Lower/Middle Badenian foraminiferal associations from the Vienna Basin (Slovak part) and Carpathian Foredeep: Biostratigraphy and paleoecology

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Abstract: The benthic and planktonic foraminiferal fauna have been analysed from the Middle Miocene sedimentary sequences. We present statistical, biostratigraphical and paleoecological results. The studied material was taken from the Slovak part of Vienna Basin and represents the borehole cores Dúbrava 47 and 48 and samples from two outcrops in the vicinity of Oslavany (Lower Badenian holostratotype) and Židlochovice (Lower Badenian faciostratotype) localities in the Carpathian Foredeep. The standard laboratory methods were used for the fossils separation. The material was processed by the few statistical methods as diversity (Simpson index), equitability, P/B ratio and cluster analyses (Ward's methods). Foraminiferal associations from the Vienna Basin have supported the Lower/Middle Badenian age (*Praeorbulina - Orbulina* biozone). In the Carpathian foredeep the Lower Badenian *Praeorbulina* biozone was determined. Foraminiferal assemblages indicate the outer shelf/upper bathyal depositional area. Benthos dominated nearly in all samples and is well preserved. The preservation of planktonic forms is not very good; the tests are rather small and misshapen. The occurrence of the warm and cool planktonic indices together can suppose temperature stratification of the water column. According to preservation of the foraminiferal fauna and species diversity and equitability, we can assume not appropriate life conditions in the investigated part of the Vienna Basin. Foraminifers in the Carpathian Foredeep are well developed and individuals have a good proportion. The presence of the stress-tolerant species which can tolerate low-oxygen supply may indicate partial restriction of the oxygen supply near the sedimentation basin ground in the both, Vienna Basin and Carpathian Foredeep areas.

Key words: Miocene, Badenian, *Foraminifera*, paleoecology, biostratigraphy, Vienna Basin

Introduction

In this paper we present the results based on planktonic and benthic foraminiferal assemblages study from the Lower and Middle Badenian stage sediments. The investigated sections are located in the Vienna Basin and Carpathian Foredeep within the Central Paratethys area (Fig. 1).

First papers, dealing with this area and describing found fossils were written in the second half of the 19. century (Czjzzek 1848, Orbigny 1846, Hoerness 1859-1870, Reuss 1851, 1860). Later papers were focused on the stratigraphy of the sediments and using foraminiferal assemblages the age of the rocks was determined (Grill 1941, 1943, Cicha et al, 1983, Papp & Schmidt 1971). Paleoecological studies based on foraminifera did not appear until the 1950s (Molčíková 1962, Šutovská 1991, Hudáčková 1995, Hudáčková & Kováč 1993, Kováč & Hudáčková 1997).

Geological settings

The Vienna Basin represents a typical pull-apart basin situated within the Alpine-Carpathian mountain belt, between the Eastern Alps and Western Carpathians (Kováč, 2000). It is one of the most explored sedimentary basins in Europe with a numerous boreholes and seismic data.

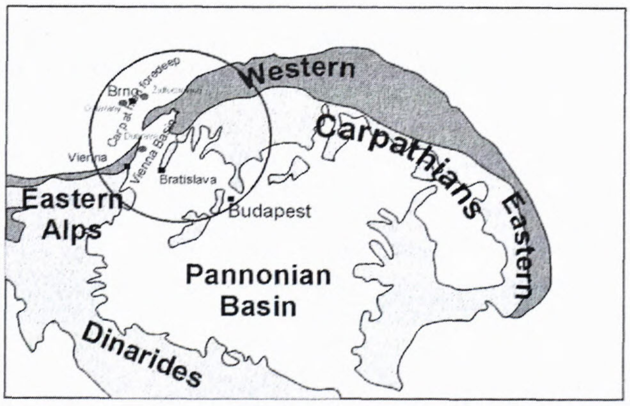

Fig. 1. Localization of the studied material.

The basin was filled by Neogene to Quaternary deposits with maximal thickness up to 5500 m in its central part (Killényi & Šefara, 1989). The Carpathian Foredeep can be classified as a peripheral foreland basin (Allen et al., 1986). The depositional history here started in the Egerian/Eggenburgian period and finalized during the Early Badenian. The biostratigraphic ages of the investigated sections have been determined by means of planktonic and benthic foraminifers, using the zonation of Grill (1941, 1943) and Cicha et al. (1975). These zonations have been correlated with the nannoplankton zones following Martini (1971) and with a timescale of Berggren et al. (1995). This paper represents a part of the paleoecological and stratigraphic studies of the Slovak part of Vienna basin.

Materials and methods

The studied material deriving from the Vienna Basin area (Slovak part) represents the borehole cores Dúbrava 47 and Dúbrava 48. In Carpathian Foredeep the samples derive from two outcrops in Oslavany (Lower Badenian holostratotype) and Židlochovice (Lower Badenian faciostratotype) localities (Fig. 2a). Poor foraminiferal assemblages were observed in Dúbrava 48 borehole. There are present only the allochthonous individuals and therefore they are not involved into statistical analyses. Borehole Dúbrava 47 is located between Dúbrava and Láb villages in the Záhorská nížina lowland. The boreholes for the petroleum research were deep in the range of 800-1800 m, penetrating the Neogene bedding sequence of the Vienna Basin. Their lithology consists of dark-grey sandy siltstone and medium-grained sandstone with micas (Fig. 2b).

The Oslavany sandpit (Fig. 2a) is situated to SSE part of the Oslavany area, SW from Brno (Czech Republic). This locality represents the Lower Badenian holostratotype (Morav) and contains autochthonous as well as redeposited micro- and macrofaunas. Sediments consist of Brno sands member containing fine- to coarse-grained polymict calcareaous sands and sandy gravels. There are frequent clay lumps with Ottnagian and rare Karpatian microfauna. Rich macro and micro fauna was documented here: *Braarudosphaera bigelowi, Holodiscus macroporus, Coccolithis miopelagicus, Orbulina suturalis, Uvigerina macrocarinata, Myrtea spinifera, Ervilia pusilla, Rzehakia socialis, Cardium moravicum* (Zimák, 1997).

The studied material deriving from the Židlochovice locality was collected from the old brickyard situated at the north of Židlochovice village and in the lower part of the Výhon hill. This locality is defined as a Lower Badenian faciostratotype (Morav) and belongs to Carpathian Foredeep area. Sediments consist of light algae limestones and carbonatic grey, blue-grey micaceous clays with lenses and beds of light algae limestones to calcareous sands (Fig. 2a). Rich fossil fauna and flora were recorded here including Foraminifera (*Spiroplactammina carinata, Spiroloculina arenaria, Lenticulina Cultrata, Uvigerina macrocarinata, U. grilli, Globigerinoides trilobus, Globorotalia mayeri, Orbulina bilobata, O. suturalis* and other, lot of Radiolaria – *Hexastylus* sp., *Hexacontium* sp., Spongodiscidae and other, Anthozoa – *Tarbellastrea reussiana, Trochoczathus plicatus* as well as lot of other forms: Bryozoa, Mollusca, fish otolits, Ostracoda, rich calcareous nannoplankton assemblage and Rhodophyta (Zimák, 1997). The uppermost part of the profile consists of loess, which has been exploited for brick production in the past.

Standard laboratory methods were used for the fossil separation. Approximately 200 gr of the sediment for each sample were soaked in diluted hydrogen peroxide, washed under running water and wet sieved over the two sieves, which upper one had meshes 0.71 mm in diameter and the bottom one 0.071 mm. Occasionally there was added the sodium pyrophosphate for the entire removal of clay components. Coarse and fine fractions, including macroperforate, microperforate and agglutinated taxa were further processed separately. The material was dried at room temperature and studied with a binocular stereomicroscope for planktonic and benthic foraminifera content. In the case of agglutinated species the transmitted light microscope was used, enabling better study of the inner shell structures and individuals set in immersion oil. Foraminiferal assemblages were analysed by a few statistical methods and therefore to pick out minimum 250 specimens from each sample was necessary. Variable numbers of specimens were picked up from the each analysed sample to provide a reference collection for more detailed studies. The individuals were conserved to the chapman's cells for later retention. The statistical methods used for foraminifers analyses comprised the diversity (Simpson's index), equitability, P/B ratio and cluster analysis (Ward's methods).

The values of diversity (H) were calculated using the Simpson's index (Buzas 1979, Magurran 1991) based on the formula $D = 1/\sum n_i (n_i - 1)/N (N - 1)$, where i is the number of species in association and N is the number of all association. Equitability (E) means the evenness distribution of an assemblage: $E = e^H/ S$, where H is diversity from the Simpson index and S is the number of genera in an assemblage. Foraminifers were also counted in order to calculate the plankton to benthos ratio. The plankton/benthos ratio (%) is the percentage of planktonic foraminifers in an assemblage: $P/B = N_p/N$, where N_p is the number of planktonic foraminifers and N is the total number of foraminifers in the sample.

Biostratigraphy

Foraminiferal associations from D47 borehole (Vienna Basin) supported the Lower/Middle Badenian (Morav/Velic) age, which present the Upper lagenide Biozone and *Spiroplectammina carinata* Biozone boundary (according to Grill 1941, 1943) or CPN7 *Praeorbulina / Orbulina* Zone (according Cicha et al. 1975). This period is defined by the presence of index species *Orbulina suturalis* Brön. and abundance of rich occurrence of *Spirorutilus carinatus* d'Orb., characterizing the Middle Badenian onset. Berggren et al. (1995) recorded the first occurrence of *Orbulina suturalis* at 15.1 Ma and used it to mark the base of the upper Lower Badenian in the Vienna Basin. *Globigerina druryi* Akers and *Globigerina decoraperta* Tak. & Saito indicate a little bit higher period according to Cicha et al. (1975), ranged to the Zone CPN8. This interval is equivalent to the nannoplankton Zone NN5 (Martini, 1971) and the Lower/Middle Badenian boundary is situated approximately on 15 Ma (Rögl, 1998; Fig. 3).

Considerably similar foraminiferal composition is marked in both, Židlochovice and Oslavany localities from the Carpathian Foredeep. The presence of *Praeorbulina glomerosa circularis* Blow (without genus *Orbulina*) indicates the *Praeorbulina* Zone (Zone CPN 6 sensu Cicha et al., 1975) and characterizes the base of the La-

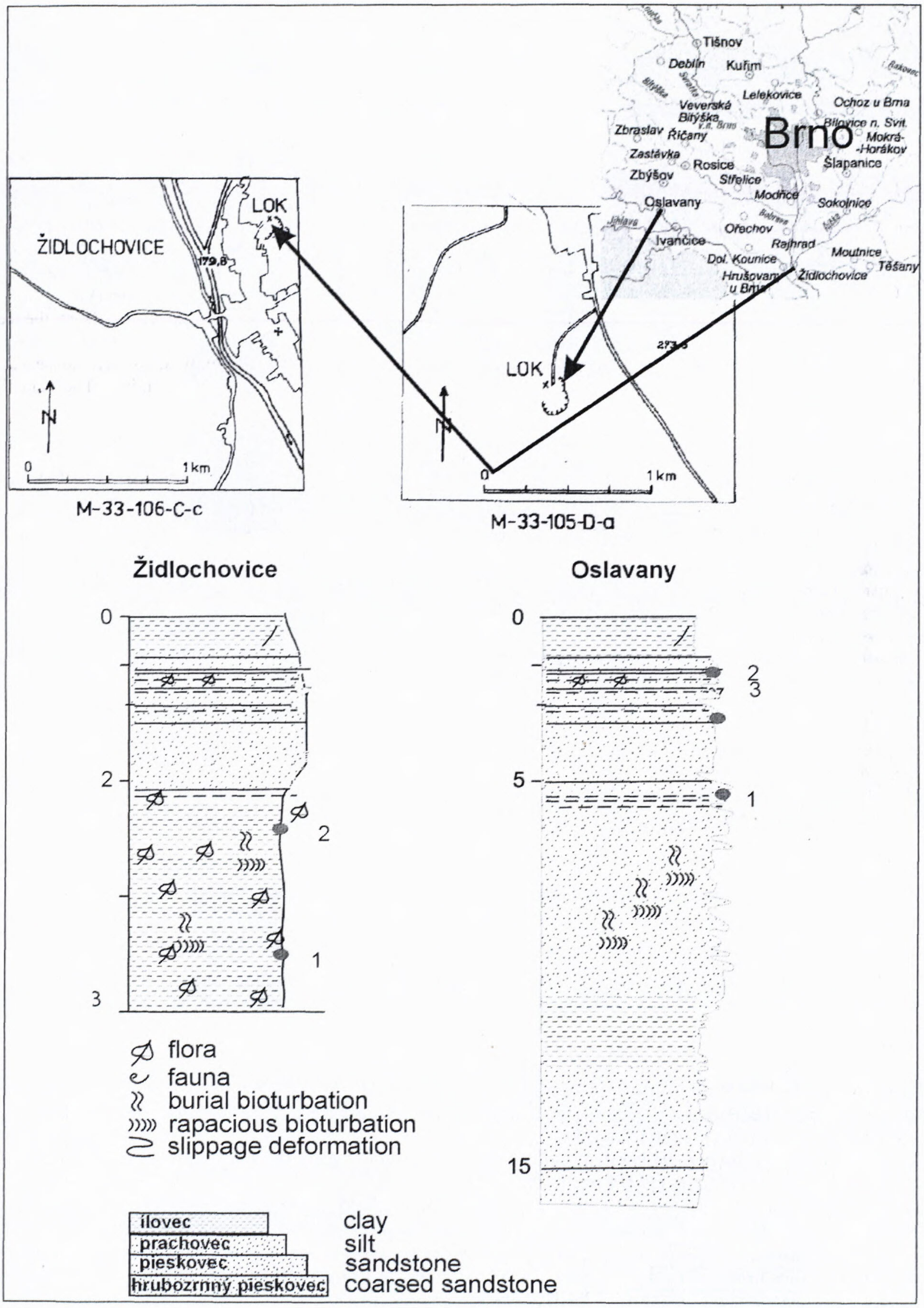

Fig. 2a. Lithological columns of the studied profiles – Židlochovice and Oslavany. 2b. Dúbrava 47.

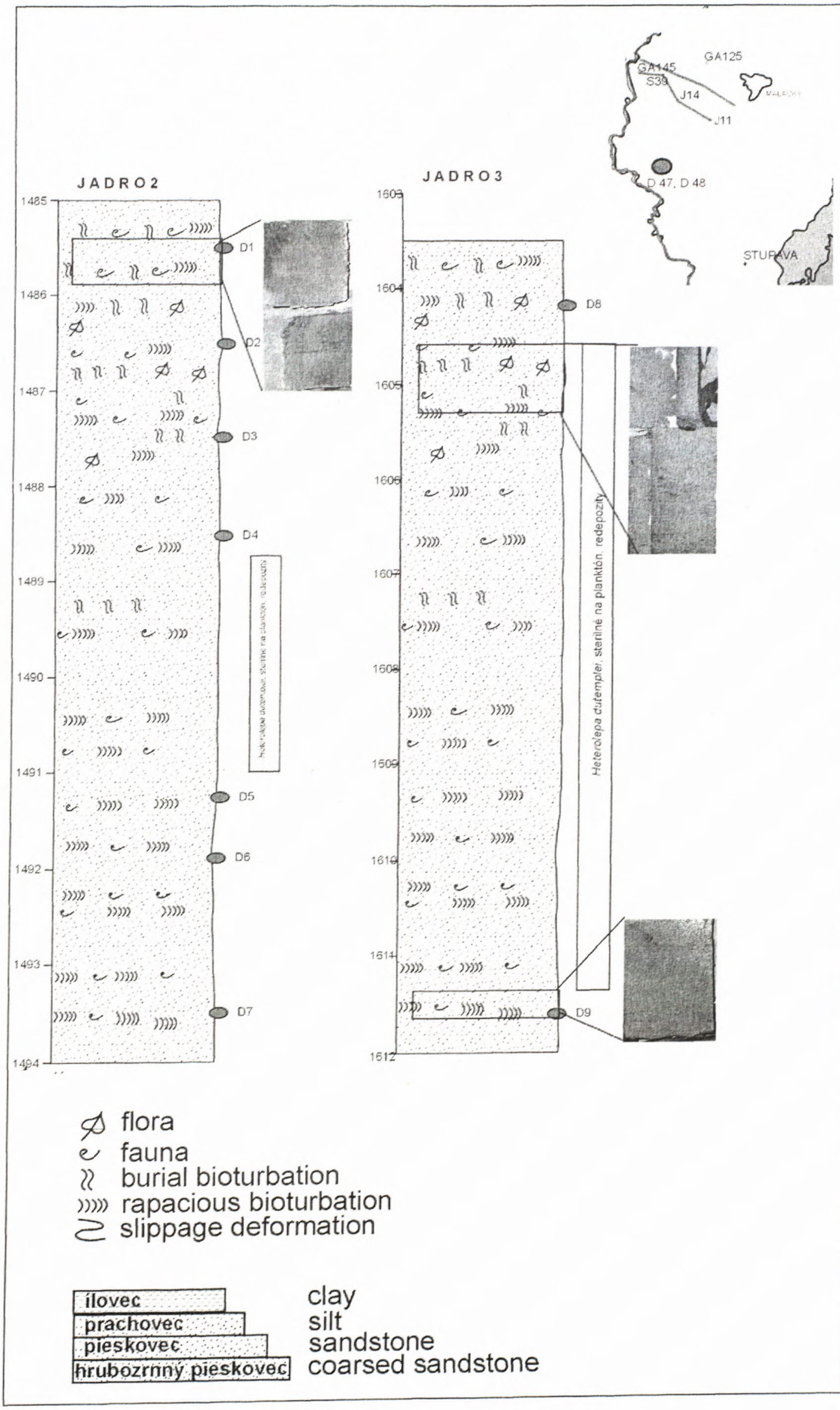

Fig. 2b. Lithological columns of the studied profiles – Dúbrava 47.

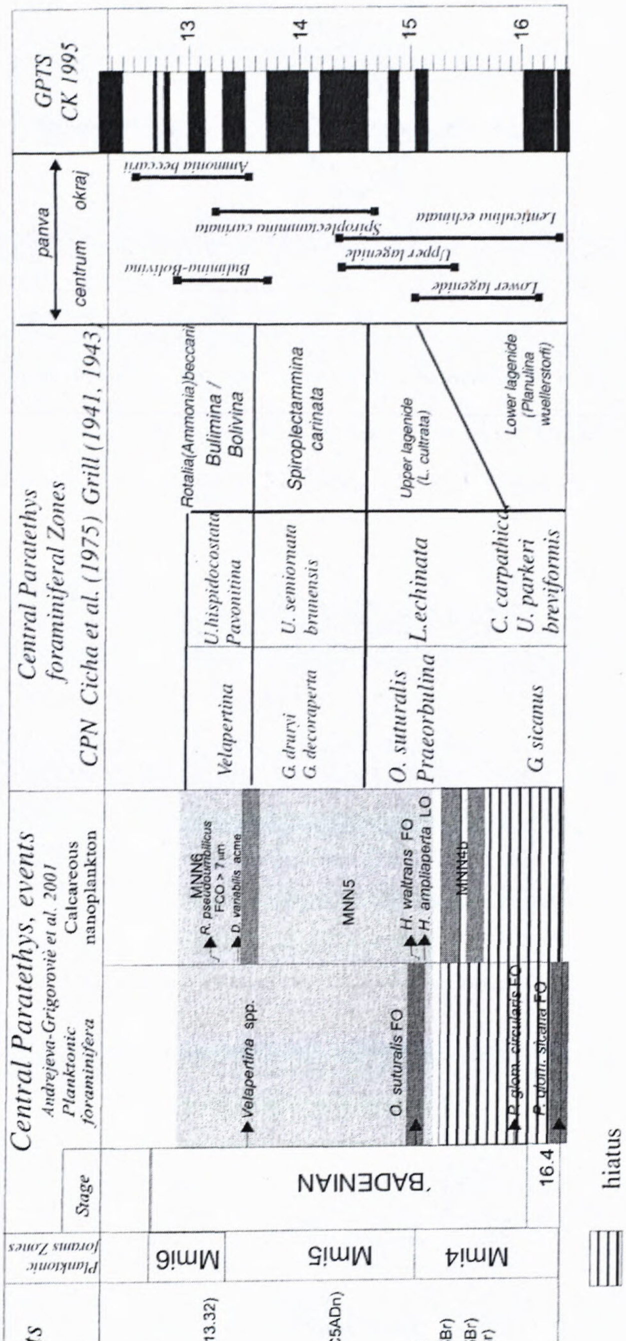

Fig. 3. Correlation of the used zonation with the foraminiferal and calcareous nannoplankton events

genide Zone in the Lower Badenian stage. The deposits with preorbulinas from the Carpathian Foredeep were described by Cicha (1995) and assigned to Karpatian/Badenian boundary period. The occurrence of *Globigerinoides bisphericus* Todd, as a typical Upper Karpatian taxa (Rögl, 1986) indicates, that the sedimentation ranged during the Lower Badenian beginning in the time period from 16.8? to 15.1 Ma (Berggren et al., 1995). According to Cicha et al. (1998) Karpatian overlaps into the Lower Badenian stage. The studied sediments can be attributed to the upper part of the nannoplankton Zone NN4 of Martini (1971). This is contrasting with new data by Spezzaferri (2004), which was undertaken to solve the debate about the age of the sediments from the Grund Formation and to propose an environmental interpretation based on benthic and planktonic foraminiferal assemblages. The studied sediments can be attributed to the Lower Lagenidae Zone in the Badenian (Langhian, Middle Miocene) on the basis of the presence of index fossils like *Praeorbulina glomerosa circularis* and *Uvigerina macrocarinata*. In agreement with Andrejeva Grigorovič et al. (2001) the Židlochovice samples are classified into the NN5a nannoplankton Zone and Oslavany locality is ranked to the NN5b/c nannoplankton Zone.

Foraminiferal assemblages

A total of 135 taxa were determined in the studied samples, including 29 planktonic and 106 benthic species. Foraminiferal assemblages are moderately to well preserved and small-sized in the case of planktonic species. Well preserved benthic assemblages are dominated nearly in all samples from the Vienna Basin. Planktonic forms are generally moderately to poor preserved, tests are rather small and misshapen, what is probably related to tectonic processes during the fossilization.

Dúbrava 47

Foraminiferal assemblages from the Vienna Basin are moderately to well preserved. Planktonic foraminiferal assemblages are scarce (0.4–15 %) and consist of dominant *Globigerinoides triloba*, *Globigerina praebulloides* and *Globigerinella obesa*. The accompanying taxa includes *Globigerina bulloides*, *Globigerinoides quadrilobatus* and *Globoquadrina altispira*. Benthic foraminiferal assemblages represent a majority in these samples and consist mainly of *Bulimina subulata*, *Heterolepa dutemplei*, *Spirorutilus carinatus*, *Pullenia bulloides*. Different composition of foraminiferal taxa is observed in the sample D3, where the planktonic taxa comprise 76 % of the total sample. Sample D3 contains dominant planktonic assemblages *Globigerina* aff. *decoraperta*, *Globorotalia mayeri* and *Globigerina* aff. *woodi*. They are associated with *G.* aff. *nepenthes* and *Globorotalia bykovae*. Benthic elements are rare and dominated mainly by *Heterolepa dutemplei*.

Židlochovice

Foraminiferal assemblages are generally well preserved and are dominated by planktonic forms such as *Globigerina praebulloides*, *Globigerinoides triloba*, *Globorotalia*

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mayeri with accompanying taxa *Globigerina bulloides*, *G. falconensis*, *Globorotalia challengeri* and *Globigerinoides quadrilobatus*. Planktonic taxa represent 60–72 % of samples. Benthic fauna is rare and includes moderately abundant *Cibicidoides ornatus*, *Nonion commune*, *Sphaeroidina bulloides* and *Stilostomella adolphina*.

Oslavany

Foraminiferal assemblages are well preserved and consist of dominant planktonic forms *Globigerinoides triloba*, *Globigerina praebulloides*, *G. quinqueloba*, *G. bulloides*, *G. falconensis*. Planktonic fauna is represented by 40–60 %. Benthic assemblages are not very abundant and the most frequent species are *Bulimina striata*, *Heterolepa dutemplei* and *Nonion commune*.

Statistical analyses and paleoenvironment

Abundance of foraminiferal fauna widely ranges. The most abundant were the samples D4, D5, D7 from Dúbrava and Z1, Z2 from Židlochovice. Diversity and equitability are distinctively shown in Fig. 4 for planktonic and in Fig. 5 for benthic species. Both values are reciprocally related and they are influenced by various factors, such as oxygen content and nutrient availability (Murray, 1991; Van der Zwaan et al., 1995). High values of equitability and diversity represent well-balanced associations living in the ideal life-conditions. Decrease of both, diversity and equitability values and the predominance of one or several taxa demonstrate stress settings acceptable only for the dominant species (Pokorný et al., 1992; Legendre & Legendre, 1983; Murray, 1991).

The cluster analyses were carried out respecting ecological claims of the single or grouped species. According to species abundance at low, middle and high latitudes reported in literature (Spezzaferri & Premoli Silva, 1991; Spezzaferri, 1995; 1996) the planktonic taxa were divided to: 1. warmer indices (*Globorotalia* s.s. groups, *Globigerinoides*, *Dentoglobigerina altispira*, *Orbulina suturalis*, *Praeorbulina glomerosa circularis*); 2. warm-temperate indices (*Globorotalia mayeri*, *Globorotalia siakensis*, *Globigerina quinqueloba*); 3. cool-temperate indices (*Globigerina woodi*, *Globigerina druryi*) and 4. cooler indices (*Globorotaloides*, *Globigerina* s.s. groups). Distribution of the paleoclimatic indices is shown in Fig. 6. Sample D5 from Vienna Basin was excluded from planktonic cluster analysis, because the planktonic fauna was not present in this sample.

Benthic forms were divided to 1. uvigerinas (*U. semiornata*, *U. accumminata*, *U. acculeata*, *U. grilli*, *U. venusta*, *U. pygmoides*, *U. graciliformis*), 2. buliminas (*B. pyrula*, *B. elongata*, *B. subulata*, *B. striata*), 3. bolivinas (*B. antiqua*, *B. dilatata*, *B. scalprata*), 4. epiphyte dwellers (*Elphidium*, *Nonion*, *Lobatula lobatula*, *Cibicides boueanus*, *Ammonia vienensis*, *Asterigerinata planorbis*), 5. agglutinated species (*Martinottiella karreri*, *Martinottiella communis*, *Reophax* sp., *Spirorutilus carinatus*, *Semivulvulina*, *Textularia*) and 6. outer shelf/slope dwellers (*Pullenia bulloides*, *Melonis pompilioides*, *Hansenisca soldanii*, *Valvulineria akneriana*, *Sphaeroidina bulloides*, *Fontbotia* *wuellerstorfi*, *Favulina hexagona*, *Cibicidoides*, *Dentalina*, *Lenticulina*). Benthic indices were viewed on the basis of literature (e.g. Murray, 1991; Yassini & Jones, 1995; Kouwenhoven et al., 1999; Bartakovics & Hudáčková, 2004) and their distribution is shown in Fig. 7.

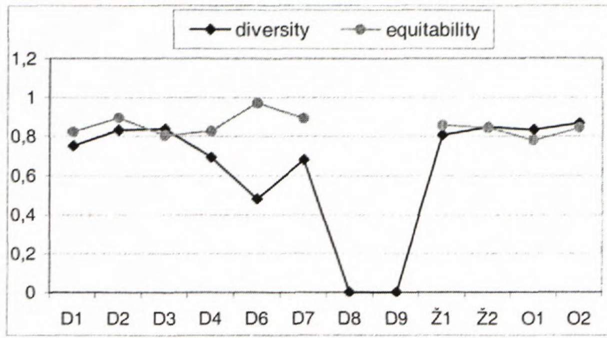

Fig. 4: The Simpson's diversity and equitability for planktonic foraminiferal groups (D1 - D9 Vienna Basin samples, Ž 1,2 Židlochovice samples, O1,2 Oslavany samples).

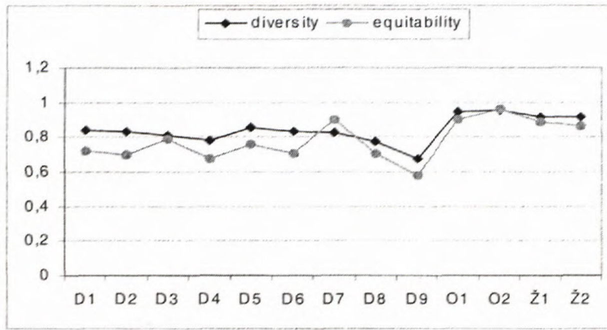

Fig. 5: The Simpson's diversity and equitability of the benthic foraminiferal groups (D1 - D9 Vienna Basin samples, Ž 1,2 Židlochovice samples, O1,2 Oslavany samples).

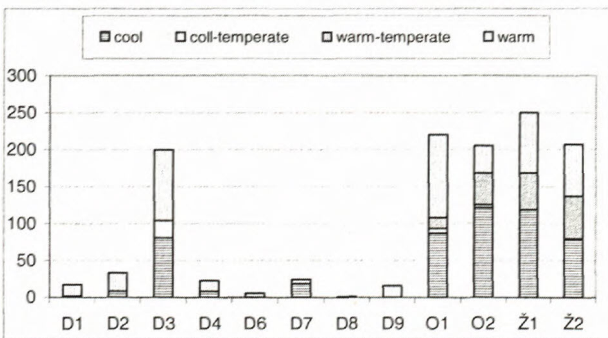

Fig. 6: Planktonic foraminifera indices according to temperature demands. Divided according to Spezzaferri & Premoli Silva (1991), Spezzaferri (1995; 1996).

The P/B ratio curve is not even but broadly fluctuated (Fig. 8). The predominance of plankton taxa was recorded only in the sample D3 from the Vienna Basin. Mostly all samples from Carpathian Foredeep correspond with these results. The sample D3 contains planktonic species not present or rare in the other samples such as *Globigerina* aff. *decoraperta*, *Globorotalia mayeri* and *G. bykovae*. Planktonic assemblages in Carpatian Foredeep samples show relatively high abundance. Dominant

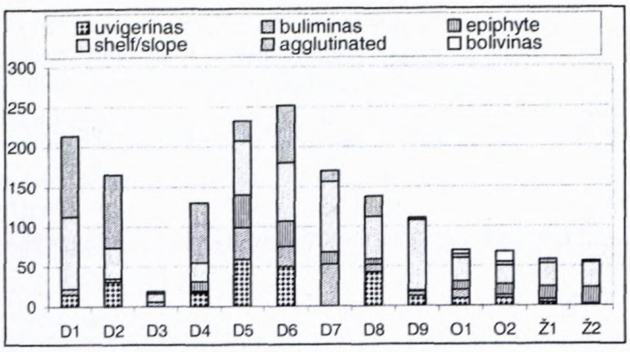

Fig. 7: Ecological groups of benthic foraminifera dwellers in the studied samples.

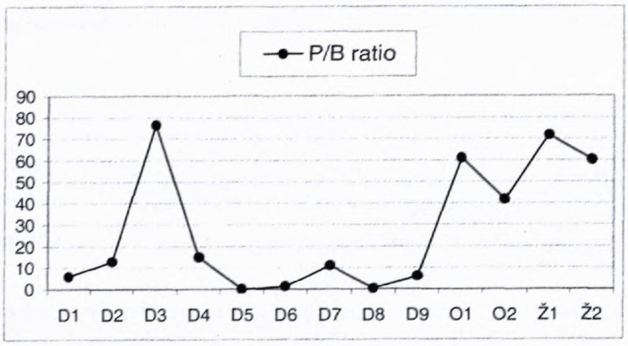

Fig. 8: Plankton/benthos ratio.

species are *Globigerinoides triloba*, *Globigerina praebulloides*, *G. quinqueloba* and *G. mayeri*. High planktonic values of equitability and diversity have been observed in the samples D2, Ž1, Ž2, O2 what support well developed and balanced associations with the most favourable life conditions from all studied samples. Planktonic associations in the samples O1 and D3 show the lowest values of equitability, but the diversity is relatively high. Warmer and cooler indices are present in both samples equally, with small-sized warm-water species as is a typical sign. These associations are not balanced adequately but diversity is high, thus we can assume adequate life conditions with temperate surface-water temperature. The occurrence of both, warm and cool indices together indicates probably temperature stratification of the water column. In the other samples the planktonic taxa are poorly represented with the low species diversity. Planktonic assemblages imply lack of nutrient supply or early transgression, what may support also bad preservation of individuals.

Abundance of the benthic associations is the most distinct sign in the Carpathian Foredeep samples what is in good accordance with the plankton diversity in these samples and indicates presentable conditions. The lowest diversity is observed in the Vienna Basin (samples D4, D7, D8 and D9) and it is conformable to plankton data. Low values can be attributed with a stressful factor, which lead to rapid aggravation of ecological conditions. Predominant benthic forms including species *Pullenia bulloides*, *Melonis pompilioides*, *Heterolepa dutemplei*, *Spirorutilus carinatus* together with uvigerinids, indicate a relatively deep environment of about 150-200 meters corresponding to the outer neritic/upper bathyal area. This depth attribution agrees with many paleoecological works (e.g. Murray, 1991; Šutovská-Holcová et al., 1993; Yassini & Jones, 1995; Spezzaferri, 2004). According to ecological demands of this species the surround deepening can be predicted.

In some samples there are present the shallow water dwellers like *Nonion*, *Elphidium*, *Lobatula lobatula*, *Ammonia vienensis* and *Asterigerinata planorbis*. They may indicate shallower depth. Nevertheless, shells of these taxa appear broken in contrast to the better preserved deep-water dwellers. Accordingly, combining the shallow-water species and deeper-water benthic foraminifers indicates the redeposition of the upper shelf sediments into the deeper parts of the sedimentary area with anoxic environments. This assumption intensifies the fact that the shallow water species were strongly compressed and deformed.

The stress-tolerant taxa *Uvigerina*, *Bulimina*, *Bolivina*, *Spirorutilus*, *Melonis*, *Pullenia* (e.g. Van der Zwaan, 1982; Murray, 1991; Van Marle, 1991; Šutovská-Holcová et al., 1993; Kouwenhoven et al., 1999; Spezzaferri et al., 2002) which can tolerate low-oxygen supply, may imply a partial restriction of the oxygen supply near the sedimentation basin ground. These species are characterized as suboxic indicators, characteristic for oxygen contents of 0.3 to 1.5 ml/l (Kaiho, 1994). Among the low-oxygen taxa belongs *Heterolepa dutemplei* also (Šutovská, 1990), representing the current species in the Vienna Basin. Under conditions without any oxygen, the benthic foraminifera are absent (Murray, 1991).

Clusters analysis of planktonic ecological groups shows highermost diversity cluster composition in D3, Ž1, Ž2, O1 and O2 samples (Fig. 9), which have very similar species representation with different temperature demands. These cluster associations developed in comparative ecological conditions and indicate temperature stratifications of water column. These samples have the highermost P/B ratio what indicates the deepening environment (Van der Zwaan et al., 1995; McGowran & Li, 1997; Gonera, 1994). The Carpathian Foredeep samples contained species *Praeorbulina glomerosa circularis*, *Globigerinoides quadrilobatus*, *G. triloba* which described Kováč & Zlinská (1998) in the Lower Badenian sediments from the East Slovakian basin and assume neritic open sea area. The second cluster encompasses the Vienna Basin planktonic assemblages with similar warm and cool indices abundance without temperate species. Cluster analyses results of plankton are comparable with the values of benthic groups analyses (Fig. 10). Two clusters were formed according to ecological demands of the benthic taxa. First cluster includes samples from the Carpathian Foredeep and one the Vienna Basin sample. Samples Ž1, Ž2 and D3 have low representation of stress-tolerant species and a high contribution of deepwater dwellers, what indicates cold and high-oxygen contents environment. Representation of euryoxibiont species is relatively high in Oslavany and it should suggest the short suboxic periods in this area. Second cluster combine the samples with a high contribution of agglutinated forms like *Spirorutilus carinatus*, *Textularia gramen abbreviata*, *Martinottiella communis*, which represent euhaline neritic Vienna Basin backgrounds deposition of Jakubov Formation (Špička, 1969).

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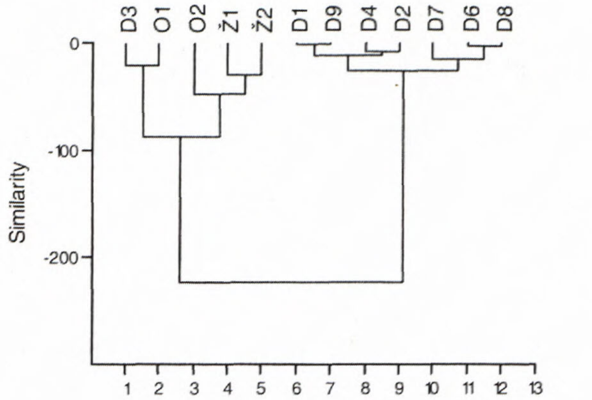


Fig. 9. Cluster analysis of ecological groups for planktonic forms.

Fig. 10. Cluster analysis of ecological groups for benthic forms.

Conclusions

In the Vienna basin samples the Lower/Middle Badenian age was supported, representing the upper lagenid Biozone and *Spiroplectammina carinata* Biozone boundary (Zone CPN8, NN5).

In both, Židlochovice and Oslavany localities from the Carpathian Foredeep, the presence of *Praeorbulina glomerosa circularis* Blow confirmed the *Praeorbulina* Zone (Zone CPN 6-7) and marked base of the lagenid Biozone in the Lower Badenian stage. The studied sediments can be attributed to the upper part of the nannoplankton Zone NN4 of Martini (1971) or to the NN5a and NN5b/c Zones of Andrejeva Grigorovič et al. (2001).

The foraminiferal associations in the Carpathian Foredeep are well developed. Individuals have broadly good proportions which show almost ideal conditions for the test formation. Temperature demands of the present species imply temperature stratification of the water column with the cooler and warmer flows zones. Židlochovice and Oslavany associations are developed in the good aerated areas; in Oslavany there was recorded the episodic low-oxygen content.

Because the extreme low plankton content in majority of the Vienna Basin samples, it is not possible to interpret the life environment certainly. Planktonic associations are not well developed and probably they had not appropriate life conditions here. The main stress factors could be deepening of background and not sufficienty nutrient-supply.

During the sedimentation the higher temperature prevailed with moderate cooling periods. In both, Vienna Basin and Carpathian Foredeep, the predominant benthic forms suggest the sedimentation area at neritic/upper bathyal boundary (about 150-200 m). Species composition supports episodic reduced oxygenation in the ground, which could be caused by circulation changes and reduced supply of the fresh water.

Systematic part

The systematic part comprises only planktonic taxa determined in the investigated sections. The taxonomic classification used here is based on several available studies. The species are discriminated following Loeblich & Tappan (1987; 1992) and Kennett & Srinivasan (1983).

Phyllum: *Granoreticulosa* (LEE, 1990)
Class: *Foraminifera* (LEE, 1990)
Order: *Globigerinida* (DELAGE et HERONARD, 1896)
Superfamily: *Globigerinacea* (CARPENTER, PARKER et JONES, 1862)
Family: *Globigerinidae* CARPENTER, PARKER et JONES, 1862

Genus: *Globigerina* D'ORBIGNY, 1826

This genus includes all trochospiral species with single, large, open umbilical aperture. It is characterized by hispid surface, penetrated by cylindrical pores.

***Globigerina quinqueloba* NATLAND 1938**

Plate 1, Fig. 1a, b, c

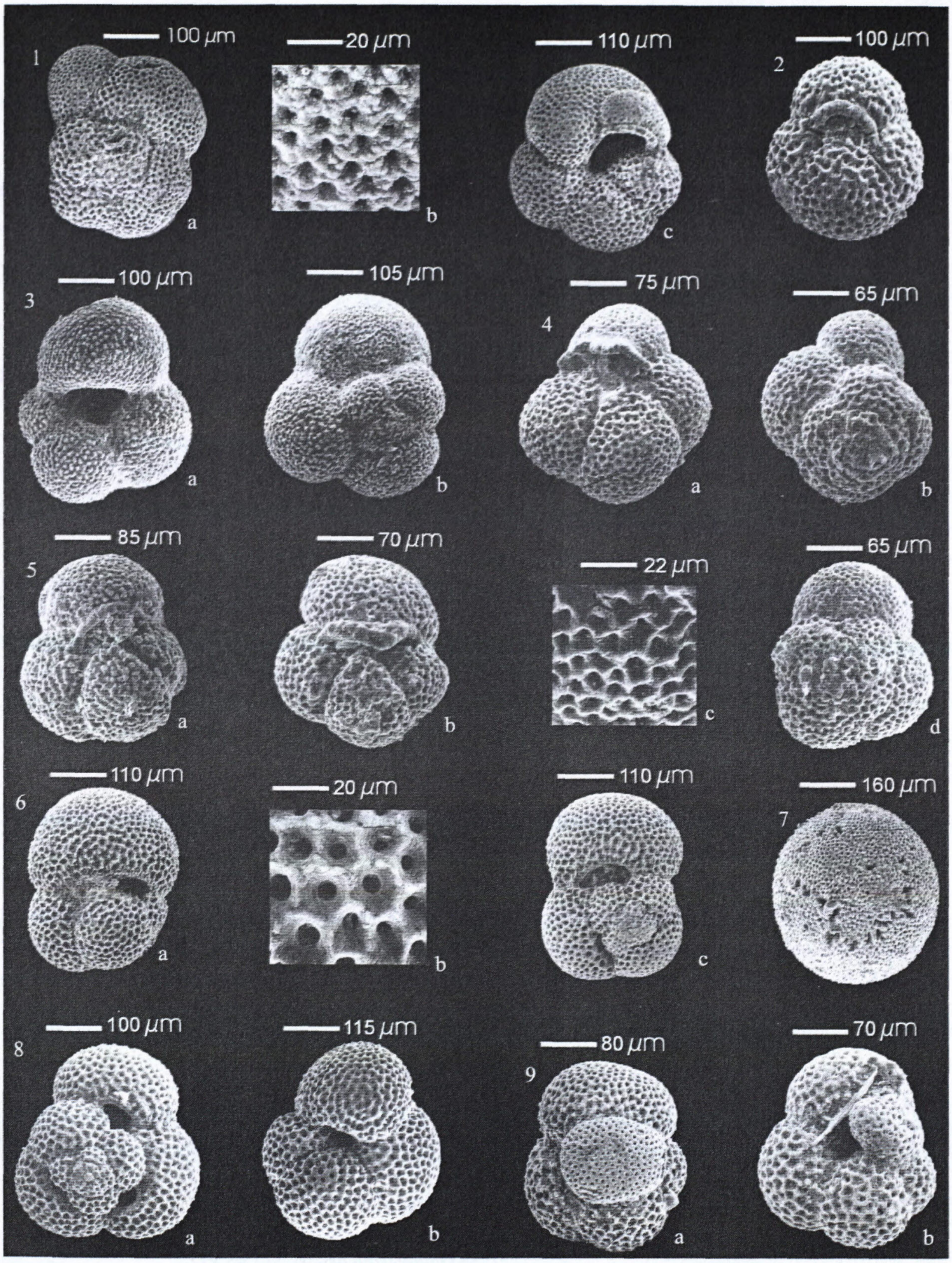
1938 *Globigerina quinqueloba* NATLAND, p. 149, pl. 6, Fig. 7
1938 *Turborotalita quinqueloba* NATLAND, pl. 31, Figs. 7-10
1957 *Globigerina angustiumbilicata* BOLLI, p. 109, pl. 22, Figs. 12-13

Diagnosis: Test small, trochospiral, slightly compressed, five chambers in the final whorl; chambers inflated, subglobular; final chamber spinose; aperture with an elongate slit. Final chamber is atypically developed in contrast with the previous.
Remarks: This species has a few morphological variants – final chamber can be smaller or larger than the others; can shield an umbilical area; bordered by a lip (it is not regular). Determined individuals from Oslavany have a final chamber smaller and without lip.
Stratigraphic distribution: Lower Miocene to Recent.

***Globigerina praebulloides* BLOW 1959**

1959 *Globigerina praebulloides* BLOW, p. 180, pl. 8, Fig. 47a – c, pl. 9, Fig. 48

Diagnosis: Test medium, trochospiral, elongate, four chambers in the final whorl, umbilicus small; aperture small, umbilical low to moderate asymmetric arch; final chamber is largest.



Pl. 1. 1 - *Globigerina quinqueloba* NAT., Oslavany, Upper Badenian, a - dorsal side, b - detail of dorsal area, c - ventral side, 2 - *Globigerina druryi* AKERS, Vienna Basin, Upper/Middle Badenian, ventral side, 3 - *Globigerina bulloides* D´ORB., Židlochovice, Upper Badenian, a - ventral side, b - dorsal side, 4 - *Globigerina* aff. *nepenthes* TODD, Vienna Basin, Upper/Middle Badenian, a - ventral side, b - dorsal side, 5 - *Globigerina* aff. *woodi* JENK., Vienna Basin, Upper/Middle Badenian, a - ventral side, b - ventral side, c - detail of dorsal area, d - dorsal side, 6 - *Globigerinoides triloba* REUSS, Židlochovice, Upper Badenian, a - ventral side, b - detail of ventral area, c - dorsal side, 7 - *Praeorbulina glomerosa circularis* BLOW, Oslavany, Upper Badenian, 8 - *Globigerinoides quadrilobatus* D´ORB., Židlochovice, Upper Badenian, a - dorsal side, b - ventral side, 9 - *Globorotaloides suteri* BOLLI, Oslavany, Upper Badenian, a - lateral side, b - ventral side.

Remarks: G. praebulloides is ancestral to *G. bulloides*, from which it differs with smaller test, elongate equatorial profile and less arched aperture.
Stratigraphic distribution: Upper Eocene to Upper Miocene (Lower Sarmatian) in the Central Paratethys.

Globigerina bulloides D'ORBIGNY 1826
Plate 1, Fig. 3a, b

1826 *Globigerina bulloides* d'ORBIGNY, p. 227

Diagnosis: Test low-trochospiral, four chambers in the final whorl; chambers spherical; surface densely perforated with simple spines; aperture umbilical, high symmetrical arch.
Remarks: G. bulloides shows large variation in the size of the aperture. Observed species from investigated areas have aperture developed variously. Large and open apertures are frequent, but we observed also smaller and constricted apertures.
Stratigraphic distribution: Middle Miocene to Recent, most frequent in Badenian.

Globigerina falconensis BLOW 1959

1959 *Globigerina falconensis* BLOW, p. 177, pl. 9, Fig. 40

Diagnosis: Test low trochospiral, slightly compressed, four chambers in the final whorl; chambers spherical, the last chamber smaller than the penultimate; surface with small regular pores and thin spines; aperture an elongate narrow arch, umbilical.
Remarks: It differs from *G. praebulloides* and *G. bulloides* in final chamber with well-developed imperforate lip. Obtained species have the last chamber turned to umbilicus and umbilicus is not overlapped. The lip is less distinct and thinner, in some cases not visible.
Stratigraphic distribution: Lower Miocene to Recent.

Globigerina diplostoma REUSS 1850

1850 *Globigerina diplostoma* REUSS, p. 373, pl. 47, Fig. 9a-b, 10, pl. 48, Fig. 1

Diagnosis: Test medium, trochospiral, four chambers in the final whorl; aperture large, open, central; surface regularly perforated with small dense pores; the test wall is thick; the last chamber is often identical or smaller than penultimate.
Remarks: It differs from *Gg. bulloides* in final smaller chamber. Several authors regard it as a younger synonym of *G. bulloides*.
Stratigraphic distribution: Lower Karpatian to Upper Badenian in the Central Paratethys.

Genus: ***Globigerina*** **D'ORBIGNY 1826**
Subgenus: ***Zeaglobigerina*** **KENNETT and SRINIVASAN 1983**

It icludes species characterized by a cancellate suface with regular subhexagonal pore pits with pores at the centers. The suface is clearly cancellate in contrast to the hispid appearance of *Globigerina (Globigerina)*.

Globigerina woodi (JENKINS 1960)
Plate 1, Fig. 5a, b, c, d

1960 *Globigerina woodi* n. sp. - JENKINS, p. 352, pl. 2, Fig. 2a – c
1998 *Globoturborotalia woodi* (JENKINS)–CICHA-RÖGL-ČTYROKÁ-RUPP et al., pl.35, Figs. 14-16

Diagnosis: Test medium, low trochospiral; chambers spherical, four in the final whorl; surface with rough subhexagonal pits; umbilicus open; aperture umbilical, highly arched, bordered with a thick rim.
Remarks: Several individuals from Dúbrava 47 have been determined as *Globigerina* aff. *woodi*. The aperture was deformed and overlapped into the umbilical area. In some cases the thicked rim converted to thick lip.
Stratigraphic distribution: Upper Oligocene to Upper Pliocene (to Upper Badenian in the Central Paratethys).

Globigerina aff. *nepenthes* TODD 1957
Plate 1, Fig. 4a, b

1957 *Globigerina nepenthes* TODD, p. 301, pl. 78, Fig. 7a–b

Diagnosis: Test compact with high spire; chambers indistinct, inflated, four in the final whorl; surface cancellate with pore pits; aperture suborbiculate, umbilical, usually bordered by a thickened rim.

Remarks: The last chambers of the determined individuals have a large morphological variability. Some have conical form, another are more rounded. The remaining chambers are more inflated and aperture is turned to side.

Stratigraphic distribution: Middle Miocene to Lower Pliocene.

Globigerina decoraperta TAKAYANAGI et SAITO 1962

1962 *Globigerina druryi* AKERS *decoraperta* TAKAYANAGI et SAITO, p. 85, pl. 28, Fig. 10a–c
1965 *Globigerina decoraperta* TAKAYANAGI et SAITO – CITA, PREMOLI SILVA and ROSSI, p. 246, pl. 23, Fig. 6a–c, pl. 31, Fig. 2a–c
1978 *Globigerina decoraperta* TAKAYANAGI et SAITO – PAPP et al., p. 272, pl. 8, Figs. 37–39

Diagnosis: Test compact, low to medium trochospiral; chambers spherical to subspherical, four in the final whorl; aperture large, umbilical, bordered by a broad rim.
Remarks: Determined species as a *G.* aff. *decoraperta* had broadly deformed aperture without a distinct rim. From *G. woodi* is dinstinguished by higherpired test.
Stratigraphic distribution: Middle Miocene to Upper Pliocene.

Globigerina druryi AKERS 1955
Plate 1, Fig. 2

1955 *Globigerina druryi* AKERS, p. 654, pl. 65, Fig. 1

Diagnosis: Test compact, low to medium trochospiral; chambers spherical, four in the last whorl; surface thick, cancelate, coarsely pited; umbilicus deep; aperture small, umbilical, bordered by a distinct lip.

Remarks: Obtained individuals were small-sized with a distinct coarsenly lip. *G. druryi* evolved from *G. woodi* and is ancestral to *G. nepenthes*
Stratigraphic distribution: Lower to Middle Miocene (Lower to Upper Badenian in the Central Paratethys).

Genus: *Globigerinoides* CUSHMAN 1927

Globigerinoides is distinguished from *Globigerina* by its supplementary sutural apertures. Surface can have cancellate or spinose character with large, distinct, regular pores.

***Globigerinoides triloba* (REUSS 1850)**
Plate 1, Fig. 6a, b, c

1850 *Globigerina triloba* REUSS, p. 374, pl. 47, Fig. 11a–d
1957 *Globigerinoides triloba* (REUSS) – BOLLI, p. 112, pl. 25, Fig. 2a–c, text Fig. 21/1a–b, Figs. 1a–b, 2a–b, 3a–b, 4a–b, pl. 31, Fig. 4a - b
1969 *Globigerinoides quadrilobatus trilobus* (REUSS) – BLOW, p. 326
1970 *Globigerinoides trilobus* (REUSS) – DREMEL, p. 63, text Fig. 41a – c

Diagnosis: Test trochospiral; chambers spherical; three in the final whorl; surface distinctly cancellate; primary aperture wide, umbilical; on the spiral side one to three supplementary apertures.
Remarks: Observed individuals exhibited great variation of a size and morphology. Some test are large with less rounded profile, another are smaller and more orbiculate.
Stratigraphic distribution: Lower Miocene to Pleistocene (Upper Egerian to Upper Badenian in the Central Paratethys).

***Globigerinoides quadrilobatus* (D´ORBIGNY 1846)**
Plate 1, Fig. 8a, b

1846 *Globigerina quadrilobata* D´ORBIGNY, p. 164, pl. 9, Fig. 7-10
1970 *Globigerinoides quadrilobatus* (D´ORBIGNY) – DREMEL, p. 58, text Fig. 40a-c

Diagnosis: Test low trochospiral; chambers distinctly rounded, three and a half to four in the final whorl; surface distinctly cancellate; primary aperture umbilical, elongated, bordered by a rim.
Remarks: Determined species have more open aperture, chambers more rounded and spherical profile.
Stratigraphic distribution: Lower Miocene to Recent (Lower to Upper Badenian in the Central Paratethys).

***Globigerinoides bisphericus* TODD 1954**

1954 *Globigerinoides bispherica* TODD, p. 681, pl. 1, Fig. 1

Diagnosis: Test spherical to subspherical, two and one-half to three chambers in the final whorl; surface distictly cancellate; primary aperture umbilical, supplementary apertures irregular, along spiral sutures.
Remarks: Gs. bisphericus is different from *Gs. triloba* in having smaller pores and more spherical profile. *Gs. bisphericus* developed from *Gs. triloba* and is the direct ancestor of *Praeorbulina*.

Stratigraphic distribution: Late Lower Miocene to early Middle Miocene (Upper Karpatian to Lower Badenian in the Central Paratethys).

Genus: *Praeorbulina* ÓLSSON 1964

***Praeorbulina glomerosa circularis* (BLOW 1956)**
Plate 1, Fig. 7

1956 *Globigerinoides glomerosa circularis* BLOW, p. 65, text Figs. 2.3-2.4

Diagnosis: Test nearly spherical; last chamber almost globular, enveloping the earlier part of the test for more than 75 percent; surface densely perforated; apertures numerous, circular, in the sutures between the last penultimate and earlier chamber.
Remarks: It differs from *O. suturalis* in lacking areal apertures.
Stratigraphic distribution: Late Lower Miocene to early Middle Miocene (early Upper Badenian in the Central Paratethys).

Genus: *Orbulina* D´ORBIGNY 1839

***Orbulina suturalis* BRÖNNIMANN 1951**

1951 *Orbulina suturalis* n. Sp. – BRÖNNIMANN, p. 135, text Fig. II, Figs. 1-2, 58, 9, Text-fig. III, Figs. 3-8, 11, 13-16, 18, 20-22, text Fig. IV, Figs. 2-4, 7-12, 15, 16, 19-22

Diagnosis: Test spherical; final chamber enveloping the early part of the test; surface densely perforated; supplementary apertures along sutures separating the final and earlier chambers.
Remarks: Orbulina was derived from *Praeorbulina.*
Stratigraphic distribution: Lower Miocene to Recent (late Lower to Upper Badenian in the Central Paratethys).

Family: *Globorotaliidae* CUSHMAN 1927
Genus: *Globorotalia* CUSHMAN 1927
Subgenus: *Jenkinsella* KENNETT et SRINIVASAN 1983

The subgenus *Jenkinsella* represents phylogenetically the group from the latest Paleogene to Neogene, usually referred as *Turborotalia* (BLOW, 1969). However, according to Srinivasan & Kennett (1981), *Turborotalia* is a Paleogene lineage and is phyletically unrelated to forms, which KENNETT & SRINIVASAN (1983) included in *Jenkinsella*. The main diagnostic features common to all species included within *Jenkinsella* are the rounded periphery lacking a distinct carina, globular to subglobular chambers arranged in a compact, low trochospire, umbilical-extraumbilical aperture bordered by a rim, cancellate surface, dense pores.

***Globorotalia acrostoma* WEZEL 1966**

1966 *Globorotalia acrostoma* WEZEL, p. 1298, pl. 101, Fig. 1-12, text Fig. 1

Diagnosis: Test small, trochospiral with low spiral; chambers subquadrate to oval, four to four and one-half

in the final whorl; surface covered with dense pores, cancellate texture; aperture large, bordered by a rim, umbilical – extraumbilical.
Remarks: This species closely resembles *Gr. mayeri* but is easily distinquished by its four to four and one-half chambers in the final whorl and larger and higher-arched aperture. *Gr. acrostoma* evolved during the earliest Miocene from *Gr. mayeri* by a reduction in number of chambers in the final whorl and by developing a larger and higher aperture (Srinivasan & Kennett, 1981).
Stratigraphic distribution: Lower Miocene to Middle Miocene (Lower Eggenburgian to Middle Badenian in the Central Paratethys).

Globorotalia bykovae (AISENSTAT 1960)

1960 *Turborotalia bykovae* AISENSTAT in SUBBOTINA - PISHVANOVA-IVANOVA, p. 69, pl. 13, Figs. 7-8
1978 *Globorotalia bykovae minoritesta* PAPP in PAPP et al., p. 278, pl. 7, Figs. 1-3

Diagnosis: Test trochospiral, planoconvex, periphery broadly angled; aperture curved medium high, umbilical-extraumbilical arch with a small lip; the wall is thin, nonspinose; surface smooth finely perforated with a normal perforation; five or six chambers in the final whorl.
Remarks: The determined species were small-sized with four to four and one-half chambers in the final whorl.
Stratigraphic distribution: Upper Karpatian to the end of the Badenian.

Globorotalia mayeri CUSHMAN et ELLISOR 1939

1939 *Globorotalia mayeri* n. sp. – CUSHMAN et ELLISOR, p. 11, pl. 2, Fig. 4a-c

Diagnosis: Test low trochospiral, slightly lobulate, broadly rounded, the final chamber depressed; chambers inflated, five in the final whorl; sutures depressed; surface perforate with large pores and ridges; umbilicus narrow; aperture high, bordered with a distinct rim, umbilical-extraumbilical.
Remarks: Gr. mayeri is distinquished from *Gr. siakensis* by its distinctly curved spiral sutures, more closely appressed and embracing chambers in the final whorl. *Gr. mayeri* is dominant in the temperate areas, while *Gr. Siakensis* is more dominant in equatorial and warm subtropical sites (Kennett & Srinivasan, 1983). Generally, the studied individuals were small sized with less distinct rim as is usually.
Stratigraphic distribution: Uppermost Oligocene to Middle Miocene (Upper Karpatian to Upper Badenian in the Central Paratethys).

Globorotalia siakensis LE ROY 1939
Plate 2, Fig. 13a, b

1939 *Globorotalia siakensis* LE ROY, p. 39, pl. 3, Figs. 30-31
1969 *Globorotalia (Turborotalia) siakensis* BLOW, p. 356, pl. 10, Figs. 7-9; pl. 11, Figs. 4-5

Diagnosis: Test large, low trochospiral, broadly rounded; chambers subspherical, inflated, six to seven in the final whorl; sutures nearly radial, depressed; surface coarsely perforate with ridges and large pores; umbilicus wide, deep; aperture umbilical-extraumbilical, bordered by a distinct rim.
Remarks: Gr. siakensis is distinguished from *Gr. mayeri* by more than five chambers in the final whorl and wide, open and deep umbilicus. *Gr. siakensis* is evolved from *Gr. opima* and is ancestral to the *Gr. mayeri* (Kennett & Srinivasan, 1983). Determined individuals are characterized by a more fine perforation and by six to six and half-one chambers in the final whorl.
Stratigraphic distribution: Upper Oligocene to Middle Miocene.

Genus: *Globorotalia* CUSHMAN 1927
Subgenus: *Menardella* BANDY 1972

The subgenus *Menardella* is characterized by lenticular, trochospiral tests, a prominent keel and smooth, perforate surfaces.

Globorotalia archeomenardii BOLLI 1957

1957 *Globorotalia archeomenardii* BOLLI, p. 119, pl. 28, Fig. 11

Diagnosis: Test low trochospiral, compressed, equatorial periphery slightly lobate, five to five and one-half chambers in the final whorl; sutures strongly curved, depressed; surface smooth, very finely perforated; umbilicus small; aperture low-arched with a distinct lip, umbilical-extraumbilical.
Stratigraphic distribution: Lower Miocene to Lower Middle Miocene.

Genus: *Globorotalia* CUSHMAN 1927
Subgenus: *Globoconella* BANDY 1975

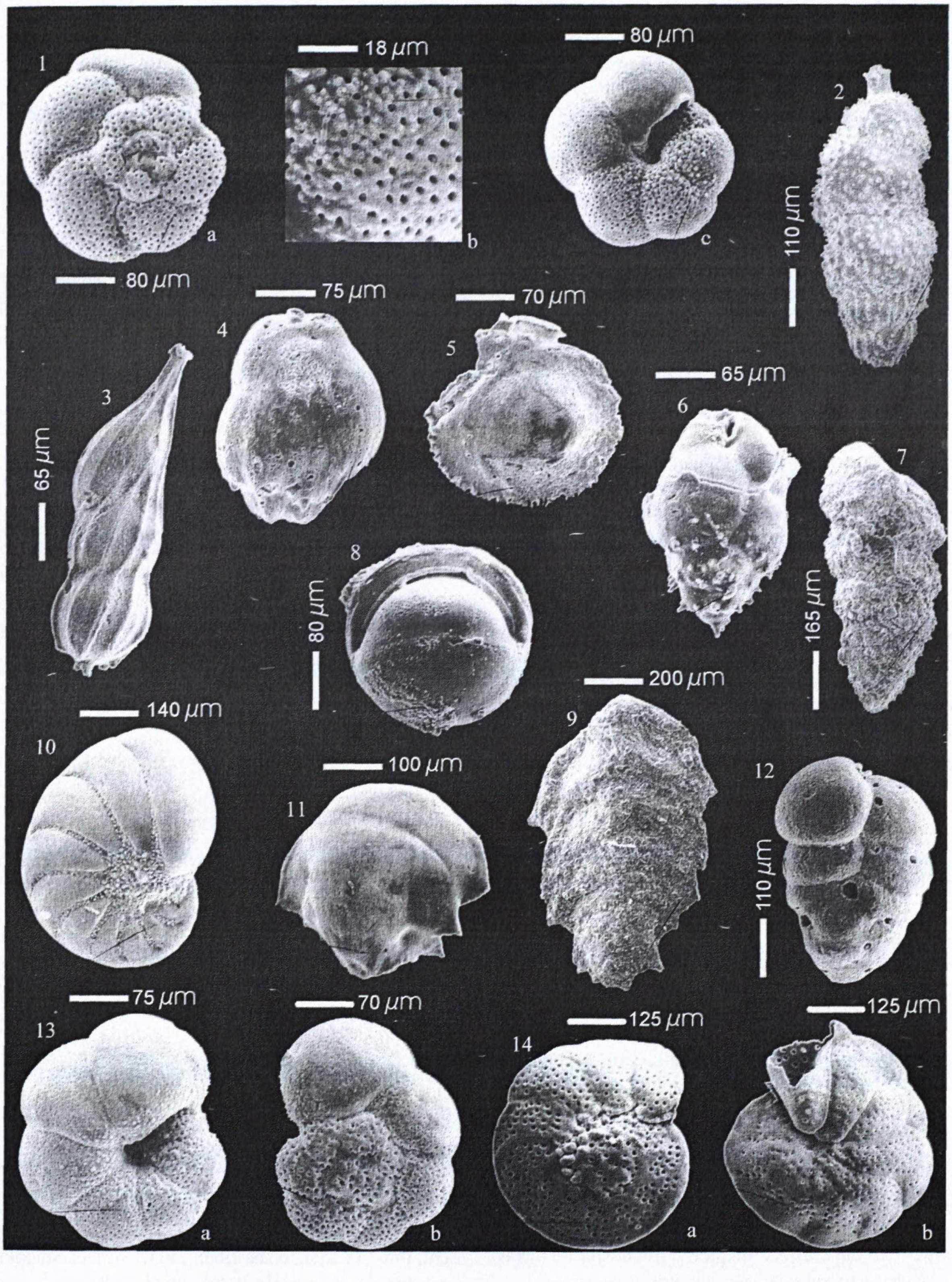
Subgenus *Globoconella* is a major lineage in temperate areas and includes keeled and nonkeeled, inflated and compressed forms with a thick walls and high-arched apertures.

Globorotalia praescitula BLOW 1959

1959 *Globorotalia praescitula* BLOW, p. 221, pl. 19, Fig. 128a-c
1969 *Globorotalia (T.) scitula praescitula* BLOW, p. 356, pl. 4, Figs. 21-23; pl. 39, Fig. 9

Diagnosis: Test low trochospiral, biconvex, not keeled; chamber four to four and one-half in the final whorl; sutures strongly curved and depressed on the spiral side; surface perforated, smooth; umbilicus small; aperture umbilical-extraumbilical with a thin lip.
Remarks: This species is ancestral to the *Gr. zealandica* and is distinguished by an increase in number of chambers in the final whorl from four to four and one-half and a low-arched aperture.
Stratigraphic distribution: Lower to Middle Miocene.

Genus: *Globorotalia* CUSHMAN 1927
Subgenus: *Hirsutella* BANDY 1972



Pl. 2. 1 - *Globorotalia challengeri* Srin. & Kenn., Židlochovice, Upper Badenian, a - dorsal side, b - detail of dorsal area, c - ventral side, 2 - *Uvigerina aculeata* d'Orb., Židlochovice, Upper Badenian, 3 - *Nodosaria sp.*, Oslavany, Upper Badenian, 4 - *Uvigerina uniseriata* Jedl., Oslavany, Upper Badenian, 5 - *Siphonina reticulata* Czjzek, Oslavany, Upper Badenian, 6 - *Bulimina subulata* Cush.. & Park., Vienna Basin, Upper/Middle Badenian, ventral side, 7 - *Textularia mariae* d'Orb., Vienna Basin, Upper/Middle Badenian, 8 - *Pullenia bulloides* d'Orb., Vienna Basin, Upper/Middle Badenian, ventral side, 9 - *Spirorutilus carinatus* d'Orb., Vienna Basin, Upper/Middle Badenian, 10 - Nonion commune d'Orb., Židlochovice, Upper Badenian, lateral side, 11 - *Ehrenbergina serrata* Reuss, Židlochovice, Upper Badenian, dorsal side, 12 - *Kareriella chilostoma* Reuss, Židlochovice, Upper Badenian, lateral side, 13 - *Globorotalia siakensis* Le Roy, Židlochovice, Upper Badenian, a - ventral side, b - dorsal side, 14 - *Cibicidoides ungerianus ungerianus* d'Orb., Židlochovice, Upper Badenian, a - dorsal side, b - ventral side.

Subgenus *Hirsutella* includes sharp-edged to keeled forms and inflated to compressed forms. Most of the species are thin walled with smooth and densely perforate tests. *Globorotalia (Globoconella) praescitula* is the ancestral form for the *Hirsutella* lineage.

Globorotalia challengeri SRINIVASAN et KENNETT 1981

Plate 2, Fig. 1a, b, c

1981 *Globorotalia challengeri* SRINIVASAN et KENNETT, n. 6, p. 499-533, pl. 1

Diagnosis: Test is a fairly low trochospiral, biconvex, equatorial periphery lobate; surface thin, coarsely perforated, smooth; chambers twelve to fifteen, five to five and one-half in the final whorl; sutures on spiral side curved, depressed; aperture has a distinct arch with a prominent lip, umbilical-extraumbilical.
Remarks: This species is morphologically similar to *Gr. mayeri* but differs being less elongated in equatorial profile and low-arched aperture. From its ancestor Gr. praescitula differs by exhibiting five to five and one-half chambers in the final whorl, more inflated chambers and more rounded periphery.
Stratigraphic distribution: Middle Miocene.

Genus: *Globorotaloides* BOLLI 1957

The genus *Globorotaloides* includes forms with a trochospiral test, ovate to spherical chambers. The final chamber is often smaller than the penultimate and may cover part of the umbilicus and appear a bulla. The surface is distinctly cancellated, aperture is umbilical-extraumbilical, later becoming umbilical.

Globorotaloides suteri BOLLI 1957

Plate 1, Fig. 9a, b

1957 *Globorotaloides suteri* BOLLI, p. 117, pl. 27, Figs. 9a-13b

Diagnosis: Test low trochospiral, periphery lobulate; chambers spherical to ovate, four to five in the final whorl, the final chamber often smaller than the penultimate and overlap the aperture; sutures depressed; surface punctate; aperture a low arch, umbilical-extraumbilical, often covered by a bulla-like final chamber.
Stratigraphic distribution: Middle Miocene to Lower Miocene.

Genus: *Globoquadrina* FINLAY 1947

Genus *Globoquadrina* includes trochospiral forms with a quadrate to subquadrate equatorial profile. Aperture is umbilical-extraumbilical with one or more tooth-like projections.

Globoquadrina venezuelana (HEDBERG 1937)

1937 *Globigerina venezuelana* HEDBERG, p. 681, pl. 92, Fig. 72b

Diagnosis: Test large, equatorial periphery slightly lobulate; chambers spherical to ovate, inflated, four in the final whorl; final chamber usually irregular; sutures slightly curved and depressed; surface densely perforate, distinctly cancellate; aperture umbilical with umbilical teeth.
Stratigraphic distribution: Middle Eocene to Early Pliocene.

Genus: *Dentoglobigerina* BLOW 1979

The genus *Dentoglobigerina* includes the morphotypes with umbilical teeth over an umbilically restricted aperture. *Dentoglobigerina* is morphologically intermediate between *Globigerina* and *Globoquadrina* (KENNETT & SRINIVASAN, 1983).

Dentoglobigerina altispira altispira CUSHMAN et JARVIS 1936)

1936 *Globigerina altispira* CUSHMAN et JARVIS, p. 5, pl. 1, Fig. 13a-c
1998 *Globoquadrina altispira* (CUSHMAN et JARVIS) - CICHA-ROGL-ČTYROKA-RUPP et al., pl. 41, Figs. 3-5

Diagnosis: Test large, highly trochospiral; four to five chambers in the final whorl; sutures depressed; surface distinctly cancellated; umbilicus wide, open; aperture umbilically restricted with umbilical teeth projecting into the umbilicus.
Stratigraphic distribution: Lower Miocene to Upper Pliocene.

Superfamily: *Candeinacea* (CUSHMAN 1927)
Family: *Candeinidae* CUSHMAN 1927

Genus: *Globigerinita* BRONNIMANN 1951

The genus *Globigerinita* is characterized by a microperforate surface with extremely small, irregularly distributed perforations. Pore pits are absent, surface is smooth. A bulla is present like *Catapsydrax* but is distinguished by its cancellated surface with large pores. *Catapsydrax* probably evolved from *Globorotaloides* suteri during the late Middle Eocene and is phylogenetically unrelated to *Globigerina* (KENNETT & SRINIVASAN, 1983).

Globigerinita uvula (EHRENBERG 1861)

1861 *Pylodexia uvula* EHRENBERG, pl. 2, Figs. 24-5
1983 *Globigerinita uvula* (EHRENBERG) – KENNETT et SRINIVASAN, p. 224, pl. 56, Figs. 6-8.

Diagnosis: Test small, high trochospiral; chambers spherical, three to four in the final whorl; surface smooth, microperforate, covered with small tubercles; aperture interiomarginal, umbilical, low arch, bordered by a thin lip.
Remarks: Globigerina bradyi WIESNER is a junior synonym (Kennett & Srinivasan, 1983).
Stratigraphic distribution: Upper Oligocene to Recent.

Genus: *Globigerinella* CUSHMAN 1927

Genus *Globigerinella* is characteristic by the forms with an initial test that later becomes nearly planispiral in the adult stage. Chambers are globular to ovate, umbilical aperture and fine spines covered the test. The genus *Globigerinella* evolved from *Globigerina praebulloides* through *Globigerinella obesa*. *Globigerinella* resemble *Jenkinsella* but is distinguished by its spinose surface ultrastructure (Kennett & Srinivasan, 1983).

Globigerinella obesa (BOLLI 1957)

1957 *Globigerinella obesa* BOLLI, p. 119, pl. 29, Figs. 2a-3b
1969 *Globigerina obesa* (BOLLI) – ROGL, p. 93, pl. 6, Fig. 5, pl. 7, Figs. 1 and 4
1987 *Globorotalia obesa* BOLLI – WENGER, p. 324, pl. 24, Figs. 13-14, 19

Diagnosis: Test low trochospiral, equatorial periphery strongly lobulate; chambers spherical, inflated, four to four and one-half in the final whorl; sutures radial, depressed; surface densely perforated; umbilicus wide, deep; aperture has a low to medium arch without lip or rim.
Remarks: Ge. obesa evolved from *Globigerina praebulloides* and is ancestral to *Globigerinella praesiphonifera* (Kennett and Srinivasan, 1983).
Stratigraphic distribution: Upper Oligocene to Recent (Early Egerian to Early Badenian in the Central Paratethys).

Globigerinella regularis (d´ORBIGNY 1846)

1846 *Globigerina regularis* D´ORBIGNY, p. 162, pl. 9, Figs. 1-3

Diagnosis: Test trochospiral to planispiral; chambers rouded, four to five in the final whorl; last chamber is the biggest; aperture umbilical; surface densely perforated with a fine spines; aperture without lip, highly arched.
Remarks: Determinated individuals from Oslavany are characterized by the five chambers in the final whorl. From *Ge. obesa* is distinguished by a bigger-size and more superficial form.
Stratigraphic distribution: Upper Karpatian to the end of the Badenian in the Central Paratethys.

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