

FORAMINIFERAL ZONATION OF THE UPPER DEVONIAN AND LOWER CARBONIFEROUS IN MORAVIA (CZECHOSLOVAKIA)

FORAMINIFEROVÁ ZONACE SVRCHNÍHO DEVONU
A SPODNÍHO KARBONU NA MORAVĚ (ČESKOSLOVENSKO)

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Abstract

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13 foraminiferal zones are defined in the Upper Devonian and Lower Carboniferous of Moravia. In each zone the data are given on the type locality, stratigraphical range, occurrence in Moravia, distribution in palaeobiogeographical realms as well as on systematics of stratigraphically important taxa. The foraminiferal zones are correlated and their stratigraphical resolution is compared with standard conodont and ammonoid zones as well as with regional zones based on tabulate and rugose corals and stromatoporoids. The correlation with other foraminiferal zonations, both in the Tethyan and in the North American and Siberian Realm is proposed and the implications of the data from Moravia for a better interregional correlation are discussed.

Key words: foraminiferal zone, conodont zone, correlation, Upper Devonian, Lower Carboniferous, Tethyan, North American, Siberian Realm.

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Introduction

The biostratigraphical importance of the Upper Devonian and Lower Carboniferous foraminiferal fauna in Moravia was already stressed in the pioneer papers by Dvořák and Conil (1969) and Conil (1977) who introduced the foraminiferal zonation of the Dinant and Namur Synclinorium in Moravia. Kalvoda (1983) pointed to the similarity between the Upper Devonian and Lower Carboniferous foraminiferal fauna in Moravia and Eastern Europe as well as to some differences in comparison with the data especially from the Dinant Basin and defined a preliminary Moravian foraminiferal zonation.

This paper represents a further step in this direction – foraminiferal zones are precisely limited, every zone has its type locality, precise definition, characterization, data on the stratigraphical range, mostly also with relation to the conodont zonation, data on occurrences in Moravia as well as the distribution in palaeogeographical realms.

The distribution of zones is given only generally within realms, the detailed data on every occurrence are out of scope of this paper. Following the papers by Mamet, Belford (1968) and Vdovenko (1980), three main palaeogeographical realms are recognized based on foraminiferal fauna – the Tethyan Realm, the Siberian Realm and the North American Realm.

Foraminiferal zonation of the Upper Devonian and Lower Carboniferous in Moravia

Nanicella Zone

Definition: The lower boundary is defined by the first occurrence of representatives of genus *Nanicella* and the upper boundary by the occurrence of *Multiseptida corallina* Bykova.

Characterization: The zone is characterized by the presence of nanicells — *Nanicella uralica* Tchuvashov, *Nanicella ovata* Reitlinger, *Nanicella bella* Bykova, the upper part then by the presence of *Paratikhinella cannula* (Bykova). According to its definition and characterization, the zone represents a concurrent range zone. Further supplementary data on the evolutionary trends of *Nanicella* may contribute to the definition of more phylozones.

Typical locality: Borehole Křtiny HV 105, southern part of the Moravian Karst. Among further important documentary points are counted Křtiny doc. point 102, and 889 (Zukalová 1979) which yielded, however, only poor preserved fauna. Therefore the Křtiny HV-105 borehole, where rich foraminiferal assemblages as well as conodont fauna were found, was chosen as a type locality.

Remarks: The *Nanicella* Zone was defined first by Conil, Groessens, Pirlet (1976) in the Dinant and Namur Synclinorium. In the original sense, however, the stratigraphical range was Givetian — Frasnian (Conil, Groessens, Pirlet 1976, Mouravieff,

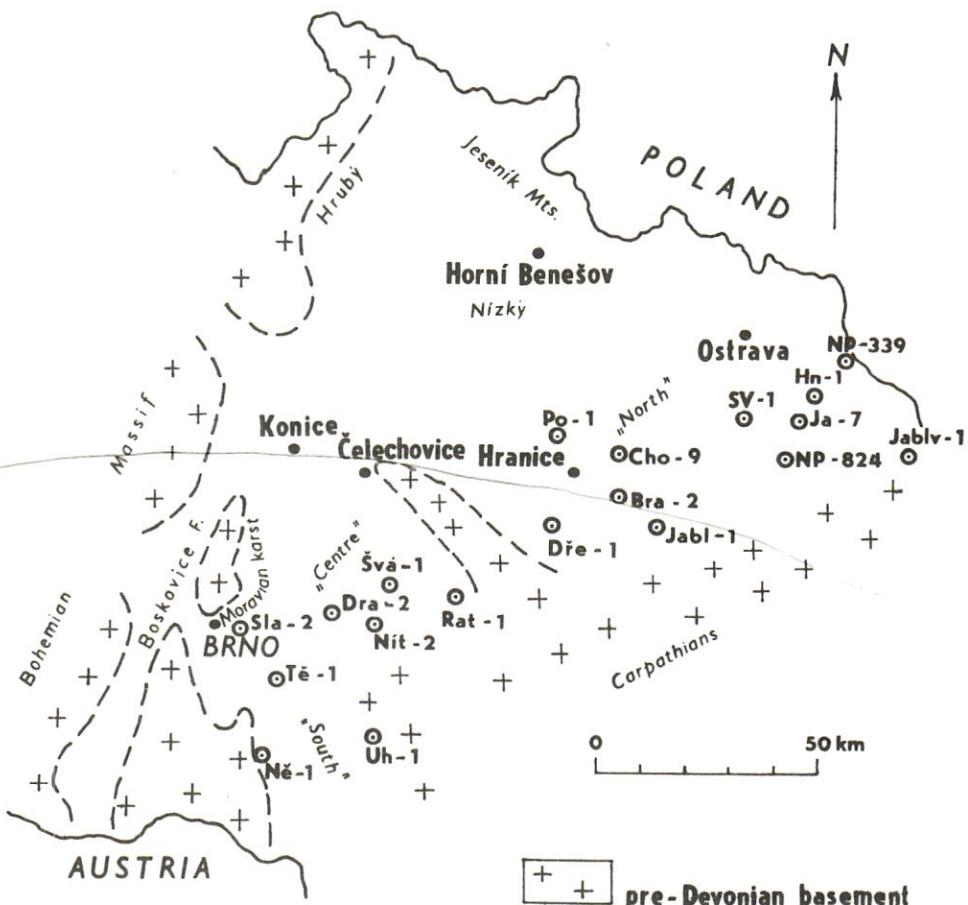


Fig. 1. Map of discussed localities and boreholes in Moravian Upper Devonian and Lower Carboniferous (modified according to Galle et al. 1988).

Obr. 1. Mapa diskutovaných lokalit v vrtů v moravském svrchním devonu a spodním karbonu (modifikováno podle Galleho et al. 1988).

Bultynck 1966). The similar stratigraphical range has also the preliminary zone 2 of Kalvoda (1983).

Stratigraphical range: Upper Givetian – Lower Frasnian. The upper boundary is documented by conodonts which can be attributed both to the Upper *P. asymmetricus* and to the *A. triangularis* Zone (Friáková 1975, Zukalová 1981).

Occurrence in Moravia: Especially the southern part of the Moravian Karst between Křtiny and Josefov, borehole Branky 1 in the region “North” on eastern slopes of the Bohemian Massif, boreholes LV 8, LV 9 and LH 50 in the Konice Devonian.

Distribution: Nanicells of the same age are known mainly in the Tethyan Realm – on the Ural and Russian Platform (Chuvashov 1965), in Belgium (Mouravieff, Bultynck 1966) and perhaps also in Germany (Beckmann 1950).

Data on systematics of stratigraphically important taxa: *Nanicella uralica* was described by Chuvashov (1965), *Nanicella ovata* by Reitlinger (1954) and *Nanicella bella* by Bykova (1952), further data on synonymy are presented by Chuvashov (1965). The classification of *Nanicella* species has been recently carried out by Pojarkov (1979).

Multiseptida corallina – Eonodosaria evlanensis Zone

Definition: The lower boundary of the zone is given by the first occurrence of *Multiseptida corallina* Bykova. In the upper part are significant genera *Eonodosaria*, *Eogeinitzina* which disappearance, together with *Nanicella*, defines the upper boundary of the zone.

Characterization: The lower part is characterized by the presence of *Multiseptida corallina* Bykova, *Tikhinella* and *Nanicella* – *Nanicella porrecta* Bykova and *Nanicella tchernyshevae* Lipina, which probably emerged somewhat later than first *Multiseptida*. The upper part of the zone is characterized by the presence of *Eonodosaria*, *Eogeinitzina*, *Frondilina* and primitive *Tournayellidae*. *Eonodosaria evlanensis* Lipina, *Eonodosaria rauserae* Lipina, *Eonodosaria cf. stalinogorski* Lipina, *Eogeinitzina devonica* Lipina, *Eogeinitzina rara* Lipina and *Frondilina sororis* Bykova are most characteristic species. *Nanicella evoluta* Reitlinger seems to be characteristic among nanicells. The presence of tikhinells – *Tikhinella fringa* Bykova and *Tikhinella multiformis* (Lipina) is recorded in the whole zone. According to the definition and characterization, the zone represents a concurrent range zone.

Type locality: Lesní lom Quarry, Brno-Líšeň (southern part of the Moravian Karst), north-western part of the upper floor. The boreholes Horákov SV 3 in southern part of the Moravian Karst and Jablunka 1 in the region “North” (see fig. 1) are counted among other important localities.

Stratigraphical range: Middle part of the Frasnian – Upper Frasnian, from the undistinguished Upper *P. asymmetricus* – *A. triangularis* Zone to the *P. gigas* Zone (*P. linguiformis* Subzone). However, it can't be excluded that the zone, similarly as in Eastern Europe, corresponds also to the lower part of *P. triangularis* Zone and thus, includes also lowermost Famennian. The appearance of *Eonodosaria* and *Eogeinitzina* in the upper subzone seems to approximate roughly the boundary of *P. gigas* and *A. triangularis* Zone.

Remarks: The zone was defined first by Zadórožnyi (1987) in the Frasnian of Western Siberia.

Occurrence in Moravia: Southern part of the Moravian Karst, regions “South”, and “North” on the eastern slopes of the Bohemian Massif.

Distribution: Similar assemblages as in Moravia are known especially in the Tethyan Realm – on the Ural (Chuvashov 1965) and Russian Platform (Bykova 1952, Lipina 1950, Reitlinger 1954, Konoplina 1959), in the Tian-Shan (Poyarkov 1969), in Middle Asia (Sabirov 1980), in Western Siberia (Zadórožnyi 1887) and in China

(Jiaxing, Yichun 1982). Similar assemblages have been, however, recorded also in the North American Realm (Toomey et al. 1970, Marchant 1987) as well as in the Siberian Realm (Menner, Reitlinger 1971, Mamet, Plafker 1982, Zadorozhnyi 1987).

Data on systematics of stratigraphically important taxa: *Eonodosaria evlanensis*, *Eonodosaria rauserae*, *Eogeinitzina devonica* and *Eogeinitzina rara* were described by Lipina (1950) as well as *Nanicella tchernyshevae*. *Nanicella porrecta*, *Multiseptida corallina*, and *Frondilina sororis* were described by Bykova (1952). Further data on synonymy and classification were presented by Poyarkov (1969, 1979), Zadorozhnyi (1987), and Mamet and Plafker (1982).

Eonodosaria evlanensis – Quasiendothyra communis Interzone

Definition: The range of the zone represents an interval between the lower boundary defined by the disappearance of *Eonodosaria*, *Eogeinitzina*, *Frondilina*, *Nanicella* and the upper boundary defined by the entry of *Quasiendothyra communis* (Rauser).

Characterization: Foraminiferal assemblages of the zone are characterized by the predominance of primitive unilocular foraminifera and by the rare presence of primitive *Tournayellidae*. In the back-reef facies, the typical Frasnian taxa as *Multiseptida corallina* Bykova and *Tikhinella* occur in the lower part of the interzone up to the stratigraphical level, corresponding to the conodont zone P. crepida (Friáková et al. 1985). According to the definition and characterization, the zone represents an interzone.

Type locality: Mokrá, Western Quarry, southern part of the Moravian Karst (Friáková et al. 1985, Hladil et al. 1989). The northwestern part of the upper floor in the Lesní lom Quarry, Brno-Líšeň and Horákov SV 3 borehole represent further important localities.

Remarks: The different development in the fore-reef facies where the Frasnian fauna became extinct at the Frasnian/Famennian boundary and in the back-reef facies where some Frasnian forms survived into the lower Famennian is characteristic of this interzone.

Occurrence in Moravia: Abundant in the Moravian Karst and in regions “South”, “Centre” and “North” (see fig. 1).

Distribution: The impoverishment of foraminiferal assemblages with preferential survival of euryfacial forms can be traced in the Lower Famennian of all palaeobiogeographical realms and reflects an event of worldwide nature (Kalvoda 1986).

Quasiendothyra communis – *Quasiendothyra regularis* Zone

Definition: The entry of *Quasiendothyra communis* (Rauser) marks the lower boundary, *Quasiendothyra regularis* Lipina is typical in the upper part of the zone and *Quasiendothyra kobeitusana* (Rauser) and *Quasiendothyra konensis* (Lebedeva) first occur at the upper boundary of the zone.

Characterization: *Quasiendothyra bella* (Chernysheva) and *Septatournayella rauserae* Lipina occur near the lower boundary of the zone in which are abundant, beside quasiendothyrs, also septabrunsiins – *Septabrunsiina nana* (Reitlinger), *Septabrunsiina kingirica* (Reitlinger), *Septabrunsiina primaeva* (Rauser) and *Septabrunsiina compressa* (Lipina). Two subzones can be subdivided. The lower subzone is characterized by the presence of *Quasiendothyra communis* (Rauser), *Quasiendothyra bella* (Chernysheva), *Septatournayella rauserae* Lipina and forms transitional between septabrunsiins and quasiendothyrs. The presence of *Quasiendothyra regularis* Lipina and the radiation of *Quasiendothyra ex gr. communis* (Rauser) is characteristic of the upper part of the zone, where primitive representatives of *Laxoendothyra parakosvensis* (Lipina) occur as well. According to the definition and characterization, the zone represents a phylozone.

Type locality: Northern wall of the upper floor of the Lesní lom Quarry, Brno-Líšeň, southern part of the Moravian Karst (samples 1–14, Friáková, Kalvoda 1986). The borehole Horákov SV 1 represents further important locality.

Stratigraphical range: The lower part of the Upper Famennian from the *P. marginifera* Zone to the Middle *P. expansa* Zone. The upper subzone ranges from the boundary interval of the *P. postera* and *P. expansa* Zone to the upper boundary of the *Quasiendothyra communis* – *Quasiendothyra regularis* Zone.

Occurrence in Moravia: Abundant in southern part of the Moravian Karst and in regions “South”, “Centre” and “North” (see fig. 1). It occurs also in the Konice Devonian.

Distribution: *Quasiendothyrs* of this zone are known mainly in the Tethyan Realm (Kalvoda 1981). In the Siberian Realm, the fauna of this zone has been recorded in the Omolon and Kolyma Massif and adjacent areas (Bogush, Yuferev 1970, Simakov et al. 1983) and in the North American Realm the *Quasiendothyra* fauna is absent.

Data on systematics of stratigraphically important taxa: *Quasiendothyra bella* was described by Chernysheva (1940), *Quasiendothyra communis* and *Quasiendothyra kobeitusana* by Rauser (1948), *Quasiendothyra regularis* by Lipina (1955) and *Quasiendothyra konensis* by Lebedeva (1956). The systematics of mentioned *quasiendothyrs* is discussed by Reitlinger (1961). Recently Durkina (1982) has published a more detailed classification of *quasiendothyrs*, however, the distinction of some taxa is quite difficult and the data on their wider distribution are still absent. More data on synonymy of *quasiendothyrid* species can be found in Bogush, Lipina, Reitlinger (1987).

Quasiendothyra kobeitusana – *Quasiendothyra konensis* Zone

Definition: The lower boundary of the zone is based on the entry of *Quasiendothyra kobeitusana* (Rauser) and *Quasiendothyra konensis* (Lebedeva). The upper boundary is defined by the disappearance of these taxa and by the occurrence of *Chernyshinella glomeriformis* (Lipina).

Characterization: The zone can be subdivided in two subzones. The lower one is characterized by a wide areal distribution and considerable variability of *quasiendothyrs*, *Laxoendothyra nigra* (Conil et Lys) and *Brunsiina uralica* Lipina being further typical taxa. The representatives of *Septabrunsiina* and *Septatournayella* are abundant as well. The upper subzone is characterized by a considerable areal restriction of facies suitable for the occurrence of multilocular foraminifera. Its base is defined by the entry of *Tournayellina beata pseudobeata* Reitlinger et Kulagina, in the higher part, *Tournayellina beata beata* (Malakhova), *Tournayellina septata* Lipina, and primitive chernyshinells – *Chernyshinella disputabilis* Dain, *Chernyshinella crassitheca* Lipina, are present. *Laxoendothyra parakosvensis* (Lipina) and septabrunsiins are abundant. The increase of the content of agglutinated grains in the structure of tests of different taxa seems to be significant as well. The facies with *quasiendothyrs* are rare, *quaiendothyrs* in them are, however, locally abundant. *Palaeospiroplectammina tschernyshinensis* Lipina emerges in the uppermost part of the zone. According to the definition and characterization, the zone represents a phylozone.

Type locality: Lesní lom Quarry, Brno-Líšeň, southern part of the Moravian Karst, eastern wall of the quarry (Kalvoda, Kukal 1987). Mokrá cement Quarry represents a further important locality.

Stratigraphical range: Uppermost Famennian – Lower Tournaisian, ranging from the Upper *P. expansa* Zone to the *S. sandbergi* Zone. The lower subzone ranges from the Upper *P. expansa* Zone to the Middle *S. praesulcata* Zone and the upper subzone from the Middle *S. praesulcata* Zone to the *S. sandbergi* Zone.

Remarks: This zone can be distinguished especially in shallow water facies of outer shelf, its

distinction in the facies of deeper part of outer shelf and inner carbonate platform is difficult. The zone was defined first by Reitlinger (1964) in Eastern Europe. Conil (1977) distinguished in Moravia the Quasiendothyra kobeitusana Zone which, however, corresponds only to the lower subzone of the Quasiendothyra kobeitusana — Quasiendothyra konensis Zone defined in this paper. The entry of *Tournayellina beata* (Malakhova) approximates the Devonian-Carboniferous boundary not only in Czechoslovakia (Kalvoda, Kukal 1987) but also in Belgium (Conil et al. 1986), in the Ural (Barskov et al. 1984) and perhaps also in China (Wu Xianghe, written communication).

Occurrence in Moravia: Abundant in the Moravian Karst, it occurs also in the Hranice Paleozoic and in the region "North" (see fig. 1).

Distribution: The zone is widely distributed in the Tethyan Realm (Lipina 1973), it has been recorded also in Australia (Mamet, Playford 1968) and in the Kolyma and Omolon Massif, Verkhoyanian Anticlinal Zone and Eltsov Synclinorium of the Siberian Realm (Yuferev 1973, Simakov et al. 1983, Bogush, Bushmina, Domnikova 1970).

Data on systematics of stratigraphically important taxa: *Laxoendothyra nigra* was described by Conil and Lys (1964), *Tournayellina beata pseudobeata* by Reitlinger and Kulagina (in Kochetkova et al. 1987). *Tournayellina beata* was described by Malakhova (1956), *Brunsiina uralica* by Lipina (in Dain 1953), *Chernyshinella disputabilis* by Dain (1953), further synonymy was presented by Lipina (1965) who described also *Chernyshinella crassitheca* and *Tournayellina septata*. Further synonymy of *Tournayellina beata* (Malakhova) was presented by Bogush (in Aksenova et al. 1980).

Chernyshinella glomiformis Zone

Definition: The lower boundary is based on the entry of *Chernyshinella glomiformis* (Lipina) and on the disappearance of quasiendothyrs. The upper boundary is based on the occurrence of *Chernyshinella tumulosa* Lipina.

Characterization: Beside the index species, other representatives of *Chernyshinella* — *Chernyshinella triangula* Lipina, *Chernyshinella disputabilis* (Dain) and *Chernyshinella crassitheca* Lipina occur frequently. The presence of *Palaeospiroplectammina tchernyshensis* Lipina is typical as well. Abundant are septabrunsiins among which *Septabrunsiina krainica* Lipina seems to be characteristic. According to the definition, the zone represents a phylozone.

Type locality: Horákov, doc. point 53/88, southern part of the Moravian Karst. Horákov Zá 12 is counted among further important localities.

Stratigraphical range: Middle Tournaisian, conodont zone Siphonodella crenulata.

Remarks: The zone corresponds to the lower part of the Chernyshinella glomiformis Zone defined by Malakhova (1959) in Eastern Europe as well as to the lower part of the Chernyshinella glomiformis Zone distinguished in Moravia by Conil (1977).

Occurrence in Moravia: Southern part of the Moravian Karst.

Distribution: Mainly Tethyan Realm, rare in the Siberian and North American Realm.

Data on systematics of stratigraphically important taxa: *Chernyshinella glomiformis* was described by Lipina (1948), as well as *Palaeospiroplectammina tchernyshensis*. *Chernyshinella tumulosa* was described by Lipina (1965) who presented further data on synonymy and classification of above mentioned species. More recent data on the systematics of *Chernyshinella glomiformis* (Lipina) and *Chernyshinella tumulosa* Lipina were presented by Bogush (in Aksenova et al. 1980).

Chernyshinella tumulosa — Spinobrunsiina Zone

Definition: The lower boundary of the zone is defined by the occurrence of *Chernyshinella tumulosa* Lipina, the upper boundary by the entry of *Paraendothyra*.

Characterization: *Spinobrunsiina* occurs probably little above the lower boundary of the zone. Chernyshinells are abundant in the lower part of the zone while in the upper part, a considerable impoverishment of foraminiferal assemblages can be traced. Chernyshinells become rare and spinobrunsiins and *Laxoendothyra parakosvensis parakosvensis* Lipina) seems to be characteristic. *Tuberendothyra* occurs in the upper part of the zone and *Tuberendothyra tuberculata* (Lipina) probably in the uppermost part of the zone. From the definition follows that the zone represents a phyozone.

Type locality: Hostěnice, doc. point Ho 44A, southern part of the Moravian Karst. Horákov, doc. point 37/88 is further important locality.

Stratigraphical range: The upper part of the Middle Tournaisian and lowermost part of the Upper Tournaisian, Upper S. crenulata – S. isosticha Zone – lower Gnathodus typicus Zone. Mestognathus harmalai Zone of shallow water conodont zonation (von Bitter, Sandberg, Orchard 1986).

Remarks: The zone corresponds to the upper part of the Chernyshinella glomiformis Zone both in Eastern Europe (Malakhova 1959) and in Moravia (Conil 1977).

Occurrence in Moravia: Southern part of the Moravian Karst, region “North” (see fig. 1).

Distribution: Wide distribution in the Tethyan Realm (Lipina 1973), rare data from the Siberian and North American Realm (Bogush in Aksenova et al. 1980, Mamet, Skipp 1970, Beauchamp, Mamet 1985).

Data on systematics of stratigraphically important taxa: *Tuberendothyra tuberculata* was described by Lipina (1948), further data on systematics of *Tuberendothyra* presented Lipina (1977). Data on *Spinobrunsiina* can be found in Conil, Groessens, Longerstey, Ramsbottom (1979).

Paraendothyra Zone

Definition: The lower boundary is based on the entry of *Paraendothyra*, the upper boundary then on the entry of *Tetrataxis*.

Characterization: The evolutionary line from paraendothyrs with relatively small basal supplementary deposits, represented by *Paraendothyra tschikmanica* (Malakhova), *Paraendothyra ninae* Ganagina and *Paraendothyra portentosa* Conil, to forms with large supplementary deposits, represented by *Paraendothyra nalivkini* Chernysheva, can be traced within the zone. Further important taxa seem to be *Rectoparaendothyra*, *Tuberendothyra tuberculata* (Lipina), *Latiendothyranopsis latispiralis* (Lipina), *Spinobrunsiina*, *Pseudoammodiscus*, *Brunisia*. The presence of “large tournayells” – *Tournayella discoidea* Dain and *Eoforschia moelleri* (Malakhova) seems to be characteristic as well. In the upper part of the zone, *Spinoendothyra* and *Inflatoendothyra* can be abundant and in the uppermost part of the zone, they can be accompanied by first *Dainella*. According to the definition and characterization, the zone can be ranked among concurrent range zones.

Type locality: Hostěnice, doc. point 51/44/3, southern part of the Moravian Karst.

Stratigraphical range: Upper Tournaisian, from the Upper G. typicus Zone to the base of the S. anchoralis Zone. Lower part of the Mestognathus praebbeckmani Zone in the shallow water conodont zonation (von Bitter, Sandberg, Orchard 1986).

Remarks: The subdivision of the zone into subzones seems to be prospective in the future. The zone corresponds to the Tournayella Zone of Conil, Groessens, Pirlet (1976) defined in the Dinant and Namur Synclinorium. The Moravian zone contain, however, a more diversified foraminiferal fauna, enabling a good correlation with Eastern Europe.

Occurrence in Moravia: Southern part of the Moravian Karst, region “North” (see fig. 1).

Distribution: Widespread in the Tethyan Realm (Conil et al. 1988, Kalvoda 1983,

Bogush, Yuferov 1966), present in the Siberian Realm (Bogush, Yuferov 1966, Simakov et al. 1983, Ivanova, Bogush 1983), paraendothyrs are absent in the North American Realm, where other taxa as *Tuberendothyra tuberculata* (Lipina), *Spinoendothyra* and *Inflatoendothyra* serve for a good correlation with the Tethyan Realm (cf. Bencle, Groves 1986).

Data on systematics of stratigraphically important taxa: *Paraendothyra nalivkini* as well as the genus *Paraendothyra* was described by Chernysheva (1940), *Paraendothyra tschikmanica* by Malakhova (1957), *Paraendothyra ninae* by Ganelina (1966) and *Paraendothyra portentosa* by Conil (in Simakov et al. 1983). Further data on systematics of *Paraendothyra* are by Bogush and Yuferov (1966). *Latiendothyranopsis latispiralis* was described by Lipina (1955), further data on systematics of *Latiendothyranopsis* as well as *Pseudoammmodiscus* and *Brunisia* can be found in Conil, Longerstaey, Ramsbottom (1979). *Tournayella discoidea* was described by Dain (1953) and *Eoforschia moelleri* by Malakhova (in Dain 1953), further data on their systematics can be found in Conil and Lys (1977) and Bogush (in Aksanova et al. 1980). The systematics of *Spinoendothyra*, *Inflatoendothyra* and *Dainella* is discussed by Lipina (1985).

Tetrataxis – Eoparastaffella simplex Zone

Definition: The lower boundary is defined by the occurrence of *Tetrataxis*, *Eotextularia diversa* (Chernysheva) being further important taxon, emerging at this boundary. The upper boundary is based on the entry of *Archaeodiscidae*.

Characterization: The zone is characterized by the abundant occurrence of *Dainella*, especially *Dainella chomatica* (Dain), in the upper part *Eoparastaffella simplex* (Vdovenko) appears. The gradual increase in the representation of genera as *Pseudolituotubella*, *Pseudolituotuba*, *Plectogyranopsis*, *Eoendothyranopsis*, *Globoendothyra*, *Omphalotis*, *Eoparastaffella*, which main development and expansion can be traced in the Visean, is apparent in this zone. It is accompanied by the gradual decline of Tournaisian forms typical of preceding zones. According to the definition and characterization, the zone can be regarded as a concurrent range zone.

Type locality: Mokrá, Cement Work Quarry, doc. points VI–VIII Hostěnice. Doc. points Hostěnice Ho IIB-E represent further important outcrops.

Stratigraphical range: Uppermost Tournaisian – lowermost Visean, conodont zone *Scaliognathus anchoralis* and lowermost *Gnathodus texanus*. Upper part of the *Mestognathus praebbeckmani* Zone in shallow water conodont zonation (von Bitter, Sanberg, Orchard 1986). Marchant, Sevastopulo, Clayton (1984) report Tetrataxis in the *Dolymae bouckaerti* Subzone (the upper subzone of the *Gnathodus typicus* Zone), in Moravia, however, Tetrataxis has been found only in the *Scaliognathus anchoralis* Zone.

Remarks: The zone corresponds to the Tetrataxis – *Eotextularia diversa* Zone and to the *Eoparastaffella α* Zone of Conil, Groessens, Pirlet (1976). The Tournaisian – Visean boundary defined at the boundary of these zones represents a level of faunal change from considerably impoverished assemblages of Tetrataxis – *Eotextularia diversa* Zone to more diversified assemblages of *Eoparastaffella α* Zone. In Eastern Europe as well as in Moravia, however, the suitable facies for the expansion of foraminiferal fauna occurred sooner and the great number of taxa known in the *Dinant Synclinorium* only in the Visean occurs here in the Upper Tournaisian (Kalvoda 1983). As also some discrepancies in the determination of the Tournaisian-Visean boundary in terms of conodont stratigraphy emerge (Ziegler, Lane 1983, von Bitter, Sandberg, Orchard 1986), a more detailed subdivision of this interval in terms of foraminiferal stratigraphy has not been performed in Moravia. The entry of *Eoparastaffella simplex* (Vdovenko) represents an important stratigraphical level also in Moravia, however, it remains to be clarified whether this level in Moravia compares with the Tournaisian-Visean boundary.

Occurrence in Moravia: Southern part of the Moravian Karst, region North, Hranice Paleozoic (see fig. 1).

Distribution: The wide distribution in the Tethyan Realm (Lipina 1973). In the Siberian Realm only the lower part of the zone can be traced and also in the North American Realm many important taxa of the upper part of the zone are absent.

Data on systematics of stratigraphically important taxa: *Eotextularia diversa* was described by Chernysheva (1948), *Eoparastaffella simplex* by Vdovenko (1954) and *Dainella chomatica* by Dain (Brazhnikova 1962). Further data on systematics of *Eotextularia diversa* (Chernysheva) can be found in Conil, Lys (1977) and Bogush (in Akseanova et al. 1980), on systematics of *Eoparastaffella simplex* Vdovenko in Brazhnikova, Vdovenko (1973) and on systematics of *Dainella chomatica* (Dain) in Vdovenko et al. (1981). The systematics of stratigraphically important genera is discussed by Conil, Longerstaey, Ramsbottom (1979).

Viseidiscus eospirillinoides – Glomodiscus oblongus Zone

Definition: The base of the zone is defined by the entry of *Archaeodiscidae* represented by genera *Viseidiscus*, *Glomodiscus*, *Planoarchaediscus* and *Uralodiscus*. The upper boundary is based on the entry of *Pojarkovella nibelis* (Durkina), *Koskinotextularia* and *Koskinobigenerina*.

Characterization: Beside the above mentioned archaediscid genera, the primitive representatives of *Archaeodiscus* ("involutus" type, Pirlet, Conil 1976) appear in the zone. The presence of Tournaisian genera *Spinobrunsiina*, *Spinoendothyra*, *Dainella*, *Tuberendothyra* and *Eotextularia* seems to be characteristic as well. In the uppermost part of the zone, *Palaeotextularia consobrina* Lipina occurs. The definition and characterization suggests that the zone represents a concurrent range zone.

Stratigraphical range: Lower Visean – lower part of the Middle Visean (V1b–V2a of the Belgian division).

Type locality: Hostěnice, profile near the abandoned quarry, doc. points Ho III, IV, Ho X1, southern part of the Moravian Karst. Mokrá, doc. point 61, represents further important locality.

Remarks: The *Glomodiscus oblongus* – *Uralodiscus rotundus* Zone was defined by Vdovenko (1980). Kalvoda (in Simpson, Kalvoda 1987) pointed out to the facial substitution between the assemblages of the *G. oblongus* – *U. rotundus* Zone and *Viseidiscus eospirillinoides* Zone in British Isles as well as in the whole Tethyan Realm and defined the *Viseidiscus eospirillinoides* – *Glomodiscus oblongus* – *Uralodiscus rotundus* Zone. An abbreviated form of this zone is presented in this paper.

Occurrence in Moravia: Southern part of the Moravian Karst, Nízký Jeseník Mountains, Hranice Paleozoic, region "North" (see fig. 1).

Distribution: Wide distribution in the Tethyan Realm (Vdovenko 1980, Simpson, Kalvoda 1987). Impoverished assemblages occur in the North American Realm (Brenkle et al. 1982). The zone can't be traced in the Siberian Realm.

Data on systematics of stratigraphically important taxa: The data on systematics of *Viseidiscus*, *Planoarchaediscus*, *Uralodiscus* and *Glomodiscus* can be found in Brenkle, Ramsbottom, Marchant (1987), the systematics of *Archaeodiscus* is, however, according to Pirlet, Conil (1976) and Conil, Longerstaey, Ramsbottom (1979). *Ammarchaediscus eospirillinoides* was described by Brazhnikova (1967), more data on systematics can be found in Vdovenko et al. (1981). *Glomodiscus oblongus* was described by Conil and Lys (1964).

Pojarkovella nibelis – Koskinotextularia Zone

Definition: The lower boundary is based on the entry of *Pojarkovella nibelis* (*Durkina*) and *Koskinotextularia* and *Koskinobigenerina*. The occurrence of *Neoarchaediscus* defines the upper boundary of the zone.

Characterization: The presence of *Pojarkovella*, *Klubonibelia*, *Endothyranopsis compressus* (Rauser et Reitlinger), *Dainella*? *tujmasensis* (Vissarionova), *Eostaffella radiata* (Brady) seems to be characteristic of this zone. Among archaediscids, the representatives of genus *Archaediscus* ("convexus" type and "concaus" type of Pirlet, Conil 1976) and *Nodosarchaediscus* are significant. In the lower part of the zone, the presence of surviving older taxa as *Spinobrunsiina*, *Spinoendothyra*, *Dainella*, *Tuberendothyra*, *Glo-modiscus* and *Uralodiscus* seems to be typical. The definition and characterization of the zone suggests that it represents a concurrent range zone.

Type locality: Hostěnice, the outcrop in the forest north of the village, doc. points Ht 1, Ht 2, southern part of the Moravian Karst. Boreholes Uhřice 14 and Uhřice 9 in the region "South" represent further important localities.

Stratigraphical range: Upper part of the Middle and lower part of the Upper Visean.

Remarks: The Pojarkovella nibelis – Koskinotextularia Zone was defined first in the Dinant and Namur Synclinorium by Conil, Groessens, Pirlet (1976).

Occurrence in Moravia: Southern part of the Moravian Karst, region "South" and "Centre" (see fig. 1).

Distribution: Wide distribution in the Tethyan Realm. It is hard to distinguish in the North American Realm and it can't be distinguished in the Siberian Realm.

Data on systematics of stratigraphically important taxa: *Pojarkovella nibelis* was described by Durkina (1959), further data on its systematics can be found in Vdovenko et al. (1981). Data on systematics of *Archaediscus* and *Nodosarchaediscus* can be found in Pirlet, Conil (1976), Conil, Longerstaey, Ramsbottom (1979) and on systematics of *Koskinobigenerina* and *Koskinotextularia* in Conil, Longerstaey, Ramsbottom (1979).

Neoarchaediscus Zone

Definition: The lower boundary of the zone is defined by the entry of *Neoarchaediscus*, the upper boundary by the entry of *Loeblichia paraammonoides* Brazhnikova.

Characterization: At the lower boundary, the representatives of *Archaediscus* termed by Pirlet, Conil (1976) "angulatus" occur. Beside the mentioned taxa, the presence of *Endothyranopsis crassus* (Rauser et Reitlinger), *Bradyina rotula* (Eichwald), *Climacammina*, *Cribrostomum*, *Howchinia* and *Monotaxinoides* seems to be characteristic. *Monotaxinoides* and *Bradyina rotula* (Eichwald) are typical of the upper part of the zone. According to the definition and characterization, the zone represents a concurrent range zone.

Type locality: Mariánské údolí near Hranice (Conil 1977). Boreholes Choryně 9 and Ostravice NP 824 in the region "North" represent further important localities.

Stratigraphical range: Middle part of the Upper Visean, V3b of the Belgian division.

Remarks: The zone was first defined by Conil, Groessens, Pirlet (1976) as *Asperodiscus* (younger synonym of *Neoarchaediscus*) Zone. The Moravian zone corresponds, however, only to subzones α to γ . Because of the relatively low surface distribution of limestones representing this zone, the more detailed subdivision (as in the Dinant and Namur Synclinorium) has not been performed in Moravia.

Occurrence in Moravia: Region "North", "Middle" and "South" (see fig 1), Hranice Paleozoic.

Distribution: The fauna of the zone is widely distributed in the whole Tethyan Realm (Vdovenko 1980) as well as in the North American Realm (Mamet, Skipp 1970, Baxter, Browne, Roberts 1979). The Siberian Realm contains only strongly impoverished foraminiferal fauna which stratigraphical correlation is rather difficult.

Data on systematics of stratigraphically important taxa: The data on systematics of *Neoarchaediscus* can be found in Brengle, Ramsbottom, Marchant (1987), the systematics of *Archaediscus* is, however, according to Pirlet and Conil (1976) and Conil, Longerstaey, Ramsbottom (1979).

Asteroarchaediscus – *Loeblichia paraammonoides* Zone

Definition: At the lower boundary, *Loeblichia paraammonoides* Brazhnikova occurs and within the zone, *Asteroarchaediscus* reaches its acme. The upper boundary is defined by the first occurrence of *Eosigmoilina*.

Characterization: The whole zone is characterized by abundant *Asteroarchaediscus* and *Neoarchaediscus*, the occurrence of *Loeblichia paraammonoides* Brazhnikova is relatively rare. According to its definition and characterization, the zone represents a concurrent range zone.

Type locality: Borehole Kozlovice SV 1, 1840, 70 m.

Stratigraphical range: The uppermost Visean, V3c of Belgian division. The goniatite zones Go β to Go γ are reported from the levels corresponding to the Asteroarchaediscus – *Loeblichia paraammonoides* Zone by Kumpera (1977).

Remarks: The zone is known only from boreholes and the occurrence of limestones with foraminiferal fauna of this zone is relatively rare. The upper boundary is drawn only theoretically according to data in Belgium (Conil, Groessens, Pirlet 1976) as Namurian foraminifera are very rare and no *Eosigmoilina* has been found in Moravia.

Occurrence in Moravia: Region "North" (see fig. 1).

Distribution: The zone can be traced both in the Tethyan and North American Realm.

Data on systematics of stratigraphically important taxa: Data on systematics of *Asteroarchaediscus* can be found in Brengle, Ramsbottom, Marchant (1987). *Loeblichia paraammonoides* was described by Brazhnikova (in Brazhnikova et al. 1956).

Relation to other Upper Devonian and Lower Carboniferous zonations

The relation to the conodont zonation has been already discussed in the preceding chapter. The data are, to a large extent, based on the joint study of conodonts and foraminifers (often from the same samples) in Moravia. The synoptical correlation is illustrated in fig. 2. The presented conodont zonation is based on data of Ziegler (1971), Ziegler and Sandberg (1984), Sandberg et al. (1978) and Lane et al. (1980). The correlation with the ammonoid zonation is based on data of Chlupáč (1979) and Paproth et al. (1983). In Moravia the zonations based on other benthic groups than foraminifers have been created in the Upper Devonian (Galle et al. 1988). The correlation of foraminiferal zonation with tabulate coral, rugose coral and stromatoporoid zones in Moravia is synoptically illustrated in fig. 3.

When comparing the foraminiferal zonation with other benthic fauna zonations from the point of view of biostratigraphical resolution, we can see that the Nanicella Zone doesn't reach the resolution of coral and stromatoporoid zones. The Multiseptida corallina – Eonodosaria evlanensis Zone and especially its possible subzones is, however, already finer than rugose coral and stromatoporoid zones. In the Famennian, especially in its upper part, the foraminiferal zonation acquires the highest resolution among benthic fauna zonations.

| | | | | | | | | |
|---------------------|-------------|------------|----------|----------------------------|---------|--------------------------|---|-------------------------------------|
| LOWER CARBONIFEROUS | TOURNASSIAN | PERICYKLUS | γ | Goniatites | β | Gnathodus billineatus | Astroarchaediscus - L. para-ammonoides Zone | 13 |
| | | | | α | | | Neoarchaediscus Zone | 12 |
| | | | | δ | | | Koskinotextularia - P. nibilis Zone | 11 |
| | | | | γ | | | V. eospirillinoides - G. oblongus Zone | 10 |
| | | | | β | | | Scaliognathus anchoralis | 9 |
| | | | | β | | | Gnathodus typicus | Paraendothyra Zone |
| | | | | α | | | Upper S. crenulata - S. isosticha | Ch. tumulosa - Spinobrun-siina Zone |
| | | | | α | | | Siphonodella crenulata | Ch. glomiformis Zone |
| | | | | G. crassa | | | Siphonodella sandbergi | |
| | | | | G. subinvoluta | | | Siphonodella duplicita | |
| DEVONIAN | FAMENNIAN | PERICYKLUS | γ | Gattendorfia | | Siphonodella sulcata | Q. konensis - Q. kobeitusana Zone | U |
| | | | | Cymaclymenia eury-omphala | | | | L |
| | | | | W. sphaeroides | | | Siphonodella praesulcata | |
| | | | | Kalloclymenia sub-armata | | | | |
| | | | | Gonioclymenia speciosa | | | Palmatolepis expansa | |
| | | | | Glymenia hoevelensis | | | | U |
| | | | | Platyclymenia annulata | | | Palmatolepis postera | |
| | | | | Prolobites delphinus | | | Palmatolepis trachytera | |
| | | | | Pseudoclymenia sandbergeri | | | Palmatolepis marginifera | |
| | | | | Sporadoceras pompeckii | | | Palmatolepis rhomboidea | E. evlanensis - Q. communis |
| GIVETIAN FRASNIAN | FRASNIAN | PERICYKLUS | γ | Cheiloceras curvispina | | Palmatolepis crepida | Interzone | 4 |
| | | | | Cheiloceras | | | | |
| | | | | Crickites holzapfeli | | | Palmatolepis triangularis | L |
| | | | | Manticoceras cordatum | | | Palmatolepis gigas | M. corallina - E. evlanensis |
| | | | | Pharciceras lunulicosta | | | Ancyrognathus triangularis | U Zone |
| | | | β | | | Polygnathus asymmetricus | Nanicella Zone | L |
| | | | | | | | | 2 |

Fig. 2. Correlation of ammonoid and conodont zonation and foraminiferal zonations (right — presented foraminiferal zonation, left — preliminary foraminiferal zonation of Kalvoda 1983).

Obr. 2. Korelace ammonoideové, konodontové a foraminifrových zonací (napravo — presentovaná foraminifrová zonace, nalevo — předběžná foraminifrová zonace) Kalvody (1983).

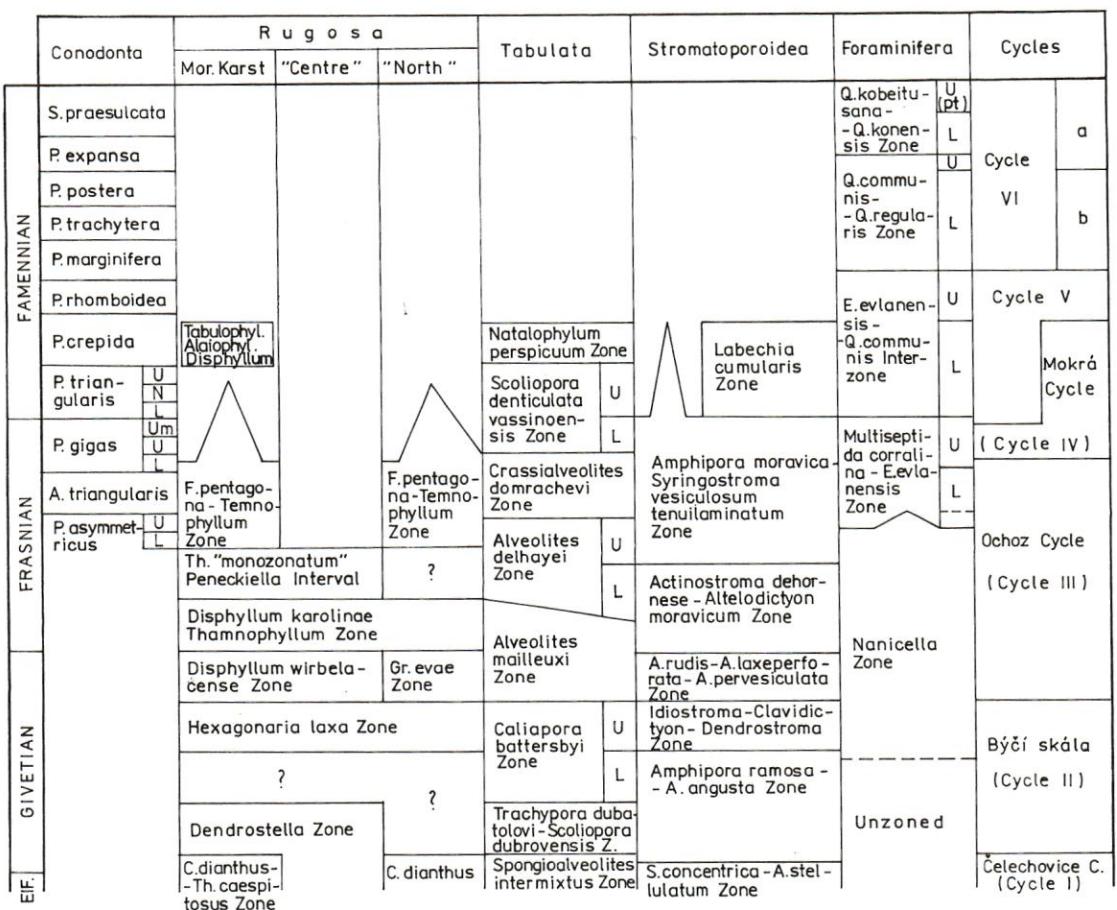


Fig. 3. Correlation chart of Upper Devonian zonations in Moravia (modified according to Galle et al. 1988).

Obr. 3. Přehledná korelační tabulka svrchnodevonských zonací na Moravě (modifikováno podle Galleho et al. 1988).

When compared with conodont and ammonoid zonation, the foraminiferal zonation apparently doesn't reach their high resolution in the Upper Devonian. Only in the Upper Frasnian, the resolution of foraminiferal and ammonoid zones seems to be similar. In the Middle and Upper Tournaisian, the stratigraphical range of conodont and foraminiferal zones seems to be comparable and foraminiferal zones seem to be finer than ammonoid zones. In the Lower and Middle Visean, the foraminiferal zonation seems to represent the finest subdivision of this interval and in the Upper Visean, only the ammonoid zonation acquires the similar resolution as foraminiferal zonation (only when compared with data from Belgium, in Moravia the foraminiferal fauna of this interval is not so well known).

Summarizing, we can say that the foraminiferal zonation represents an important biostratigraphical subdivision of the Upper Devonian and Lower Carboniferous, in some intervals reaching finer stratigraphical resolution than the standard conodont and ammonoid zonation. Nevertheless, the Upper Devonian and Lower Carboniferous calcareous foraminifera were, in a large extent, benthic forms and thus, the zonation based on them bears all shortcomings of a benthic fauna zonation. In this respect, the precise interregional correlation of foraminiferal zonations is of uttermost importance.

Palaeobiogeography

As already suggested before, three major palaeogeographic units can be recognized in agreement with Mamet, Belford (1968) and Vdovenko (1980) in the studied interval — the Tethyan, Siberian and North American Realm.

The Tethyan Realm included not only Western and Eastern Europe but also the Tian Shan and Middle Asia, West Siberia and probably also China, Laos and Vietnam. The Tethyan influences can be recognized in the Upper Famennian, Upper Tournaisian and Upper Visean of Australia (Mamet, Belford 1968, Mamet, Playford 1968) and in the Upper Famennian and Tournaisian of the Kolyma and Omolon Massif and Verkhoyanian Anticlinal Zone (Yuferev 1973, Simakov et al. 1983).

The Siberian Realm (Taimyr-Alaska Realm of Mamet, Belford 1968) included, in the first instance, Middle Siberia, the foraminiferal fauna of the Kolyma and Omolon Massif and Verkhoyanian Anticlinal Zone showing a distinct Siberian affinity only in the Visean. The Siberian affinity of Alaskan foraminiferal fauna seems to be supported by the occurrence of Upper Frasnian *Juferevella*, so far recorded only in the Kuznets Basin (Zadorozhnyi 1987a) and in Alaska where it is represented by *Juferevella farewellii* (Mamet, Plafker 1982).

The North American Realm, even though positioned in the tropical and subtropical latitudes, shows, in comparison with the Tethyan Realm, a considerably impoverished and often endemic foraminiferal fauna. Ross (1982) suggested for the Middle and Upper Carboniferous foraminiferal North American fauna a filter dispersal route around temperate northern Euamerica, the Tethyan seaway being closed. According to Copper (1986), the ocean between Laurussia and Gondwana closed already in the Late Devonian which resulted in the introduction of cold waters into tropical areas. Thus it seems probable that also in the Upper Devonian and Lower Carboniferous, the migration route in the higher latitudes, probably along the presumed isthmus between North America and Siberia (Rowley et al. 1985), played an important role. The second migration route apparently functioned only during major eustatic rises and connected the North American Realm with the Tethyan Realm across the barriers of the Old Red Continent. However, the long-termed impoverished and endemic character of North American foraminiferal but also coral fauna (cf. Oliver 1977, Sando, Bamber, Armstrong 1975) suggests that also other factors than the relative isolation might have been in play, e. g. the mentioned introduction of cold waters (Copper 1986).

Interregional correlation

In the interregional correlation only zonations with highest biostratigraphical resolution, covering the largest part of the Upper Devonian and Lower Carboniferous, have been chosen, both in the Tethyan, North American and Siberian Realm.

In the Tethyan Realm, the zonations in Western and Eastern Europe as well as in the Tian Shan and West Siberia seem to be most important. The foraminiferal zonation of the Dinant and Namur Synclinorium is based on the data by Conil, Groessens, Pirlet (1986), Paproth et al. 1983, Conil et al. (1986). The East European zonation rests on papers by Lipina, Reitlinger (1970), Chuvashov (1964), Lipina (1973, 1979), Reitlinger (1977), Zadorozhnyi (1987) and the foraminiferal zonation in the Tian Shan on papers by Poyarkov (1969), Poyarkov, Skvortsov (1977) and the foraminiferal zonation in West Siberia on papers by Bogush (1985) and Zadorozhnyi (1987).

In the Siberian Realm, the foraminiferal zonation of the Kuznets Basin rests on data by Bushmina, Bogush, Kononova (1984) and Zadorozhnyi (1987). The foraminiferal zonation of the Omolon and Kolyma Massif is based on papers by Yuferev (1973), Menner, Reitlinger (1971) and Simakov et al. (1983). The foraminiferal zonations of the Kolyma and Omolon Massif are very similar, only the Upper Visean zones

| | Moravia | Namur and Dinant Syn- clinorium | Eastern Europe | Tian-Shan | Western Siberia | Omolon and Kolyma Massif | Kuznets Basin | North America | Conodont Zonation |
|-----|----------|---|-------------------|--|--------------------|--|---------------------------------------|---|---|
| | | | | | | | | | |
| | | | | | | | | | G.bilineatus |
| | | | | | | | | | Unzoned interval |
| | | | | | | | | | ? |
| | | | | | | | | | G.texanus |
| | | | | | | | | | S.anchoralis |
| | | | | | | | | | Upper Lower |
| | | | | | | | | | Upper S.crenu- lata-S.isostic- ha |
| | | | | | | | | | S.crenulata |
| | | | | | | | | | S.sandbergi S.duplicata S.sulcata |
| | | | | | | | | | S.praesulcata P.expansa |
| | | | | | | | | | P.postera P.trachytera P.marginifera |
| | | | | | | | | | P.rhomboidea P.crepida P.triangularis |
| Gl. | FRASNIAN | Multisepti- da corallina - Eono- dosaria ev- lanensis Z. | Nanicella Zone | T.multifor- mis-E.eva- nensis Zone | IV | M.coralli- na - E.eva- nensis Zone | E.evanen- sis-N.por- recta Zone | T.multifor- mis-E.eva- nensis Zo- ne | P.gigas |
| | | Nanicella Zone | | N.bella Zone | III | S.horrida - N.polypora Zone | | E.evanen- sis-M.cor- allina Zone | A.triangularis |
| | | | | | | | | | P.asymmetricus |

Fig. 4. Correlation chart of Upper Devonian and Lower Carboniferous foraminiferal zonations.
Obr. 4. Přehledná korelační tabulka svrchnodevonských a spodnokarboniských foraminifrových zo-
nací.

are rather different (the foraminiferal assemblages of the Kolyma Massif show stronger Tethyan influence) and the Upper Frasnian E. evlanensis – T. multiformis Zone has been recognized only in the Kolyma Massif.

In the North American Realm, the zonation of Mamet et Skipp (1970) was preferred. Recently, some inadequacies of the zonation have been suggested by Baxter, Browne, Roberts (1979), Brengle et al. (1982) and Brengle and Groves (1987), however, no alternative zonation, covering the whole range of the zonation of Mamet and Skipp, has been created. The Frasnian data rests on papers by Toomey et al. (1970) and Marchant (1987).

The synoptical illustration of interregional correlation is presented in fig. 4.

Conclusions

The foraminiferal zonation in Moravia reflects some general trends of the evolution of foraminiferal assemblages in the Tethyan Realm and it bears thus, a great similarity with other zonations defined in this realm. The Moravian foraminiferal zones were defined rather broader to enable a more precise definition of zonal boundaries and the growing knowledge in future will surely contribute to a more detailed subdivision into subzones, some of them being hinted already in this paper. Nevertheless, the Upper Devonian – Lower Carboniferous foraminiferal zonation in Moravia reaches, as a whole, a comparable stratigraphical resolution as other important foraminiferal zonations in Western and Eastern Europe. In some intervals, as e. g. in the Upper Visean, the foraminiferal fauna in Moravia is still not so well known as in Western or Eastern Europe, in other intervals, however, the results from Moravia contribute substantially to a better stratigraphical correlation in the Tethyan Realm. These results can be summarized in the following points:

1. Some characteristic Frasnian genera as *Multiseptida* and *Tikhinella* were able to survive to the Lower Famennian.
2. *Quasiendothyra communis* (Rauser) occurs in Moravia, contrary to Western Europe, in the P. marginifera conodont zone.
3. The disappearance of quasiendothyrs in Moravia can be traced only in the conodont zone S. sandbergi (Lower Tournaisian). It accords with the results from the Omolon Massif (Simakov et al. 1983) as well as from Eastern Europe (Bogush et al. 1987). In this respect, the data from the Dinant and Namur Synclinorium (Conil et al. 1986) seem to represent rather an endemic development.
4. The Tournayellina beata pseudobeata Subzone, approximating in Moravia the Devonian – Carboniferous boundary, can be traced both in Western Europe and in the Ural and perhaps also in China.
5. The Paraendothyra Zone defined in Moravia seems to be better correlative than other alternative zones. The occurrence and widespread dispersal of paraendothyrs seem to represent a rapid event and the Paraendothyra Zone can be recognized both in the Tethyan Realm (Western Europe, Eastern Europe, China, Tian-Shan) and in the Siberian Realm (Omolon and Kolyma Massif, Verkhoyanian Anticlinal Zone) in the similar stratigraphical level.
6. The detailed correlation of conodont and foraminiferal zonation in Moravia underlines an endemic character of the Upper Tournaisian foraminiferal fauna of the Dinant Basin and it enables a more precise correlation of Tournaisian – Visean boundary beds.
7. On the whole, the Moravian foraminiferal zonation contributes, because of its close comparison with conodont zonation, not only to a better correlation between the foraminiferal zonations in Eastern and Western Europe, but also to a better correlation between foraminiferal zonations generally.

When comparing the evolution of foraminiferal assemblages in different palaeogeographical realms, some general features seem to be apparent. In the upper parts of the stages (Upper Frasnian, Upper Famennian, Upper Tournaisian, Upper Visean), there seem to

occur the lowest palaeobiogeographical differentiation. On the other hand, the lower parts of the stages (Lower Famennian, Lower Tournaisian, Lower Visean) seem to represent periods with the greatest palaeogeographical differentiation within stages. This pattern has its impact on the interregional correlation and it seems to reflect some major climatic oscillations accompanied by migration and in some cases also by evolutionary events of foraminiferal fauna. The discussion of this topic is, however, out of scope of this paper and more data on it can be found in Kalvoda (1990a, b).

SOUHRN

Ve svrchním devonu a spodním karbonu na Moravě je definováno 13 foraminiferových zón. U každé zóny je uvedena definice, charakteristika, typická lokalita, výskyt na Moravě, stratigrafický rozsah, rozšíření v jednotlivých paleogeografických oblastech a údaje o systematice stratigraficky důležitých taxonů.

Foraminiferové zóny jsou srovnány se standardními konodontovými a ammonoideoevými zónami i s místními zónami vytvořenými na základě studia tabulátních korálů, rugozních korálů a stromatoporoideí.

Foraminiferové zóny svrchního devonu a spodního karbonu na Moravě jsou korelovány s foraminiferovými zonacemi v západní a východní Evropě, v západní Sibiři, na Čan-Šanu, v kuzněckém pánvi, v omolonském a kolymském masívu a v Severní Americe. Srovnání ukazuje, že moravská foraminiferová zonace je srovnatelná s nejjemnějšími foraminiferovými zonacemi ve východní a západní Evropě. Oproti východoevropské zonaci má výhodu, že je vztázena ke konodontové zonaci a oproti západoevropské, že umožňuje jemnější členění ve frasu a ve svrchním tournai.

Souběžné studium foraminiferové a konodontové fauny na Moravě umožnilo lépe pochopit některé problematické otázky interregionálních korelací. Ukázalo se, že rody *Tikhinella* a *Multiseptida* považované za indexové frasné formy přežívají v některých facích do spodního famenu. Dalším poznatkem je, že stratigraficky významný druh *Quasiendothyra communis* (Rauser) se vyskytuje na Moravě na rozdíl od západní Evropy v konodontové zóně P. marginifera. Údaje konodontové stratigrafie ukázaly, že zástupci rodu *Quasiendothyra* přežívají na Moravě podobně jako v omolonském a kolymském masívu na Sibiři do spodního tournai a vymírají při hranici spodního a středního tournai. Dospud se předpokládalo, že vymírání quasiendothyry je podobně jako v západní Evropě spojeno s hranicí famenu a tournai. Výsledky na Moravě ukazují, že hranice famenu a tournai approximuje spíše objevení *Tournayellina beata pseudobeata* Reitlinger et Kulagina. Dále údaje z Moravy naznačují, že řada taxonů považovaných ve stratotypové oblasti v dinanském synklinoriu za indexové viséské formy, se může objevovat už ve svrchním tournai, a pozdější výskyt ve stratotypové oblasti je zjavně faciálně ovlivněn.

Když srovnáme evoluci foraminiferových společenstev v jednotlivých paleogeografických oblastech, ukazuje se, že svrchní části stupňů (svrchní frasn, svrchní famen, svrchní tournai, svrchní visé) reprezentují období nejmenší paleobiogeografické diferenciace a spodní části stupňů období největší paleobiogeografické diferenciace uvnitř stupňů. Tento charakteristický rys má svůj dopad na interregionální korelace a odráží pravděpodobně velké klimatické oscilace doprovázené migracemi a v některých případech i evolučními eventy foraminiferové fauny. Diskuse této otázky však již překračuje rámec tohoto příspěvku a bližší údaje o nich mohou být nalezeny v práci Kalvoda (1989a, b).

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PLATE 1

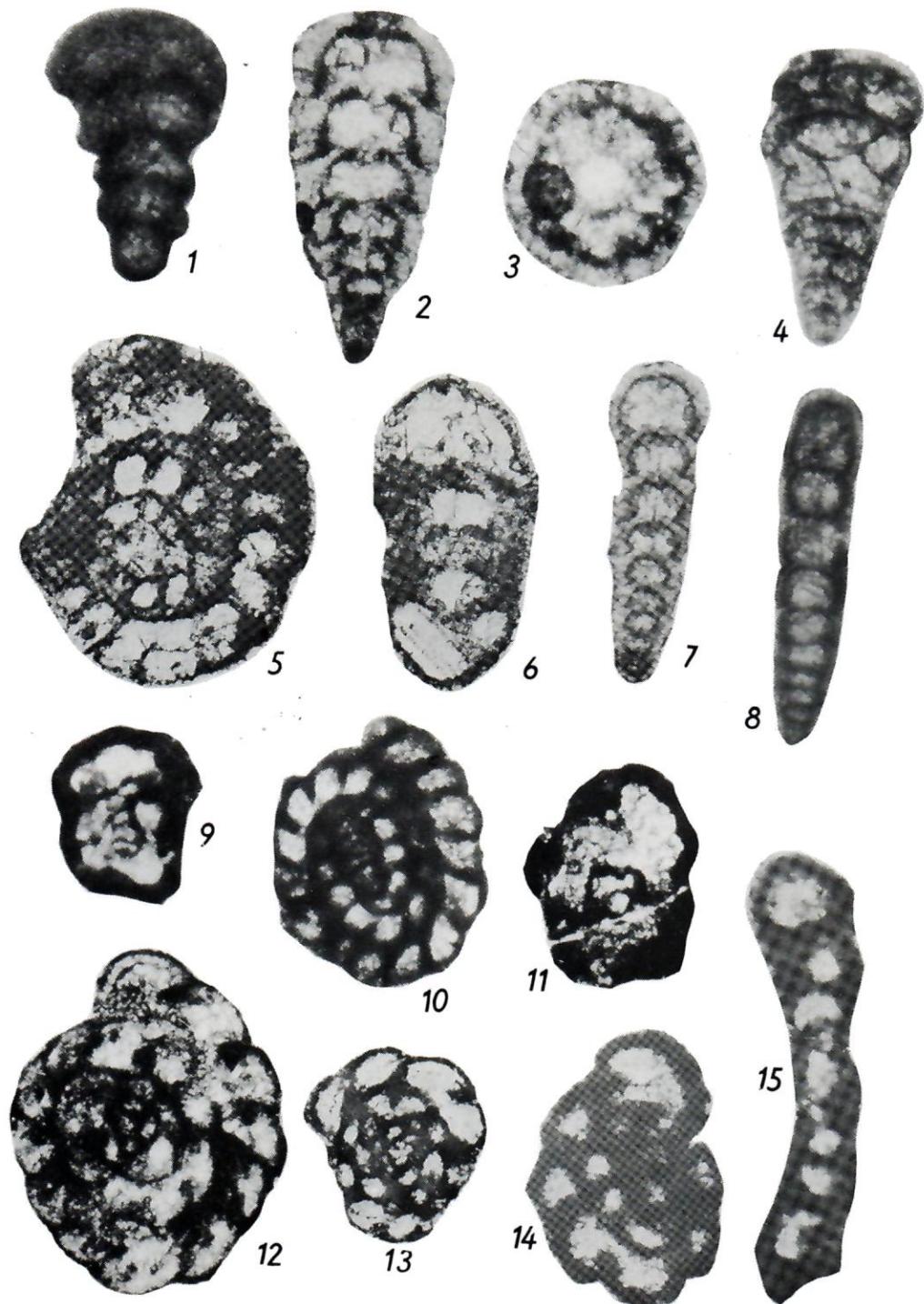


PLATE 2

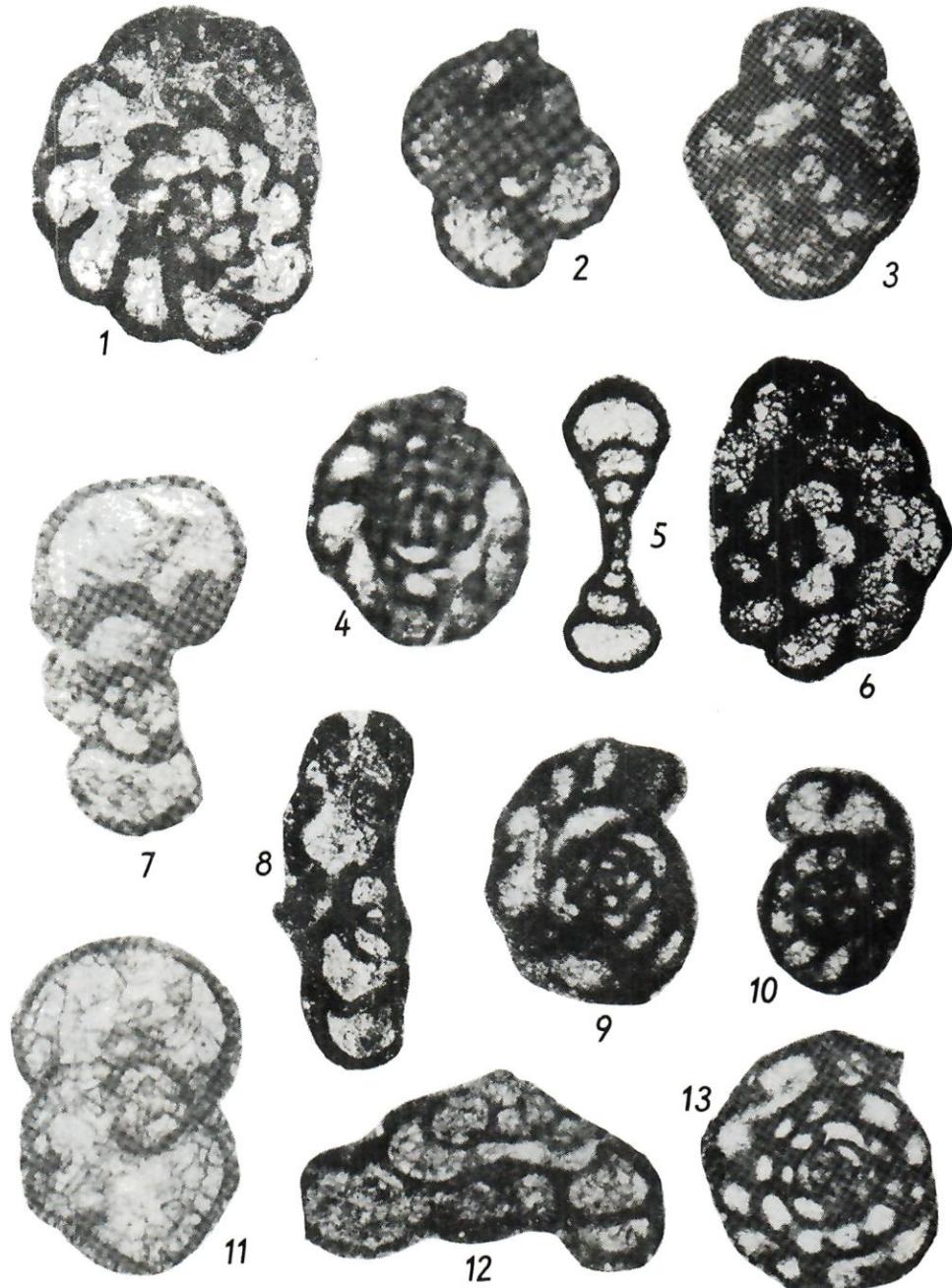
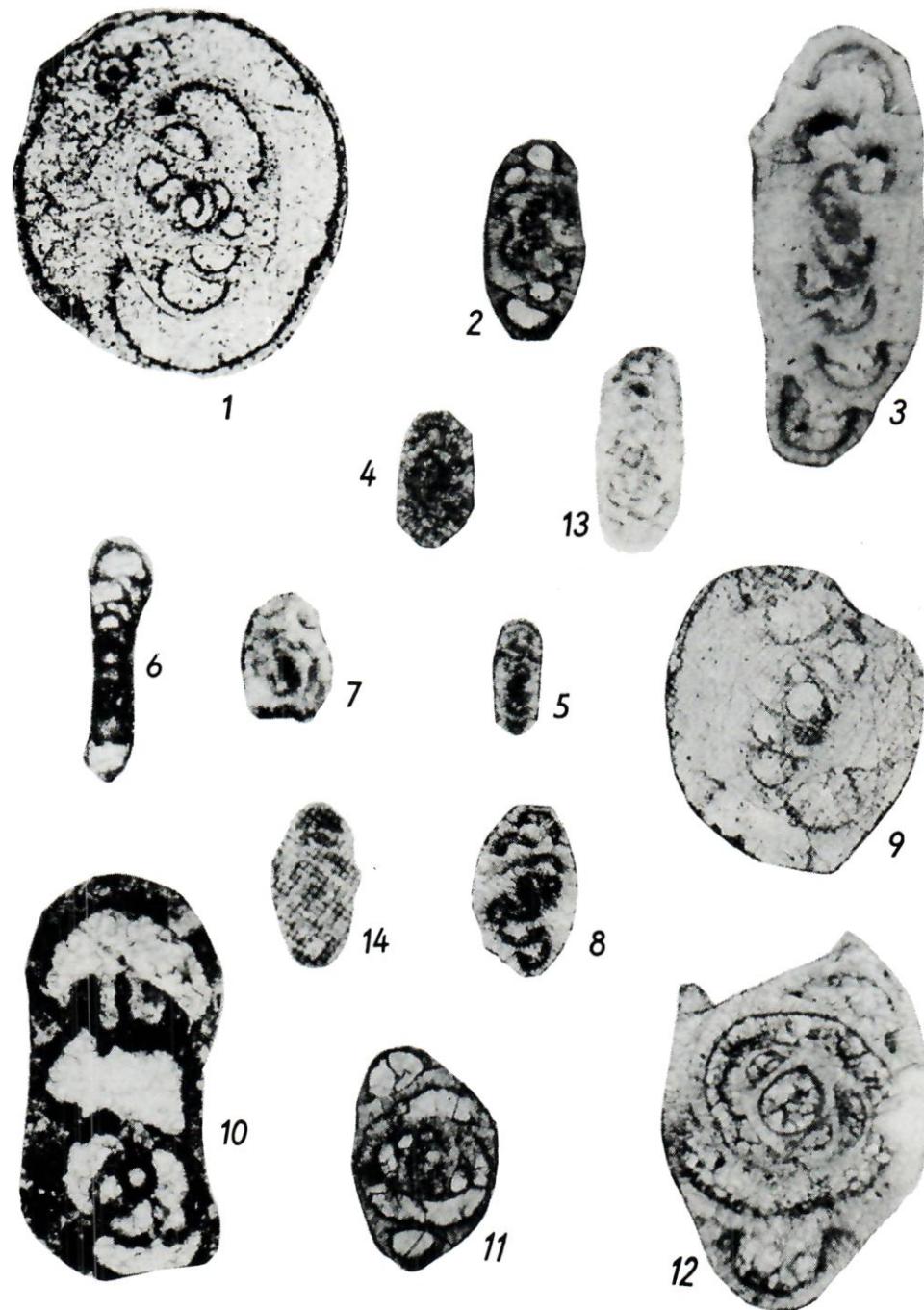


PLATE 3



PLATE 4



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PLATE 1

- Fig. 1. *Frondilina sororis* Bykova, 1952
Borehole Horákov SV 3, 173.2 m, 84 \times . Multiseptida corallina-Eonodosaria evlanensis Zone.
- Fig. 2, 3. *Multiseptida corallina* Bykova, 1952
2 – borehole Horákov SV 1, 318.5 m; 3 – borehole Horákov SV 1, 318.9 m; 80 \times . Multi-septida corallina-Eonodosaria evlanensis Zone.
- Fig. 4. *Eogeinitzina devonica* Lipina, 1950
Borehole Horákov SV 3, 176.8 m, 70 \times . Multiseptida corallina-Eonodosaria evlanensis Zone.
- Fig. 5, 6. *Nanicella porrecta* Bykova, 1952
Borehole Krtiny HV 105, 178.0 m, 75 \times . Multiseptida corallina-Eonodosaria evlanensis Zone.
- Fig. 7. *Eonodosaria stalinogorski* Lipina, 1950
Borehole Janovice 7, 1 110 m, 70 \times . Multiseptida corallina-Eonodosaria evlanensis Zone.
- Fig. 8. *Eonodosaria evlanensis* Lipina, 1950
Borehole Horákov SV 3, 176.8 m, 77 \times . Multiseptida corallina-Eonodosaria evlanensis Zone.
- Fig. 9, 11. *Tournayellina beata pseudobeata* Reitlinger et Kulagina, 1987
Lesní lom Quarry, Brno-Líšeň, bed 239, 60 \times . Quasiendothyra kobeitusana-Quasiendo-thyra konensis Zone.
- Fig. 10. *Quasiendothyra kobeitusana* (Rauser, 1948)
Lesní lom Quarry, Brno-Líšeň, bed 219, 50 \times . Quasiendothyra kobeitusana-Quasiendo-thyra konensis Zone.
- Fig. 12. *Quasiendothyra konensis* (Lebedeva, 1956)
Lesní lom Quarry, Brno-Líšeň, bed 240, 70 \times . Quasiendothyra kobeitusana-Quasiendo-thyra konensis Zone.
- Fig. 13. *Quasiendothyra communis* (Rauser, 1948)
Brno-Líšeň, doc. point M. b. 6, 50 \times . Quasiendothyra kobeitusana-Quasiendothyra konen-sis Zone.
- Fig. 14. *Quasiendothyra communis* (Rauser, 1948)
Borehole Těšany 1, bore core No 22, 80 \times . Quasiendothyra kobeitusana-Quasiendothyra regularis Zone.
- Fig. 15. *Septatournayella rauserae* Lipina, 1955
Borehole Žarošice 1, bore core No 59, 115 \times . Quasiendothyra kobeitusana-Quasiendothy-ra regularis Zone.

PLATE 2

- Fig. 1, 6. *Paraendothyra nalivkini* Chernysheva, 1940
1 – borehole Mokrá V 49, 204 m, 40 \times ; 6 – borehole Mokrá S 1, 80.5 m, 50 \times . Paraendo-thyra Zone.
- Fig. 2. *Chernyshinella glomiformis* (Lipina, 1948)
Borehole Mokrá S 2, 89.0 m, 70 \times . Chernyshinella glomiformis Zone.
- Fig. 3. *Chernyshinella tumulosa* Lipina, 1955
Hostěnice, doc. point Ho 44A, 70 \times . Chernyshinella tumulosa-Spinobrunsiina Zone.
- Fig. 4, 9. *Dainella chomatica* Dain, in Brazhnikova, 1962
4 – borehole Mokrá S 1, 58.0 m; 50 \times ; 9 – borehole Mokrá S 2, 121.5 m, 50 \times . Tetrataxis-Eoparastaffella simplex Zone.
- Fig. 5. *Tournayella discoidea* Dain, 1953
Borehole Mokrá S 1, 80.5 m, 45 \times . Paraendothyra Zone.
- Fig. 7. *Paraendothyra* sp.
Hostěnice, doc. point Ho 44B, 56 \times . Paraendothyra Zone.

- Fig. 8. *Pseudolituotubella* sp.
Borehole Mokrá MV 274, 14.3 m, 56×. Tetrataxis-Eoparastaffella simplex Zone.
- Fig. 10. *Eoparastaffella simplex* V do v e n k o , 1954
Borehole Mokrá S 2, 101.2 m, 52×. Tetrataxis-Eoparastaffella simplex Zone.
- Fig. 11. *Tournayellina septata* Lip i n a , 1955
Hostěnice, doc. point Ho 44A, 70×. Chernyshinella tumulosa-Spinobrunsiina Zone.
- Fig. 12. *Tetrataxis* sp.
Borehole Mokrá MV 274, 14.3 m, 70×. Tetrataxis-Eoparastaffella simplex Zone.
- Fig. 13. *Spinoendothyra recta* (Lip i n a , 1955)
Borehole Mokrá MV 274, 14.3 m, 45×. Tetrataxis-Eoparastaffella simplex Zone.

PLATE 3

- Fig. 1. *Koskinobigenerina* sp.
Borehole Uhřice 7, bore core No 9, 70×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 2. *Glomodiscus* sp.
Borehole Uhřice 7, bore core No 9, 100×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 3. *Dainella* ex gr. *tuimasensis* (Vissari on ova , 1948)
Borehole Uhřice 7, bore core No 9, 65×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 4. *Endothyranopsis compressus* (Rauser et Reitlinger , 1936)
Borehole Nítkovice 7, bore core No 1, 85×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 5, 9. *Pojarkovella nibelis* (Durk i n a , 1959)
5 – borehole Uhřice 10, bore core No 15, 68×; 9 – borehole Uhřice 10, bore core No 15, 100×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 6. *Spinobrunsiina* sp.
Borehole Uhřice 9, bore core No 9, 110×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 7. *Koskinotextularia* sp.
Borehole Uhřice 9, bore core No 9, 70×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 8. *Klubonibelia* sp.
Borehole Uhřice 14, bore core No 9, 70×. Pojarkovella nibelis-Koskinotextularia Zone.
- Fig. 10. *Nodosarchaediscus* sp.
Borehole Nítkovice 7, bore core No 1, 70×. Pojarkovella nibelis-Koskinotextularia Zone.

PLATE 4

- Fig. 1. *Archaeodiscus karreri* Br a d y , 1873
Borehole Uhřice 10, core No 13, 63×. Neoarchaediscus Zone.
- Fig. 2, 8. *Neoarchaediscus* sp.
2 – borehole Choryně 9, 774.3 m, 85×; 8 – borehole Choryně 9, 749.4 m, 85×. Neoarchaediscus Zone.
- Fig. 3. *Nodosarchaediscus* sp.
Borehole Ostravice NP 824, 1788.4 m, 125×. Asteroarchaediscus-Loeblichia paraammonoides Zone.
- Fig. 4, 5, 7. *Asteroarchaediscus* sp.
4, 5 – borehole Hnojník 1, 1106.0 m, 63×. 7 – borehole Žukov NP 339, 1788.3 m, 63×. Asteroarchaediscus-Loeblichia paraammonoides Zone.
- Fig. 6. *Loeblichia paraammonoides* (Br a z h n i k o v a , 1956)
Borehole Kozlovice SV 1, 1981.1 m, 70×. Asteroarchaediscus-Loeblichia paraammonoides Zone.
- Fig. 9, 12. *Archaeodiscus* sp.
Borehole Ostravice NP 824, 1788.5 m, 105×. Asteroarchaediscus-Loeblichia paraammonoides Zone.
- Fig. 10. *Nevillea* sp.
Borehole Choryně 9, 768.0 m, 70×. Neoarchaediscus Zone.
- Fig. 11. *Archaeodiscus* sp.
Borehole Choryně 9, 759.4 m, 84×. Neoarchaediscus Zone.
- Fig. 13, 14. *Neoarchaediscus* sp.
Borehole Ostravice NP 824, 1788.4 m, 105×. Asteroarchaediscus-Loeblichia paraammonoides Zone.