

## Foraminiferal suborder Robertinina from the Badenian of Kozjansko (Eastern Slovenia)

### Foraminiferni podred Robertinina iz badenija na Kozjanskem (vzhodna Slovenija)

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**Abstract:** In this study, two Badenian foraminiferal species of the suborder Robertinina from Kozjansko (Eastern Slovenia) are presented. Both species *Ceratobulimina contraria* (Reuss) and *Hoeglundina elegans* (d'Orbigny) occur frequently in samples from the Lower to Upper Badenian (Middle Miocene). The occurrence of *C. contraria* in the Upper Badenian indicates a wider stratigraphic range for the Central Paratethys than was previously recognized. This species has not been determined from Middle Miocene strata of Slovenia before this work. *H. elegans* is already known from the Middle Miocene of Slovenia, but in this paper specimens are described, imaged and classified for the first time.

**Povzetek:** V prispevku sta predstavljeni dve badenijski foraminiferni vrsti iz podreda Robertinina s Kozjanskega (vzhodna Slovenija). Obe vrsti, *Ceratobulimina contraria* (Reuss) in *Hoeglundina elegans* (d'Orbigny), sta številčno zastopani v vzorcih od spodnjega do zgornjega badenija (srednji miocen). Pojav vrste *C. contraria* v zgornjebadenijskih plasteh kaže na njen širši stratigrafski razpon kot je bil za območje Centralne Paratetide poznan doslej. V srednjemiocenskih sedimentih Slovenije vrsta še ni bila določena. Vrsta *H. elegans* je iz srednjega miocena Slovenije sicer že poznana, vendar je v prispevku prvič opisana, upodobljena in uvrščena v sistem.

**Key words:** Foraminifera, Robertinina, Badenian, Miocene, Central Paratethys

**Ključne besede:** foraminifere, Robertinina, badenij, miocen, Centralna Paratetida

## INTRODUCTION

The suborder Robertinina LOEBLICH & TAPPAN, 1984 is the last of twelve suborders described in the foraminiferal classification of LOEBLICH & TAPPAN (1987). The suborder is defined by the following characteristics; planispirally to trochospirally-enrolled tests, chambers commonly with internal partition and hyaline perforate wall composed of ultrastructurally and optically radiate aragonite (LOEBLICH & TAPPAN, 1984). With the exception of the extinct suborder Involutinina, which died out during the Mesozoic, all other hyaline foraminifera have tests formed of calcite. According to the foraminiferal classification of LOEBLICH AND TAPPAN (1987), the suborder Robertinina includes 48 genera, ranging from the Upper Triassic to Holocene. From the Middle Miocene, six genera are recognized globally, and only four have been noted in European sediments: *Ceratobulimina* Toulou, 1915, *Lamarckina* (Berthelin, 1881), *Hoeglundina* Brotzen, 1948 and *Robertina* d'Orbigny, 1846. Due to its relatively low species diversity in the Middle Miocene deposits, the suborder Robertinina represents a less frequent mentioned foraminiferal taxon in the literature.

## MATERIAL AND METHODS

Robertininas of Kozjansko were studied from six sections of the Planina syncline; Imenska Gorca, Plohov breg, Javoršica, Sveta Ana and Trobni Dol on the northern flank and Drensko Rebro on the south-

In Slovenia, foraminifera of the suborder Robertinina are poorly represented in sedimentary sequences. In Miocene sediments, only the species *Hoeglundina elegans* has been identified. It is noted as *Hoeglundina elegans* or *Epistomina elegans* from the Lower Egerian of the Laško syncline (DOZET ET AL., 1999), from the Upper Egerian of the Laško syncline (DOZET ET AL., 1999) and Planina syncline (PETRICA ET AL., 1995, DOZET ET AL., 1999), from the Lower Badenian of Dravinjske gorice (RIJAVEC, 1975), from the Middle Badenian of the Laško syncline (RIJAVEC, 1976 in 1984) and Planina syncline (RIJAVEC, 1977), and from the Upper Badenian of the Laško syncline (RIJAVEC, 1976 in 1984). The species hasn't been described, imaged and classified further in a system previously. The species *Ceratobulimina contraria* hasn't been determined in any other previous research in Slovenia.

In Kozjansko, robertininas were studied from six sections. The investigated area belongs to the Planina syncline, the westernmost margin of the Central Paratethys (BUSER, 1977, 1979, ANIČIĆ & JURIŠA 1984, ANIČIĆ & JURIŠA 1985, ANIČIĆ ET AL., 2004).

ern flank (OBLAK, 2006). One hundred and twenty-eight samples of Badenian marl and marly calcarenite were studied. Samples range from the Lower Badenian Lower Lagenidae Zone to the Upper Badenian *Virgulinella pertusa* Zone (Figure 1, OBLAK, 2006). 187 species were deter-

mined and classified into seven foraminiferal suborders. The suborder Robertinina is represented by two species: *Ceratobulimina contraria* (Reuss) and *Hoeglundina elegans* (d'Orbigny). Although the preservation is poor due to aragonitic composition, the characteristic appearance of both species allows accurate identification of specimens.

## RESULTS AND DISCUSSION

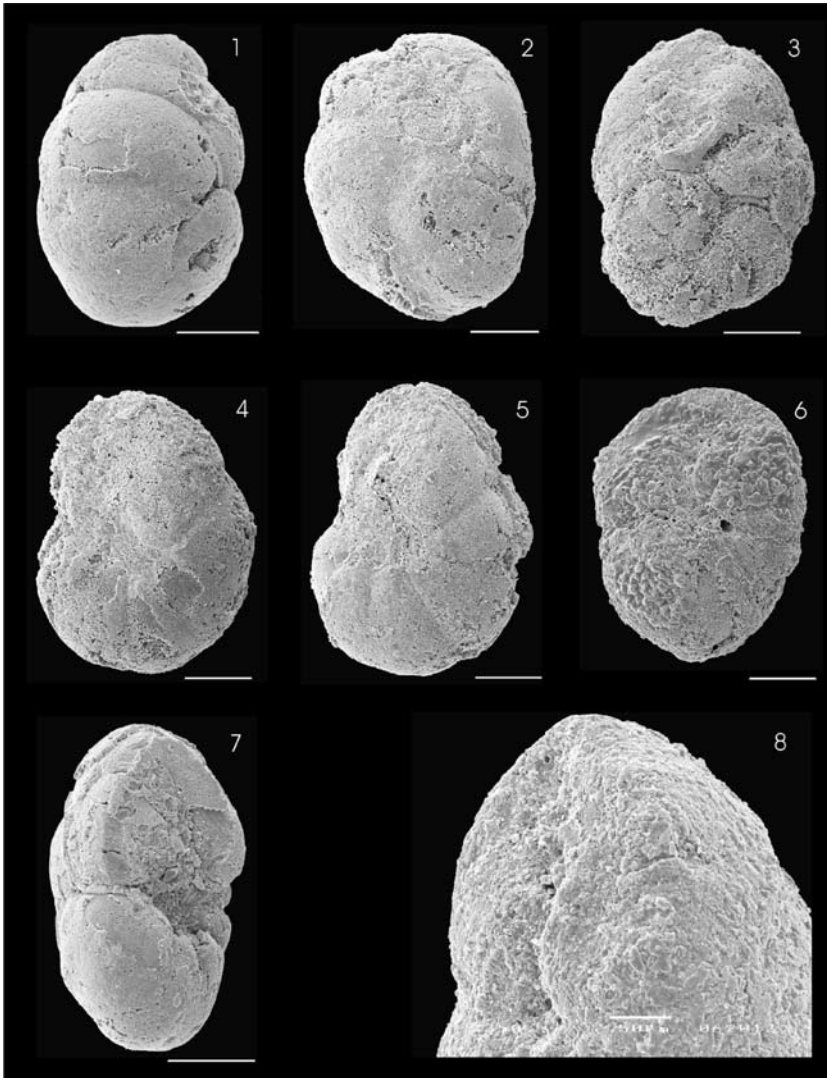
### Taxonomy of Foraminifera

(according to LOEBLICH & TAPPAN, 1987)

Ordo Foraminiferida Eichwald, 1830  
 Subordo Robertinina Loeblich & Tappan, 1984  
 Superfamilia Ceratobuliminacea Cushman, 1927  
 Familia Ceratobuliminidae Cushman, 1927  
 Subfamilia Ceratobulimininae Cushman, 1927  
 Genus *Ceratobulimina* Toulou, 1915

*Ceratobulimina contraria* (Reuss, 1851)  
 (Plate 1, figs. 1-8)

- 1851 *Rotalina contraria* - REUSS, 76, Taf. V, Fig. 37a-c.  
 1969 *Ceratobulimina (Ceratobulimina) contraria* (Reuss) - LANGER, 62, Abb. 12b-c, Taf. 3, Fig. 15.  
 1975 *Ceratobulimina contraria* (Reuss) - POPESCU, 105, pl. XC, Figs. 2a-b.  
 1982 *Ceratobulimina contraria* (Reuss) - DONDI & BARBIERI, tav. XLIII, Fig. 2.  
 1987 *Ceratobulimina contraria* (Reuss) - LOEBLICH & TAPPAN, pl. 473, Figs. 9-13.  
 1995 *Ceratobulimina contraria* (Reuss) - YASSINI & JONES, 142, Figs. 960-961.  
 1998 *Ceratobulimina contraria* (Reuss) - CÍCHA ET AL., 89, pl. 29, Figs. 9-10.



**Plate 1.** *Ceratobulimina contraria* (Reuss, 1851). Fig. 1: Spiral side; J 33, Fig. 2: Spiral side; J 33, Fig. 3: Spiral side; J 33, Fig. 4: Umbilical side; J 33, Fig. 5: Umbilical side; J 33, Fig. 6: Umbilical side; J 27, Fig. 7: Side view; J 33, Fig. 8: Aperture; J 32. Scale bar represents 100  $\mu\text{m}$ .

**Tabla 1.** *Ceratobulimina contraria* (Reuss, 1851). Sl. 1: Spiralna stran; J 33, Sl. 2: Spiralna stran; J 33, Sl. 3: Spiralna stran; J 33, Sl. 4: Umbilikalna stran; J 33, Sl. 5: Umbilikalna stran; J 33, Sl. 6: Umbilikalna stran; J 27, Sl. 7: Pogled s strani; J 33, Sl. 8: Ustje; J 32. Merilce predstavlja 100  $\mu\text{m}$ .

*Material:* Rare to numerous tests from 15 samples (Figure 1).

*Description:* Test consists of trochospirally arranged chambers. It is ovate in outline. Spiral side is slightly convex. Sutures are curved on the spiral side and straight on the umbilical side. Umbilicus is deep. Periphery is broadly rounded. Surface is very smooth and finely perforate. Aperture is in a shape of a narrow loop, running vertically along the apertural face. Wall is aragonitic (LOEBLICH & TAPPAN, 1987).

*Remark:* Preservation of tests is poor. In the study of GRÜNIG (1985), specimens are similar to mine by shape but differ in low slitlike aperture that characterize the genus *Ceratocancriis*. Considering this, the species is cited as *Ceratocancriis contraria*.

*Size:* Test height is 0.38 - 0.45 mm, broadness 0.27 - 0.34 mm and thickness 0.2 mm.

*Occurrence:* The species was first described from the Oligocene of Germany

(remark: in 1851, the geological period Oligocene hasn't been assigned yet so these strata were determined as of Eocene age). In Germany, it is known from the Oligocene (LOEBLICH & TAPPAN, 1987) and the Middle Miocene (LANGER, 1969), in Denmark from the Oligocene (LOEBLICH & TAPPAN, 1987) and in Italy from the Upper Oligocene to the Serravallian, maybe also to the Tortonian; it is most common in the Serravallian (DONDI & BARBIERI, 1982: identified from samples collected in the Po Valley).

The species is extant; it is noted from the South Pacific (YASSINI & JONES, 1995).

In the Central Paratethys, it appears from the Upper Eocene to the end of the Middle Badenian, its appearance in the Ottnangian and Karpatian is not certain (CICHA ET AL., 1998). In Hungary, it is known from the Lower Egerian (SZTRÁKOS, 1979) and in Romania from the Miocene (POPESCU, 1975).

Familia Epistominidae Wedekind, 1937

Subfamilia Epistomininae Wedekind, 1937

Genus *Hoeglundina* Brotzen, 1948

*Hoeglundina elegans* (d'Orbigny, 1826)

(Plate 2, Figs. 1-5)

1826 *Rotalia (Turbinulina) elegans* - D'ORBIGNY, 110.

1959 *Epistomina elegans* (d'Orbigny) - DIECI, 81, tav. VI, Fig. 31.

1960 *Hoeglundina elegans* (d'Orbigny) - BARKER, 216, pl. 105, Figs. 3-6.

1975 *Hoeglundina elegans* (d'Orbigny) - POPESCU, 106, pl. XC, Figs. 3a-c.

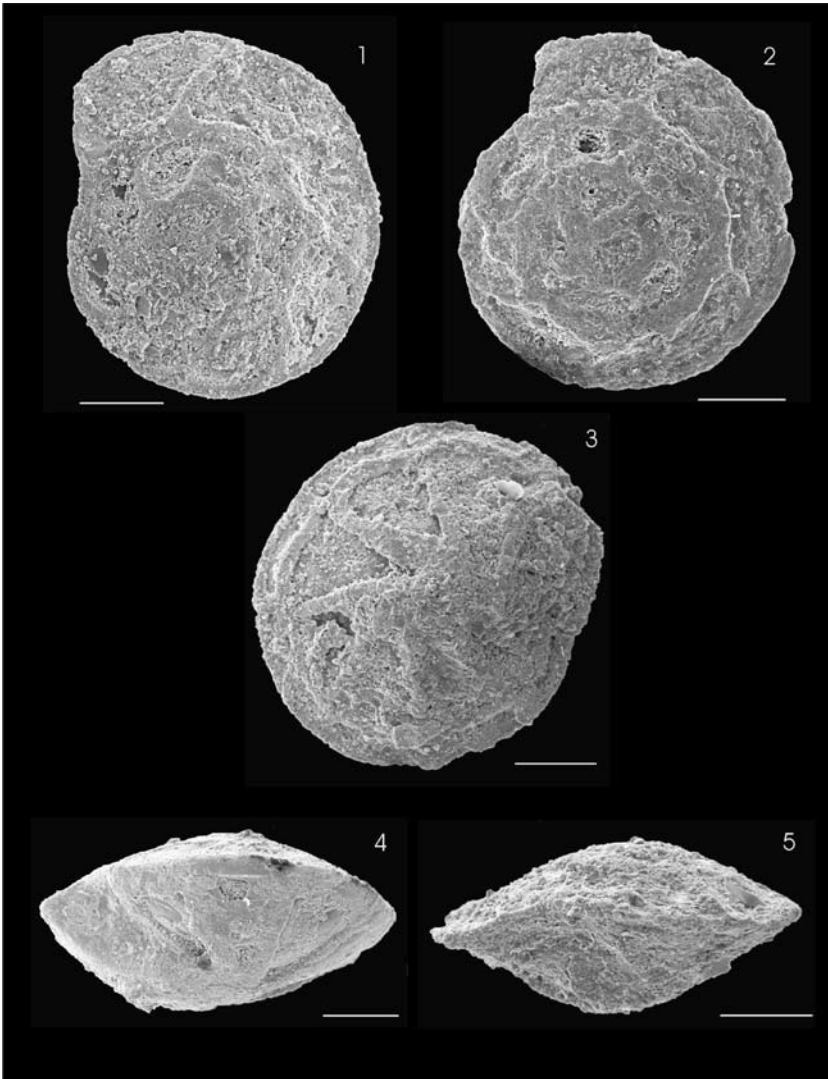
1982 *Hoeglundina elegans* (d'Orbigny) - DONDI & BARBIERI, tav. XLI, Fig. 10.

1985 *Hoeglundina elegans* (d'Orbigny) - PAPP & SCHMID, 59, Taf. 49, Fig. 1-6.

1991 *Hoeglundina elegans* (d'Orbigny) - CIMERMAN & LANGER, 56, pl. 59, Figs. 10-12.

1998 *Hoeglundina elegans* (d'Orbigny) - CICHÁ ET AL., 108, pl. 29, Figs. 19-21.

1998 *Hoeglundina elegans* (d'Orbigny) - ROBERTSON, 114, pl. 44, Figs. 2a-e.



**Plate 2.** *Hoeglundina elegans* (d'Orbigny, 1826). Fig. 1: Spiral side; Dr 17, Fig. 2: Spiral side; J 32, Fig. 3: Umbilical side; Dr 17, Fig. 4: Side view; Dr 17, Fig. 5: Side view; J 32. Scale bar represents 100  $\mu\text{m}$ .

**Tabla 2.** *Hoeglundina elegans* (d'Orbigny, 1826). Sl. 1: Spiralna stran; Dr 17, Sl. 2: Spiralna stran; J 32, Sl. 3: Umbilikalna stran; Dr 17, Sl. 4: Pogled s strani; Dr 17, Sl. 5: Pogled s strani; J 32. Merilce predstavlja 100  $\mu\text{m}$ .

*Material:* Rare to numerous tests from 16 samples (Figure 1).

*Description:* Test is trochospiral and bi-convex. Sutures are thickened. They are curved backward on the spiral side, and straight and oblique on the umbilical side. Periphery is subacute. Surface is smooth and finely perforate. Slitlike aperture is lateromarginal. Wall is aragonitic (LOEBLICH & TAPPAN, 1987).

*Size:* Test diameter is 0.42 - 0.52 mm and thickness 0.25 mm.

*Remark:* Preservation of tests is poor.

*Occurrence:* There are no data about the type locality and type level by the first description (D'ORBIGNY, 1826). In Italy, the species is known from the Middle Eocene to Pleistocene, it is very frequent in the Upper Pliocene (DONDI & BARBIERI, 1982; Po Valley, DIECI, 1959; Tortonian, Pliocene). In Middle America, it is known from the Upper Eocene (BOLLI ET AL., 1994), Miocene and Pliocene (ROBERTSON, 1998), in California, from the Pleistocene (ROBERTSON, 1998), in Australia, from the Upper Oligocene and Lower Miocene (LI & MCGOWRAN, 2000), in the India Ocean from the Pliocene and Pleistocene (BASOV & KRASHENINNIKOV, 1995), and in the Atlantic from the Pleistocene (LÉVY ET AL., 1998).

The species is extant; it is known from the Atlantic (BARKER, 1960), Pacific (DIECI, 1959, YASSINI & JONES, 1995) and Mediterranean (DIECI, 1959, CIMERMAN & LANGER, 1991, SGARRELLA & MONCHARMONT ZEI, 1993).

In the Central Paratethys, it appears from the Upper Eocene to the end of the Bades-

nian (CICHA ET AL., 1998). It is most frequent in the Karpatian and Badenian (CICHA ET AL., 1971). In Austria, it is known from the Upper Eocene (GOHRBANDT, 1961) and Karpatian (RÖGL, 1969), and in Bavaria, from the Kiscellian to Ottnangian (REISER, 1987: Lower Rupelian - Lower Egerian, WENGER, 1987: Upper Egerian - Lower Ottnangian).

*Remark:* In the literature that discusses Paleogene sedimentary sequences (Eocene of Italy: GRÜNIG (1985), Eocene of Slovenia: CIMERMAN ET AL. (2006), Lower Egerian of Hungary: SZTRÁKOS (1979)), morphologically similar tests have been determined as the species *Hoeglundina eocenica* (Cushman & Hanna). In the study of BRAGA & GRÜNIG (1975), the specimens noted as *H. elegans* from the Oligocene of Belgium are identified in the synonymy of the species *H. eocenica* from the Eocene of Italy. There are three possible interpretations of the cited literature above. That the species *H. elegans* ranges from the Eocene to Holocene, while the morphologically similar *H. eocenica* is restricted to the Paleogene only, where the two very similar species were coexistent. Alternatively, *H. eocenica* (Paleogene) and *H. elegans* (Neogene) may be chronologically distinct species; in this case identification of *H. elegans* in Paleogene strata would represent a false identification of *H. eocenica*. It is also possible that both names are only synonyms of one species, ranging from the Eocene to Holocene. Further comparative study of specimens from the Paleogene and Neogene is required to determine the relationship between both species.

### Distribution of robertininas in sections

Species *Ceratobulimina contraria* and *Hoeglundina elegans* were found in all six sections (Figure 1). *C. contraria* appears in 15 samples from the Lower Badenian (Lower Lagenidae Zone) to Upper Badenian (*Bolivina dilatata* Zone). In Plohov breg and Sveta Ana sections, it is delimited to the Lower Badenian; in the early Lower Badenian (Lower Lagenidae Zone) it was found only in the sample Sa 17m of the Sveta Ana section, while in the late Lower Badenian (Upper Lagenidae Zone) it becomes more common in both sections.

In other four sections: Imenska Gorca, Javoršica, Trobni Dol and Drensko Rebro, the species appears in the Middle and Upper Badenian only. The highest abundance is seen in the Upper Badenian sample J 33. *H. elegans* appears in 16 samples from the Lower Badenian Upper Lagenidae Zone to Upper Badenian *Bolivina dilatata* Zone. It is more common in the Middle and Upper Badenian with highest abundances being seen in Middle Badenian samples Td 3 and Dr 17. In sections Imenska Gorca, Javoršica, Trobni Dol and Drensko Rebro, the co-occurrence of both species is noted.

### CONCLUSIONS

In Kozjansko (Eastern Slovenia), the foraminiferal suborder Robertinina is represented with two species; *Ceratobulimina contraria* (Reuss) and *Hoeglundina elegans* (d'Orbigny). Both species were found in samples from the Lower to Upper Badenian. They are scarce in the Early Lower Badenian (Lower Lagenidae Zone) but increased abundance is noted in the Middle and Upper Badenian. Highest abundances are seen in the late Middle Badenian (*Uvigerina* cf. *pygmaea* Zone) and in the early Upper Badenian (*Bolivina dilatata* Zone).

Due to their occurrence throughout whole sections the species have little stratigraphic value for the Badenian, which coincides with previous studies of the Central Paratethys (CICHA ET AL., 1998). Moreover, occurrence of the species *Ceratobulimina contraria* in Upper Badenian samples points to its even wider stratigraphic range; the last appearance data of the species is moved from the Middle Badenian (CICHA ET AL., 1998) to early Upper Badenian (this study). Both species are described, imaged, classified and represented by their exact occurrence through the sections for the first time in Slovenia.





## POVZETKI

**Foraminiferni podred Robertinina iz badenija na Kozjanskem (vzhodna Slovenija)**

V prispevku je predstavljen foraminiferni podred Robertinina iz badenijskih plasti Kozjanskega. Podred Robertinina je bil opisan zadnji izmed dvanajstih foraminifernih podredov, ki jih zajema foraminiferna klasifikacija LOEBLICH in TAPPANOVE (1987). Podred vključuje foraminifere s planispiralno do trohospiralno zavrtimi hišicami, večinoma notranje predeljenimi kamricami in steklasto porozno steno, zgrajeno iz strukturno in optično žarkovitega aragonita (LOEBLICH & TAPPAN, 1987). Stene hišic vseh preostalih steklastih foraminifer, z izjemo v mezozoiku izumrlega podreda Involutinina, so namreč kalcitne. V podred Robertinina je po omenjeni klasifikaciji (LOEBLICH & TAPPAN, 1987) uvrščenih 48 rodov, s stratigrafskim razponom od zgornjega triasa do danes. Iz srednjega miocena je poznanih šest rodov, od tega v Evropi le štirje; *Ceratobulimina* Toulou, 1915, *Lamarckina* (Berthelin, 1881), *Hoeglundina* Brotzen, 1948 in *Robertina* d'Orbigny, 1846. Glede na relativno majhno vrstno diverzitetu v srednjemiocenskih sedimentih je podred Robertinina kot takson v literaturi manj poznan. V Sloveniji je bila iz miocenskih plasti doslej določena le vrsta *Hoeglundina elegans* (RIJAVEC, 1975, 1976, 1977 in 1984, PETRICA ET AL., 1995, DOZET ET AL., 1999).

Na Kozjanskem je bilo vzorčenih šest profilov; Imenska Gorca, Plohov breg, Javoršica, Sveta Ana, Trobni Dol in Drensko Rebro (OBLAK, 2006), ki pripadajo Planinski sinklinali, oziroma zahodnemu obrobju nekdanje Centralne Paratetide (BUSER, 1977 & 1979, ANIČIČ & JURIŠA 1984, ANIČIČ & JURIŠA 1985, ANIČIČ ET AL., 2004). Iz 128 vzorcev laporja in laporastega kalkarenita je bilo določenih 187 foraminifernih vrst iz sedmih podredov. Red Robertinina je zastopan z vrstama *Ceratobulimina contraria* (Reuss) in *Hoeglundina elegans* (d'Orbigny) in se pojavlja v vseh šestih profilih (slika 1). *C. contraria* je prisotna v vzorcih od starejšega spodnjega badenija (spodnja lagenidna biocona) do starejšega zgornjega badenija (biocona *Bolivina dilatata*), medtem ko se pojavlja *H. elegans* od mlajšega spodnjega badenija (zgornja lagenidna biocona) dalje. Obe vrsti sta najpogostejši v mlajšem srednjem badeniju (biocona *Uvigerina* cf. *pygmea*) in starejšem zgornjem badeniju (biocona *Bolivina dilatata*), kjer je opazen tudi trend skupnega pojavljanja.

Prisotnost *C. contraria* v zgornjebadenijskih vzorcih kaže na širši stratigrafski razpon kot je bil za območje Centralne Paratetide poznan doslej. Glede na dosežane raziskave naj bi živela vrsta na tem območju namreč le do konca srednjega badenija (CICHA ET AL., 1998). Iz srednjemiocenskih sedimentov Slovenije vrsta še ni bila poznana. *H. elegans*, ki je bila iz srednjega miocena Slovenije že določena, je v prispevku prvič opisana, upodobljena in uvrščena v sistem.

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## REFERENCES

- ANIČIĆ, B., JURIŠA, M. (1984): *Osnovna geološka karta SFRJ 1:100.000, list Rogatec, L 33-68*. Zvezni geološki zavod, Beograd.
- ANIČIĆ, B., JURIŠA, M. (1985): *Tolmač k Osnovni geološki karti SFRJ 1:100.000, list Rogatec L 33-68*. Zvezni geološki zavod, Beograd, 76 str.
- ANIČIĆ, B., OGORELEC, B., DOZET, S. (2004): *Geološka karta Kozjanskega, 1:50.000*. Geološki zavod Slovenije, Mladinska knjiga, Ljubljana.
- BARKER, R. W. (1960): Taxonomic Notes on the Species Figured by H. B. Brady in his Report on the Foraminifera Dredged by H.M.S. Challenger During the Years 1873-1876. Accompanied by a Reproduction of Brady's Plates. *Soc. Econom. Paleont. Miner.*; Spec. Publ., Vol. 9, pp. 1-238, Tulsa.
- BASOV, I. A., KRASHENINNIKOV, V. A. (1995): *Stratigraphy and Foraminifers of the Pliocene and Quaternary Deposits of the Timor Trough (the Indian Ocean)*. Naučni mir, Moskva, 112 pp.
- BOLLI, H. M., BECKMANN, J.-P., SAUNDERS, J. B. (1994): *Benthic foraminiferal biostratigraphy of the south Caribbean region*. Cambridge University Press, Cambridge, 408 p.
- BRAGA, G., GRÜNIG, A. (1975): Foraminiferi bentonici dell'Eocene superiore. In: Braga, G., De Biase, R., Grünig, A. & Proto Decima, F., Foraminiferi bentonici del Paleocene ed Eocene della sezione di Possagno. *Schweizerische Paläontologische Abhandlungen.*; Vol. 97, pp. 85-199, Basel.
- BUSER, S. (1977): *Osnovna geološka karta SFRJ 1:100.000, list Celje L 33-67*. Zvezni geološki zavod, Beograd.
- BUSER, S. (1979): *Tolmač k Osnovni geološki karti SFRJ 1:100.000, list Celje L 33-67*. Zvezni geološki zavod, Beograd, 72 str.
- CICHA, I., RÖGL, F., RUPP, C., CTYROKA, J. (1998): Oligocene - Miocene foraminifera of the Central Paratethys. *Abh. Senckenberg. Naturforsch. Ges.*; Vol. 549, 325 p., Frankfurt am Main.
- CICHA, I., ZAPLETALOVÁ, I., PAPP, A., CTYROKA, J., LEHOTAYOVA, R. (1971): Die Foraminiferen der Eggenburger Schichten-gruppe (incl. Arcellinida). In: Steininger, F. & Seneš, J. (Eds.), *Chronostratigraphie und Neostratotypen, Miozän der Zentralen Paratethys*. Bd. II, Eggenburgien, VEDA, Bratislava, pp. 234-355.
- CIMERMAN, F., LANGER, M. R. (1991): Mediterranean Foraminifera. *Dela IV. razreda SAZU.*; Vol. 30, 118 str., Ljubljana.

- CIMERMAN, F., JELEN, B., SKABERNE, D. (2006): Late Eocene benthic foraminiferal fauna from clastic sequence of the Socka - Dobrna area and its chronostratigraphic importance (Slovenia). *Geologija*.; Vol. 49/1, pp. 7-44, Ljubljana.
- DIECI, G. (1959): I foraminiferi tortoniani di Montegibbio e Castel Vetro. *Palaeontographia Italica*.; Vol. LIV (n. ser. vol. XXIV), pp. 1-113, Pisa.
- DONDI, L., BARBIERI, R. (1982): *Foraminiferi Padani, Atlante iconografico e distribuzione stratigrafica (Terziario e Quaternario)*. AGIP S.p.A., Milano, 52 pls.
- DOZET, S., RIJAVEC, L., GRAD, K. (1999): Western Kozje Area Tertiary (Eastern Slovenia). *Rudarsko metalurški zbornik*.; Vol. 46, No. 3, pp. 475-489, Ljubljana.
- GOHRBANDT, K. (1961): Die Kleinforaminiferenfauna des obereozänen Anteils der Reigruber Serie bei Bruderndorf (Bezirk Korneuburg, Niederösterreich). *Mitt. Geol. Ges.*; Vol. 54, pp. 55-145, Wien.
- GRÜNIG, A. (1985): Systematical description of Eocene benthic foraminifera of Possagno (Northern Italy), Sansoain (Northern Spain) and Biarritz (Aquitaine, France). *Memorie di Scienze Geologiche, Inst. Geol. Mineal. Uni. Padova*.; Vol. XXXVII, pp. 251-302, Padova.
- LANGER, W. (1969): Beitrag zur Kenntnis einiger Foraminiferen aus dem mittleren und oberen Miozän des Nordsee-Beckens. *N. Jb. Geol. Paläont. Abh.*; Vol. 133, pp. 23-78, Stuttgart.
- LÉVY, A., MATHIEU, R., POIGNANT, A., ROSSET-MOULINIER, M. (1998): 44. Data Report: Distribution of Pleistocene Benthic Foraminifers from the Eastern Equatorial Atlantic Ocean. In: Mascle, J., Lohmann, G. P. & Moullade, M. (Eds), *Proceedings of the Ocean Drilling Program, Scientific Results*.; Vol. 159, pp. 605-610, Texas.
- LI, Q., MCGOWRAN, B. (2000): Miocene foraminifera from Lakes Entrance Oil Shaft, Gippsland, southeastern Australia. *Memoir of the Association of Australasian Palaeontologists*.; Vol. 22, pp. 1-142, Canberra.
- LOEBLICH, A. R. JR., TAPPAN, H. (1984): Suprageneric classification of the Foraminiferida (Protozoa). *Micropaleontology*.; Vol. 30, No. 1, pp. 1-70, New York.
- LOEBLICH, A. R. JR., TAPPAN, H. (1987): *Foraminiferal Genera and their Classification*.; Vol. 1-2, 970 p., 847pls., Van Nostrand Reinhold, New York.
- D'ORBIGNY, A. (1826): Tableau Méthodique de la Classe des Céphalopodes. *Ann. Sci. D'Hist. Nat.*; Ser. 7, pp. 7-150, Paris.
- OBLAK, K. (2006): *Foraminiferna taksonomija, biostratigrafija in paleoekologija badenija v Planinski sinklinali (vzhodna Slovenija, Centralna Paratetida)*: Ph.D. Thesis. Ljubljana: University of Ljubljana 2006; 310 p, 60 pls.
- PAPP, A., SCHMID, M. E. (1985): Die Fossilen Foraminiferen des Tertiären Beckens von Wien. Revision der Monographie von Alcide d'Orbigny (1846). *Abh. Geol. Bundesanst.*; Vol. 37, 311 p., Wien.

- PETRICA, R., RIJAVEC, L., DOZET, S. (1995): Stratigraphy of the Upper Oligocene and Miocene beds in the Trobni Dol area (Kozjansko). *Rudarsko metalurški zbornik.*; Vol. 42, No. 3-4, pp. 127-141, Ljubljana.
- POPESCU, G. (1975): Études des foraminifères du miocène inférieur et moyen du nord-ouest de la Transylvanie. *Mémoires Inst. Géol. Géophys.*; Vol. XXIII, pp. 5-121, Bucarest.
- REISER, H. (1987): Die Foraminiferen der bayerischen Oligozän - Molasse; Systematik, Stratigraphie und Paläobathymetrie. *Zitteliana.*; Vol. 16, pp. 3-131, München.
- REUSS, A. E. (1851): Über die fossilen Foraminiferen und Entomostraceen der Septarienthone der Umgegend von Berlin. *Zeitsch. Deut. Geol. Gesel.*; Vol. 3, pp. 49-92, Berlin.
- RIJAVEC, L. (1975): *Korelacija miocenskih plasti v vzhodni Sloveniji, II. faza.* Arhiv geološkega zavoda Slovenije, 63 p., Ljubljana.
- RIJAVEC, L. (1976): *Korelacija miocenskih plasti v vzhodni Sloveniji, III. faza.* Arhiv geološkega zavoda Slovenije, 52 p., Ljubljana.
- RIJAVEC, L. (1977): *Korelacija miocenskih plasti v vzhodni Sloveniji, IV. faza.* Arhiv geološkega zavoda Slovenije, 56 p., Ljubljana.
- RIJAVEC, L. (1984): *Oligocen i miocen područja između Rudnice i Boča (istočna Slovenija) na osnovi mikrofosila.* Ph.D. Thesis. Zagreb: Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet Zagreb 1984, 141 p.
- ROBERTSON, B. E. (1998): Systematics and paleoecology of the benthic Foraminifera from the Buff Bay section, Miocene of Jamaica. *Micropaleontology.*; Vol. 44, No. 2, 266 p., New York.
- RÖGL, F. (1969): Die miozäne Foraminiferenfauna von Laa an der Thaya in der Molassezone von Niederösterreich. *Mitt. Geol. Ges.*; Vol. 61, pp. 63-123, Wien.
- SGARRELLA, F., MONCHARMONT ZEI, M. (1993): Benthic foraminifera of the Gulf of Naples (Italy): systematics and autoecology. *Boll. Soc. Paleont. Ital.*; Vol. 32, No. 2, pp. 145-264, Modena.
- SZTRÁKOS, K. (1979): La stratigraphie, paléocologie, paléogéographie et les Foraminifères de l'Oligocène du nord-est de la Hongrie. *Cahiers Micropaléontologie.*; Vol. 3, 95 p., Paris.
- WENGER, W. F. (1987): Die Foraminiferen des Miozäns der bayerischen Molasse und ihre stratigraphische sowie paläogeographische Auswertung. *Zitteliana.*; Vol. 16, pp. 173-340, München.
- YASSINI I., JONES, B. G. (1995): *Recent Foraminifera and Ostracoda from estuarine and shelf environments on the southeastern coast of Australia.* The University of Wollongong Press, Wollongong, 484 p.

