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Middle Ordovician graptolite fauna from Praha – Červený vrch (Prague Basin, Czech Republic)

PETR KRAFT [1] *– JAROSLAV KRAFT* [2]

[1] Charles University, Faculty of Science, Institute of Geology and Palaeontology, Albertov 6, 128 43 Praha 2, Czech Republic. E-mail: kraft@natur.cuni.cz
[2] West Bohemian Museum, Department of Palaeontology, Kopeckého sady 2, 301 36 Plzeň, Czech Republic. E-mail: jkraft@volny.cz

Abstract. Graptolites collected from a section of the Šárka Formation at Praha – Červený vrch indicate the uppermost Arenigian (lower part of the Corymbograptus retroflexus Biozone). The pendent *Didymograptus* cf. *spinulosus* indicating the Llanvirnian age is recorded from this locality. It is evident that the graptolite faunas span the Arenigian/Llanvirnian boundary interval. Thirteen species of graptolites including seven graptoloid species were found. The succession of graptolite assemblages is compared with the measured section at Rokycany – Drahouš used here as a standard for this interval. The data set from Praha – Červený vrch indicates overthrusting within this section of the Šárka Formation.

Key words: Middle Ordovician, graptolites, Prague Basin, stratigraphy

Introduction

A rich graptolite fauna is documented from the lowermost part of the Šárka Formation, Corymbograptus retroflexus Biozone (Fig. 1b) exposed temporarily at the building-site in Praha – Červený vrch (Fig. 1a). The site was accessible during the construction of terrace-houses at the northern side of the eastern end of Egyptská Street in Praha-Vokovice (Fig. 1 in Budil et al. 2003, this volume). The exposure yielded the richest graptolite assemblage known from the Šárka Formation in the eastern part of the Prague Basin. This graptolite assemblage is remarkable with respect to its composition and especially to the quantitative ratio of individual species.

The preservation is generally not very good and the majority of specimens are flattened and preserved only as a thin organic film on the bedding planes. However, several specimens are preserved in relief displaying structural details of rhabdosomes.

In the first step of field research, it was recognized that graptolites are quite abundant in the middle part of the shale portion of the section, especially in layer No. 8 (see Fig. 2 in Budil et al. 2003, this volume). Subsequently, the attention was paid mainly to the lower part of layer No. 8, which is richest in graptolites. In addition, layers Nos. 7 and 10 were also sampled.

Phyllocarid crustaceans (genus *Caryocaris*) dominate in shales. They occur in thousands of fragments and very often in clusters or concentrations widespread on bedding planes covered with high amount of clastic mica. Other fossils are less abundant but among them graptolites predominate. Semi-quantitative analysis of all recorded fossil remains from all shale samples (Fig. 2a) as well as from the lower part of layer No. 8 (Fig. 2b) illustrate this fact – dendroids together with graptoloids constitute 89 % to 90.7 % of the non-phyllocarid assemblage.

Graptolites were often found in accumulations with phyllocarids; isolated specimens or clusters were recorded less frequently.

Graptolite assemblages

Dendroid graptolites are relatively abundant in comparison to most other localities of the Šárka Formation. They are dominated by *Acanthograptus* sp. and *Ptilograptus suavis* (Fig. 3). They are usually strongly fragmented, displaying an influence of wave dynamics and/or transport.

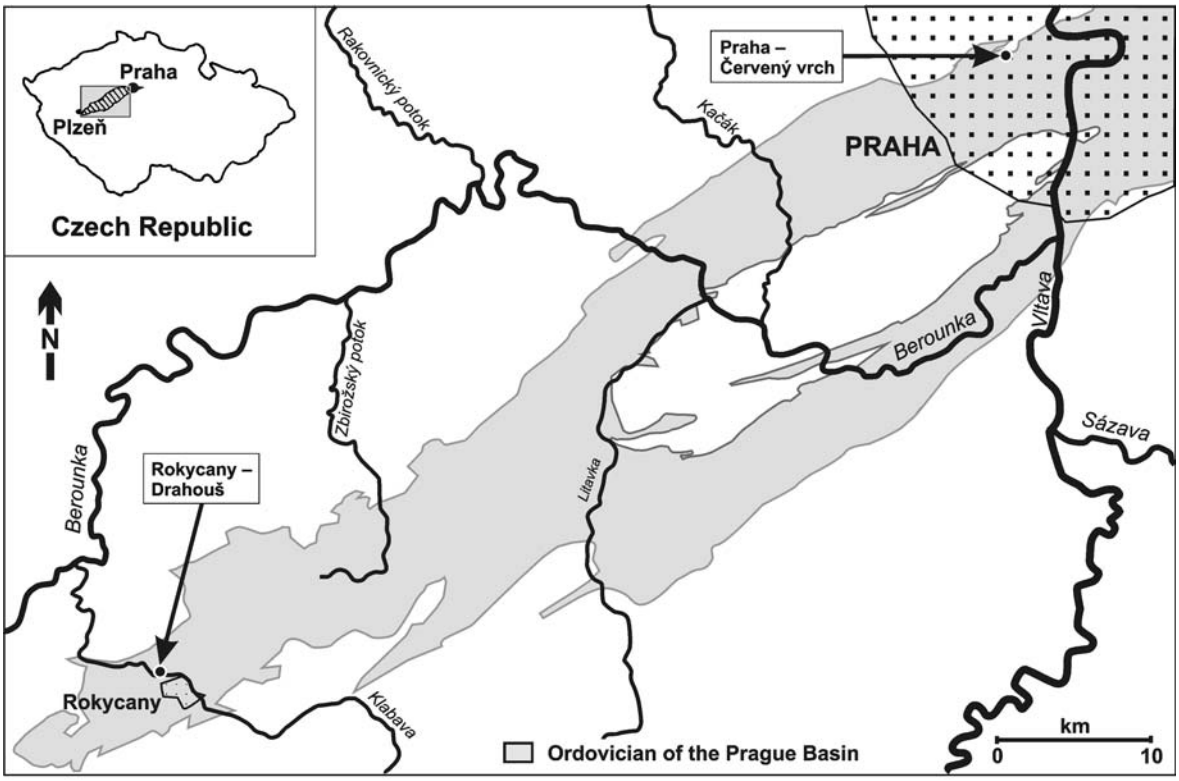
Among all localities in the Prague Basin "*Dendrograptus*" cf. *titanus* is the most frequent at Praha – Červený vrch.

Graptoloids are dominated by species of *Undulograptus*. Their relative abundance is illustrated in Fig. 3, ranging approximately from 71.2 to 73.7 %. Many isolated siculae were found in the studied section. The majority of them apparently also belong to this genus. If these were counted, the relative abundance would reach almost 80 %. The abundance ratio between the two species of *Undulograptus – U. novaki* and *U.* sp. n. – is 3 : 2. *Aulograptus cucullus* is the third most abundant species (slightly more than 10 % of relative abundance). Index species *Corymbograptus retroflexus* is remarkably uncommon (less than 3.5 %) at Praha – Červený vrch.

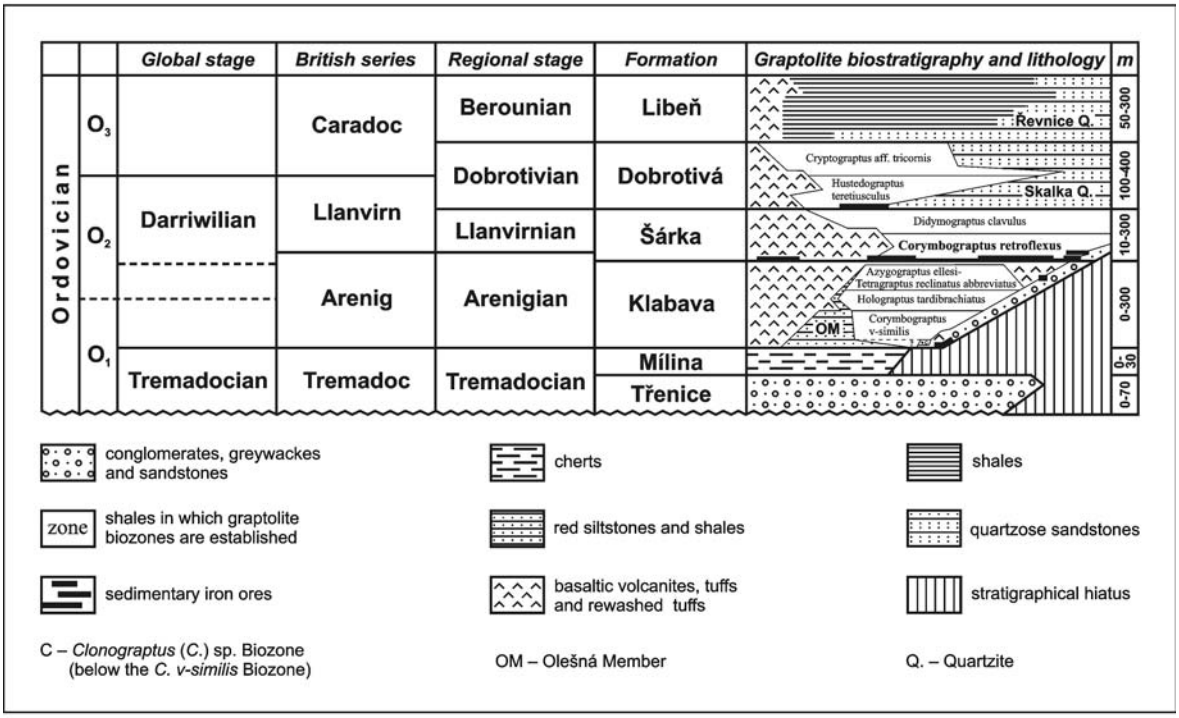
Stratigraphic aspects

Graptolite data

A unique section of the lowermost portion of the Šárka Formation was accessible at Praha – Červený vrch. This important stratigraphic interval is known only from several temporary outcrops. Up to date, Praha – Červený vrch to-



a



b

Fig. 1. a – location map displaying the sample sites at Praha – Červený vrch and Rokycany – Drahouš in the Prague Basin; b – stratigraphy of the Lower Ordovician to the lowermost part of the Upper Ordovician in the Prague Basin. The Corymbograptus retroflexus Biozone including the studied interval is marked by bold letters. After Kraft et al. 2001, modified.

gether with Rokycany – Drahouš are the best-studied exposures of this stratigraphic level. Both outcrops yielded the richest known graptolite assemblages of the lowermost part of the Corymbograptus retroflexus Biozone. The assemblages from the two places are almost identical, although they have been recorded from the northeasternmost (Praha – Červený vrch) and the southwesternmost (Rokycany – Drahouš) parts of the Prague Basin. Tab. 1 illustrates a comparison of the graptolite assemblages from both localities.

Close similarities between the graptolite faunas recovered from these locations are displayed in the faunal list in Tab 1: from the total of 17 species, 11 species obviously occur at both localities.

From 10 species belonging to planktic taxa (9 graptoloids and 1 "planktic dendroid"), 7 occur at both sites. *Didymograptus* (s. l.) *ferrugineus*, *Undulograptus* sp. n. and maybe *Acrograptus lipoldi* are the only taxa known from one locality. The first species is extremely rare but known from several localities in the western and central parts of the basin. The second one has been found only at Praha – Červený vrch but it dominates there the graptolite assemblages.

Among the 7 species of benthic graptolites (dendroids), 4 have been recorded from both localities. Two species – *Dictyonema prokopi* J. Kraft, P. Kraft et Seidl, 1993 and *Desmograptus* sp. – have been found only at Rokycany – Drahouš represented by two specimens or by one, respectively (Kraft et al. 1993).

Differences between the two sections can be seen in the relative abundance of some species. The index species *Corymbograptus retroflexus*, which is very common at many localities including Rokycany – Drahouš, is not as frequent at Praha – Červený vrch. *Didymograptus* (s. l.) *stanislavi* is rather abundant at Rokycany – Drahouš while only a few specimens have been found at Praha – Červený vrch. Other species either display more or less the same relative abundances at both places or are too rare for such comparisons.

Graptolite paleoecology

The assemblages of both planktic and benthic graptolites clearly indicate a shallow- (or at least not too deep) water environment and point to the presence of a nearby hardground or at least some substrate suitable for the attachment of abundant dendroids. Proterozoic ridges are located close to both localities and it can be suggested that they formed paleohighs along the northwestern margin of the basin during the late Arenigian and early Llanvirnian times. These ridges, from which predominantly silicites have been preserved, functioned as sources of clastic material for shales (Drost et al. 2003, this volume). It may also be suggested that the strata exposed at Praha – Červený vrch were deposited in a slightly shallower environment compared to those at Rokycany – Drahouš. This can be interpreted from the rare occurrences of species with large rhabdosomes such as *Corymbograptus retroflexus* and *Didymograptus* (s. l.) *stanislavi* reflecting higher water energy, hence a more dynamic environment at Praha – Červený vrch.

Tab.1. Comparison of the recorded graptolite species at Praha – Červený vrch and Rokycany – Drahouš

Taxa		Praha – Červený vrch	Rokycany – Drahouš
Graptoloids	*Corymbograptus retroflexus*	+	+
	Didymograptus spinulosus	cf.	+
	Didymograptus (s. l.) *stanislavi*	+	+
	Didymograptus (s. l.) *ferrugineus*	–	+
	Didymograptus (s. l.) sp. n.	+	+
	Aulograptus cucullus	+	+
	Acrograptus lipoldi	?	+
	Undulograptus novaki	+	+
	Undulograptus sp. n.	+	–
?	"*Dendrograptus*" cf. *titanus*	+	+
Dendroids	*Dictyonema dubium*	+	+
	Dictyonema prokopi	–	+
	Dendrograptus vokovicensis	+	+
	Dendrograptus sp.	+	?
	Desmograptus sp.	–	+
	Ptilograptus suavis	+	+
	Acanthograptus sp.	+	+

Sedimentologic aspects

Many different levels with concentrations of siliceous nodules occur within the shales of the Šárka Formation. Gradual changes in the type of nodules probably caused by environmental changes are observed in the measured section at Rokycany – Drahouš. The oldest nodules appear 1.1 m above the base of the Šárka Formation, i.e., on the base of the shales. These "old nodules" are specifically characterized as deep black-colored, fine-grained, small, flat, lenticular to elongated narrow bodies. These nodules show sharp boundaries against the surrounding shales and can be completely separated. Their surfaces are often limonitized. Incomplete nodules occur concurrently in the same strata. These "semi-nodules" are black, rounded or elongated lenses inside the shales. Their lithologic character is the same like that of the nodules. The only difference is that they cannot be fully separated from the matrix because there is no disctinct boundary against the surrounding shales. Both the nodules and "semi-nodules" almost in every cases contain fragments of phyllocarid crustaceans. These types of nodules are not limited to certain horizons and are irregularly distributed within the shales. They disappear 9.4 m above the fault, i.e., at least 13.3 m above the base of the Šárka Formation.

The second type of nodules, the "young nodules" appear higher up in the section. The lowermost occurrence of this type of nodules is 8.1 m above the fault, i.e., at least 12 m above the base of the Šárka Formation.

In contrast to the "old nodules", they are bigger, usually rounded, spheric or cylindric, siliceous, and outer as well as splitted fresh surfaces show some coarser-grained appearance. This type of nodules occurs in local horizons. At Rokycany – Drahouš, a succession of probably local sub-

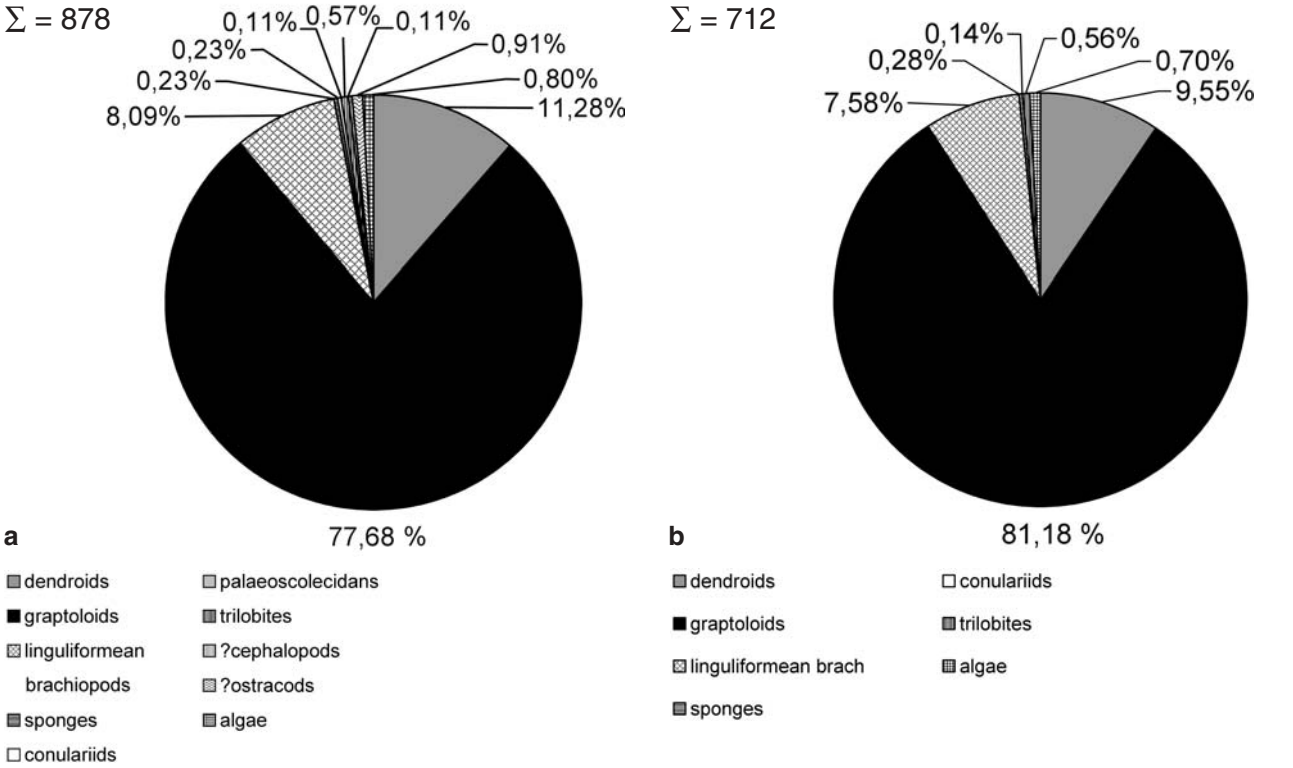


Fig. 2. Relative abundances of recorded fossil groups at Praha – Červený vrch with exclusion of phyllocarid crustaceans. The diagrams result from a semi-quantitative analysis of all fossils discovered during non-selective collectings. a – taxa from the whole succession of shales, b – taxa from the best-studied lower part of layer No. 8.

types has been observed. There, the older sub-type is represented by relatively small nodules containing in most cases exclusively the rhynchonelliformean brachiopod species *Euorthisina moesta* and only a minority of the nodules is free of any fossil remains.

The younger sub-type gradually replaces the previous one in the overlying horizons and it continues throughout the remaining part of the measured section. This sub-type is characterized by bigger nodules than the previous one and, in contrast, contains a very diversified fauna.

The two main types of nodules formed within certain intervals in the lower part of the Šárka Formation apparently extended throughout the Prague Basin at least from Rokycany to Prague. These two types of nodules were also found in the section at Praha – Červený vrch but the horizon of "young nodules" is overlain by strata with the "old nodules" there suggesting a reverse superposition caused by a tectonic reposition.

Implications of the dataset

It is concluded that the studied strata at Praha – Červený vrch represent stratigraphic as well as environmental and biofacies equivalents to the succession at Rokycany – Drahouš. The precise biostratigraphic correlation throughout the basin, based on characteristic graptoloid assemblages, is very reliable within the lower Corymbograptus retroflexus Biozone (roughly corresponding to the lower part of the Šárka Formation). The close similarities in graptolite species composition reflect a comparable bathymetric position at both localities (Kraft and Kraft 2002a, 2002b).

The measured section studied in detail at Rokycany – Drahouš (Kraft and Kraft 1993, 1994) provided a possibility to subdivide the natural faunal succession into certain assemblages (Kraft and Kraft 2000). Therefore, this section is used as a standard for the upper Arenigian through the lower Llanvirnian interval in the Prague Basin. It serves as a control for tectonically affected successions like at Praha – Červený vrch.

The detailed comparison between Praha – Červený vrch and Rokycany – Drahouš allowed the following conclusions:

1. Layer No. 8 (Fig. 2 in Budil et al. 2003, this volume) yielded faunas corresponding to the lowermost part of the Šárka Formation, chronostratigraphically belonging to the uppermost Arenigian (Period 4 sensu Kraft and Kraft 2000).
2. The sequence corresponding to the subsequent Period 5 of Kraft and Kraft (2000) had to be exposed in some of the overlaying strata at Praha – Červený vrch. There is no direct evidence in the section for the presence of Period 5 and the younger periods. However, the pendent *Didymograptus* cf. *spinulosus*, a Llanvirnian species characteristic for this interval, was recovered from the shale debris there.
3. Sediments of layer No. 7 with a nodule horizon (Fig. 2 in Budil et al. 2003, this volume) are considered to represent a younger block tectonically replaced in between

older rocks. Different kinds of data support this conclusion.

The nodules contain mollusc and arthropod fauna typical for the higher parts of the Corymbograptus retroflexus Biozone. The presence of several species of trilobites and, especially, cephalopods and echinoderms evidences stable, open marine conditions during Period 7 sensu Kraft and Kraft (2000). The shale matrix of these nodules provides only limited and no additional information. No species typical for the lowermost part of the Šárka Formation (Period 4) were recorded and only one specimen of the long-ranging *Undulograptus novaki* was found.

In addition, horizons of nodules typical for Period 7 at Drahouš occur in layer No. 7 at Praha – Červený vrch. In contrast, the nodules and "semi-nodules" rich in phyllocarid crustaceans occur in Period 4 at Rokycany – Drahouš and in layer No. 8 at Praha – Červený vrch.

Tectonized section and repetition of strata can be expected at Praha – Červený vrch (Fig. 4). There, the Proterozoic rocks with core of silicites likely formed a rigid buttres during the compression and lateral shortening of the basin fill. This shortening close to any rigid barrier results in a higher deformational gradient and a strong local deformation in general. Thus, overthrust or even intense imbrication are expected close to such rheologic heterogenities.

Systematic paleontology

All material studied is housed in the West Bohemian Museum in Plzeň.

Dendroidea Nicholson, 1872
Dendrograptidae Roemer in Frech, 1897

Dictyonema dubium Počta, 1894
Plate I, fig. 4

Material: 5 fragments of rhabdosomes.

Remarks: This species is not common in general. However, its highest abundance is restricted to the lowermost portion of the Šárka Formation (lower part of the Corymbograptus retroflexus Biozone). It is rare higher up in the formation. Only poorly preserved material was found at Praha – Červený vrch. All crucial biometric data correspond to the descriptions given by Bouček (1956) and Kraft (1975).

Dendrograptus vokovicensis Bouček, 1933
Plate I, fig. 3

Material: 10 fragments of rhabdosomes.

Remarks: This species ranges from the uppermost part of the Klabava Formation (upper Arenigian) to the top

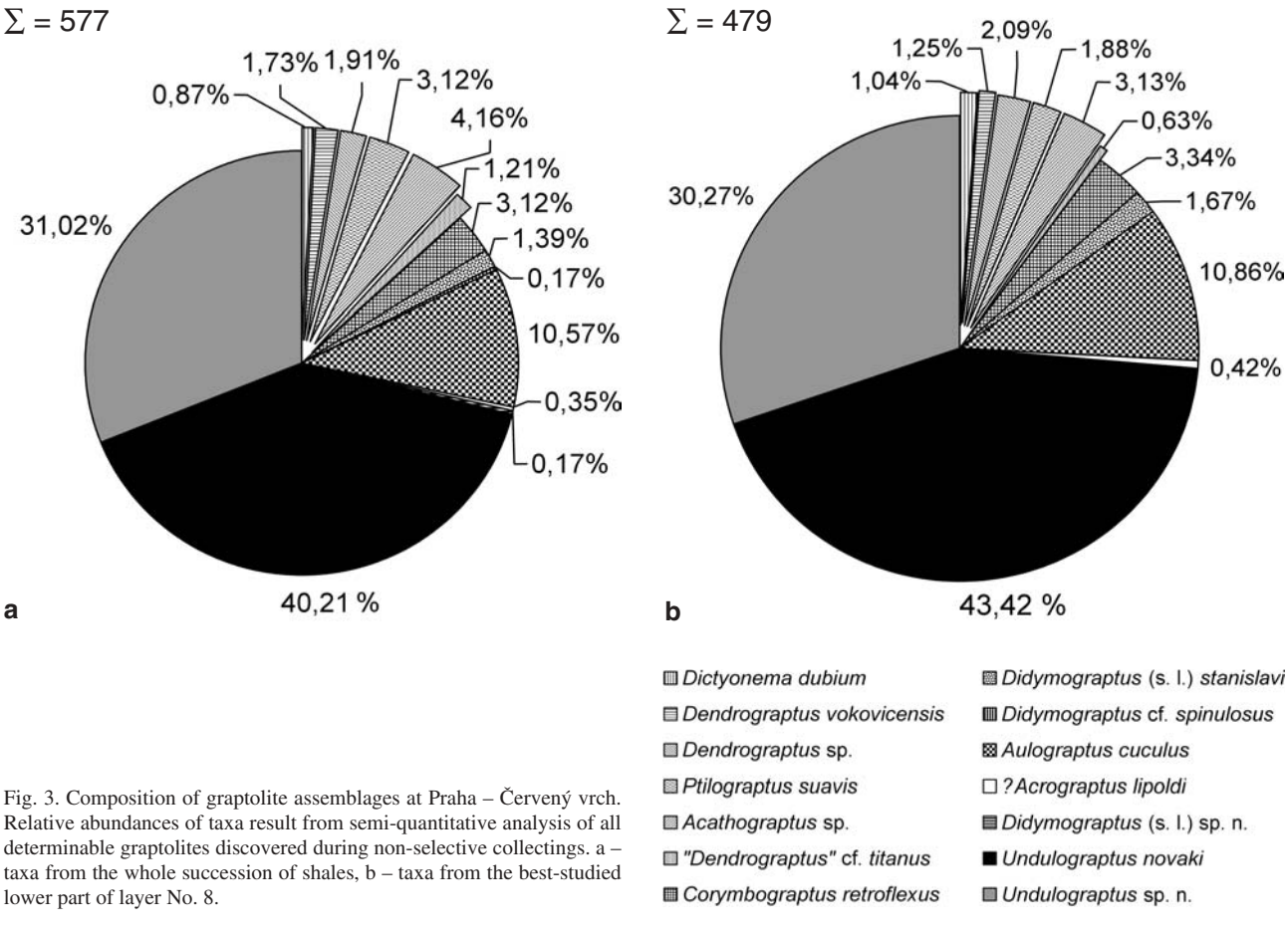
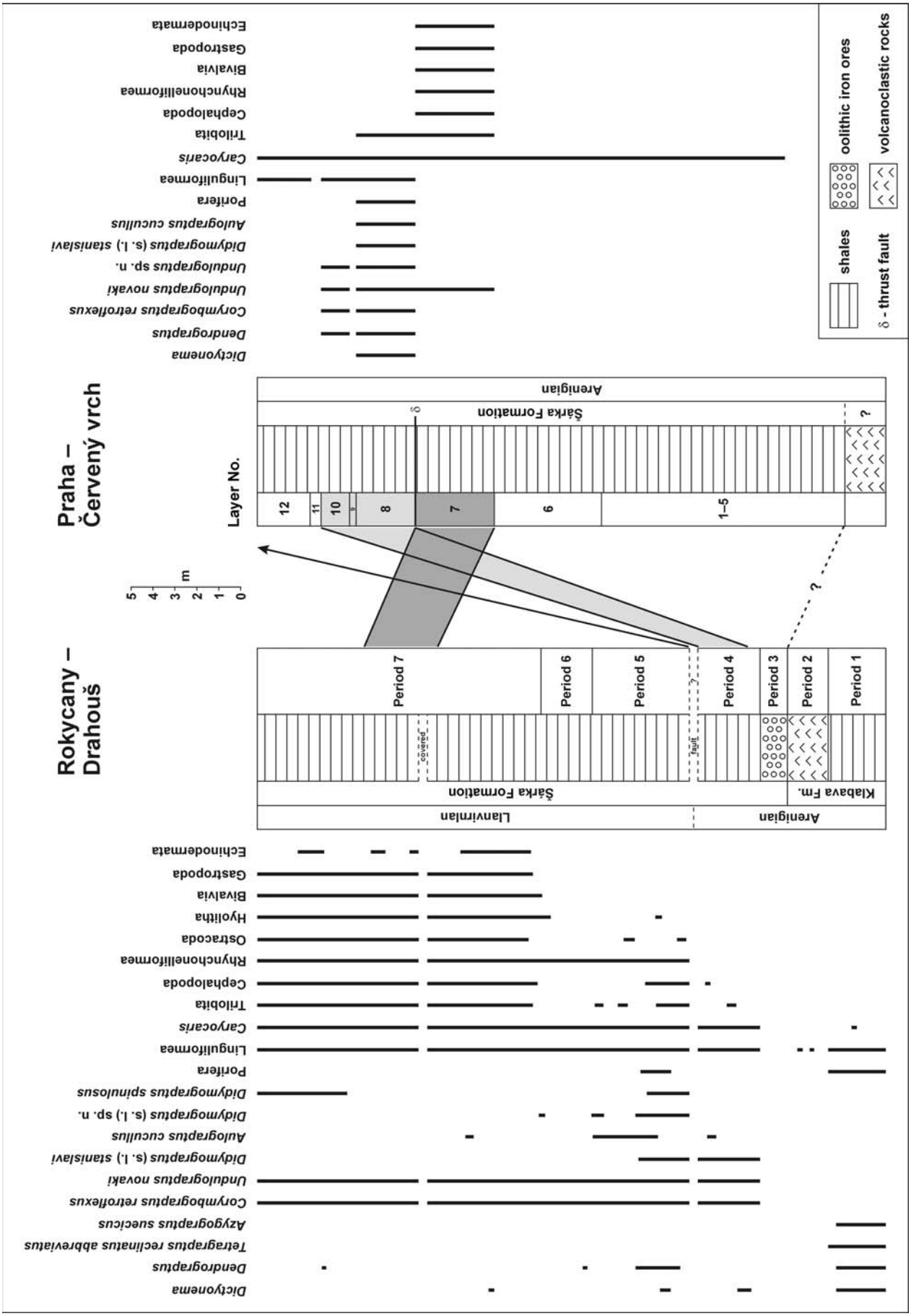


Fig. 3. Composition of graptolite assemblages at Praha – Červený vrch. Relative abundances of taxa result from semi-quantitative analysis of all determinable graptolites discovered during non-selective collectings. a – taxa from the whole succession of shales, b – taxa from the best-studied lower part of layer No. 8.


Rokycany – Drahouš
Praha – Červený vrch
Arenigian
Llanvirnian
Šárka Formation
Klabava Fm.
Period 1
Period 2
Period 3
Period 4
Period 5
Period 6
Period 7
covered
fault
Layer No.
12
11
10
9
8
7
6
1–5
m
5
4
3
2
1
0
shales
oolithic iron ores
volcanoclastic rocks
δ - thrust fault
Dictyonema
Dendrograptus
Corymbograptus retroflexus
Undulograptus novaki
Undulograptus sp. n.
Didymograptus (s. l.) stanislavi
Aulograptus cucullus
Porifera
Linguliformea
Caryocaris
Trilobita
Cephalopoda
Rhynchonelliformea
Bivalvia
Gastropoda
Echinodermata
Ostracoda
Hyolitha
Didymograptus spinulosus
Didymograptus (s. l.) sp. n.
Azygograptus suecicus
Tetragraptus reclinatus abbreviatus

of the Šárka Formation (upper Llanvirnian). Several fragments probably belonging to this species have been described from the overlying Dobrotivá Formation (Dobrotivian). Its maximum abundance has been, however, recorded in the lower part of the Šárka Formation. The studied material from Praha – Červený vrch is composed exclusively of small fragments of rhabdosomes. The arrangement of stipes, density of thecae and angle of inclination are in accordance with biometric data published by Bouček (1933) and Kraft (1975) for this taxon.

Dendrograptus sp.
Plate I, figs. 2, 5

Material: 11 fragments of rhabdosomes.

Description: Rhabdosome probably shrub-like, distally sparsely branched. It grows up from a short stem with attaching disc at its base. The stem is 0.35 mm wide and 1.5 mm long. Diameter of the disc of one colony being 17 mm in size is about 1.8 mm. Stipe width 0.35–0.5 mm. Stipe density ranges between 5 to 6 in 10 mm. Branching dichotomous, angle of divergence usually 60–75°. Basal parts of thecae and single stolons including triad branching are observed sporadically in half-relief.

Remarks: In all biometric features this species strongly resembles *Callograptus horaki* (Bouček, 1956), which occurs in the underlying Azygograptus ellesi-Tetragraptus reclinatus abbreviatus Biozone in the Klabava Formation. The only difference from this taxon is the lack of dissepiments. With respect to a sparse arrangement of dissepiments in *C. horaki*, a phylogenetic relationship between both species cannot be excluded.

Ptilograptidae Hopkinson in Hopkinson et Lapworth, 1875

Ptilograptus suavis Počta, 1894
Plate I, fig. 1

Material: 18 fragments of rhabdosomes.

Remarks: One of the two most abundant dendroid graptolites at Praha – Červený vrch. Its stratigraphic range is probably restricted to the Šárka Formation. However, it is most frequent in the Corymbograptus retroflexus Biozone.

Acanthograptidae Bulman, 1938

Acanthograptus sp.
Plate I, figs. 7, 8

Material: 24 stipe fragments

Remarks: Isolated stipe fragments of this species were originally described as rests of plant *Bojophyton pragensis* Obrhel 1959. Kraft (1975) referred them to the material of species *Acanthograptus havliceki* Kraft, 1975. Kenrick et al. (1999) proved that *B. pragensis* is a dendroid graptolite. This species ranges from the upper part of the Klabava Formation (upper Arenigian) to the top part of the Šárka Formation (upper Llanvirnian).

? Dendroidea Nicholson, 1872
Family unknown

"*Dendrograptus*" cf. *titanus* Kraft, 1990
Plate I, figs. 6, 9

Material: 7 fragments of rhabdosomes with proximal ends.

Diagnosis: Rhabdosome was probably conical. It is robust, strongly sclerotized including sicular region. Stipes 1.2–2.0 mm wide, sparsely arranged (4–6 in 10 mm). Branching dichotomous. The short, 0.08–0.12 mm wide nema projects from the apex of sicula.

Remarks: Fragments with the same characters but without observable nema were described by Kraft (1990) from the uppermost part of the Klabava Formation as a new species *Dendrograptus titanus*. Later, similar rhabdosomes with nema were found at the localities of Rokycany – Drahouš and Rokycany – Stráň (quarry) in the western part of the Prague Basin. It appears that all fragments from the locations mentioned above belong to one species of a "planktic dendroid".

Graptoloidea Lapworth, 1875
Dichograptidae Lapworth, 1873

Corymbograptus retroflexus (Perner, 1895)
Plate II, figs. 3, 5, 6

Material: 18 fragments of specimens (5 of them with preserved proximal region of rhabdosome).

Remarks: It is the index species of the lower of the two graptolite biozones in the Šárka Formation. This robust graptolite is one of the most common graptolite taxa in that zone. However, its fragments (extremely poorly preserved and often only as shadows on the bedding planes) occur only sporadically at Praha – Červený vrch.

Didymograptus cf. *spinulosus* Perner, 1895
Plate II, figs. 7, 10

Material: 1 specimen.

Remarks: The features of the studied specimen correspond to the description of *D. spinulosus* with respect to the architecture of proximal end and the character of stipe divergence, thecal density (13.5 thecae in 10 mm) and initial width of stipes in $th1^1$ (0.5 mm) and $th1^2$ (0.6 mm). Length of sicula (1.7 mm but sicula is broken) can be estimated to

←
Fig. 4. Comparison of the sections at Rokycany – Drahouš and Praha – Červený vrch. The former section is modified from Kraft and Kraft (2000), the latter one is modified from Budil et al. (2003, this volume). The measured continuous section at Rokycany – Drahouš with plotted ranges of selected taxa (mainly present in both sections) is used as the reference section.

be in accordance with *D. spinulosus*. However, the development of the stipe width displays slender stipes and their moderate widening in the specimen from Praha – Červený vrch: 0.6 mm in th2, 0.65 mm in th3, 0.8 mm in th5, 1.1 mm in th10, 1.35 mm in th14 and maximum distal width 1.5 mm in th17 (vs. typical *D. spinulosus*: 0.65–0.95 mm in th2, 1.0–1.6 mm in th5, 1.3–2.0 mm in th10 and a maximum width of 2.4 mm.

The FAD of this species is a marker for the base of the Llanvirnian. Its presence at Praha – Červený vrch evidences Llanvirnian strata in the lower part of the Šárka Formation. Unfortunately, it has not been recovered from the outcrop, but only from shale debris.

Didymograptus (s. l.) *stanislavi* (Bouček, 1973)
Plate II, figs. 1, 12

Material: 8 fragments, 6 of them with proximal portions of rhabdosome.

Remarks: Biometric data of the studied specimens are in accordance with the original description of Bouček (1973). So far this species has been known only from the western part of the Prague Basin. There, it is locally abundant in the lowermost part of the Šárka Formation. It has been recorded from Rokycany – Stanislav Mine, Rokycany – Drahouš, and several drill cores in the Klabava-Ejpovice area.

Didymograptus (s. l.) sp. n.
Plate II, fig. 9

Material: Fragments of 1 specimen.

Remarks: Several specimens of this undescribed new species have been recorded from Rokycany – Drahouš. There, it occurs in the lower part of the Šárka Formation. It is characterized by horizontal stipes with narrow but distinct and prominent common canal and large thecae. In the fragments from Praha – Červený vrch, the stipe is 2.0–2.2 mm wide (in one fragment, probably of a more proximal portion, it reaches 1.8 mm). Thecae are max. 1.3 mm wide in aperture, their free part is 1.8–1.9 mm long. Their number is 5.5–7 in 10 mm.

Aulograptus cucullus (Bulman, 1932)
Plate II, figs. 13, 14

Material: 61 specimens, most of them with proximal region of rhabdosome.

Remarks: All features of the studied specimens correspond to the original description. This species is restricted to the lower part of the Šárka Formation.

Sigmagraptidae Cooper et Fortey, 1982

? *Acrograptus lipoldi* Bouček, 1973

Material: 2 small fragments of stipes

Remarks: All recognizable features, including slight prothecal folds, fit the corresponding ones of *A. lipoldi*. However, the two very small fragments do not allow unequivocal identification, and a confusion with graptolites with similar attributes cannot be excluded.

?Diplograptidae Lapworth, 1873

Undulograptus novaki (Perner, 1895)
Plate II, figs. 8, 11

Material: 232 specimens.

Remarks: This species represents the most abundant graptoloid from Praha – Červený vrch. Although adult specimens prevail at other localities, the early astogenetic stages are most common at this locality. Siculae with two or three initial thecae are of high relative abundance. It is probable that most of the fairly common isolated siculae also belong to this taxon.

We refer *Pseudoclimacograptus* (*P.*) *klabavensis* Bouček, 1937 to the synonymy of this species . This is based on a preliminary study of rich material collected at Rokycany – Drahouš.

U. novaki is the only graptoloid ranging throughout the whole succession of the Šárka Formation.

Undulograptus sp. n.
Plate II, figs. 2, 4

Material: 179 specimens.

Remarks: This taxon is similar to *Undulograptus dicellograptoides* described by Maletz (1998) from the upper part of Arenig of Newfoundland. Later, Chen et al. (2001) mentioned *U. dicellograptoides* from the lower Darriwilian of Alxa (North China). *U.* sp. n. differs from *U. dicellograptoides* in possessing shorter sicula (1.3 vs. 2 mm), $th1^1$ originates higher, approximately at half length of sicula (vs. closer to the aperture), and distal portions of $th1^1$ and $th1^2$ grow horizontally straight after they bend outward from the sicula (vs. upward growing of apertural portion forming a loop).

U. sp. n. is hitherto known only from Praha – Červený vrch. In contrast to *U. novaki*, mature specimens of *U.* sp. n. obviously prevail there.

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Plate I

Dendroid graptolites from Praha – Červený vrch.

1 – *Ptilograptus suavis* Počta, large fragment of rhabdosome, S 03752, x2; 2, 5 – *Dendrograptus* sp., 2 – proximal part of rhabdosome, S 03720, x4, 5 – fragment with stolons and basal parts of thecae preserved in half-relief, S 03726, x6; 3 – *Dendrograptus vokovicensis* Bouček, small fragment of rhabdosome with visible thecae, S 03718, x6; 4 – *Dictyonema dubium* Počta, flattened fragment of rhabdosome, S 03724, x4; 6, 9 – "*Dendrograptus*" cf. *titanus* P. Kraft, 6 – proximal part of rhabdosome with preserved nema, S03735, x6, 9 – large fragment of rhabdosome with preserved proximal part, S 03740, x4; 7, 8 – *Acanthograptus* sp., 7 – fragment of stipe preserved in half-relief, S 03745, x8, 8 – flattened fragment of stipe, S 03748, x4. All specimens with the exception of the specimen in Fig. 3 come from layer No. 8. Specimen in Fig. 3 was found out of the section.

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Plate II

Graptoloids from Praha – Červený vrch.

1, 12 – *Didymograptus* (s. l.) *stanislavi* (Bouček), 1 – view of a part of rhabdosome of the largest fragment, S 03739, x4, 12 – detail of proximal end, obverse view, S 03744, x8; 2, 4 – *Undulograptus* sp. n., 2 – specimen preserved in relief, reverse view, S 03635, x8, 4 – the largest found specimen, obverse view, S 03640, x4; 3, 5, 6 – *Corymbograptus retroflexus* (Perner), 3 – fragment of stipe, S 03703, x4, 5 – proximal end, obverse view, S 03704, x8, 6 – proximal end, S 03733, x8; 7, 10 – *Didymograptus* cf. *spinulosus* Perner, S 03732, 7 – the only found specimen, x4, 10 – detail of proximal end, x12; 8, 11 – *Undulograptus novaki* (Perner), 8 – early astogenetic stage of rhabdosome, obverse view, S 03743, x12, 11 – obverse view, S 03664, x4; 9 – *Didymograptus* (s. l.) sp. n., fragments of stipe, S 03738, x4; 13, 14 – *Aulograptus cucullus* (Bulman), 13 – fragment of rhabdosome with some parts preserved in half-relief, reverse view, S 03714a, x8, 14 – detail of proximal part of rhabdosome, reverse view, S 03714b, x8. Specimens in Figs. 1–6 and 12–14 were collected in layer No. 8, Fig. 11 in layer No. 10 and Figs. 7–10 were found out of the section.

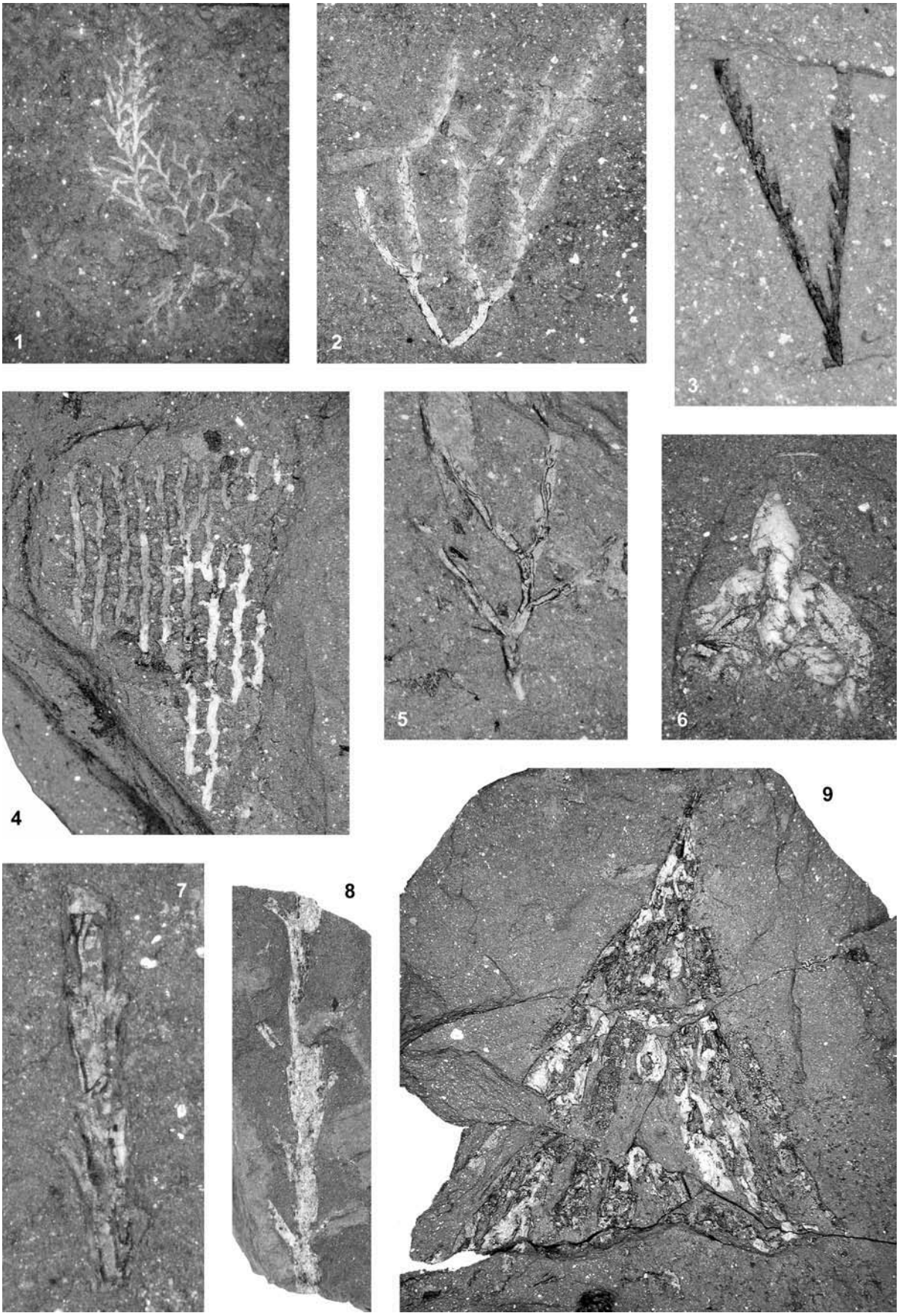

Plate I

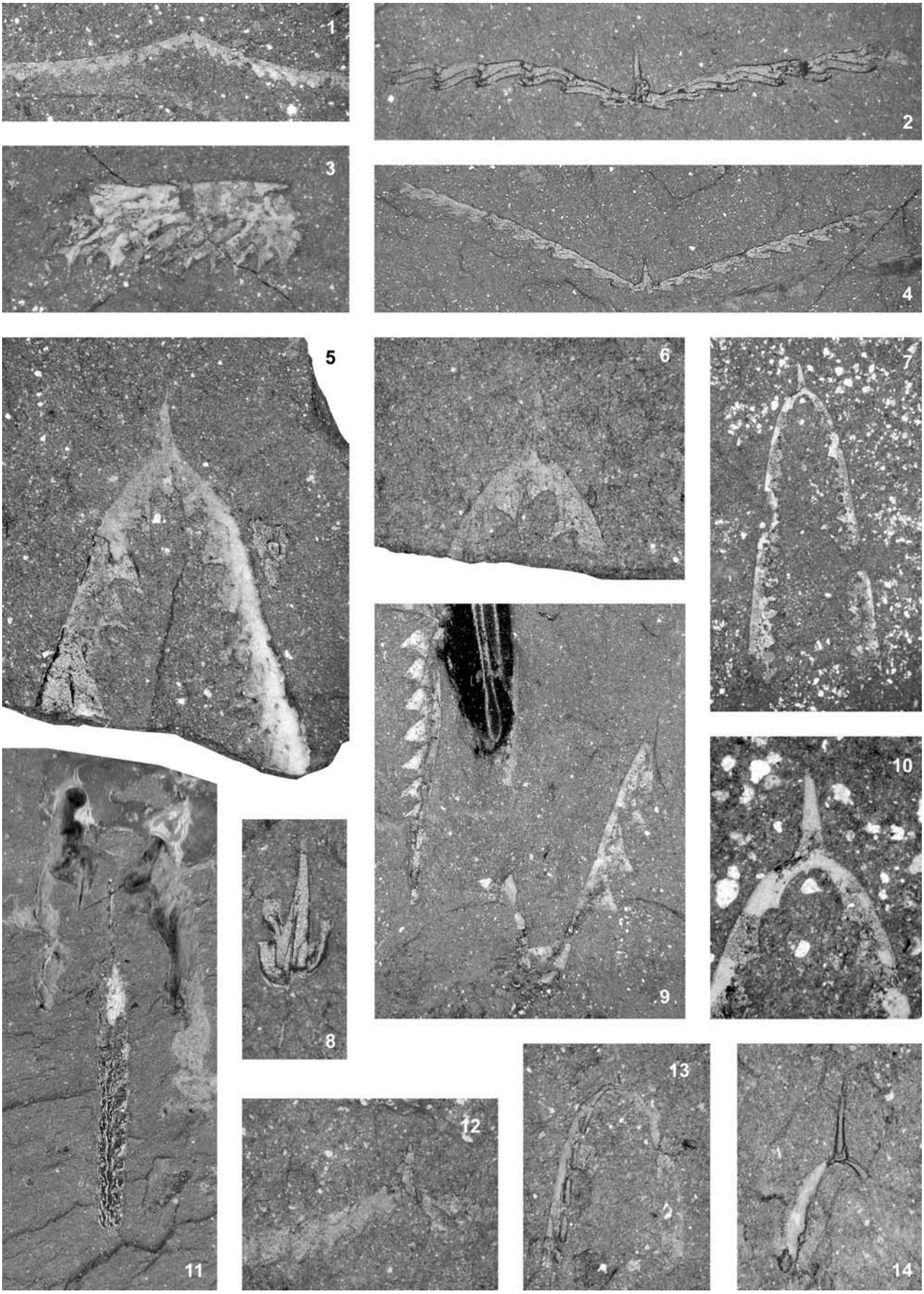

Plate II