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Přídolí – the Fourth Subdivison of the Silurian

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With contributions by

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With 44 figures, 1 table and 6 plates

Tschechoslowakei
Barrandium (Prager Mulde)
Karnische Alpen
Silur
Stratigraphische Korrelation
Ludlow/Přídolí-Grenze
Internationaler Stratotyp
Graptolithen
Conodonten
Chitinizoa
Trilobita
Echinodermata
Bivalvia
Brachiopode

IGCP-Project Ecostratigraphy

Contents

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Zusammenfassung

Diese Arbeit faßt die Ergebnisse einer internationalen Arbeitsgruppe zur Definition der Ludlow/Pridoli-Grenze und des Pridoli (Obersilur) im Typusprofil und in Referenzprofilen der Prager Mulde (Barrandium) in der Tschechoslowakei zusammen. Nach Ratifizierung durch den 27. Internationalen Geologenkongreß in Moskau 1984 gilt die hier abgehandelte Grenze als international verbindlich.

Im Barrandium ist die Schichtfolge des Pridoli rein marin ausgebildet. Eine reiche Fossilführung zeichnet die vorherrschenden Karbonat- und Schiefergesteine aus. Unbeeinflußt von spätkaledonischen Bewegungen dauerte die marine Sedimentation vom Beginn des Silurs (und schon früher) bis nahe dem Ende des Mitteldevons ohne größere Lücken an. Aufgrund dieser günstigen Verhältnisse, weiters hervorragender Aufschlüsse und einer langen Erforschungsgeschichte ist die Kenntnis über das Vorkommen verschiedenster biostratigraphisch wichtiger Fossilgruppen, die Lithologie und die physische Stratigraphie bestens dokumentiert und bekannt. Sämtliche verfügbaren Daten werden hier in einer modernen und dem letzten Stand wiederspiegelnden Arbeit nach einer gründlichen Revision vorgelegt bzw. erstmals mitgeteilt.

Die Untergrenze der Pridoli-Stufe wird aufgrund des Vorkommens von Graptolithen und anderen Gruppen, insbesondere von Conodonten und Chitinozoen definiert. Weiters wird die Entwicklung des Obersilurs der Prager Mulde beschrieben, dazu der internationale Stratotyp für diesen Zeitabschnitt und 9 wichtige Referenzprofile. Für jedes Profil machen wir detaillierte Angaben über die Schichtfolge und ihre Fossilführung. Von H. JAEGER werden ausführlich die Graptolithen der Pridoli-Stufe abgehandelt, da sie für die Charakterisierung und Korrelation dieses Abschnittes im Silur die wichtigsten Zeitmarken darstellen.

Summary

The Ludlow – Přídolí boundary beds in the Prague Basin (Barrandian area, Bohemia) were studied in great detail to provide all the information necessary for the establishment of the Přídolí international boundary stratotype which was accepted at the 27th International Geological Congress in Moscow in 1984. In the Barrandian area the Přídolí occurs in a purely marine succession in which fossil rich carbonate and shale facies predominate. Unaffected by late Caledonian movements, marine sedimentation persisted without substantial break from the beginning of the Silurian to the later part of the Middle Devonian. These conditions, in combination with excellent exposures and a long history of investigation made possible a study of biostratigraphy, physical stratigraphy and lithology. The Přídolí lower boundary is well defined on the basis of graptolites and other faunas (especially conodonts and chitinozoans). In this paper a general development of the highest subdivision of the Silurian System in the Prague Basin, its international boundary stratotype and nine most important reference sections are described concerning their lithology and fossil content. A systematic review of the Přídolian graptolites became a part of this paper since they represent the most important fossil group for the international correlation of the Přídolí.

1. Introduction

The study of the Přídolí was included into the research programme of the Geological Survey of Czechoslovakia immediately after the establishment of the Silurian – Devonian international boundary stratotype in Bohemia at the Montreal International Geological Congress in 1972. Since 1973 all the available sections of the Přídolí in the Prague Basin (Barrandian area, Bohemia) were revised and the ten best sections through the Ludlow – Přídolí boundary were selected, measured and prepared for the detailed study by a working team.

In 1975 the study of the Přídolí was included into the Project No. 53, ECOSTRATIGRAPHY, I.G.C.P., as the most important Bohemian subproject. First results were submitted to the Subcommission on Silurian Stratigraphy by its working group (H. JAEGER, J. KŘÍŽ and H. P. SCHÖNLAUB) in the form of the progress report (May 1981).

The Přídolí and its lower limit was evaluated in comprehensive supplementary submission to the Subcommission on Silurian Stratigraphy in March 1983. Both submissions provided necessary data for the establishment of the Přídolí international stratotype in Bohemia accepted at the 27th. International Geological Congress in Moscow in 1984.

The work was realized in terms of international cooperation of the Geological Survey of Czechoslovakia within the Geologische Bundesanstalt, Vienna, Laboratoire de Géologie, Université Rennes, France, and Museum für Naturkunde, Berlin. Field investigations of sections, study of bivalves and general biostratigraphy were carried out by J. KŘÍŽ (Geological Survey, Prague), conodont sampling and studies were carried out by H. P. SCHÖNLAUB (Geologische Bundesanstalt, Vienna), graptolites were collected and studied by H. JAEGER (Museum für Naturkunde, Berlin), chitinozoan sampling and studies were made by F. PARIS (Université de Rennes). A. ANGELIDIS (Geofysika n. p., Brno) studied physical stratigraphy. Lithology was studied by Z. KUKAL (Geological Survey, Prague). Important data on other fossil groups were provided by I. CHLUPÁČ (Geological Survey, Prague) – phyllocarids and other non-trilobite arthropods, V. HAVLÍČEK (Geological Survey, Prague) – brachiopods, M. KRUTA (Czechoslovak Academy of Sciences, Prague) – ostracods, J. MAREK (Charles University, Prague) – cephalopods, R. PROKOP (National Museum, Prague) – echinoderms, M.

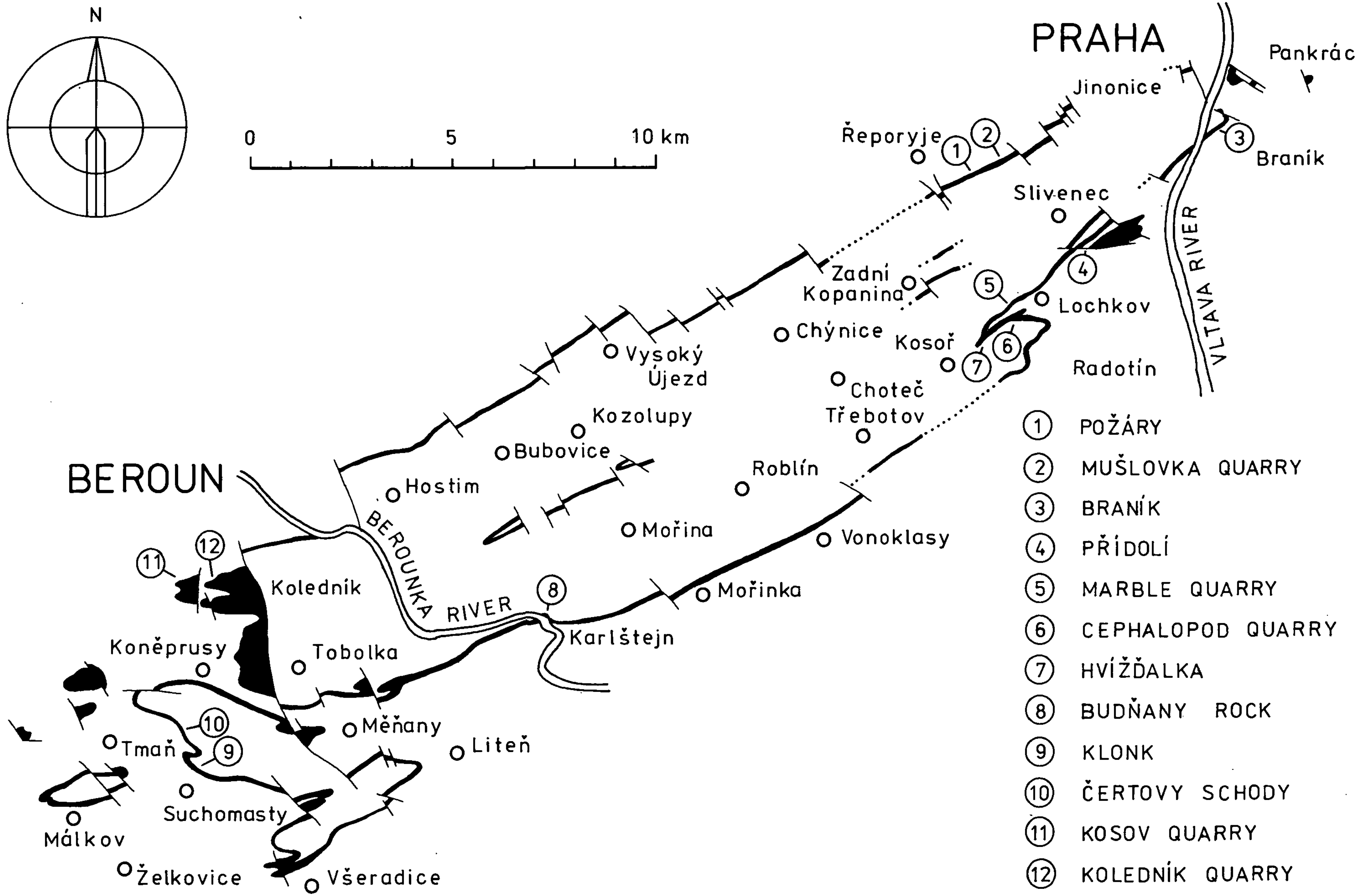

Fig. 1: Distribution of the Přídolí in the Prague Basin (Barrandian area, Central Bohemia) and principal localities for the study of the Ludlow/Přídolí boundary rocks.

Šnajdr (Geological Survey, Prague) – trilobites and V. Turek (National Museum) – cephalopods.

Reference collections are deposited in the Geological Survey, Prague, Geologische Bundesanstalt, Vienna (conodonts), Université de Rennes (chitinozoans), Museum für Naturkunde, Berlin (graptolites except types which are deposited in the Geological Survey, Prague).

2. History of Stratigraphical Studies

The principles of stratigraphy and faunal succession of lower Paleozoic strata in central Bohemia were laid down by J. Barrande (1852–1881) in his classical work Système silurien du centre de Bohême.

The Přídolí corresponds in Central Bohemia to the Přídolí Formation described by Prantl & Přibyl (1948) and named after the Přídolí area near Velká Chuchle, Prague. The base of the formation was defined by the first occurrence of *Monograptus ultimus*. The concept of the Přídolí Formation was accepted by Svoboda & Prantl in their detailed mapping of the Barrandian (1946 to 1958), by Horný (1955, 1962) and by Chlupáč (1972, 1977) in his studies of the Silurian – Devonian boundary in Bohemia. The first International Symposium on the Silurian and Devonian in Prague (1958) agreed with this interpretation and with the establishment of the Budňanian Stage for the Kopanina and Přídolí Formations. After Berdan et al. (1969) proposed the name Přídolian for the uppermost stage of the Silurian, the Budňanian Stage was abolished and four stages for the Silurian in Bohemia (Llandoverian, Wenlockian, Ludlovian, and Přídolian) were accepted by Kříž (1975), Chlupáč (1972, 1977), Chlupáč, Kříž & Schönlaub (1980).

Recently, the same subdivisions of the Silurian have been used in geological maps made in the Geological Survey of Czechoslovakia. When Přídolí was accepted as international unit in 1984, the Subcommission on Silurian Stratigraphy recommended to replace the name Přídolí Formation to avoid the duplication of the formation and series names. This was realized by Kříž (1986) who proposed a new name Požáry Formation in spite of the fact that this proposal may not be accepted practically for the reasons mentioned by Lawson (1977). The lower boundary of the Požáry Formation was defined as the top of a distinct bed marker called "cephalopod bank" which occurs in the uppermost Kopanina Formation. At the boundary stratotype of the Požáry Formation in the Požáry Section the lower limit of the formation is at the top of level no. 87. Fig. 27 shows that the lower boundary of the Požáry Formation is diachronous and does not correspond to the Ludlow – Přídolí boundary.

3. Facies Development of the Požáry Formation in Bohemia (Prague Basin)

The Požáry Formation in Bohemia is characterized by carbonate sedimentation. The formation follows the facies pattern of the Kopanina Formation (Ludlow) only partly at the base. The middle and upper parts of the Formation are characterized by two principal facies:

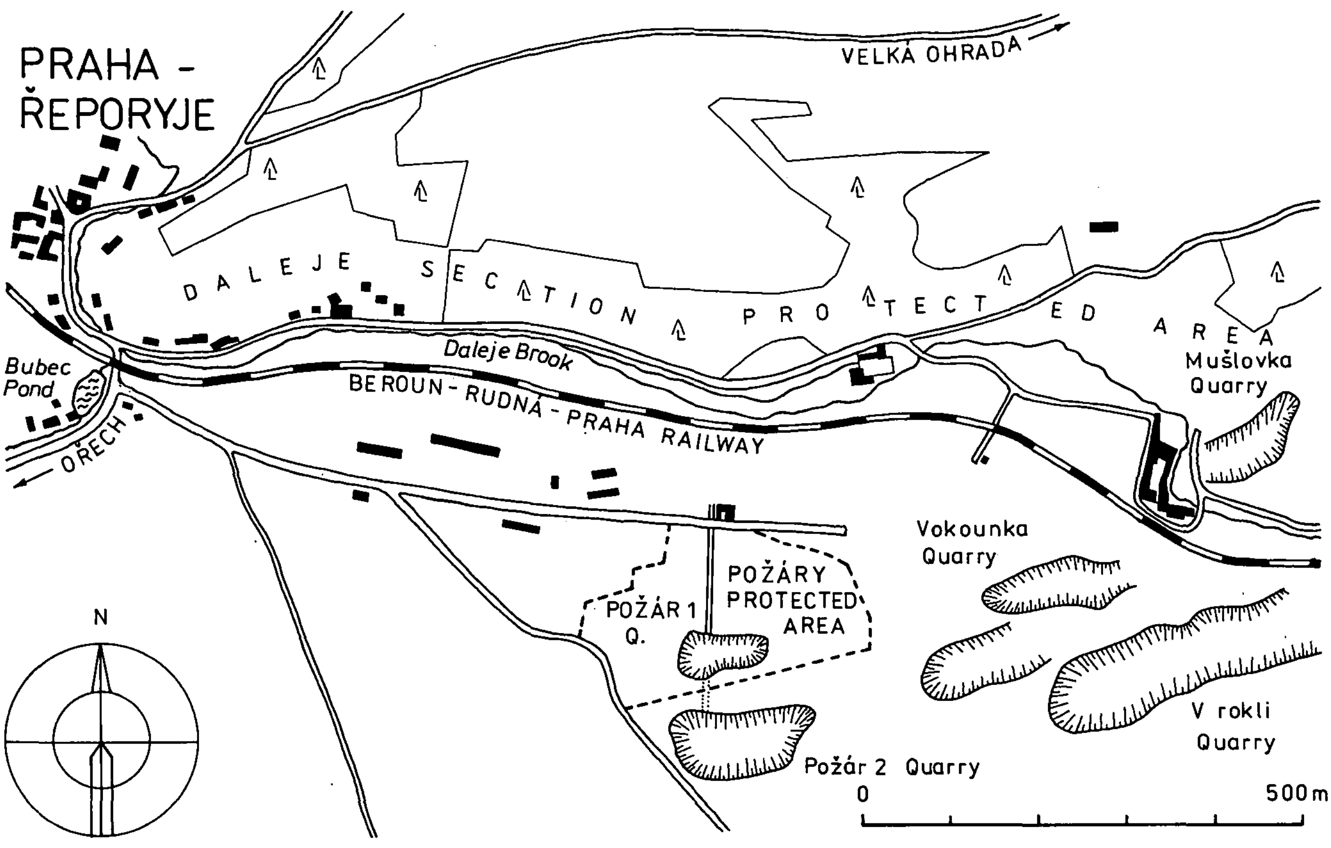

Fig. 2: Location of the lower boundary international stratotype of the Přídolí (Požáry Section) near Řeporyje in Prague, Bohemia.

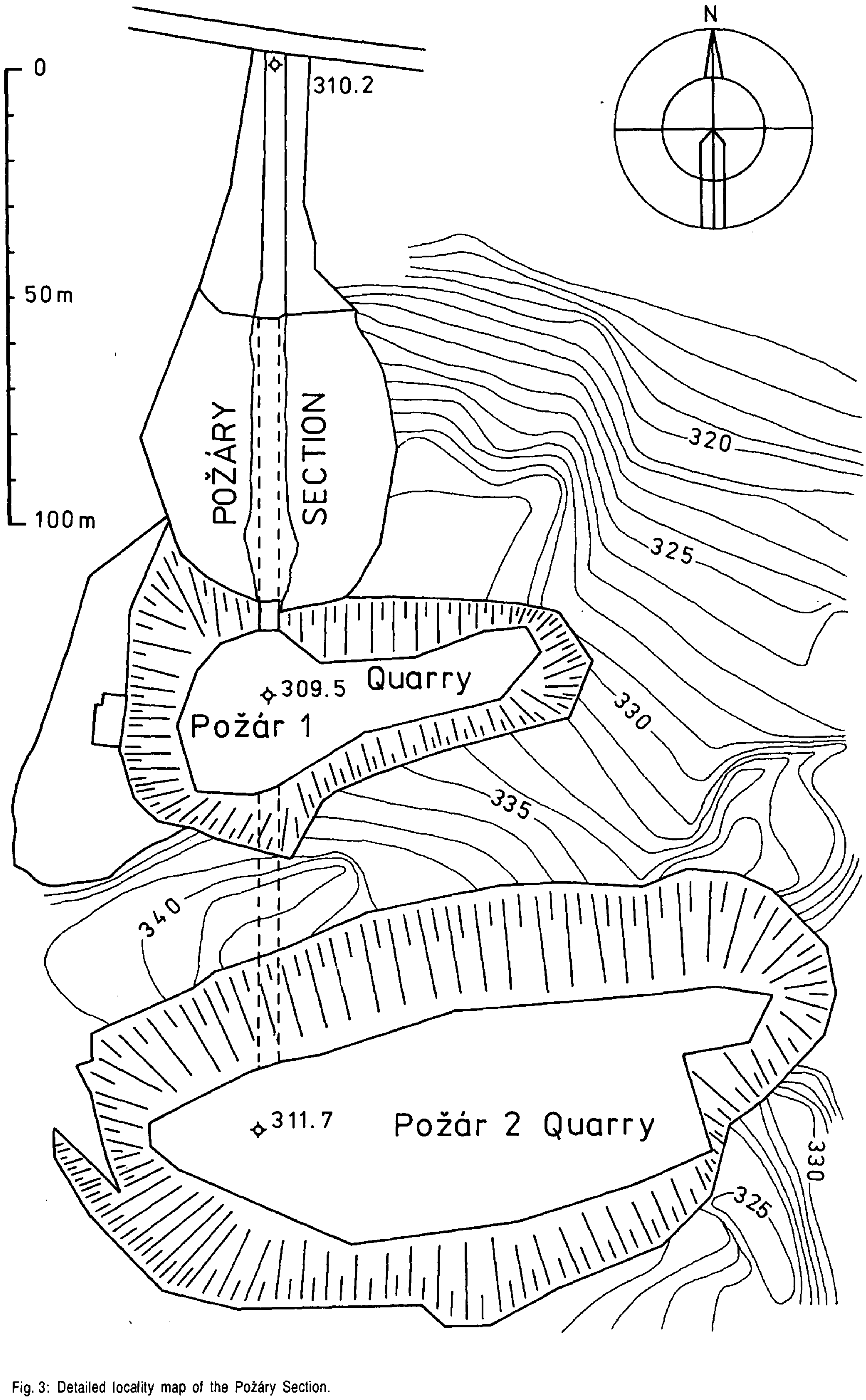

Fig. 3: Detailed locality map of the Požáry Section.

1) Dark-coloured, dominantly biomicrite to micrite platy limestones with abundant intercalations of calcareous shales. The facies is developed in the wide marginal belt of the central Bohemia synclinorium.
2) Biodetrital, brachiopod and crinoid limestones. The facies is developed in the vicinity of the Svatý Jan volcanic center area.

The facies distribution was studied in detail by HORNÝ (1955, 1955a, 1962) and CHLUPÁČ (1972).

The fauna of the platy limestones and shales is characterized by a large proportion of planktonic, epiplanktonic and nektonic organisms: graptolites, chitinozoans, ostracods, phyllocarids, eurypterids and cephalopods. Benthic forms are also abundant: bivalves, cephalopods, dendroids, brachiopods, and trilobites. In the upper parts of the formation crinoids are very common. The platy limestones and calcareous shales were deposited in a deeper environment than the facies of biodetrital brachiopod and crinoid limestones.

Thickness of the Požáry Formation ranges from 15 to 20 m in the region of prevailing biodetrital limestones (broader vicinity of Bubovice) to almost 50 m in the facies of platy limestones. Maximum of the thickness (80–90 m) was observed in the Koledník – Tobolka area. The Požáry Formation is in the Barrandian area exposed in numerous sections. The total length of the lower limit exposure is about 10 km.

4. Facies Development of the Ludlow – Přídolí Boundary in Bohemia (Prague Basin)

In the Prague Basin the Ludlow – Přídolí boundary is not isochronous with the Kopanina Formation – Požáry Formation boundary. In some localities the Ludlow – Přídolí limit is at the same level as the Kopanina Formation – Požáry Formation boundary (Braník, Kavčí Hory), being not transitional but sharp since the top of the Kopanina Formation is represented by the top of the "cephalopod bank" and the base of the Přídolí is represented by laminites consisting of regular alternations of micrite-rich biomicrites and fine-grained biodetrital limestones. Common are calcareous shale intercalations.

At some other localities the top of the Kopanina Formation is below the Ludlow – Přídolí boundary or above the boundary which is thus developed or within the facies of coarse biodetrital limestones with cephalopods (Hvížďalka Section, Cephalopod Quarry) or within the facies of platy limestones (Požáry Section, Mušlovka Quarry, Koledník Quarry, Kosov Quarry, Marble Quarry).

In the facies where the top of the Kopanina Formation is developed predominantly as shales with subordinate limestones or limestone concretions (south-western margin of the Silurian – Devonian synclinorium) the boundary rocks are developed in the same facies (Lejškov) or in the facies of platy limestones with shale intercalations (Čertovy schody Section).

5. Principal Localities of the Ludlow – Přídolí Boundary Beds in Bohemia (Prague Basin)

Ten localities were chosen for detailed investigation of the boundary in Bohemia, and a revision was made of several others. The selected sections were measured and studied bed by bed in an interval comprising mostly whole outcrop or at least several metres above and below the boundary. Within this interval, all beds were numbered and the faunal content collected and studied. In the boundary interval each distinct limestone bed of uniform lithology was assigned a number. Shale intercalations were also assigned a number or, in most cases, were designed by the underlying and overlying numbers. Where thick uniform beds or thick monotonous sequences of platy limestones were sampled, the numbers with letters (e. g. 1a, 1b, 1c etc.) were employed.

All sections of the Ludlow – Přídolí boundary beds are situated in the vicinity of Prague (fig. 1), the most distant locality is about 40 km from the city. The most complete and best accessible Požáry Section with the international boundary stratotype of the Přídolí is at the south-western border of Prague. All localities are freely and easily accessible for study by the modern system of transportation, including good quality highways, county roads, trains, buses, and in Prague (Braník Section, Lochkov-Marble Quarry, Cephalopod Quarry, Mušlovka Quarry, Požáry Section and Hvížďalka Section) the city transportation system.

The Barrandian area is freely accessible to geologists and tourists of any nation, and collection of fossils for comparative studies is permitted. However, the Silurian – Devonian area is a natural reservation and thus any non-scientific collection and excessive devastation of the exposures is forbidden.

5.1. Požáry Section

This most instructive section of monoclinal, south-westerly dipping rocks, is located on the southern slope of Daleje Valley (fig. 2), about 1 km E of Řeporyje, at the south-western border of Prague, in an abandoned railway cut in the entrance to the Požár 1 and 2 Quarries (fig. 3, fig. 4). Exposed are 31 m of the Kopanina Formation, 45 m of a complete sequence of the Požáry Formation (Přídolí), complete section of the Lochkov Formation (Lochkov), and the lower part of the Prag. The section was previously studied by BOUČEK (1937), BARNETT (1972) and CHLUPÁČ (1953, 1957, 1972).

Since September 1982 the section and area shown at Fig. 2 are protected by Law no. 40/1956. Part of the statute NVP no. 3/1982 is the regulation that the section is freely accessible to public and that the sampling by scientists is without restrictions. On the other hand several regulations concerning the conservation of the section are part of the statute: excessive devastation of the section is prohibited, the section should be kept free of vegetation and the Geological Survey of Czechoslovakia has the duty to renumber the section when necessary. Protected area is at present managed by the State Conservation of Nature and by the members of the Czech Union for the Conservation of Nature (C. U. C. N.) in Prague.

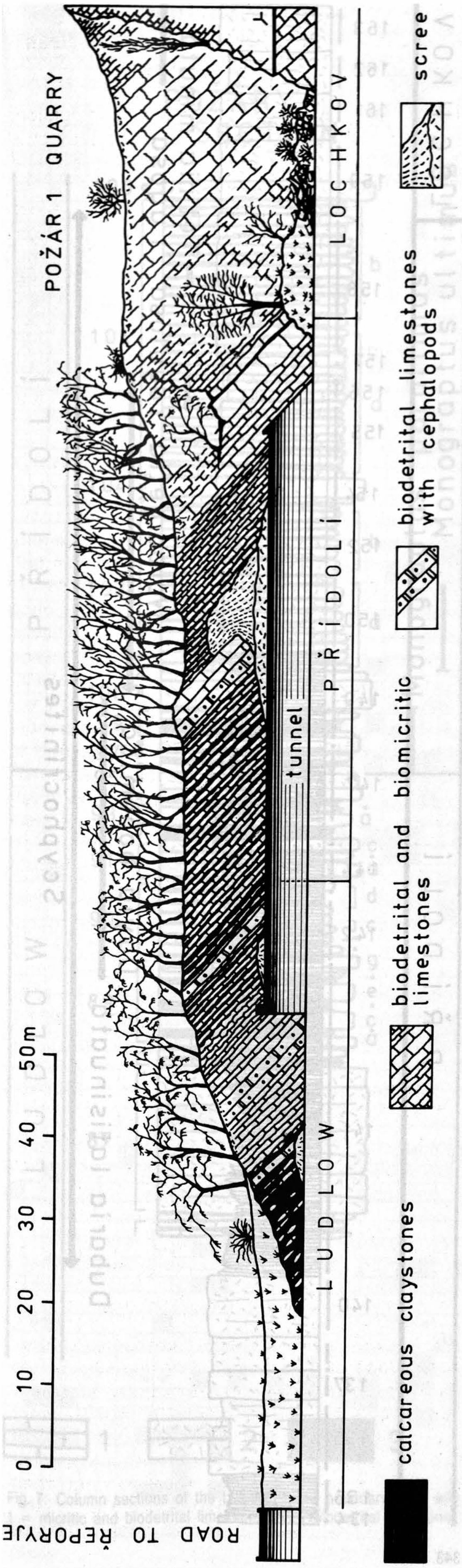

Fig. 4: Schematic representation of the Požáry Section.

Fig. 5: Požáry Section – Ludlow/Přídolí boundary beds. Dot above number 95 indicates bed no. 96 with first occurrence of *Monograptus parultimus*.

The Kopanina Formation (Ludlow) consists in the lower part of the section (Figs. 4, 6) of tuffaceous and calcareous shales with concretions and lenses of grey fine-grained limestone. The higher part is represented by brachiopod and trilobite biodetrital limestones with the transition to massive crinoidal limestones. The upper part of the Kopanina Formation sequence is built out of platy, greyish-black to grey micrite to biomicrite limestones with calcareous shale intercalations. Top of the Kopanina Formation is developed as a bank of biodetrital limestone with cephalopods (layer no. 87). The lower part of the Požáry Formation (Ludlow – Přídolí) is developed as greyish-black biomicrite to micrite limestones with calcareous shale intercalations, the higher parts as laminites. Upper parts are developed as biodetrital limestones with cephalopods and brachiopods. The uppermost part of the Požáry Formation is developed as crinoidal limestones with transition to the Lochkov Formation (Lochkov, Devonian).

5.1.1. Microscopic Description of the Boundary Beds Interval

(By Zdeněk KUKAL)

The lower part of the boundary beds section in Požáry (fig. 7) consists of an alternation of biodetrital and biomicritic limestones with variable proportions of micrite. Mud-supported biomicrites prevail over bioclast-supported biodetrital limestones. The grain size of bioclasts is strongly variable, mean grain size varies mostly between 0,15 and 0,25 mm, maximum grain size attains even few centimetres (bed no. 87).

Most of biodetrital and biomicritic limestones consist of unsorted hash of skeletal fragments. Only in few layers some traces of sorting processes could be observable (e. g. bed no. 91a). Layers of sorted biodetrital limestones are thin and form lenses between unsorted micrite-rich limestones. There are various sorts of bioclasts among which crinoid ossicles predominate being followed by shell fragments of bivalves, brachiopods, ostracods. Some trilobites were also observed. In micrites the amount of sponge spicules is considerable. Some phosphatic conodonts are also present.

Limestones contain very small admixture of clay and even quartzose silt. Maximum amount of terrigenous silt was observed in bed no. 90. The amount of organic

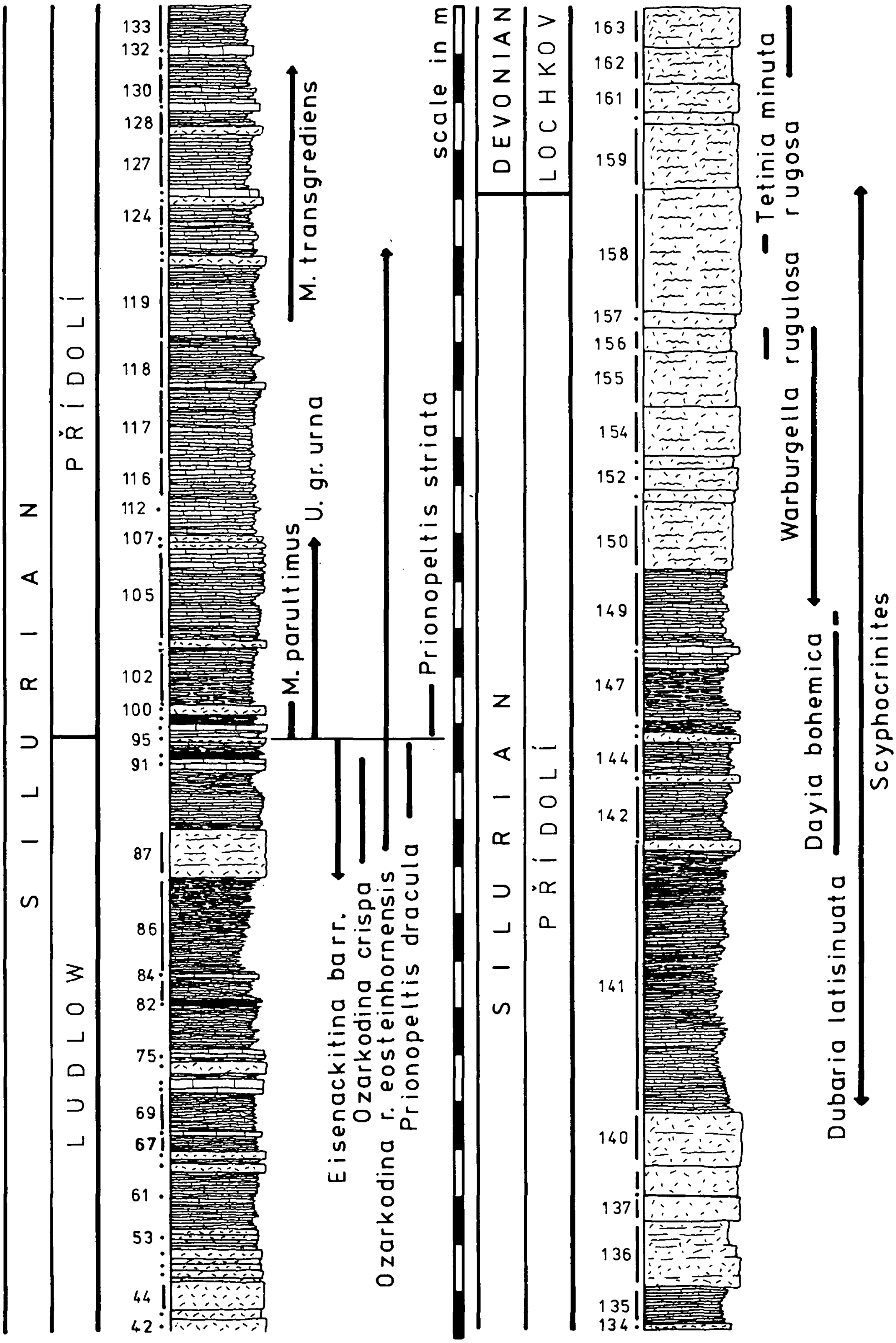

Fig. 6: Column section of the Požáry Section. Scale is in metres; see also addendum, p. 343.

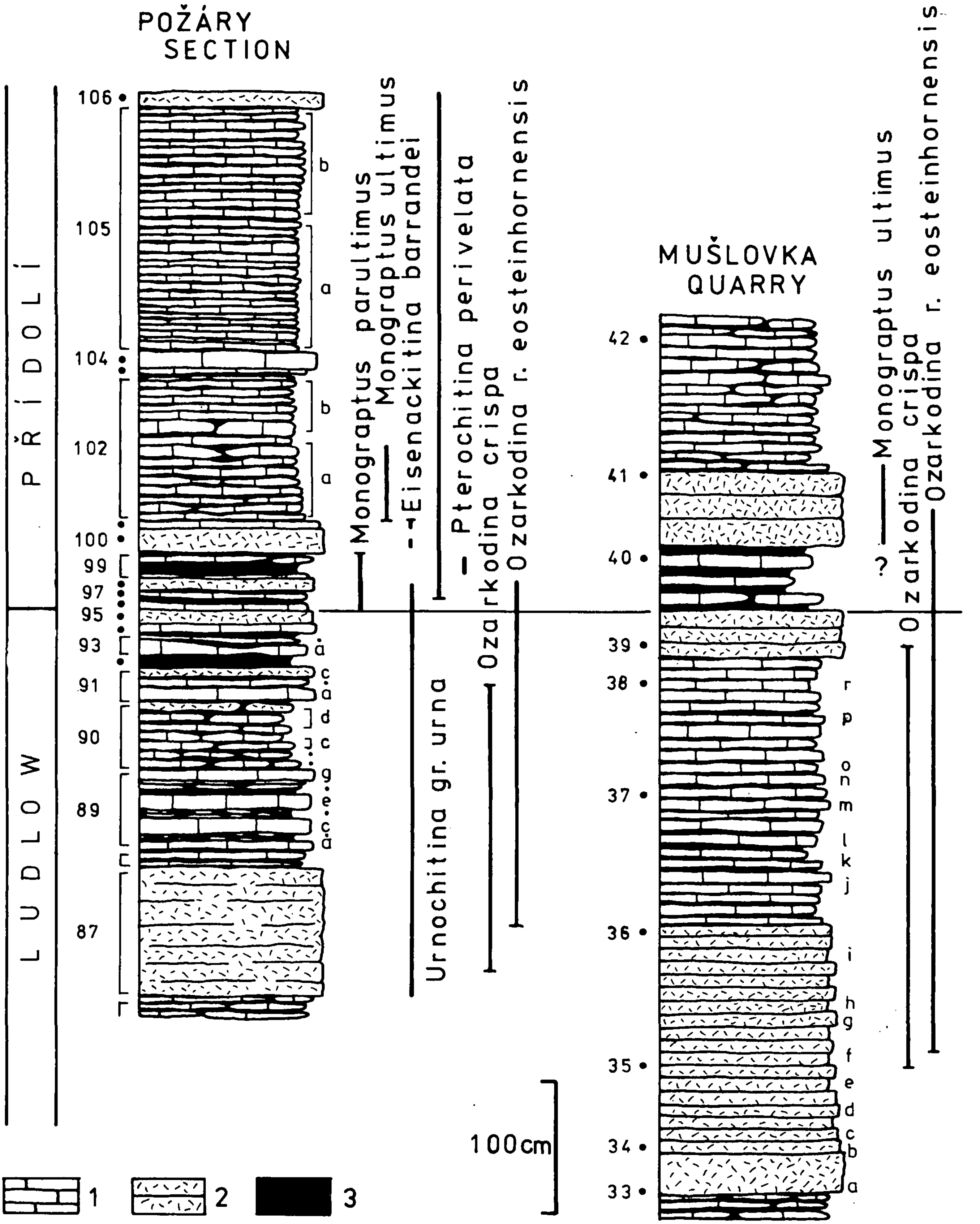

Fig. 7: Column sections of the Ludlow/Přídolí boundary beds with fossil ranges at the localities Požáry Section and Mušlovka Quarry. 1 = micritic and biodetrital limestones; 2 = biodetrital limestones; 3 = calcareous shales.

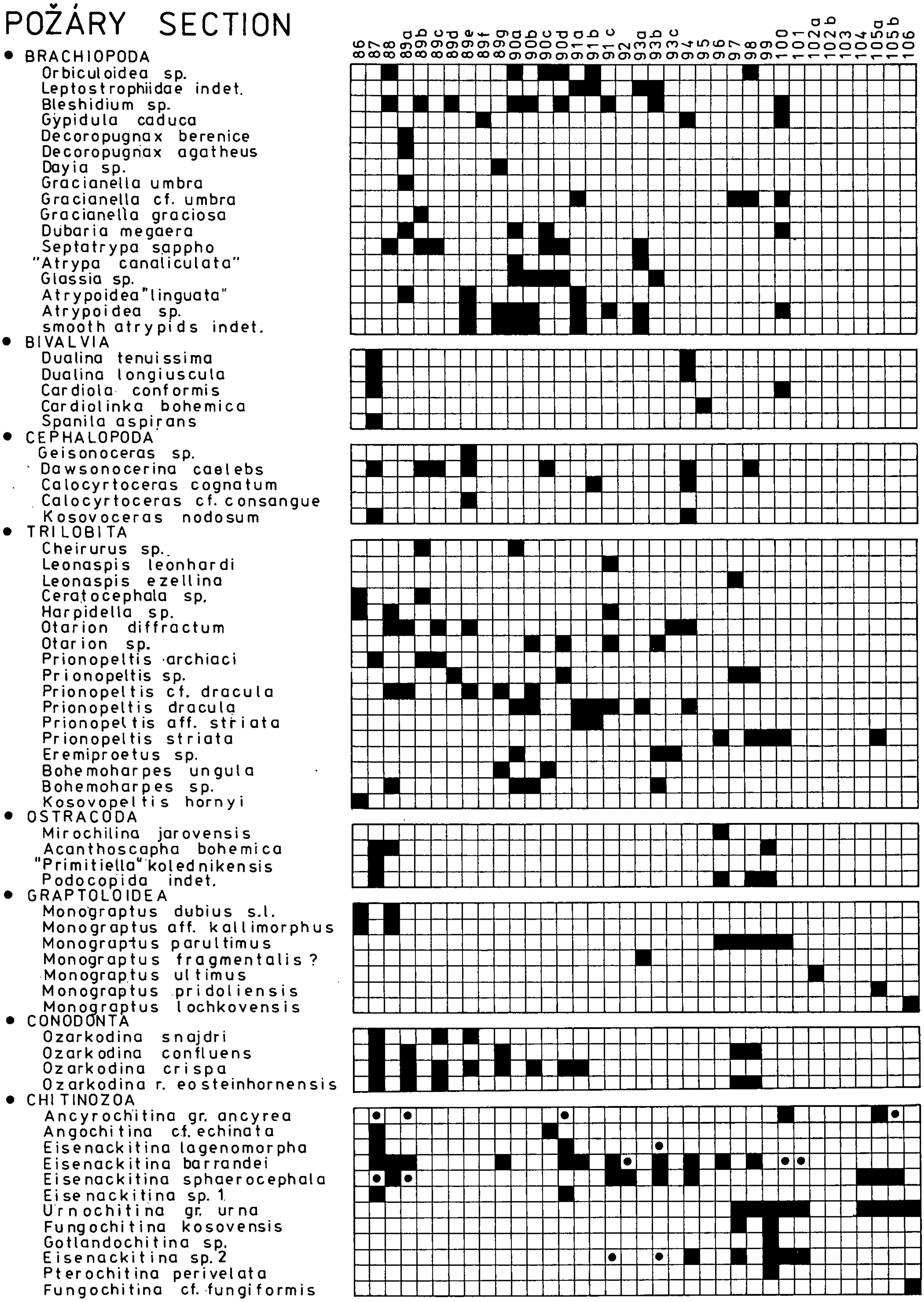

Fig. 8: Fossil ranges in the Ludlow/Přídolí boundary beds at the Požáry Section.

matter is negligible. Some dolomitization occurs, mostly in the form of nests of late-diagenetic heterogenous dolomite growing from the micrite pockets. Pyrite content is considerable in several layers. Irregular aggregates and cubic crystals of pyrite are present. Micrite in the groundmass is slightly recrystallized and attains even a nodular texture. Sparite nests are abundant being evidently of primary nature. In this case, sparite fills the primary vugs and voids in the shells and within them. Pseudosparite is also present.

In the layers just below the Ludlow – Přídolí boundary (beds no. 93 and 94) dismicrite occurs in great quantity. This birds-eye structure is of microscopical nature – the size of dismicrite lenses being of a size between 0,2–1 mm. Dismicrite is concentrated into laminae only a few millimetres thick. In several layers microstylolites are very abundant. They are not accompanied by the concentration of an insoluble residue and thus no considerable pressure solution can be assumed.

Interpretation: The top of the Ludlow sequence is characterized mostly by unsorted bioclast-supported and micrite-supported biodetrital and biomicritic limestones (fig. 9). The biogenic detritus is completely unsorted. There are no evidences, in these limestones, of specific bathymetric regimes. Some intercalations of sorted clast-supported biodetrital limestones indicate, however, episodical intensive sorting and thus possibly the depths up to several tens of metres. They might represent even storm deposits. In the uppermost parts of the Ludlow sequence occur specific limestones with dismicrites which might indicate a shallowing of the environment and even a peritidal depositional environment.

106	c	Bu	
105		L + BM	T
104		BM - Bu	S
103	L	BM/M	D
102	L	Bs/BM/Bu	
101	L	BM/M	
100	c	Bu	T
99	L	BM/Bu/M	
98		Bu/BM	
97		BM	DP
96	L	Bs/BM	
95	c	Bu	D
94		B + BM	
93a		BM	
91c		Bu - BM	
91a		Bs - BM	D
90d'		Bu	
90d		BM	T
90a		M	
89g		BM	D
89c		Bu - Bs	
88a		BM - Bu	
87		BM + Bu	P

LEGEND:

Bs - biodetrital sorted
Bu - biodetrital unsorted
BM - biomicritic
M - micritic
c - coarse
L - laminite
T - terrigenous admixture
D - dolomitization
S - silicification
P - phosphate

Fig. 9: Microscopic characters of the Ludlow/Přídolí boundary beds at the Požáry Section.

Greater part of the sequence of the Přídolí in Požáry Section is represented by laminites. They consist of a regular alternation of micrite-rich biomicrites and fine grained biodetrital limestones. There are sharp and sometimes even erosive boundaries between these two types of limestones. The laminae of biodetrital limestones are grouped into packets forming thus macroscopically evident platy limestones. The flaggy intercalations between them are formed of packets of micrite laminae.

Two exceptional layers (no. 100, 106) were recognized within this part of sequence, i. e. coarse unsorted biodetrital limestones. They contain special association of bioclasts, especially big brachiopods and bivalves and also trilobites and coral fragments. Some pockets of micrite are situated in the intergranular space but mostly sparite prevails over micrite. Some terrigenous admixture was also observed in the form of quartz grains of very fine sand and silt size (0,03–0,1 mm).

Micrites are richer in clay and they contain also some silty terrigenous admixture. Dolomitization is negligible, only some rhombs of late diagenetic dolomite were observed. Silicification is very selective being present only in some bioclasts which are replaced by chalcedonic silica. Small amounts of phosphate fragments were also observed.

Micrite is partly recrystallized into microsparite, some nests of sparite also occur being evidently of primary nature.

Many limestones are dissected by microstylolites. They are accompanied by films of organic matter and some pyrite concentrations.

Interpretation: The whole sequence of the Přídolí studied in the Požáry Section represents comparatively quiet limestone sedimentation influenced by climatic cycles and interrupted by several large events. During most of the time short-time climatic oscillations influenced the alternation of laminae of biodetritic limestones and micrites. Long-term oscillations caused the alternation of deposition of limestone beds (with prevailing biodetrital laminae) and micritic beds (with prevailing clayey micrite laminae). There can be an alternative explanation: lamination could be also caused by episodic events during which biodetritic laminae were deposited. The lamination, however, is too regular to be so and the first climatic alternative should be preferred.

The two coarse biodetrital layers (nos. 100, 106) could either represent strong episodic events (storms, etc.), or some shallowing of the basin or change in the current regime.

The general bathymetric interpretation of the basal Přídolí sequence is rather difficult. Most of the section was deposited below wave-base i. e. in the depths of several tens of metres. Fine grained bioclasts could be sorted even by the comparatively slow bottom traction currents. The regularity and lateral consistency of limestone layers speaks in favour of quiet sedimentation in quiet water.

5.1.2. Physical stratigraphy

(By Aris ANGELIDIS)

Bulk density, mineralogical density, porosity, magnetic susceptibility, K-contents and gamma activity were studied in the carbonate part of the Požáry Section 25 metres beneath and 10 metres above the Ludlow – Přídolí boundary. The boundary interval was sampled mostly bed-by-bed, the rest of the section maximally each second meter of the thickness but mostly less. 55 samples were studied. Except the characters mentioned above also content of U and Th was measured. The contents were so little that the results are not included in this paper. The study of the physical stratigraphy showed that also the weathered rocks may give to us sufficient results when compared with unweathered rocks from the deep boreholes. These results may well supplement biostratigraphic and lithostratigraphic characteristic of the sequences. This is also true for the Ludlow – Přídolí boundary rocks in the Prague Basin. As in other studied sections (Kosov, Mušlovka and Hvížďalka), the boundary may be characterized well by the magnetic susceptibility and by the gamma activity of the limestones.

In the Požáry Section the lowermost beds of the Přídolí show distinct decreasing of gamma activity (PPM U EKV) down to 2,8 PPM U EKV and distinct increasing of the magnetic susceptibility (J. SI) up to 15,2 (10^{-6} J. SI) both in bed no. 99. For other parts of the section see fig. 10. In contrary to the lowermost Přídolí rocks the top of the Kopanina Formation limestones – biodetrital limestones with accumulations of cephalopods show distinct increasing of the gamma activity – up to 10,4 PPM U EKV in bed no. 87 and minimum of magnetic susceptibility down to 1,9 (10^{-6} J. SI) in the same bed.

The results obtained from the study of the Požáry Section are similar to the results from the sections Mušlovka, Hvížďalka and Kosov. The base of the Přídolí where first *Monograptus parultimus* occurs is characterized by the distinct decreasing of the gamma activity which together with fossil content may be useful at least for the correlation within the area of the Prague Basin. This is in agreement with the UHMANNS (1975) conclusions about the importance of the magnetic susceptibility and gamma activity studies for the lithostratigraphy.

5.1.3. Biostratigraphy

Fossil ranges of fossils collected bed by bed are presented on fig. 8 for the boundary interval and on fig. 6 for the whole Požáry Section. The base of the Přídolí is defined by the first occurrence of *Monograptus parultimus* in bed no. 96. This is in agreement with the first occurrence of the chitinozoan species *Urnochitina* gr. *urna* in bed no. 97, the first occurrence of trilobite index species *Prionopeltis striata* in bed no. 96. Last occurrence of the conodont species *Ozarkodina crispa* is beneath in bed no. 91a and the first occurrence of *Ozarkodina r. eosteinhornensis* is also below, in bed no. 87. As in other sections studied the ostracode *Mirochilina jarovensis* occurs first together with *Monograptus parultimus* – in bed no. 96. Also *Eisenackitina barrandei* occurs through boundary rocks having last occurrence in bed 101. *Pterochitina perivelata* occurs first in bed no. 99.

5.2. Mušlovka Quarry

The section is located on the northern slope of Daleje Valley, about 500 m east of the Požáry Section. The section is very similar to the section Požáry (fig. 7) but only the lower 5 m of the Přídolí are exposed above more than 40 m of the Ludlow sequence. Facies development and fossil content are closely related to those of the Požáry Section. The Mušlovka Quarry represents a classical locality known to BARRANDE and studied first in detail by BOUČEK (1937) and then by KŘÍŽ & SCHÖNLAUB (1980).

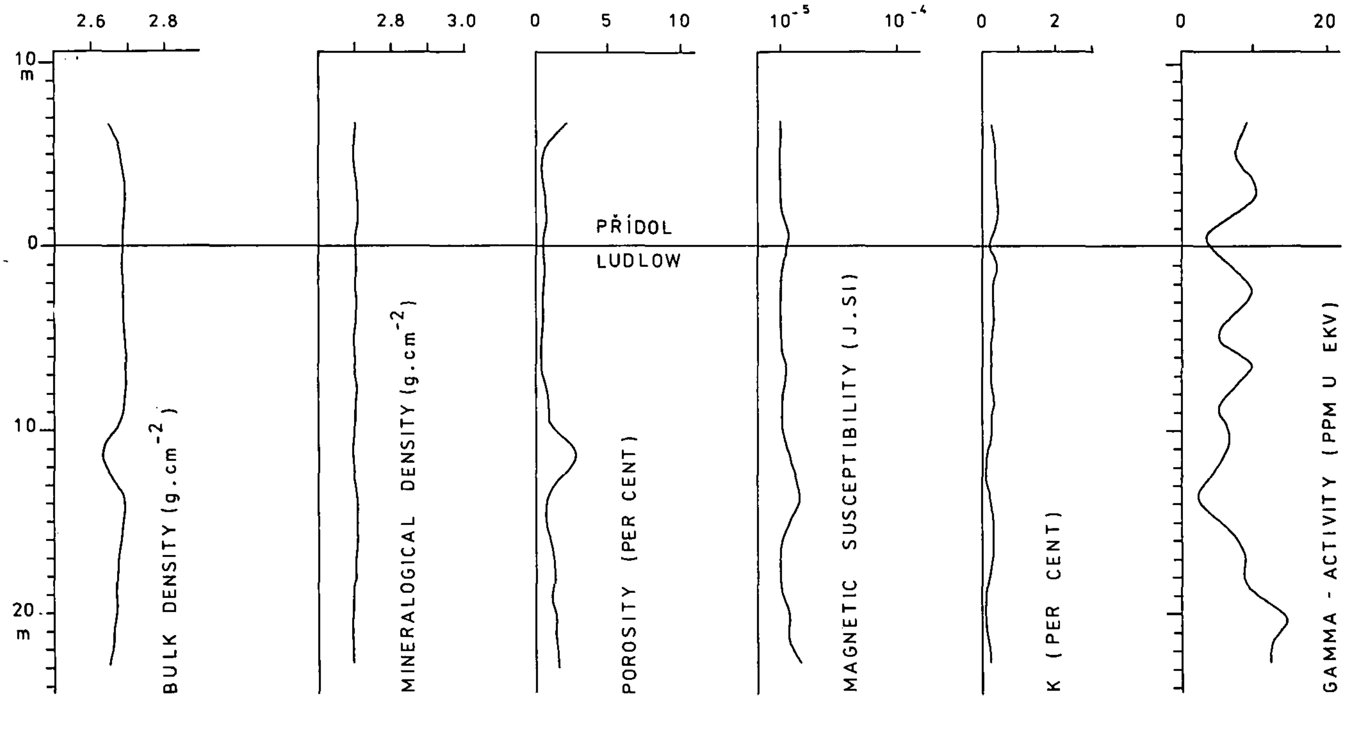

Fig. 10: Physical stratigraphy of the Ludlow/Přídolí boundary beds at the Požáry Section. For column section with scale see Fig. 6.

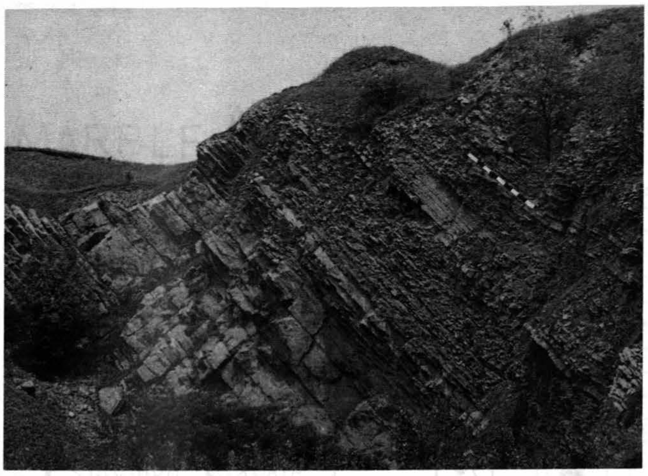

Fig. 11: Mušlovka Quarry section.

The succeeding 10 to 15 m of the Požáry Formation is covered by debris and the rest is exposed in the quarry south-east of Mušlovka Quarry (Černý lom Quarry). The sequence here is exposed up to the lower parts of the Lochkov Formation (Lochkov Stage) and was described by CHLUPÁČ (1953). Fossil ranges of the index fossils are the part of the column section (fig. 6). On this figure the Mušlovka Quarry section is correlated with the similar Požáry Section. Correlation is based on conodonts and graptolites. For the very difficult accessibility of the boundary interval the section was not sampled for chitinozoans. Mušlovka Quarry is also protected by Law no. 40/1956, statute no. 3/1982 NVP as a part of large protected area "Daleje Section" (fig. 2). The regulations are the same as the regulations for the conservation of the Požáry Section.

5.3. Lochkov Marble Quarry

The section is located in an old quarry 0,5 km SW of Lochkov, close to the southern border of Prague (fig. 1). Exposed is the Kopanina Formation in the thickness of about 5 m and the overlying Požáry Formation (more than 10 m). The upper part of the Kopanina Formation is developed as the bank of biodetrital limestone with common cephalopods which was quarried here as the well known dark "Lochkov Marble". The base of the Požáry Formation is developed as grey to black micrite to biomicrite limestones with calcareous shale intercalations.

The upper parts of the Kopanina Formation contain rich cephalopod, bivalve and trilobite fauna. The lower and middle parts of the Požáry Formation contain rich graptolite, cephalopod, eurypterid, phyllocarid, bivalve, trilobite and ostracode fauna. The section is a well known palaeontological locality. The fossils, especially cephalopods, have been quarried here since BARRANDEs time in a more than 100 m long row of test pits. The section was previously studied by PŘIBYL (1940) who established here the Přídolian graptolite zones for the first time.

Also this section was studied in great detail bed-by-bed. Fossil ranges (figs. 12, 13) for all the important groups of fossils and detailed column section are shown. The base of the Přídolí is defined by the first occurrence of *Monograptus parultimus* in bed no. 12. In the same bed starts the occurrence of chitinozoan species *Urnochitina* gr. *urna*. Interesting is the occurrence of *Monograptus formosus* in the bed no. 8 together with *Monograptus* sp. gr. *dubius* below the base of the Přídolí. Occurrence of *Eisenackitina barrandei* is similar as in Požáry Section. *Pterochitina perivelata* occurs first in the layer no. 13/14, close above the base of the Přídolí. The last occurrence of the conodont species *Ozarkodina crispa* is below the base of the Přídolí in bed no. 10. First occurrence of the species *Ozarkodina r. eosteinhornensis* was recorded in bed no. 3.

At Marble Quarry section the Ludlow – Přídolí boundary is above the Kopanina Formation – Požáry Formation boundary.

5.4. Hvížďalka Section

This section is situated in the Radotín Valley about 1 km SW from the Marble Quarry. Both sections are developed in similar facies. Exposed is about 10 m of the Kopanina Formation, an almost complete sequence of the Požáry Formation (about 45 m thick), and then overlying Lochkov Formation (Lochkov Stage). The uppermost Kopanina Formation is developed as a thick bank of biodetrital limestone with common cephalopods in some levels. The Požáry Formation is developed in the facies of greyish-black micrite to biomicrte platy limestones with shale intercalations. The section was exposed in the early 1960's in connection with the opening of new quarries for the Lochkov cement works. It was first studied by HORNÝ (1962). The facies development of the higher parts of the Požáry Formation is the same as on the other slope of the Radotín Valley where the Silurian – Devonian section "U topolů" is situated (CHLUPÁČ, 1972).

Fossil ranges for all the important groups of fossils are shown on the detailed column section of the boundary interval (fig. 12). Also this section was sampled bed-by-bed for conodonts, graptolites and chitinozoans.

Abrupt lithological change is developed at the Kopanina Formation – Požáry Formation boundary. First laminites of the Požáry Formation above the massive biodetrital limestones of the "cephalopod bank" contain index fossil of the *Monograptus pridoliensis* Subzone – *Monograptus pridoliensis*. The study of chitinozoans confirmed that the top of the "cephalopod bank" at the section corresponds to the lower parts of the Přídolí. *Eisenackitina barrandei* occurs up to bed no. 7 and *Urnochitina* gr. *urna* occurs first in bed no. 5. This means that the top of the Kopanina Formation corresponds to the *Monograptus parultimus* and the *Monograptus ultimus* Zones. Also conodonts agree with this interpretation. *Ozarkodina crispa* last occurrence is in the topmost parts of bed no. 4. The base of bed no. 5 may be thus concerned as the base of the Přídolí at the Hvížďalka Section.

5.5. Lochkov Cephalopod Quarry

The section is situated about 1 km SW of Lochkov, close to the southern border of Prague in a small abandoned quarry. Exposed is the upper part of the Kopanina Formation in the thickness of 4 m and the lowermost part of the Požáry Formation (1,5 m). The Kopanina Formation is developed as calcareous shales

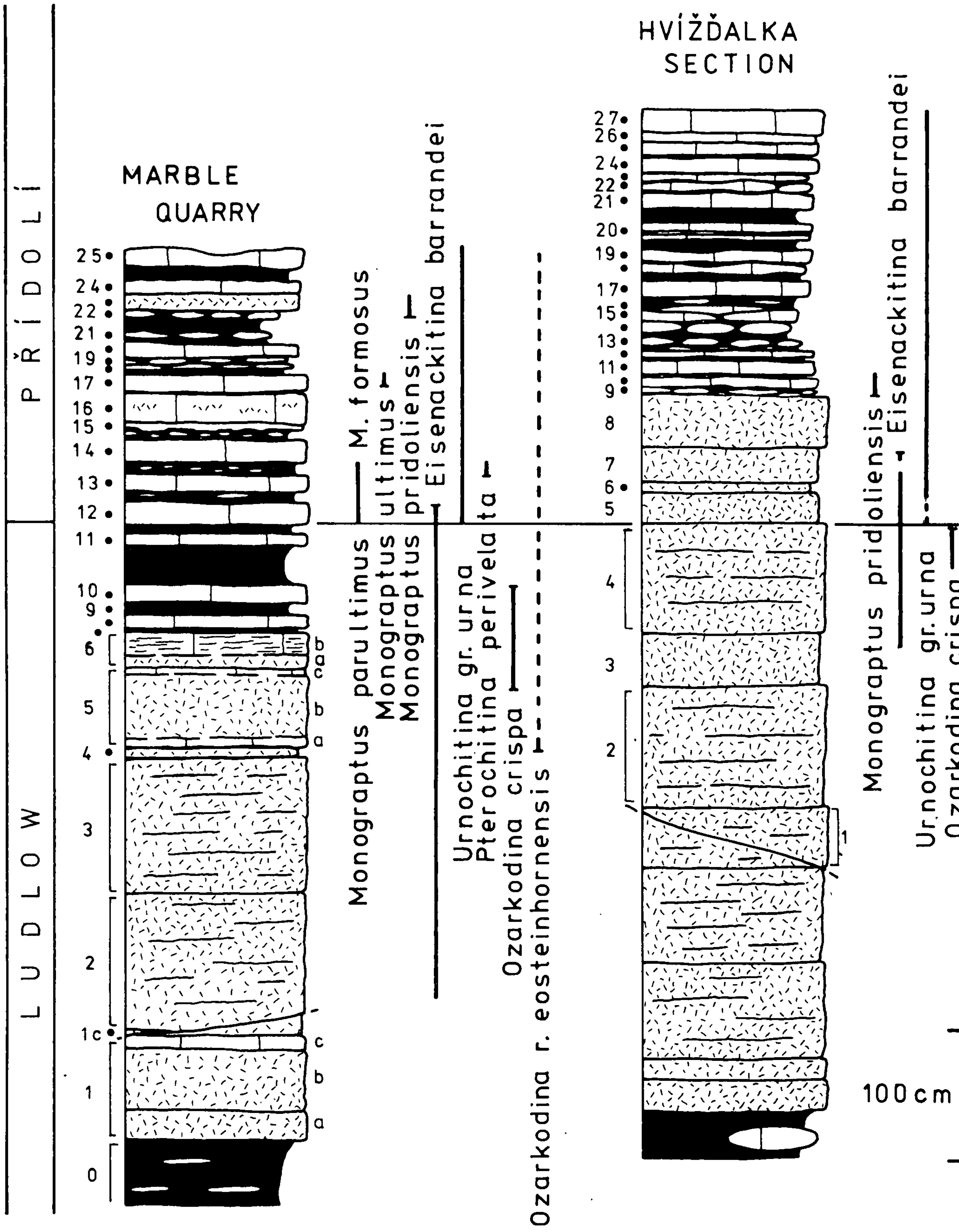

Fig. 12: Column sections of the Ludlow/Přídolí boundary beds with fossil ranges at the localities Marble Quarry and Hvížďalka. For lithology see fig. 7; see also addendum, p. 343.

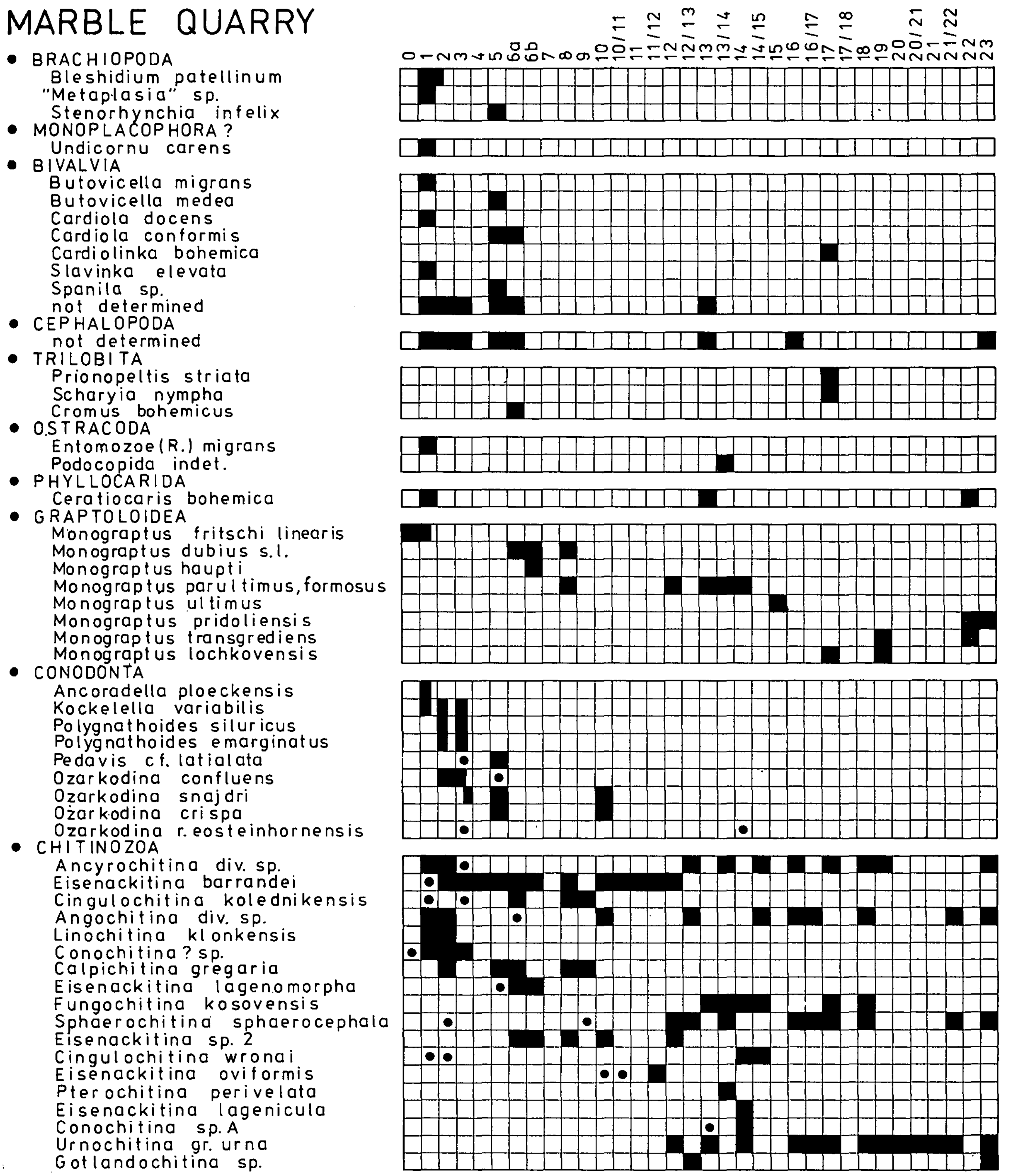

Fig. 13: Fossil ranges at the Ludlow/Přídolí boundary in the locality Marble Quarry near Lochkov. The base of the Přídolí is at the base of bed no. 12.

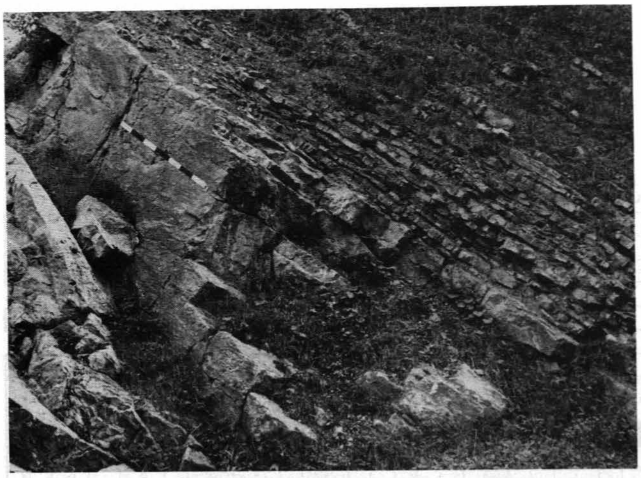

Fig. 14: Hvížďalka Section.

Fig. 15: Hvížďalka Section, detailed view of the basal beds of the Požáry Formation, Přídolí.

Fig. 16: Cephalopod Quarry section.

with limestone concretions. The uppermost parts are represented by a 1,6 m thick bank of biodetrital limestone with very common cephalopods, bivalves and some trilobites. The uppermost level of the Kopanina Formation (beds no. 6, 7) contain *Monograptus parultimus* and correspond thus to the base of the Přídolí.

The Cephalopod Quarry ("Orthoceras Quarry") is an old palaeontological locality. The fauna from this section has been listed in numerous papers e. g. BOUČEK (1941, 1951), SVOBODA & PRANTL (1950), PETRÁNEK & KOMÁRKOVÁ (1953), HORNÝ (1955), HAVLÍČEK, HORNÝ, CHLUPÁČ & ŠNAJDR (1958), CHLUPÁČ (1967). The section was studied in detail by KODYM & KOLIHA (1928) and by KŘÍŽ & SCHMITTOVÁ (1963).

The column section (fig. 17) shows the lithology and fossil ranges of most important graptolites, chitinozoans and conodonts. The section is correlated with the Braník Section developed in the same facies belt.

Monograptus parultimus occurs first in bed no. 6. Cephalopod Quarry is the type locality of *Monograptus formosus* which occurs in bed no. 8 above the last occurrence of *Monograptus parultimus* and together with *Monograptus ultimus*.

Chitinozoan species *Urnochitina* gr. *urna* occurs first in the topmost part of bed no. 5c just beneath the first occurrence of *Monograptus parultimus*. *Eisenackitina barrandei* occurs also in the top of bed no. 5c. Important is the discovery of the first occurrence of *Linochitina klonkensis* at the base of *Monograptus parultimus* Biozone.

Ozarkodina crispa last occurs just below the first occurrence of *Monograptus parultimus* and first occurrence of *Ozarkodina r. eosteinhornensis* is at the base of the *Monograptus parultimus* Biozone.

The Ludlow – Přídolí boundary is most probably within the topmost 10 cm of bed no. 5c.

The Cephalopod Quarry section is protected by the Law no. 40/1956 as palaeontological locality by the statute MK 9861/1976. The regulations are the same as regulations for the conservation of the Požáry Section.

5.6. Braník Section

The section is situated on the east bank of Vltava River in Prague, south of the Vyšehrad Fortress. Exposed are the uppermost 3 m of the Kopanina Formation and about 10 m of the Požáry Formation. The Kopanina Formation is developed as calcareous shales with limestone concretions and at the top as a massive bank of biodetrital limestone with common cephalopods and bivalves (110 cm). The lowermost parts of the Požáry Formation are developed as laminites with shale intercalations. The section is an old palaeontological locality known already to BARRANDE. Fossil ranges are shown in the detailed column section (fig. 17) and correlated with the Cephalopod Quarry which is situated approximately 7 km in SW direction.

In the Braník Section the "cephalopod bank" shows minimal thickness. Beds no. 9–13 in the total thickness 95 cm represent here 1700 cm of the thickness of the "cephalopod bank" at the Kosov Quarry section.

Monograptus parultimus occurs first in the topmost 4 cm of bed no. 13 in the micritic limestone. *Urnochitina* gr. *urna* occurs first just below the top of bed no. 13. Last occurrence of *Eisenackitina barrandei* is within bed no. 12. Interesting is the first occurrence of *Pterochitina perivelata* in bed no. 14. Important is the occurrence of *Monograptus branikensis* in beds no. 15, 17 and 19.

The Ludlow – Přídolí boundary lies within the topmost 5 cm of bed no. 13.

The section is a part of the protected area Braník Rocks. It is protected by the Law no. 40/1956, by the statute NVP 5/1968. The regulations are the same as for other protected localities but because the locality is

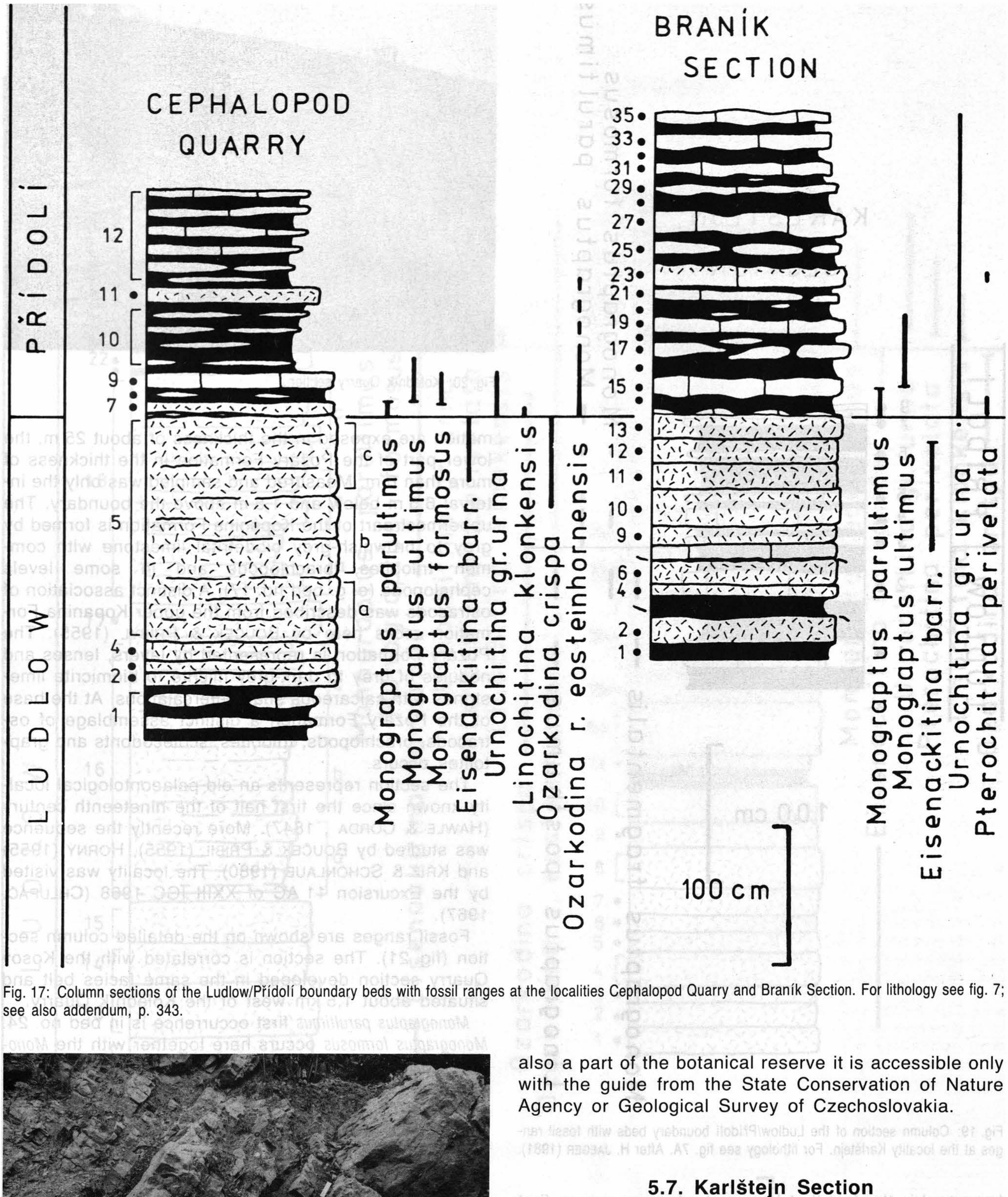

Fig. 17: Column sections of the Ludlow/Přídolí boundary beds with fossil ranges at the localities Cephalopod Quarry and Braník Section. For lithology see fig. 7; see also addendum, p. 343.

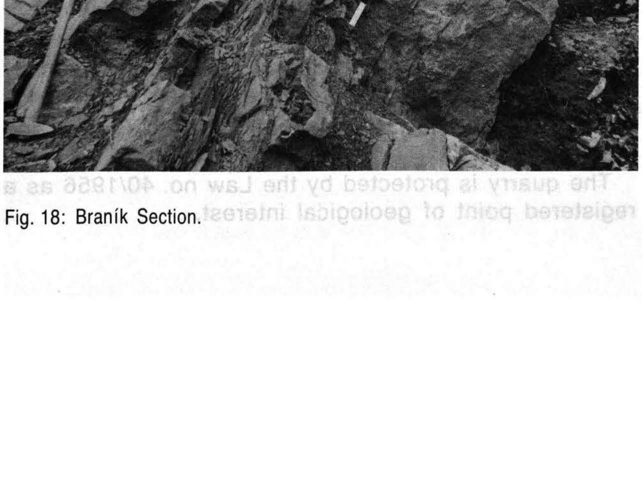

Fig. 18: Braník Section.

also a part of the botanical reserve it is accessible only with the guide from the State Conservation of Nature Agency or Geological Survey of Czechoslovakia.

5.7. Karlštejn Section

This important section of the Ludlow – Přídolí boundary is not exposed at present. The section was exposed only temporarily in 1981 and was situated by the road below the Budňany Rock in Karlštejn near the house no. 132. The section was measured and collected by JAEGER. The whole sequence is developed in the facies of dark micrite limestones with calcareous shales intercalations. It contains rich graptolite fauna. The sequence here in Karlštejn is transitional across the Ludlow – Přídolí boundary which is situated below bed no. 3 where the first *Monograptus parultimus* occurs.

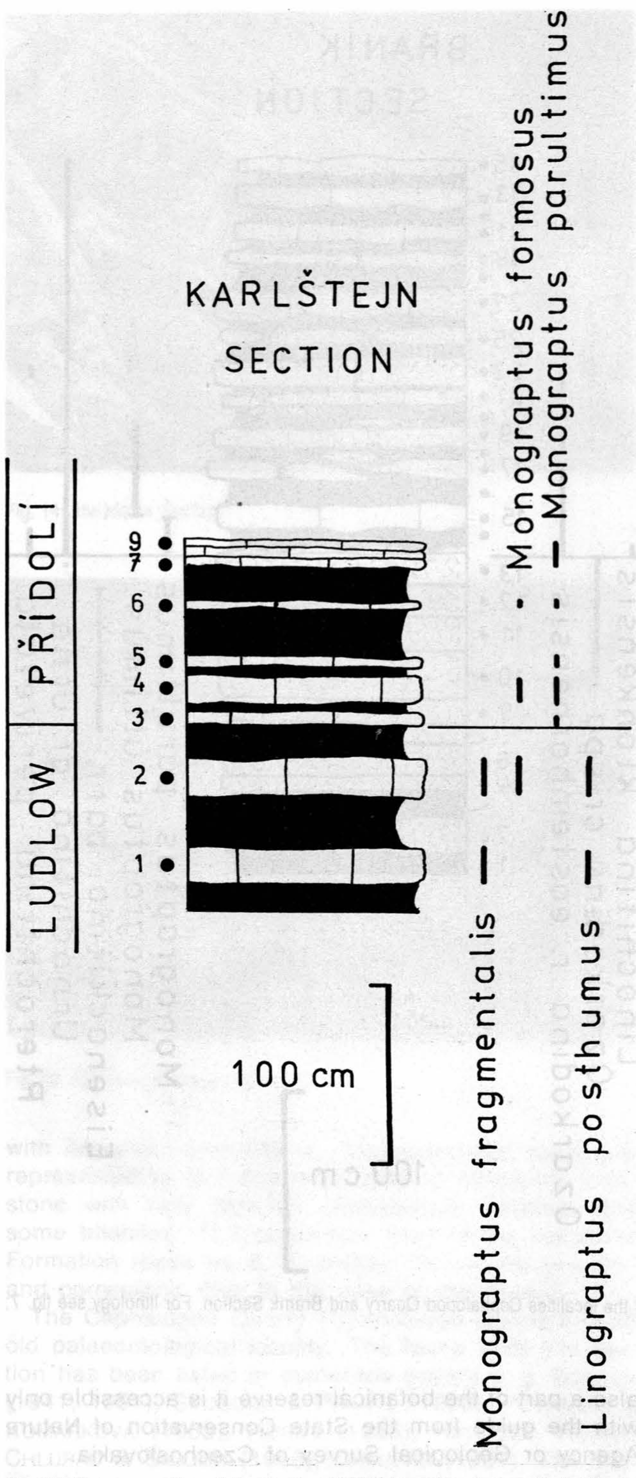

Fig. 19: Column section of the Ludlow/Přídolí boundary beds with fossil ranges at the locality Karlštejn. For lithology see fig. 7A. After H. JAEGER (1981).

Important is the fact that *Monograptus formosus* occurs first below the Ludlow – Přídolí boundary in bed no. 2 and continues in occurrence above the boundary up to bed no. 6. Other graptolite species ranges are shown in the column section on fig. 19.

5.8. Koledník Quarry

The section is situated in an abandoned quarry between the villages Jarov and Koledník, south of the town of Beroun. The upper parts of the Kopanina Formation are exposed in the thickness of about 25 m, the lower part of the Požáry Formation in the thickness of more than 6 m. Measured and sampled was only the interval 6,5 m below and 1,5 m above the boundary. The uppermost part of the Kopanina Formation is formed by grey to brownish-grey biodetrital limestone with common trilobites, brachiopods and in some levels cephalopods (e. g. bed no. 17). A distinct association of ostracods was described from the upper Kopanina Formation rocks here by BOUČEK & PŘIBYL (1955). The Požáry Formation is represented by layers, lenses and nodules of grey to dark-grey micrite to biomicrite limestones with calcareous shale intercalations. At the base of the Požáry Formation a distinct assemblage of ostracods, brachiopods, trilobites, scolecodonts and graptolites occurs.

Fig. 20: Koledník Quarry section.

The section represents an old palaeontological locality known since the first half of the nineteenth century (HAWLE & CORDA , 1847). More recently the sequence was studied by BOUČEK & PŘIBIL (1955), HORNÝ (1955) and KŘÍŽ & SCHÖNLAUB (1980). The locality was visited by the Excursion 11 AC of XXIII IGC 1968 (CHLUPÁČ, 1967).

Fossil ranges are shown on the detailed column section (fig. 21). The section is correlated with the Kosov Quarry section developed in the same facies belt and situated about 1,5 km west of the Koledník Quarry.

Monograptus parultimus first occurrence is in bed no. 24. *Monograptus formosus* occurs here together with the *Monograptus parultimus* in bed no. 26. *Urnochitina* gr. *urna* first occurrence is in bed no. 24 where it occurs together with *Linochitina klonkensis* which occurs first in bed no. 23. *Pterochitina perivelata* occurs first in bed no. 25. The base of the Přídolí lies at the base of bed no. 24 i. e. just above the base of the Požáry Formation. This is in agreement with the occurrence of ostracode fauna characterized by *Mirochilina jarovensis*. The position of the boundary is also well documented by conodonts. *Ozarkodina crispa* last occurrence is in bed no. 18c beneath the base of the Přídolí and *Ozarkodina r. eosteinhornensis* occurs first just above bed no. 17, 194 cm below the base of the Přídolí. The base of the Přídolí is further characterized by mass occurrence of *Cardiolinka bohemica* (Bivalvia) in bed no. 24 and *Prionopeltis striata* (first in bed no. 26).

The quarry is protected by the Law no. 40/1956 as a registered point of geological interest.

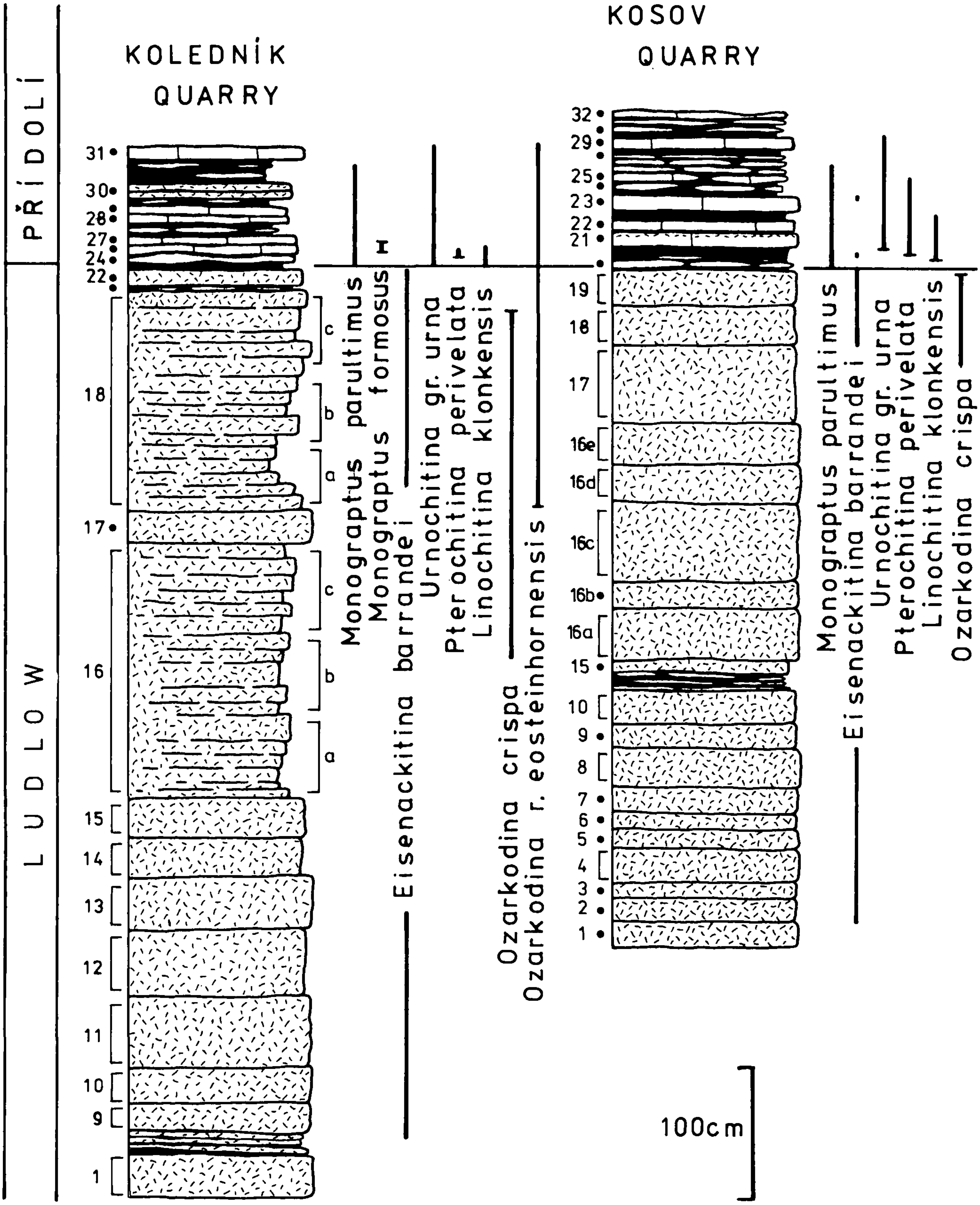

Fig. 21: Column sections of the Ludlow/Přídolí boundary beds with fossil ranges at the localities Koledník Quarry and Kosov Quarry. For lithology see fig. 7; see also addendum, p. 343.

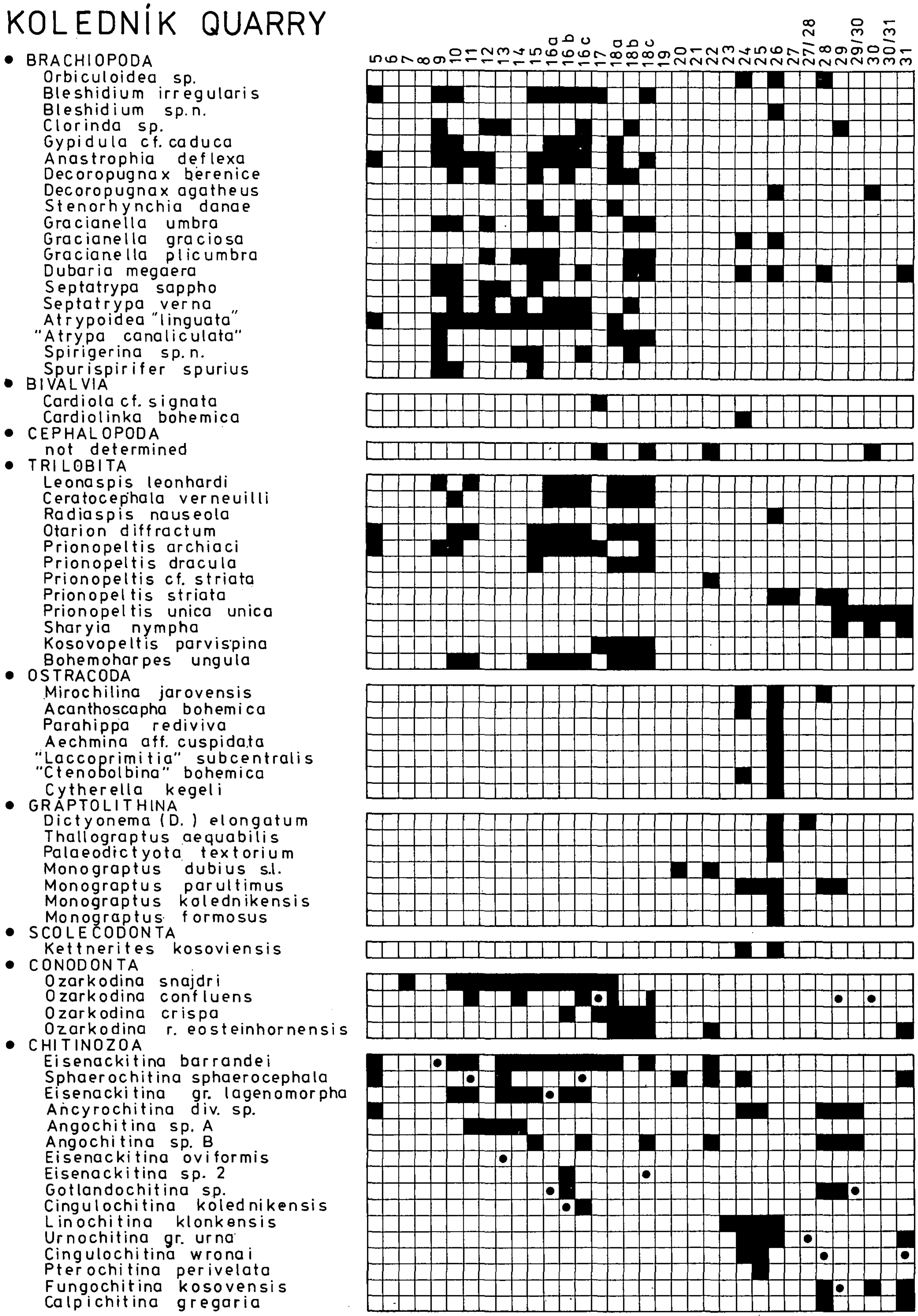

Fig. 22: Fossil ranges at the Ludlow/Přídolí boundary beds in the locality Koledník Quarry. The base of the Přídolí is at the base of bed no. 24.

5.9. Kosov Quarry

The section is situated in an abandoned part of the Kosov Quarry, about 3 km south of Beroun town. In the quarry the upper parts of the Motol Formation (Wenlock), Kopanina Formation, and the lower and middle parts of the Požáry Formation are exposed. Bed-by-bed study was confined to the Ludlow – Přídolí boundary interval exposed in the northeastern face of the quarry. The uppermost 3,5 m of the Kopanina Formation is developed as grey to brownish-grey biodetrital limestone with common brachiopods, trilobites and ostracods. At the top bedding plane a rich assemblage of cephalopods occurs. The lowermost 1,5 m of the Požáry Formation is represented by layers, lenses and nodules of grey to dark-grey micrite to biomicrite limestones with calcareous shale intercalations. The base of the Požáry Formation is rich in trilobites, graptolites, ostracods, brachiopods and bivalves. At this level also vascular plants were found (*Cooksonia, ?Taeniocrada*).

Fig. 23: Kosov Quarry section.

The Kosov Quarry is a well known sequence of the Silurian and a classical palaeontological locality from which the rich fauna has been described in numerous papers. The section was studied previously in detail by HORNÝ (1955), BOUČEK & PŘIBYL (1955), and described by HAVLÍČEK, HORNÝ, CHLUPÁČ & ŠNAJDR (1958).

The section is protected as a registered point of geological interest.

The fossil ranges are shown on the detailed column section of the Ludlow – Přídolí boundary interval (fig. 21). *Monograptus parultimus* occurs first in bed no. 20/21 which is considered as the base of the Přídolí in this section. *Eisenackitina barrandei* last occurrence is in bed no. 24. *Urnochitina* gr. *urna* occurs first in bed no. 21, *Pterochitina perivelata* occurs first in bed no. 20/21 and *Linochitina klonkensis* in bed no. 20.

Last occurrence of *Ozarkodina crispa* is in bed no. 19, beneath the base of the Přídolí. The boundary is further well documented by the mass occurrence of bivalve *Cardiolinka bohemica* in bed no. 20/21. In bed no. 21 occurs first trilobite *Prionopeltis striata* and ostracode *Mirochilina jarovensis*.

5.10. Čertovy schody

The section is situated close to the main entrance to the Čertovy schody Quarries, about 1,2 km south-west

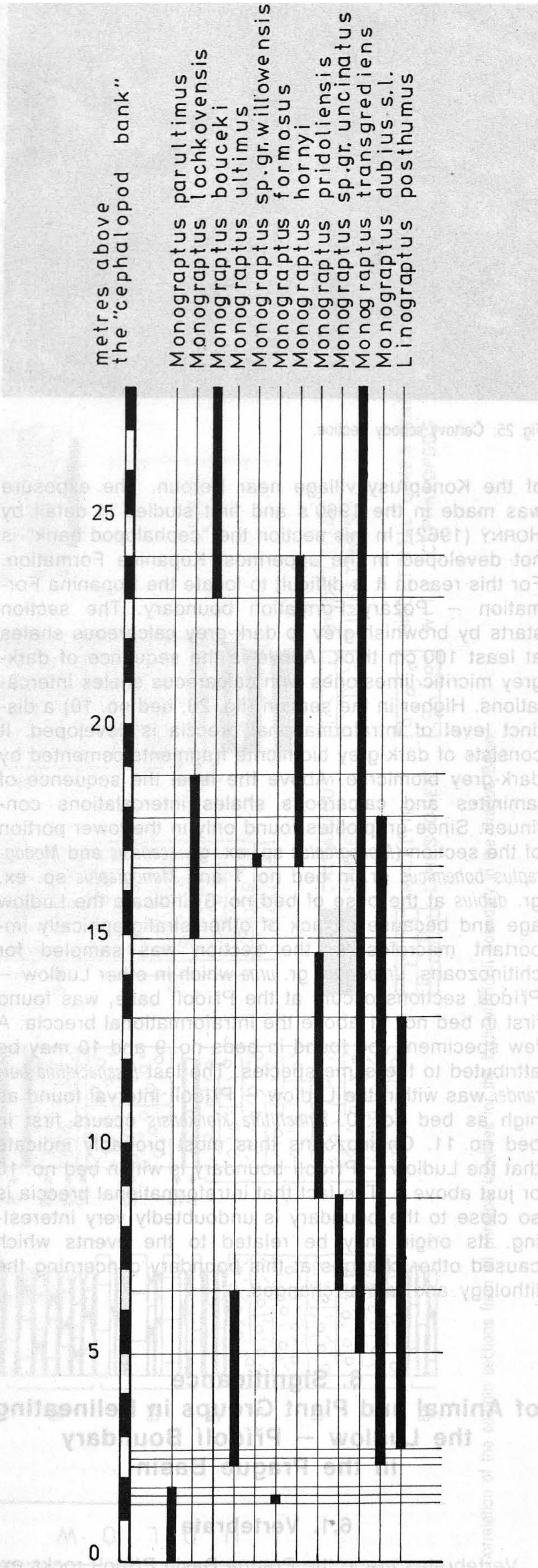

Fig. 24: Distribution of graptolites in the Požáry Formation at the Kosov Quarry section. According to JAEGER (1978, 1879, 1981) field work.

Fig. 25: Čertovy schody Section.

of the Koněprusy village near Beroun. The exposure was made in the 1960's and first studied in detail by HORNÝ (1962). In this section the "cephalopod bank" is not developed in the uppermost Kopanina Formation. For this reason it is difficult to locate the Kopanina Formation – Požáry Formation boundary. The section starts by brownish-grey to dark-grey calcareous shales at least 100 cm thick. Above is the sequence of dark-grey micritic limestones with calcareous shales intercalations. Higher in the section (fig. 26, bed no. 10) a distinct level of intraformational breccia is developed. It consists of dark-grey biomicrite fragments cemented by dark-grey biomicrite. Above the level the sequence of laminites and calcareous shales intercalations continues. Since graptolites found only in the lower portion of the section (*Monograptus* sp. ex. gr. *scanicus* and *Monograptus bohemicus* gr. in bed no. 1 and *Monograptus* sp. ex. gr. *dubius* at the base of bed no. 3) indicate the Ludlow age and because of lack of other stratigraphically important macrofossils, the section was sampled for chitinozoans. *Urnochitina* gr. *urna* which in other Ludlow – Přídolí sections occurs at the Přídolí base, was found first in bed no. 11 above the intraformational breccia. A few specimens too found in beds no. 9 and 10 may be attributed to the same species. The last *Eisenackitina barrandei* was within the Ludlow – Přídolí interval found as high as bed no. 10. *Linochitina klonkensis* occurs first in bed no. 11. Chitinozoans thus most probably indicate that the Ludlow – Přídolí boundary is within bed no. 10 or just above it. The fact that intraformational breccia is so close to the boundary is undoubtedly very interesting. Its origin may be related to the events which caused other changes at this boundary concerning the lithology and faunal changes.

6. Significance of Animal and Plant Groups in Delineating the Ludlow – Přídolí Boundary in the Prague Basin

6.1. Vertebrata

Vertebrates are in the Prague Basin Přídolí rocks extremely rare. An acanthodian *Onchus graptolitorum* has been found in upper levels of the Přídolí.

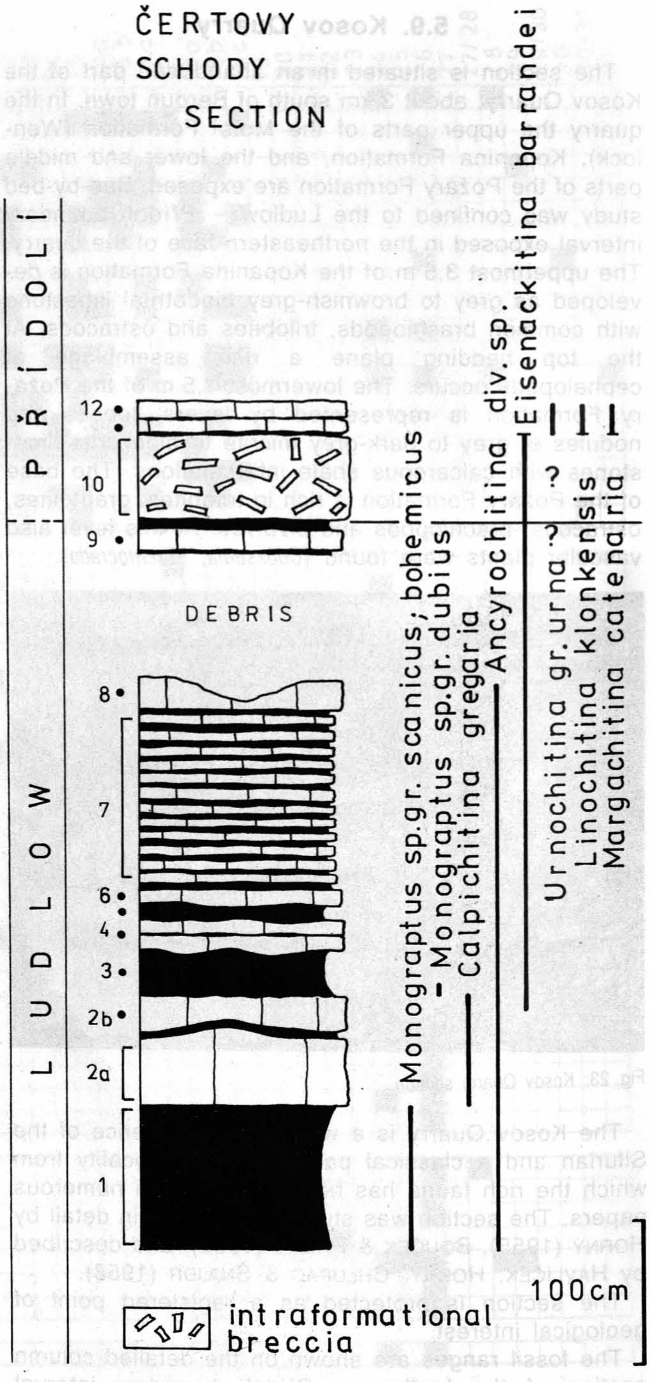

Fig. 26: Column section of the Ludlow/Přídolí boundary beds at the locality Čertovy schody Section. For lithology see fig. 7.

6.2. Graptolithina

(By Hermann JAEGER)

Plate 1–4

6.2.1. Occurrence and Preservation

In the type Přídolí graptolites occur in most rock-types varying from grey-black argillaceous shales (Podolí) through grey-black somewhat calcareous shales with interbedded dark bituminous nodular and platy limestones (Čertovy schody) to dark or lighter grey, brown to yellow weathering platy and nodular brachiopod-cephalopod limestones with or without interbedded argillaceous to calcareous shales (Kosov Quarry). Graptolites are almost lacking only in the

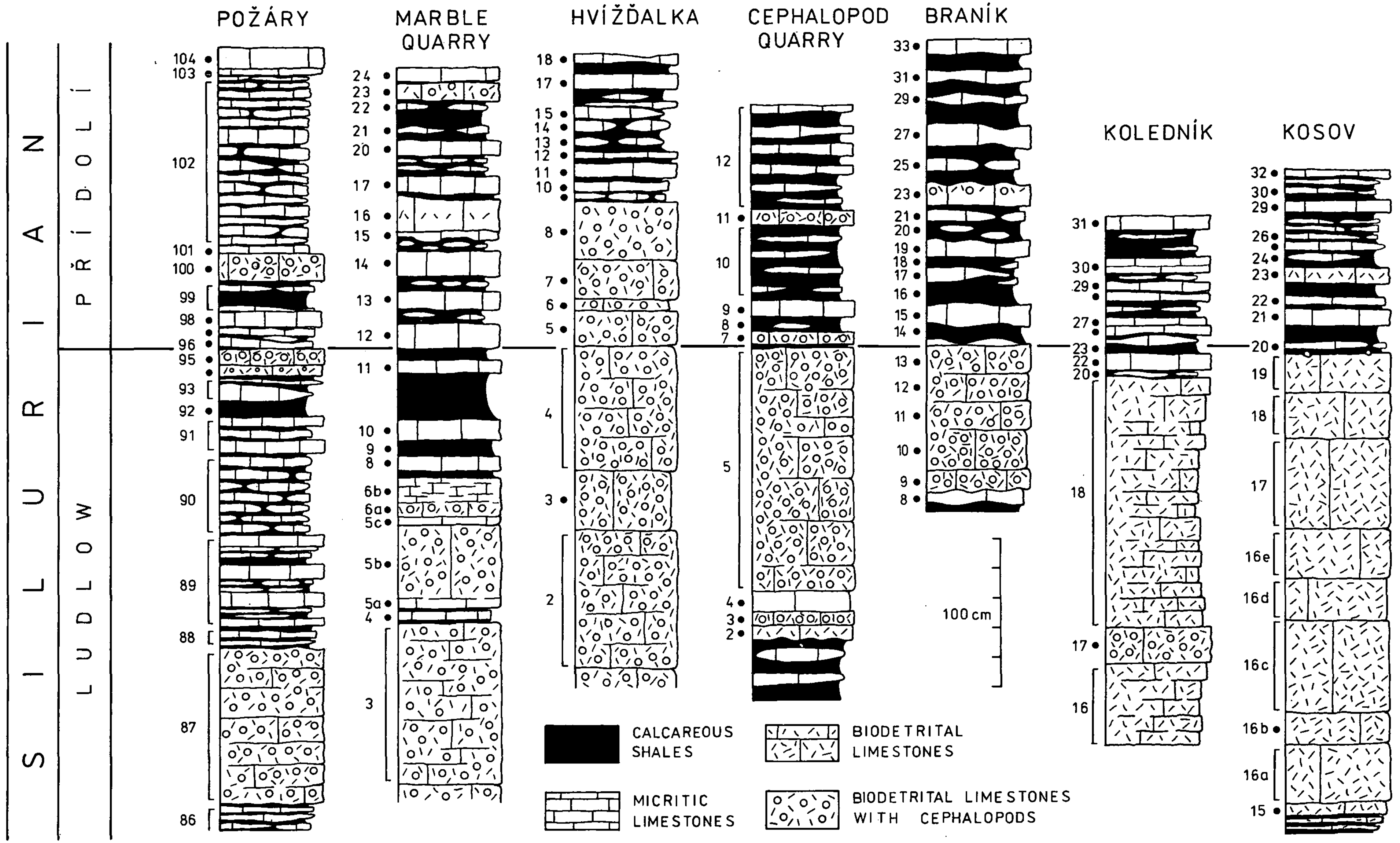

Fig. 27: Correlation of the column sections from all principal localities for the Ludlow/Přídolí boundary in the Prague Basin.

coarse bright-grey to white crinoid and brachiopod limestones that consist of densely packed shells of, for instance, *Dayia bohemica* or *Dubaria megaera* (for instructive photographs of exposures see HORNÝ, 1962).

Graptolites usually occur bed by bed, but may be looked for in vain at certain intervals, without obvious reason. As a rule, they are of frequent occurrence, often even densely crowding bedding planes. The diversity is always low; the associations consist of a few species only, half a dozen forms being the exceptional maximum in a zone; typically, a sole greatly predominating species is to be seen on the bedding planes. However, the frequency of individual species may vary from bed to bed and from section to section (see descriptions of the graptolites).

In addition to the biochronologically most important Graptoloidea that form the subject of this study, dendroid graptolites also occur in every section, and with similar frequency as the Graptoloidea (see BOUČEK, 1957).

Preservation is normally good, regardless of whether the graptolites are flattened, as is the rule in the various shales, or whether they are preserved in full relief, as is typical for the limestones, in which the graptolites occur often so densely packed that graptolite limestones are formed, e. g. in the Zones of *M. parultimus*, *M. ultimus* and *M. lochkovensis*. The periderm is strongly coalified, typically black and brittle. Nevertheless, I succeeded in etching out of the rock half a dozen species; of some only fragments, of others the entire growth series of rhabdosomes have been prepared (*M. parultimus, M. ultimus*). Because of the no stronger than Jura-type Variscan folding of the Barrandian Silurian, flow cleavage and resultant deformations of the graptolites occur only exceptionally and remain slight, e. g. in a number of beds in the Kosov Quarry.

By contrast, in the upper portion of the Barrandian Ludlow (Kopanina Formation), i. e. in beds above the Zone of *M. fritschi linearis* and below that of *M. parultimus*, graptolites are generally far less frequently met with than in the succeeding Přídolí, except for a few localities (Karlštejn) and except for certain beds (Mušlovka). That is probably due to the predominance of coarse biodetrital limestones in much of the calcareous facies of the upper Kopanina. Compared with the graptolite fauna of the coeval grey-green claystones on the East European Platform, the Barrandian late Ludlow yields an impoverished, very low diversity monograptid fauna.

6.2.2. Foundation of the Přídolí

As milestones on the way towards recognizing the Přídolí as a stratigraphical entity of its own within the Silurian of the Barrandian, reference may be made to the papers by BOUČEK (1934), PŘIBYL (1940) and PRANTL & PŘIBYL (1948). The latter introduced the term Přídolí Beds for the Bohemian "Middle Ludlow" (= Upper Budňany = Upper eβ = eβ_2).

The breakthrough of the notion that the Přídolí Beds are significantly younger than the British middle Ludlow came at the Bonn – Brussels Arbeitstagung 1960 (ERBEN, 1962). Instrumental towards that end was the work of A. J. BOUCOT (e. g. 1960), who convincingly demonstrated that certain topostratigraphical units on the European continent that were believed to be of middle Ludlovian age, e. g. the Köbbinghäuser Schichten in the Rheinisches Schiefergebirge, are in reality younger than the British middle Ludlow and even younger than the British upper Ludlow, thereby confirming J. SHIRLEYS correlations advanced with considerable foresight as early as 1938, and inspiring other workers to reconsider the correlations of even more distant strata, such as the Přídolí Beds in Bohemia. (For more detailed historical accounts see JAEGER, 1965; 1981).

6.2.3. General Characterization of Přídolian Graptolites

The chief reason, why the Přídolí was recognized as a stratigraphical stage of its own relatively late, is perhaps the fact that the contained graptolites virtually lack forms with extreme morphologies. There is hardly any species that can be as easily identified as many other graptolites from various earlier times. Upon closer inspection of the Přídolian graptolites, quite a number of forms will be found that prove to be highly peculiar to this stage, which renders the Přídolian graptolite fauna as a whole characteristic and distinct from both the preceding Ludlovian and the succeeding Lower Devonian faunas that are dominated by other types of graptolites. This very fact sufficiently justifies differentiating the Přídolí as a separate stage in graptolite history, and as a stage in Silurian stratigraphy as well.

Except for a few hold-overs from the Ludlow, the large majority of graptoloid species is confined to the Přídolí. The hold-overs are the following: *M. dubius* is sporadically met with at least up to the *perneri* Zone. The extraordinary *M. formosus* is a typical constituent of both the uppermost Ludlovian *fragmentalis* Zone plus the two basal Přídolian *parultimus* and *ultimus* Zones. *Linograptus posthumus* extends through all of the Přídolí and – as the sole species in the Barrandian – even passes over into the Devonian. The Přídolian *L. posthumus* is special in that it exhibits a greater variability than in the Devonian; rhabdosomes composed of 4, 5, 6, 7, 8 and even more branches occur in subequal proportions, whereas in the Devonian the variability of the number of branches is much reduced, 4 branched rhabdosomes forming the large majority.

Most typical of the Přídolí are several groups of small to medium-sized, stout and straight, biform species that possess more or less developed paired lateral extensions of the thecal apertures, at least proximally, and simpler thecae distally (*M. parultimus, M. ultimus, M. branikensis, M. lochkovensis* and *M. transgrediens*). Another species of this type, *M. nimius* KOREN (1983) was described from Kazakhstan. It is this morphological fashion that renders the Přídolian graptolite fauna so peculiar. With the extinction of *M. transgrediens* by the end of the Přídolí, this type of graptolite disappeared for ever.

That morphology was fore-shadowed by such Ludlovian species as *M. deubeli, M. sigmoidalis, M. roemeri, M. latilobus* and possibly certain others, but none of those can be linked with any of the Přídolian forms.

The second element, which is of approximately equal importance as the former, is represented by small to medium-sized, straight or slightly curved species with virtually uniform *uncinatus* type thecae (*M. similis, M. hornyi, M. prognatus, M. bouceki, M. perneri* and *M. beatus* with rather modified *uncinatus* thecae). A few other species of this type have been described from the Přídolí elsewhere, e. g. *M. birchensis* BERRY & MURPHY (1975) from Nevada, where it crosses the Silurian – Devonian boundary, *M. mironovi* KOREN (1938) and several more derived forms from Kazakhstan.

Species of the *uncinatus* group make their first appearance also already in the Ludlow (*M. uncinatus* itself in the uppermost *vulgaris* Zone and *colonus* Zone), but are of subordinate significance in those old times. It is in the Devonian that they reach the peak of their evolution, and then even acquire the exclusive right.

A third, rare element that was only recently found by the writer, is a spinous species (*M.* sp. gr. *willowensis* BERRY & MURPHY with paired lateral apertural spines in the proximal thecae). This type of graptolite was hitherto known only from the Přídolí of Nevada and Kazakhstan. It is somewhat of a surprise in strata of this age, as comparable spinous species are a dominating element in much of the lower half of the Ludlow.

6.2.4. Graptolite Zonation

In establishing a sequence of graptolite zones that basically stood the test of time PŘIBYL (1940) made his "upper eβ" a reference unit for interregional and even global correlations, i. e. he laid the foundations for the current use of the Přídolí as an international stratigraphical Standard Unit. There would appear to be little point in tracing here the ever changing modifications of the Přídolian zone scale that were published subsequent to PŘIBYLS (1940) pioneer paper (mostly by PŘIBYL himself – PŘIBYL, 1943a, 1948, 1981, 1983; PRANTL & PŘIBYL, 1948, 1951; BOUČEK, 1960; JAEGER, 1967, 1981). The newest zonal chart for the type Přídolí that I consider as adequate to our present knowledge is shown in Table 1.

Table 1: Graptolite zonation of the type Přídolí in the Prague Basin (Barrandian area).

Devonian	Zone of *Monograptus uniformis* (inclusive of the basal beds with *M. uniformis angustidens*)
Silurian	
	Interzone of *Monograptus transgrediens*
	Zone of *Monograptus perneri*
Přídolí	Band of *Monograptus beatus*
	Zone of *Monograptus bouceki*
	Zone of *Monograptus lochkovensis*
	Upper Subzone of *Monograptus lochkovensis*
	Subzone of *Monograptus pridoliensis*
	Lower Subzone of *Monograptus lochkovensis*
	Zone of *Monograptus ultimus*
	Zone of *Monograptus parultimus*
Ludlow	Zone of *Monograptus fragmentalis*

A total of nine biochronological subdivisions of the type Přídolí based on graptolites I would now recognize, as compared with five in PŘIBYLS original chart. Such fineness is unrivalled by any other chronology. Future work will be likely to result in further refinement of the graptolithological time-scale for the following reason: The ranges of *M. ultimus – M. lochkovensis – M. bouceki* are not contiguous, but separated by shorter or longer intervals (up to several metres in thickness) that did not yield zonal graptolites, thus leaving space for the possible insertion of additional zones or subzones. As only *M. parultimus* and *M. ultimus* are almost certainly successive members of a lineage that morphologically and temporally grade into each other, it is only at the junction of these two zones that the zone boundary has to be drawn arbitrarily.

Data on the local ranges, local and regional occurrences of the graptolites and its zones, associations and thicknesses are to be found in the descriptions of the graptolites.

Zone is here defined as follows: in the individual section it is that interval that extends from the level of the first appearance of the selected zone fossil (graptolite species) to the first appearance of the immediately succeeding zone fossil.

Note that the so defined practical zone, as I wish to call it, is in principle of shorter duration than the biozone (BUCKMAN, 1902), i. e. the life-time total of the same zone fossil. The biozone boundaries remain hypothetical, because the full life-time can hardly ever be demonstrated in the field. Note also that in the individual section the lower and upper boundary of a zone can be drawn only if the immediately preceding and succeeding zones are represented by zone fossils. Thirdly note that the margin of error in correlating a zone from one locality to the other cannot be greater than a fraction of its duration.

6.2.5. Regional Distribution

Přídolian graptolites are known from many areas in all continents, with the exception of South America and Antarctica. At least *M. transgrediens* and *M. formosus*, possibly also *M. bouceki*, are known from all five continents that yielded so far Přídolian graptolites. *M. ultimus* was found in four continents. It may simply be a matter of future research that more species will be shown to be cosmopolitan. It is only fair to state that the Přídolian *Monograptus* species are of outstanding value for worldwide correlations. They are the most powerful tool in high-resolution chronology for that age, as are the graptolites of earlier and later times.

A certain provincialism or facies dependence, yet poorly understood, has become apparent. The most striking example is seen in Kazakhstan (KOREN, 1983): In thick sequences of sandstones and siltstones a *Monograptus* fauna was recovered that is markedly more diverse than that of the type Přídolí. Though it yielded most of the classical Bohemian species, different ranges were given for some, and the cosmopolitan *M. ultimus* has been looked for in vain there.

6.2.6. Description of Graptolites

Explanation of terms and abbreviations, repositories

Th	theca, thecae
th_1, th_2 ...	first, second theca etc.
Z	number of thecae in 1 cm; e.g. Z = (9–11¾) – (8–7) as stated for *M. lochkovensis* means the following: in the initial cm Z varies between 9–11¾, it decreases to 8–7 in the distal cm of adult rhabdosomes
D	dorso-ventral width. Example *M. lochkovensis*: D = (0,9–1,2) (0,5–0,7) – 2½ (2) mm: first two brackets = width at th_1 inclusive of apertural processes and the smallest width without processes, i. e. the width right above th_1; 2½ (2) mm means maximum width in the distal portion of adults across the thecal aperture and immediately above, respectively.
ε	distance from aperture of sicula (exclusive of dorsal tongue) to dorsal margin (ridge of hoods in hooded thecae) of th_1 (see text-fig. 40).
prox.	proximal
dist.	distal

Localities, as a rule, are listed only for the middle and late Přídolian species, whereas the occurrence of the older species may be gathered from the columnar sections.

Repository: The majority of the graptolites figured herein and bearing catalogue-numbers prefixed g ... are housed in the Paläontologisches Museum, Museum für Naturkunde, Humboldt-Universität, Berlin, D. D. R. The type series of the new species, *M. branikensis* and *M. hornyi*, are deposited in the Geological Survey of Czechoslovakia, Prague (HJ).

6.2.7. Coverage

The ensuing descriptions of graptolites cover the majority of monograptids from the type Přídolí, particularly those species that are of major stratigraphical significance and on which, as a rule, substantial morphological and stratigraphical data can be adduced. In addition, some hitherto unrecorded forms are described. Several other, usually rare and mostly poorly understood species will not be described herein. For instance, *Monograptus* sp. gr. *willowensis* (BERRY & MURPHY, 1975) that was found in a ½ cm thick layer within the *lochkovensis* Zone is too poorly preserved to be photographed and to be properly documented; that form represents the sole spinous species in the type Přídolí. Also not described will be *M. dubius* (two forms) that is sporadically met with up to the *perneri* Zone. Finally, the ubiquitous and long-ranging *Linograptus posthumus* (REINHARD RICHTER), will be omitted, the sole species that crosses the Silurian – Devonian boundary in the Barrandian area.

6.2.8. Systematic part

Monograptus fragmentalis BOUČEK, 1936

Pl. 2, figs. 14–15,18,20–21

v.* 1936 *Monograptus fragmentalis* n. sp. – BOUČEK, p. 7; text-figs. 1l–n.
1976 *Pristiograptus fragmentalis* (BOUČEK). – BOUČEK et al., p. 88–91; pl. 2, figs. 1–7; pl. 3, fig. 1; text-figs. 2a–e.

Description: This species can be characterized as a giant *M. dubius* attaining a length in excess of 80 mm and a width of 2½–3½ mm in flattened, but tectonically not deformed rhabdosomes, the higher figure being the typical one. The maximum width is reached at th_{25-30}. Increase in width varies considerably, at th_{10} between 2,0–2,6 mm in adults, whereas 12 mm long juveniles have a width of ±1,8 mm at th_{10}. Juveniles cannot be distinguished from genuine *M. dubius* in our present state of knowledge. There are no isolated rhabdosomes.

Interthecal septa progressively overlap toward the distal part. About th_{10} the interthecal septum originates in the level of the aperture of the preceding theca; in the succeeding thecae the septa are set more and more lower down until in the distal part they begin in the level of the aperture of th_{n-2} which remains the typical position. BOUČEK et al. (1976, text-fig. 2) drew a still lower point of origin for adult Serbian specimens, namely half-way between the apertures of th_{n-2} and th_{n-3} which I did not observe in Bohemian rhabdosomes.

Z prox. = 9–10 (11), dist. 8. Sicula: Length about 2 mm; width of aperture 0,3–0,4 mm; length of dorsal tongue 0,1–0,2 mm; ε = 1,15–1,4 mm.

Zone and association: *M. fragmentalis* remained a problematical species for almost half a century. It can be shown, particularly in the section Karlštejn, that it forms the uppermost zone of the Kopanina Formation, i. e. Ludlow. When adult, the species can easily be recognized by its large size, by which it contrasts sharply with the small *M. parultimus*, index of the immediately succeeding zone. *M. fragmentalis* occurs frequently, associated with common *M. formosus* and infrequent *Linograptus posthumus*. In Serbia it is, additionally, associated with *M. parultimus*, which proves that these two zones succeed each other without hiatus.

Geographic distribution: *M. fragmentalis* is known to me by autopsy from Bohemia and Yugoslavia (eastern Serbia, Ruj Mountains, section Potok Zajednica = Dubsky Potok in BOUČEK et al., 1976).

Monograptus formosus BOUČEK, 1931

Text-figs. 28a–e; pl. 3, figs. 4–5; pl. 4, fig. 13

v.* 1931 *Monograptus formosus* n. sp. and *Monograptus purkyněi* n. sp. – BOUČEK, p. 8–9, 18–19, text-figs. 9a–d
v. 1940 *Monograptus (? Spirograptus) convexus*. – PŘIBYL, p. 73, pl. 1, fig. 12
v. 1946 *Spirograptus ? formosus* BOUČEK. – PŘIBYL, p. 36–38, pl. 9, fig. 4.
v. 1964 *Monograptus formosus* BOUČEK. – JAEGER et al., p. 255–256; pl. 6, figs. 1–2.
v. 1967 *Monograptus formosus* BOUČEK. – JAEGER, p. 286, pl. 14, figs. b–c.
. 1969 *Monograptus paraformosus* n. sp. – JACKSON & LENZ, p. 27–28, pl. 4, figs. 1,2,4.
1973 *Monograptus formosus* BOUČEK. – KOREN, p. 151–153; pl. 1, figs. 13–16.
. 1976 *Formosograptus formosus* (BOUČEK). – BOUČEK et al., p. 85–88, text-fig. 1a–f; pl. 1, figs. 1–3; pl. 3, fig. 5.
v 1976 *Tamplograptus convexus* (PŘIBYL), *T. formosus* (BOUČEK) and *T. paraformosus* (JACKSON & LENZ). – TSEGELNJUK, p. 114–116; pl. 35, figs. 1–9.
1979 *Monograptus formosus* (BOUČEK). – PAŠKEVIČIUS, p. 173–175; pl. 15, figs. 3–4; pl. 31, figs. 1–3.

Stratum typicum et locus typicus: Požáry Formation, Přídolí, Zone of *M. ultimus*; Cephalopod Quarry (Orthoceras Quarry) near Lochkov.

Description: Rhabdosome arcuate, dorsally concave. Thecae in side-view roughly triangular, particularly proximally, to a lesser extent distally, of the general type of *M. spiralis*, laterally flattened, terminating with a pair of wing-like lateral processes that are directed proximo-laterally and somewhat backwardly; the wings are so strongly twisted that they almost form tubes, the inner side of their broadly-rounded ends faces laterally; in anterior view the processes are seen to diverge in proximo-lateral direction, while the hood-like dorsal thecal wall is medially reflexed. Often these characteristic processes cannot be discerned, when the rhabdosome is viewed on the bedding-plane.

Measurements: Length of rhabdosome up to 40 mm. Z = 8 – (9–10) (seldom up to 11). D = (0,6–0,7) (±0,1) – (1,3–1,6) (0,6–0,8) mm in specimens that are preserved in full relief or moderately flattened; in more strongly flattened, and occasionally even somewhat tectonically deformed Bohemian specimens D may amount to 0,9–1,0 mm at th_1 and up to 2,1 (1,0) mm in the distal part. Maximum width is attained around th_{15}.

Sicula: Length 1,2–1,4 mm (inclusive of dorsal tongue that is 0,1 mm long); width of aperture 0,2 mm; ε = 1,7–2,1 mm (seldom less). Apex reaches up to the apertural region of th_1 but does not extend to the ridge of the thecal hook. The sole complete sicula that I etched out of the rocks possesses only one metasicular ring.

Comparison: This beautiful graptolite, that for a long time appeared to be an alien and archaic element in late Silurian faunas, superficially resembles many Llandoverian and Wenlockian species as well as the

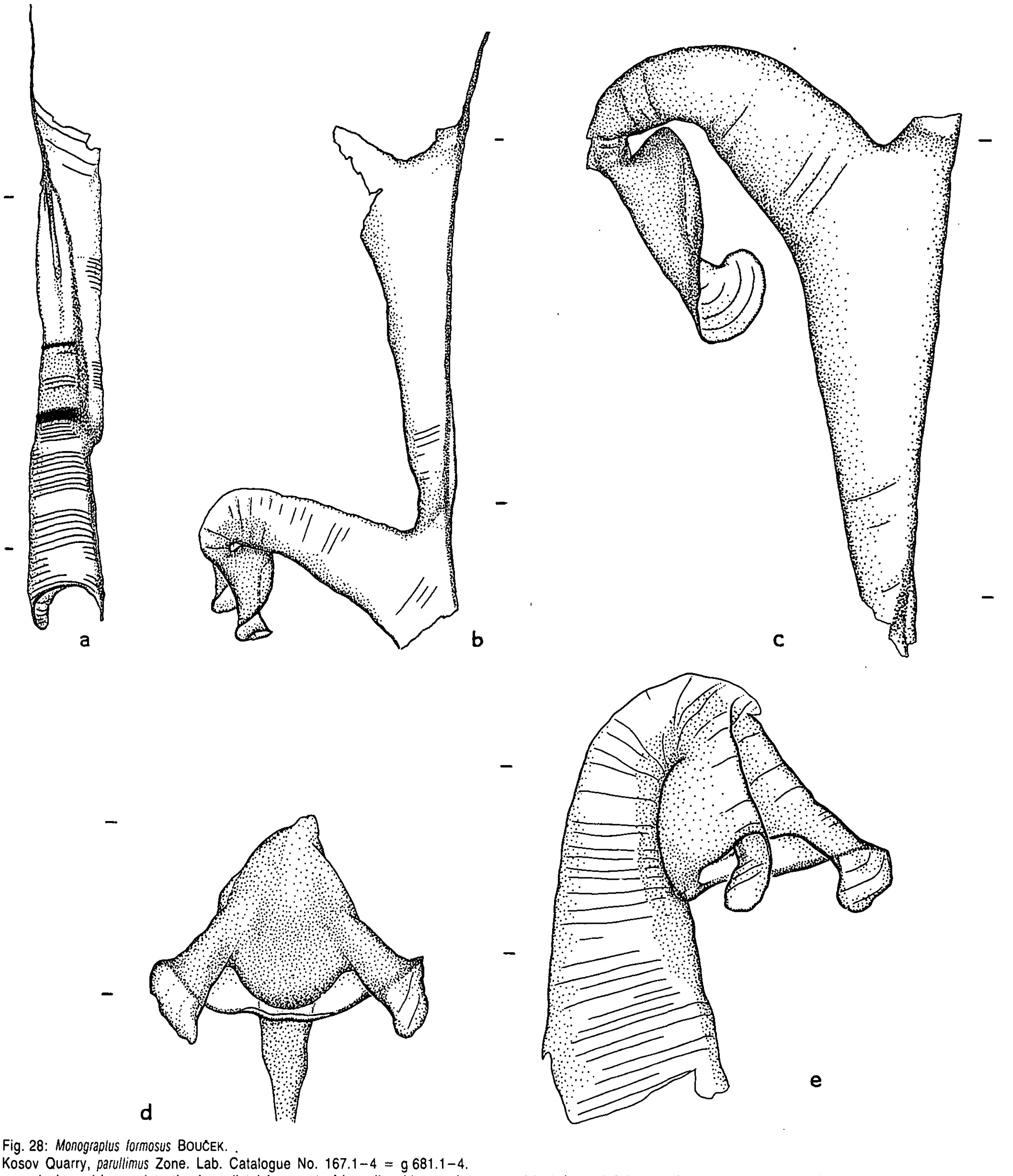

Fig. 28: *Monograptus formosus* BOUČEK.
Kosov Quarry, *parultimus* Zone. Lab. Catalogue No. 167.1–4 = g 681.1–4.
a = sicula and incomplete th_1; b = distal fragment of juvenile with complete second last theca, left lateral view; c = adult theca with only left wing preserved; d–e = theca in anterior and right antero-lateral view.
Point scale for a–c = 1 mm, for d–e = ¼ mm.

middle Lower Devonian *yukonensis* group. In the last few decades several other, still insufficiently known, late Ludlovian species have been erroneously assigned to *M. formosus*, or the "*formosus* group", particularly on the East European Platform, which sometimes resulted in confused correlations. For instance, a rather similar species is *M. caudatus* (TSEGELNJUK) that differs in the following:

❶ the smallest width between th_1 and th_2 is 0,3–0,4 mm (instead of ±0,1 in *formosus*), i. e. the initial thecae are less isolated,
❷ Z = 11–12,
❸ the long thecal hoods lack any indication of wing-like processes,
and
❹ ε = 1,35–1,65 mm.

In Volhynia *M. caudatus* comes in well below *M. formosus* (TSEGELNJUK, 1976, text-fig. 9), but the ranges of the two species may slightly overlap. *M. aculeatus* (TSEGELNJUK) with similar dimensions as *M. caudatus*, possesses thecal hoods that bear a pair of lateral spines plus a median spine.

Zone: In the Bohemian sections *M. formosus* occurs frequently to rarely from the *fragmentalis* Zone, through the *parultimus* Zone to well into the *ultimus* Zone, i. e. it demonstrably crosses the Ludlow – Přídolí boundary, apparently without undergoing a significant change. Its occurrence would appear to be rather capricious, e. g. at Karlštejn it is seen in large numbers in several beds in all three zones, though never attaining the abundance of *M. parultimus* and *M. ultimus*, whereas in the Kosov Quarry only a few specimens turned up.

Geographic distribution: *M. formosus* has been reported from all continents, except South America and Antarctica, hence it would appear to be a truly cosmopolitan species. A thorough comparative study on the global scale has yet to be undertaken.

Monograptus parultimus JAEGER, 1975

Text-figs. 29–34; pl. 1, figs. 1–2,5,8–9; pl. 2, figs. 3–6, 23–24; pl. 4, fig. 12

v. 1899 *Monograptus ultimus* n. sp. – PERNER, p. 13–14, pl. 16, figs. 4–5,? 11a,b (non: text-fig. 14a,b = *M. ultimus*).

v. 1940 *Monograptus (Pristiograptus) ultimus* PERNER. – PŘIBYL, pl. 1, figs. 9–10,? 11 (possibly transient to *M. ultimus*).

v.* 1975 *Monograptus parultimus* n. sp. – JAEGER, p. 119–125, text-fig. 4, pl. 2, figs. 4,8.

v. 1976 *Pseudomonoclimacis ultimus* (PERNER). – TSEGELNJUK, p. 106, pl. 30, figs. 10–12.

v. 1976 *Pseudomonoclimacis podolicus* sp. nov. – TSEGELNJUK, p. 106–107, pl. 31, figs. 1–3.

v. 1979 *Monoclimacis parultimus* (JAEGER). – PAŠKEVIČIUS, p. 160–162, pl. 10, figs. 1–5; pl. 24, figs. 16–19; pl. 25, figs. 1–5.

v. 1983 *Ludensograptus parultimus* (JAEG.). – TSEGELNJUK, p. 94,145.

Stratum typicum et locus typicus: Požáry Formation, Přídolí, Zone of *M. parultimus*, bed 80–90 cm above its base; Kosov Quarry.

Description: Rhabdosome small, short and straight; laterally slightly flattened. Thecae peculiar, somewhat sigmoidal; the moderately thickened apertural margins broadly undulating, i. e. in lateral view slightly convex (incipient lappet), ventrally with shallow depression.

Undulation of the apertural margin is initiated by upward bending and widenig of a few fuselli (growth increments) on the flanks and their correlative thinning out toward the ventral apertural margin; it is completed by the addtion of one to three fuselli that do not unite ventrally in the median plane, but end blindly at the antero-ventral margin of the aperture; typically, this applies at least to th_1, whereas in the majority of the succeeding thecae shortened fuselli may not be added at all.

Both expressivity and penetrance of the undulations of the apertural margins vary considerably even in the same population, i. e. among rhabdosomes that have been etched out of the same rock-sample; typically, the undulation is most pronounced at th_1; expressivity weakens gradually through the succeeding two or three thecae, though mild, but distinct undulations may be seen till the distal end; in the other extreme, the characteristic undulations are almost imperceptible as early as th_1. In many rhabdosomes th_1 is distinctly protracted, such as to be reminiscent of a spout; in other rhabdosomes th_1 does not exhibit any protraction. The degree of protraction and undulation of the apertural margins are not correlated with each other. Interthecal septa do nowhere overlap.

Sicula typically with strong ventral curvature and conspicuous dorsal tongue. Again there is much variation in the degree of sicular curvature, often the sicula is virtually straight. Interestingly, in a few siculae the dorsal tongue has swung backwards resulting in a very broad aperture simulating that of *M. hercynicus* PERNER, *M. deubeli* JAEGER and certain *M. bohemicus* (BARRANDE). Though this mutation is also observed in the succeeding *M. ultimus*, it would appear that it did not achieve any evolutionary significance among the Přídolian graptolite faunas; consequently, it is not accorded taxonomic status.

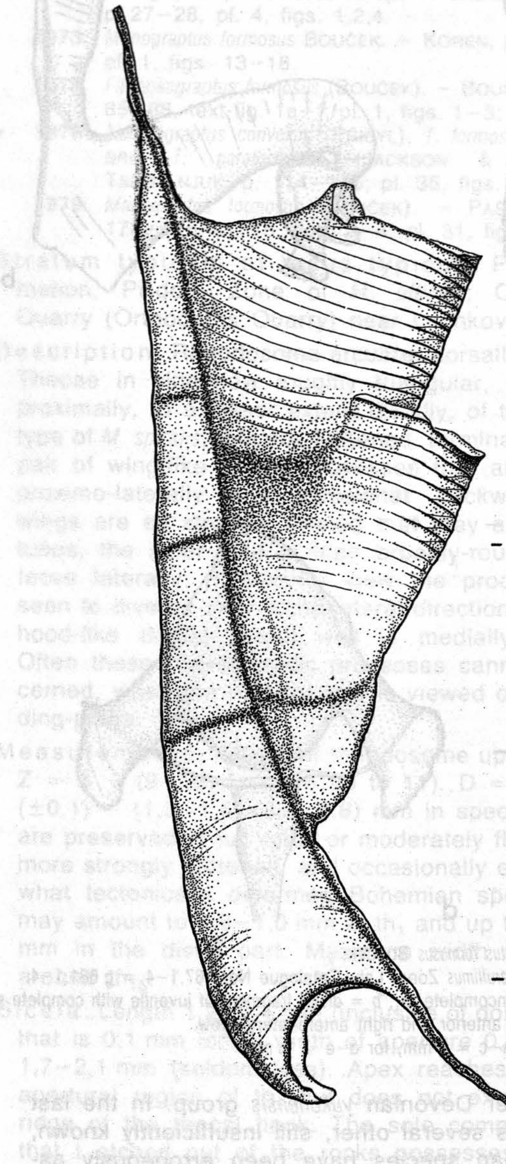

Fig. 29: *Monograptus parultimus* JAEGER.
Kosov Quarry, *parultimus* Zone, flattened.
Note sicula of normal shape with long ventrally deflected dorsal tongue, and at apertural margin of th_1 incomplete, narrow, only partly formed last fusellus and ventro-laterally narrowing second last fusellus.
Lab. Catalogue No. 119 = g 682.1. Point scale = 1 mm.

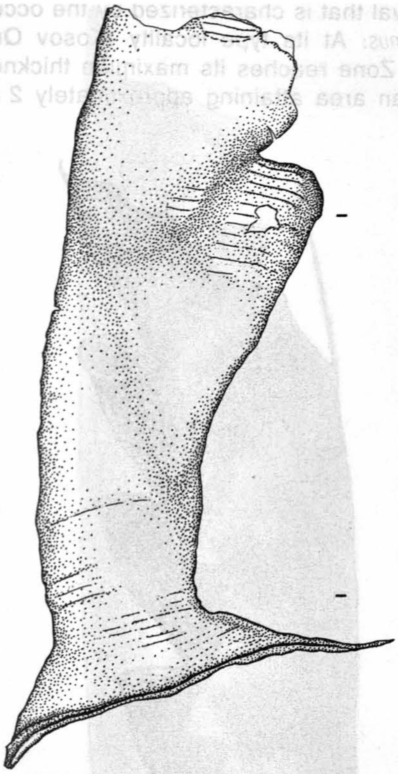

Fig. 30: *Monograptus parultimus* JAEGER.
Kosov Quarry, *parultimus* Zone, flattened specimen with *hercynicus*-type sicula. Lab. Catalogue No. 167.6. = g 681.6. Point scale = 1 mm.

In addition to the thickened aperture of the prosicula there are two sicular rings on the metasicula ("Stillstandsgürtel" of KRAFT, 1926).

The virgella invariably originates at the first metasicular ring, i. e. at a clearly defined, fixed point, situated a considerable distance above the aperture of the prosicula, consequently in a higher position than in the older graptolites, in which the point of origin of the virgella is known to me. Origination of the virgella at the first metasicular ring I observed also in the Přídolian *M. ultimus, M. pridoliensis, M. perneri, M. transgrediens*, in the Lower Devonian *M.* cf. *praehercynicus* and in the middle Ludlovian *M. fritschi* and *M. dubius*. This would appear to exemplify a phylogenetical trend of distal migration of the point of origin for the virgella. This parallel evolution in so widely differing species may be considered as a further example for the "programme"-evolution in graptolites.

The sequence of events leading to the same result, i. e. origination of the virgella at the first metasicular ring differs among species in the following way: In the listed Přídolian and Devonian species, and in the middle Ludlovian *M. dubius* the first metasicular ring is formed during a halt of sicular growth in length, i. e. this ring represents a true "Stillstandsgürtel" being formed at the temporary aperture of the growing sicula. The virgella begins its growth simultaneously with that ring. By contrast, in *M. fritschi* the virgella grows independently of and earlier than the ring, which is added to the metasicular wall at the point of origin of the virgella after both sicula and virgella have attained a considerable length.

Measurements: Length of rhabdosome rarely exceeding 20 mm. Z = 11–14, usually ±12 (constant), in the first ½ cm = ±6–7; D = (0,55–0,8) (0,4–0,6) – (1,0–>1,5) (0,75–1,2) mm for rhabdosomes preserved in full relief. In flattened specimens D at th_1 may attain 0,9 mm.

Lateral diametre: ±0,3 mm at th_1 to 0,5–0,65 mm in the distal portion.

Sicula: Length 2–2,2 mm (inclusive of dorsal tongue, exclusive of virgella and nema), prosicula ±0,5–0,6 mm (exclusive of nema); width of aperture 0,25–0,4 mm (in *hercynicus*-type siculae 0,7 mm); length of dorsal tongue 0,17–2,5 (rarely 0,3–0,4) mm. ε = 1,15–1,5 (usually 1,3–1,4) mm.

Comparison: In its size, shape and construction of the rhabdosome *M. parultimus* closely resembles *M. ultimus*, with which it was confounded for 80 years. In the stratigraphically succeeding *M. ultimus* the lateral apertural margins have grown out to sizeable lappets and the ventral margin is deeply excavated. The two

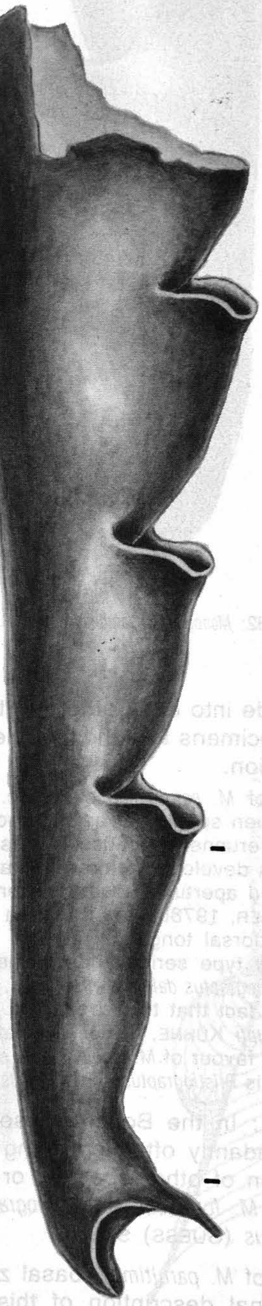

Fig. 31: *Monograptus parultimus* JAEGER. Holotype.
Specimens from figs. 31–34 from Kosov Quarry, *parultimus* Zone, 80–90 cm above base of Přídolí, in full relief.
In figs. 31–34 note variation in shape of sicula and thecae, particularly th_1.
No. of Lab. Catalogue 33.1–4 = g 607.1–4. Point Scale = 1 mm.

tive interval that is characterized by the occurrence of *M. parultimus*. At its type locality (Kosov Quarry) the *parultimus* Zone reaches its maximum thickness in the Barrandian area attaining approximately 2 m.

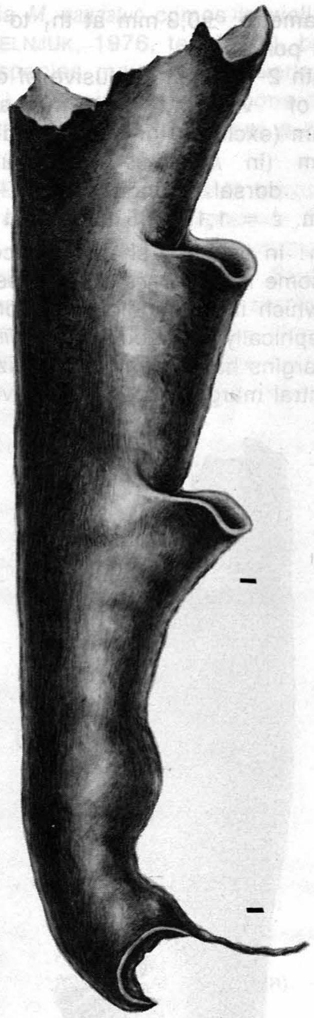

Fig. 32: *Monograptus parultimus* JAEGER. Paratype.

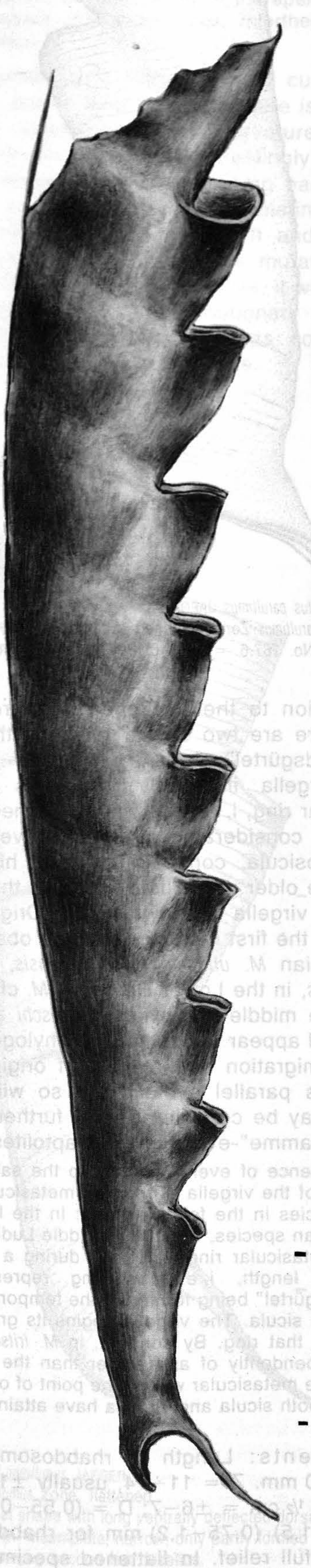

Fig. 33: *Monograptus parultimus* JAEGER. Paratype.

seem to grade into each other, so that assignment of transient specimens to either species becomes an arbitrary decision.

The origin of *M. parultimus* is cryptic. The older *M. haupti* which had beeen suggested as the ancestor of *M. ultimus* is an unlikely forerunner, because it does not exhibit any tendency towards developing paired lateral apertural lobes; instead, unpaired apertural hoods are formed in the adults of *M. haupti* (JAEGER, 1978b) and its sicula is peculiar in having a very small dorsal tongue, if at all.

Study of the type series and of a large collection of topotypus of *Monograptus dalejensis* BOUČEK, 1936 revealed to me the surprising fact that this species is a senior synonym of *Monograptus haupti* KÜHNE, 1955. The latter name has to be suppressed in favour of *M. dalejensis*. A still younger synonym of *M. dalejensis* is *Pristiograptus* (?) *tauragensis* PAŠKEVIČIUS, 1974.

Association: In the Bohemian sections *M. parultimus* occurs abundantly often crowding bedding-planes to the exclusion of other species, or together with rare to frequent *M. formosus* and *Linograptus posthumus*, and rare *M. dubius* (SUESS) s. l.

Zone: Zone of *M. parultimus*, basal zone of the Přídolí. In the original description of this species (JAEGER, 1975) I recorded *M. parultimus* from the *ultimus* Zone as the latter was conceived in the Barrandian area at that time.

Subsequent studies revealed, that in all of the Bohemian sections *M. ultimus* is preceded by a distinc-

Fig. 34: *Monograptus parultimus* JAEGER. Paratype.

Geographic distribution: In addition to Bohemia, *M. parultimus* is known to me by autopsy as a common species from the following: East European Platform in the Soviet Union (Volhynia, e. g. borehole Gushcha; Lithuania, borehole Pajevonis); Carnic Alps in Austria (Cellon) and the Ruj Mountains, eastern Serbia, Yougoslavia (section Potok Zajednica). In the Serbian section *M. parultimus* is associated with *M. formosus*, *M. fragmentalis* and *Linograptus posthumus*, which demonstrates that the index species for the last Ludlovian and first Přídolian graptolite zones have overlapping ranges, and that those two zones are really contiguous.

Monograptus ultimus PERNER, 1899

Text-figs. 35a–b,36a–c,37a–d,38;
pl. 1, figs. 3–4,7,11,13; pl. 2, figs. 7–8

v.* 1899 *Monograptus parultimus* n. sp. – PERNER, p. 13–14, text-figs. 14a (= lectotype, PŘIBYL, 1943a, p. 35) and 14b (non: pl. 16, figs. 4–5 = *M. parultimus*, ? 11a, b).

v. 1964 Pristiograptus bugensius sp. nov., *Pristiograptus aduncus* sp. nov. and ? *Pristiograptus rarus* sp. nov. – TELLER, p. 38–43; pl. 1, figs. 4–6; pl. 2, figs. 1,4–6,9; pl. 7, figs. 13–15,18–19; pl. 9, figs. 1–9; text-figs. 4–5; ?pl. 1, figs. 1–3; pl. 9, figs. 10–12; text-fig. 3).

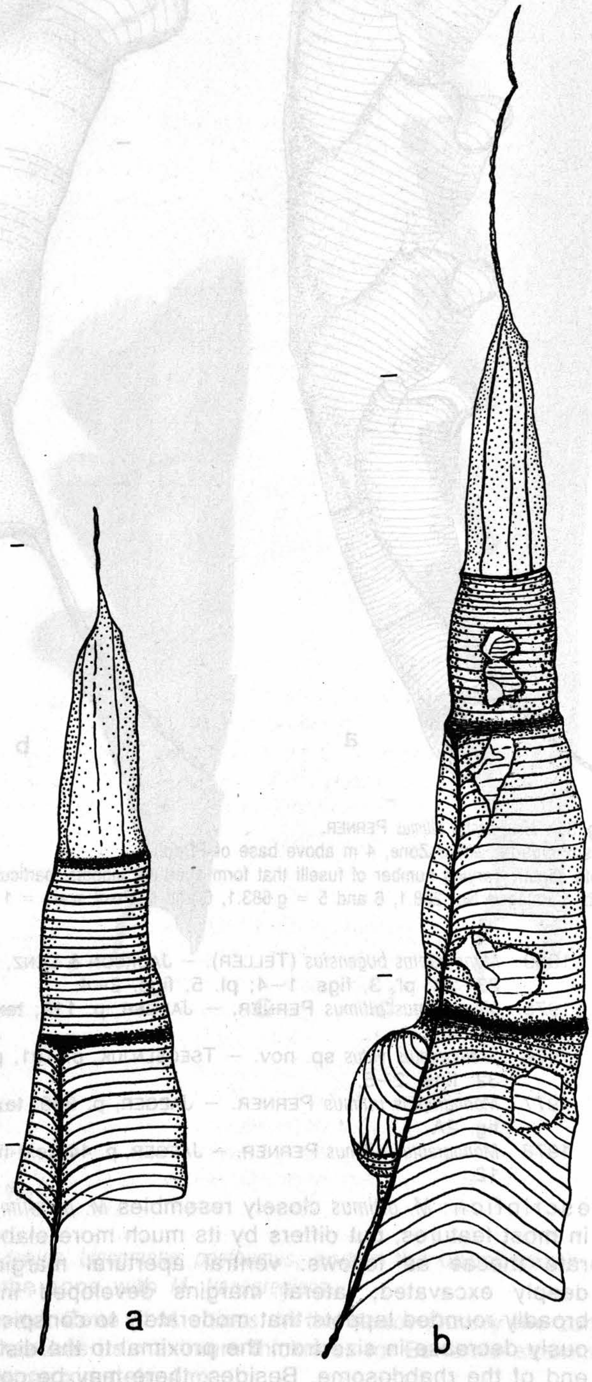

Fig. 35 : *Monograptus ultimus* PERNER.
Kosov Quarry, *ultimus* Zone, 4 m above base of Přídolí.
a = Prosicula and growing metasicula; b = sicula with bud of th_1, aperture still incomplete; note two metasicular rings and origin of virgella at first ring.
Lab. Catalogue No. 268.2–3 = g 683.2–3. Point scale = 1 mm.

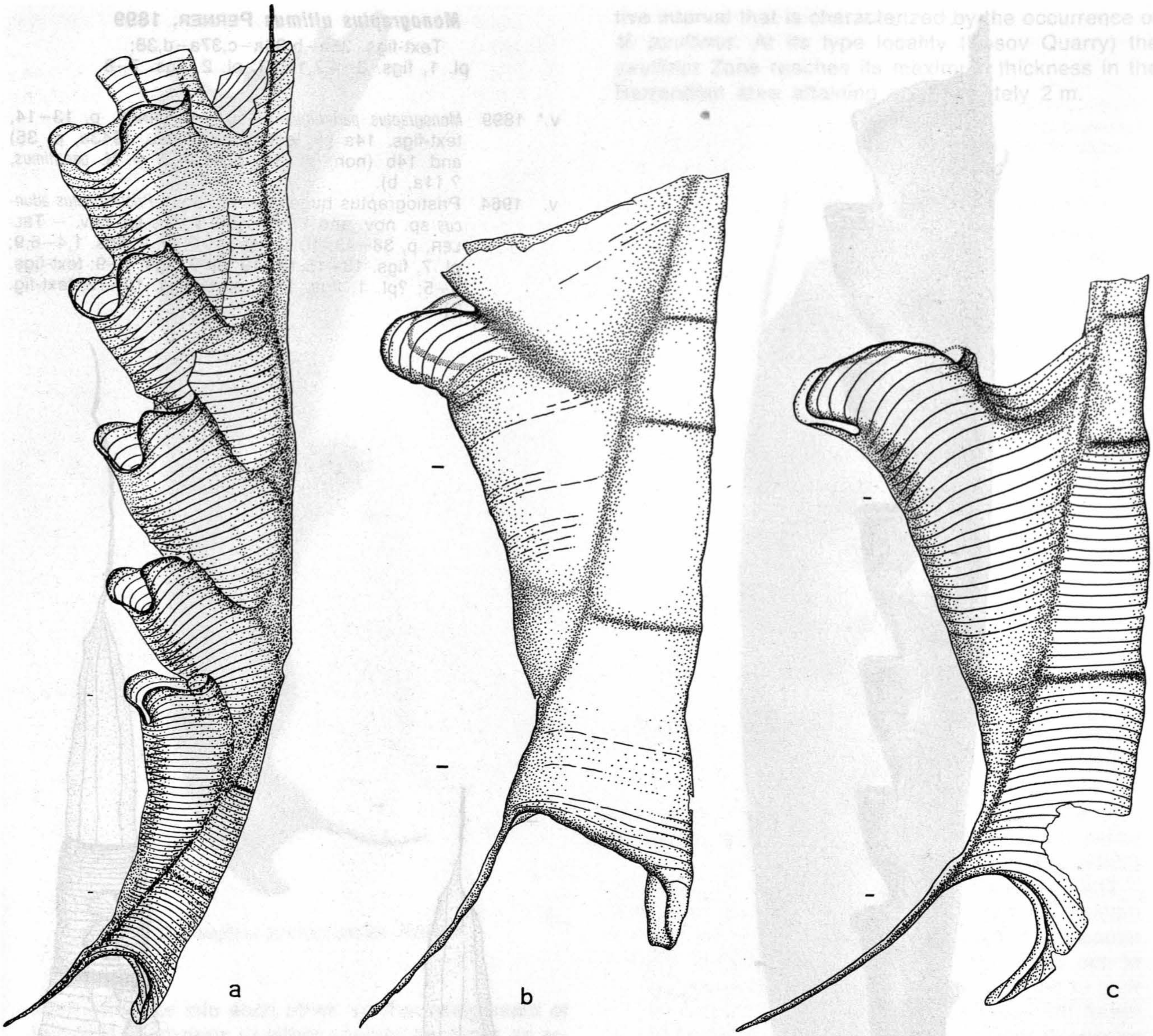

Fig. 36.: *Monograptus ultimus* PERNER.
Kosov Quarry, *ultimus* Zone, 4 m above base of Přídolí.
Note slightly varying number of fuselli that form apertural lappets, particularly in th_1; same sample.
Lab. Catalogue No. 268.1, 6 and 5 = g 683.1, 6 and 5. Point scale = 1 mm. 36a after JAEGER (1978a).

. 1969 *Monograptus bugensius* (TELLER). – JACKSON & LENZ, p. 23–24; pl. 3, figs. 1–4; pl. 5, figs. 2–4.
v. 1975 *Monograptus ultimus* PERNER. – JAEGER, p. 119, text-fig. 4b.
v. 1976 *Skalograptus vetus* sp. nov. – TSEGELNJUK, p. 101, pl. 32, figs. 2–5.
v. 1977 *Monograptus ultimus* PERNER. – JAEGER, p. 339, text-fig. 2A.
v. 1978 *Monograptus ultimus* PERNER. – JAEGER, p. 44, text-fig. 12.

Description: *M. ultimus* closely resembles *M. parultimus* in most features, but differs by its much more elaborate thecae as follows: ventral apertural margins deeply excavated; lateral margins developed into broadly rounded lappets that moderately to conspicuously decrease in size from the proximal to the distal end of the rhabdosome. Besides, there may be considerable variation in the length of the lappets of corresponding thecae even among rhabdosomes of the same bed (sample). The longer the lappets the more strongly dorsolaterally convex they are, and the more pronounced may be a downward curvature. The longest lappets may form almost half-tube-shaped structures. Shorter lappets remain rather flat to moderately vaulted, shield-like processes, that project antero-distally rather than antero-proximally, particularly beyond the initial few thecae. This results in the deceptive appearance of relatively simple distal thecae, when the rhabdosome is viewed in the bedding-plane.

As would be expected, some phylogenetic progression in the expressivity of the apertural lappets is observed, when the species is traced through successively higher beds of its zone. However, the picture is not too simple, as is revealed by the study of specimens that have been etched out of the rock from three different levels (4 m, 5 m and 5,5 m above the base of the Přídolí). In the lowest sample (4 m) the length of the lappets in th_1 varies from 0,23–0,4 mm (measured along the dorsal margin of the lappet); variation in size is moderate, lappets with extreme length are not observed. Among rhabdosomes of the highest sample (5,5 m) (each sample consisting of about 80 specimens) the same parameter varies from 0,23–0,56 mm, i. e. variation is much greater, but specimens with very long lappets are few.

At th_1 four or five to about 10 fuselli take part in the formation of the antero-ventral margin of the lappet, and two to over half a dozen in the formation of the dorsal margin depending on the length of the lappet. Though the number of fuselli forming either margin typically appears to differ, there are other rhabdosomes in the same sample in which the number is equal, say five fuselli along both the antero-ventral and the dorsal margin. Frequently, a slight difference between the left and the right side of the same theca is observed, e. g. the dorsal margin of the left wall may be formed by two fuselli and that of the right wall by three, and vice versa. In the distal thecae at least three fuselli form the antero-ventral margin, and at least two the dorsal margin.

Measurements: Length of rhabdosome rarely exceeding 20 mm. Z = ±12–14½, in the first ½ cm ±6–7. D = (0,8–1,1) (0,5–0,7) – (1,0–1,5, rarely up to 1,8) (0,6–1,2) mm (usually 1,2–1,4 mm) for specimens in full to low relief. (For size of apertural lappets see paragraph "Description").

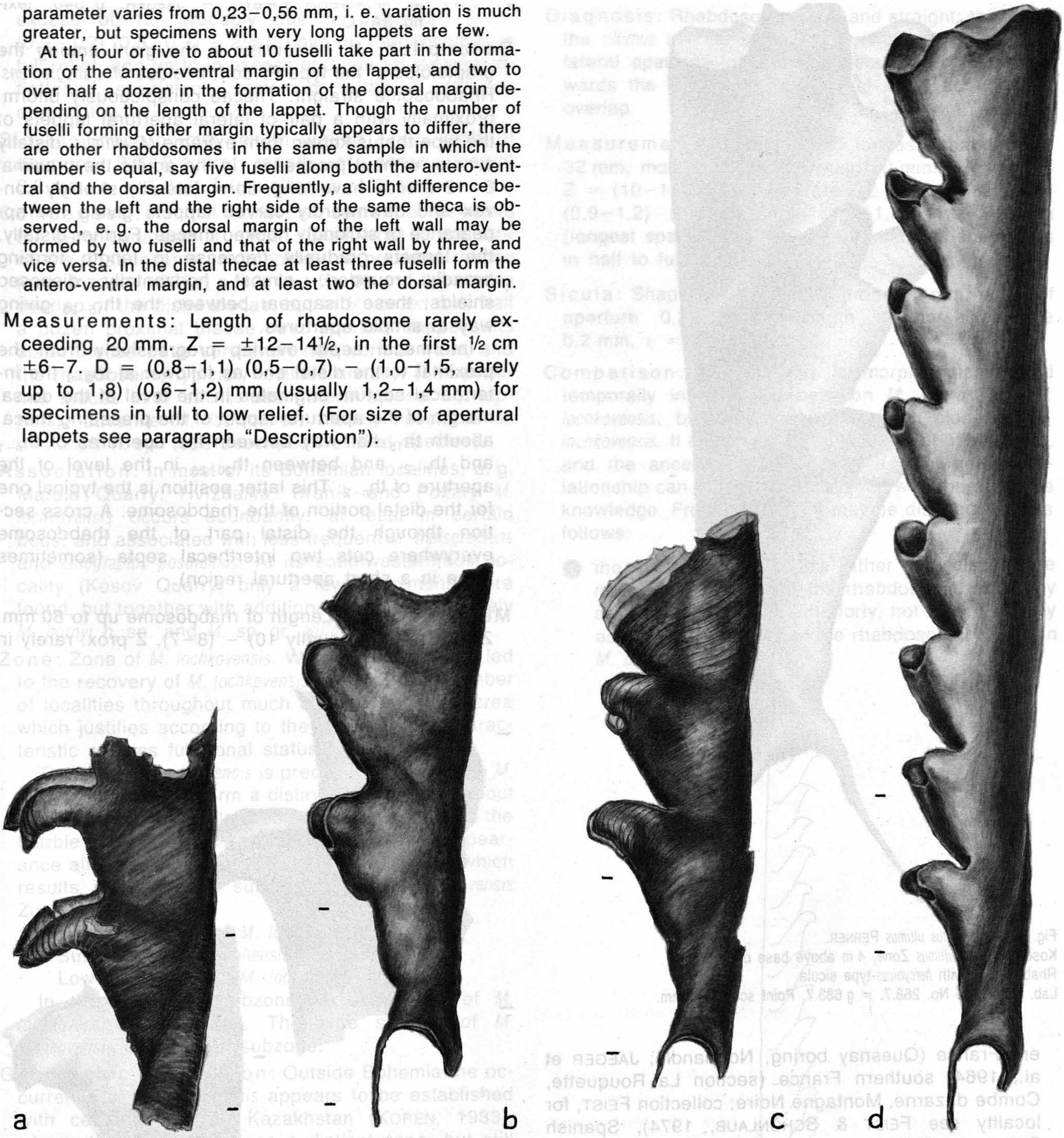

Fig. 37: *Monograptus ultimus* PERNER.
Kosov Quarry, *ultimus* Zone, 5½ m, uppermost sample of dissolved rhabdosomes.
Note extremely varying size of apertural lappets (fig. a–c).
a and c = juveniles; b = proximal fragment of adult rhabdosome.
Lab. Catalogue No. 269.3–5 and 269.1 = g 602.3–5 and 602.1. Point scale = 1 mm.

Sicula: Length 1,8–2,2 mm (inclusive of dorsal tongue); width of aperture ±0,3–0,4 mm; length of dorsal tongue 0,2–0,25 (0,3) mm; ε = 1,2–1,5 (1,6) mm. Rarely *hercynicus*-type siculae. Two metasicular rings; virgella originates at first ring.

Association: In the European and North African sections *M. ultimus* occurs abundantly, typically crowding bedding planes to the exclusion of other species. In Bohemia it is associated with rare *M. formosus, M. dubius, Linograptus posthumus*, and in the upper fourth of the zone with *M. transgrediens*.

Zone: Zone of *M. ultimus*. In the Kosov Quarry the zone reaches its maximum thickness for Bohemia attaining approximately 4 m.

Geographic distribution: In addition to Bohemia, *M. ultimus* is known to me by autopsy from the following: East European Platform in Poland (Chelm boring) and Soviet Union (Gushcha boring, Volhynia), north-

Fig. 38: *Monograptus ultimus* PERNER.
Kosov Quarry, *ultimus* Zone, 4 m above base of Přídolí.
Rhabdosome with *hercynicus*-type sicula.
Lab. Catalogue No. 268.7. = g 683.7. Point scale = 1 mm.

ern France (Quesnay boring, Normandie; JAEGER et al., 1964) southern France (section La Rouquette, Combe d'Izarne, Montagne Noire; collection FEIST, for locality see FEIST & SCHÖNLAUB, 1974), Spanish Pyrenees (Pallaresa valley; collection HAUDE) and Morocco (sections Aîn Deliouine and Iriqui, Wadi Draa; the species occurs in the Orthoceratite Limestone and shales, respectively). On the basis of the paper by JACKSON & LENZ (1969) I have no doubt hat the species described by those authors as *M. bugensius* is a genuine *M. ultimus*, which would establish its occurrence also in the Cordilleran region of Canada (Porcupine River, Yukon Territory).

Monograptus lochkovensis PŘIBYL, 1940

Text-fig. 39a–b; pl. 1, fig. 16; pl. 3, figs. 16–17

v.* 1940 *Monograptus (Pristiograptus) lochkovensis* n. sp. – PŘIBYL, p. 69, pl. 1, fig. 6.
? 1973 *Pristiograptus lochkovensis* (PŘIBYL). – SPASSOV, p. 133–134, pl. 1, fig. 1,1a.
v. 1977 *M. lochkovensis* PŘIBYL. – JAEGER, p. 340, text-fig. 3A–C.

Description: *M. lochkovensis* is the giant among the graptoloids of the type Přídolí, besides *M. transgrediens*. Rhabdosome straight. Thecae conspicuously biform: proximally with a pair of lateral apertural lappets of the type that is known from extreme *M. ultimus*; distally simple, without processes. In the adults the proximal 8–12 thecae have long, dorso-laterally strongly convex and downwardly curved lappets giving the appearance of strikingly hooked thecae. Farther distally, the lappets gradually decrease in length forming broadly rounded, almost horizontally disposed shields; these disappear between the th_{15-25} giving way to simple apertures.

Interthecal septa overlap progressively from the proximal to the distal end as follows: at th_{8-9} the interthecal septum originates in the level of the dorsal margin of the apertural lappet of the preceding theca, abouth th_{15} half-way between the apertures of th_{n-1} and th_{n-2}, and between th_{20-25} in the level of the aperture of th_{n-2}. This latter position is the typical one for the distal portion of the rhabdosome. A cross section through the distal part of the rhabdosome everywhere cuts two interthecal septa (sometimes three in a short apertural region).

Measurements: Length of rhabdosome up to 80 mm. Z = (9–11¾) (usually 10) – (8–7), Z prox. rarely in

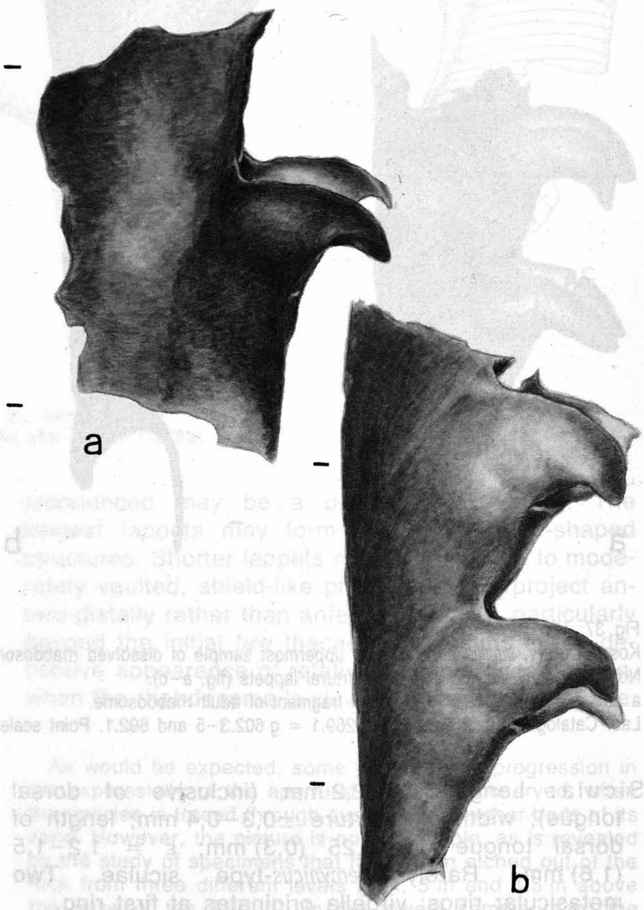

Fig. 39: *Monograptus lochkovensis* PŘIBYL.
Lochkov, Marble Quarry, locus typicus et stratum typicum, approximately 4 m above base of Přídolí, *lochkovensis* Zone.
Thecal fragments from the proximal rhabdosome portion.
Lab. Catalogue No. 277.1–2 = g 684.1–2. Point scale = 1 mm.

excess of 12, probably due to distortion; D = (0,9–1,2) (0,5–0,7) – 2½ (2) mm for rhabdosomes in full relief, and up to in excess of 3 mm for moderately flattened specimens; maximum width is attained around th_{30}.

Sicula: Shape normal, length around 2 mm, width of aperture 0,3–0,4 mm, length of dorsal tongue 0,2 mm, ε = 1,3–1,7 (usually 1,5–1,6) mm.

Comparison: Adult *M. lochkovensis* somewhat resemble the early Ludlovian *M. roemeri* (BARRANDE) in the size of the rhabdosome, morphology of proximal thecae (see JAEGER, 1978a, p. 42, text-fig. 9) and the strong overlap of the distal thecae; but in *M. roemeri* only half a dozen proximal thecae bear apertural lappets, its distal thecae have very short free ventral walls, and the rhabdosome typically reclines distally. (The proximal thecae in *M. colonus* bear lateral spines, not lappets). Juvenile *M. lochkovensis* closely resemble *M. branikensis* n. sp. (see description of that species).

Association: In most of its Bohemian localities, e. g. Marble Quarry, Hvížďalka, Braník and Požáry *M. lochkovensis* occurs abundantly, at least in certain beds, and associated with less frequent *M. transgrediens* and *Linograptus posthumus*. At its southwesternmost locality (Kosov Quarry) only a few specimens were found, but together with additional associates, namely *M. hornyi* n. sp. and *M.* sp. gr. *willowensis* BERRY.

Zone: Zone of *M. lochkovensis*. Work in recent years led to the recovery of *M. lochkovensis* in a sufficient number of localities throughout much of the Barrandian area which justifies according to the range of this characteristic species full zonal status.

Typically, *M. lochkovensis* is preceded by beds with *M. pridoliensis* that also form a distinct horizon throughout the Barrandian area. In a sole section, namely in the Marble Quarry, *M. lochkovensis* makes its first appearance already below the beds with *M. pridoliensis*, which results in a tripartite subdivision of the *lochkovensis* Zone as follows:

Upper Subzone of *M. lochkovensis*
Subzone of *M. pridoliensis*
Lower Subzone of *M. lochkovensis*

In the *pridoliensis* Subzone no specimens of *M. lochkovensis* were found. The type stratum of *M. lochkovensis* is its upper subzone.

Geographic distribution: Outside Bohemia the occurrence of *M. lochkovensis* appears to be established with certainty only in Kazakhstan (KOREN, 1983), where it also characterizes a distinct zone, but still ranges through most of the succeeding *bouceki* Zone. A record from Bulgaria (SPASSOV, 1963) remains doubtful, because the published figures do not exhibit the specific features of *M. lochkovensis*.

***Monograptus branikensis* n. sp. JAEGER**

Text-fig. 40; pl. 1, figs. 10,12 and 14

Derivatio nominis et locus typicus: Braník is the type locality, bed 19.

Holotype: The rhabdosome pl. 1, fig. 10

Repository: Geological Survey, Prague, no. HJ 54.

Stratum typicum: Požáry Formation, Přídolí, strata between the *ultimus* Zone (below) and the *pridoliensis* Subzone (above).

Diagnosis: Rhabdosome short and straight; thecae of the *ultimus* and *lochkovensis* type, with a pair of long, lateral apertural lappets that decrease in lenght towards the distal end; interthecal septa do nowhere overlap.

Measurements: Length of longest rhabdosome 32 mm, most specimens around 10 mm.
Z = (10–11) – (10–9) (rarely Z prox. = 12). D = (0,9–1,2) (0,55–0,8) – (1,6–1,8) (1,0–1,2) mm (longest specimen D = 2,2 (1,5) mm), all specimens in half to full relief.

Sicula: Shape normal, length around 2 mm, width of aperture 0,3–0,4 mm, length of dorsal tongue 0,2 mm, ε = 1,5–1,6 mm.

Comparison: *M. branikensis* is morphologically and temporally intermediate between *M. ultimus* and *M. lochkovensis*, but morphologically much closer to *M. lochkovensis*. It could well be a descendant of *M. ultimus*, and the ancestor of *M. lochkovensis*, but neither relationship can be safely established with the available knowledge. From *M. ultimus* it may be distinguished as follows:

❶ the apertural lappets are rather long also in the more distal portion of the rhabdosome, and they are directed proximo-anteriorly, not antero-distally as is typical of most of the rhabdosomal length in *M. ulitmus*;

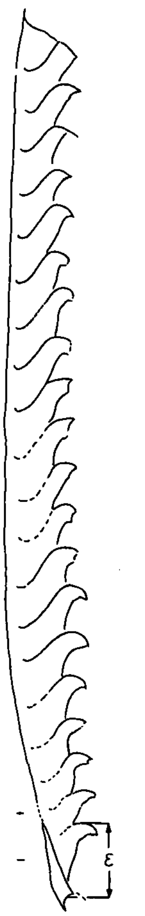

Fig. 40: *Monograptus branikensis* n. sp. JAEGER. Braník, bed 19. Holotype HJ 54 (= pl. 1, fig. 10).
Note non-overlapping interthecal septa.
Point scale = 1 mm.

❷ the thecal count is less;
❸ width
and
❹ ε are greater;
❺ the curvature of the sicula is less.

From *M. lochkovensis* this new species can be safely distinguished by one character only, namely by the lack of overlap of the interthecal septa also in the distal part, i. e. rhabdosomes up to a length of 15 thecae may not be discriminated. Besides, the apertural lappets of the proximal thecae are typically less down-curved than in *M. lochkovensis*; but this feature is subject to astogenetic variation and also to considerable variation due to differences in the mode of burial and preservation, so that it may not be applicable in the critical case. The hook-shape of the proximal thecae in *M. lochkovensis* is to some extent a function of rhabdosomal age being moderate in juveniles and most pronounced in the adults. It is easy to distinguish the large adult or half-grown rhabdosomes of *M. lochkovensis* from the small *M. branikensis*, but it may be impossible to separate the juveniles of the two species. One may be wondering, if the beds with *M. branikensis* represent nothing more than layers that contain just juvenile populations of *M. lochkovensis* ? But there are rare longer rhabdosomes that possess the critical length not exhibiting any overlap of the interthecal septa in the distal portion. Moreover, virtually every higher bed that yields true *M. lochkovensis*, exhibits the full growth scale from short juvenile to big adult rhabdosomes of that species.

Zone and association: At its type locality *M. branikensis* occurs infrequently together with rare *M. dubius* and *Linograptus posthumus*. It characterizes there the approximately one metre thick interval that is situated between the *ultimus* Zone below and the *pridoliensis* Subzone above (the Lower Subzone of *M. lochkovensis* was not ascertained at Braník). This range of *M. branikensis* is so far only known from its type locality. As *M. branikensis* was recognized not until the final phase of this study, no specific search for it was made in other sections, where its occurrence may be also expected.

It is only in Hvížďálka, where *M. branikensis* possibly also occurs, but in a higher level, namely at the junction from the *pridoliensis* Subzone to the Upper *lochkoviensis* Subzone. There specimens occur abundantly in one or two beds, but almost all are juveniles, seldom exceeding the critical length of 15 thecae; in addition, they are tectonically deformed. In the few longer rhabdosomes that are satisfactorily preserved the interthecal septa around th_{17} do not overlap, i. e. they should be assigned to *M. branikensis*. If this identification could be verified by future work, the total range of *M. branikensis* would comprise the span from immediately above the *ultimus* Zone to immediately above the *pridoliensis* Subzone. However, so far no specimen of *M. branikensis* was found within the *pridoliensis* Subzone.

Geographic distribution: *M. branikensis* is hitherto known only from Bohemia.

Monograptus rectiformis PŘIBYL, 1981?

v* 1981 *Monograptus rectiformis* sp. nov. – PŘIBYL, p. 372–373, pl. 1, figs. 2–3; pl. 2, figs. 1–2; text-fig. 1 (7–9).

Discussion: Under this name PŘIBYL described and figured from the Kosov Quarry medium-sized, straight-rhabdosomes, virtually without any indication of dorsal retroflexion in the range of the sicula. The thecae are said to be of the *uncinatus* type, with uniform, down-curved apertural hoods. PŘIBYLs longest rhabdosome is 37 mm, but most are 15–20 mm in length. Z = 12½–10, D = (1,1–1,3) (0,9–1,0) – (2,0–2,2) (1,6–1,8) mm that is attained beyond th_{13-15}, apparently in flattened specimens.

Of the four rhabdosomes figured by PŘIBYL only one (his pl. 1, fig. 3) clearly shows *uncinatus* type thecae, the hoods of which, however, beyond the initial half a dozen thecae, decrease in magnitude such that the lateral and ventral margins of the thecal apertures can be seen in side view. The thecal type of the other three figured specimens (two of them only 14 thecae long, the third about 18 thecae), including the holotype, would appear to me uncertain. The apertural "hooks" could well be paired lappets as, for instance, in *M. lochkovensis*. That suspicion is corroborated by the observation that the free ventral walls do not stand vertically, as is typical of the *uncinatus* group, but instead are inclined towards the axis of the rhabdosome.

In conclusion, it would appear that the type series of *M. rectiformis* PŘIBYL contains two species with different thecal types. Pending the clarification of this point by future special studies, *M. rectiformis* will not be considered any further in this work.

In addition to the species of the *uncinatus* group that are being described herein, usually rare specimens belonging to that group have been found sporadically in various levels starting off with the top of the Zone of *M. ultimus*. Because part of that material is insufficient for a critical description, and because a complete coverage of the graptolites of the type Přídolí is beyond the scope of this work, I refrain from including those and certain other forms in this study.

Monograptus transgrediens PERNER, 1899

Text-figs. 41a–c; pl. 1, figs. 15, 17–18;
pl. 2, figs. 12, 16–17,19,22 and 25

Description: *M. transgrediens* is the other giant among the graptolites of the type Přídolí attaining a length of 100 mm and a width of 3 mm. Rhabdosome straight, except for the usual gentle ventral deflexion of the dorsal edge at the proximal extremity about the range of the initial 4–7 thecae. Occasional moderate ventral curvatures (as in PERNERs type specimen) or irregular flexions of all or part of the rhabdosome are not typical but likely to be almost always post mortem phenomena. Stout, free virgula often seen to continue beyond the last theca for several cm (in excess of 3 cm).

Thecae biform: proximal few thecae with a pair of short, rounded lateral apertural lappets flanking the initially deeply excavated ventral margin; lappets biggest in th_1, being blinkers-like, straight-forwardly directed; indeed, in rhabdosomes that lie on the rock-surface often only the characteristic lappets of th_1 may be recognized, while the succeeding thecae give

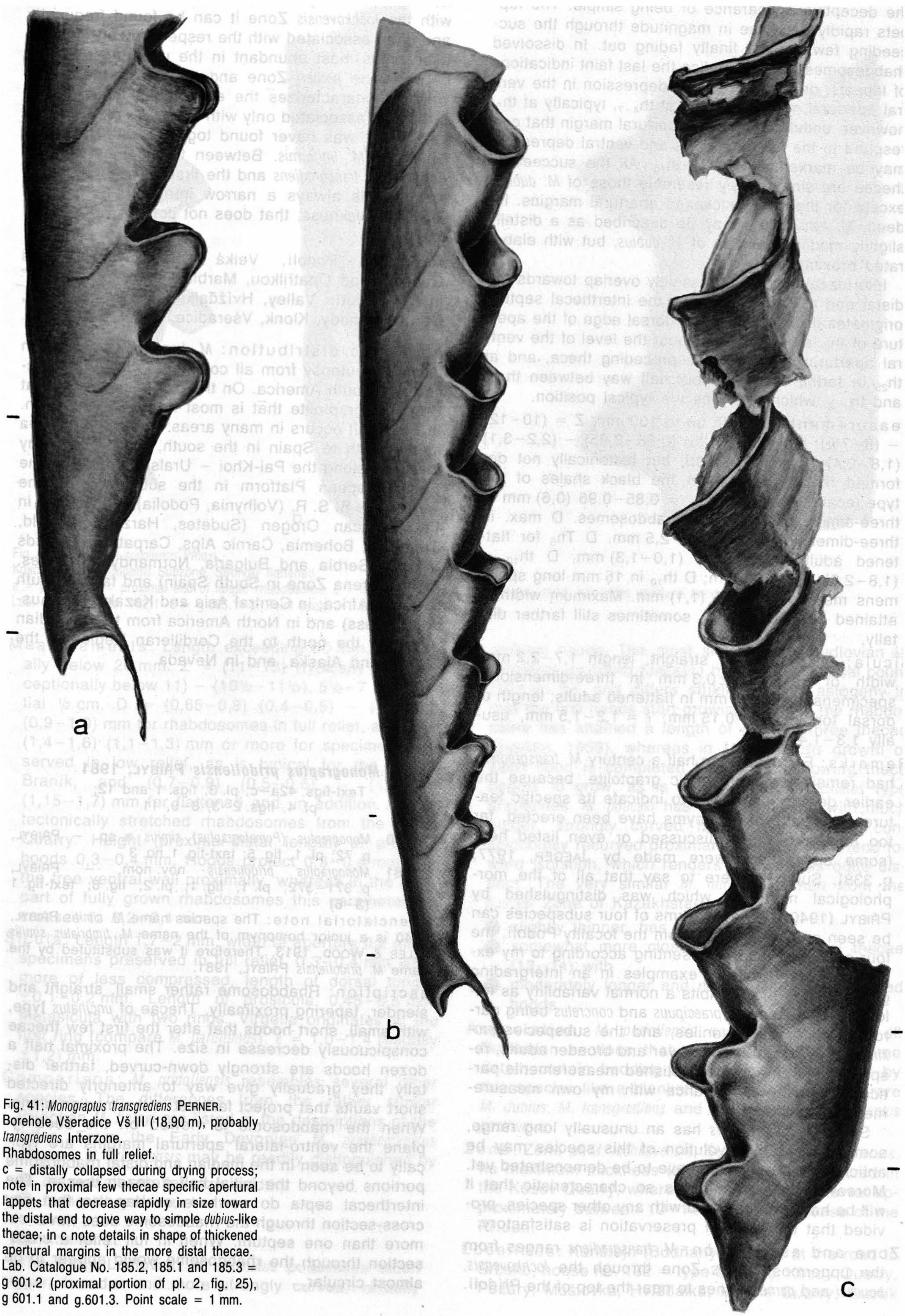

Fig. 41: *Monograptus transgrediens* PERNER. Borehole Všeradice Vš III (18,90 m), probably *transgrediens* Interzone. Rhabdosomes in full relief. c = distally collapsed during drying process; note in proximal few thecae specific apertural lappets that decrease rapidly in size toward the distal end to give way to simple *dubius*-like thecae; in c note details in shape of thickened apertural margins in the more distal thecae. Lab. Catalogue No. 185.2, 185.1 and 185.3 = g 601.2 (proximal portion of pl. 2, fig. 25), g 601.1 and g.601.3. Point scale = 1 mm.

the deceptive appearance of being simple. The lappets rapidly decrease in magnitude through the succeeding few thecae, finally fading out. In dissolved rhabdosomes from Všeradice the last faint indications of lappets, or rather of a mild depression in the ventral apertural margin, is seen at th_{4-7}, typically at th_5; however, undulations of the apertural margin that correspond to the lateral lappets and ventral depression may be marked still about th_{10}. All the succeeding thecae are simple; they resemble those of *M. dubius*, except for their less thickened apertural margins. Indeed, *M. transgrediens* may be described as a distally slightly modified version of *M. dubius*, but with elaborated proximal thecae.

Interthecal septa progressively overlap towards the distal end as follows: at Th_{10} the interthecal septum originates in the level of the dorsal edge of the aperture of th_9, around th_{15-20} about the level of the ventral apertural margin of the preceding theca, and at th_{25} or farther distally about half way between th_{n-1} and th_{n-2}, which becomes the typical position.

Measurements: Length up to 100 mm, Z = (10–12) – (8–7½); D = (0,9–1,25) (0,65–0,85) – (2,2–3,1) (1,8–2,4) mm for flattened, but tectonically not deformed rhabdosomes from the black shales of the type locality Podolí; D Th_1 = 0,85–0,95 (0,6) mm in three-dimensional juvenile rhabdosomes. D max. in three-dimensional adults = 2,5 mm. D Th_5 for flattened adults = (1,5–1,8) (1,0–1,3) mm, D th_{10} = (1,8–2,3) (1,5–1,9) mm; D th_{10} in 15 mm long specimens may be only 1,5 (1,1) mm. Maximum width is attained between th_{20-30}, sometimes still farther distally.

Sicula: Shape normal, straight, length 1,7–2,2 mm; width of aperture ±0,3 mm in three-dimensional specimens, up to 0,5 mm in flattened adults; length of dorsal tongue 0,1–0,15 mm; ε = 1,2–1,5 mm, usually 1,3–1,4 mm.

Remarks: For more than half a century *M. transgrediens* had remained an enigmatic graptolite, because the earlier descriptions failed to indicate its specific features. A wealth of synonyms have been erected, far too numerous to be discussed or even listed here (some suggestions were made by JAEGER, 1977, p. 338). Suffice it here to say that all of the morphological multitude which was distinguished by PŘIBYL (1940, 1943a) in terms of four subspecies can be seen on a single slab from the locality Podolí, the four supposed taxa representing according to my experience only arbitrary examples in an intergrading growth series that exhibits a normal variability as follows: the subspecies *praecipuus* and *concretus* being narrower or broader juveniles, and the subspecies *proximus* and *transgrediens* narrower and broader adults, respectively; some of the published measurements particularly Z, are at variance with my own measurements of the originals.

Since *M. transgrediens* has an unusually long range, some measurable evolution of this species may be anticipated, but this will have to be demonstrated yet. Moreover, *M. transgrediens* is so characteristic that it will be hardly confounded with any other species, provided that the state of preservation is satisfactory.

Zone and association: *M. transgrediens* ranges from the uppermost *ultimus* Zone through the *lochkovensis*, *bouceki* and *perneri* Zones to near the top of the Přídolí. At first it is of sporadic occurrence, but starting off with the *lochkovensis* Zone it can be found frequently and often associated with the respective zone fossils; it becomes most abundant in the uppermost Přídolí between the *perneri* Zone and the top of the stage, where it characterizes the eponymous interzone, in which it is associated only with *Linograptus posthumus*. *M. transgrediens* was never found together with the basal Devonian *M. uniformis*. Between the topmost occurrence of *M. transgrediens* and the first bed with *M. uniformis* there is always a narrow interval, at the most 1,5 m in thickness, that does not contain zonal graptolites.

Localities: Podolí, Velká Chuchle (Eurypterid Quarry), Pod Opatřilkou, Marble Quarry, "U topolů" in the Radotín Valley, Hvížďalka, Požáry, Karlštejn, Čertovy schody, Klonk, Všeradice, Kosov and others.

Geographic distribution: *M. transgrediens* is known to me by autopsy from all continents, except Antarctica and South America. On the global scale it is that Přídolian graptolite that is most frequently met with. In Europe it occurs in many areas from the Kara Sea in the north to Spain in the south, namely at many localities along the Pai-Khoi – Urals fold-belt, on the East European Platform in the subsurface of the western U. S. S. R. (Volhynia, Podolia) and Poland, in the Variscan Orogen (Sudetes, Harz, Kellerwald, Thuringia, Bohemia, Carnic Alps, Carpatho-Balkanids in East Serbia and Bulgaria, Normandy, Pyrenees, Ossa-Morena Zone in South Spain) and farther south in North Africa; in Central Asia and Kazakhstan, Australia (Yass) and in North America from the Canadian Arctic in the north to the Cordilleran Region in the Yukon and Alaska, and in Nevada.

Monograptus pridoliensis PŘIBYL, 1981

Text-figs. 42a–c; pl. 3, figs. 1 and 12; pl. 4, figs. 2–3, 8–9, 11

v. 1940 *Monograptus (Pomatograptus) similis* n. sp. – PŘIBYL, p. 72; pl. 1, fig. 5; text-fig. 1 no. 3

v.* 1981 *Monograptus pridoliensis* nov. nom. – PŘIBYL, p. 371–372; pl. 1, fig. 1; pl. 2, fig. 6; text-fig. 1 (3–6)

Nomenclatorial note: The species name *M. similis* PŘIBYL, 1940 is a junior homonym of the name *M. fimbriatus similis* ELLES & WOOD, 1913. Therefore it was substituted by the name *M. pridoliensis* PŘIBYL, 1981.

Description: Rhabdosome rather small, straight and slender, tapering proximally, Thecae of *uncinatus* type, with small, short hoods that after the first few thecae conspicuously decrease in size. The proximal half a dozen hoods are strongly down-curved, farther distally they gradually give way to anteriorly directed short vaults that project farthest in the median plane. When the rhabdosome is viewed on the bedding-plane the ventro-lateral apertural margins are typically to be seen in the median and distal rhabdosome portions beyond the initial half a dozen thecae. The interthecal septa do nowhere overlap, so that any cross-section through the rhabdosome does never cut more than one septum. When in full relief a cross-section through the rhabdosome would appear to be almost circular.

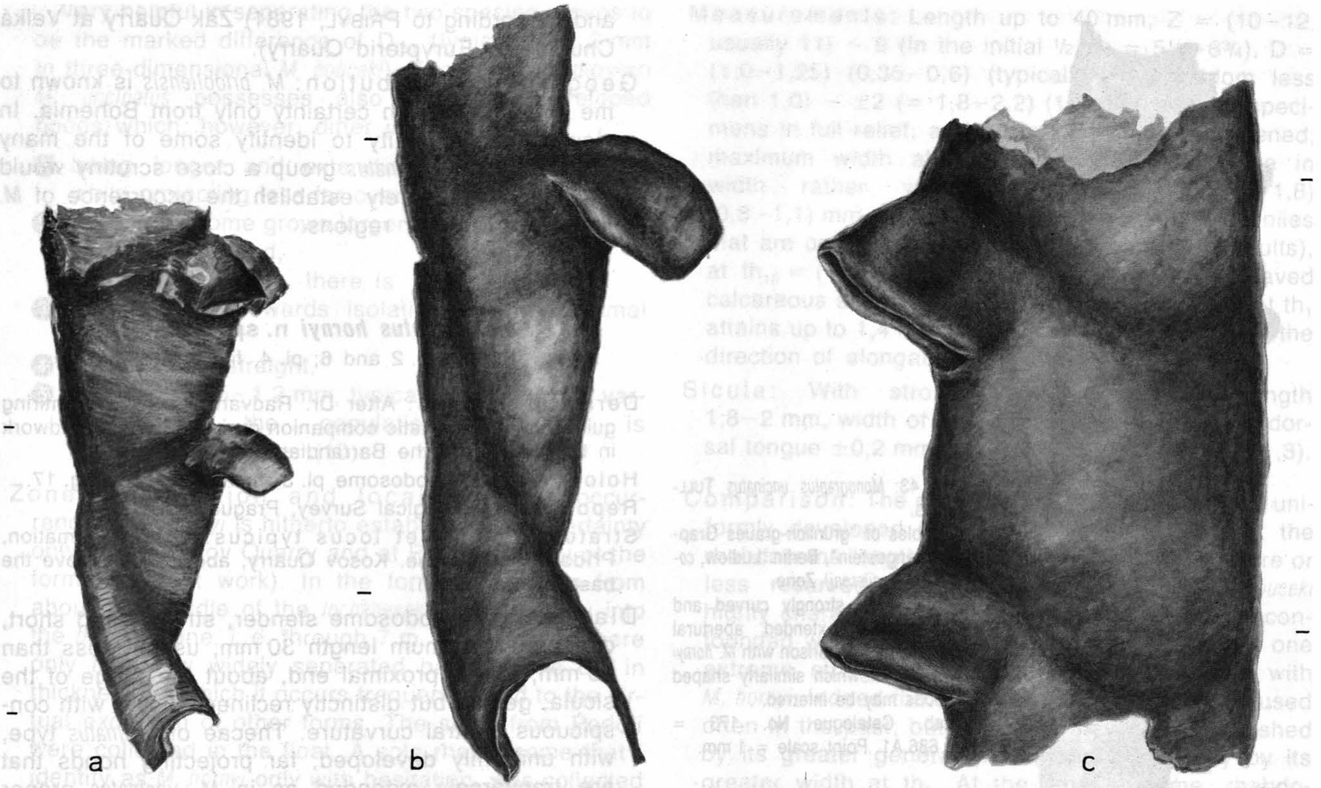

Fig. 42: *Monograptus pridoliensis* PŘIBYL.
Kosov Quarry, *pridoliensis* Subzone. Strongly flattened.
a = juvenile; b = proximal end of longer rhabdosome; c = adult distal fragment with very short, spout-like apertural hoods.
Lab. Catalogue No. 102.1–3 = g 685.1–3. Point scale = 1 mm.

Measurements: Length exceeding 30 mm, but usually below 20 mm. Z = (11–13) (typically ±12, exceptionally below 11) – (10½–11½), 5½–7 in the initial ½ cm. D = (0,65–0,8) (0,4–0,5) – (1,2–1,3) (0,9–1,0) mm for rhabdosomes in full relief, and up to (1,4–1,6) (1,1–1,3) mm or more for specimens preserved in low relief, as is typical for the locality Braník, and (0,7–0,9) (0,5–0,6) – (1,3–2,1) (1,15–1,7) mm for flattened and, in addition, slightly tectonically stretched rhabdosomes from the Kosov Quarry. Height (proximal-distal length) of proximal hoods 0,3–0,4 mm. Hoods project 0,3–0,4 mm over the free ventral wall proximally, whereas in the distal part of fully grown rhabdosomes this parameter decreases to 0,2–0,1 mm.

Sicula: Length 1,7–2 mm, width of aperture 0,2 mm in specimens preserved in full relief, 0,3–0,4 mm when more or less compressed, length of dorsal tongue ±0,1–0,2 mm. Length of prosicula 0,45–0,5 mm. Metasicula with two rings. Virgella originates at the first ring (compare *M. parultimus*). ε = 1,0–1,4 (usually ±1,2) mm.

Comparison: *M. pridoliensis* resembles several other species. The differences from the rather similar Přídolian *M. hornyi* are listed in the descriptions of the latter. From the Early Devonian *M. praehercynicus* JAEGER, *M. pridoliensis* may be readily distinguished by

❶ its overall smaller size (width),
❷ higher thecal count
and
❸ smaller ε.

The Early Ludlovian *M. uncinatus* possesses much bigger, broader and more strongly curved, virtually uniform hoods. The most similar Early Ludlovian *M. micropoma micropoma* (JAEKEL) has a lesser thecal count (10±¼–⅛), and differs strikingly in its astogeny in that the first hoods start growing not until the rhabdosome has attained a length of at least three thecae (JAEGER, 1959), whereas in *M. pridoliensis* growth of each hood is completed before the following theca begins to grow, as is typical of true *uncinatus* type graptolites. *M. bouceki* has uniform thecae with much bigger, strongly curved hoods, and at the conspicuolsy recurved proximal end the thecae tend toward isolation, which renders this species quite distinct. The very similar *M. mironowi* KOREN from the *bouceki* Zone of Kazakhstan remains

❶ slightly thinner, has
❷ somewhat more closely spaced proximal thecae (13–14) with
❸ moderately longer and more uniformly developed hoods.

Association: *M. pridoliensis* occurs frequently in all Bohemian sections that were investigated in some detail; certain bedding-planes are even covered by this species like a blanket. It is associated with rare *M. dubius*, *M. transgrediens* and not infrequent *Linograptus posthumus*.

Zone: Zone of *M. lochkovensis*, Subzone of *M. pridoliensis*. Its maximum thickness (about 4 m) was measured in the Kosov Quarry, where it comprises the interval approximately between 10–14 m above the base of the Přídolí.

Localities: Karlštejn (Budňany) (quarry at the road to Srbsko, house no. 132 = type locality), Kosov Quarry, Požáry, Mušlovka, Hvížďalka, Marble Quarry, Braník and (according to PŘIBYL, 1981) Žák Quarry at Velká Chuchle (= Eurypterid Quarry).

Geographic distribution: *M. pridoliensis* is known to me by autopsy with certainty only from Bohemia. In view of the difficulty to identify some of the many species of the *uncinatus* group a close scrutiny would be required to safely establish the occurrence of *M. pridoliensis* in other regions.

Fig. 43: *Monograptus uncinatus* TULLBERG.
Cobbles of "grünlich-graues Graptolithengestein", Berlin. Ludlow, *colonus (= nilssoni)* Zone.
Note large, strongly curved and transversely extended apertural hoods for comparison with *M. hornyi* n. sp., for which similarly shaped hoods may be inferred.
Lab. Catalogue No. 173 = g 686.A1. Point scale = 1 mm.

***Monograptus hornyi* n. sp. JAEGER**

Pl. 3, figs. 2 and 6; pl. 4, figs. 16–17

Derivatio nominis: After Dr. Radvan HORNÝ, my untiring guide and enthusiastic companion during 30 years fieldwork in the Silurian of the Barrandian area.

Holotype: The rhabdosome pl. 3, fig. 2 and pl. 4, fig. 17.

Repository: Geological Survey, Prague, no. HJ 57.

Stratum typicum et locus typicus: Požáry Formation, Přídolí, *bouceki* Zone. Kosov Quarry, about 24 m above the base of the Přídolí.

Diagnosis: Rhabdosome slender, straight and short, observed maximum length 30 mm, usually less than 20 mm; at the proximal end, about the range of the sicula, gently, but distinctly reclined. Sicula with conspicuous ventral curvature. Thecae of *uncinatus* type, with uniformly developed, far projecting hoods that are tranversely extended as in *M. uncinatus* proper (text-fig. 43). Initial one to two thecae with slight indication of isolation. Interthecal septa do nowhere overlap. Typical Z = (11–12) – (10–9); in specimens disposed normal to the direction of stretching that was caused by weak flow cleavage $Z_{prox.}$ may attain 13 and more, whereas in specimens lying parallel to the direction of elongation $Z_{prox.}$ may decrease to 10. Typical D = (0,75–0,85) (0,4–0,5) – (±1,5) (±1,0) mm (rhabdosomes flattened or in very low relief in yellowish weathering laminated calcareous shales from the Kosov Quarry); maximum width is attained between th_{10-15}. Observed variation of maximum width in specimens from the Kosov Quarry is (1,3–1,8) (0,9–1,3) mm depending on the disposition of the rhabdosomes to the direction of tectonic elongation. In specimens from Podolí that are preserved as completely flattened films in apparently non-cleaved, black argillaceous shales D = ±(1,0) (0,6–0,7) – ±1,8 (1,2–1,4) mm.

Sicula: Length 1,5–1,8 mm, width of aperture 0,3–0,4 mm, length of dorsal tongue ±0,2 mm, ε = typically 1,2–1,3 mm (but varying from 1,0–1,5) mm depending on the disposition of the rhabdosome to the direction of stretching).

Comparison: *M hornyi* may be readily distinguished from the preceding *M. pridoliensis* by its larger and uniformly developed hoods. The succeeding and even coeval *M. bouceki*, with which *M. hornyi* seems to have been confounded often in the past,

❶ grows markedly wider,
❷ has more isolated, more projecting and rather claw-shaped initial thecae,
and
❸ often exhibits a strong reflexion of the proximal extremity involving up to 5 thecae, whereas the dorsal recurvature in *M. hornyi* is virtually due to the dorsal convexity of its sicula thus matching only extremely straight rhabdosomes of *M. bouceki*.

Very helpful in separating the two species proves to be the marked difference of D_{th1} (typically = 1,2 mm in three-dimensional *M. bouceki*). The Lower Ludlovian *M. uncinatus* possesses also uniformly developed hoods which, however, differ in

❶ being longer and extending farther downward, while projecting less far over the free ventral wall;
❷ the rhabdosome grows larger, its proximal extremity is not reclined,
and as a corollary, there is
❸ no indication towards isolation of the proximal thecae;
❹ the sicula is straight,
❺ ε is less (0,85–1,2 mm, typically about 1 mm, varying with the population) and Z is higher = (12–13) – (10).

Zone, association and localities: The occurrence of *M. hornyi* is hitherto established with certainty only in the Kosov Quarry and at Podolí (quarry of the former cement work). In the former it ranges from about the middle of the *lochkovensis* Zone to low into the *bouceki* Zone, i. e. through 7 m. It was found there only in a few widely separated bands some cm in thickness, in which it occurs frequently, and to the virtual exclusion of other forms. The slabs from Podolí were collected in the float. A sole rhabdosome that I identify as *M. hornyi* only with hesitation, was collected in the *perneri* Zone at Velká Chuchle. That would suggest a total range from the *lochkovensis*, through the *bouceki* into the *perneri* Zone.

Monograptus bouceki Přibyl, 1940

Pl. 3, figs. 3,7–11,13 and 15

v* 1940 *Monograptus (Pomatograptus) boučeki* n. sp. – Přibyl, p. 71, pl. 1, figs. 7–8; text-fig. 1
1943 *Monograptus boučeki* Přibyl. – Přibyl, p. 6, pl. 1, figs. 1?,2 and 3? [in part possibly *M. hornyi* n. sp.].
v 1964 *Monograptus boučeki* Přibyl. – Teller, p. 56–57, pl. 2, fig. 13; pl. 5, fig. 5; pl. 6, figs. 1–3; pl. 8, figs. 12–13; pl. 14, figs. 4–5; text-figs. 13a–d.
v 1967 *Monograptus boučeki* Přibyl. – Jaeger, pl. 14, fig. a.
1972 *Monograptus bouceki* Přibyl. – Jackson & Lenz, p. 588–589, text-figs. 3A–F,I.
1975 *Monograptus bouceki* Přibyl. – Lenz, p. 82; pl. 1, figs. 7, 10, 12–14, text-figs. 2A,C–F
1978 *Monograptus bouceki* Přibyl. – Jackson, Lenz & Pedder, p. 21, pl. 3, fig. 11.
v 1981 *Monograptus bouceki* Přibyl. – Přibyl, pl. 2, figs. 3–5.
1983 *Monograptus bouceki* Přibyl. – Koren, text-fig. 2 (listed in diagramme).

Description: Rhabdosome small to medium-sized, straight to strongly reclined in the proximal portion; degree of proximal retroflection extremely variable, in the one extreme being just a gentle, but distinct, recurvature at the proximal end, about the range of the sicula, indeed being due virtually to the conspicuous dorsal convexity of the ventrally deflected sicula, after the normal ventral deflection of the dorsal edge of the rhabdosome that becomes marked around th_{5-7}; in other extreme, all of the proximal portion up to th_5 may be recurved. Thecae of *uncinatus* type, with long, uniformly developed hoods that project far over the vertical free ventral walls; initial few thecae, above all th_1, especially far projecting, claw-like, with pronounced tendency toward isolation. Interthecal septa do nowhere overlap.

Measurements: Length up to 40 mm, Z = (10–12, usually 11) – 9 (in the initial ½ cm = 5½–6¾). D = (1,0–1,25) (0,35–0,6) (typically ±1,2 seldom less than 1,0) – ±2 (= 1,8–2,2) (1,3–1,7) mm for specimens in full relief, and up to 2,5 mm when flattened; maximum width attained around th_{15}; increase in width rather variable, at th_5 = (1,3–1,8) (0,8–1,1) mm (maximum figure observed in juveniles that are only 7 thecae in length as well as in adults), at th_{10} = (1,8–2,2) (1,2–1,4) mm. In mildly cleaved calcareous shales from the Kosov Quarry width at th_1 attains up to 1,4 mm in specimens lying normal to the direction of elongation.

Sicula: With strong ventral curvature; length 1,8–2 mm, width of aperture ±0,3 mm, length of dorsal tongue ±0,2 mm, ε = 1,2–1,5 mm (usually ±1,3).

Comparison: The claw-like initial thecae, and the uniformly developed long thecal hoods throughout the rhabdosome length, and in addition, the often more or less recurved proximal portion, render *M. bouceki* highly characteristic, so that it should hardly be confounded with any other species. However, at the one extreme, straight rhabdosomes may be confused with *M. hornyi*; indeed the two seem to have been confused often in the past; but *M. bouceki* may be distinguished by its greater general width, and particularly by its greater width at th_1. At the other extreme, rhabdosomes with strongly recurved proximal end are reminiscent of *M. supinus* Koren from the *bouceki* and *perneri* Zones in Kazakhstan, which has a similarly reflexed and, in addition, abruptly and much more tapering proximal end; moreover, *M. supinus* has longer, possibly spinelike apertural processes. It may be hypothesized that *M. bouceki* is phylogenetically intermediate between *M. hornyi* and *M. supinus*, grading into those two on either side of the morphological spectrum.

Association: In the Barrandian sections *M. bouceki* appears to be of uneven frequency. Though at the localities in the vicinity of Prague, e. g. at the type locality Marble Quarry, occasionally up to a dozen rhabdosomes of this species may be seen scattered over a slab of dark micritic limestone that is typical of the *bouceki* Zone (and further portions of the Přídolí) in this region, *M. bouceki* is of relatively infrequent occurrence there being by far outnumbered by its common associate *M. transgrediens*, while *M. dubius* and *Linograptus posthumus* are rare companions. In the brighter limestones and calcareous shales of the Kosov Quarry the frequency ratio is reversed, *M. bouceki* being the dominant species.

Zone: Latest *M. bouceki* occurs above *M. perneri*. At Hvížďalka *M. bouceki* ranges through 14 m of strata, the lower 9 m of which represent the *bouceki* Zone; the uppermost occurrence of *M. bouceki* is there 2 m above the highest bed with *M. perneri*, whose Zone falls there demonstrably entirely into the range of *M. bouceki*. In the Kosov Quarry the thickness of the *bouceki* Zone amounts to at least 5 m, possibly much more.

Localities: Marble Quarry, Hvížďalka, Kosoř, Velká Chuchle (Eurypterid Quarry), Požáry, Čertovy schody, Kosov Quarry.

Geographic distribution: As may be seen from the synonymy list, *M. bouceki* has been recorded from many parts of the world. Although a world-wide distribution of this species may be expected, this can not yet be considered as safely established; a number of published descriptions appear to suggest differences from the type material, e. g. the recorded width for th_1 often being too low. However, without having compared the originals a definite assessment cannot be given here.

Monograptus prognatus Koren, 1983

Pl. 4, fig. 7

* 1983 *Monograptus prognatus* sp. nov. – Koren, p. 424–427; pl. 51, figs. 8–14; pl. 52, figs. 1–5, 8–10; text-fig. 6.

Discussion: *M. prognatus* is a medium-sized, up to 60 mm long and 2–2,3 (1,75–1,8) mm wide, straight graptolite, with thecae of *uncinatus* type that possess uniform, large hoods; the interthecal septa overlap progressively toward the distal end, which renders this species highly distinct from all other *uncinatus* type graptolite of the Přídolí, but foreshadows a specific feature of the basal Devonian *M. uniformis*.

In the Přídolí of the Balkhash area, Kazakhstan, *M. prognatus* is a frequent and long-ranging graptolite that extends from the base of the *lochkovensis* Zone upwards through possibly all of the higher Přídolí.

In the Barrandian area, Marble Quarry section, in the Lower Subzone of *M. lochkovensis* a sole, rather distal fragment, 9 mm in length, was found that clearly exhibits the uniform, large apertural hoods and, at its distal end, the extreme of the characteristic overlap of the interthecal septa, i. e. a cross-section in the apertural region will hit there the maximum of three interthecal septa. Greatest width = (2,1–2,2) (1,4–1,5) mm.

Monograptus perneri Bouček, 1931

Pl. 2, figs. 9–11 and 13; pl. 4, figs. 4–6

v.* 1931 *Monograptus perneri* n. sp. – Bouček, p. 175, 179; text-figs. 1a–d,2

v. 1943 *Monograptus perneri* Bouček. – Přibyl, p. 5; pl. 1, figs. 6–7

v. 1964 *Monograptus perneri* Bouček. – Teller, p. 57–59; pl. 1, figs. 11–12; pl. 2, figs. 7–8, 12; pl. 4, figs. 10–11; pl. 6, figs. 4–6; pl. 8, fig. 11; text-fig. 14a,b.

1973 *Monograptus* cf. *perneri* Bouček. – Biske & Rinenberg, p. 175; pl. 1, fig. 6a,b.

v. 1975 *Monograptus kasachstanensis* sp. nov. – Mikhailova, p. 155–156; pl. 37, figs. 7–10.

v. 1983 *Monograptus perneri kasachstanesis* Mikhailova. – Koren, p.409.

Description: Rhabdosome small, gently arcuate, dorsally concave, which is most pronounced at the proximal extremity; but strongly curved sicula ventrally deflected. Thecae of *uncinatus* type, with virtually uniform, relatively large, strongly curved hoods; th_1 often especially far projecting, with indication of isolation. Interthecal septa do not overlap.

Measurements: Length up to 15 mm, but usually hardly 10 mm. Z = typically 11–12, but varying from 10–13; in the first ½ cm = 6–7. D = (0,8–1,1) (0,45–0,6) – (1,0–1,25) (0,65–0,8) mm for specimens that are preserved in full relief to low relief, or that may be even flattened but not affected by cleavage. Maximum D may be attained at th_1, or at th_5 the latest. Rhabdosomes from Dlouhá hora that are flattened and, in addition, deformed by mild flow cleavage, attain a width of 1,5 (1,0) mm, when forming a big angle with the direction of elongation.

Sicula: Length 1,5–1,8 mm, width of aperture 0,3–0,5 mm (broadened apertures that are somewhat reminiscent of the siculae of *M. hercynicus* are not infrequent), length of the relatively large dorsal tongue ±0,2 mm. ε = 1,1–1,5 mm (typically 1,2–1,3).

Comparison: Owing to its distinctive morphology *M. perneri* will be hardly confused with any other species; only straight distal fragments may be confounded with the similarly sized *M. beatus* and *M. microdon* (Reinh. Richter). *M. microdon* possesses less far projecting apertural hoods that also differ in shape, and its distal interthecal septa overlap.

Association: *M. perneri* typically occurs in large swarms covering bedding planes irrespective of the type of rock (black argillaceous shale, brownish weathering calcareous shale and dark micritic limestone), and usually to the virtual exclusion of other species. Rare associates are *M. transgrediens, M. dubius* (small form), *M.* cf. *hornyi* and *Linograptus posthumus*.

Zone: Zone of *M. perneri*

Localities: Podolí, Marble Quarry, Velká Chuchle (Eurypterid Quarry), Hvížďalka, Pod Opatřilkou, Dlouhá hora.

Geographic distribution: In addition to Bohemia, the occurrence of *M. perneri* is demonstrably established on the East European Platform in Poland, and in Middle Asia (NE-Balkhash area in Kazakhstan, U. S. S. R.). The representatives from Kazakhstan cautiously have been interpreted as a geographical subspecies by Koren (1983), indeed a rigorous comparison is difficult to be made due to the different state of preservation.

Monograptus beatus Koren, 1983

Pl. 4, figs. 1,10 and 15

v. 1975 *Monograptus* n. sp. aff. *microdon*. – Jaeger, p. 115; pl. 1, figs. 1–2; text-fig. 5d.

v * 1983 *Monograptus beatus* sp. nov. – Koren, p. 416–419; pl. 49, figs. 7–10; pl. 50, figs. 1–5; text-fig. 4b–g.

Description: Rhabdosome small, slender and straight, except for the gently to moderately reclined proximal extremity. Thecae uniform, apparently of modified *uncinatus* type, sigmoidal, with long, strongly curved, ? transversely triangular hoods as in *M. microdon*. Growth of the individual theca is completed before that of the succeeding theca begins. Interthecal septa do not overlap.

Measurements for specimens in low relief: Length up to 20 mm; Z = 10–11 (9–10); D = 0,7±0,05 (0,4±0,05) – (1,0–1,2) (0,8–0,9) mm.

Sicula: Of normal shape, gently ventrally deflected; length about 1,7–2 mm, width of aperture 0,2 mm, length of dorsal tongue 0,15–0,2 mm, ε = 1,3–1,75 mm (usually 1,5–1,6 mm).

Remarks: Koren (1983) gives slightly differing measurements for almost every parametre, most of which I believe to be virtually due to the different state of preservation, the specimens from Kazakhstan being in full relief, whereas the Bohemian rhabdosomes are in low relief, at the best. Figures for D as given by

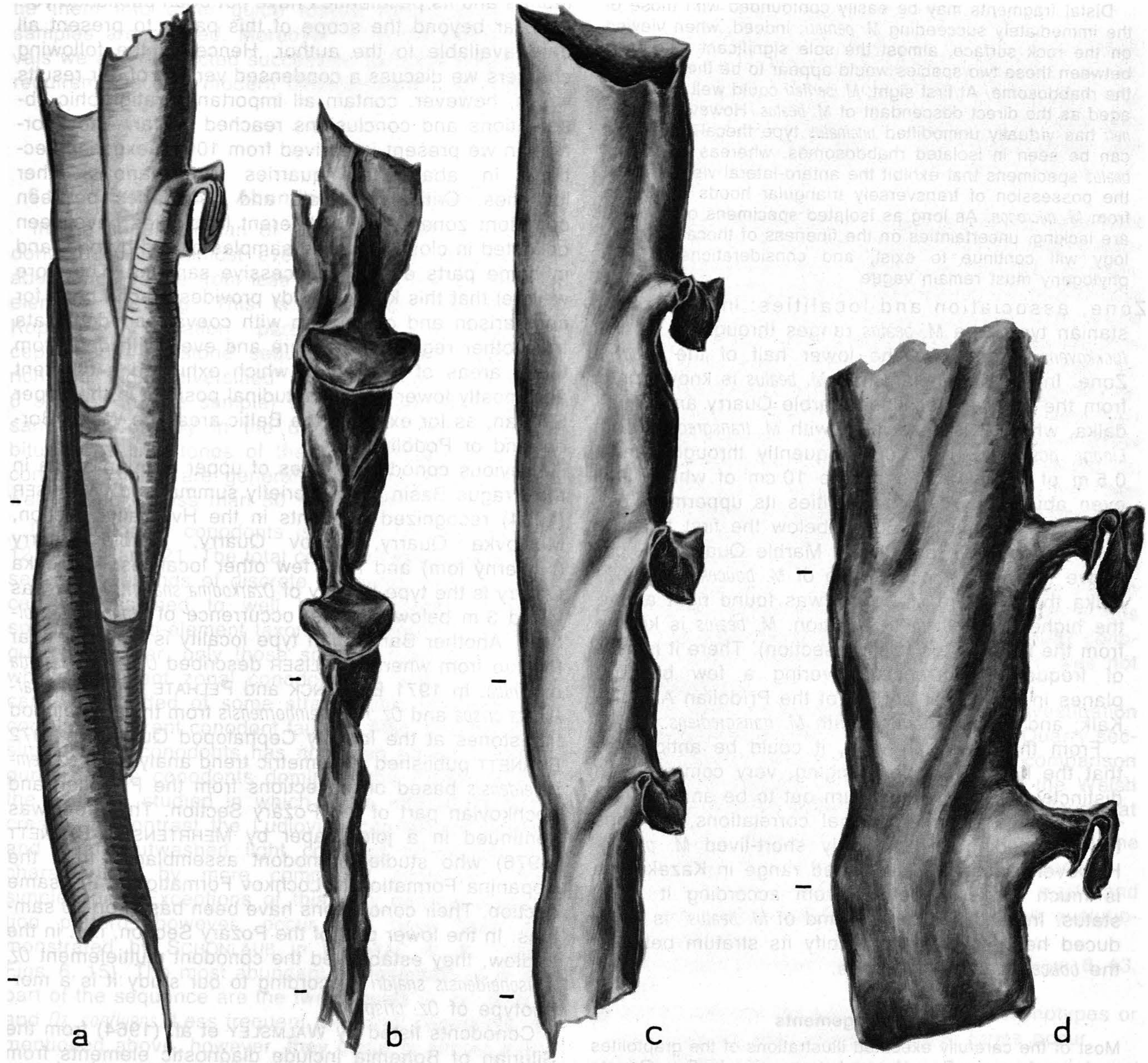

Fig. 44: *Monograptus microdon* REINHARD RICHTER.
Karlík near Dobřichovice. Basal Devonian *uniformis* Zone. In full relief or somewhat distorted. This type of thecae is inferred to be characteristic of *M. beatus* also.
a = proximal extremity with sicula and th_1, lateral view; b = anterior view of another proximal end with destroyed apertural sicular region, but showing well preserved transversely triangular thecal hoods; note differing shape of hoods in th_1 and th_2; c = middle portion of rhabdosome in lateral and slightly anterior view; d = adult fragment in lateral view.
Lab. Catalogue No. 220 C.1–4 = g 600 C1–4. Point scale = 1 mm.

KOREN: (0,55–0,65) (0,3–0,35) – (0,85–1,0) (0,7–0,75) mm, Z = 11½–12 (10½–11), ε = 1,25–1,4 mm.

Comparison: *M. beatus* closely resembles *M. microdon* (pl. 4, fig. 10 and text-figs. 44a–d), particularly its typical form, but differs in the following:

❶ it is invariably reclined proximally, whereas *M. microdon* typically exhibits a ventrally curved proximal extremity, though there is a considerable variability of this feature in *M. microdon*, specimens with more or less recurved proximal end being not rare;

❷ more significant is the greater width at th_1 that in *M. microdon* is only ±0,4 (±0,3) mm;

❸ the interthecal septa do nowhere overlap, in contrast to *M. microdon*, where they exhibit progressive overlap distally of the th_{6-7}.

M. microdon silesicus JAEGER remains distinctly smaller: D th_1 = 0,2 mm. *M. microdon aksajensis* KOREN is also thinner: D = 0,25 (0,2) – (0,7–0,9) (0,55–0,8) mm and has a higher thecal count: Z = (12½–13) (12–12½). *M. kallimorphus* KRAATZ (1958) (and its likely junior synonym *M. balticus* TELLER, 1966)

❶ grows wider (about 1,5 mm),

❷ its interthecal septa overlap distally and

❸ ε = 1,7–>2 mm in tectonically undeformed specimens.

Distal fragments may be easily confounded with those of the immediately succeeding *M. perneri*; indeed, when viewed on the rock surface, almost the sole significant difference between these two species would appear to be the shape of the rhabdosome. At first sight, *M. perneri* could well be envisaged as the direct descendant of *M. beatus*. However, *M. perneri* has virtually unmodified *uncinatus* type thecal hoods, as can be seen in isolated rhabdosomes, whereas certain *M. beatus* specimens that exhibit the antero-lateral view suggest the possession of transversely triangular hoods as known from *M. microdon*. As long as isolated specimens of *M. beatus* are lacking, uncertainties on the fineness of thecal morphology will continue to exist, and considerations on the phylogeny must remain vague.

Zone, association and localities: In its Kazakhstanian type area *M. beatus* ranges through all of the *lockkovensis* Zone and the lower half of the *bouceki* Zone. In the Barrandian area *M. beatus* is known only from the adjacent localities Marble Quarry and Hvížďalka, where it is associated with *M. transgrediens* and *Linogr. posthumus*. It occurs frequently through hardly 0,5 m of strata, in the middle 10 cm of which it is even abundant. At both localities its uppermost occurrence is some 30–50 cm below the first appearance of *M. perneri*, and in the Marble Quarry 170 cm above the highest occurrence of *M. bouceki*; at Hvížďalka the last rare *M. bouceki* was found right above the highest *M. perneri*. In addition, *M. beatus* is known from the Carnic Alps (Cellon section). There it is also of frequent occurrence, covering a few bedding planes in the higher portion of the Přídolian Alticola-Kalk; and it is associated with *M. transgrediens*.

From the European view, it could be anticipated that the here very short-ranging, very common and distinctive *M. beatus* might turn out to be an excellent datum plane for interregional correlations, as does the succeeding and similarly short-lived *M. perneri*. However, because its reported range in Kazakhstan is much longer, I refrain from according it zonal status. Instead, the term "Band of *M. beatus*" is introduced here, in order to signify its stratum between the *bouceki* and *perneri* Zones.

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6.3. Conodonts

(By Hans-Peter SCHÖNLAUB)

Since the first report of Silurian conodonts from Bohemia by O. H. WALLISER (1964) our knowledge about the conodont fauna in this interval of the Barrandian sequence has increased considerably. Based on more than 250 samples from 7 sections and numerous localities which were sampled by O. H. WALLISER, S. G. BARNETT, V. H. WALMSLEY et al. and the author in the last two decades an almost complete stratigraphic record in the upper Silurian has been covered. Although the results can well be compared with the "standard conodont sequence" in other regions, e. g. the Carnic Alps, a full documentation of the sequence of conodont faunas and its pecularities have not been published yet. It is far beyond the scope of this paper to present all data available to the author. Hence, in the following chapters we discuss a condensed version of our results which, however, contain all important stratigraphic observations and conclusions reached so far. The information we present is derived from 100 % exposed sections in abandoned quarries and various other localities. Critical intervals and boundaries between conodont zones and/or different lithologies have been collected in closely spaced samples of bed-by-bed, and in some parts even in successive samples. Therefore we feel that this kind of study provides a solid base for comparison and correlation with coeval conodont data from other regions elsewhere and even with data from those areas of deposition which exhibited a different and mostly lower palaeolatitudinal position in the upper Silurian, as for example the Baltic area, the Welsh Borderland or Podolia.

Previous conodont studies of upper Silurian strata in the Prague Basin can be briefly summarised: WALLISER (1964) recognized condonts in the Hvížďalka section, Mušlovka Quarry, Kosov Quarry, Marble Quarry (= Černý lom) and from few other localities. Mušlovka Quarry is the type locality of *Ozarkodina snajdri*, which was found 3 m below the first occurrence of *Monograptus ultimus*. Another Barrandian type locality is Jinonice near Prague from where WALLISER described *Ozarkodina sagitta bohemica*. In 1971 BULTYNCK and PELHATE reported *Ozarkodina crispa* and *Oz. r. eosteinhornensis* from the cephalopod limestones at the locality Cephalopod Quarry. In 1972 BARNETT published a biometric trend analysis of *Oz. remscheidensis* based on collections from the Přídolian and Lochkovian part of the Požáry Section. This work was continued in a joint paper by MEHRTENS & BARNETT (1976) who studied conodont assemblages from the Kopanina Formation to Lochkov Formation in the same section. Their conclusions have been based on 16 samples. In the lower part of the Požáry Section, i. e. in the Ludlow, they established the conodont multielement *Oz. remscheidensis snajdri* (according to our study it is a morphotype of *Oz. crispa*).

Conodonts listed by WALMSLEY et al. (1964) from the Silurian of Bohemia include diagnostic elements from the Wenlock, Ludlow and Přídolí. Beside others they recognized index conodonts from the siluricus – and the eosteinhornensis – Zones.

On the occasion of the Second European Conodont Symposium two upper Silurian localities (Mušlovka Quarry and Koledník Quarry) and three from the Přídolí – Lochkov boundary (U topolů, Karlštejn and Klonk) were described in detail. From the former two sections conodonts of the Přídolí age were also illustrated (SCHÖNLAUB in CHLUPÁČ et al., 1980).

Previously mentioned conodont reports from the upper Silurian of the Barrandian sequence were based on either isolated "spot-samples" or were derived from continuous longer ranging sections. However, different from modern conodont sampling methods initiated by J. KŘÍŽ and the author in the Barrandian in recent years, the first conodont samples were taken from too long intervals. As we know today an interval of 2,5–3 m mentioned in the literature resulted in insufficient data about the true ranges and the mutual relationships of a sequence of conodont faunas. To recognize evolutionary trends, the composition, and transition between distinct conodonts elements, to compare faunas as well as to tie them into other guide fossils almost bed-by-bed samples are needed. Moreover, in some critical intervals we even collected successive samples to fulfill the requirements of a modern biostratigraphic analysis.

6.3.1. Distribution, Abundance and Preservation

In the upper Silurian of the Barrandian area conodonts occur in almost every limestone sample. The abundance varies from less than 10 to more than 200 elements per kg. This is particularly true for the Kopanina Formation part of the organodetritic cephalopod limestone sequence with an individually rich and "highly diversified" conodont fauna (more than 6 species in one sample) in more than 90 % of the samples. Contrary in the dark, often laminated and bituminous limestones of the basal Požáry Formation conodont yields are generally low and index species were found in less than 50 % samples.

Distribution of conodonts is shown in Figs. 6, 7, 8, 12, 13, 17 and 21. The total conodont fauna consists of several thousands of discrete elements most of which can be assigned to well known Silurian conodont species if multi-element taxonomy is applied. In our figures, however, only those species have been listed which represent zonal conodonts or which otherwise can be regarded of some stratigraphic importance to correlate different conodont faunas. Also, distribution of simple cone conodonts has not been added in our figures. These conodonts dominate the Přídolí part of the sections studied in which shale intercalations increase. In contrast the Ludlovian cephalopod bearing and often outwashed light coloured limestones are characterized by more compound conodonts than simplecones. Exceptions of this very general distribution pattern, however, occur and have been demonstrated by SCHÖNLAUB in CHLUPÁČ et al. (1980, Figs. 6, 15). The most abundant representatives in this part of the sequence are the two species *Oz. exc. excavata* and *Oz. confluens*. Less frequent are zonal conodonts. As mentioned above, however, they occur in almost every sample in representative amounts starting with the name bearer of the *ploeckensis*-Zone, *A. ploeckensis*, at the base of the cephalopod limestone in Marble Quarry.

Due to our short sample intervals the ranges of index conodonts have been closely spaced. We tried to prove their occurrences by repeated processing on one or other sample. Different from the Ludlow part conodont abundance and diversification are very low in the Přídolí. All faunas are dominated by simple cones, belonging to the genera *Belodella, Panderosus* and *Drepanodus*; less frequent are *Oz. r. eosteinhornensis, Oz. confluens* and *Oz. e. excavata*.

Conodonts from the upper Kopanina Formation and from the Požáry Formation are generally well preserved. Their surface is predominantly smooth and without recrystallized overgrowths or any formation of crust. Also, there is no indication of abnormal fragmentation, deformation or abrasion due to reworking or current effects. Přídolí conodonts, however, appear to be smaller in size than those from the Ludlow beds. Overall conodont color is greyish reflecting a CAI between 3 and 4. Nevertheless in many blade elements the distribution of white matter can still be observed.

6.3.2. Taxonomic Remarks

The conodont zonal scheme of WALLISER (1964, 1971) for the Silurian was largely based on the sequence at Cellon in the Carnic Alps. To establish this scheme also conodonts from Germany, Bohemia and Spain were utilised. With little modifications and amendments this scheme has become generally accepted.

The proposed integration of geographically separated faunas into this scheme has raised several stratigraphical and nomenclatorical problems in the upper Silurian. Two of these difficulties concern the mutual relationship between zonal conodonts *Oz. snajdri* and *Oz. crispa* which according to WALLISERs investigation did not co-occur in one single section, i. e. at Cellon. The younger *Oz. crispa*, name-bearer of the *crispa* Zone, was originally reported from the Santa Creu d'Olorde Quarry near Barcelona, Spain, but also found at Cellon below strata which are characterized by another guide conodont, *Oz. r. eosteinhornensis*. From this relationship the two youngest Silurian conodont zones emerged. They were preceded by the *latialata* and the *siluricus* Zone, the first up to WALLISERs study recognised only at Cellon, the latter – inter alia – at Cellon, at Santa Creu and in Bohemia. At Mušlovka Quarry in the upper part of this zone WALLISER identified the short-ranging index conodont *Oz. snajdri*. Until his study this conodont was not found elsewhere.

Our present comprehensive conodont investigation which included restudies of the Santa Creu Quarry section and certain beds at Cellon as well as comparison with conodont faunas from coeval strata in the Welsh Borderland and the Baltic region led us to believe that

❶ the *latialata* Subzone evidently is restricted to the basal part of a newly established *snajdri* Zone;
❷ a phylogenetic relationship between *Oz. snajdri* and *Oz. crispa* exists which suggests an iterative evolutionary pattern;
❸ the ranges of these two species overlap (Figs. 8, 13, 22);
❹ either one can be split into several morphotypes or varieties but also intergradational forms occur, and finally
❺ some of the morphs may be useful for correlation purposes.

Yet we were not able to reconstruct the complete apparatus and make any taxonomic revision which obviously will result from our study. This concerns the generic assignment of the two species under consideration as well as the possible taxonomic splitting into two chronological subspecies and the question which name should then be applied. This nomenclatorial approach will be emphasised by a forthcoming paper with four coauthors. Provisionally, in this report we follow a classification which is closest to the species concept treated by WALLISER (1964). To a minor part these considerations already affect the zonal scheme presented below.

6.3.3. Conodont Zonation

The conodont based subdivision of the entire Silurian was established by WALLISER (1964). He proposed 11 successive zones, the base of each was defined by the appearance of the zone index conodont. In this scheme he subdivided the upper Silurian, i. e. the Ludlow and pre-Lochkovian into 6 zones which by evidence (and partly tentatively) were tied into the well known graptolite zonation. In recent years this provisional correlation has become well established due to numerous additional biostratigraphic data provided by various studies from different regions throughout the world (cf. JAEGER, 1975, COOPER, 1980).

In the upper Silurian of the Barrandian area (Prague Basin) the middle Ludlow *siluricus* Zone was first recognized by WALLISER 1964. Our present study proved this zone at Mušlovka Quarry (SCHÖNLAUB in CHLUPÁČ et al., 1980), at Požáry Section (base of bed no. 15) and in Marble Quarry (0,25–1,8 m above the base of bed no. 1). In the latter two localities this zone is preceeded by strata of the *ploeckensis* Zone. The index conodont has been positively identified in bed no. 15 at Požáry Section at the level 0,77–0,63 m below the top and at Marble Quarry at the base of bed no. 1. Both zonal conodonts are associated with *Monograptus fritschi linearis*. At Mušlovka Quarry, however, the *siluricus* Zone extends at least 5 m above the last known occurrence of that graptolite. This observation agrees well with the graptolite based age of this zone at Cellon (cf. JAEGER, 1975: 116–117).

The following *snajdri* Zone was proved at all localities under discussion (Mušlovka Quarry, Požáry Section, Marble Quarry, Koledník Quarry, Kosov Quarry and Cephalopod Quarry). At Mušlovka, Koledník and Marble Quarries the name bearer is associated with *Pedavis latialata* in its lower 1–2 m, at section Marble Quarry *P.* cf. *latialata* first occurs some 25 cm below the onset of *Oz. snajdri*. Up to now there is no evidence at all to suggest that any of the three index conodonts are related to each other, i. e. they are not evolutionary species of a lineage. Obviously this fact explains their different ranges between the Barrandian area (Prague Basin) and the Carnic Alps.

In terms of the graptolite zonation the *snajdri* Zone fills the time interval between the last occurrence of *M. fritschi linearis* and the first income of *M. parultimus* in the carbonate facies. As shown below, however, also the succeeding *crispa* Zone must be placed in that interval. Yet, no other graptolites than *M. dubius* s. l. and *M.* aff. *kallimorphus* have been recorded together with *Oz. snajdri* and *Oz. crispa*.

The base of the *Oz. crispa* Zone is drawn at the first occurrence of typical representatives of this species. It is connected with its forerunner *Oz. snajdri* in an ancestral – descendent sequence which can be demonstrated in the Carnic Alps (Cellon), Santa Creu d'Olorde (Barcelona – Spain) and in all Barrandian sections under study. Generally, both species overlap in terms of rock thickness through a distance of 1–2 m. In those sections which were sampled closely spaced the same or closely resembling morphotypes occur suggesting simultaneity even of individual beds, e. g. at Mušlovka, Požáry and Koledník. In contrary, missing morphotypes in a sequence, for example on top of the "cephalopod bank" at Kosov Quarry immediately below the graptolite *M. parultimus* suggest stratigraphic gaps. Interestingly, in the sections Cephalopod Quarry, Koledník Quarry, Požáry Section and Mušlovka Quarry among the youngest representatives of *Oz. crispa* those specimens occur which are morphologically closely related to *Oz. crispa* found and described in the Balitc region under the names *Spathognathodus crispus* by FAHRAEUS (1969) from the Hamra Beds, *"Hindeodella snajdri"* and *"H. crispa"* (JEPPSON, 1974, 1983 – in press) or *"Spathognathodus" snajdri* and *"S." crispus* (VIIRA, 1982). According to these authors they occur in the Hamra and Sundre Beds of the Gotland sequence and in the strata ranging from the Paadla Stage up to the lowermost Kaugatuma Stage of the East Baltic upper Silurian (Saaremaa Island – Estonia).

The only graptolite records from the *crispa* Zone are those indicated in figs. 8, 13, 22. In all sections studied in great detail including a bed-by-bed collection at Cellon the last occurrence of *Oz. crispa* is below the income of *Monograptus parultimus*. At Cellon *M. parultimus* starts in the interbed immediately above the last limestone bed containing *Oz. crispa*! Consequently, the *crispa* Zone is pre-Přídolí in age!

Since several years it became clear that the succeeding *eosteinhornensis* Zone, contrary to WALLISERS data from Cellon extends further below the biostratigraphic framework. Our collections from the Prague Basin – and even from Cellon – confirm the longer range of the name bearer *Oz. r. eosteinhornensis* by new and additional evidence derived from the sections Mušlovka, Požáry and Koledník:

1. A *snajdri* Zone age for the first occurrences of *Oz. r. eosteinhornensis* is suggested by few representatives in bed no. 75 at Požáry Section about 6,5 m below the base of the Přídolí and at the Marble Quarry section about 2 m below the Přídolí. Based on the morphology and the accompanying pl-elements there is little doubt about the specific assignment.
2. Striking more abundant representatives of *Oz. r. eosteinhornensis* have been found in strata indicating the *crispa* Zone. At hand is good material from the base of this zone at Mušlovka, from several samples at Požáry (beds no. 87–89) and from Koledník Quarry. Objectively these specimens cannot be distinguished from younger collections in the Přídolí. Our conclusion agrees well with other reports about the extended range of *Oz. r. eosteinhornensis* (WALLISER, 1971; BULTYNCK & PELHATE, 1971; MEHRTENS & BARNETT, 1976; EBNER, 1976; SCHÖNLAUB, 1981). It is also supported by new collections from Cellon where it occurs together with *Oz. crispa* in the uppermost 20 cm of its range.
3. As already noted by BARNETT (1972) and MEHRTENS & BARNETT (1976) as well as other reports about Přídolian conodonts from the Barrandian *Oz. r. eosteinhornensis* ranges throughout the Přídolí without any significant morphological changes. Our collections from the basal portion of the Přídolí support this conclusion reached by other authors in different regions as well for this interval of time.

In conclusion the question must be raised about the definition of *eosteinhornensis* Zone. We agree that this zone is neither a taxon-range-zone nor a lineage-zone; as demonstrated above the value of a successive appearance-zone is not further supported by any line of evidence. Hence, is it an "assemblage zone" consisting of 3–4 different ranging conodonts, i. e. *Oz. snajdri, Oz. crispa, Oz. confluens* and *Oz. r. eosteinhornensis*, the latter defining the zone by absence of the remainders? In any case it will be difficult to recognise this "datum plane" which apparently coincides with the extinction of *Oz. crispa* at or close to the base of the Přídolí.

6.3.4. Regional Occurrences

The three zonal conodonts of the upper Silurian, i. e. *Oz. snajdri*, *Oz. crispa* and *Oz. r. eosteinhornensis* the ranges of which may help to define the Ludlow – Přídolí boundary exhibit a wide geographical distribution. Besides the areas already mentioned in the foregoing chapters (Barrandian, Carnic Alps, Gotland, East Baltic and northeastern Spain) one or the other guide conodonts were reported from various parts of the World. The most important occurrences are:

- *Oz. snajdri*
  Central Alps – Palaeozoic of Graz (EBNER, 1976), North America – New York – Midcontinent (REXROAD & NICOLL, 1971; REXROAD & CRAIG, 1971; POLLOCK & REXROAD, 1973).
- *Oz. crispa*
  Podolia (DRYGANT, 1971), North America – Nevada – Appalachians (KLAPPER & MURPHY, 1975; HELFRICH, 1975), Australia – New South Wales (COOPER, 1977).
- *Oz. r. eosteinhornensis*
  Central Alps (EBNER, 1976; BUCHROITHNER, 1979; NEUBAUER, 1979), Yugoslavia and Bulgaria (SPASSOV, 1960; SPASSOV & FILIPOVIC, 1966), Isle of Chios (KAUFMANN, 1965; ROTH, 1968), Turkey (HAAS, 1968; BUGGISCH, 1973), France (BULTYNCK & PELHATE, 1971; BULTYNCK, 1977; RACHEBŒUF in BABIN et al., 1979), Spain – Pyrenees and Guadarrama (BULTYNCK, 1971; BUCHROITHNER et al., 1978; BUCHROITHNER, 1979), Britain – Welsh Borderland and Central England (COLLISON & DRUCE, 1966; WALLISER, 1966; ALDRIDGE, 1975), East Baltic (FAHRAEUS, 1969, KALJO & VIIRA, 1968; KALJO, 1978; VIIRA, 1982), Podolia (MASHKOVA, 1967, 1968, 1970, 1972; DRYGANT, 1968), Ural (CHERNYKH, 1969), Western Arctic U. S. S. R. – Vaygach (MASHKOVA, 1970), North America – Appalachians – Nevada – Midcontinent – Nova Scotia (LEGAULT, 1969; REXROAD & NICOLL, 1971; REXROAD & CRAIG, 1971; BARNETT, 1972; POLLOCK & REXROAD, 1973; KLAPPER & MURPHY, 1975; HELFRICH, 1978).

This wide geographical distribution clearly demonstrates the usefulness and applicability of upper Silurian conodonts for biostratigraphic purposes. It should be mentioned however, that only very few of these occurrences are based on longer ranging sections and – even more important – were sampled for conodonts in closely spaced intervals. Future collection may well turn out additional conodonts and more precise biostratigraphic information.

6.3.5. Conodonts and the Ludlow – Přídolí Boundary

As regards conodonts there is no evidence to define this boundary in terms of an evolutionary sequence. On the other side we have stated above that the last occurrence of the guide conodont *Ozarkodina crispa* practically coincides with the first appearance of *Monograptus parultimus*, the index graptolite of the basalmost Přídolí. This observation and the downward extended longer range of *Oz. r. eosteinhornensis* in mind we conclude the following statements:

1. The correlation value of *Oz. r. eosteinhornensis* is less than previously assumed. Its first occurrence in the upper Whitcliffe Formation may but must not correspond to the first appearance in the upper Kopanina Formation. In short, the recorded occurrences of this species in the upper Whitcliffe, the Ludlow Bone Bed and the basal Downton are no evidence to suggest an exact correlation only with the basalmost Přídolí.
2. According to R. J. ALDRIDGE (pers. comm.) *Oz. crispa* first occurs in the uppermost Whitcliffe Formation just below its top. By correlation with Bohemia this datum is far below the base of the Přídolí. Consequently it may be concluded that the Ludlow – Přídolí boundary plane lies in the Downton.
3. By comparison with Podolia, parts of the Rashkov Beds (Rashkov Suite) of the Skala (Skala Horizon) equate with the upper Kopanina Formation. Based on the occurrence of *Oz. crispa* (DRYGANT, 1971; ABUSHIK et al., 1981) at least the "lower subsuite" is older than the base of the Přídolí. The figured specimen of DRYGANT appears to me as an early representative of *Oz. crispa*. If this is right it might well be that the *crispa* Zone extends further up in the Rashkov Suite.
4. Regarding conodont data the lower portion of the Skala is possibly uppermost Ludlow in age.

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6.4. Chitinozoa

(By Florentin PARIS)
Pl. 5–6

Chitinozoans are of primary importance to delimit the Ludlow – Přídolí boundary and to establish stratigraphical correlations at a large scale. Indeed these organic microfossils, which display a world-wide distribution, are common to extremely abundant in the Přídolí type-area in Bohemia (e. g. more than 750 specimens per gram of rock in bed 14 of Hvížďalka Section). So far, no standard chitinozoan biozonations have been erected in the Silurian although the stratigraphical distribution of Wenlockian and Ludlovian chitinozoans is fairly well established, especially in Northern Europe (viz LAUFELD, 1974; DORNING, 1981; NESTOR, 1982; VERNIERS, 1982...). For a long time, the biostratigraphy of Přídolian chitinozoans was poorly documented. Recent investigations have demonstrated that several species, which are restricted to the Přídolí in Bohemia, occur also in equivalent strata in south-western Europe (CRAMER & DIEZ, 1978; PARIS, 1981) as well as in North Africas (JAGLIN & MASSA, 1985).

Upper Silurian chitinozoans from the Barrandian were first described by EISENACK (1934). Recently a detailed study was carried out on late Přídolí material from the type localities of the Silurian – Devonian boundary (PARIS, LAUFELD & CHLUPÁČ, 1981). In the present paper, nine sections exposing the Ludlow – Přídolí boundary have been collected bed-by-bed or even more closely spaced (252 samples have been processed for a total thickness of 41 meters rock exposures). The chitinozoans occur in pure limestones, as well as in calcareous claystones. Their preservation is fairly good, especially for the thick-walled forms (*Eisenackitina*, *Urnochitina*...). However, in the shales, the chitinozoans are usually flattened and their ornamentation is partly destroyed. Large variations of the abundance of these microfossils have been noticed while a few samples are barren.

Two main assemblages can be distinguished on the basis of the occurrence of the most representative species (at this stage of the biostratigraphical study the detailed frequency of each species is not taken in account).

6.4.1. First Assemblage

Pl. 5, figs. 1–13

It is characterized by the occurrence of *Eisenackitina barrandei*, a species recently described by PARIS & KŘÍŽ (1984) and closely related to the "*E. lagenomorpha – intermedia* complex" (sensu EISENACK, 1968, p. 26, fig. 8–13). In previous works *E. barrandei* was probably confused with one of these two species which were originally described in the so-called "*Beyrichia*" Limestones (EISENACK, 1931, 1955). In the investigated sections in Bohemia, *E. barrandei* is well represented in almost all upper Ludlow beds. In some sections, this taxon extends a few centimetres above the first occurrence of *Monograptus parultimus* (figs. 7, 8, 12, 13) whereas in the others *E. barrandei* disappears just below the Ludlow – Přídolí boundary (figs. 17, 21, 22). In this *E. barrandei* biozone several subordinate taxa are represented (Pl. 5, figs. 1–13). Some of them extend into the Přídolí (*Sphaerochitina sphaerocephala, Ancyrochitina ancyrea, Ancyrochitina* cf. *primitiva, C. (Calpichitina) gregaria, Cingulochitina wronai, Angochitina* cf. *echinata*...). A few others are restricted to the uppermost Ludlow (*Ancyrochitina pedavis, Cingulochitina kolednikensis*). The latter is present in Koledník Quarry, Marble Quarry and Kosov Quarry sections (PARIS & KŘÍŽ, 1984, fig. 2) while the former is only recorded in the lower part of the Kosov Quarry section, where it is abundant in bed no. 8. It is noteworthy that *A. pedavis* was described by Laufeld (1974) from the Hamra Beds of Gotland but never recorded from the "*Beyrichia*" Limestones (LAUFELD, 1974, p. 47) nor in the Kuressaare Estonian Stage (NESTOR, 1982).

6.4.2. Second Assemblage

Pl. 6, figs. 1–12

It is characterized in all investigated sections by the occurrence of *Urnochitina* gr. *urna*. Typical *U. urna* is extremely abundant in the upper Přídolí and extend to the topmost Silurian (cf. PARIS, LAUFELD & CHLUPÁČ, 1981, PARIS, 1981). Atypical specimens are found a few centimeters below or immediately above the first occurrence of *Monograptus parultimus*. Provisionally these individuals are related to *Urnochitina urna* on the basis of their peculiar outline (Pl. 6, figs. 8 and 10) although future biometric studies on the whole *U.* gr. *urna* population would probably demonstrate that they belong to different species. Nevertheless *U.* gr. *urna* is of great importance for stratigraphical correlations (WRONA, 1980; DEGARDIN & PARIS, 1978; PARIS, 1981; DE BOCK, 1982; JAGLIN & MASSA, 1985; PARIS, in press...) as it is most probably completely restricted to the Přídolí. In addition, this cosmopolitan form (viz PARIS, 1981, p. 387) does not show distinct environmental control.

Another species of high stratigraphical value is *Pterochitina perivelata* which occurs with *Urnochitina* gr. *urna* a few centimetres above the earliest *Monograptus parultimus* in all Bohemian sections studied in great detail. It is worthy noting that in Bohemia, *P. perivelata* seems to be uncommon while in other parts of the World this species is well represented in the Přídolí (cf. CRAMER & DIEZ, 1978; JENKINS & LEGAULT, 1979, PARIS, 1981; NESTOR, 1982, JAGLIN & MASSA, 1985, PARIS in press).

Linochitinia klonkensis is fairly abundant in the upper Přídolí (PARIS, LAUFELD & CHLUPÁČ, 1981) and is represented in the upper part of almost all the investigated sections. This taxon occurs usually with the earliest *U.* gr. *urna* or immediately below (e. g. bed no. 20 in Kosov Quarry section; bed no. 23 in Koledník Quarry section). However, a few individuals of *Linochitina*, referred here to *L. klonkensis*, have been recorded in the lower part of the Marble Quarry section (base of beds no. 1 and 2).

Among the important components of the *U.* gr. *urna* assemblage is *Fungochitina kosovensis*, a species recorded from all investigated sections (figs. 8, 13, 22) except in Cephalopod Quarry where sampling was not closely spaced. Consequently *F. kosovensis*, which is so far unknown in the upper Přídolí (PARIS & KŘÍŽ, 1984) seems to be characteristic of the lower part of the Přídolí (up to the *M. ultimus* Zone).

Moreover the *U.* gr. *urna* assemblage contains a few other taxa, less siginifcant for detailed stratigraphical purpose, which are scattered in the upper part of the studied sections (e. g. *Sphaerochitina spaerocephala, Gotlandochitina* sp., *Ancyrochitina* div. sp., *Angochitina* div. sp...). The sudden occurrence of an extremely large amount of *Eisenackitina* cf. *intermedia* in a single bed (no. 14) in Hvížďalka Section is yet unexplained.

As far as chitinozoans are concerned, a very little lithological control is well demonstrated at the Hvížďalka Section (fig. 12) where a characteristic *U.* gr. *urna* assemblage occurs in cephalopods bearing biodetrital limestones instead in laminites as documented in other sections. In these biodetrital beds (nos. 5–8) even graptolites are not present due to lithological control.

To summarize, the chitinozoan zonation elaborated from the investigated material shows an important break coinciding with the Ludlow – Přídolí boundary as defined on graptolite evidence (first occurrence of *Monograptus parultimus*). The interval of dubiousness is usually restricted to a few centimetres. Obviously these data would be of primary importance for stratigraphical correlations even if the Bohemian chitinozoan assemblages are less diversed than those recorded in contemporaneous shelf deposits of the North Gondwana Margin (e. g. North Africa, Spain...). In fact, in this palaeogeographic Province, more endemic taxa (e. g. *Pseudoclathrochitina carmenchui, Plectochitina carminae, Margachitina elegans*) are associated with *U. urna* and *P. perivelata* during late Silurian times (JAGLIN & MASSA, 1985).

6.5. Eurypterids

(By Ivo CHLUPÁČ)

The Požáry Formation contains rather frequent remains of eurypterids which are concentrated in its shale-rich development. The following species may be reported:

Pterygotus (Acutiramus) bohemicus BARRANDE, 1872
Pterygotus (Acutiramus) nobilis BARRANDE, 1872.

Pterygotus (Pterygotus) barrandei SEMPER, 1898
Pterygotus (Pterygotus?) fissus SEEMANN, 1906
Slimonia acuminata (SALTER, 1856)
Paracarcinosoma accrocephala (SEMPER, 1898)

Pterygotus (A.) bohemicus is the most common and best known eurypterid of the Požáry Formation. It is already known from the lower Přídolian *Monograptus ultimus* Zone (Dlouhá hora and Kosov near Beroun, Cephalopod Quarry) but its acme development falls within the upper Přídolí (e. g. vicinity of Prague, Karlštejn, Klonk etc.). The range of this species passes the Silurian – Devonian boundary to the lower and upper Lochkovian.

Pterygotus (A.) nobilis is an incompletely known species. Several specimens were referred to this species from the lower Požáry Formation (Dlouhá hora) and upper Přídolí (Praha – Velká Chuchle).

Pterygotus (P.) barrandei is a rather well known species. Its acme development clearly falls within the upper Přídolí; its occurrence in the lower Přídolí is rare (Dlouhá hora).

Pterygotus (P.?) fissus is based on a single find of cheliceral ramus from the lower Přídolí at Dlouhá hora. The systematic status of this incompletely known and rather problematic species is doubtful.

Slimonia acuminata occurs sporadically in the Přídolí strata: SVOBODA & PRANTL (1948) reported it from the lower Přídolí *M. ultimus* Zone, *M. lochkovensis* Zone and *M. transgrediens* Interzone. According to author's view, the conspecificity of Bohemian species with those from Scotland is not sufficiently proved.

Paracarcinosoma accrocephala is known particularly from the upper Přídolí *M. transgrediens* Interzone. Its occurrence in the lower Přídolí is doubtful.

All remains of eurypterids in the Přídolí of the Prague Basin are confined to demonstrably marine sediments which show no traces of an unusual salinity. Eurypterids occur together with many other fossils, particularly nautiloids, bivalves, graptolites, brachiopods, phyllocarid crustaceans, ostracods etc.

Eurypterids of the Barrandian area are concentrated in shale-rich development of the Přídolí and Lochkovian, i. e. in the dark platy limestone facies developed in the SE flank of the Silurian – Devonian synclinorium. Most of eurypterid remains is preserved as isolated fragments, but joined rami of chelicers sometimes in connection with other segments and endognaths are not rare and even almost complete specimens have been exceptionally found. This mode of preservation makes any transport improbable. In general, the composition of eurypterid fauna, strongly dominated by *Pterygotidae*, is in accordance with similar purely marine eurypterid faunas reported from Scotland, North America, North Africa etc. (cf. KJELLESVIG-WAERING, 1961, CASTER & KJELLESVIG-WAERING, 1964).

Concerning the biostratigraphical distribution, the following may be reported: The base of the Přídolí shows a marked enrichment in eurypterids, particularly if compared with the underlying Kopanina Formation where only rare finds are known. The most common occurrence falls within the upper Přídolí, the lower Lochkovian shows again a marked decrease of development. Among the Bohemian Přídolian species, *Pterygotus (A.) bohemicus*, *Paracarcinosoma accrocephala* and with reserve also *Slimonia acuminata* pass over the Silurian – Devonian boundary.

6.6. Phyllocarid Crustaceans

(By Ivo CHLUPÁČ)

Four species of phyllocarid crustaceans are known from the Přídolí strata of the Prague Basin:

Ceratiocaris bohemica Barrande, 1872.
Ceratiocaris grata NOVÁK, MS (CHLUPÁČ sp. n. 1984)
Montecaris sp.
Aristozoe? sp.

Ceratiocaris bohemica is the most common phyllocarid of the Přídolí. Its occurrence continues from the underlying Kopanina Formation. The species attains its acme development in the upper Přídolí (*M. transgrediens* Interzone). Its occurrence is clearly concentrated in the shale-rich development of the SE limb of the Silurian – Devonian synclinorium where *C. bohemica* is rather common at all better exposed localities.

Ceratiocaris grata is locally common in the upper Přídolí at the localities in the vicinity of Prague.

Montecaris sp. is known only in one juvenile specimen found in the lower Přídolí (*M. ultimus* Zone) at the Kosov Quarry. It is the oldest representative of the genus otherwise known from the Lower to Upper Devonian strata.

Aristozoe? sp. is also represented by a single specimen from the upper Přídolí, locality Velká Chuchle near Prague.

The phyllocarid fauna of the Přídolí is markedly different from that of the lowest Devonian (Lochkovian) and no determinable species passes the Silurian – Devonian boundary (cf. CHLUPÁČ et al., 1972; CHLUPÁČ, 1970).

All phyllocarids of the Přídolí of the Barrandian area are constituents of a normal marine assemblage and occur in various growth stages together with other fossils as well as eurypterids. Phyllocarids are clearly concentrated to the shale-rich facies where they belong to fairly common fossils. Although the finds of complete exoskeletons are extremely rare, detached carapaces and abdomens have been found not rare in close proximity and abdomens are frequently preserved as jointed segments with telson and furca. The mode of occurrence does not point to any significant transport.

6.7. Ostracoda

(By Miroslav KRUTA)

Ostracods are common in the Přídolí but their modern study is not yet completed. The ostracod fauna is in Bohemian Přídolí characterized by a comparatively low diversity. Most common are podocopids. Representatives of *Beyrichiacea* are rare in comparison to other regions (e. g. Podolia). Stratigraphic ranges and occurrences were confirmed in the fourteen previously described species from the Přídolí. From these two species (*Acanthoscapha bohemica* and *Parahippa rediviva*) are crossing the Ludlow – Přídolí boundary. Both species are also known from the uppermost Přídolí (locality Klonk, bed no. 13). The lowermost Přídolí (*M. parultimus* Zone and *M. ultimus* Zone) is characterized by the assemblage of the species: *Aechmina* sp. *Mirochilina jarovensis*, *"Laccoprimitia" subcentralis*, *Ziva bohemica*, *"Cytherella" kegeli*, *Klonkina cornigera*, *Craspedobolbina* sp. A. Of these species *M. jarovensis*, *Ziva bohemica*, *Klonkina cornigera* and *Craspedobolbina* sp. A were also found in the uppermost Přídolí at Klonk (bed no. 13).

The species *Vltavina bohemica, Boucia ornatissima, Tricornina navicula* are restricted to the uppermost Přídolí in Bohemia.

It seems to be most probable that the whole Přídolí in the Prague Basin is represented by just one distinct Zone with index species *Mirochilina jarovensis*. In the upper Přídolí a distinct horizon with *Boucia ornatissima* and *Vltavina bohemica* is developed in the Prague Basin (cf. CHLUPÁČ et al., 1972).

In general, the Přídolian ostracod fauna is peculiar. Its biostratigraphic importance, however, remains to be evaluated.

6.8. Trilobita

(By Milan ŠNAJDR)

Twenty seven species of trilobites are so far known from the Přídolí of the Prague Basin. There was a distinct progress in the study of trilobites from the Ludlow – Přídolí boundary rocks and in the Přídolí in the last two decades connected with the Ludlow – Přídolí boundary research programme. Advanced stage of the study makes trilobites of greater stratigraphic importance than previously supposed. Detailed collection in the shale-rich facies led to the discovery of several new species and species known only from the carbonatic development (ŠNAJDR, 1982, 1983).

The Ludlow – Přídolí boundary in the Prague Basin is well characterized by the *Prionopeltis praecedens* – *Prionopeltis dracula* – *Prionopeltis archiaci* – *Prionopeltis* sp. n. A – *Prionopeltis striata* – *Prionopeltis unica unica* – *Prionopeltis unica obo* – *Prionopeltis klonk* lineage. The uppermost Kopanina Formation is characterized by the presence of the first four species of the lineage, the basalmost parts of the *M. parultimus* Zone by occurrence of *Prionopeltis striata* which continues up to the *M. ultimus* Zone. *P. unica unica* occurs in the *M. ultimus* Zone while *P. unica obo* occurs only in the *M. transgrediens* Interzone. *Prionopeltis klonk* is known only from the uppermost Přídolí.

Otarion diffractum passes the Ludlow – Přídolí boundary and occurs up to the *M. ultimus* Zone. The boundary is also passed by the long range species *Ceratocephala verneuilli* which occurs throughout the Přídolí. To the basal *M. parultimus* Zone the species *Radiaspis nauseola* is restricted. *Cheirurus transiens, Encrinuraspis? testosteron, Harpidella schrieli, Prionopeltis striata, Eremiproetus senex junior* and *Bohemoharpes bupthalmus* are characteristic trilobites occurring in the two basal zones – *M. parultimus* and *M. ultimus*. *Leonaspis ezelina* and *Scharyia nympha* range wider – from the base of the *M. parultimus* Zone up to the base of the *M. transgrediens* Interzone.

Cromus leirion and *Dicranogmus* sp. n. occur rarely in the *Monograptus lochkovensis* Lower Subzone.

Shale-rich facies of the *M. transgrediens* Interzone is characterized by the occurrence of the trilobite species *Cromus krolmusi, Prionopeltis klonk* and *Lacunoporaspis chlupaci*. Upper part of the Přídolí is in the Prague Basin, in the facies of biodetrital limestones, characterized by the species *Balizoma concomitans, Calymene nabrici, Calymene chica, Prionopeltis unica obo, Sculptoproetus heureka, Prionopeltis prokopi, Decoroscutellum ascriptum, Coniproetus affinis* subsp. n., *Warburgella* sp. n. and *Tetinia minuta*. *Tetinia minuta* is in the Prague Basin a stratigraphically important species which occurs just below the Přídolí – Lochkovian boundary.

6.9. Echinodermata

(By Rudolf J. PROKOP)

Particularly crinoids are abundant in the shale-rich and biodetrital limestones facies and are a major rock-forming constituent of the latter. In spite of this only a little attention was paid to upper Silurian crinoids in the Prague Basin. Taxonomy and stratigraphic ranges were revised for the 12 most important known species occurring in the Přídolí in Bohemia and in other parts of the World. From the lower graptolite zones *Scyphocrinites elegans, Bohemicocrinus pulverens, Pisocrinus ubaghsi* were recorded. All these species occur throughout the Přídolí in Bohemia reaching its acme development in uppermost parts of the Přídolí. *Scyphocrinites elegans* occurs up to the Lochkovian. *Monograptus transgrediens* Interzone and especially its uppermost parts contain rich crinoid assemblages represented by both, *Camerata* and *Inadunata*.

To the *Monograptus transgrediens* Interzone are restricted the species *Carolicrinus barrandei, Hexacrinites* sp. A., *Zenkericrinus melocrinoides* and *Trichocrinus crepidatus*. The species *Scyphocrinites subornatus* and *Parapisocrinus grandis* also occur in the upper parts of the Přídolí but pass the Silurian – Devonian boundary to the Lochkovian Stage.

Previously recorded species from the Přídolí which are not included into the list above are either synonymous with other species or fragmentary and dubious: *Vletavicrinus haueri* WAAGEN-JAHN (= *Bohemicocrinus pulverens*); into the synonymy of the species *Scyphocrinites elegans* were included after the revision the following species: *Scyphocrinites decoratus, Scyphocrinites excavatus* var. *schlotheimi, Scyphocrinites excavatus* var *schröteri, Scyphocrinites excavatus* var. *zenonis* and *Scyphocrinites elegans* var. *typ*. This is in agreement with the opinion of SPRINGER (1917).

Upper Ludlow (Kopanina Formation) is characterized by the common occurrence of pisocrinids which disappear below the Ludlow – Přídolí boundary. Upper Přídolian crinoid associations are characterized by different types of pisocrinids and scyphocrinitids. Majority of the species occurs in the shale-rich facies of laminites and calcareous shales. Especially the scyphocrinitids are preserved as long stem-fragments and calyxes joined with arms, complete calyxes are characteristic of hexacrinids. The morphology of calyxes and mode of preservation indicate the depth of several tens of metres, most probably below the wave-base and presence of slow bottom traction currents. This is in agreement with the lithology of the sediments. Accumulations of scyphocrinitid fragments in upper parts of the Přídolí and in the lowermost parts of the Lochkovian forming "Scyphocrinites" Horizon were deposited in shallow environment of several metres. In this facies also lobolites are abundant in several localities. They are forming distinct beds (Black Quarry near Mušlovka, Požáry, Karlštejn).

6.10. Cephalopods

(By Jaroslav MAREK & Vojtěch TUREK)

Although cephalopods are abundant and diversified in the Ludlow – Přídolí boundary beds, their stratigraphic importance is limited by the lack of modern systematic revision. 68 species of cephalopods were revised for this report to confirm their stratigraphic distribution. The results are based on the study of BARRANDE's types in the collections of the National Museum and on recent collections made by authors at the localities Cephalopod Quarry, Budňany Rock near Karlštejn, Kosov Quarry and Kavčí hory in Prague. Also, all the cephalopods collected at the measured sections were included when determinable.

Upper parts of the Kopanina Formation (Ludlow) are in most of the studied sections (Marble Quary, Hvížďalka, Cephalopod Quarry and Braník) developed as cephalopod limestones or biodetrital limestones with common cephalopods. These types of limestones form in above mentioned sections the almost topmost part of the Kopanina Formation. In other sections (Požáry, Mušlovka, Koledník) the cephalopod limestones or the biodetrital limestones with cephalopods form distinct beds or horizons in some distance beneath the first occurrence of *Monograptus parultimus*. In some sections (e. g. Cephalopod Quarry, Mušlovka, Hvížďalka), beds of limestones with cephalopods occur close above the Ludlow – Přídolí boundary. Cephalopod limestones or biodetrital limestones with common cephalopods occur in several levels of the Přídolí's higher parts. In the vicinity of Řeporyje (Mušlovka Quarry and Požáry) the level of cephalopod limestones is developed about 20 m below the top of the Přídolí. Cephalopod limestones are also developed in the topmost part of the Přídolí at many localities, listed by CHLUPÁČ et al. (1972) – e. g. Karlštejn, U topolů. Cephalopods are also common fossils in the shale-rich facies together with other molluscs, graptolites and phyllocarid crustaceans.

Cephalopod limestones are mostly formed by orthoceraconic forms. Uppermost Kopanina Formation is characterized by occurrence of the species *Geisonoceras severum, G. rivale, G. socium, G.? nobile, Kionoceras neptunicum, K. bacchus* and *K.? araneosum*. None of these species was so far found in the base of the Přídolí in the Prague Basin. Of actinoceratids most common are the species *Sactoceras pellucidum* and *S. richteri*. Common are also oncoceratids with cyrthocerakonic shells as *Oncoceras sociale, O. plebeium, O.? circumflexum* and *"Cyrtoceras" forbessi*. Gomphoceratids are always rare. Characteristic components are lechritrochoceratids *Kosovoceras sandbergeri* and *Kosovoceras nodosum*. Both the species are presented in the uppermost parts of the Kopanina Formation (Ludlow). *K. nodosum* is most common in the Prague area while *K. sandbergeri* in the vicinity of Beroun. Together with these species *Lechritrochoceras degener* occurs. Other species of the genus *Lechritrochoceras* are also characteristic for the upper parts of the Kopanina Formation: *L. trochoides, L. similans, L. mulus* and others.

Very high diversity of cephalopods in the uppermost Kopanina Formation in Bohemia is caused by secondary accumulations of empty shells by bottom track currents and surface currents. In other facies than cephalopod limestones or biodetrital limestones with cephalopods the diversity of cephalopods is considerably lower.

Because accumulations of cephalopods are almost not presented at the base of the Přídolí in Bohemia, the overall diversity is lower. Cephalopod fauna is mostly characterized by a few species which pass from the Kopanina Formation higher: *Dawsonocerina caelebs, "Orthoceras" novellum, Calocyrtoceras cognatum* and *Peismoceras* sp.

Higher levels of the cephalopod limestones are characterized mainly by orthocone cephalopods (orthocerakonic). Most characteristic are the species *Orthocycloceras fluminese (= Cycloceras bohemicum), Parakionoceras originale* (which occurs at the locality Cephalopod Quarry 100 cm above the base of the Přídolí), *Dawsonoceras omega, Murchisoniceras murchisoni* and *Corbuloceras corbulatum*. Characteristic but rare are actinoceratids *"Orthoceras" docens* and *"Orthoceras" steiningeri*. Breviconic oncocerids and discosorids (genera *Pentameroceras, Hexameroceras, Rhizoceras, Mandaloceras* etc.) form also an important part of the Přídolian cephalopod associations.

6.11. Gastropoda

Gastropods are rich in both the cephalopod limestone facies and shale-rich facies of the Kopanina Formation and Požáry Formation. They were not studied in detail yet and we may refer in this report only to CHLUPÁČ et al. (1972) and HORNÝ (1955).

6.12. Monoplacophora

Monoplacophorids are characteristic but rare fossils known from the upper parts of the Přídolí in the Prague Basin. Most common is *Drahomira rugata* found also recently in the *Monograptus transgrediens* Interzone rocks (HORNÝ, 1963). Further *Drahomira barrandei, Drahomira glaseri* and *Palaeoscurria discoides* were recorded from the Přídolí in the Prague Basin.

6.13. Bivalvia

(By Jiří KŘÍŽ)

Bivalvia are abundant in all the facies of the upper Kopanina Formation and in the Požáry Formation except the brachiopod-rich facies of organodetrital limestones in the vicinity of Srbsko and Svatý Jan pod Skalou in uppermost parts of the Přídolí.

Most attention was paid to the bivalves from the Ludlow – Přídolí boundary rocks and lower and middle parts of the Přídolí. Upper parts of the Přídolí were already studied by the author for this purpose in connection with the study of the Silurian – Devonian boundary in Bohemia (in CHLUPÁČ et al., 1972).

Mostly epibyssate bivalves are characteristic of the facies of cephalopod limestones in the upper parts of the Kopanina Formation (Ludlow). Most common and distinct are cardiolids *Cardiola conformis, C. cornucopiae, Isiola fluctuans* and rare *Cardiolinka bohemica*; lunulacardiids: *Spanila cuneus, S. gracilis, S. aspirans, Tetinka securiformis*; antipleurids: *Dualina comitans, D. tenuissima, D. longiuscula, D. secunda*; praeostreids: *Praeostrea bohemica*.

Basalmost beds of the Přídolí are characterized by the lower diversity association of bivalves but mass occurrence of the species *Cardiolinka bohemica* (Cephalopod Quarry, Kosov Quarry). From the uppermost Kopanina Formation continues the occurrence of the species *Cardiolinka bohemica, Cardiola conformis, Praeostrea bohemica, Dualina longiuscula* and *D. secunda*.

The lower third of the Přídolí is in Bohemia characterized by the species *Cardiolinka bohemica, Cardiolinka fortis* and *Cardiolinka irregularis* (infaunal cardiolids), *Praecardium quadrans* (infaunal praecardiid). Middle third by the species *Cardiolinka concubina, Cardiolinka fortis, Snoopia insolita* (infaunal cardiolids), *Pterinopecten cybele* (epibyssate or semi-infaunal pterinopectinid) and *Actinopteria migrans prospera* (semi-infaunal pterineid) and *"Astarte" bohemica*.

The upper third of the Přídolí sequence is in Bohemia characterized by the occurrence of infaunal cardiolids *Cardiolinka concubina, Cardiolinka fortis* and *Snoopyia insolita*, infaunal praecardiids *Praecardium primulum, P. concurens, P. ficus, P. fidens*, reclining antipleurids *Dualina socialis, D. secunda* and *D. robusta*. For the facies of the cephalopod limestones in uppermost part of the Přídolí *Snoopyia insolita, S. veronika, Pygolfia nina, Cardiolinka concubina, Lunulacardium eximium, L. evolvens, L. bohemicum, Leptodesma carens* and *Mytilarca* div. sp. are most characteristic. In the shale-rich facies development the epibyssate and semi-infaunal bivalves are prevailing together with infaunal praecardiids and antipleurids, reclining praeostreids and infaunal cardiolids. Characteristic are the species *Pterochaenia impatiens, Joachimia falcata, Snoopyia insolita, Praeostrea bohemica* and *P. monica* and *Pterinopecten cybele*.

Most characteristic for the detailed stratigraphy are cardiolids which are common, determinable even on the basis of fragments and represented by well known lineages of the genera *Cardiolinka, Snoopyia* and *Pygolfia*. Biostratigraphical and correlation value of cardiolids are confirmed already by several papers listed by KŘÍŽ (1979; 1982).

6.14. Brachiopods

(By Vladimír HAVLÍČEK)

There are 25 species of brachiopods known from the Přídolí of the Prague Basin.

Brachiopods represented in the upper Wenlock, lower and middle Ludlow in Bohemia form a substantial component of the benthic assemblages; brachiopod assemblages are mostly well diversified as reflected by descriptions of many brachiopod species from the upper Wenlock and lower and middle Ludlow (Horizons with *Encrinuraspis beaumonti* and *Ananaspis fecunda* sensu HORNÝ, 1955, 1962).

Increasing of diversity occurs in upper Ludlow (Kopanina Formation – Horizon with *Prionopeltis archiaci* sensu HORNÝ (1955, 1962). Missing are representatives of the suborders *Orthida* and *Strophomenida* and *Cyrtiidae* with exception of the genus *Spuriispirifer*. Also rhynchonellids are rarely presented in the uppermost Kopanina Formation. Characteristic are representatives of *Atrypacea* with smooth and slightly ribbed shells. Atrypids occur commonly as monospecific assemblages; they are not disarticulated. Most common species are listed on figs. 8, 13, 22. The facies of cephalopod limestones (Cephalopod Quarry, Marble Quarry) was not favourable for brachiopods; they are represented mostly by *Stenorhynchia infelix*.

Some brachiopod species cross the Ludlow – Přídolí boundary e. g. *Dubaria megaera*. In spite of this mostly new species occur in the base of the Přídolí which may be distinguished from the Ludlow ones e. g. *Bleshidium* sp. n., *Decoropugnax* sp. n. and *Dubaria harpyia*.

In comparison with the uppermost part of the Ludlow in Bohemia brachiopod diversity increases at the base of the Přídolí. Increase in diversity of brachiopods continued during Přídolí time to reach the maximum in the topmost levels. Most important immigrants are representatives of genera *Lanceomyonia, Areostrophia, Felinotoechia* and *Merista*. The genus *Hebetoechia* reappears in Bohemia again in the upper Přídolí by two species *H. hebe* and *H. compta*. First representatives of the genus *Dayia* were recorded at the Požáry Section just below the first occurrence of *Monograptus parultimus* (bed no. 89g). Upper parts of the Přídolí are characterized by presence of *Dayia bohemica* and *Dayia* cf. *minor*. Distinct horizons are formed especially by the species *Dubaria latisinuata* in upper portions of the Přídolí (e. g. Požáry Section, Black Quarry near Mušlovka) and *Dayia bohemica* in uppermost portions of the Přídolí (e. g. Požáry Section and others listed by CHLUPÁČ, 1972).

6.5. Other Faunal Groups

For the purpose of this report only most important groups of fossils were studied. Nevertheless it is most probable that with the advancing knowledge of other groups their stratigraphic importance will increase too. At present there is a little knowledge about corals which are known only thanks to the microscopic study of the Požáry Section from the Ludlow – Přídolí boundary. No modern study is also available for conulariids (BOUČEK, 1928, listed 3 species from the *Monograptus transgrediens* Interzone). *"Conularia"* sp. was found in the basalmost portion at the Požáry Section; from the same level PRANTL (1938) recorded two species of *Hederella*. There are some finds of bryozoans from the biodetrital limestone facies of the upper part of the Přídolí. More attention was paid to the dendroid graptolites. BOUČEK (1957) listed 8 species from the *Monograptus ultimus* Zone, 1 species from the *M. perneri* Zone and 6 species from the *M. transgrediens* Interzone. In some levels of the Přídolí in Bohemia dendroid graptolites are quite common but should be revised to be used in detailed biostratigraphy.

6.16. Flora

From the basal parts of the *Monograptus ultimus* Zone (Kosov Quarry) not rare finds of fossil flora are known. They were studied by OBRHEL (1962) and attributed to four species: *Cooksonia* cf. *hemisphaerica, Cooksonia* sp., *?Cooksonia* sp. and *?Taeniocrada* sp. Occurrence of the simple vascular flora at the base of the Přídolí in the Prague Basin is correlable with the widespread occurrence of this flora in other parts of the world.

7. Conclusions

At the international Přídolí boundary stratotype in Bohemia the rocks and their fossil content present an evidence that the Ludlow – Přídolí time interval was in this part of the Prague Basin characterized by slow change of the sea bottom conditions which were only occasionally influenced by strong episodic events (storms etc.). The sea bottom was most probably below the wave-base. In the Požáry Section the Ludlow – Přídolí boundary is relatively high above the "cephalopod bank" within the facies of platy limestones with calcareous shale intercalations of the Požáry Formation which contains predominantly planktic organisms such as graptolites and chitinozoans. Gradually decreasing diversity of benthic organisms such as brachiopods, bivalves and trilobites starting below the boundary indicates gradual change of sea bottom living conditions corresponding to the transitional character of the Ludlow – Přídolí boundary at the stratotype. Planktic organisms, widely distributed in the boundary rocks indicate their deposition in a pelagic open-sea environment. International acceptance of the Přídolí as the fourth subdivision of the Silurian System and the Požáry Section as its boundary statotype corresponds thus to the fundamental principles of the stratigraphic classification.

The boundary is well defined biostratigraphically on the basis of graptolites and other faunas (especially by chitinozoans and conodonts). The definition of the Přídolí lower boundary is natural since also other Silurian subdivisions and the Silurian – Devonian boundary are defined on the basis of graptolites, the group on which also fundamental Silurian biozonation is based.

The Prague Basin (Barrandian area) is an excellent area for the establishment of the Ludlow – Přídolí international stratotype since most of the sections through the Přídolí are there completely exposed and conserved or only partly covered by scree. This is in agreement with the I. S. S. C. Report 2 (1964) – "Definition of Geologic Systems", which strongly recommends the establishment of type boundaries points in continuously deposited sections.

The Požáry Section may serve also as the unit stratotype of the Přídolí as well as its boundary stratotype since the complete Přídolí is exposed. The top of the Přídolí is automatically defined by the International Silurian – Devonian boundary stratotype at Klonk near Suchomasty which was established in 1972.

The Ludlow – Přídolí boundary is defined at the base of the *Monograptus parultimus* Zone. At the lower boundary stratotype (Požáry Section) the boundary is defined by the first occurrence of *Monograptus parultimus* within bed no. 96.

The first occurrence of the chitinozoan *Urnochitina* gr. *urna* is a suitable auxiliary indicator of the boundary, and a prominent species indicating whole Přídolí in many world areas. Because of its wide facies tolerance, the species is used for correlation between shale-rich and biodetrital limestone facies.

The boundary can be also defined by using faunas that occur in the upper part of the Ludlow. These include: chitinozoan *Eisenackitina barrandei* and *Ozarkodina crispa* in combination with first occurrences of *Ozarkodina r. eosteinhornensis* below the Ludlow – Přídolí boundary.

Addendum

(By Hermann Jaeger)

Between delivering the manuscript and correcting the galley proofs further research has revealed a few incompletenesses and inaccuracies in the section columns concerning the ranges of zonal graptolites.

The observed occurrences are as follows:

Požáry (Fig. 6)
- *M. parultimus*: beds 96 – 100 (base)
- *M. ultimus*: immediately above 101 – just below 102
- *M. pridoliensis*: near 105
- *M. lochkovensis*: 106 – 108
- *M. boucecki*: 114 – 117 (plus 0,5 m)
- *M. transgrediens*: 0,5 m above 105 – near 119

Marble Quarry (Fig. 12)
- *M. dubius* and/or *M fragmentalis?*: 6a – 12
- *M. formosus*: 8 – 14
- *M. parultimus*: 12 – 14
- *M. ultimus*: 15
- *M. pridoliensis: 22 – 23*
- *M. lochkovensis*: 17, 19 and around 34

Hvížďalka (Fig. 12)
- *M. pridoliensis*: top of 8 – 10
- *M. branikensis* or *M. lochkovensis*: 10/11 – 12
- *M. lochkovensis*: 17 and 21
- *M. transgrediens*: 11 – top of Přídolí

Branik (Fig. 17)
- *M. parultimus*: not found
- *M. ultimus*: uppermost 5 cm of bed 13
- *M. branikensis*: 15 – 19
- *M. pridoliensis*: 25 – 27

Koledník (Fig. 21)
- *M. fragmentalis*: 20 – 22
- *M. parultimus*: 24 – 28

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Plate 1

Figs. 1–2, 5, 8–9: *Monograptus parultimus* JAEGER.
Fig. 1 and 5 in low relief, figs. 2, 8 and 9 in full relief.
In figs. 2 and 9 note conspicuous ventral deflection of sicula, which is typical, and in fig. 1 only slight recurvature, which also occurs. In figs. 5 and 8 note protracted apertural margin of th_1, and in fig. 9 less elaborate aperture of th_1. Fig. 9 exhibits course of interthecal septa.
Figs. 1–2, 5 and 8 from Kosov Quarry; distances above base of Přídolí = base of *parultimus* Zone: fig. 1 = 50 cm, g 634; fig. 2 = 80–100 cm, g 635; fig. 5 = 100–120 cm, g 636; fig. 8 = 65 cm, g 637.
Fig. 9 from Cephalopod Quarry, 0–5 cm above cephalopod limestone (= bed 6), g 633 a.1.

Figs. 3–4, 6–7, 11 and 13: *Monograptus ultimus* PERNER.
Figs. 3, 4, 7 and 13 in low relief, fig. 6 flattened and fig. 11 in full relief.
In fig. 3 note both apertural lappets at th_1, and in fig. 7 especially at th_2 and th_3.
Figs. 3–4, 6–7 and 13 from Kosov Quarry; distances above base of Přídolí: fig. 3 = 430 cm, g 639; fig. 4 = 320–350 cm, g 640; fig. 6 = 320–350 cm, g 641; fig. 7 = 320–350 cm, g 642; fig. 13 = 430 cm, g 643.
Fig. 11 from Cephalopod Quarry, 20 cm above cephalopod limestone (= bed 9), g 638.

Figs. 10, 12 and 14: *Monograptus branikensis* n. sp. JAEGER.
Sicular region and first few thecae in full relief, farther distally in low relief. In fig. 10 note non-overlapping interthecal septa near distal end (compare with corresponding thecae in *M. lochkovensis*, fig. 16). Note similarities with and differences from apertural lappets in *M. ultimus* and *M. lochkovensis*, particularly more deflected lappets in the proximal rhabdosome portion of *M. lochkovensis*.
All from Braník. Fig. 10 holotype HJ 54, bed 19; figs. 12 and 14 from bed 17 (HJ 56, HJ 55).

Fig. 16: *Monograptus lochkovensis* PŘIBYL.
Marble Quarry near Lochkov, type locality, approximately 4 m above top of cephalopod limestone. Zone of *M. lochkovensis*. Specimen in full relief; g 644.

Figs. 15 and 17–18: *Monograptus transgrediens* PERNER.
Podolí, quarry of the cement factory, type locality. Interzone of *M. transgrediens*. Graptolites flattened, but not tectonically deformed, in black argillaceous shale.
Note difference in width between very old (gerontic) rhabdosome (fig. 17) and another, already rather long adult specimen (fig. 15). Fig. 18 is a juvenile on the same bedding-plane as specimen fig. 17, but photograph mounted in proximity to the latter. In figs. 15 and 18 note *transgrediens*-type initial thecae with rounded and deflected apertural region.
Fig. 15 = g 645.4, fig. 17–18 = g 646.1–2.

Magnification: Figs. 15 and 17–18 = × 3; figs. 1–2, 10, 12 and 16 = × 5; figs. 3–9, 11 and 13–14 = × 10; note mm-scale.

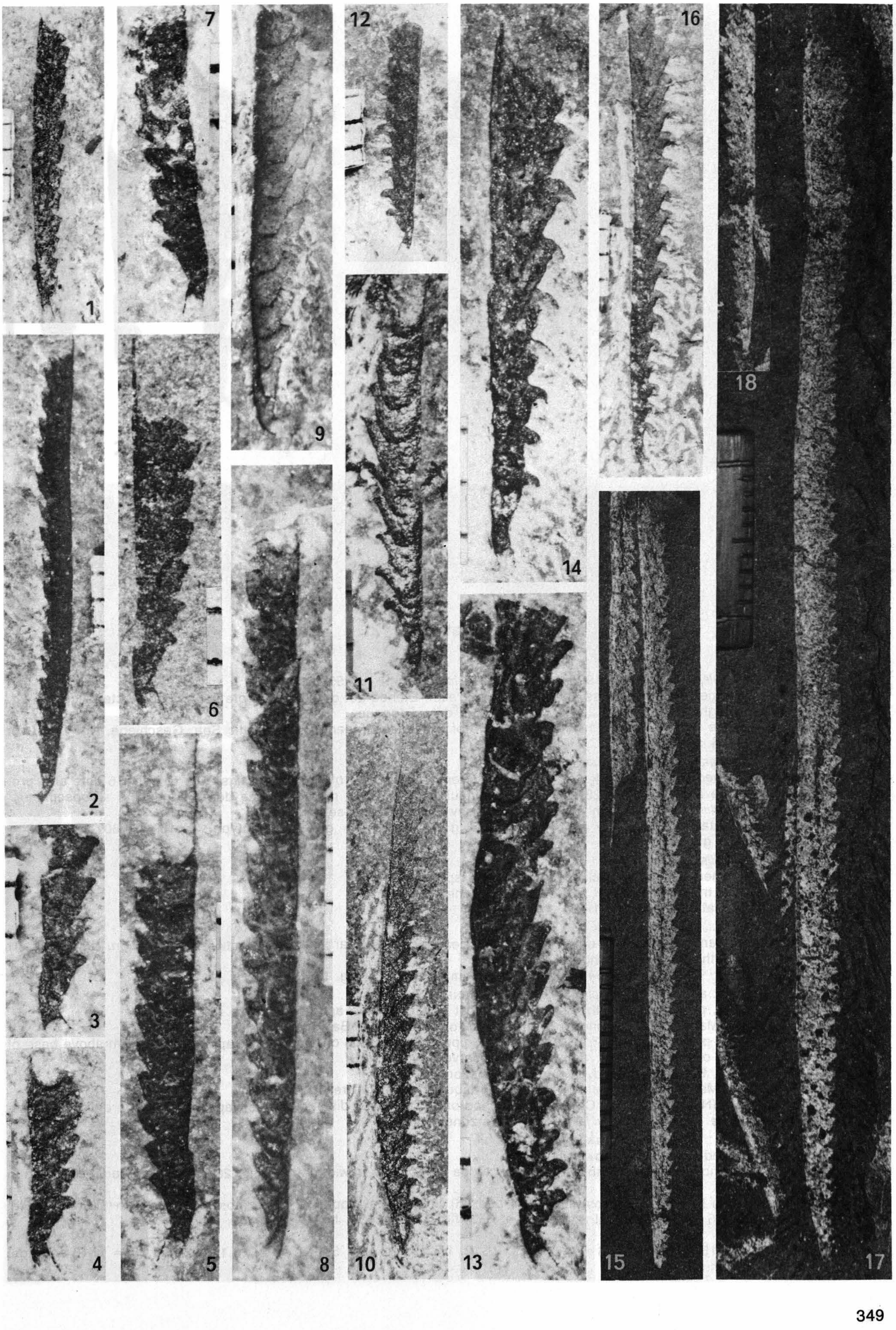
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Plate 2

Figs. 1–2: *Monograptus dalejensis* BOUČEK, 1936 (= *Monograptus haupti* KÜHNE, 1955).
Juvenile rhabdosomes, with hood-less apertures, in full relief. Etched out of the rock. Note ventrally deflected sicula in fig. 1 and almost straight sicula in fig. 2. Note absence of dorsal tongue.
Late Ludlow (above the Zone of *M. fritschi linearis*). Isle of Hiddensee (near Rügen), Baltic Sea. Geschiebe, No. 1 of Lab. Catalogue. G 626.4 and g 626.1.

Figs. 3–6, 23–24: *Monograptus parultimus* JAEGER.
Rhabdosomes etched out of the rock. Note increasing ventral deflection of sicula from figs. 3 to 6; in fig. 6 note also protraction of aperture at th_1; in figs. 23 and 24 note undulating apertural margins. Long dorsal tongue in all specimens.
Basal Přídolí, *parultimus* Zone, 80 cm above base, Kosov Quarry. Type series.
No. 33 of Lab. Catalogue. Fig. 3 = g 607.4; fig. 4 = g 607.3; fig. 5 = g 607.1 (holotype); fig. 6 = g 607.2; fig. 23 = g 607.5; fig. 24 = g 607.6.

Figs. 7–8: *Monograptus ultimus* PERNER.
Rhabdosomes etched out of the rock. Note apertural lappets.
Kosov Quarry, 5½ m above base of Přídolí, *ultimus* Zone.
No. 269 of Lab. Catalogue. G 602.1–2.

Figs. 9–11, 13: *Monograptus perneri* BOUČEK.
Rhabdosomes flattened and weakly deformed by flow cleavage. Black bar indicates direction of elongation. Note ventrally deflected sicula with long dorsal tongue.
Dlouhá hora, *perneri* Zone. G 647–649 (fig. 13 = proximal portion of fig. 9).

Figs. 12, 16–17, 19, 22 and 25: *Monograptus transgrediens* PERNER.
Note initial thecae, particularly th_1 that projects farthest and gives the appearance of a rounded beak.
Fig. 12 = g 650, Marble Quarry, junction from *bouceki* to *perneri* Zone, Band of *M. beatus*.
Figs. 16–17 (17 = prox. part) = g 651, Kosov Quarry, uppermost portion of *ultimus* Zone, approximately 5 m above base of Přídolí, lowermost occurrence of *M. transgrediens*, preserved in low relief.
Fig. 19 = g 645.1, Podolí, flattened, *transgrediens* Interzone.
Fig. 22 = g 652, Marble Quarry, *lochkovensis* Zone, rhabdosome in full relief.
Fig. 25 = g 601.2 (No. 185 of. Lab. Catalogue), etched out of the rock, distal portion collapsed during the drying process; borehole Všeradice VS III, probably *transgrediens* Interzone.

Figs. 14–15, 18, 20–21: *Monograptus fragmentalis* BOUČEK.
Specimens flattened or with very low relief.
In figs. 14 and 15 note different width and different mode of increase in width, and in fig. 20 overlap of interthecal septa in distal part.
All specimens from Karlštejn, topmost limestone bed (20 cm thick) of Kopanina, uppermost Ludlow, *fragmentalis* Zone. Fig. 14 = g 652; fig. 15 (21 = proximal portion) = g 653; fig. 18 = g 654; fig. 20 = g 655.

Magnification: Figs. 14–15 = × 2; fig. 16 = × 3; figs. 9–12, 17, 19–21 = × 5; figs. 1–8, 13,18, 22 and 25 = × 10 and figs. 23–24 = × 20; see mm-scale.

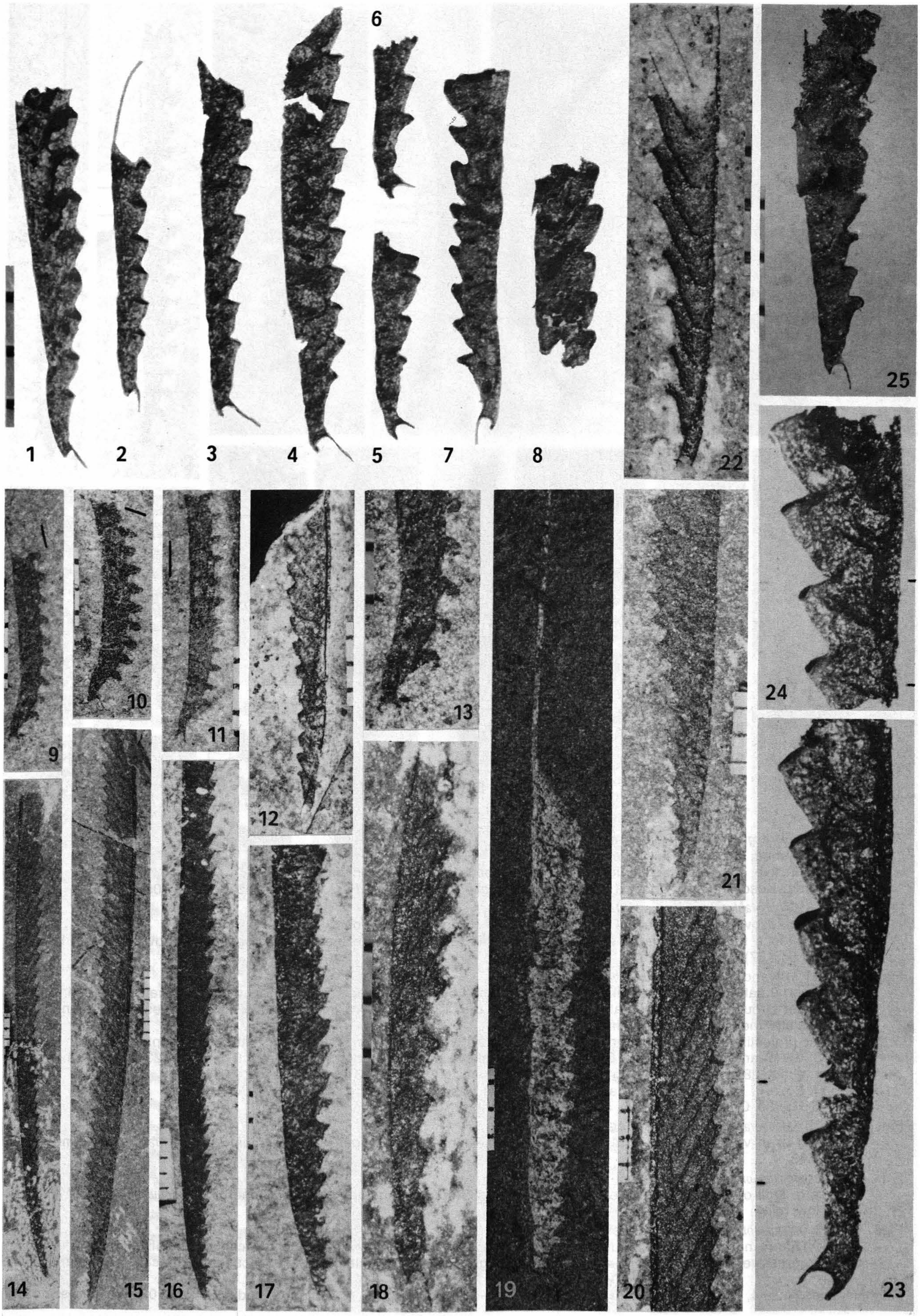
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Plate 3

Figs. 1 and 12: *Monograptus pridoliensis* PŘIBYL.
Fig. 1 flattened, fig. 12 in full relief.
Note distinctive distalward diminution of apertural hoods, particularly in fig. 1.
Fig. 1 from Kosov Quarry, about 12 m above base of Přídolí, g 658. Fig. 12 from Požáry, bed 105, g 657.

Figs. 2 and 6: *Monograptus hornyi* n. sp. JAEGER.
Flattened, Kosov Quarry, about 24 m above base of Přídolí, *bouceki* Zone.
Note difference from *M. pridoliensis* and *M. bouceki*; in fig. 6 (HJ 58) note moderate elongation by flow-cleavage. Fig. 2 = holotype (HJ 57).

Figs. 3, 7–11, 13 and 15: *Monograptus bouceki* PŘIBYL.
Figs. 3 and 9 flattened and, in addition, slightly deformed by flow cleavage; figs. 7–8 in very low relief; figs. 10, 11 and 13 in full relief throughout or somewhat distorted distally (fig. 13); fig. 15 proximally in relief, distally preserved as an impression, exhibits the extreme of proximal reflexion.
Note far projecting, claw-like proximal thecae, particularly th_1, and non overlapping interthecal septa.
Figs. 3, 7–10 and 13 from Kosov Quarry. Distance above base of Přídolí: figs. 3 and 9 = about 23 m, g 661.1–2; figs. 7–8 = about 28 m, g 662.1–2; fig. 10 = about 24½ m, g 663; fig. 13 = about 28 m, g 664.
Fig. 11 Požáry, beds no. 116 (= about 4½ m above base of Přídolí) g 665.
Fig. 15 Marble Quarry, about 9 m above base of Přídolí, g 666.

Figs. 4 and 5: *Monograptus formosus* BOUČEK.
Flattened or in very low relief. Karlštejn, topmost limestone bed of Kopanina, uppermost Ludlow, *fragmentalis* Zone, g 667 and g 668.

Fig. 14: *Monograptus uncinatus* TULLBERG.
Oderberg, east of Berlin. Geschiebe of grünlich-graues Graptolithengestein, Ludlow, Zone of *M. colonus* = Zone of *M. nilssoni*, in low relief; g 671.

Figs. 16–17: *Monograptus lochkovensis* PŘIBYL.
Marble Quarry near Lochkov, about 4 m above base of Přídolí, *lochkovensis* Zone, specimens in full relief.
Note progressive overlap of interthecal septa and slight variation in distalward simplification of thecae; g 670 and g 604.

Magnification: Figs. 4, 5, 10 and 17 = × 3; figs. 1–3, 6–8, 11 and 13 = × 5; figs. 9 and 12 = × 10; note mm-scale.

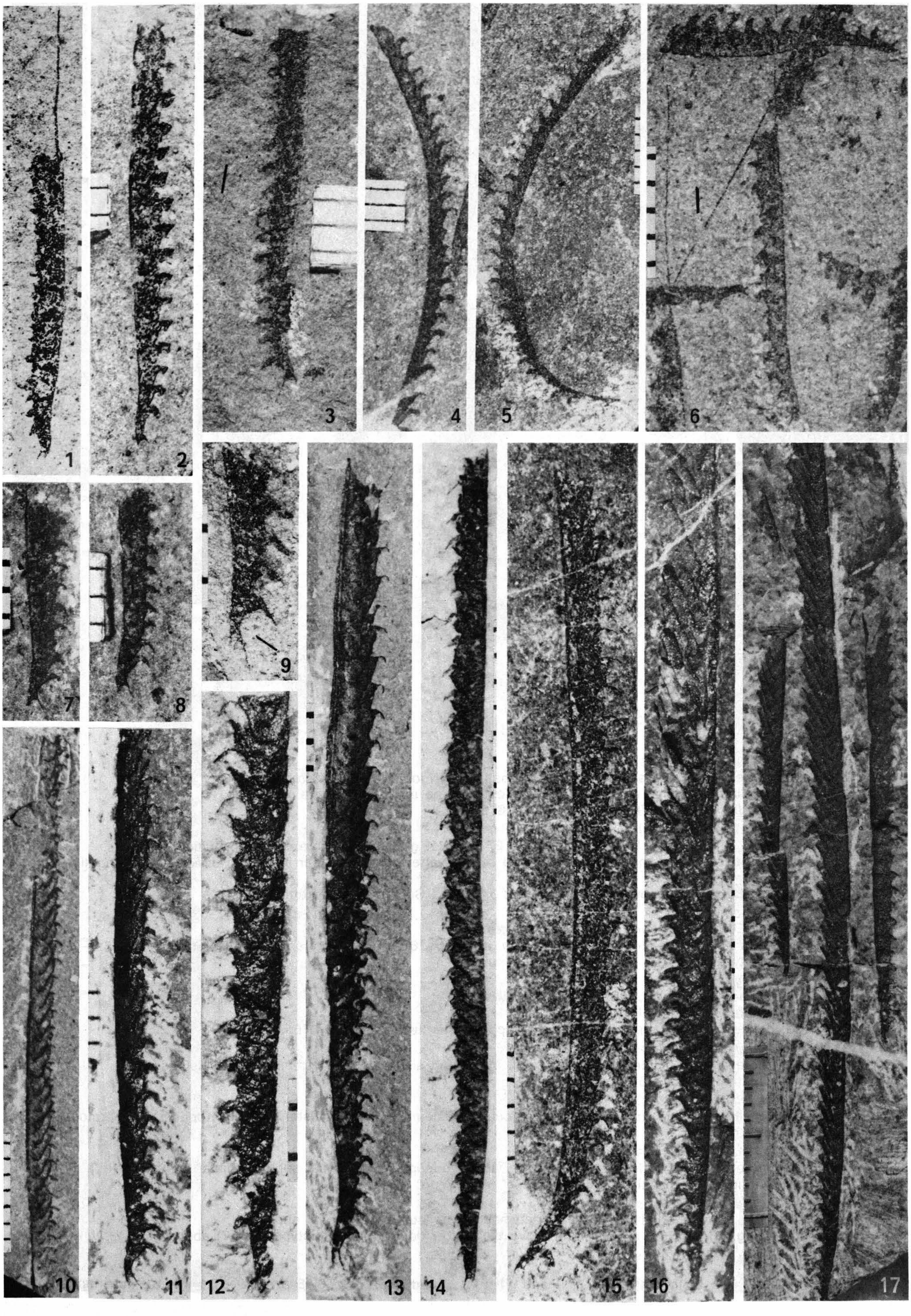
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Plate 4

Figs. 1, 10 and 15: *Monograptus beatus* KOREN.
Marble Quarry near Lochkov, about 12 m above base of Přídolí, Band of *M. beatus*.
Note slightly reclined proximal extremity and non-overlapping interthecal septa.
Fig. 1 = g 677; fig. 10 = g 678 and fig. 15 = g 679.

Figs. 2–3, 8–9 and 11: *Monograptus pridoliensis* PŘIBYL.
Figs. 2, 8 and 9 in low relief, from Braník, beds 27 and 25, g 672–674; note rapid diminuition of hoods.
Figs. 2 and 11 flattened and moderately deformed by cleavage, note black bar indicating direction of elongation, fig. 11 distally tilted.
Kosov Quarry, about 11 m above base of Přídolí; *pridoliensis* Subzone; g 659 and g 660.

Figs. 4–6: *Monograptus perneri* BOUČEK.
Velká Chuchle, Eurypterid Quarry, Zone of *M. perneri*.
Specimens in low relief. Note strongly curved sicula, and in fig. 6 far projecting, somewhat isolated th$_1$; g 675.1–2 (fig. 6 = proximal extremity of fig. 5).

Fig. 7: *Monograptus prognatus* KOREN.
Marble Quarry, bed 17, Lower Subzone of *M. lochkovensis*.
Fragmentary rhabdosome in full relief.
Note large, deflected hoods and extremely overlapping interthecal septa; g 676.

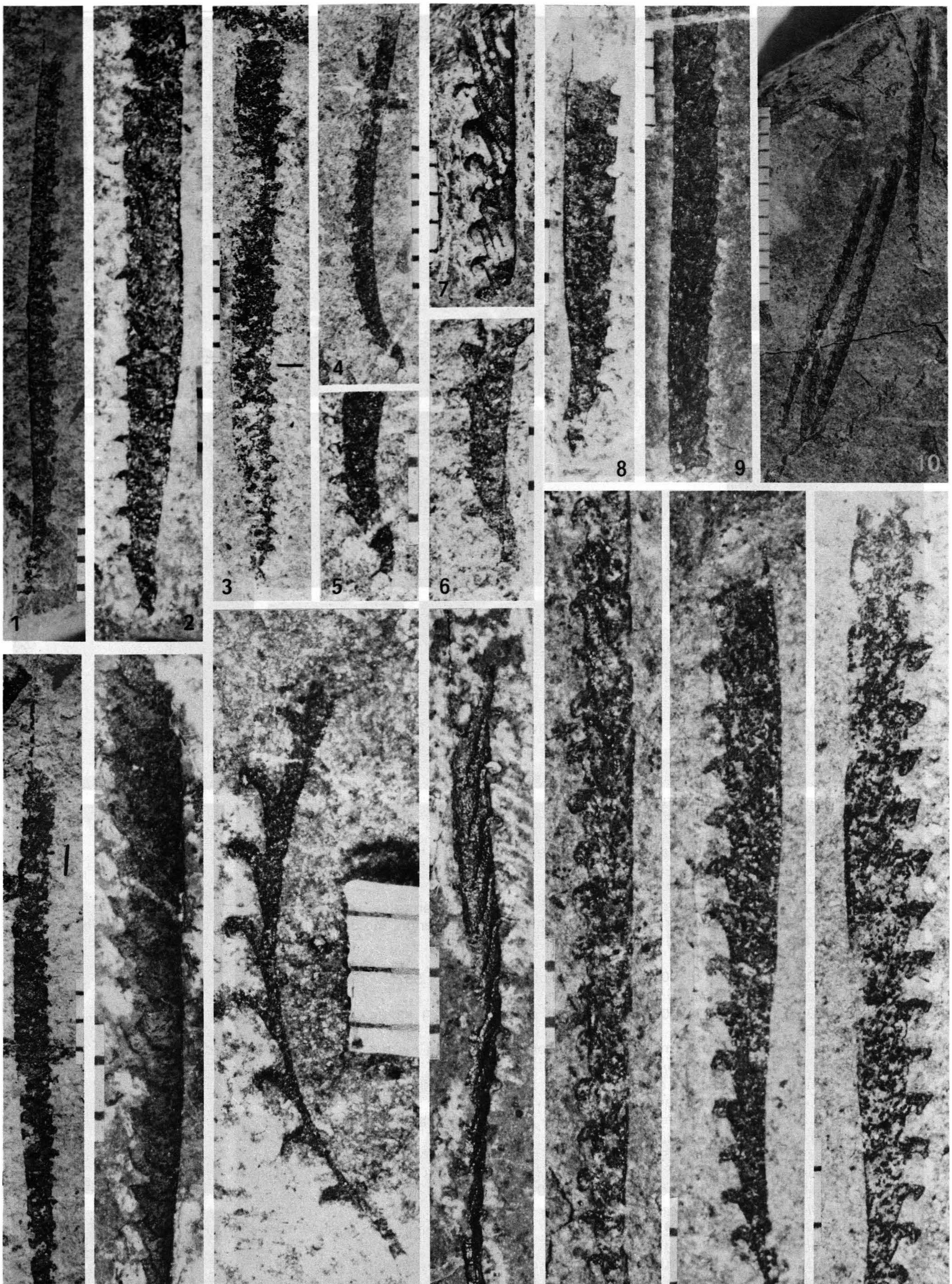
Fig. 12: *Monograptus parultimus* JAEGER.
In full relief; note almost simple apertural margin in th$_1$ and sicula with only minor ventral deflexion.
Cephalopod Quarry, bed 6; g 633 c.1.

Fig. 13: *Monograptus formosus* BOUČEK.
Juvenile with well preserved proximal end with sicula. Karlštejn, topmost limestone bed of Kopanina, uppermost Ludlow, *fragmentalis* Zone; g 669.

Fig. 14: *Monograptus microdon* REINHARD RICHTER.
In full relief; note proximal and distal extremities, and overlapping interthecal septa of distal thecae.
Karlík near Dobřichovice, basal Devonian Zone of *M. uniformis*; g 680.

Figs. 16–17: *Monograptus hornyi* n. sp. JAEGER.
Flattened; in fig. 17 note transversely expanded hoods, particularly at th$_{5,8,12}$ and $_{14}$.
Kosov Quarry, fig. 16. (HJ 59) about 17 m above base of Přídolí, fig. 17 (holotype, HJ 57) about 24 m; *lochkovensis* Zone and *bouceki* Zone, respectively.

Magnification: Fig. 10 = × 3; figs. 1, 3–4, 7, 9 and 11 = × 5 and figs. 2, 5–6, 8 and 12–17 = × 10; note mm-scale.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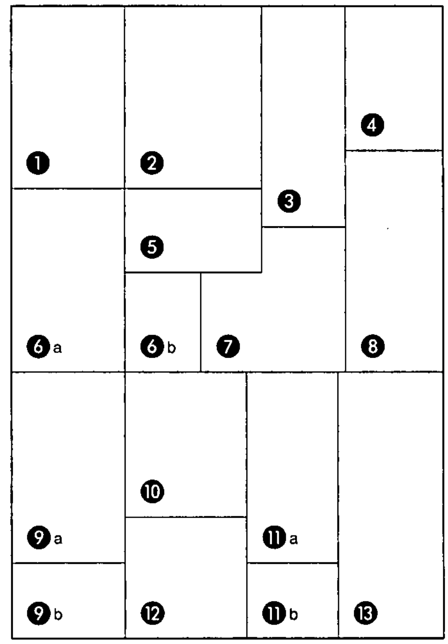


Plate 5

Late Ludlow Chitinozoa from Bohemia
(except fig. 10: early Přídolí specimen)

Figs. 1–2: *Ancyrochitina pedavis* LAUFELD.
Kosov Quarry, bed 8, IGR 53230, × 400.
1 – (M.38), specimen in full relief.
2 – (0.38), specimen with a collapsed chamber.

Fig. 3 and 5: *Cingulochitina wronai* PARIS.
Koledník Quarry, bed 24, IGR 53210.
3 – (Q.35.2), note the copula and the scar of the reduced carina (× 500).
5 – (P.37.2), detail of the aboral end showing the scar of the carina, the copula and remains of the collarette of the preceding individual (destroyed).

Figs. 4: *Eisenackitina barrandei* PARIS.
Koledník Quarry, bed 18 b (60 cm below top of bed 18), IGR 53208, (M.38.2), × 400.

Figs. 6a–b: *Eisenackitina* gr. *intermedia* (EISENACK).
Koledník Quarry, bed 16 b (100 cm below top of bed 16), IGR 53206, (N.40.4).
6a – × 400.
6b – note the peculiar pattern of ornamentation of the aboral margin (anastomosed tubercles), × 1.500.

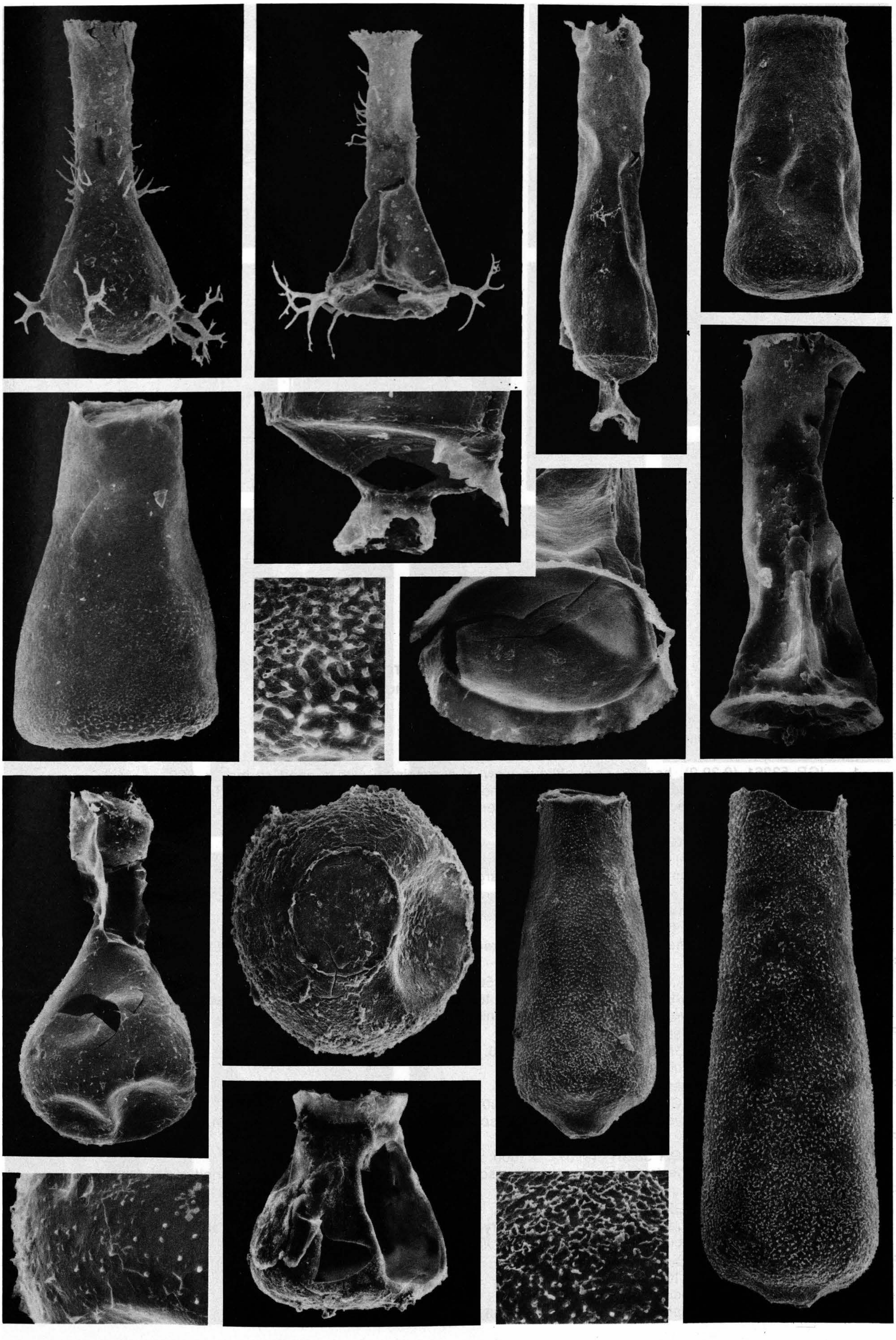
Figs. 7 and 8: *Cingulochitina kolednikensis* PARIS.
Koleník Quarry, bed 16 c (55 cm below top of bed 16), IGR 53207.
7 – (P.37.4), aboral view showing the well-developed carina, × 750.
8 – (R.40.2), partially flattened specimen with an unusually short carina, × 500.

Figs. 9 a–b: *Sphaerochitina sphaerocephala* EISENACK.
Braník Section, bed 17, IGR 52812 (N.39.4).
9a – general view, × 500.
9b – detail of the tiny ornamentation, × 1.500.

Fig. 10: *Calpichitina (Calpichitina) gregaria* PARIS.
Koledník Quarry, bed 31, IGR 53212 (T.33.2), oral view showing the operculum in situ, × 750.

Figs. 11 a–b and 13: *Eisenackitina* sp. A.
Koledník Quarry, bed 16 b (100 cm below top of bed 16), IGR 53206.
11a – (Q.40), lateral view of a specimen in full relief; note the protuberant basal process, × 300.
11b – detail of the ornamentation of the aboral margin of the specimen illustrated on fig 11a, × 1.000.
13 – (M.40.3), lateral view of a large specimen, × 300.

Fig. 12: *Eisenackitina* gr. *lagenomorpha* (EISENACK).
Braník Section, bed 11, IGR 52803 (N.30.3). The tiny ornamentation of this sepcimen is coated with organic matter, × 500.



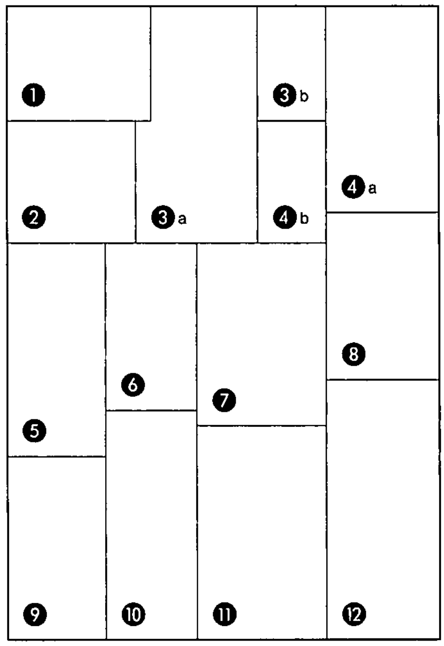


Plate 6

Early Přídolí Chitinozoa from Bohemia
(except figs. 7, 10: topmost Ludlow)

Figs. 1 and 2: *Pterochitina perivelata* (EISENACK).
Kosov Quarry.
1 – IGR 53261 (0.39.2), bed 25. Oral oblique view of a specimen with a short carina, × 500.
2 – IGR 53252 (0.40), bed 21. Specimen showing the structure of the carina which results from the folding of the outer-layer. On this dameged specimen, the carina is broken along its distal end so that its two sides are separated, × 500.

Figs. 3 a–b: *Fungochitina kosovensis* PARIS.
Kosov Quarry, bed 22, IGR 53254 (0.42).
3a – specimen in full relief, × 400.
3b – detail of the ornamentation of the aboral margin, × 1.500.

Figs. 4 a–b: *Eisenackitina* cf. *intermedia* (EISENACK).
Hvížďalka Section, bed 14, IGR 53402 (0.39.4).
4a – note the scattered tubercles, × 400.
4b – detail of the ornamentation (the tubercles are larger and more scattered than in *E. barrandei*), × 1.500.

Fig. 5: *Angochitina* sp B.
Koledník Quarry, bed 28, IGR 53211 (N.39.4), × 500.
This form, with a reduced neck, is closely related to the individuals identified by EISENACK (1972, pl. 17, fig. 1–12) as *Angochitina echinata* from the Leba borehole, Pomerania.

Fig. 7: *Bursachitina ? concava* EISENACK.
Marble Quarry, bed 9, IGR 53329, (0.41.3), × 500.
Note the large aboral process.

Fig. 8: *Urnochitina* gr. *urna* (EISENACK).
Kosov Quarry, bed 23, IGR 53257, (N.37.3), × 500.
This form is significantly smaller than the typical specimen of *U. urna*, recorded higher in the succession.

Fig. 9: *Gotlandochitina* ? sp.
Kosov Quarry, bed 25, IGR 53261, (M.37), × 500.
Most of the spines are destroyed; however, their scars seem to be distributed along longitudinal rows.

Fig. 10: ? *Unrnochitina* gr. *urna* (EISENACK).
Marble Quarry, bed 9, IGR 53329, (N.36), × 500.
These connected individuals may represent the very first form of the „*urna*‚group". They are present (but extremely rare) 50 cm below the first occurrence of *Monograptus parultimus* in the Marble Quarry section.

Figs. 11 and 12: *Urnochitina urna* (EISENACK).
Braník Section, bed 31, IGR 52828, × 400.
11 – (N.38), typical specimen.
12 – (J.41.3), elongate specimen showing a slightly displaced operculum.