Organic walled microfossils of the Barrandian area: a review

Mikrofosilie s organickou stěnou v barrandienské oblasti: souhrn (Czech summary)

(*6 text-figs.*)

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The present contribution compiles all bibliographical references concerning Acritarcha, Prasinophyta, Mazuelloida, Chitinozoa, Spores, and Cyanobacteria described in the Proterozoic, Cambrian, Ordovician, Silurian, and Devonian sediments of the Barrandian area. More than 130 references include books, publications in journals, abstracts from international and national conferences. The survey of literature resulted into compilation of five tables where separate papers dealing with the above mentioned groups are graphically related to the studied stratigraphical intervals.

Key words: Bohemia, Barrandian area, Proterozoic, Cambrian, Ordovician, Silurian, Devonian, organic-walled microfossils

Introduction

Microfossil groups embraced recently under the term OWM (= Organic Walled Microfossils) were generally unknown in the last century and thus no specimen of the groups Acritarcha, Prasinophyta, Mazuelloida, Chitinozoa, Spores, and/or Cyanobacteria has been studied by J. Barrande from the rocks of his "Systême silurien de centre de la Bohême".

Our recent knowledge on micropalaeontological content of rocks of the Barrandian area differs strikingly from that of the Barrande's time. OWM are documented from the Proterozoic, Cambrian, Ordovician and Devonian sediments. Shorter or longer papers describing OWM of the Barrandian area encompass more than 130 in number, being dispersed in different symposia proceedings, conference abstracts, journals and books. To have a complete overview on all data is not easy even for specialists and thus this contribution to the J. Barrande Volume was compiled. It has three main goals:

1. to compile the existing references,
2. to summarize up to now accessible data on the OWM and,
3. to plot them in tables and to evaluate them shortly from the stratigraphical point of view.

Proterozoic

Proterozoic OWM are classified as belonging to Acritarcha, Cyanobacteria and/or supposedly algae. They have been reported from all lithostratigraphical units in the Barrandian area, being interpreted as late Riphean to Vendian in age.

The first record of Proterozoic microfossils was published by Rodic (1925) who studied samples from the vicinity of Prague. The observed bodies were assigned to radiolaria because of their peculiar morphology. From that time data on OWM assemblages are published in about fourty of papers.

Small to middle-sized, solitary or "colonial" sphaeres, usually 5 to 30 mm in diameter, represent the most common morphology. They are assigned to different taxa: *Nevidia* Vavrdová 1968, *Chabiosphaera* Drábek 1972, *Palaeocryptidium* Deflandre 1955, *Favososphaera* Burmann 1972, *Sphaerocongregus* Moorman 1974, and/or simply designated as "sphaerical microfossils". Filaments of supposed cyanobacterial origin, generally classified as diferent species of the genus *Siphonophycus* Schopf 1968, emend. Knoll, Swett et Mark 1991, are commonly reported from the silicified lithotypes. Occurrence of "vase-shaped" microfossils, similar to the genus *Melanocyrillium* Bloeser 1985, as well as finds of the genera *Podolina* German in Timofeev et al. 1976, *Buedingiisphaeridium* Schaarschmidt 1963, *Octaedrixium* Rudavskaya 1973, *Baltisphaeridium* Eisenack 1958 *ex* Eisenack 1959, emend. Eiserhardt 1989, and *Annulum* Martin 1983 (reported as *Granomarginata* Volkova 1968) are rare. As very rare finds the following microfossils were reported: 1. algal colony cf. *Botryococcaceae* (Konzalová, 1973), 2. acanthomorph acritarcha, 3. colonial rock-forming microfossils classified as *Bohemipora pragensis* Pacltová 1977, 4. structurally preserved metaphyta in contact metamorphosed anthraxolite (Pacltová 1990).

Cambrian

There are only two levels contaning the OWM in the Cambrian rocks of the Barrandiana area. The older occurrence is related to the Lower Cambrian Paseky Shale Member of the Holšiny–Hořice Formation in the Příbram–Jince Basin. The second level is represented by the Middle Cambrian Jince Formation of both the Příbram–Jince Basin and the Skryje–Týřovice area.

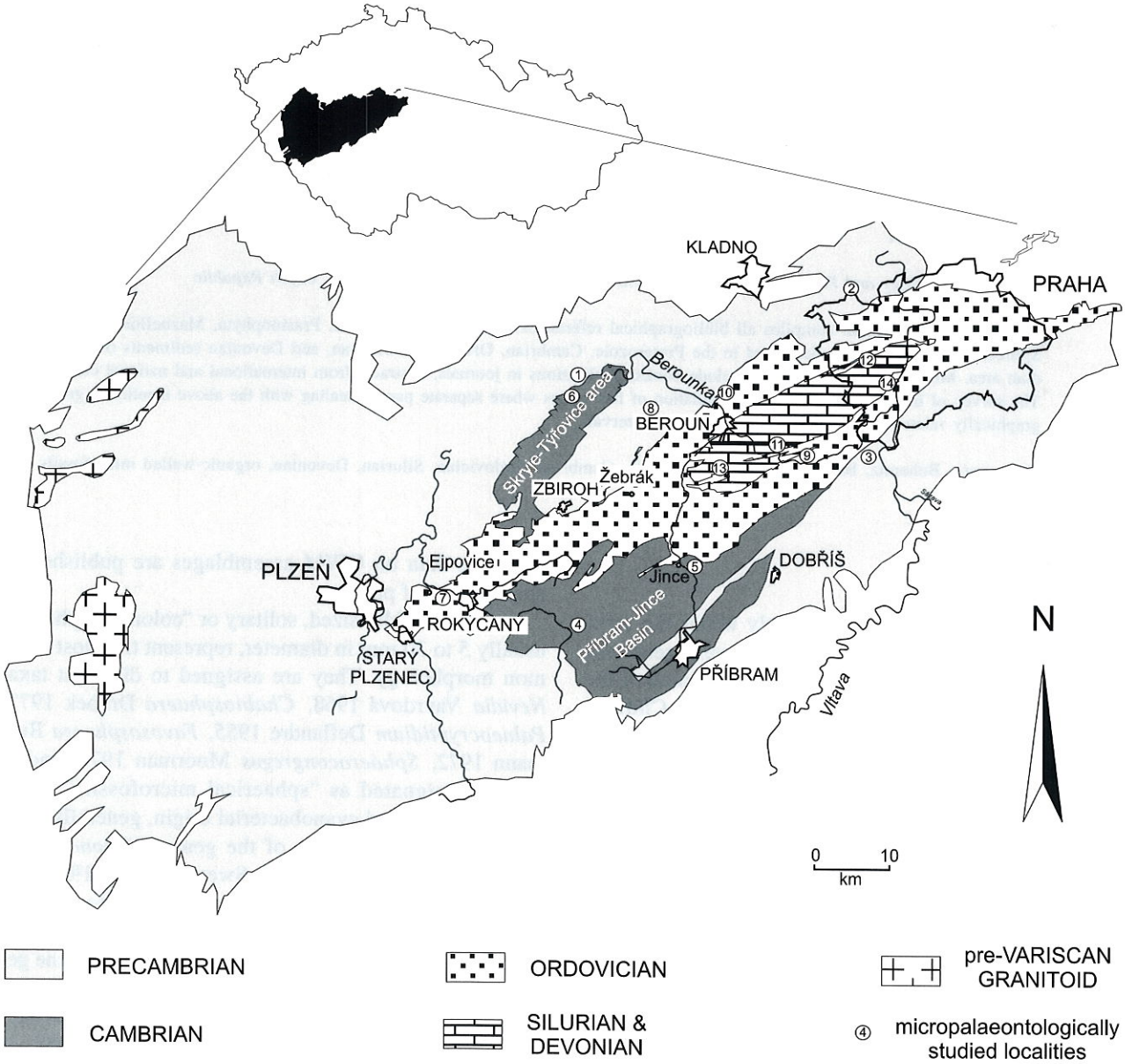


Fig. 1. Sketch map of the Barrandian area.
1 – Čertova skála (Precambrian, Kralupy–Zbraslav Group); 2 – Šárka (Precambrian, Blovice Formation); 3 – Vrané dam (Precambrian, Blovice Formation); 4 – Kočka (Lower Cambrian, Paseky Shale Member); 5 – Jince-Vinice (Middle Cambrian, Jince Formation); 6 – Skryje-Luh (Middle Cambrian, Jince Formation); 7 – Klabava-Starý hrad, Ejpovice, Drahouš (Lower and Middle Ordovician, Klabava and Šárka Formations); 8 – Krušná hora (Middle Ordovician, Šárka Formation); 9 – Hlásná Třebaň (Upper Ordovician, Kosov Formation); 10 – Hýskov (Lower Silurian, Želkovice Member); 11 – Klučice (Lower Silurian, Motol Member); 12 – Požáry (Upper Silurian, Požáry Formation); 13 – Klonk near Suchomasty (Silurian–Devonian boundary, Přídolí Formation – Dvorce–Prokop Limestone); 14 – U kapličky (Lower Devonian, Zlíchov Formation).

Filamentous tubular bodies of probable cyanophyte origin (*Siphonophycus*, *Polytrichoides* Hermann 1974, emend. Hermann 1976 in Timofeev et al. 1976, and several other genera) and common sphaeromorphic specimens of the genus *Leiosphaeridia* Eisenack 1958, emend. Downie et Sarjeant 1963 prevail in the Paseky Shale Member, being associated with the exceptional *Kodymirus* assemblage (Chlupáč et al. 1996). Finds of acritarchs are rare but presence of the genera *Skiagia* Downie 1981, *Volkovia* Downie 1981, *Alliumella* Umnova et Vanderflit 1971 the chronostratigraphical assignment to the higher part of the Lower Cambrian make possible (Fatka – Konzalová 1995). Micropalaeontological study of well preserved carbonaceous mega-alga *Marpolia* Walcott 1919 from the Paseky Shale prooved that different parts of this megafossil contain several "part-based" microfossil species and genera (Steiner – Fatka 1996).

Middle Cambrian Acritarcha of the Jince Formation are typified by common occurrence of the genera *Eliasum* Fombella 1977, *Cristallinium* Vanguestaine 1978, *Timofeevia* Vanguestaine 1978, and *Adara* Fombella 1977. The best diversified assemblage of moderate to good preservation was ascertained in the lower part of the *Onymagnostus hybridus* Zone of the Příbram–Jince Ba-

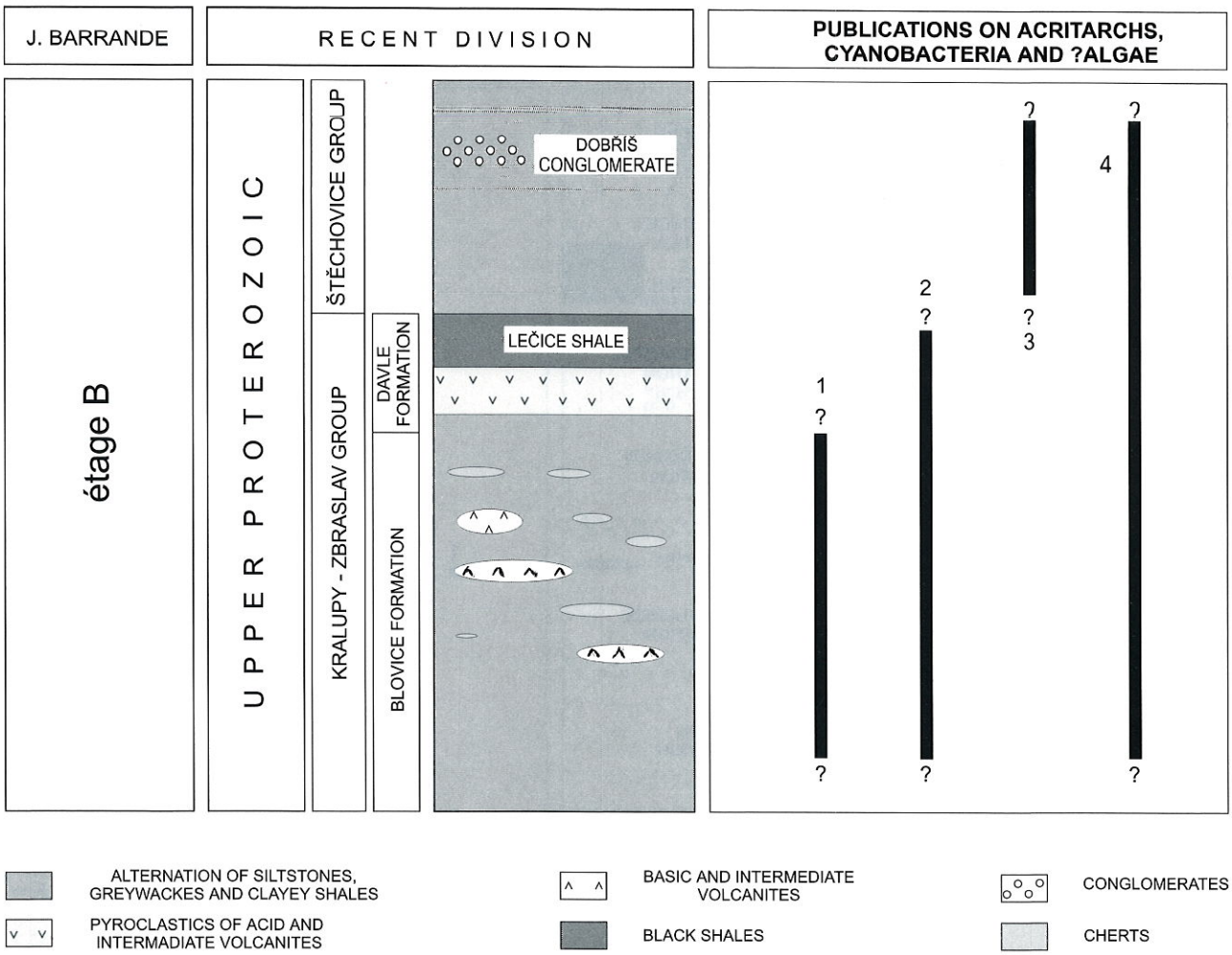


Fig. 2. Stratigraphy of the Precambrian.
1 – Rodic (1925, 1932), Čorná (1969), Pacltová (1970, 1976b, 1977a, 1990a,b, 1992, 1997), Drábek (1972), Fatka – Gabriel (1991); 2 – Ciniburk (1962), Konzalová (1972), Vavrdová – Mrázek (1991), Vavrdová (1994, 1999); 3 – Konzalová (1973, 1974a); 4 – Konzalová (1981, 1988, 1997).

sin. Because of comparatively rapid sedimentation in other levels of the Jince Formation, acritarcha are poorly diversified and also the state of preservation is poor to moderate (Slavíková 1968, Vavrdová 1982, Fatka 1989).

In the Skryje–Týřovice area, the heating associated with volcanic activity of the Křivoklát–Rokycany Volcanic Complex (Upper Cambrian to Lower Ordovician) influenced organic matter and thus our knowledge of acritarch assemblages suffers by comparatively poor state of preservation. Presence of the genera *Eliasum*, *Cristallinium* and *Timofeevia* is documented (Vavrdová 1976, Chlupáč et al. 1998).

Middle Cambrian acritarch assemblages of both Příbram–Jince Basin and the Skryje–Týřovice area fit well with the *C. cambriense – Eliasum/Timofeevia* Zone of Vanguestaine and van Looy (1983).

Ordovician

OWM are missing in the lowermost Ordovician and/or are poorly preserved in higher parts of the Middle and in the Upper Ordovician because of unfavourable lithological character of sediments. Starting with the Arenigian Stage, well diversified acritarch and chitinozoan assemblages are documented. In several levels they are accompanied by cryptospores.

Acritarcha. Arenigian to early Darriwillian Klabava Formation is typified by very well diversified acritarch assemblages of moderate to very good preservation associated with generally common chitinozoa. The following acritarch genera are more or less gradually appearing within the Klabava Formation – *Cymatiogalea* Deunff 1961, *Stelliferidium* Deunff et al. 1974, *Stellechinatum* Turner 1984, *Pirea* Vavrdová 1972, *Polygonium* Vavrdová 1966, *Rhopaliophora* Tappan et Loeblich 1971, *Veryhachium* Deunff 1954, emend. Downie et Sarjeant 1963, *Baltisphaeridium*, *Striatotheca* Burmann 1970, *Vavrdovella* Loeblich et Tappan 1976, *Coryphidium* Vavrdová 1972, *Peteinosphaeridium* Staplin et al. 1965, *Aureotesta* Vavrdová 1972, *Arbusculidium* Deunff 1968, *Nothoidium* Loeblich et Tappan 1976, *Frankea* Burmann 1970, emend. Eisenack et al. 1976, *Dicrodiacrodium* Burmann 1968 (e.g. Vavrdová 1993, Fatka 1993).

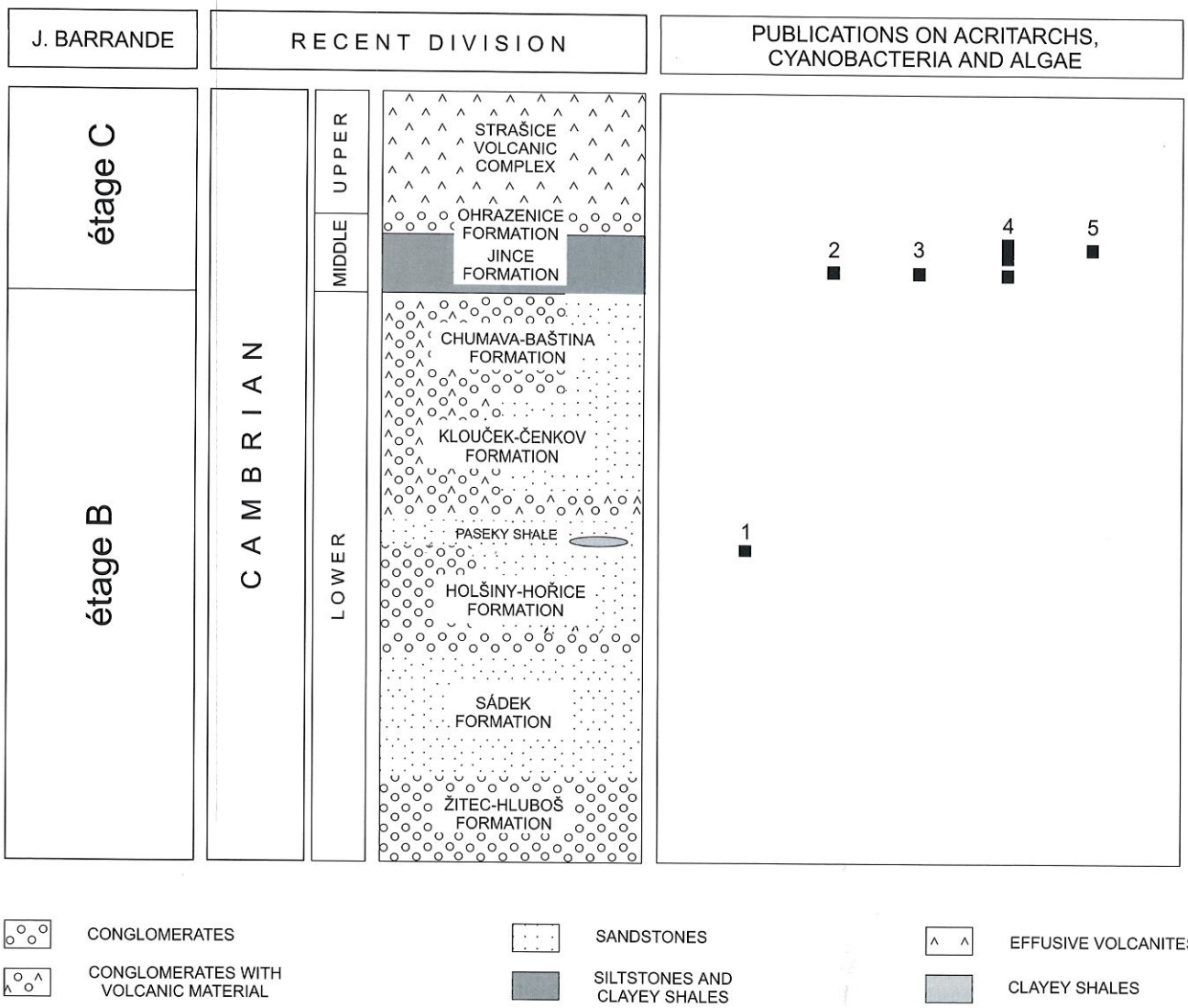
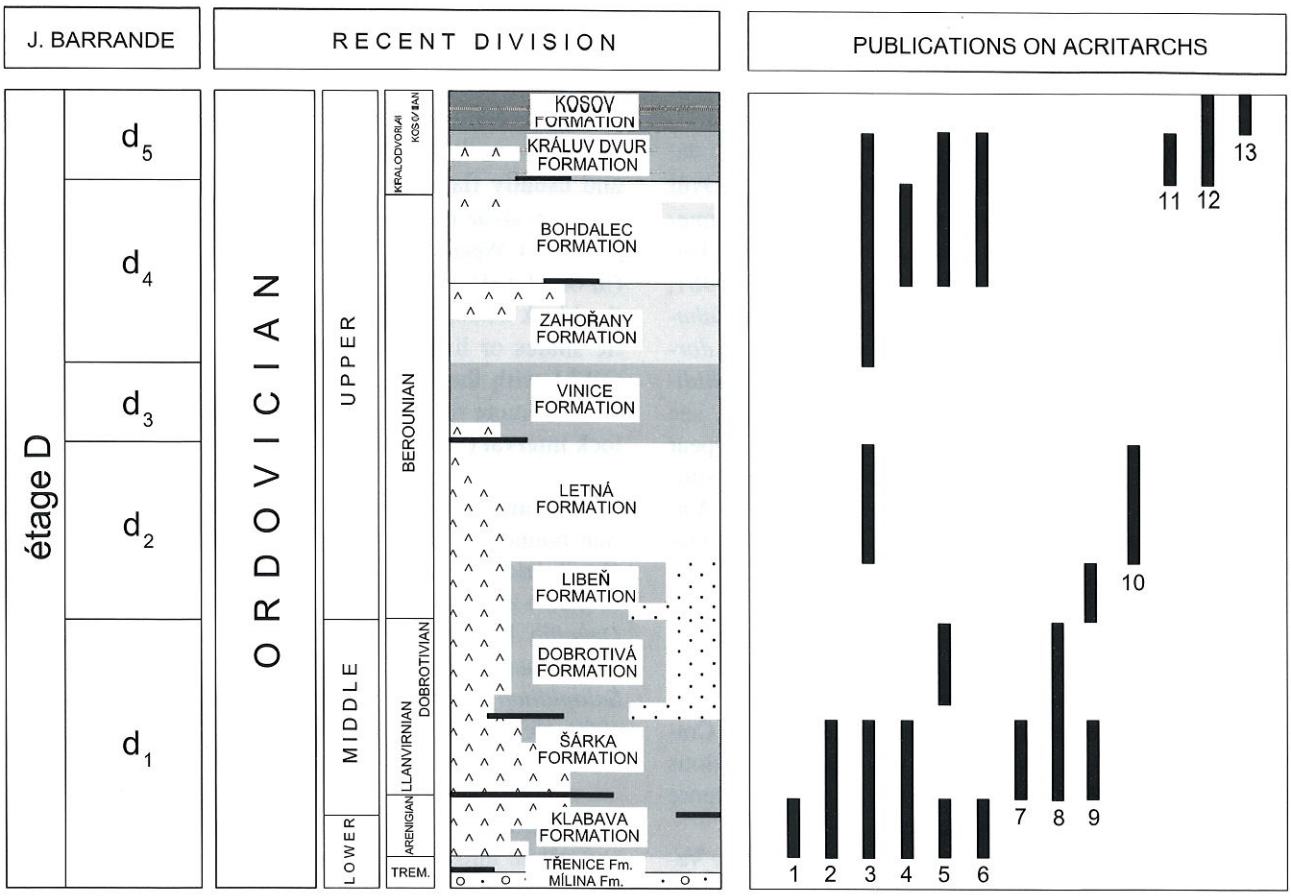


Fig. 3. Stratigraphy of the Cambrian System.
1 – Fatka – Konzalová (1993, 1995), Konzalová – Fatka (1995), Steiner – Fatka (1996), Konzalová (1997); 2 – Vavrdová (1966, 1976, 1978, 1982a), Konzalová (1974), Chlupáč et al. (1998); 3 – Fatka (1989); 4 – Vavrdová (1976, 1982a); 5 – Slavíková (1968).
1, 3, 4, 5 – Příbram–Jince Basin; 2 – Skryje–Týřovice area.

The number of specimens and also the diversity of acritarch assemblages are suddenly reduced with the onset of black-shale sedimentation near the base of the Šárka Formation. In the Barrandian area several genera appear for the first time: *Adorfia* Burmann 1970, *Arkonia* Burmann 1970, *Ferromia* Vavrdová 1978, *Glaukotesta* Vavrdová 1982, *Ordovicidium* Tappan et Loeblich 1971, *Sylvanidium* Loeblich 1970.

The content of organic matter in Middle and Upper Ordovician sediments is generally low and the analysed samples contain only rare acritarcha of the genera *Cheleutochroa* Loeblich et Tappan 1978, *Orthosphaeridium*

Fig. 4. Stratigraphy of the Ordovician System. ⇨
Acritarcha
1 – Vavrdová (1972, 1973, 1974, 1993), Fatka (1991a, 1992b, 1993), Brocke et al. 1998, Brocke – Fatka (1999); 2 – Vavrdová (1976, 1977, 1978, 1990a 1997), Fatka et al. (1994, 1996), Brocke et al. (1995), Fatka et al. (1996, 1997a,b), Servais – Fatka (1996a,b, 1997), Brocke et al. (1998); 3 – Vavrdová (1986); 4 – Vavrdová (1982a); 5 – Vavrdová (1966); 6 – Vavrdová (1965); 7 – Čorná (1970), Servais – Brocke – Fatka (1994a,b, 1996); 8 – Eisenack (1948); 9 – Vavrdová (1995); 10 – Čorná (1969); 11 – Konzalová-Mazancová (1969); 12 – Fatka (1990), Dufka – Fatka (1991, 1993); 13 – Vavrdová (1982a, 1984b, 1988, 1989a), Dufka (1990).
Chitinozoa
14 – Fatka (1991a, 1993); 15 – Paris – Mergl (1984); 16 – Fatka – Kraft, J. – Kraft, P. (1994, 1996); 17 – Eisenack (1948); 18 – Fatka – Kraft, J. – Kraft, P. (1997, 1998); 19 – Dufka – Fatka (1991, 1993).
Spores
20 – Vavrdová (1990a); 21 – Vavrdová (1982, 1984a,b, 1988, 1989a), Martin (1984), Gray (1988); 22 – Čorná (1970).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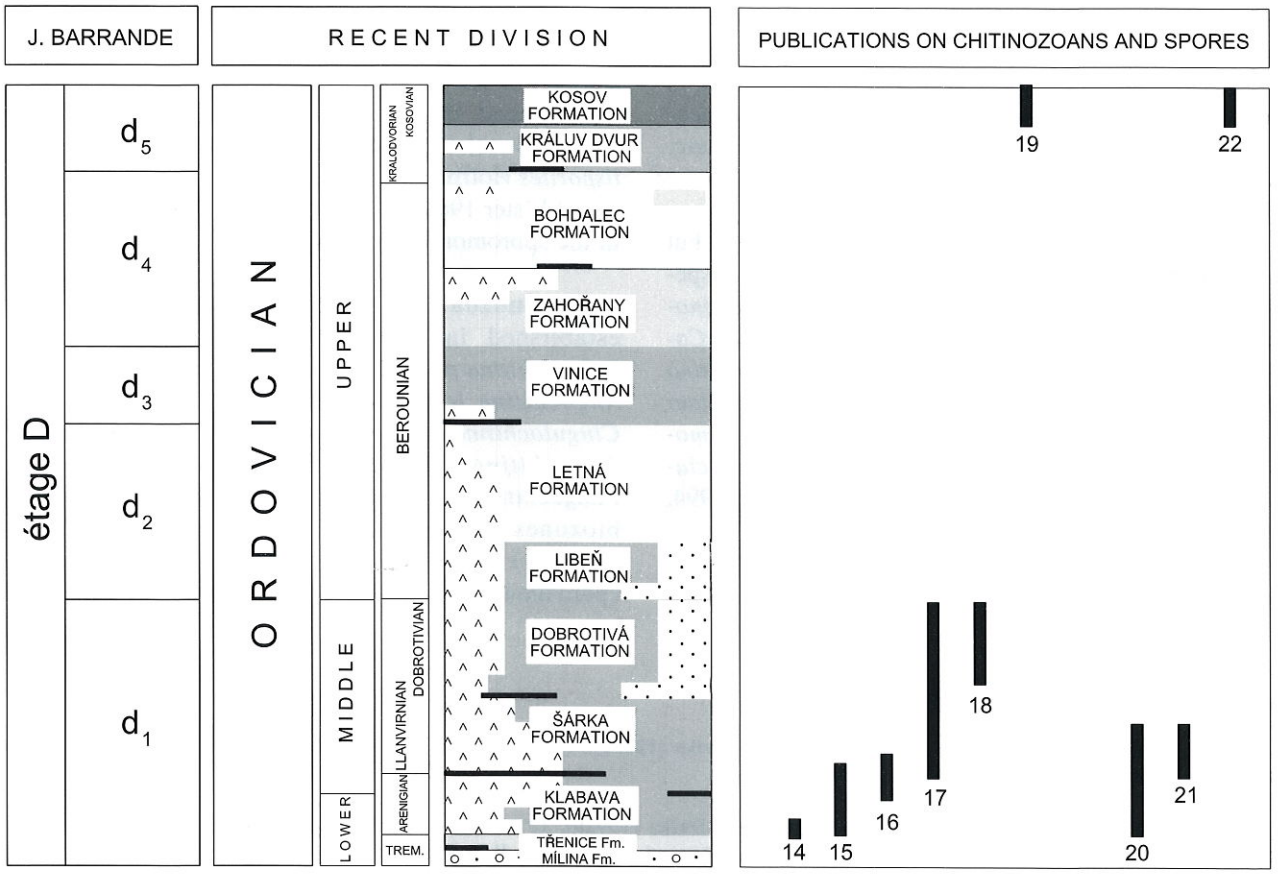
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QUARTZITES
VOLCANIC PRODUCTS
CLAYEY AND SILTY SHALES
ALTERNATING GREYWACKES, QUARTZITES, SILTSTONES AND CLAYEY SHALES

Eisenack 1968, emend. Kjellström 1971, emend. Turner 1984, *Villosacapsulla* Loeblich et Tappan 1976, *Neoveryhachium* Cramer 1970, *Asketopalla* Loeblich et Tappan 1969 (see Vavrdová 1986).

In the Ashgillian moderately preserved acritarch assemblages were studied in samples from the Králův Dvůr and Kosov Formations. In the Kosov Formation, numerous redeposited acritarch taxa were established (e.g. *Volkovia* Downie 1981, *Archaeodiscina* Naumova 1961, emend. Volkova 1968, *Adara*, *Eliasum*, *Timofeevia*, *Saharidia* Combaz 1967, *Vulcanisphaera* Deunff 1961, *Adorfia* Burmann 1970, *Arkonia* Burmann 1970, *Coryphidium* Vavrdová 1972, *Frankea*, *Stelliferidium*, etc., see Vavrdová 1988, 1989). Several acritarch genera appear in the Upper Ordovician and cross the Ordovician–Silurian boundary (e.g. *Diexallophasis* Loeblich 1970, *Ammonidium* Lister 1970, *Tylotopalla* Loeblich 1970, *Oppilatala* Loeblich et Wicander 1976, etc., see Dufka – Fatka 1993).

Cryptospores. Morphology of the genera *Attritasporites* Combaz 1967 and *Virgatasporites* Combaz 1967 associated with the "coenobial acritarch" *Ericanthea* Cramer et Diez 1977 in the Klabava and Šárka formations (see Vavrdová 1990a) fits well with the precryptospore phase in the sporomorph evolution.

Llanvirnian (early Darriwillian) dyad, reported by Vavrdová (1990a) from the Šárka Formation, represents the oldest report of permanent dyad and could be interpreted as beginning of the cryptospore phase in the sporomorph evolution. This phase is very well documented in the latest Ordovician Kosov Formation, where *Archaeozonotriletes*, *Nodospora*, *Rugospora*, *Tedraletes*, etc. commonly occur (see Vavrdová 1988, 1989).

Chitinozoa. The chitinozoa are usually flattened but well determinable. The following chitinozoan index species are established in the Klabava Formation: *Lagenochitina* cf. *destombesi*, *Amphorachitina conifundus*, *Conochitina symmetrica*, *Eremochitina* sp., *Desmochitina bulla*, *Cyathochitina calix*, *Cyathochitina campanulaeformis*, *Siphonochitina formosa*, *Armoricochitina armoricana*, *Linochitina pissotensis* and *Laufeldochitina clavata* (see Paris – Mergl 1984, Fatka – Kraft – Kraft 1994, 1997, in press).

The chitinozoan taxa are fitting well the peri-Gondwanan biozones of Paris (1990).

Silurian

Samples of Llandovery and Wenlock black graptolitic shales are dominated by common particles of amorphous kerogen, poorly preserved prasinophycean-like sphaeres and usually flattened Chitinozoa. Acritarcha, prasinophycean algae (*Tasmanites* Newton 1875 and *Cymatiosphaera* O. Wetzel 1933 ex. Deflandre 1954), mazuelloids (in one level) occur in pale claystone interlayers within the black shale, benthic fauna free sequence or in tuffitic shales or limestones with abundant benthic fauna. OWM with the exception of Chitinozan, were studied from no more than six levels of the Llandovery and Wenlock interval (see Dufka 1992).

Acritarcha. Several genera cross the Ordovician–Silurian boundary: *Diexallophasis*, *Multiplicisphaeridium*, *Oppilatala*, *Tylotopalla*, while other taxa appear for the first time in the Lower Silurian (*Ammonidium* Lister 1970, *Deunffia* Downie 1960, *Domasia* Downie 1960, *Helosphaeridium* Lister 1970, *Piliferosphaera* Loeblich 1970, *Salopidium* Dorning 1981, *Tectonosphaeridium* Dufka 1990, etc.) There are no data on Acritarcha of the Ludlow and Přídolí.

Cryptospores and miospores. Dirpersed cryptospores and trilete miospores of the only one level *Artemopyra brevicosta–Hispanaediscus verrucatus* Assemblage Zone were established by Dufka (1995a) in the upper Wenlock. Occurrence of the following genera – *Artemopyra* Burgess et Richardson 1991, *Hispanaediscus* Cramer 1966, emend. Burgess et Richardson 1991, *Apiculiretusispora* Streel 1964, *Rugosisporites* Dufka 1995, *Ambitisporites* Hoffmeister 1959, and *Synorisporites* Richardson et Lister 1969 is indicative for the miospore phase 4 in the sporomorph evolution.

Chitinozoa. The following index species were established in sequence: *Spinachitina fragilis*, *Belonechitina postrobusta*, *Eisenachitina dolioliformis*, *Angochitina longicolis*, *Margachitina margaritana*, *Cingulochitina cingulata*, *Conochitina pachycephala*, *Angochitina elongata*, *Belonechitina barrandei*, *Fungochitina kosovensis*. Index species of the other two biozones (*Margachitina elegans* and *Anthochitina superba*) were not established but presence of eponymous biozones is supposed, based on presence of

Fig. 5. Stratigraphy of the Silurian System. ⇨

Acritarcha

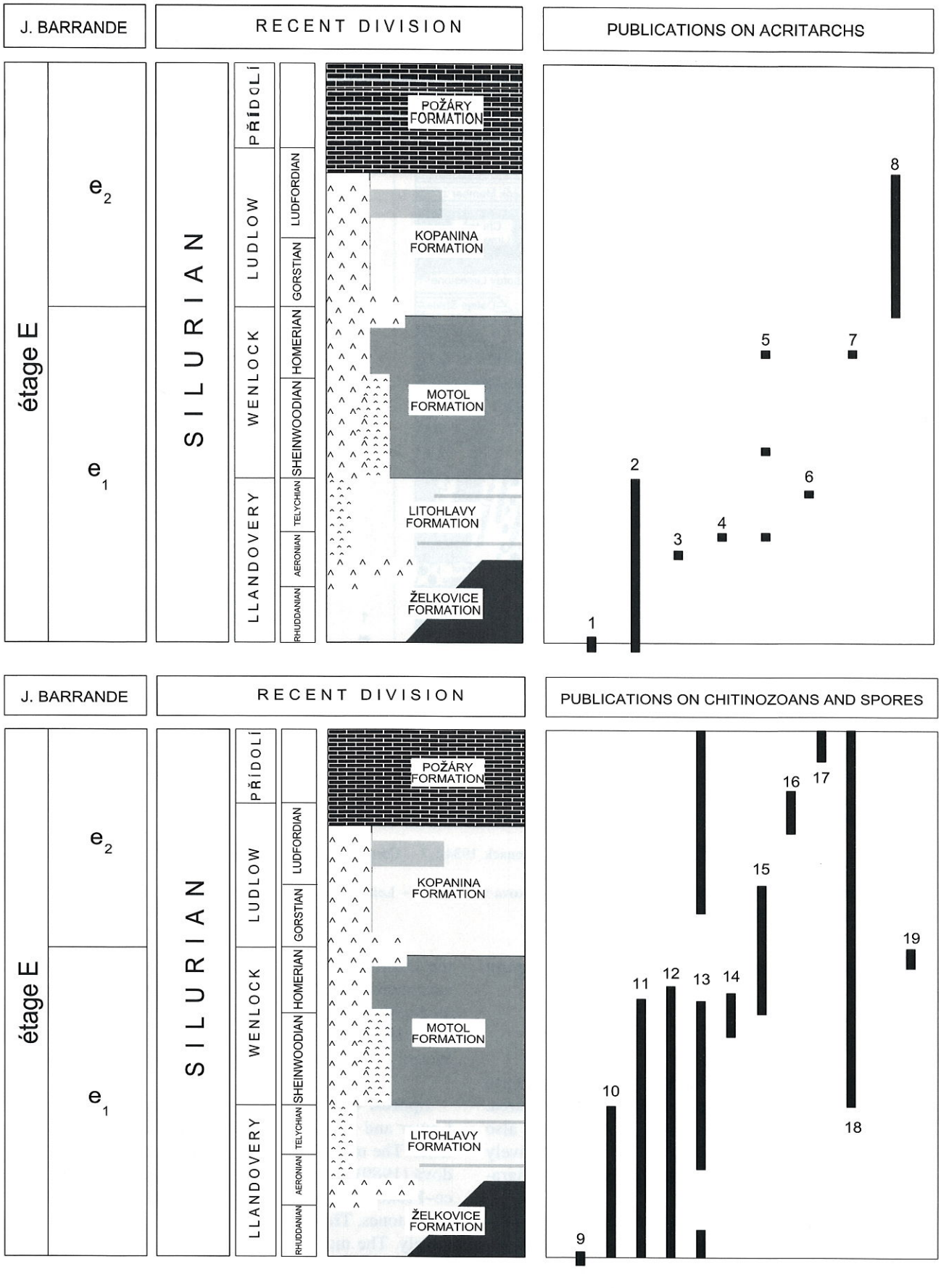
1 – Dufka – Fatka (1991, 1993); 2 – Dufka (1990b); 3 – Dufka (1990a); 4 – Dufka (1992); 5 – Dufka (1991b); 6 – Dufka – Pacltová (1988); 7 – Dufka (1991a); 8 – Eisenack (1934).

Chitinozoa

9 – Dufka – Fatka (1991, 1993), 10 – Dufka (1989), 11 – Dufka (1992b), 12 – Dufka – Kříž – Štorch (1995), 13 – Verniers et al. (1996), 14 – Dufka (1995b), 15 – Kříž – Dufka – Jaeger – Schönlaub (1993), 16 – Paris – Kříž (1984), Kříž – Jaeger – Paris – Schönlaub (1986), 17 – Paris – Laufeld – Chlupáč (1981), 18 – Eisenack (1934).

Spores

19 – Dufka (1995a), Kříž – Dufka – Jaeger – Schönlaub (1993).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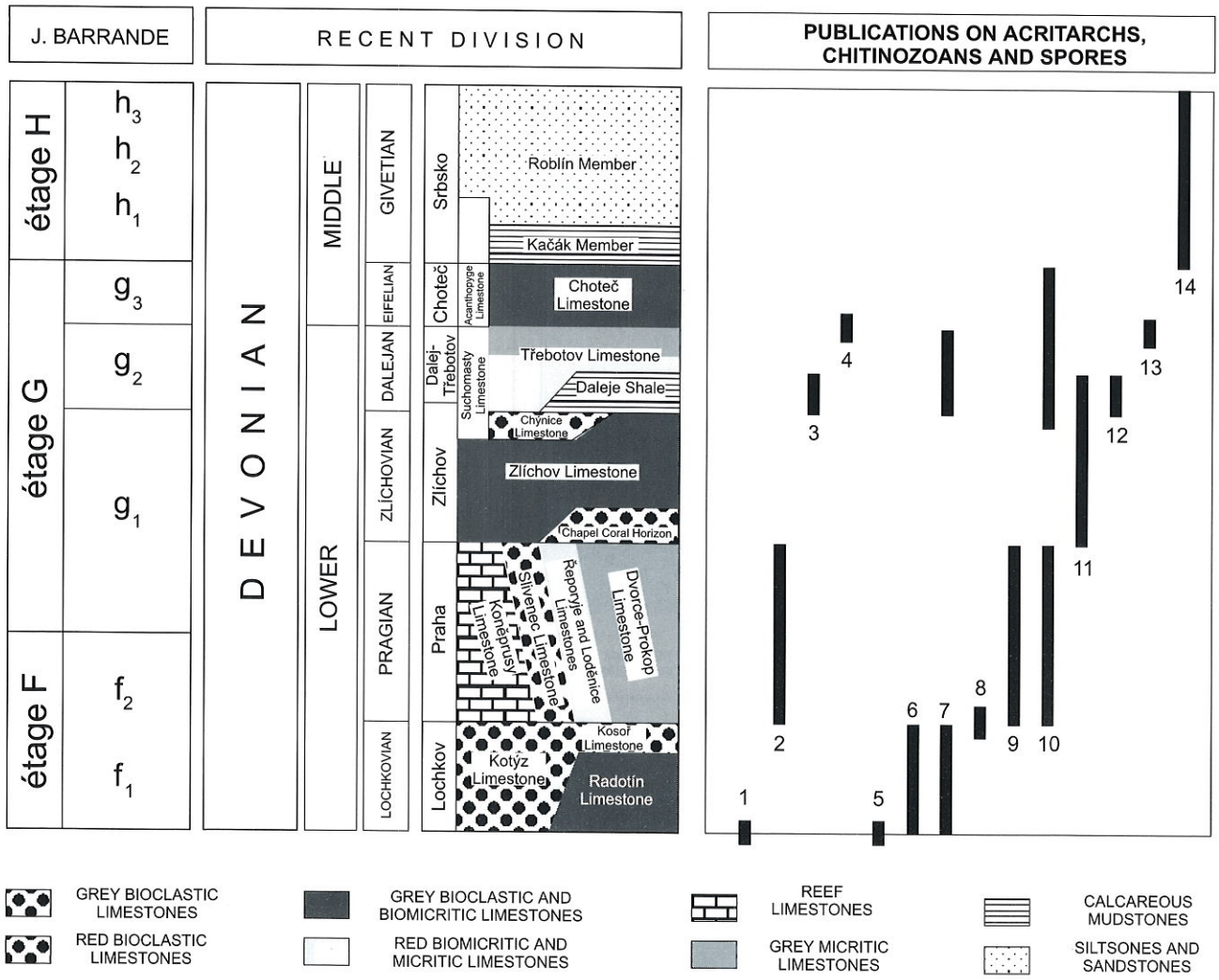

Fig. 6. Stratigraphy of the Devonian System.
Acritarcha
1 – Paris (1981); 2 – Vavrdová (1989b); 3 – Čorná (1969), Lele (1972), Riegel (1974); 4 – McGregor (1981).
Chitinozoa
5 – Paris – Laufeld – Chlupáč (1981), Paris (1981); 6 – Eisenack 1934); 7 – Čorná (1969); 8 – Chlupáč et al. (1985).
Spores
9 – Vavrdová (1989b); 10 – McGregor (1979); 11 – Chibrikova (1982); 12 – Lele (1968, 1972), Čorná (1969); 13 – McGregor (1980, 1981); 14 – Obrhel (1959, 1961).

other, stratigraphically important accompanying species.

Devonian

Our knowledge on Devonian OWM are not adequate to the stratigraphical importance of the Barrandian area. There is no detailed study focussed on Acritarcha, also spores were studied only preliminarily. Comparatively well known are chitinozoan assemblages in two stratigraphically important levels.

Acritarcha. Poorly diversified and moderately preserved acritarch assemblages are reported at the Silurian–Devonian boundary interval at Klonk by Paris (1981) – genus *Leiosphaeridia* sp. Vavrdová (1989) documented the genus *Pterospermella* Eisenack 1972 and *Multiplicisphaeridium–Piliferosphaera–Diexallophasis* complex in the Dvorce–Prokop Limestone. Lele (1972) established specimens of *Baltisphaeridium* and *Veryhachium* associated with several prasinophyta (*Retisphaeridium* Staplin et al. 1965, *Tasmanites* Newton 1875, *Cymatiosphaera* Wetzel 1933 *ex* Deflandre 1954) in the Daleje Shale.

Spores. Well diversified spores were reported from the Lower and Middle Devonian sediments by several authors. The most diversified assemblages studied by Vavrdová (1989) and McGregor (1981) come from the Dvorce–Prokop Limestone, and/or Dvorce–Prokop–Zlíchov Limestones, Třebotov Limestone and Daleje Shale respectively. The most common taxa are assigned to the following genera: *Calamospora* Shopf, Wilson et Bentoll 1944, *Retusotriletes* Naumova 1953, *Apiculiretusispora* Streel 1964, emend. Streel 1967, and *Emphanisporites* McGregor 1961.

Chitinozoa. Comparatively poorly diversified but well preserved chitinozoan assemblages are reported from two levels. The Silurian–Devonian boundary interval at Klonk is typified by *Urnochitina urna* in the Požáry Formation (uppermost Silurian) and common *Angochitina chlupaci* in the Radotín Limestone (Lochkov Formation, Lochkovian see Paris 1981, Paris et al. 1981). The second of studied levels is the Lochkovian–Pragian boundary, where several species of the genera *Eisenackitina*, *Margachitina* and *Urnochitina* are typical for the upper Lochkovian, species of the genus *Gotlandochitina* is crossing the boundary and *Angochitina* is characteristic for the lower Pragian (see Chlupáč et al. 1985).

Conclusion

Different organic-walled microfossils of the groups Acritarcha, Prasinophyta, Mazuelloida, Chitinozoa, Spores, and/or Cyanobacteria occur commonly in Proterozoic to Devonian sedimentary rocks of the Barrandian area.

Although only for chitinozoa and spores formal zonations have been proposed, specimens of the other groups are widely distributed and have a good potential for stratigraphy, facial and palaeogeographical interpretations.

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Mikrofosilie s organickou stěnou v barrandienské oblasti: souhrn

Tento příspěvek se pokouší shrnout existující bibliografii o zástupcích skupin Acritarcha, Prasinophyta, Mazuelloida, Chitinozoa, Cyanobacteria a sporách zjištěných v proterozoických, kambrických, ordovických, silurských a devonských sedimentech Barrandienu. Zahrnuje více než 130 citací knih, článků v časopisech a abstraktů na mezinárodních i národních konferencích a setkáních. Pokud to bylo možné, jsou jednotlivé publikace vztaženy ke studovaným stratigrafickým intervalům.