN, 342, pl. 5, figs. 1a–b.
1987 *Pullenia bulloides* (D'ORBIGNY) – MILLER & KATZ, 136, pl. 4, figs. 4a–b.
1987 *Pullenia bulloides* (D'ORBIGNY) – WENGER, 299, Taf. 13, Fig. 17–18.
1993 *Pullenia bulloides* (D'ORBIGNY) – SGARRELLA & MONCHARMONT ZEI, 240, pl. 24, figs. 12–13.
1995 *Pullenia bulloides* (D'ORBIGNY) – YASSINI & JONES, 181, figs. 966–967.
1998 *Pullenia bulloides* (D'ORBIGNY) – CICHA et al., 121, pl. 66, figs. 12–13.
1998 *Pullenia bulloides* (D'ORBIGNY) – ROBERTSON, 230, pl. 92, figs. 1a–b.
2003 *Pullenia bulloides* (D'ORBIGNY) – RÖGL & SPEZZAFERRI, pl. 7, figs. 11–12.
2005 *Pullenia bulloides* (D'ORBIGNY) – VÉNEC-PEYRÉ, 214–215, Pl. 35, Fig. 2.
2007 *Pullenia bulloides* (D'ORBIGNY) – SCHÜTZ et al., 457, Taf. 5, Fig. 6a–b.

Material: Numerous tests in samples from all six sections (Tab. 2).

Description: Globular test is planispiral by growth. It is involute. Whorls enlarge slowly in size. Last whorl consists of four, rarely of four and a half chambers that are triangular in a side view. They are as long as high and they enlarge slowly as added. Radial sutures are straight and flush. Periphery is rounded and smooth in outline. Umbilicus is very narrow and flush. Wall is calcareous and optically granular; it is very finely perforated. Surface is smooth. Apertural face is very low and broad. Slitlike aperture is interiomarginal and equatorial, extending laterally to the umbilici.

Size: Test diameter is 0.28–0.35 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Early Upper Badenian (*Bolivina dilatata* Zone). Reworked tests were found also in the Lower Sarmatian samples (*Anomalinoides dividens* Zone).

Occurrence: The species was first described from the Late Upper Badenian of the Vienna basin. In the Middle America, it is known from the Upper Eocene to Pleistocene (ROBERTSON, 1998), in South America from the Upper Eocene to Pliocene (ROBERTSON, 1998; EMILIANI, 1954: Miocene, Pliocene; HASSON & FISCHER, 1986: Miocene, Pliocene), in Italy from the Middle Eocene to Pleistocene, it is numerous in the Pliocene (DONDI & BARBIERI, 1982: Po Valley, EMILIANI, 1954: Oligocene; GIANNINI & TAVANI, 1960: Miocene, Pliocene, DIECI, 1959: Miocene to Pleistocene). In New Zealand, it appears in the Oligocene, in North Africa and Australia in the Miocene and Pliocene (EMILIANI, 1954), in Australia in the Lower Miocene (LI & MCGOWRAN, 2000), in the Mediterranean in the Middle Miocene (CHERIF et al., 1994), in Algeria in the Messinian (POIGNANT & MOISSETTE, 1992), and in the Atlantic in the Miocene, Pliocene (BELANGER & BERGGREN, 1986) and Pleistocene (LÉVY et al., 1998).

The species is extant and is cosmopolitan (LONGINELLI, 1956; DIECI, 1959). It is noted from the South Atlantic, North Pacific (BARKER, 1960; ROBERTSON, 1998) and South Pacific (YASSINI & JONES, 1995). It is noted also from the Mediterranean where appears scarcely (SGARRELLA & MONCHARMONT ZEI, 1993).

In the Central Paratethys, it exists from the Upper Eocene to the end of the Badenian (CICHA et al., 1998), SCHÜTZ et al. (2007) determined it also from the Lower Sarmatian. In Bavaria, it is noted from the Kiscellian to Ottnangian (REISER, 1987: Upper Rupelian – Lower Egerian, WENGER, 1987: Upper Egerian – Middle Ottnangian), in Croatia from the Kiscellian (ŠIKIĆ, 1985) and Upper Badenian (BAJRAKTAREVIĆ, 1979; PIKIJA et al., 1984), in Austria from the Karpatian (RÖGL, 1969, 1998) and Early Lower Badenian (RÖGL & SPEZZAFERRI, 2003), in Romania from the Lower and Middle Miocene (POPESCU, 1975), and in Poland from the Badenian (SZCZECHURA, 2000)

In Slovenia, the species has not been described yet, it is only imaged from the Upper Eocene (Priabonian) of Socka-Dobrna area (northern of Celje; CIMERMAN et al., 2006) and from the Middle Miocene of Slovenske Gorice (RIJAVEC, 1978b). It is also noted from the Lower Egerian to Upper Badenian sediments. It is mentioned from the Lower Egerian of the Celje syncline (RIJAVEC, 1984) and Laško syncline (RIJAVEC, 1976a, 1984; DOZET et al., 1999), from the Upper Egerian of the Laško syncline (RIJAVEC, 1977, 1984; DOZET et al., 1996, 1999) and Planina syncline between Trobni Dol and Rudnica mountain (RIJAVEC & DOZET, 1996), from the Eggenburgian of the Celje syncline (RIJAVEC, 1984), from the Karpatian of Slovenske gorice (JELEN & RIFELJ, 2003), from the Lower Badenian of the Laško syncline (RIJAVEC, 1977, 1984; DOZET & RIJAVEC, 1994; DOZET et al., 1999), Planina syncline between Trobni Dol and Rudnica mountain (RIJAVEC & DOZET, 1996), and of Bizeljsko syncline (DOZET et al., 1998). It is known also from the Middle Badenian of Slovenske gorice (RIJAVEC, 1974), Dravinjske gorice (RIJAVEC, 1975), Celje syncline (RIJAVEC, 1978a), Laško syncline (RIJAVEC, 1976a, 1984), Planina syncline by Planina pri Sevnici (RIJAVEC, 1977), and Bizeljsko syncline (DOZET et al., 1998). It appears in the Upper Badenian of the Laško syncline (RIJAVEC, 1984).

Ecology and palaeoecology: The genus *Pullenia* is infaunal and typical for cold marine waters of the outer shelf and bathyal (MURRAY, 1991). Fossil specimens from the Central Paratethys are reported from sediments of the shelf to bathyal (shallow neritic to bathyal) (CICHA & ZAPLETALOVÁ, 1967). The extant species occurs down to 5000 m and is more frequent deeper than 550 m (DIECI, 1959). At the Australian coast, it is recorded from the outer shelf and bathyal (outer shelf and continental slope) (YASSINI & JONES, 1995). In the Mediterranean, it appears in muddy bottom from the shelf to bathyal (circalittoral to bathyal) (SGARRELLA & MONCHARMONT ZEI, 1993).

Superfamilia Chilostomellacea BRADY, 1881
Familia Heterolepidae GONZÁLES-DONOSO, 1969
Genus *Heterolepa* FRANZENAU, 1884

Heterolepa dutemplei (D'ORBIGNY, 1846)
(Pl. 4, figs. 2a–c)

1846 *Rotalina dutemplei* – D'ORBIGNY, 157, Tab. VIII, fig. 19–21.
1967 *Heterolepa dutemplei* (D'ORBIGNY) – CICHA & ZAPLETALOVÁ, 144, Taf. 21A, Fig. 1.
1969 *Heterolepa dutemplei* (D'ORB.) – RÖGL, 103, Taf. 5, Fig. 13a–c.
1971 *Heterolepa dutemplei* (D'ORBIGNY) – CICHA et al., 285, Taf. 25, Fig. 1–3.
1975 *Heterolepa dutemplei* (D'ORBIGNY) – POPESCU, 104, pl. LXXXVI, figs. 1a–2c, pl. LXXXVIII, figs. 2a–c, pl. LXXXIX, figs. 1a–3c.
1985 *Heterolepa dutemplei* (D'ORBIGNY) – PAPP & SCHMID, 59, 61, Taf. 50, Fig. 1–3, Taf. 52, Fig. 1–6.

1987 *Heterolepa dutemplei* (d'Orbigny) – Loeblich & Tappan, pl. 709, figs. 1–8.
1987 *Heterolepa dutemplei* (d'Orbigny) – Wenger, 327, Taf. 22, Fig. 6–8.
1998 *Heterolepa dutemplei* (d'Orbigny) – Cicha et al., 107, pl. 71, figs. 1–3.
2003 *Heterolepa dutemplei* (d'Orbigny) – Rögl & Spezzaferri, pl. 7, figs. 23–25.

Material: Numerous tests in samples from all six sections (Tab. 2).

Description: Biconvex test is trochospirally enrolled and circular in outline. Spiral side is evolute and weakly convex, rarely high convex; with three to four visible whorls. Umbilical side is involute and highly convex. The last whorl is built of rarely 6 and more frequently of 7–9 chambers that increase slowly in size. They are parallelogram to trapezoidal in shape on the spiral side and triangular on the umbilical side. Sutures are oblique and flush on the spiral side, and straight to curved backward and slightly depressed on the umbilical side. Whorl suture is flush to slightly depressed toward the end of the last whorl. Periphery is subangular and smooth to very slightly lobate in outline toward the latest part of the test. Wall is calcareous, optically granular and coarsely perforate. Surface is smooth. Slitlike interiomarginal aperture is developed on the upper half of the apertural face and extends in a short distance on the spiral side. It is bordered by a lip.

Remark: Specimens of this study show a great variety in convexity of the spiral side. Tests with different degree of convexity were originally described as separate species; *Rotalina kalembergensis* d'Orbigny, *Heterolepa dutemplei* d'Orbigny (low convexity) and *Rotalina haidingerii* d'Orbigny (high convexity). Papp & Schmid (1985) placed all these forms into a single species, *Heterolepa dutemplei* (d'Orbigny).

Size: Test diameter is 0.53–0.6 mm and thickness 0.4 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to ? Early Upper Badenian (*Bolivina dilatata* Zone). Tests (reworked?) were found also in the Lower Sarmatian samples (*Anomalinoides dividens* Zone) of two sections.

Occurrence: The species was first described from the Late Lower Badenian of the Vienna basin. According to Popescu (1975) its first occurrence is in the Oligocene. In Tunisia, it is known from the Serravallian (Salaj, 1992), in Sardinia (Italy) from the Middle Miocene (Barbieri & d'Onofrio, 1984) and in Algeria from the Messinian (Poignant & Moissette, 1992).

In the Central Paratethys, it is known from the Upper Kiscellian to the end of the Badenian (Cicha et al., 1998); it is most common in Late Early Badenian (Papp & Schmid, 1985). In Bavaria, it is noted from the Kiscellian to Middle Ottnangian (Reiser, 1987: Lower Rupelian – Lower Egerian; Wenger, 1987: Upper Egerian – Middle Ottnangian), in Romania from the Oligocene to Middle Miocene (Popescu, 1975), in Hungary from the Egerian (Sztràkos, 1979), and in Austria from the Karpatian (Rögl, 1969, 1998) and Early Lower Badenian (Rögl & Spezzaferri, 2003).

In Slovenia, the species has not been described and imaged yet. It is only noted from Kiscellian to Upper Badenian sediments. It is mentioned from the Kiscellian of Zasavje (Kolar, 1978), from the Upper Egerian of the Laško syncline (Dozet et al., 1999), from the Eggenburgian of the Celje syncline (Rijavec, 1984), from the Karpatian of Slovenske gorice (Jelen & Rifelj, 2003), from the Lower Badenian of the Celje syncline (Rijavec, 1978a), Laško syncline (Rijavec, 1984), Planina syncline by Plohov breg (Rijavec, 1977), and of Bizeljsko syncline (Dozet et al., 1998). It is noted also from the Middle Badenian of Celje syncline (Rijavec, 1978a), Laško syncline (Rijavec, 1984), Planina syncline by Planina pri Sevnici (Rijavec, 1977), and of Bizeljsko syncline (Dozet et al., 1998). From the Upper Badenian, it is known of the Laško syncline (Rijavec, 1984) and Planina syncline by Dobje (Rijavec, 1977).

Ecology: The genus *Heterolepa* is epifaunal and is probably attached to hard substrates. It occurs in temperate to cold marine waters from the shelf to bathyal (Murray, 1991). It is an oxic indicator (Rögl & Spezzaferri, 2003). The fossil species *Heterolepa dutemplei* from the Central Paratethys shows wide depth-range, with an optimum in the sublittoral. It is euryhaline but within euhaline limits (Cicha & Zapletalová, 1967).

Familia Gavelinellidae HOFKER, 1956
Subfamilia Gavelinellinae HOFKER, 1956
Genus *Hansenisca* LOEBLICH & TAPPAN, 1987

Hansenisca soldanii (D'ORBIGNY, 1826)
(Pl. 5, figs. 1a–c)

1826 *Gyroidina soldanii* – D'ORBIGNY, 112.
1956 *Gyroidina soldanii* D'ORBIGNY – LONGINELLI, 71, tav. XIV, figg. 16a–b.
1960 *Gyroidina soldanii* D'ORBIGNY – GIANNINI & TAVANI, 42, tav. VII, figg. 15–16.
1975 *Gyroidinoides soldanii* (D'ORBIGNY) – POPESCU, 103, pl. LXXXIV, figs. 2a–c.
1979 *Gyroidinoides soldanii* (D'ORBIGNY) – POPESCU, 47, pl. XXVIII, figs. 6a–c.
1982 *Gyroidina soldanii* D'ORBIGNY – DONDI & BARBIERI, tav. XL, fig. 1.
1985 *Gyroidina soldanii* D'ORBIGNY – PAPP & SCHMID, 60, Taf. 50, Fig. 4–9.
1986 *Gyroidinoides soldanii* (D'ORBIGNY) – BELANGER & BERGGREN, 344, pl. 6, figs. 3a–c.
1987 *Hansenisca soldanii* (D'ORBIGNY) – LOEBLICH & TAPPAN, pl. 719, figs. 5–9.
1987 *Gyroidina soldanii* D'ORBIGNY – REISER, 101, Taf. 12, Fig. 7, 10–11.
1991 *Gyroidinoides soldanii* (D'ORBIGNY) – CIMERMAN & LANGER, 75, pl. 85, figs. 5–6.
1998 *Hansenisca soldanii* (D'ORBIGNY) – CICHA et al., 105, pl. 72, figs. 6–8.
2003 *Gyroidinoides soldanii* (D'ORBIGNY) – RÖGL & SPEZZAFERRI, pl. 8, fig. 4.

Material: Numerous tests in samples from all six sections (Tab. 2).

Description: Test is trochospirally enrolled, composed of three to four whorls. Whorls enlarge gradually in size. Spiral side is evolute and slightly convex, umbilical side is involute and highly convex. On the spiral side, the last whorl stands above the level of earlier stage. Equatorial section of the test is circular while the transverse section is conical. Last whorl is built of 9–10 chambers that appear trapezoidal on the spiral side, and triangular on the umbilical side. They enlarge slowly as added. Sutures are straight, oblique and depressed on the spiral side. On the umbilical side, they are straight, radial and flush; toward the umbilicus they may get incised. Whorl suture is depressed. Umbilicus is wide and deep. Periphery is angular; it is smooth in outline in the early part of the last whorl and slightly lobate in the late part. Wall is calcareous and optically granular. It is finely perforate. Surface is smooth. Short slitlike aperture is interiomarginal and equatorial. It is bordered by a weak lip.

Remark: *Hansenisca soldanii* has been established as the type species of the genus *Hansenisca* LOEBLICH & TAPPAN, 1987. The main characteristic of the genus is having an open umbilicus which is surrounded by small umbilical chamber folia. Tests observed in this study show open umbilicus therefore they are classified in the genus *Hansenisca*.

Size: Test diameter is 0.32–0.35 mm and thickness 0.2 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Late Upper Badenian (*Virgulinella pertusa* Zone). Reworked tests were found also in the Lower Sarmatian samples (*Anomalinoides dividens* Zone).

Occurrence: The species was first described on recent specimens from the Adriatic Sea (Italy). The species has existed from the Cretaceous (OGNIBEN, 1958). In Italy, it is known from the Upper Eocene (ASCOLI, 1956) to Pleistocene (DONDI & BARBIERI, 1982: ?Upper Oligocene to Pleistocene; OGNIBEN, 1958: Oligocene, Aquitanian; GIANNINI & TAVANI, 1960: Miocene, Pliocene; DIECI, 1959: Tortonian to Pleistocene), and in Algeria from the Messinian (POIGNANT & MOISSETTE, 1992).

The species is extant; it is known from the Atlantic, Pacific and Antarctica (LONGINELLI, 1956; DIECI, 1959: Atlantic, Pacific). It is noted also from the Mediterranean (CIMERMAN & LANGER, 1991; LOEBLICH & TAPPAN, 1987) and Adriatic Sea (DIECI, 1959).

In the Central Paratethys, it appears from the Egerian to the end of the Badenian (CICHA et al., 1998) although some authors report about its earlier appearance; from the Kiscellian in Croatia (ŠIKIĆ, 1985) and Hungary (SZTRÀKOS, 1979: Upper Kiscellian), and from the whole Oligocene in Bavaria (REISER, 1987: Lower Rupelian – Lower Egerian). The species becomes abundant in the Karpatian (CICHA et al., 1998). In Croatia, it is noted also from the Middle Badenian (BAJRAKTAREVIĆ, 1982), in Austria from the Karpatian (RÖGL, 1998) and Early Lower Badenian (RÖGL & SPEZZAFERRI, 2003), and in Romania from the Upper Badenian (POPESCU, 1979).

In Slovenia, the species has not been described and imaged yet. It is only noted from Lower Egerian to Upper Badenian sediments. It is mentioned from the Lower Egerian of the Celje syncline (Rijavec, 1984), Laško syncline (Rijavec, 1976a, 1984, Dozet & Rijavec, 1994) and Planina syncline (Rijavec, 1977; Rijavec & Dozet, 1996), from the Upper Egerian of the Celje syncline (Rijavec, 1984; Dozet & Rijavec, 1994), Laško syncline (Rijavec, 1977: subspecies *G. soldanii girardana*; Dozet et al., 1996, 1999) and Planina syncline (Rijavec & Dozet, 1996), from the Lower Badenian of the Celje syncline (Rijavec, 1978a), from the Karpatian of Slovenske gorice (Jelen & Rifelj, 2003), from the Middle Badenian of Slovenske gorice (Rijavec, 1974), Dravinjske gorice (Rijavec, 1975), Laško syncline (Rijavec, 1976a, 1984; Dozet & Rijavec, 1994), Planina syncline at Planina pri Sevnici (Rijavec, 1977) and Bizeljsko syncline (Dozet et al., 1998), and from the Upper Badenian of Slovenske gorice (Rijavec, 1974) and the Laško syncline (Rijavec, 1984).

Ecology: The species is characteristic for the deep bathyal and abyssal zones (Wenger, 1987). It occurs down to 1800 m and it is more common deeper than 550 m (Dieci, 1959). In the Tyrrhenian Sea, it is reported from the soft sediment at 210 m (Cimerman & Langer, 1991).

Genus *Hanzawaia* Asano, 1944

Hanzawaia boueana (d'Orbigny, 1846)
(Pl. 5, figs. 2a–c)

1846 *Truncatulina boueana* – d'Orbigny, 169, Tab. IX, fig. 24–26.
1967 *Hanzawaia boueana* (d'Orbigny) – Cicha & Zapletalová, 145, Taf. 10, Fig. 1a–c.
1975 *Hanzawaia boueana* (d'Orbigny) – Cicha et al., 242, Taf. 2, Fig. 4a–c.
1975 *Hanzawaia boueana* (d'Orbigny) – Popescu, 79, pl. LXXXVII, figs. 3a–c, pl. LXXXVIII, figs. 1a–c.
1985 *Cibicides boueanus* (d'Orbigny) – Papp & Schmid, 64, Taf. 56, Fig. 6–9.
1998 *Hanzawaia boueana* (d'Orbigny) – Cicha et al., 106, pl. 72, figs. 9–11.
2007 *Hanzawaia boueana* (d'Orbigny) – Schütz et al., 457, Taf. 6, Fig. 1a–c.

Material: Numerous tests in samples from all six sections (Tab. 1).

Description: Flattened test is very low trochospiral. It is circular in outline. Spiral side is flat or slightly concave and convolute, while the umbilical side is convex and involute. Whorls enlarge rapidly in size. The last whorl comprises 8–10 chambers that are crescentic in shape. They gradually increase in size. Sutures are strongly curved backward and weakly depressed on both sides. Periphery is angulate. It is smooth in outline, or may be slightly lobate toward the end of the last whorl. Wall is calcareous, optically granular and moderately perforate. Surface is smooth. Aperture is interiomarginal and equatorial, and continues on the spiral side.

Size: Test diameter is 0.3–0.35 mm and thickness 0.1 mm.

Age: From the Early Lower Badenian (Lower Lagenidae Zone) to Late Upper Badenian (*Virgulinella pertusa* Zone). Reworked tests were found also in the Lower Sarmatian samples (*Anomalinoides dividens* Zone).

Occurrence: The species was first described from Late Lower Badenian of the Vienna basin. Its first appearance was placed in the Eocene (Ogniben, 1958). In Australia, it is noted from the Lower Miocene (Li & McGowran, 2000), in Italy from the Tortonian to Pleistocene (Dieci, 1959; Ogniben, 1958: Langhian to Quaternary; Giannini & Tavani, 1960: Miocene, Pliocene), and in Algeria from the Messinian (Poignant & Moissette, 1992).

In the Central Paratethys, it is known from the Egerian to the end of the Badenian (Cicha et al., 1975, 1998); it is numerous particularly in the Upper Lagenidae Zone (Papp & Schmid, 1985: Vienna basin). In Romania, it is noted from the Lower Miocene (Popescu, 1975), and in Croatia from the Upper Badenian (Pikija et al., 1984). Schütz et al. (2007) determined the species in Lower Sarmatian sediments where could be reworked from older sediments.

In Slovenia, the species has not been described and imaged yet. It is only noted as *Hanzawaia boueana* or *Cibicides boueanus* from Lower Egerian to Upper Badenian sediments. It is mentioned from the Lower Egerian of the Laško syncline (Rijavec, 1984; Dozet et al., 1999), from the Upper Egerian of the Celje syncline (Rijavec, 1984), from the Lower Badenian of the Laško syncline (Rijavec, 1976a, 1984; Dozet et al., 1999), from the Middle Badenian of Dravinjske gorice (Rijavec, 1975), the Celje syncline (Rijavec, 1975, 1978a), Laško syncline (Rijavec, 1976a, 1984, Dozet et al., 1996, 1999), Planina syncline by Trobni Dol (Petrica et al., 1995) and Planina pri Sevnici (Rijavec, 1977), and of the Krško-Brežice plain (Dozet et al., 1998). It is known also from the Upper Badenian of Slovenske gorice (Rijavec, 1974), the Laško syncline (Rijavec, 1976a, 1984, Dozet et al., 1996) and Planina syncline by Trobni Dol (Petrica et al., 1995) and Škarnice (Rijavec, 1977).

Ecology: Extant specimens of the genus *Hanzawaia* are epifaunal and attached to hard substrates. They are found in temperate to warm marine waters of the inner shelf (Murray, 1991).

Conclusions

In the Middle Miocene sediments of the Planina syncline, 85 species and 2 subspecies of the foraminiferal suborder Rotaliina have been determined. The following species show particular high abundance in all sections: *Angulogerina angulosa, Trifarina bradyi, Sphaeroidina bulloides, Cibicidoides ungerianus, Nonion commune, Melonis pompilioides, Pullenia bulloides, Heterolepa dutemplei, Hansenisca soldanii* and *Hanzawaia boueana* (Tab. 2). In the studied area, they are present already in the lowest Badenian biozone, the Lower Lagenidae Zone. The shortest stratigraphic range is seen for *Trifarina bradyi,* which ranges up to the Late Middle Badenian *Uvigerina* cf. *pygmea* Zone. Most of other abundant rotaliins, *Angulogerina angulosa, Cibicidoides ungerianus, Nonion commune, Melonis pompilioides* and *Pullenia bulloides* occur up to the Early Upper Badenian *Bolivina dilatata* Zone, and species *Sphaeroidina bulloides, Hansenisca soldanii* and *Hanzawaia boueana* up to the Late Upper Badenian *Virgulinella pertusa* Zone. The longest stratigraphic range is shown by the species *Heterolepa dutemplei* which is found in the Trobni Dol section also in the Lower Sarmatian *Anomalinoides dividens* Zone. In Sarmatian samples of the Imenska Gorca section, some other species are found (*Sphaeroidina bulloides, Cibicidoides ungerianus, Pullenia bulloides, Heterolepa dutemplei, Hansenisca soldanii* and *Hanzawaia boueana*); but are considered to be reworked Badenian specimens.

All species, which are presented in this work, appear in the Central Paratethys from the beginning to the end of the Badenian. Few of them: *Cibicidoides ungerianus*, *Nonion commune* (Papp & Schmid, 1998), *Pullenia bulloides* and maybe also *Hanzawaia boueana*, if not reworked (Schütz, 2007) range further into the Sarmatian. In this view, the results of this study are comparable with findings of previous studies of the Central Paratethys. More interesting is the presence of *Heterolepa dutemplei* tests in the Lower Sarmatian sample of the Trobni Dol section. If they are not reworked this could be an evidence for an increased biostratigraphic range for the species within the region.

From Middle Miocene sediments of Slovenia, the species *Angulogerina angulosa* and *Trifarina bradyi* are identified for the first time. Longer stratigraphic ranges are seen for: *Melonis pompilioides* (extending into the Middle and Upper Badenian), *Cibicidoides ungerianus* and *Nonion commune* (extending into the Upper Badenian), and possibly for *Heterolepa dutemplei* (extending into the Sarmatian).

All foraminifera show high abundance from the Lower Badenian Lower Lagenidae Zone up to the Early Upper Badenian *Bolivina dilatata* Zone. Abundance reduces in the following Late Upper Badenian *V. pertusa* Zone. Most species are indicators for deeper environments, from the shelf to bathyal or even abyssal zone: *A. angulosa, T. bradyi, S. bulloides, C. ungerianus, M. pompilioides, P. bulloides, H. dutemplei* and *H. soldanii*. The species *A. angulosa, T. bradyi, C. ungerianus, M. pompilioides, P. bulloides, H. dutemplei* and *H. boueana* are known to be euhaline so indicate full marine conditions. The pattern of abundance of the investigated species can be interpreted as evidence of environmental change that occurred towards the end of the Middle Miocene; when shoaling within the sea occurred and brackish conditions developed (Kováč et al., 2004, Oblak, 2006). The frequent epifaunal high-oxygen indicators *C. ungerianus* and *H. dutemplei* show that the bottom waters were well oxygenated from the beginning of the Badenian at least up to the Early Upper Badenian (*B. dilatata* Zone).

Tabla 2. Distribution of rotaliinas in the studied sections (after Oblak, 2006). Columns represent a percentage of positive samples (samples where the particular species is present).

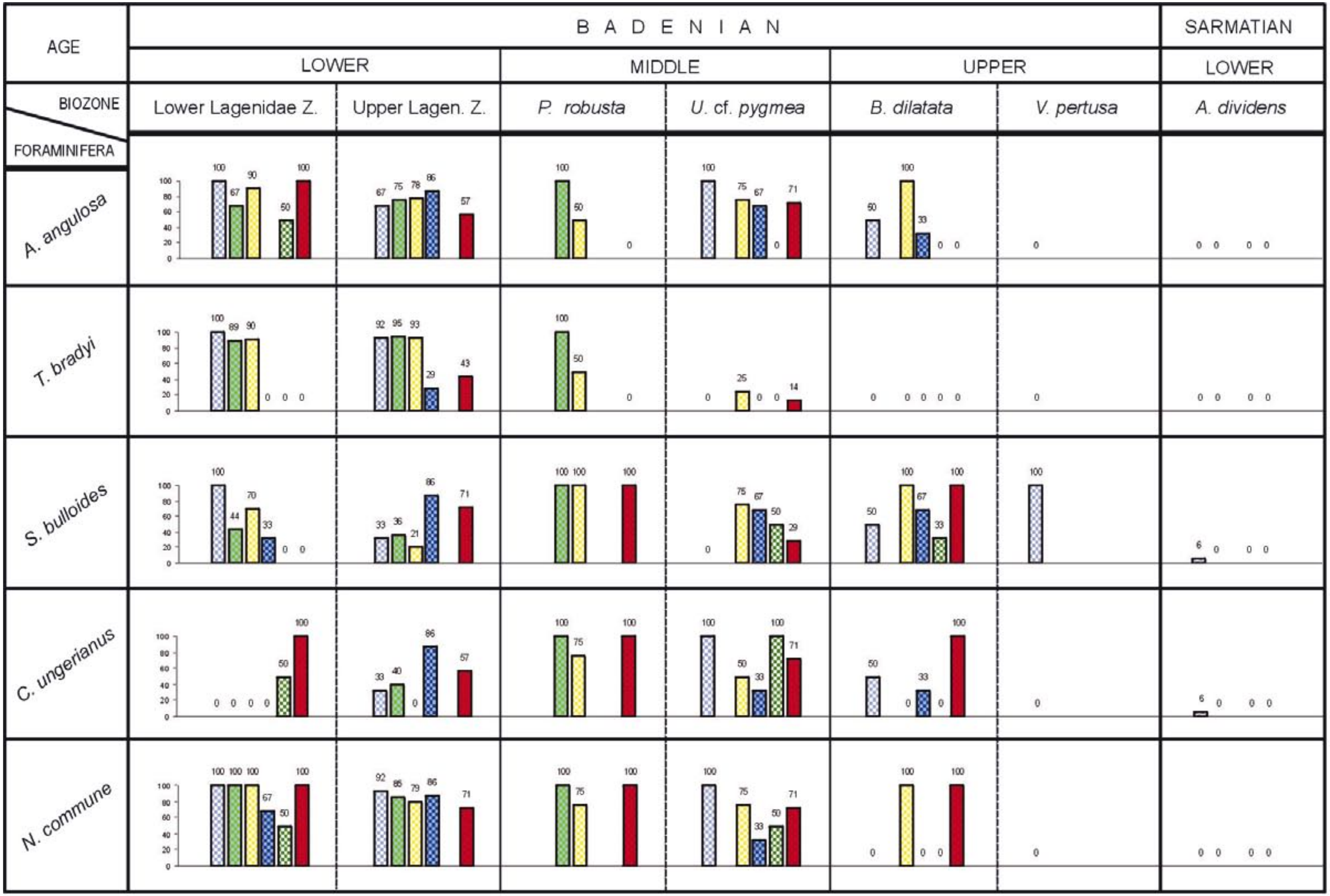
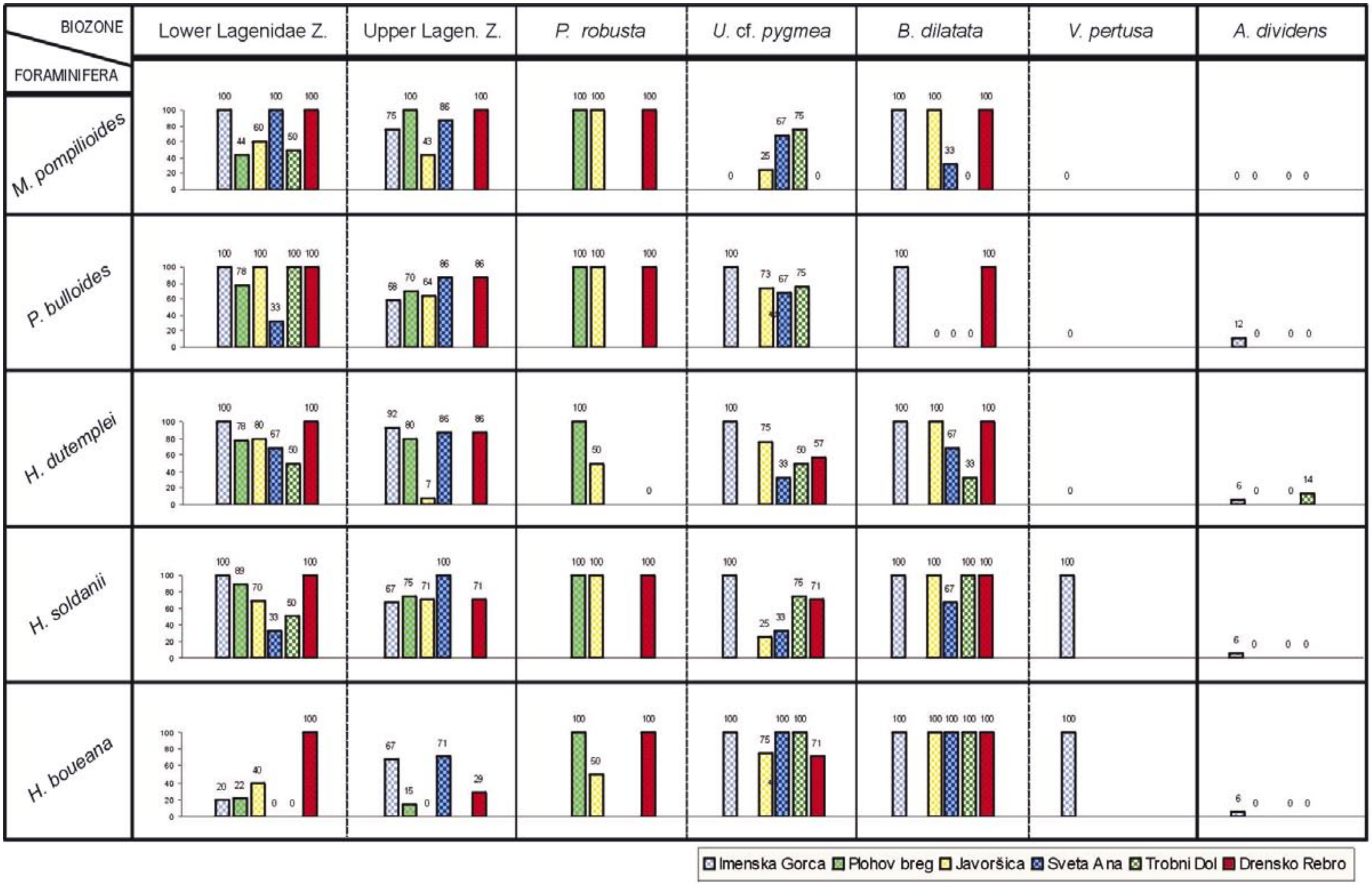


Tabela 2. Pojavljanje rotaliin v obravnavanih profilih (po OBLAK, 2006). Stolpci predstavljajo odstotek pozitivnih vzorcev (vzorcev, kjer je posamezna foraminiferna vrsta prisotna).



In this paper, all species, except for the recent *Angulogerina angulosa* from the Adriatic Sea (Cimerman & Langer, 1991), are described for the first time in Slovenia.

Najpogostejše srednjemiocenske rotaliine (podred Rotaliina, Foraminifera) Kozjanskega (vzhodna Slovenija)

Povzetek

Podred Rotaliina je bil določen leta 1896 kot podred Rotalidae s strani avtorjev Delage & Herouard (v Rotaliina sta ga preimenovala Loeblich in Tappan leta 1961) (Loeblich & Tappan, 1987). Z več kot 600 rodovi predstavlja drugi največji foraminiferni podred. Vključuje bentoške foraminifere večkamričnih hišic s porozno steklasto lamelarno kalcitno steno. Glede na način rasti, predeljenost kamric, ornamentiranost površine, prisotnost kanalnega sistema in izoblikovanost ustja so rotaliine zelo heterogene. Zaradi velike tolerance do okoljskih parametrov, kot so substrat, globina, temperatura, slanost in hrana, se pojavljajo v zelo različnih okoljih (Billman et al., 1980, Murray, 1991). Najstarejše rotaliine so našli v triasnih plasteh, podred živi še danes in je kozmopolitsko razširjen (Loeblich & Tappan, 1987).

V nalogi so obravnavane srednjemiocenske foraminifere podreda Rotaliina iz Planinske sinklinale na Kozjanskem (vzhodna Slovenija, sl. 1.). Vzorčene so bile badenijske in sarmatijske plasti šestih profilov: Imenska Gorca, Plohov breg, Javoršica, Sveta Ana, Trobni Dol in Drensko Rebro (sl. 1). Pobranih je bilo 159 vzorcev, ki segajo od spodnjebadenijskih spodnje lagenidne in zgornje lagenidne biocone, preko srednjebadenijskih *Pseudotriplasia robusta* in *Uvigerina* cf. *pygmea* biocon, zgornjebadenijskih *Bolivina dilatata* in *Virgulinella pertusa* biocon do spodnjesarmatijskih *Anomalinoides dividens* in *Elphidium hauerinum* biocon (tab. 1.). Rotaliine se v mlajši sarmatijski bioconi *Elphidium hauerinum* ne pojavljajo več, zato biocona v nadaljevanju ni več obravnavana. Iz podreda Rotaliina je bilo določenih 85 vrst in 2 podvrsti. Najpogostejše vzdolž vseh profilov so naslednje vrste: *Angulogerina angulosa, Trifarina bradyi, Sphaeroidina bulloides, Cibicidoides ungerianus, Nonion commune, Melonis pompilioides, Pullenia bulloides, Heterolepa dutemplei, Hansenisca soldanii* in *Hanzawaia boueana*. Vse omenjene vrste se pojavljajo na preiskanem območju od najnižje badenijske spodnje lagenidne biocone dalje (tab. 2). Med njimi kaže najkrajši stratigrafski razpon vrsta *Trifarina bradyi*, ki je prisotna do mlajše srednjebadenijske *Uvigerina* cf. *pygmea* biocone. Večina ostalih rotaliin, *Angulogerina angulosa, Cibicidoides ungerianus, Nonion commune, Melonis pompilioides* in *Pullenia bulloides,* se pojavlja do starejše zgornjebadenijske *Bolivina dilatata* biocone in vrste *Sphaeroidina bulloides, Hansenisca soldanii* in *Hanzawaia boueana* dalje do mlajše zgornjebadenijske *Virgulinella pertusa* biocone. Najdaljši stratigrafski razpon je razviden pri vrsti *Heterolepa dutemplei*, ki je bila najdena še v starejši spodnjesarmatijski *Anomalinoides dividens* bioconi. V sarmatijskih vzorcih profila Imenska Gorca so bile sicer najdene še nekatere druge rotaliine: *Sphaeroidina bulloides, Cibicidoides ungerianus, Pullenia bulloides, Heterolepa dutemplei, Hansenisca soldanii* in *Hanzawaia boueana*, ki pa so bile glede na spremljajočo mikrofavno po vsej verjetnosti prenešene iz starejših, badenijskih plasti.

Vse vrste, ki so obravnavane v tej nalogi, se pojavljajo na območju Centralne Paratetide od začetka do konca badenija, vrsti *Cibicidoides ungerianus* in *Nonion commune* še naprej v sarmatij (Papp & Schmid, 1998). V tem pogledu so rezultati te raziskave primerljivi z ugotovitvami predhodnih raziskav Centralne Paratetide. Zanimivejša pa je prisotnost hišic vrste *Heterolepa dutemplei* v

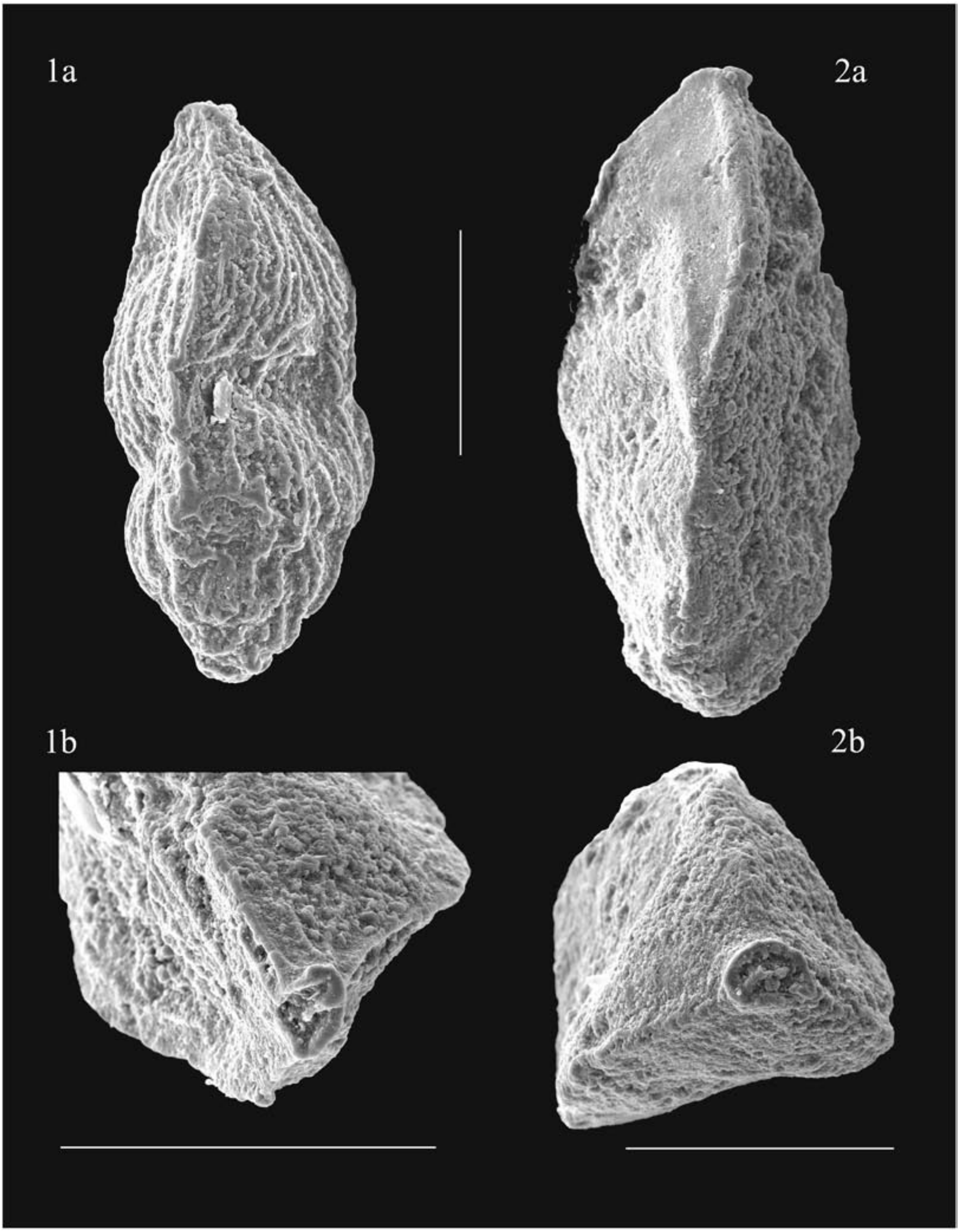
Plate 1 – Tabla 1

1. *Angulogerina angulosa* (Williamson); a. side view (Ig 4), b. enlarged aperture with a toothplate (Ig 4).
1. *Angulogerina angulosa* (Williamson); a. stranski pogled (Ig 4), b. povečano ustje z zobno ploščico (Ig 4).

2. *Trifarina bradyi* Cushman; a. side view (Ig 4), b. enlarged aperture with a toothplate (Ig 4).
2. *Trifarina bradyi* Cushman; a. stranski pogled (Ig 4), b. povečano ustje z zobno ploščico (Ig 4).

Scale bar = 100 μm.
Merilce = 100 μm.

Plate 1 – Tabla 1



spodnjesarmatijskih plasteh profila Trobni Dol. Če hišice niso prenešene, bi bil s tem lahko dokazan daljši stratigrafski razpon vrste.

V srednjemiocenskih sedimentih Slovenije sta vrsti *Angulogerina angulosa* and *Trifarina bradyi* določeni prvič. Daljši stratigrafski razpon je dokazan za vrste: *Melonis pompilioides* (razširjen v srednji in zgornji badenij), *Cibicidoides ungerianus* in *Nonion commune* (razširjen v zgornji badenij) in morda tudi vrste *Heterolepa dutemplei* (razširjen v sarmatij).

Predstavljene foraminifere so zelo številčne od spodnjebadenijske spodnje lagenidne biocone vse do starejše zgornjebadenijske biocone *Bolivina dilatata*, in skoraj izginejo v naslednji, mlajši zgornjebadenijski bioconi *V. pertusa*. Večina teh vrst je značilnih za globlja okolja, od šelfa do globine batiala ali celo abisala: *A. angulosa, T. bradyi, S. bulloides, C. ungerianus, M. pompilioides, P. bulloides, H. dutemplei* in *H. soldanii*. Vrste *A. angulosa, T. bradyi, C. ungerianus, M. pompilioides, P. bulloides, H. dutemplei* in *H. boueana* so evhaline in kažejo na morsko okolje. Vzorec njihovega pojavljanja je verjetno posledica spremembe okolja, do katere je prišlo proti koncu srednjega miocena; ko je začelo morje plitveti in se oslajevati (Kováč et al., 2004, Oblak, 2006). Pogosta epifavnistična indikatorja oksičnega okolja, *C. ungerianus* in *H. dutemplei*, kažeta, da je bila voda pri dnu dobro prezračena od začetka badenija vsaj do starejšega zgornjega badenija (*B. dilatata* biocona).

Vse vrste, razen recentne *Angulogerina angulosa* iz Jadranskega morja (Cimerman & Langer, 1991), so v Sloveniji opisane prvič.

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Plate 2 – Tabla 2

1. *Sphaeroidina bulloides* d'Orbigny; a. umbilical side (J 28), b. side view (Pb 23).
1. *Sphaeroidina bulloides* d'Orbigny; a. umbilikalna stran (J 28), b. stranski pogled (Pb 23).

2. *Cibicidoides ungerianus* (d'Orbigny); a. spiral side (Pb 23), b. umbilical side (Pb 23), c. side view (Pb 23).
2. *Cibicidoides ungerianus* (d'Orbigny); a. spiralna stran (Pb 23), b. umbilikalna stran (Pb 23), c. stranski pogled (Pb 23).

Scale bar = 100 µm.
Merilce = 100 µm.

Plate 2 – Tabla 2

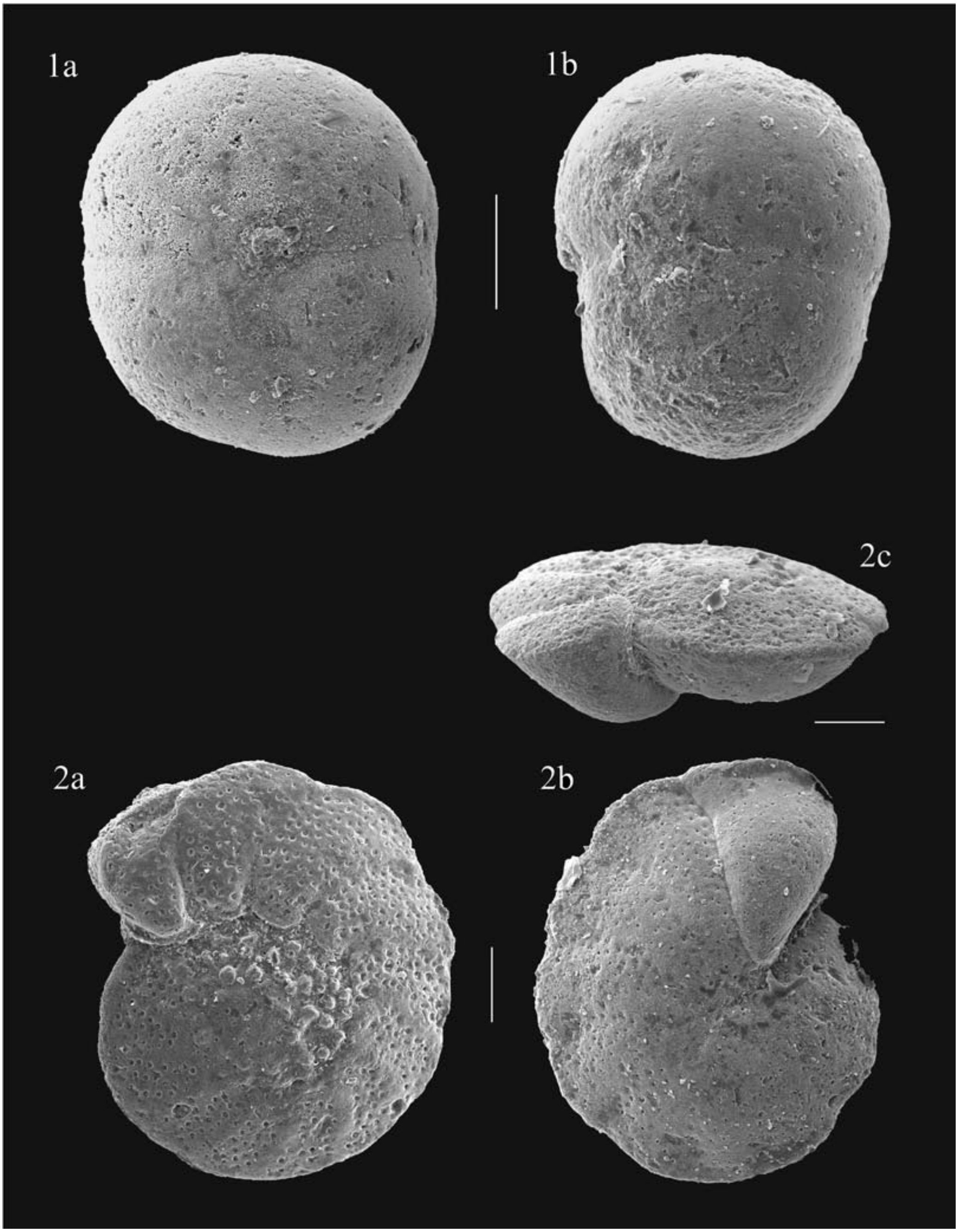

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Plate 3 – Tabla 3

1. *Nonion commune* (d'Orbigny); a. side view (Ig 4), b. front view (Ig 4).
1. *Nonion commune* (d'Orbigny); a. stranski pogled (Ig 4), b. pogled od spredaj (Ig 4).

2. *Melonis pompilioides* (Fichtel & Moll); a. side view (Pb 23), b. front view (Pb 23).
2. *Melonis pompilioides* (Fichtel & Moll); a. stranski pogled (Pb 23), b. pogled od spredaj (Pb 23).

Scale bar = 100 µm.

Merilce = 100 µm.

Plate 3 – Tabla 3

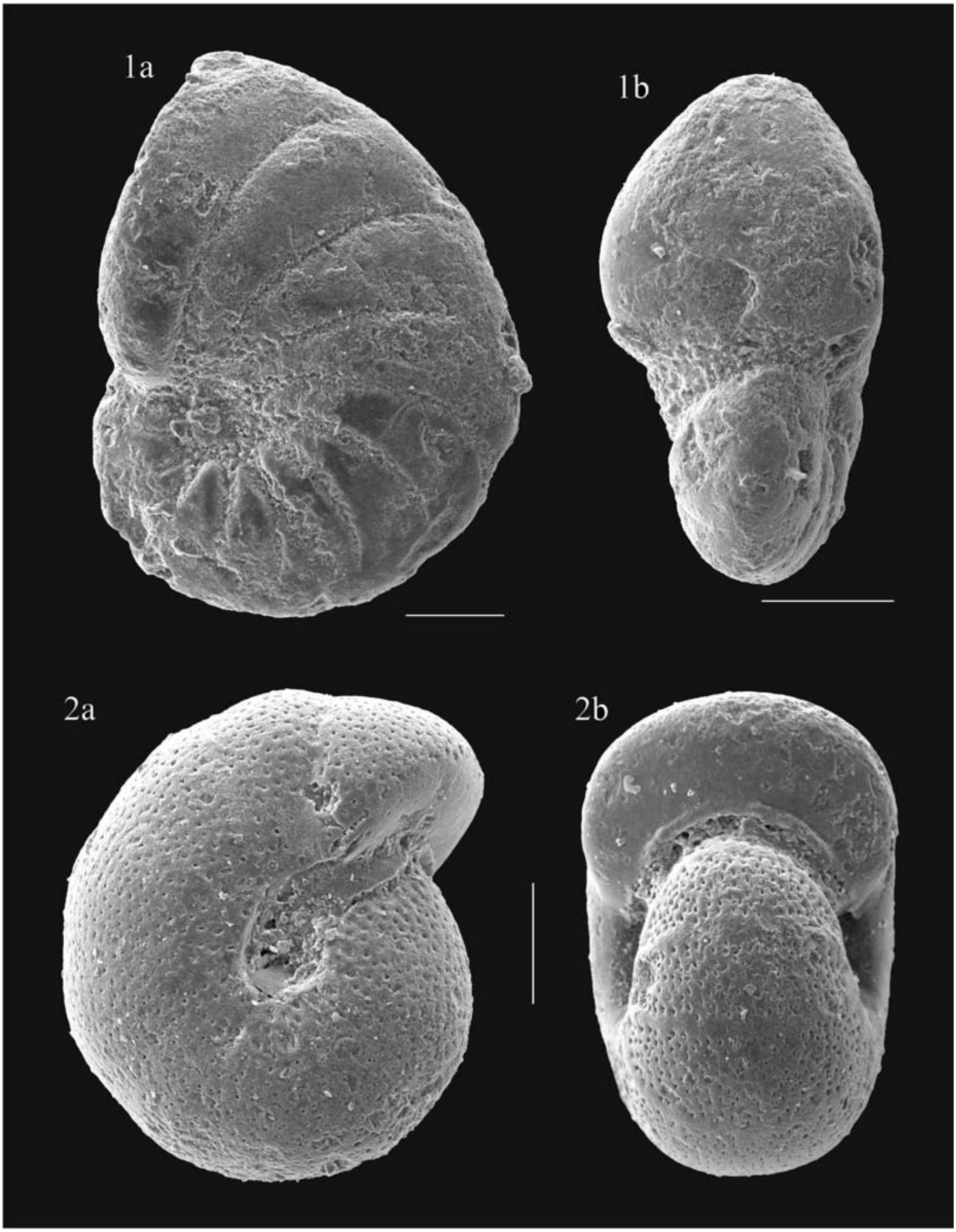

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Plate 4 – Tabla 4

1. *Pullenia bulloides* (d'Orbigny); a. side view (Pb 23), b. front view (Pb 23).
1. *Pullenia bulloides* (d'Orbigny); a. stranski pogled (Pb 23), b. pogled od spredaj (Pb 23).

2. *Heterolepa dutemplei* (d'Orbigny); a. spiral side (Pb 23), b. umbilical side (Pb 23), c. side view (Pb 23).
2. *Heterolepa dutemplei* (d'Orbigny); a. spiralna stran (Pb 23), b. umbilikalna stran (Pb 23), c. stranski pogled (Pb 23).

Scale bar = 100 µm.

Merilce = 100 µm.

Plate 4 – Tabla 4

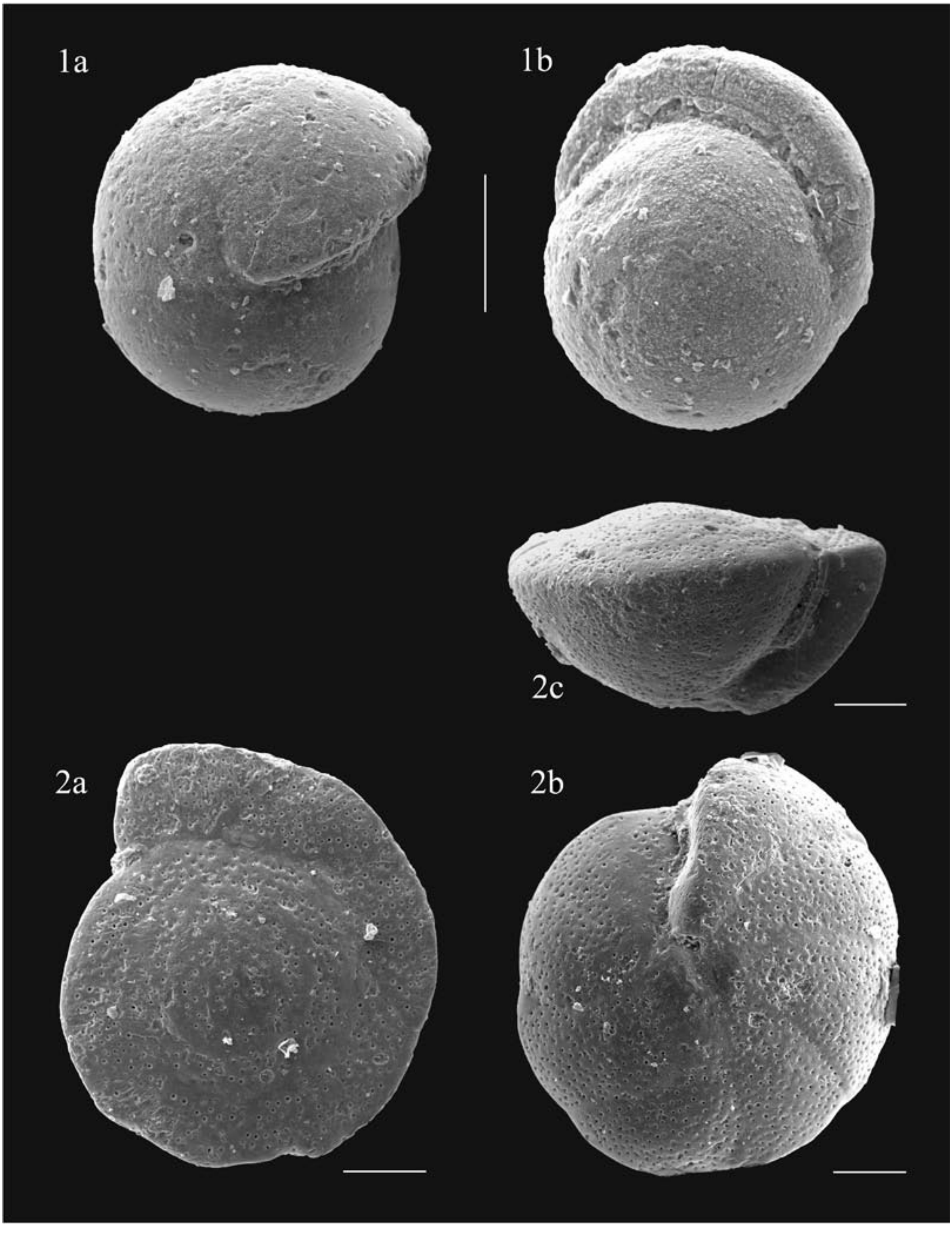

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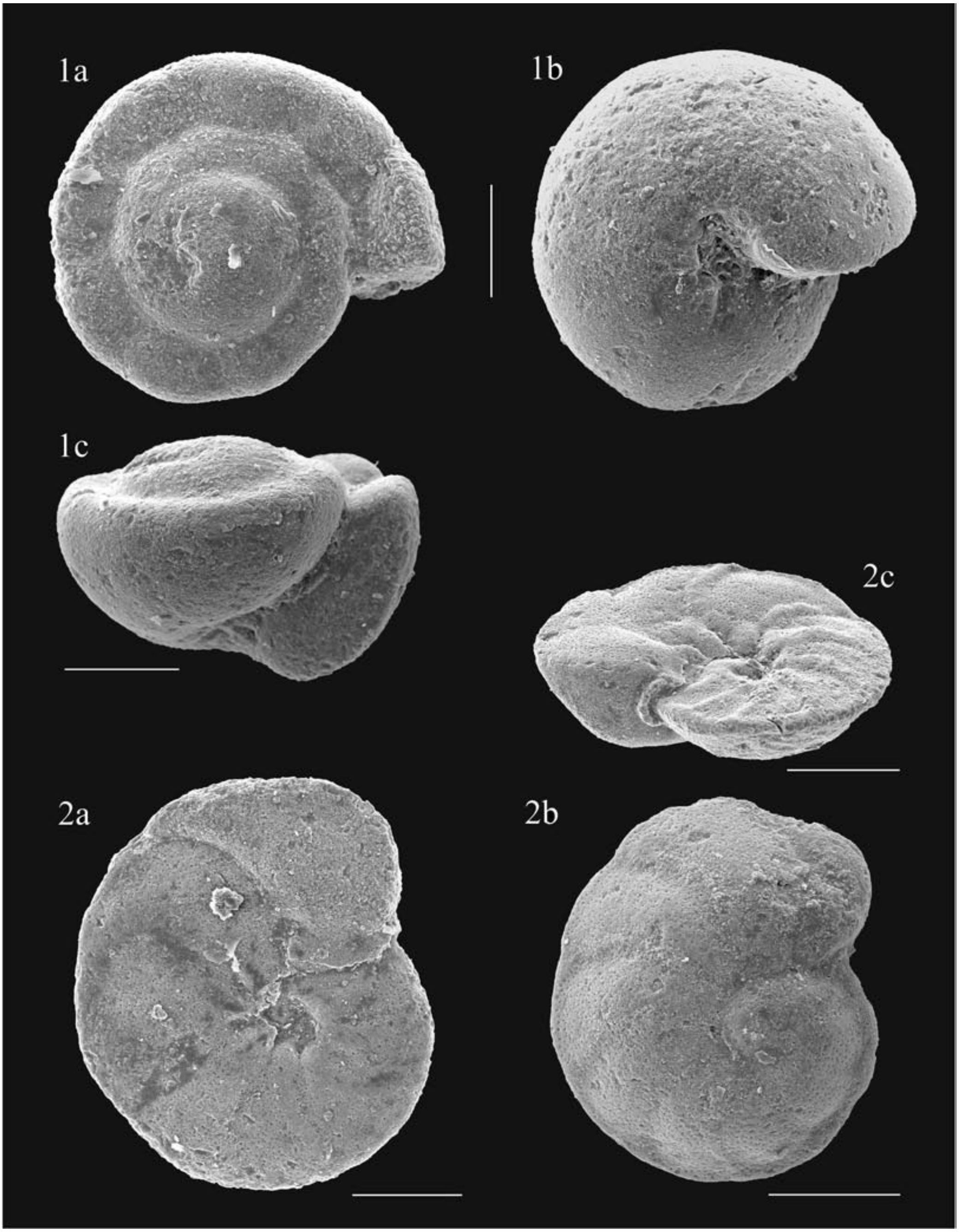
Plate 5 – Tabla 5

1. *Hansenisca soldanii* (d'Orbigny); a. spiral side (Pb 23), b. umbilical side (Pb 23), c. side view (Pb 23).
1. *Hansenisca soldanii* (d'Orbigny); a. spiralna stran (Pb 23), b. umbilikalna stran (Pb 23), c. stranski pogled (Pb 23).

2. *Hanzawaia boueana* (d'Orbigny); a. spiral side (Pb 23), b. umbilical side (Pb 23), c. side view (J 32).
2. *Hanzawaia boueana* (d'Orbigny); a. spiralna stran (Pb 23), b. umbilikalna stran (Pb 23), c. stranski pogled (J 32).

Scale bar = 100 µm.
Merilce = 100 µm.

Plate 5 – Tabla 5



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