Slovak Geol. Mag., 10, 4 (2004), 285 – 291

Genus *Borelis* (Foraminiferida, Alveolinidae) in Paleogene of the Western Carpathians

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Abstract: The genus *Borelis* is described from the Paleogene sediments of the Western Carpathians for the first time. It was found in three localities in bioherm limestones in the Borové Formation of the Sub-Tatric Group of the Central Carpathian Paleogene in the northern rim of the Liptovská kotlina basin (Northern Slovakia). The tests were placed in the species *Borelis vonderschmitti* (SCHWEIGHAUSER). The accompanying association (e.g. *Chapmanina gassinensis* SILVESTRI, *Halkyardia minima* (LIEBUS), *Fabiania cassis* (OPPENHEIM) a. o.) corresponds with the association, accompanying this species in the type localities in Northern Italy (Colli Berici) and the same is also the age assignment at the boundary Middle/Upper Eocene (SBZ 18/SBZ 19).

Key words: Foraminiferida, *Alveolinidae*, *Borelis*, Western Carpathians, Liptovská kotlina basin, boundary Middle/Upper Eocene.

Introduction

Alveolinid foraminifers belong among important constituents of Tertiary foraminiferal assemblages. During the period Paleocene-Middle Eocene the genus *Alveolina* was spread into numerous evolutionary lines (Hottinger 1960, Drobne 1977, White 1992 a. o.). It allowed the detail biozonation of referred time interval. The only disadvantage consists of the restricted space distribution of alveolinid foraminifers. They are bounded to protected shallow water environments (lagoons, back-reef environments), where the water depth does not overreach 50 m.

At the end of Middle Eocene the genus *Alveolina* died out soon after the tests of some its species reached dimensions being gigantic for foraminifers (e.g. Lutetian *Alveolina gigantea* CHECCHIA-RISPOLI attained length 6-7 cm). At the boundary of Middle and Upper Eocene it was exchanged by the new genera *Borelis* DE MONTFORT and *Praebullalveolina* SIREL et AÇAR belonging also to the family *Alveolinidae*. Some similarities were manifested also by the genus *Malatyna* SIREL et AÇAR, but this belongs to the family *Riveroinidae*. Contrary to the Middle Eocene alveolinids the tests of these genera are very tiny and their dimensions till the end of Eocene did not overreach 1.25 mm (*Praebullalveolina afyonica* in Sirel & Açar 1982).

The data about the occurrence of genus *Borelis* and *Praebullalveolina* in Paleogene are very sporadic. SIREL & AÇAR (1982) the scarcity of their occurrence explain by the fact, that the shallow water back-reef environments with abundant porcellaneous foraminifers are virtually absent in Upper Eocene.

Occurrences of genera *Borelis* and *Praebullalveolina* in Paleogene sediments

In 1951 Schweighauser described in Northern Italy (Colli Berici, Cave Zengele) the new species *Neoalveolina vonderschmitti* occurring in limestones at the boundary of Middle and Upper Eocene. Recently the genus *Neoalveolina* SILVESTRI is supposed to be the synonym of genus *Borelis* DE MONTFORT (compare Loeblich & Tappan 1987, p. 362). Stratigraphic position of this species in the uppermost Middle Eocene and at the boundary of Middle and Upper Eocene was confirmed also by Ungaro (1969). Bassi et al. (2000) locate the first occurrences of this species to the boundary SBZ 18/SBZ 19 sensu biozones suggested in publication by Serra-Kiel et al. (1998). The stratigraphic range of the species *B. vonderschmitti* was later enlarged to the whole Upper Eocene (Bassi & Loriga Broglio 1999) in the range SBZ 18–SBZ 20. The species occurrences in Paleogene sediments are always very rare. Until now the species *B. vonderschmitti* (SCHWEIGH.) was found besides the type territory (Colli Berici, Northern Italy) also in other areas of Italy (Monti Lessini, Maiella, Umbria), but also in Slovenia, Croatia, Germany and Oman (compare Bassi & Loriga Broglio 1999).

The genus *Praebullalveolina* was defined by Sirel & Açar (1982) for individuals from Upper Eocene limestones with *Nummulites fabianii* (PREVER) in Western Turkey with the type species *P. afyonica* SIREL et AÇAR. The genus is described by Barbin et al. (1997) from the boundary Upper Eocene/Oligocene in the area of Priabona (Northern Italy). The genus *Praebullalveolina* was described also from Eocene of northeastern Spain (Travé et al. 1996), but Sirel & Açar (1998) the Spanish form

assigned into the genus *Malatyna* as a new species *M. vicensis* SIREL et AÇAR.

There is worth mentioning also about the genus *Malatyna*, being defined by Sirel & Açar in 1993 with the type species *M. drobnae*. Tests of this genus with their setting are similar the miliolid foraminifers, but belong into the different family (*Riveroinidae* SAIDOVA) and using careful observation they cannot be interchanged with alveolinid foraminifers. The genus appears at the end of Middle Eocene and persists to Upper Eocene.

While the youngest occurrences of the genus *Praebullalveolina* are known from Oligocene, the genus *Borelis* flourish in Miocene (e.g. *Borelis melo* (FICHTEL et MOLL) in Badenian) and survived till recent in the Red sea and in the Indian ocean (Reiss & Gwitzman 1966).

In Paleogene the tests of the genera *Praebullalveolina* and *Borelis* are very similar and for their reliable distinguishing there is necessary to study a bigger number of various sections. Sirel & Açar (1982) state, that their genus *Praebullalveolina* differs from *Borelis* because it has one row of apertures in apertural side and one row of alveoli in the roof of chamberlets. From definitions of both genera by Loeblich & Tappan (1987, pp. 362 and 364, Tabs. 374, 375 and 382) there results that the differences between them are minimal and in non-oriented sections nearly imperceptible.

Genus *Borelis* in Western Carpathians

During detail investigation of bioherm limestones in the northern rim of the Liptovská kotlina basin (Northern Slovakia) the authors found in thin sections from three localities the sections of tests, which could be associated with the genus *Borelis*. The extreme scarcity of this form is manifested by the fact, that in more than 350 studied thin sections from mentioned three localities, there were found only 33 sections of the tests *Borelis*, being enlisted into the species *Borelis vonderschmitti* (SCHWEIGHAUSER). The description of the species is as follows[1]:

Family *Alveolinidae* EHRENBERG, 1839
Genus *Borelis* DE MONTFORT, 1808

Borelis vonderschmitti (SCHWEIGHAUSER, 1951)
(Pl. 1, Figs. 1-6, Pl. 2, Figs. 1-2)

1951 *Neoalveolina vonderschmitti* – Schweighauser, pp. 466-468, Figs. 1-5
1999 *Borelis vonderschmitti* – Bassi & Loriga Broglio, p. 233, Pl. 3, Figs. 1-6 (with detail synonymy).

Studied material: 33 various sections
Description: Tests of porcellaneous, globular to weakly nautiloid form (Pl. I, Figs. 1-5), sometimes weakly deformed (Pl. I, Fig. 6). Equatorial diameter of tests is 0.15-0.71 mm, oblique diameter is 0.50-0.91 and index of elongation 0.95-1.16. Tests with diameter 0.5-0.6 mm have 5-6 whorls, maximal number of whorls is 9 (Pl. I, Fig. 4). Only individuals of megalospheric generation are present. Proloculus is tiny of diameter 0.03-0.045 mm (Pl. I, Figs. 1 and 3). The first two whorls are streptospirally coiled and not divided (Pl. I, Fig. 1). Next whorls are divided with thick septa for chambers (Pl.II, Fig. 2) and chamberlets (Pl. I, Figs. 2 and 4). The last whorl contains 6-8 chambers and 35-40 chamberlets. Cavities of chambers are of oblong to moderately oval outline and are wide 0.020 mm and high 0.030-0.040 mm. Basal layer is very thin (0.010-0.015 mm).

Stated values are corresponding with those being described by Schweighauser (1951) and Bassi & Loriga Broglio (1999), only the diameter of proloculus has in the case of Carpathian occurrences bigger range (above stated authors describe 0.030-0.035 mm), but this range could belong to the variability of species *B. vonderschmitti* (though even Schweighauser (1951) when establishing the species *B. vonderschmitti* presented doubt, whether is it only one species).

Description of localities in Western Carpathians

Three described localities are located between villages Východná and Važec in northern rim of Liptovská kotlina basin (Fig. 1). More detail data concerning geology of Paleogene sediments in studied area are presented in monograph by Gross & Köhler et al. (1980).

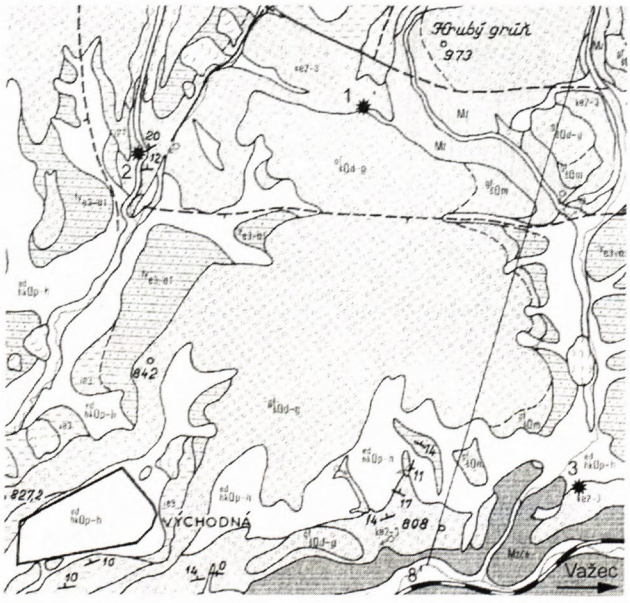
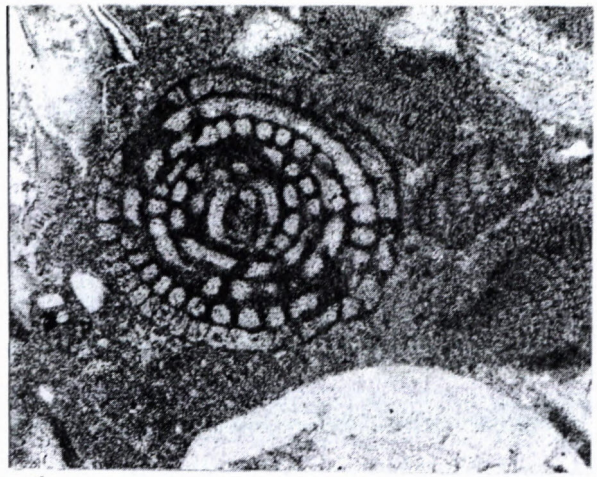


Fig. 1. Part of geological map 1 : 50 000 (Gross et al. 1980, supplemented) of the territory between Východná and Važec villages and studied localities: 1 - Hrubý Grúň, 2 – Hybica, 3 – west of Važec.
Explanations: ke2-3 – basal transgressive lithofacies (breccias, conglomerates, limestones, carbonatic sandstones) = Borové Formation sensu Gross et al. (1984), ie3 – clayey lithofacies = Huty Formation, fye3-o1 – flysch lithofacies = Zuberec Formation, other – Quaternary.

[1]For description of alveolinid foraminifers there was used the terminology established by Reichel (1936-1937) and detaily explained and completed by Hottinger (1960), Drobne (1977) and White (1992).



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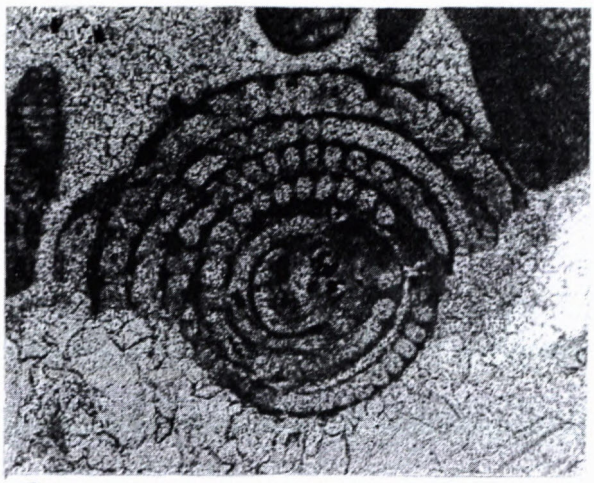

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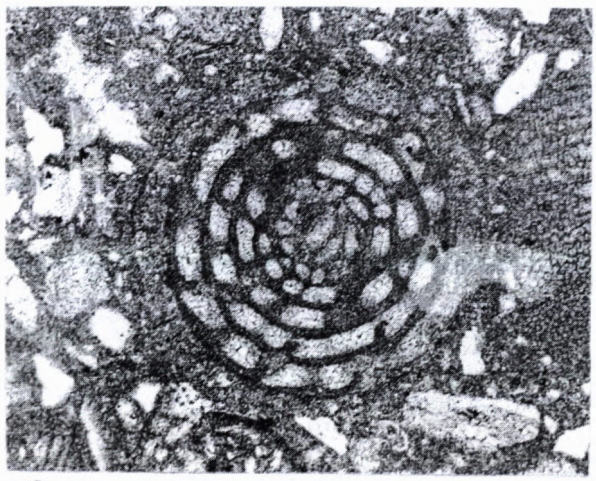

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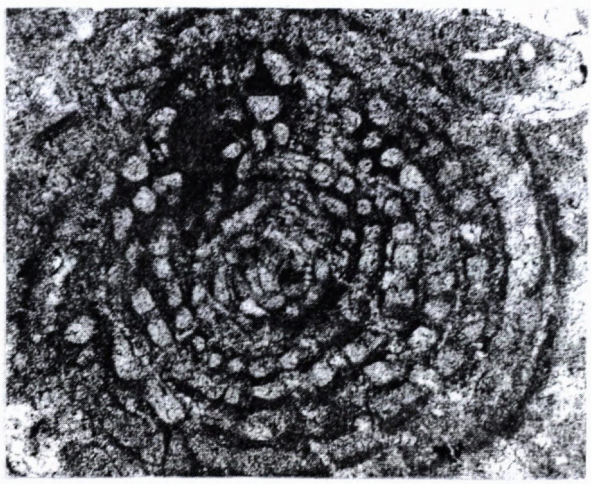

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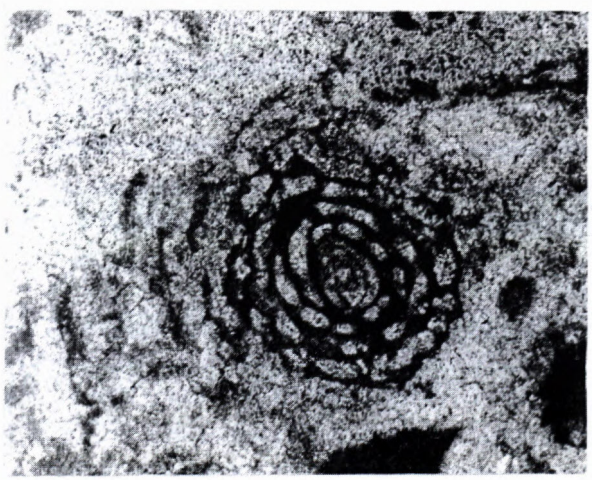

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Plate I

1.-6. *Borelis vonderschmitti* (SCHWEIGHAUSER), all figures magnified 80x.
Fig. 1 – Oblique axial section, Važec locality, thin section Ke-1; Fig. 2 – Part of axial section, Važec locality, thin section Bu-113; Fig. 3 – Oblique equatorial section, Važec locality, thin section Ke- 4; Fig. 4 – Oblique section, Važec locality, thin section Ke-11; Fig. 5 – Oblique section, Važec locality, thin section Ke-4; Fig. 6 – Oblique section, Hybica locality, thin section Bu- 202. Photo by the authors.

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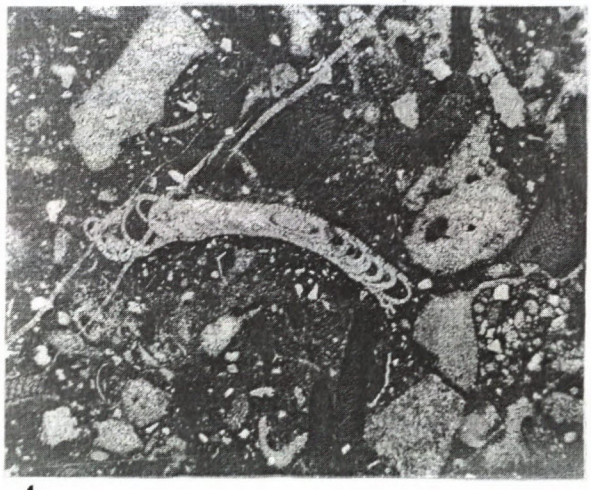

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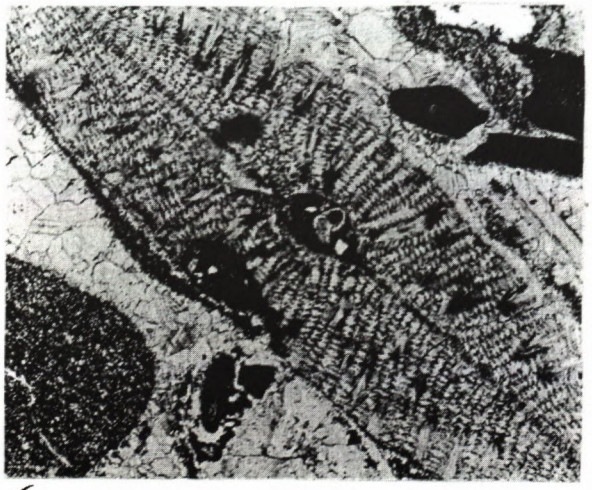

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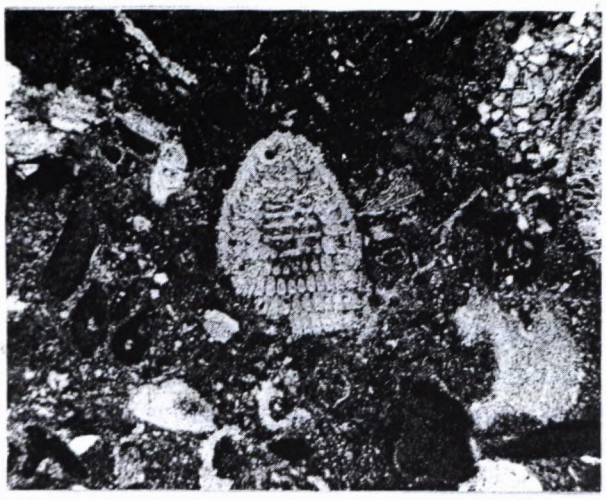
Plate II

1.-2. *Borelis vonderschmitti* (SCHWEIGHAUSER), magnified 80x.

Fig. 1 – Oblique section, Hrubý Grúň locality, thin section Bu- 85; Fig. 2 – Oblique equatorial section, Važec locality, thin section Ke- 4; Fig. 3 – *Halkyardia minima* (LIEBUS) in oblique section, Važec locality, thin section Bu-119, magn. 80x; Fig. 4 – *Linderina* cf. *brugesi* SCHLUMBERGER, oblique section, Važec locality, thin section Ke-3, magn. 25x; Fig. 5 – *Heterostegina* sp. and *Discocyclina* sp. in oblique sections, Važec locality, thin section Ke- 2, magn. 25x; Fig. 6 – *Orbitoclypeus varians* (KAUFMANN) in oblique section, Važec locality, thin section Ke-13, magn. 25x. Photo by the authors.



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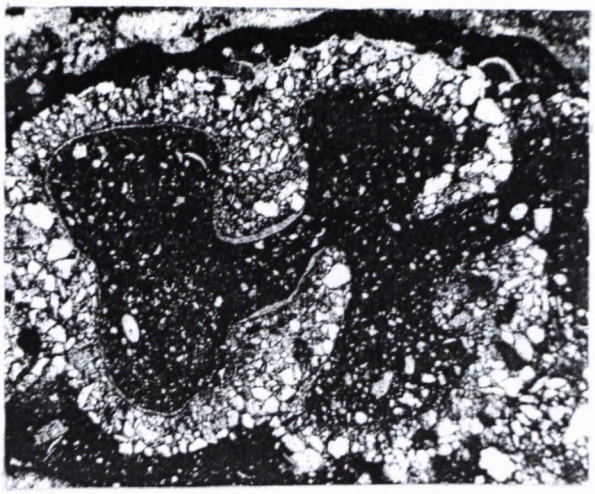

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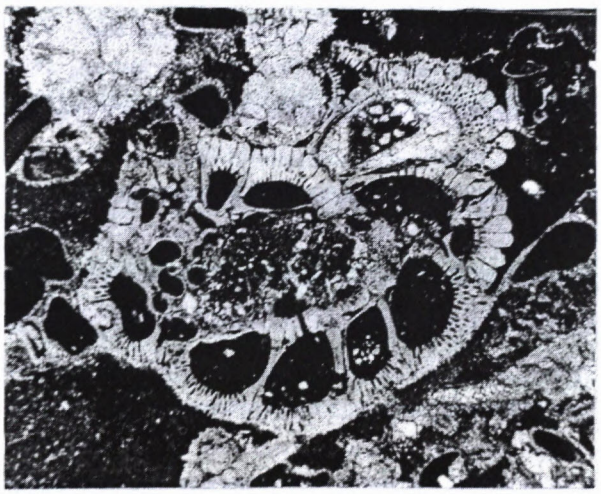

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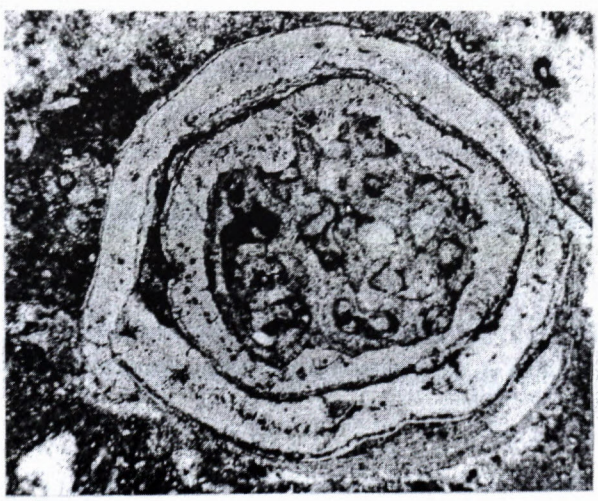

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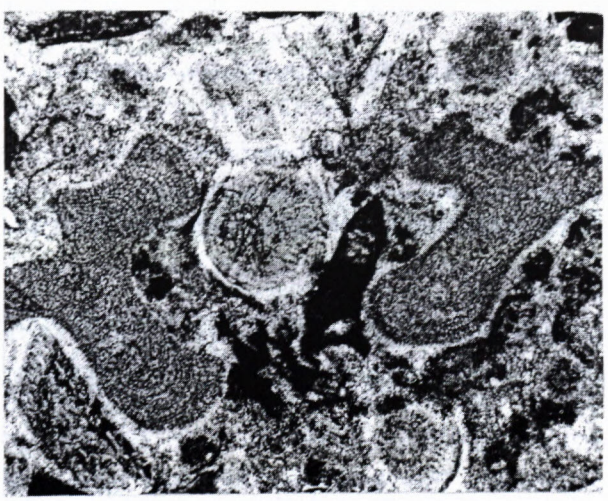

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Plate III

Fig. 1 – *Chapmanina gassinensis* SILVESTRI in oblique section, Važec locality, thin section Bu-115, magn. 25x; Fig. 2 – *Haddonia heissigi* HAGN in oblique section, Važec locality, thin section Ke-12, magn. 25x; Fig. 3 – *Fabiania cassis* (OPPENHEIM) in oblique section, Važec locality, thin section Ke-12, magn. 25x; Fig. 4 – *Gyroidinella magna* (LE CALVEZ) in oblique section, Važec locality, thin section Ke-7, magn. 25x; Fig. 5 – *Polystrata alba* (PFENDER) DENIZOT, Hrubý Grúň locality, thin section Bu- 80, magn. 25x; Fig. 6 – *Gypsina* cf. *linearis* (HANZAWA) and *Chapmanina* sp., Hybica locality, thin section Bu- 201, magn. 25x. Photo by the authors.

Slovak Geol. Mag., 10, 4 (2004), 285 – 291

1. Hrubý Grúň, elevation point 933. Near the margin of the road from the village Východná to elevation point Hrubý Grúň (973) opposite to the water tank there are outcropping the underlying Triassic Wetterstein dolomites with rough weathered surface. Depressions in the dolomite surface are infilled with terra rossa. The Paleogene sequence begins with approximately 1.5 m thick conglomerate layer with dolomite pebbles. In overlier the sequence continues with ca 5 m thick bed of organogenic packstones, containing also the *Borelis* tests;

2. Hybica. The Hybica stream flowing southwards from the foothill of the High Tatra Mts. near the elevation point 814 cuts a large body of bioherm Paleogene packstones. The body lying on Mesozoic substrate (Triassic Gutenstein limestones) outcrops in the length more than 100 m and thickness to 12 m. Despite a large number of taken samples, the genus *Borelis* was found only in two of them: In the lowermost bed (sample A) and approximately 8 m above the stream level (sample F).

3. Near the recently weakly used road from Východná to Važec (northward from this road is located a highway), westward from the Važec village there is slightly outcropped app. 10 m thick body of bioherm packstones. The biggest number of sections of *Borelis vonderschmitti* (SCHWEIGHAUSER) (19 from the total number 33) was found there. In the overlier of limestones in abandoned open pits there are outcropping sandstones with rich nummulite fauna of the Upper Eocene (SBZ 20 with *Nummulites fabianii fabianii* (PREVER) and *N. fabianii retiatus* ROVEDA).

In all localities containing the genus *Borelis* the rocks, organogenic packstones (locally also grainstones – Hybica), have roughly the same composition with the main component of coralline algae, the genus *Sporolithon*. Among the algae there are present also abundant sections of *Polystrata alba* (PFENDER) DENIZOT (Pl. III, Fig. 5). Next often present components are the cyclostomate Bryozoa, rare are the fragments of Lamellibranchiata, segments of crinoids, spines of Echinodermata and tubes of worms. The coral fragments – massive as well as solitary forms – are also present.

The foraminifera have an important share in composition of assemblages. The large foraminifers are represented by *Nummulites variolarius* (LAMARCK), *Nummulites* sp., *Chapmanina gassinensis* SILVESTRI (Pl. III, Figs. 1 and 6), *Halkyardia minima* (LIEBUS) (Pl. II, Fig. 3), *Fabiania cassis* (OPPENHEIM) (Pl. III, Fig. 3), *Orbitoclypeus varians* (KAUFMANN) (Pl. II, Fig. 6), *Linderina* cf. *brugesi* SCHLUMBERGER (Pl.. II, Fig. 4) and *Heterostegina* sp. (Pl. II, Fig. 5). From the small foraminifers there can be mentioned *Haddonia heissigi* HAGN (Pl. III, Fig. 2), *Gyroidinella magna* (LE CALVEZ) (Pl. III, Fig. 4), *Gyroidinella* cf. *carpatica* SAMUEL et KÖHLER, *Gypsina* cf. *linearis* (HANZAWA) (Pl. III, Fig. 6), *Acervulina* sp., also the miliolid and rotalid forms are present. The absence of planktonic forms proves, that the assemblage is derived from protected back-reef environment.

The frequent presence of relatively big fragments of massive corals (mainly in the Važec locality) demonstrates at least the existence of smaller coral patch-reefs in this environment.

Conclusions

The assemblages accompanying *Borelis vonderschmitti* (SCHWEIGH.) in described localities are comparable with those accompanying this species in sections in Northern Italy (Colli Berici).

Schweighauser (1951) in accompanying assemblage mentions the presence of *Fabiania*, *Halkyardia* and *Chapmanina*. The limestones with *Neoalveolina* (= *Borelis*) *vonderschmitti* he places into the boundary layers between the uppermost Lutetian and lowermost Priabonian.

Ungaro (1969) describing the profile Mossano (Colli Berici) mentions the presence of *Neoalveolina* (= *Borelis*) with *Nummulites* aff. *biedai*, *N.* aff. *fabianii*, *N.* aff. *striatus*, *Baculogypsinoides* and *Chapmanina*. The beds with this assemblage he places into the uppermost part of Middle Eocene (into "Biarritzian").

Bassi et al. (2000) introduce the presence of *Borelis vonderschmitti* (SCHWEIGH.) in the upper part of Calcari nummulitici formation (uppermost Bartonian/base of Priabonian, SBZ 18/SBZ 19) in assemblage with *Glomalveolina ungaroi* BASSI et LORIGA (the last representant of genus *Alveolina*), *Nummulites variolarius/incrassatus*, *N. beaumonti discorbinus*, *N. ptukhiani*, *Discocyclina augustae*, *D. radians labatlensis*, *Asterocyclina stellata stellaris*, *Nemkovella strophiolata*, *Sphaerogypsina globulus*, *Chapmanina gassinensis*, *Fabiania*, *Gyroidinella* and *Silvestriella tetraedra*. They notice also the presence of encrusting foraminifers – *Victoriella*, *Haddonia*, *Acervulina* and *Gypsina*. The important role in assemblage have also the coralline algae.

The comparison with these assemblages confirms, that also localities Hrubý Grúň, Hybica and Važec can be situated into the transitional beds between Middle Eocene (Bartonian) and Upper Eocene (Priabonian), SBZ 18/SBZ 19. According this also the biostratigraphic data published in monograph by Gross & Köhler et al. (1980) need correction, because these localities were dated as Upper Eocene (Lower Priabonian).

Recent *Borelis schlumbergeri* (REICHEL) allows to estimate also the environment, where the fossil representants of the genus *Borelis* lived. According to Reiss & Gwitzman (1966) in the Gulf of Elat (Izrael) this species is present in the depth between 1.5 to 20 m, most of all above 3 m, but Hottinger (1977) from the same area describes the presence of this species in the depth between 20 and 45 m, most frequently between 30 a 35 m. The individuals from deeper waters are more elongated, from the shallower waters they are more rounded. Hottinger (l. c.) notices the high intra-species variability of *B. schlumbergeri* (REICHEL).

Taking into account the above reviewed and regarding also further members of assemblages, there is necessary to suppose that the fossil representants of genus *Borelis* accommodated shallow protected waters in depths between 3 to 35 m. The spherical form of tests favours the depths 3-20 m. In such depths also bioherm limestones of the northern rim of the Liptovská kotlina basin were deposited.

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