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The Lochkovian-Pragian Boundary in the Lower Devonian of the Barrandian Area (Czechoslovakia)

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With 17 figures, 1 table and 4 plates

Tschechoslowakei
Barrandium
Karnische Alpen
Devon
Stratigraphische Korrelation
Lochkov-Prag-Grenze
Tentaculiten
Conodonten
Graptolithen
Chitinozoa
Trilobita
Brachiopoda

IGCP-Project Ecostratigraphy

Contents

Zusammenfassung

Im Barrandium Böhmens wurde die Lochkov/Prag-Grenze des Unterdevons an 6 ausgewählten Profilen in Hinblick auf ihren Makro- und Mikrofossilinhalt biostratigraphisch untersucht. Für Korrelationszwecke sind in erster Linie Dacryoconariden, Conodonten, Chitinozoen, Trilobiten, Graptolithen und Brachiopoden geeignet. Die traditionelle Lochkov/Prag-Grenze liegt innerhalb einer kontinuierlichen marinen Entwicklung, die pelagische Kalke wie auch organodetritische Flachwasserkalke umfaßt. Faunenabfolge und Evolutionsreihen einzelner Tiergruppen beweisen lückenlose Sedimentationsbedingungen. Die Lochkov- und Prag-Zeit und im besonderen die Grenze zwischen den beiden Stufen sind durch ihren Fossilinhalt klar zu charakterisieren. Ausgehend von den Verhältnissen im Barrandium und in den Karnischen Alpen wird eine auf Conodonten basierende Grenzziehung zwischen der Lochkov- und Prag-Stufe vorgeschlagen.

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Summary

Six selected sections of the Lochkovian-Pragian boundary beds in the Barrandian area of central Bohemia were subjected to investigations of mega- and microfossils. Joint occurrence of different stratigraphically important fossil groups, particularly dacryoconarid tentaculites, conodonts, chitinozoans, trilobites, graptolites, brachiopods a. o. allows a correlation from different viewpoints. The Lochkovian-Pragian boundary as originally defined ist drawn in a conformable succession of marine carbonate rocks which include fine-grained pelagic up to shallow water biodetrital facies. The faunal relationships and lineages suggest an uninterrupted development and evolution. The Lochkovian-Pragian boundary interval and the boundary proper is distinguishable by means of dacryoconarid tentaculites, conodonts, chitinozoans, trilobites, brachiopods, echinoderms etc. A proposal for a conodont based Lochkovian-Pragian boundary is presented.

1. Introduction

The Lower Devonian stages Lochkovian and Pragian, established by the first International Symposium on Silurian and Devonian in 1958 and accepted as standard stages by the Subcommission on Devonian Stratigraphy in 1983, show a complex facies development within the Barrandian type area in central Bohemia. A predominance of various kinds of micritic, sparitic, biodetrital and in the Pragian also reefal limestones rich in benthic and pelagic faunas is characteristic (for general dàta see CHLUPÁČ, 1976, 1982). The presence and joint ocurrence of groups on which the zonal subdivisions are based allow a correlation of different kinds of zonation and biostratigraphic features and accentuate the importance of the Barrandian sections for wide-scale correlations.

As the Lochkovian-Pragian boundary represents a significant limit wihtin the Lower Devonian, a detailed investigation of this boundary was started in 1980 and finished in 1984. The Lochkovian-Pragian boundary is exposed in the Barrandian at many places, and consequently, the work was concentrated on several sections. It is thus merely the first attempt to evaluate the boundary from mega- and micropalaeontological viewpoints.

The work was conducted by the Geological Survey, Prague, and realized in terms of international cooperation within the Geologische Bundesanstalt, Vienna, and Laboratoire de Géologie, Université de Rennes, France. Field investigations of sections and biostratigraphic study of most part of megafossils were carried out by I. CHLUPÁČ, study of dacryoconarid tentaculites by P. LUKEŠ (both Geological Survey, Prague), conodont sampling and studies were made by H. P. SCHÖNLAUB (Geologische Bundesantalt, Vienna), and of chitinozoans by F. PARIS (Université de Rennes). Some graptolites were determined by HERMANN JAEGER (Museum für Naturkunde, Berlin), brachiopods by V. HAVLÍČEK (Geol. Survey, Prague), and echinoderms by R. PROKOP (National Museum, Prague).

Reference collections are deposited in the Geological Súrvey, Prague, Geologische Bundesanstalt, Vienna (conodonts) and Université de Rennes (chitinozoans).

2. Description of sections

Six sections with well exposed and tectonically undisturbed Lochkovian-Pragian boundary interval were selected within the Barrandian and subjected to a "bed by bed" study. These sections cover different types of facies development characteristic of the Barrandian area.

2.1. Černa rokle near Kosoř

Classic Lower Devonian outcrops in the Černa rokle gorge SE of the village Kosoř are situated at the SW periphery of Prague (for topographic position see fig. 1).

The sequence, exposed particularly on the NW slope of the gorge in old quarries and adjacent outcrops, includes the upper Lochkovian and Pragian strata. The former, developed as the platy Radotín Limestone of the Lochkov Formation, is accessible in a sequence about 40 m thick, the latter, developed as nodular Dvorce-Prokop Limestone, is cropping out at a total thickness of 160–180 m. The outcrops are well known palaeontological localities famous since Barrande's time (reported in the 19th century as "Lochkov" – see CHLUPÁČ, 1983), and rich faunas were described in many monographs, beginning with BARRANDE's (1852). The biostratigraphy was studied especially by KODYM & KOLIHA (1928), CHLUPÁČ (1953, 1957, 1962) and SCHÖNLAUB (1980). The outcrops serve as the type locality of the

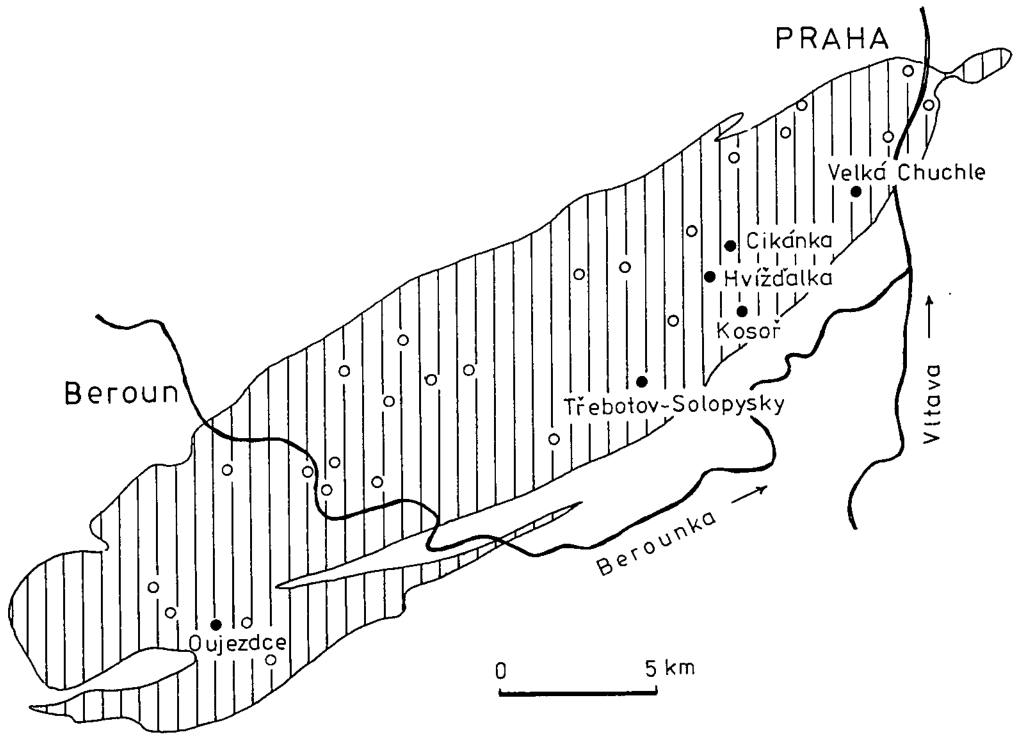


Fig. 1: Location of the Lochkovian-Pragian boundary sections. ● = sections described in this paper; ○ = sections studied during former etapes of investigations; area of Siluro-Devonian outcrops vertically lined.

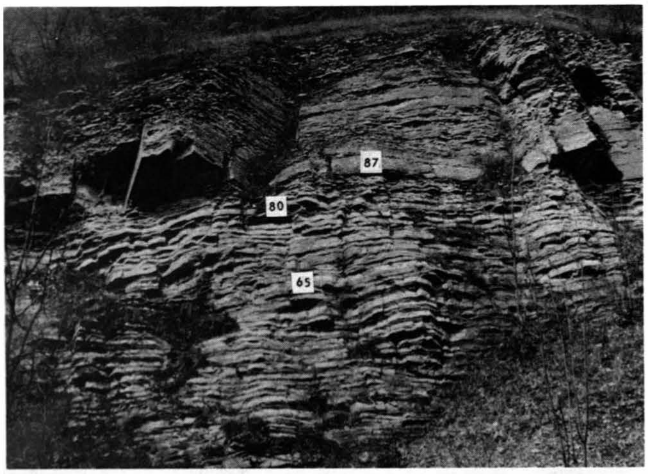


Fig. 2: Černá rokle near Kosoř, face wall of the old quarry, original stratotype of the Lochkovian-Pragian boundary. Topmost Lochkovian in the Radotín, lowest Pragian in the Dvorce-Prokop Limestone facies. 65 = dark micritic marker bed; 80 = last Lochkovian bed; 87 = thicker bank of the Dvorce-Prokop Limestone with nodular structure.

Radotín Limestone within the Lochkov Formation and according to the original definition from 1958 (see Prager Arbeitstagung etc., 1960, p. 150) the westernmost quarry (fig. 2) constitutes the holostratotype of the Lochkovian-Pragian boundary beds.

The sequence of the Lochkovian-Pragian boundary beds has been studied in detail just in this stratotype quarry. The upper Lochkovian strata, exposed here at a thickness of 24 m, are developed as dark grey platy, predominantly microsparitic limestones alternating regularly (in intervals 10–30 cm) with dark, brownish weathering calcareous shales (mudstones). The limestones show distinct lamination and irregular graded bedding, indicated particularly in thin layers or laminae of coarser biodetrital limestone with common accumulations of larger shelly fossils. Megafossils are very common and are represented even by well preserved thin shells, as is the case in nautiloids, bivalves, brachiopods, gastropods, etc. Trilobites occur as isolated exoskeletal parts but rare complete specimens have also been found; in coarser biodetrital layers, organic remains are often fragmentary.

Within the upper Lochkovian sequence exposed in the quarry, 80 individual and numbered (1–80) limestone beds have been distinguished, the shale interbeds being numbered according to the underlying and overlying limestones (e. g. interbed 65/66 = shale between limestone beds Nos. 65 and 66).

The upper Lochkovian part of the section provided the following biostratigraphic data:

Common shelly fauna traceable in the whole upper Lochkovian sequence consists of orthoconic nautiloids (*"Orthoceras" deletum*, characteristic), bivalves *Panenka* div. sp., *Neklania* div. sp., *Hercynella* div. sp., *Služka bohemica*, *Lunulacardium* div. sp., *Leiopteria (Actinopteria) migrans migrans*, gastropods *Stylonema solvens*, *Raphistomina tarda*, *Praenatica proeva*, hyolithids *Orthotheca intermedia*; common trilobites are represented by *Lepidoproetus lepidus lepidus*, *Leonaspis lochkovensis*, *Scharyia angusta*, *Ranunculoproetus heteroclytus*, *Otarion novaki*, phyllocarids by *Ceratiocaris cornwallisensis damesi* and brachiopods by *Plectodonta mimica*, *Glossoleptaena emarginata*, *Rugoleptaena zinkeni*, *Areostrophia interjecta*, *Orbiculoidea intermedia*, etc.

The common occurrence of index graptolites *Monograptus hercynicus* falls within the interval of beds 25 to 28 (shale interbeds), the last specimen probably belonging to this species was found in interbed 57/58. Graptolites found in interbeds 54/55, 57/58 and at the base of bed 77 belong to *Monograptus kayseri* or *M. aequabilis notoaequabilis* (?), all kindly reviewed by H. Jaeger.

Dacryoconarid tentaculites, prolific almost in all the upper Lochkovian limestone beds exposed, are represented by the index *Paranowakia intermedia* commonly occurring up to the bed 74 (rock-forming accumulations in beds 61 and 62); *P. geinitziana* has been found already in bed 41, its acme-development falls within the interval of beds 74–79; less common occurrence persists up to the lowest Pragian (according to a letter of April 27, 1983, G. Alberti found rare specimens of *P. geinitziana* up to the bed 87). *Nowakia sororcula* is markedly common in the topmost Lochkovian (beds 75–80 and frequently continues into the lower Pragian. Species determined as *Nowakia* cf. *acuaria* have been found sporadically beginning with bed 58. Recently described new species of tentatculites, namely *Nowakia kosorensis* and *N. vesta* derive from bed 63 and its proximity, *N. praesororcula* is common in beds 72–73 (Lukeš, 1985).

Some differences in stratigraphic distribution are clearly shown in trilobites: *Spiniscutellumm umbilliferum* is generally common up to the interval of beds 60–65; starting with bed 67 it seems to be replaced by *S.* ? *plasi* which continues up to the end of the Lochkovian sequence. *Lochkovella misera*, common up to bed 74, ist replaced in few uppermost Lochkovian beds by *Reedops limespragensis* wich continues up to the lowest Pragian.

Among bivalves, *Hercynella paraturgescens = radians* is clearly concentrated in the topmost Lochkovian (particularly beds 67–80) and less frequently continues into the lowest Pragian. *Hercynella bohemica = nobilis* dominates in the underlying part of the Lochkovian sequence. Among brachiopods, *Howellella inchoans* forms accumulations in the lower part of the sequence (beds 1–11), *H. digitatoides* being rather frequent even in higher beds. Other brachiopods show no marked changes and some of them continue from the uppermost Lochkovian into the Pragian (e. g. *Eoglossinotoechia cacuminata*, *Rugoleptaena zinkeni*, *Plectodonta mimica*, *Caplinoplia pragensis* and *Leptochonetes* cf. *tardus*, det. V. Havlíček).

Conodonts occur in very low numbers: *Icriodus* sp. n. A (bed 63), *Ozarkodina excavata* (bed 63, 64), *Ancyrodelloides omus* and *Ozarkodina wurmi* (bed 64). Further investigations may supplement this so far incomplete data.

Chitinozoans are numerous (up to 30 specimens per gram of rock) but rather slightly diversified in all fifteen samples collected in the last 24 metres of the upper Lochkovian sequence. *Eisenackitina bohemica* and *Gotlandochitina ramosus* are successively dominant: the former ist very well represented from bed 1 to bed 54, the latter is the most common chitinozoan from bed 62 to bed 80. Some taxa seem to be restricted to one bed (*Calpichitina* sp. in bed 77, *Cingulochitina* sp. in bed 65), while others appear in different samples (e. g. *Eisenackitina* cf. *cupellata* from bed 21 to bed 77, *Margachitina catenaria tenuipes* in beds 62, 63, 65 and 77. *Eisenackitina elongata* (beds 10/11 and 15), *Eisenackitina* sp. A (bed 21) and *Margachitina catenaria catenaria* (bed 21) seem to be restricted to the lower part of the interval studied. A special attention should be paid to *Urnochitina* sp. A in beds 62, 65 and 70, as this form is closely related to *Urnochitina urna*, the index chitinozoan from the Pridolian.

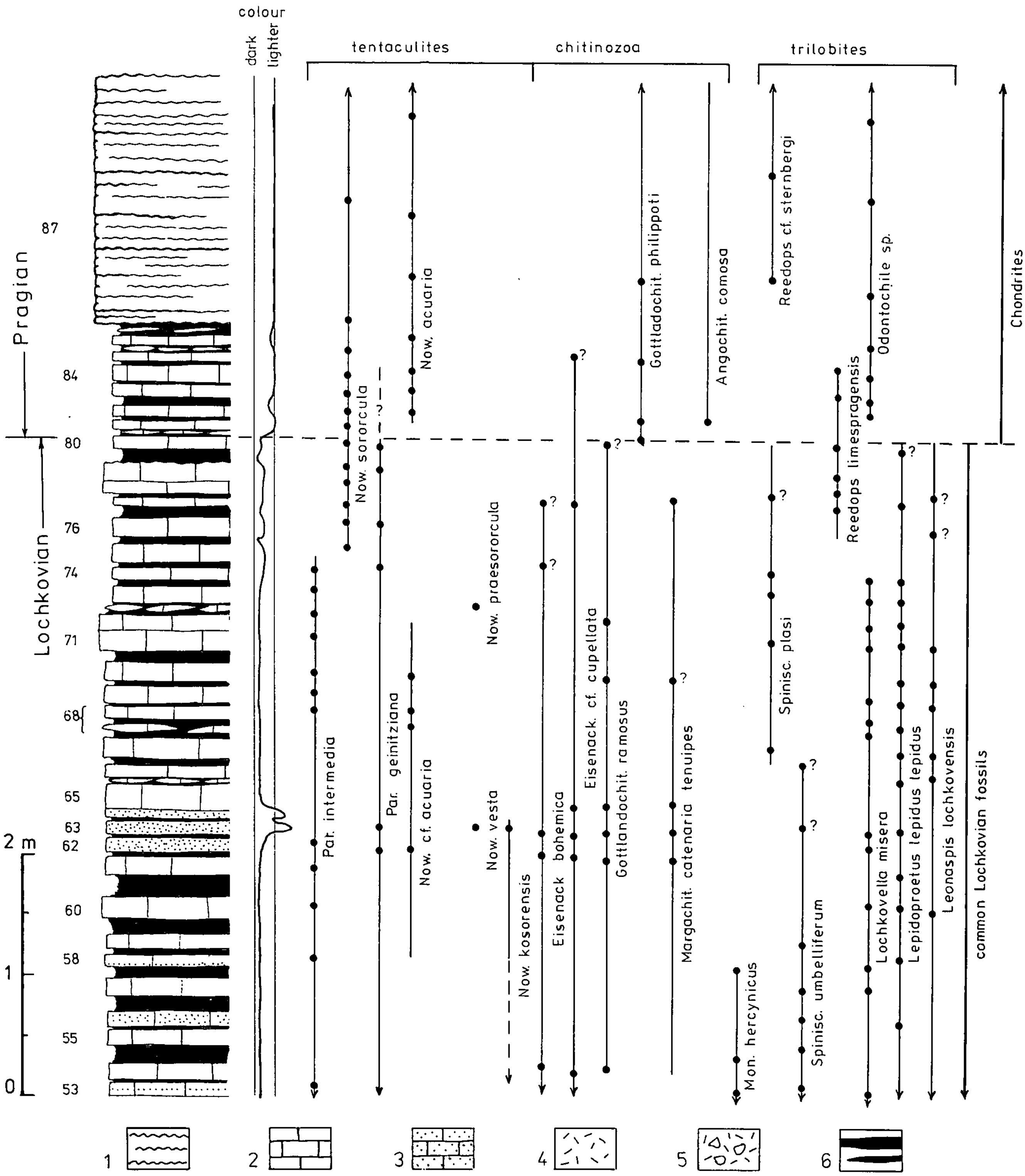


Fig. 3: Černá rokle near Kosoř, diagrammatic section of the Lochkovian-Pragian boundary interval. 1 = grey micritic limestones; 2 = dark grey and grey microsparitic limestones; 3 = lighter sparitic limestones; 4 = coarser biodetrital and sparitic limestones; 5 = brecciose layers; 6 = calcareous shales. In diagrams of occurrences: ● = occurrence proved; full line = occurrence expected; dashed lines = occurrence not certain.

Within the upper Lochkovian interval exposed, the tentaculite limestone constituting bed 62, two layers of markedly lighter-grey and coarser biosparitic limestone of the "Kosoř type" (beds 63 and 64) and the very fine-grained up to micritic dark bed 65 may serve as lithologic marker beds.

The base of the Pragian sequence, as defined by CHLUPÁČ (1969) according to the original definiton of the boundary in 1958 (Prager Arbeitstagung 1960, p. 510), begins with lighter grey micritic *Chondrites*-bearing limestones with thin intercalations of grey and greenish-brown calcareous shales. The characteristic nodular structure ist well developed from the thicker bank 87 upwards.

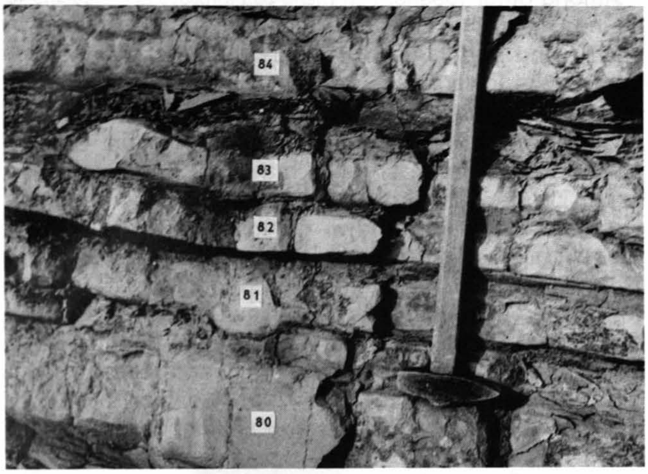


Fig. 4: Detail of the Lochkovian-Pragian boundary interval at Černá rokle near Kosoř. 80 = topmost Lochkovian bed; 81–84 = lowermost Pragian beds.

In contrast to the underlying Lochkovian rocks, all limestones and shales contain common *Chondrites* burrows, the limestones are markedly fine-grained (micritic) and lighter in colour. Lamination is absent in limestones and bedding planes are irregular, often knobby. Alle these are characteristic features of the Dvorce-Prokop Limestone. In spite of the clear lithological difference, the Lochkovian-Pragian boundary drawn between beds 80 and 81 shows no traces of erosion or of a break: the upper and lower limits of the boundary shale interbed 80/81 are unsharp and the boundary beds, traceable in the outcrop, show an absolutely concordant position.

It should be also noted that micritic limestones similar in lithology with that of the Pragian base, appear as fillings of some nautiloid shells already in several uppermost Lochkovian beds – a testimony that the lithology of the Dvorce-Prokop Limestone is merely due to mechanical factors (e. g. decrease of current activity) and not a result of a drastic and immediate change of environment. This is also apparent in biostratigraphic data, namely in some persisting fossils.

From the biostratigraphic viewpoint, the Lochkovian-Pragian boundary is less expressed especially in tentaculites: The dominating *Nowakia sororcula* survives from the topmost Lochkovian into the lowest Pragian in a great abundance, whilst *Paranowakia geinitziana* shows a marked decline. Typical large specimens of *Nowakia acuaria* appear close above the Lochkovian-Pragian boundary (bed 82 etc.), but the presence of *N. acuaria* s. lat. cannot be excluded even in the topmost Lochkovian.

Trilobites show a marked change at the boundary in the section studied: *Odontochile* starts to develop vigorously (first found in bed 82), and the same is true of the large-eyed representatives of *Reedops*, e. g. *R. prospicens*, *R.* cf. *sternbergi* a. o. *Reedops limespragensis* persists from the topmost Lochkovian into the lowest Pragian (last found in bed 84).

Whilst some *Hercynella* species and reported brachiopods continue, the other and characteristic Lochkovian benthic fauna is replaced by different, although commonly allied forms; this also concerns the majority of determinable nautiloids, hyolithids, phyllocarids etc. Among fishes, *Machaeracanthus bohemicus* persists (found in bed 73 and at different levels of the Pragian sequence exposed).

A characteristic lower Pragian trilobite fauna has been found in the higher part of bank 87 and in the overlying few meters: *Odontochile hausmanni*, *O.* sp. cf. *cristata*, *Reedops prospicens*, *R.* cf. *sternbergi*, *Phacops (Prokops) hoeninghausi*, *Cheirurus (Pilletopeltis) albertii*, *Crotalocephalina gibba*, *Decoroproetus concentricus*, *Dicranurus monstrosus*, *Platyscutellum formosum formosum*, accompanied by other common fossils of the Dvorce-Prokop limestone including *Kralovna* sp., *Panenka* sp., *Eoglossinotoechia cacuminata*, *Dalejodiscus subcomitans*, *Leptochonetes tardus*, rugose and auloporid corals and common tentaculites *Nowakia acuaria*.

The lowest part of the Pragian Dvorce-Prokop Limestone seems to be almost barren of conodonts. According to SCHÖNLAUB (in CHLUPÁČ et al., 1980), *Icriodus* cf. *steinachensis* and *Pelekysgnathus serratus* start at a level some 40 m above the base. In the lowest part of the Pragian sequence only single cones of *Belodella* type were found (they straddle the Lochkovian-Pragian boundary).

Chitinozoans are less common than is the case in the upper Lochkovian (1 to 4 specimens per gram of rock). *Gotlandochitina philippoti* and related forms dominate in the first two metres of basal Pragian (beds 81, 85/86 and 87). This species, however, is present already in the topmost Lochkovian bed 80 and its occurrence cannot be excluded even in previous beds. A few specimens tentatively referred to *Eisenackitina bohemica* and *E. cupellata* are still present in interbed 85/86. In spite of the very low abundance of chitinozoans in bed 81, the occurrence of *Angochitina comosa* is to be pointed out.

2.2. Třebotov – Solopysky

This locality is situated SW of Prague, about 600 m SW of the village of Třebotov, W of Solopysky. It is one of the row of natural outcrops on the left bank of the Brook Švarcava. The outcrop of the Lochkovian-Pragian boundary beds is located in the upper part of the steep rocky slope, in the NW flank of the local complex anticlinal structure. The section was formerly studied by CHLUPÁČ (1953: 290–291, 1957: 376).

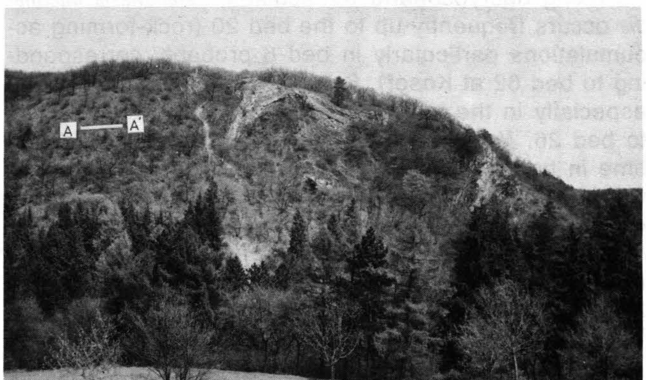


Fig. 5: Anticlinal structure in the Lochkovian strata in the Švarcava Valley S of Třebotov. Interval of the Lochkovian-Pragian boundary beds studied designated in the left part (A–A').

The Lochkovian is here developed as the Radotín Limestone (thickness about 60 m), the total Pragian sequence as the Dvorce-Prokop Limestone (about 100 m thick). The interval studied in detail comprises the last 6 m of the Lochkovian and first 6 m of the Pragian sequence (figs. 5–7).

The topmost Lochkovian consists of dark-grey platy microsparitic and sparitic limestones alternating with intercalations of calcareous mudstones in intervals 5–15 cm (lithology is similar to the Kosoř section but sparitic layers are more frequent). As a lithologic marked bed may serve the bed 7 – lighter coloured sparitic limestone (18 cm thick) which most likely corresponds to bed 63 at Kosoř.

Common upper Lochkovian fauna found in many beds of the uppermost Lochkovian interval studied includes *Lepidoproetus lepidus lepidus* (very frequent), *Scharyia angusta, Ranunculoproetus heteroclytus, Leonaspis lochkovensis, Otarion novaki, Crotalocephalina chlupaci, "Orthoceras" deletum, Parakionoceras* sp., *Orthotheca intermedia, Areostrophia interjecta* (very frequent in some layers), *Plectodonta mimica, Rugoleptaena zinkeni, Raphistomina tarda, Neklania* div. sp., *Panenka* div. sp., *Conocardium aptychoides* etc. (assemblage identical with that of Kosoř section).

Fig. 6: Section S of Třebotov, detail of the Lochkovian-Pragian boundary interval. 26 = topmost Lochkovian bed; 27–31 = layers of the Dvorce-Prokop Limestone, lowest Pragian.

Among dacryoconarid tentaculites, *Paranowakia intermedia* occurs frequently up to the bed 20 (rock-forming accumulations particularly in bed 6 probably corresponding to bed 62 at Kosoř). *P. geinitziana* has been identified especially in the interval of beds 13–22, fragments up to bed 26. *Nowakia sororcula* has been found for the first time in bed 21 and continues across the boundary upwards into the lower Pragian. *Nowakia* cf. *acuaria* is sporadic (beds 11, 12, 26 etc.), characteristic specimens of *N. acuaria* appear as late as in the earliest Pragian. The new species *Nowakia gemina* LUKEŠ derives from the level 2,8 m below the Pragian base.

Trilobites show some differences in occurrence analogous to those assessed at Kosoř: *Spiniscutellum umbelliferum*, prolific in older layers, has been found in fragments up to bed 7, *S. ? plasi* has been identified in the interval of beds 10 to 21, possible fragments up to bed 25. Rather common *Lochkovella misera* continues up to bed 21; starting with 22 it seems to be replaced even in this section by *Reedops limespragensis*. *Ceratonurus* sp. n. comes from beds 23 and 24 (oldest representative of the genus so far reported).

Among other fossils, *Hercynella paraturgescens = radians* is abundant in the topmost Lochkovian (first found in bed 9) and continues in markedly decreasing abundance in the lowermost Pragian layers. A large fin-spine of *Machaeracanthus bohemicus* comes from bed 19.

Chitinozoans are extremely abundant (up to 700 specimens per gram of rock) in the last 5 metres of the upper Lochkovian. From bed 1 to bed 13 the assemblages are dominated by two groups of species, namely *Gotlandochitina ramosus* and *Eisenackitina bohemica* complex. Typical *E. bohemica* are extremely numerous in bed 13 which represents their last occurrence in the processed material. *E.* cf. *cupellata* has been recorded in beds 5 and 7. Very rare *Urnochitina* sp. A. (bed 1) and *Margachitina catenaria tenuipes* (bed 7) occur in the lower part of the interval studied. The abundance of chitinozoans decreases in the topmost Lochkovian beds and the assemblages are frequently monospecific. However, in some cases, subordinate taxa such as *Calpichitina* sp. (beds 22 and 24), *Margachitina catenaria tenuipes* (bed 25) or a few representatives of *Eisenackitina* ? are associated with the dominating *Gotlandochitina ramosus*.

Conodonts were so far not studied in the section described.

The Lochkovian-Pragian boundary shows the same character as at Kosoř: The last microsparitic up to micritic dark-grey layer 26 which evidently terminates the Lochkovian sequence, is overlain by a very thin shale interbed (1 cm) followed by somewhat lighter micritic limestone with *Chondrites* burrows, agreeing in lithology with the Dvorce-Prokop Limestone, the concordant position being evident.

The Pragian Dvorce-Prokop Limestone is in the lowest 40 cm still platy (persisting structures of the Radotín Limestone), the characteristic nodular structure appearing first in beds above this interval.

The lower part of the Dvorce-Prokop Limestone is less fossiliferous: *Reedops sternbergi* has been found about 1 m above the base and the typical *Nowakia acuaria* at the same level (continues upwards).

Chitinozoans: Of the seven samples collected in the lowermost Pragian (first 230 cm), only one level is barren (36–42 cm above the Lochkovian-Pragian boundary). The genus *Gotlandochitina*, mainly *G. philippoti*, is still predominating up to one metre above the Pragian base. However, the poor preservation of chitinozoans in beds 28 and 29 does not allow precise identification of all these *Gotlandochitina*. Very few *Angochitina comosa* occur for the first time one metre above the Lochkovian-Pragian boundary. In the two next samples processed (180 and 225–230 cm above the boundary), *A. comosa* is the only component of the chitinozoan assemblage.

2.3. Praha – Velká Chuchle (Přídolí)

The Lochkovian-Pragian boundary beds are well exposed on the N slope of the valley between Velká Chuchle and Slivenec in the S part of Prague, especially in a disused quarry near the street V dolích (Přídolí) and in adjacent outcorps. The Lochkovian and lower Pragian strata, formerly described by CHLUPÁČ (1953: 283–285), form here a synclinal structure and the sect-

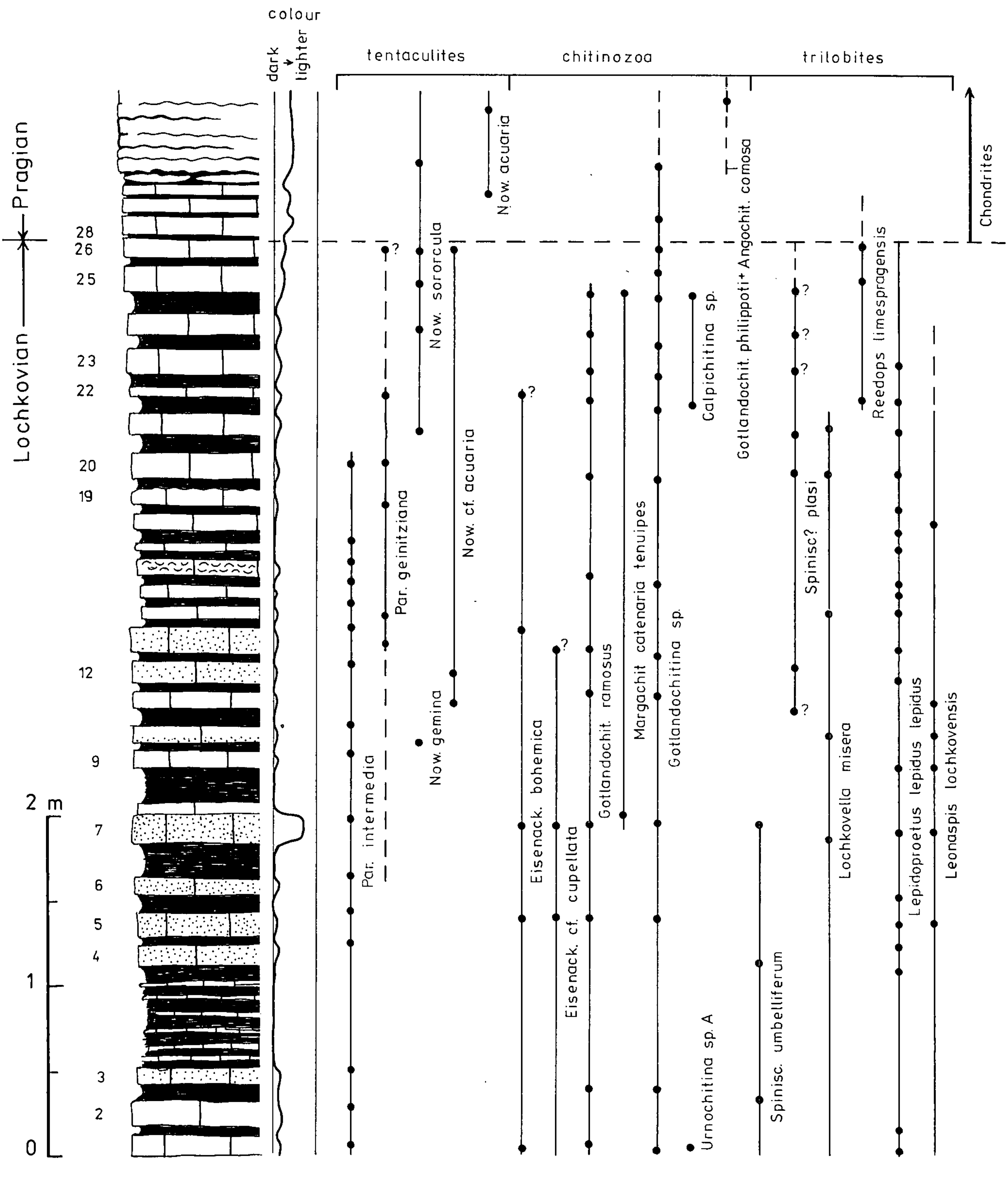


Fig. 7: Třebotov – Solopysky, Švarcava Valley, diagrammatic section of the Lochkovian-Pragian boundary interval. Legend as in fig. 3.

ion studied in detail is situated in the western flank, face wall of the former quarry (fig. 8).

The topmost Lochkovian is developed as well-bedded platy limestones with subordinate dark shale layers. Compared with the Kosoř and Třebotov sections, the proportion of coarser organic detritus is markedly greater and the colour lighter; in general, light-grey sparitic limestones with cherts predominate in the last Lochkovian metres studied. The lowest Pragian shows here also a marked biodetrital influx and particularly in the lowest 150 cm light grey biosparitic limestones prevail over the biomicritic. The typical grey micrites of the Dvorce-Prokop Limestone are developed higher up. The rocks are strongly affected by tectonics and the preservation of megafossils is less favourable.

A characteristic topmost Lochkovian trilobite fauna has been found in the last thicker light-grey sparitic bed of the Lochkovian sequence, just below the thin darker

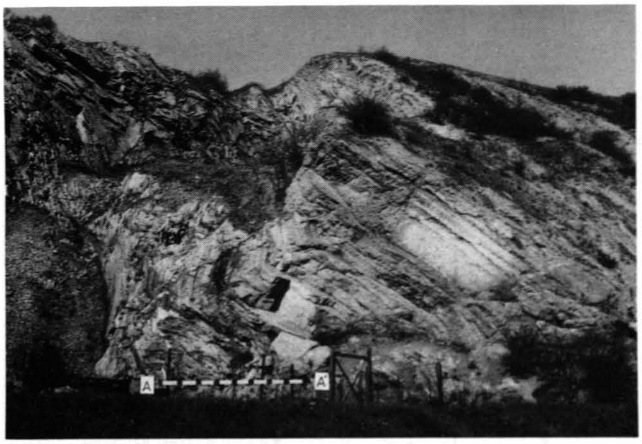


Fig. 8: Old quarry at Praha-Velká Chuchle (Přídolí) showing the upper Lochkovian and lower Pragian sequence. Interval of the Lochkovian-Pragian boundary studied in detail designated on the left (A–A').

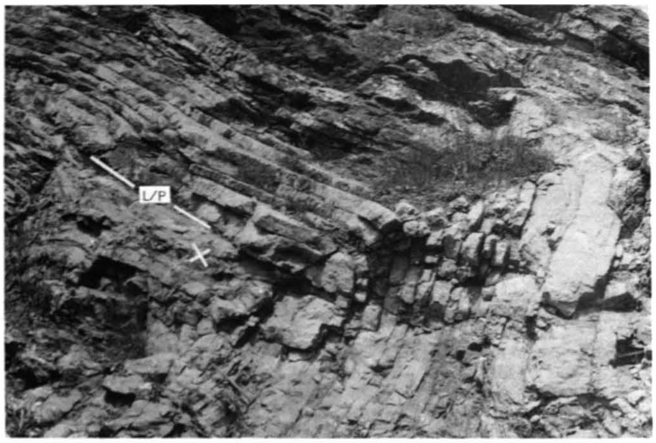


Fig. 9: Praha – Velká Chuchle (Přídolí), detail of the Lochkovian-Pragian boundary interval. X = last Lochkovian bed with common fossils, L/P = inferred Lochkovian-Pragian boundary.

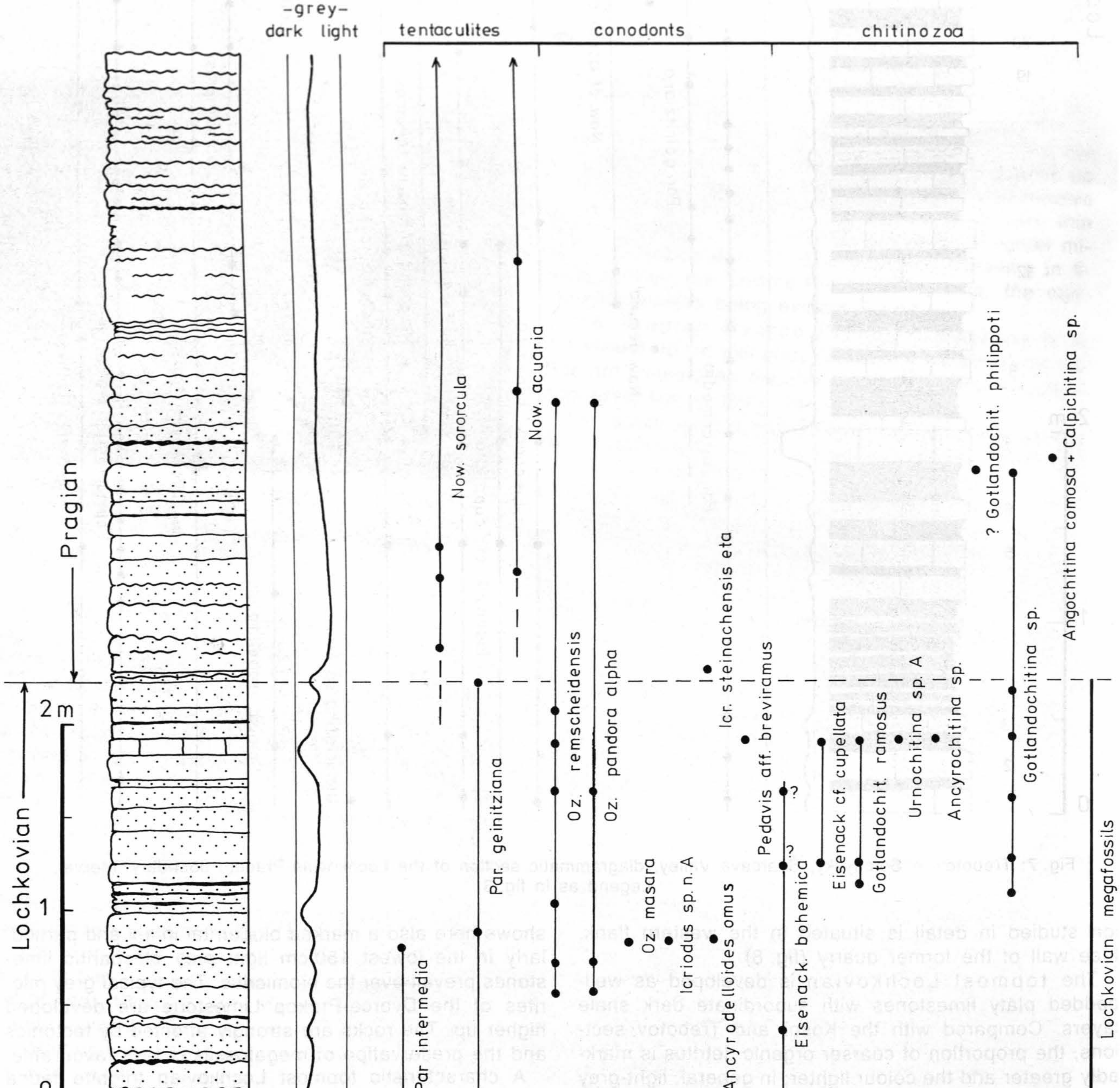


Fig. 10: Praha – Velká Chuchle, old quarry at Přídolí, Lochkovian-Pragian boundary interval. Legend as in fig. 3.

coloured knobby bed constituting the inferred Lochkovian-Pragian boundary (fig. 10): *Spiniscutellum ? plasi* (common), *Leonaspis lochkovensis, Lepidoproetus lepidus lepidus, Ranunculoproetus heteroclytus* a. o. Characteristic lower Pragian trilobites collected in the lowest 10 m of the Dvorce-Prokop Limestone sequence include *Odontochile hausmanni, Reedops sternbergi, R. prospicens, R. cephalotes, Crotalocephalina gibba, Phacops (Prokops) hoeninghausi* and *Platyscutellum formosum formosum* (fossils collected particularly by Mr. P. BUDIL).

Among tentaculites, *Paranowakia intermedia* starts about 20 m below the upper Lochkovian boundary and persists up to the level about 150 cm below the Pragian base. *P. geinitziana* has been identified still in the last 120 to 150 cm of the Lochkovian sequence, but its occurrence slightly above this interval cannot be excluded. *Nowakia sororcula* is in the section studied concentrated in the lowest few metres of Pragian; the coarser detrital character of the topmost Lochkovian layers might have negatively affected its preservation in this part of the section. Characteristic specimens of *Nowakia acuaria* have been found 50 cm above the inferred Pragian base and their occurrence continues upwards.

Conodonts were studied from an interval approximately 2 m below and above the presumed Lochkovian-Pragian boundary. 15 samples yielded fairly rich and diversified conodonts. Beside the long ranging taxon *Ozarkodina excavata excavata* and the single cone genera *Belodella* and *Neopanderodus*, the following index conodonts occur:

- *Ozarkodina remscheidensis* (almost in all samples up to 1,5 m above the boundary),
- intermediate morphotypes of *Oz. remscheidensis* and *Oz. pandora* alpha-morphotype (1,6 m below up to 1,5 m above the boundary),
- *Ancyrodelloides omus* (1,3 m below the boundary),
- *Icriodus* sp. n. A (1,3 m below the boundary),
- *Icriodus steinachensis* eta-morphotype (0,1–0,2 m above the boundary),
- *Pedavis* sp. aff. *breviramus* (0,2 m below the inferred Lochkovian-Pragian boundary).

From 19 samples processed for a research of Chitinozoa, ten were barren and others provided poor assemblages (1 to 4 specimens per gram of rock). *Gotlandochitina* (poorly preserved *G. ramosus* and related forms) is the most abundant chitinozoan in the uppermost Lochkovian of this section. A few *Eisenackitina* (*E. bohemica* and *E.* cf. *cupellata*) are also present (180–190, 100–105, 60–70 and 36–44 cm below the presumed upper Lochkovian boundary), *Urnochitina* sp. A was found 36–44 cm below the boundary. The lowermost Pragian is unfavourable for the chitinozoans in the section studied. Except for a sample collected 115–120 cm above the inferred Lochkovian-Pragian boundary, which has yielded numerous *Angochitina comosa*, the other samples were devoid of chitinozoans or provided only fragmentary *Gotlandochitina* (85–95 and 110-115 cm above the Pragian base).

2.4. Cikánka quarry near Praha-Slivenec

Instructive outcrops of the Lochkovian-Pragian boundary beds are accessible in the proximity of the well-known Cikánka marble quarry, about 2 km SW of Praha-Slivenec, N of the Radotín valley. For a detailed investigation, the sequence exposed in the old quarry Ve skále on the SW border of the large marble quarry has been selected (see figs. 11–13).

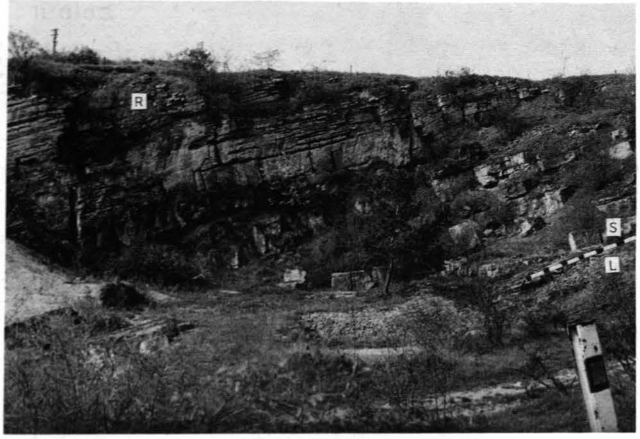


Fig. 11: Cikánka quarry near Praha-Slivenec, old quarry. L = topmost Lochkovian beds; S = base of the Pragian Slivenec Limestone, Ř = Řeporyje Limestone.

The Lochkovian sequence is here developed in a transitional facies between the Radotín and the Kotýs Limestones, i. e. mostly as fine to coarser-grained grey to light grey sparitic limestones with only subordinate and thin calcareous shale intercalations and laminae. In the topmost part of the Lochkovian sequence, the biodetrital influx increases, the colour becomes markedly lighter, bedding surfaces knobby and the rocks acquire a character of the Kotýs Limestone. Well preserved shelly fossils are markedly less common than at Kosoř and other localities in the Radotín Limestone, and broken fragments concentrated in some layers and laminae predominate, which all points to an increasing energy during sedimentation.

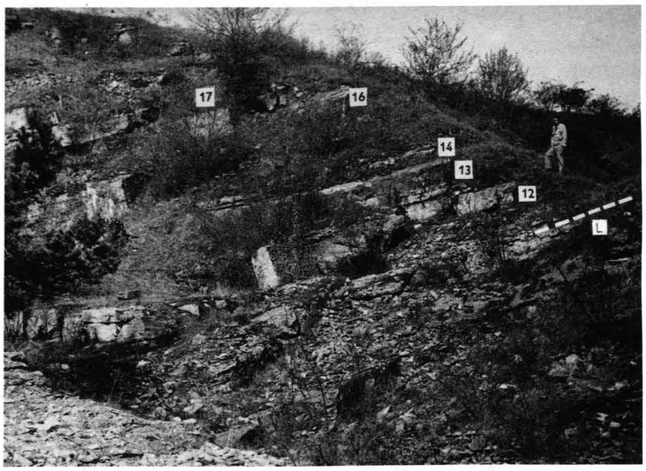


Fig. 12: The Lochkovian-Pragian boundary interval in the old quarry at Cikánka. L = topmost Lochkovian (beds 5–11), 12–17 = Slivenec Limestone (lowest Pragian).

In the section studied in detail, only the last 2 m of the Lochkovian sequence are exposed (fig. 12). They are represented by light grey sparitic, mostly crinoidal limestones, well sorted and recrystallized, forming beds 15–20 cm thick. Whilst the lowest accessible beds 1 to 5 are still platy and with even bedding planes (similar as in the underlying upper Lochkovian sequence exposed in the Cikánka marble quarry proper), the remaining uppermost Lochkovian beds (6 to 11) are markedly lighter in colour, with knobby bedding surfaces and only

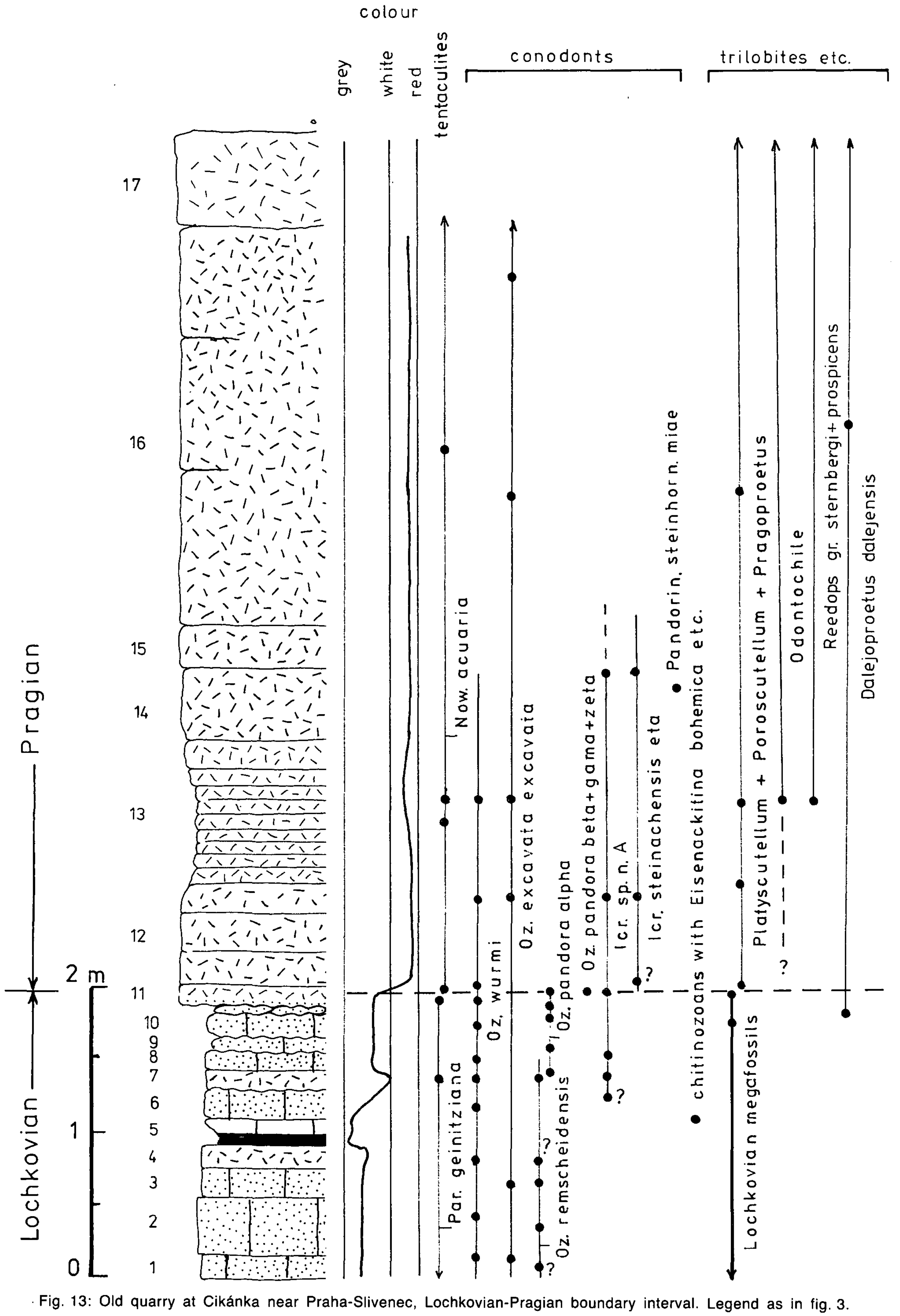


Fig. 13: Old quarry at Cikánka near Praha-Slivenec, Lochkovian-Pragian boundary interval. Legend as in fig. 3.

with very thin pelitic films, corresponding in lithology to the Kotýs Limestone developed particularly in the NW limb of the Barrandian.

As lokal marker beds traceable even in other outcrops in vicinity, may serve bed 5 – darker grey thin bedded laminated shaly dolomitic limestone, and bed 7 – light grey to whitish coarser biodetrital layer with abundant megafossils of the topmost Lochkovian.

A rather rich uppermost Lochkovian fragmentary shelly fauna has been found especially in bed 7 (5–12 m thick): *Spiniscutellum? plasi* (common), *Lepidoproetus lepidus lepidus, Lochkovella misera, Leonaspis lochkovensis, Otarion* cf. *novaki, Crotalocephalina chlupaci, Gravicalymene* sp., *Paranowakia geinitziana*, fragments of bivalves (*Neklania, Panenka*), *Conocardium* sp., *Eoglossinotoechia cacuminata, Rugoleptaena* sp., *Cryptonella* aff. *melonica* (common), *Plectodontą mimica*, abundant atrypid brachiopods, platyceratid gastropods, crinoids and *Pleurodictyum* grown on crinoid stems. The last but one Lochkovian bed 10 yielded large specimens of *Neklania, Panenka* and *Hercynella* accompanied by other less common late Lochkovian elements.

A transitional Lochkovian-Pragian assemblage has been found in the bed 11: in its lower 5 cm thick part the Lochkovian elements still predominate such as *Lepidoproetus lepidus lepidus* and *Lochkovella* cf. *misera*, whilst in its upper part, 5 to 7 cm thick and reddish in colour, Pragian elements with *Platyscutellum formosum slivenecense, Poroscutellum* sp., *Pragoproetus* cf. *pragensis* and *Reedops limespragensis* have been found. Rather rare tentaculites of bed 11 belong to *Paranowakia geinitziana* and *Nowakia acuaria*, the latter being found only in the upper part of the bed.

For conodont investigations, 14 samples were collected in the uppermost 3,3 m of the Lochkovian sequence, one sample from the boundary bed 11, and 8 samples from the lowermost 6 m of the Pragian. Conodont distribution is listed in fig. 13.

The lower samples up to the shale interbed 4/5 yielded long-ranging taxa such as *Ozarkodina wurmi, O. excavata excavata* and simple cones, mostly belonging to *Belodella* and *Neopanderodus*. In a sample taken 1.37 m below the interbed 3/4 a fragmentary specimen of *Ancyrodelloides* occurred and in bed 2 juvenile representatives of *Icriodus* were found.

A more diversified conodont fauna starts above the shale interbed 3/4, which clearly corresponds with data from the section at Velká Chuchle – Přídolí. Both *Icriodus* sp. n. A and *Ozarkodina pandora* alpha-morphotye make their appearance at this level. In bed 10 *Ozarkodina pandora* epsilon-morphotype occurs, in the boundary bed 11 various morphotypes of *Oz. pandora* appear, namely alpha, beta, gamma and zeta.

Chitinozoans were found only in bed 5 (darker micritic to microsparitic shaly laminated limestone), approximately 90 cm below the Pragian base, which yielded fairly abundant *Eisenackitina bohemica, Gotlandochitina ramosus*(?) and *Urnochitina* sp. A. The other components of the assemblage are a few specimens of *Margachitina catenaria tenuipes, Ancyrochitina* sp. and *Fungochitina* sp. The lithology of other beds in the Lochkovian-Pragian boundary interval seems to be unfavourable for the preservation of chitinozoans.

The lower Pragian sequence consists of the Slivenec Limestone: Thick bedded coarsely biodetrital sparitic and in some layers also biomicritic crinoidal, prevalently rose-coloured limestones predominate, constituting the well-known decorative Slivenec Marble.

The megafauna, common in some layers, is mostly fragmentary, showing traces of redeposition. Among trilobites, the representatives of *Platyscutellum, Poroscutellum* and *Pragoproetus* are most characteristic: *Platyscutellum formosum slivenecense, Poroscutellum infaustum, P. expectans, Pragoproetus pragensis, P. menaniensis* a. o. accompanied by *Reedops prospicens, R.* cf. *sternbergi, Metascutellum multiverrucatum, Dalejoproetus dalejensis, Bojocoryphe splendens, Odontochile* sp., *Leonaspis* cf. *confluens, Otarion* sp. and common brachiopods *Eoglossinotoechia cacuminata, Rugoleptaena zinkeni, Dalejodiscus subcomitans, Leptochonetes tardus, Caplinoplia pragensis, Strophochonetes* sp., *Kyrtatrypa* sp., *Oglu* sp. (det. by V. Havlíček) a. o. have been found in several layers within the lowest 4 m of the Slivenec Limestone (especially beds 13 and 16).

An abundant and less fragmentary fauna is contained in a red biomicritic layer near the upper limit of the Slivenec Limestone, in the transitional beds to the Řeporyje Limestone, about 12 m above the Pragian base: Apart from the species mentioned, also *Dicranurus monstrosus* (common), *Reedops* aff. *bronni, R. prospicens* (common), *Odontochile hausmanni, O.* cf. *rugosa, Cheirurus (Pilletopeltis) albertii, Gravicalymene* sp., *Orthonychia* ex gr. *bohemica*, cystoids *Bulbocystis mirus* (common), blastoids etc. occur here (fossils of this layer collected particularly by Dr. J. Vaněk).

Tentaculites of the whole sequence of the Slivenec Limestone are represented by the dominant *Nowakia acuaria*, other tentaculites being sporadic.

Conodonts of the bed 12 at the very base of the Pragian are represented by *Icriodus steinachensis* eta morphotype which has here its first appearance. *Icriodus* sp. n. A co-occurs at this level together with *Ozarkodina wurmi*, and *Oz. excavata excavata* (contained also in higher beds 13 and 14). In a conodont collection kindly provided by O. H. Walliser, Göttingen, this distribution is confirmed: Sample W376 from the boundary bed (possibly close to 11) bears *Icriodus steinachensis* eta morphotype together with *Icriodus* sp. n. A., whereas sample W180 from a level 2–3 m above the lower Pragian boundary yielded *Icriodus steinachensis* eta-morphotype.

In the section studied, the Slivenec Limestone attains a total thickness of 12.5 m. In its topmost part, it passes by increase of the micritic component and decrease of coarse organic detritus into the Řeporyje Limestone (red to brown micritic and microsparitic nodular limestones with *Chondrites*, total thickness 4–5 m), which, in turn, passes into a thick (more than 100 m) sequence of the Dvorce-Prokop Limestone exposed in close proximity.

2.5. Radotín Valley – Hvížďalka quarry

The large Hvížďalka quarry is situated on the S side of the Radotín Valley, W of the Lochkov cement plant, about 1 km N of the village Kosoř. The quarry exposes a more than 100 m thick sequence involving part of the upper Lochkovian and ending near the lower Zlíchovian boundary. The Lochkovian-Pragian boundary beds, studied here already at the beginning of the quarrying works (Chlupáč, 1953: 288–290, text-fig. 2), are exposed at the present time on the E side of the quarry; the section investigated in 1982, is situated on the lowest floor of the quarry (due to quarrying works the outcrop is not permanent).

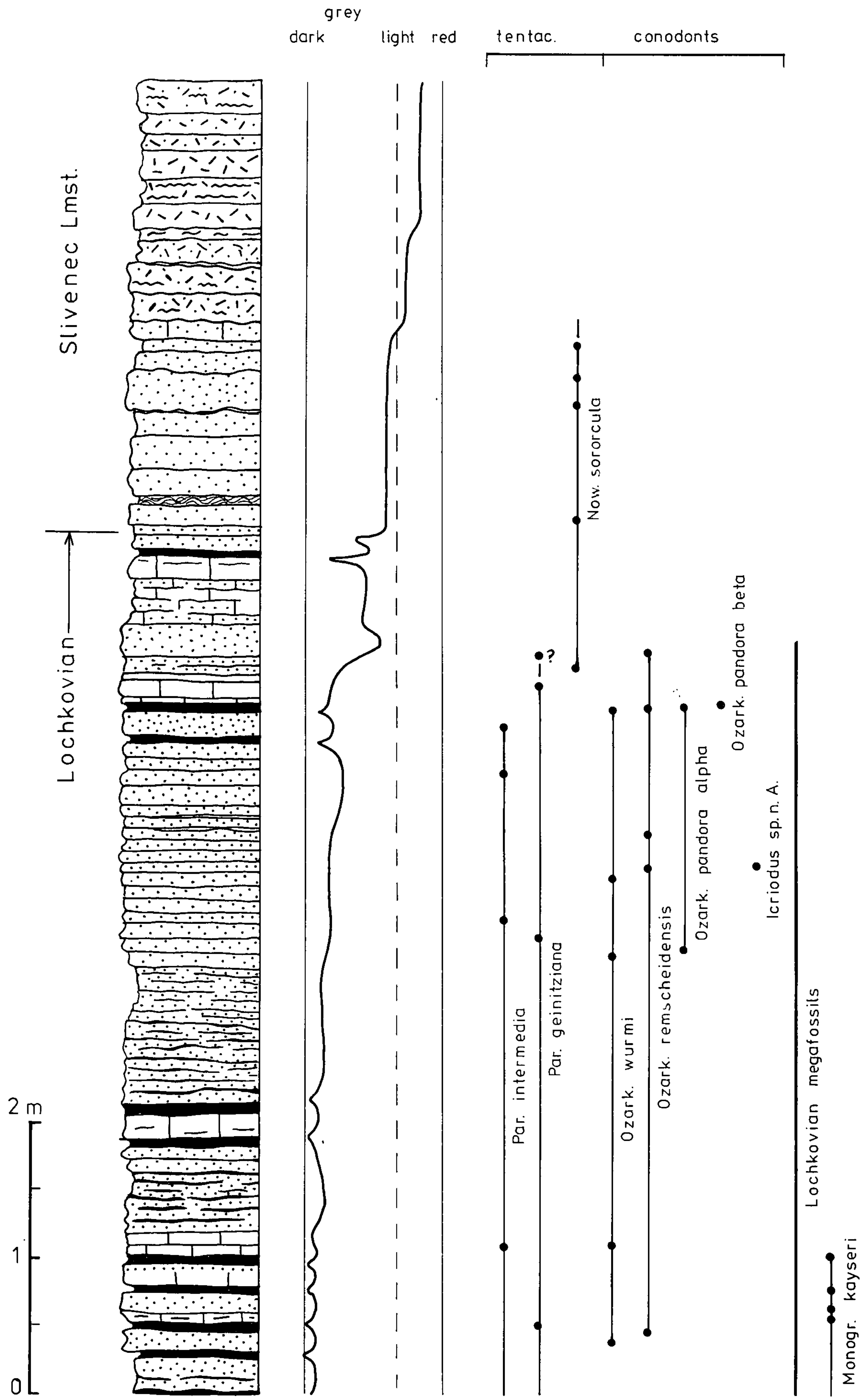


Fig. 14: Hvížďalka quarry in Radotín Valley, Lochkovian-Pragian boundary interval. Legend as in fig. 3.

The upper Lochkovian shows here a similar development as in the Cikánka quarry but the proportion of calcareous shale interbeds is somewhat greater. Rather fine- to medium-grained dark grey bituminous and platy sparitic limestones of the Kosoř type with thin dark shale interbeds predominate in the topmost 6 m of the Lochkov Formation (fig. 14).

The shelly fauna is common but fragmental in this interval. Among trilobites, *Leonaspis lochkovensis* and *Lepidoproetus lepidus lepidus* are prolific. *Spiniscutellum umbelliferum* has been found up to 4 m below the top, and a specimen of *S.* ? *plasi* 1.5 m below the top. *Aerostrophia interjecta* is particularly common in the interval 1.8 to 2.4 m below the top. Shale interbeds with common graptolites *Monograptus kayseri* and *Monograptus* sp. constitute a local marker interval 4.8 to 5.1 m below the top of the Lochkov Formation.

A light grey 20 cm thick layer of biodetrital limestone 63 to 83 cm below the top may serve as a local lithologic marker bed (it probably corresponds to bed 7 in the Cikánka quarry section). Layers of dark grey markedly fine-grained microsparitic up to micritic limestones 100–120 cm below the top are most likely equivalent to layer 5 at Cikánka.

A marked change in colour is noticeable above the darker grey limestones of the Kosoř type and this level is interpreted as the inferred upper limit of the Lochkov Formation. Despite the lighter coloured layers within the uppermost part of the Kosoř Limestone sequence, this change of colour is prominent, and the succeeding light-grey sparitic limestone layers with knobby bedding surfaces and greenish clayey laminae constitute a distinct transitional interval, here 160 to 220 cm thick, below the Slivenec Limestone proper. Determinable and stratigraphic important megafossils have not been found within this part of the section.

Above the light-grey interval, a coarser bioclastic influx is perceptible and the markedly increasing amount of red crinoidal debris is characteristic, being accompanied in some layers also by an increase of micritic component. This interval, 6 m thick at the lower floor of the quarry and markedly decreasing in thickness westwards, constitutes the lower Pragian Slivenec Limestone. Whereas fossils are not readily obtainable in fresh and hard rocks, fauna collected in proper vicinity of the quarry demonstrates the Pragian age (e. g. *Platyscutellum formosum slivenecense, Reedops* ex gr. *sternbergi* etc).

Upwards, the biomicritic component increases and the Slivenec Limestone passes into the red micritic and nodular Řeporyje Limestone (thickness 1,5 to 5 m in the quarry) and this, in turn, into a sequence of grey micritic Dvorce-Prokop Limestone constituting the remaining part of the Pragian (thickness more than 100 m).

The Hvížďalka section yielded common tentaculites, mainly in the upper Lochkovian: *Paranowakia intermedia* has been indentified up to the level 130 cm below the marked colour change from dark to light-grey limestones; *P. geinitziana* was prolific in the upper Lochkovian up to the level about 1 m below the colour change. *Nowakia sororcula* is common in the last metre of the limestones of the Kosoř type, passes the colour change and continues in the Slivenec Limestone being found even in the lower part of the Dvorce-Prokop Limestone exposed. Typical specimens of *Nowakia acuaria* were identified in the Slivenec and all overlying limestones of the Pragian age.

Conodonts were so far investigated in the topmost part of the Lochkov Formation (Kosoř Limestone) only, i. e. in the last 6 m: *Ozarkodina wurmi* and *O. remscheidensis* occur in the whole interval studied, *O. pandora* alpha morphotype up to the level 3.25 m below the colour change, *O. pandora* beta morphotype in the sample 5.0 to 5.10 below the colour change, and *Icriodus* sp. n. A in the sample 3.65–3.80 m below the top of dark grey limestones.

Chitinozoans were so far not investigated in the Hvížďalka section.

2.6. Oujezdce quarry near Suchomasty

This locality is situated at the SW edge of the Devonian outcrops of the Barrandian area, in the S flank of the flat syncline called the "Koněprusy Devonian". The Lochkovian-Pragian boundary beds are well exposed in the old Oujezdce quarry about 1,5 km NE of Suchomasty, between the Bukoš-Koněprusy highway and the elev. point 447 (Újezd hill). The eastern part of the quarry was figured by HORNY (1960: pl. 4, fig. 2).

The Lochkovian-Pragian boundary beds (fig. 15) are developed in a shallow water and biodetrital facies – Kotýs Limestone in the Lochkovian, and the Vinařice Limestone in the lowest Pragian. The stratigraphic situation is here analogous to that studied in old quarries near Vinařice (CHLUPÁČ, 1953: 300–301), no more accessible (covered by debris from the active Homolák quarry).

The upper Lochkovian, developed as the typical Kotýs Limestone, consists of grey to light-grey sparitic limestones with knobby bedding surfaces and only very slight influx of clayey material concentrated in slight films between individual layers. These rocks constitute the prevalent part of the northern face of the quarry and are exposed at a thickness about 15 m. The megafossils are fragmentary and rare; only *Leonaspis* cf. *lochkovensis, Decoroscutellum* sp., *Coniproetus (Tropiconiproetus) eurysthenes* (first find in the Lochkovian), *Lepidoproetus* cf. *lepidus, Otarion* sp., chonetid brachiopods were found in the interval of 4–6 m below the top. The facies is not favourable for microfossils: among conodonts only long-ranging forms (e. g. *Ozarkodina excavata excavata*) were found and the same is true on chitinozoans (only *Eisenackitina bohemica* identified in a sample collected 3.5 m below the inferred lower Pragian boundary).

A marked lightening of the colour is observable about 14 m from the base of the outcrop; the limestones become light-grey to white, the films of clayey material greenish, the knobby surface of beds is less expressed, and the amount of coarser bioclastic material is increasing towards the top, including rose-coloured crinoidal segments. This interval (about 6 m thick) is very poor in fossils and only *Leonaspis* sp., rugose corals and orthoconic nautilids have been found.

In the topmost beds exposed (from about 20 m above the base of the section exposed), an influx of markedly coarser bioclastic and finer micritic material is well traceable. The colour becomes light-grey with rose-coloured partings and spots and the whole character of the rock points to the Vinařice Limestone of the lower Pragian. These beds contain already at the base a rich lower Pragian megafauna, namely trilobites *Platy-*

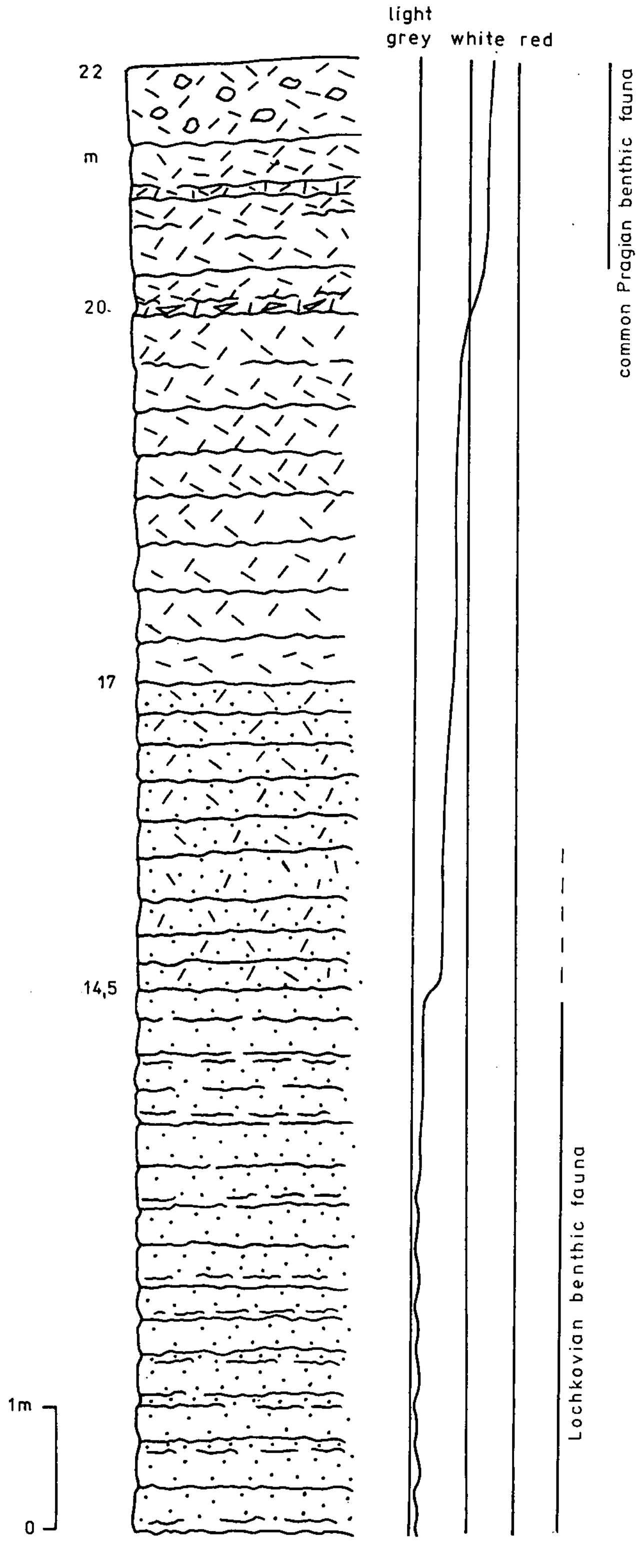


Fig. 15: Oujezdce quarry near Suchomasty, Lochkovian-Pragian boundary interval. Legend as in fig. 3.

scutellum ex gr. *viator* (common), *Metascutellum pustulatum, Poroscutellum* sp., *Pragoproetus menaniensis, Coniproetus* sp., *Dalejoproetus dalejensis*, (cf. subsp. *fokuston*), *Lepidoproetus diademifer, Gerastos (Longiproetus) confusus, Crotalocephalina globifrons*, brachiopods (kindly determined by V. HAVLÍČEK) *Eoglossinotoechia cacuminata* (common), *E. surgens surgens, Stenorhynchia pseudolivonica, Sieberella sieberi, Sieberella* sp., *Clorinda* sp., *Howellella konieprusensis, Myriospirifer myriofila, Kyrtatrypa canalibalda* (common), *Oglu* sp., *Resserella* sp., *Tastaria lenis, Pholidostrophia lunetta, Strophonella* cf. *bohemica, Leptaena goldfussiana, Caplinoplia pragensis, Dalejodiscus* sp., rugose corals, fenestellid bryozoans, *Pleurodictyum* sp. and others. Crinoids are the most common rock-forming organisms and their common and well preserved roots suggest the autochthony of at least part of the benthic fauna; a crown of *Kerrycrinus gratiosus* PROKOP (det. by R. PROKOP) was found on the weathered surface of the limestone.

Higher beds are not exposed in the Oujezdce quarry, but in its proximity a rather thick (about 50 m) sequence of the Vinařice Limestone passes gradually upwards and laterally into the white reefal Koněprusy Limestone, the total thickness of the Pragian being up to 200 m.

3. Stratigraphic significance of some fossil groups in the Lochkovian-Pragian boundary beds of the Barrandian

(Fig. 16)

3.1. Dacryoconarid tentaculites

(Plate 1)

Dacryoconarid tentaculites are prolific in the platy limestones of the Radotín (and Kosoř) Member of the Lochkovian and in different facies of the Pragian.

The index upper Lochkovian tentaculite zonal species *Paranowakia intermedia* occurs in the first few metres above the last layers with the older zonal index *Homoctenowakia bohemica*, and reaches its maximum development within the late upper Lochkovian. However, it does not reach the Lochkovian-Pragian boundary and its last specimens were found about 1 m below the Pragian base at Kosoř and other sections studied.

Paranowakia geinitziana starts developing within the range of *P. intermedia* but it attains its acme-development within the very late upper Lochkovian close below the Pragian base. Its survival into the Pragian seems to be rather sporadic and in many cases problematical in the Barrandian sections studied.

Nowakia sororcula appears for the first time in the uppermost Lochkovian in beds with common *P. geinitziana*, close above the last finds of *P. intermedia*. *N. sororcula* continues in great abundance in the lowest Pragian; its general occurrence seems to be influenced by the facies of sediments (often concentrated in fine-grained microsparitic limestones, less common or absent in coarser bioclastic ones).

Nowakia acuaria – the most typical tentaculite of the Pragian – has been reported by BOUČEK (1964) already from the upper Lochkovian. Our collections confirmed the occurrence of similar forms designated provisorily as *Nowakia* cf. *acuaria* in upper Lochkovian beds jointly with *P. intermedia*. Typical and larger specimens of *N. acuaria* appear close above the Pragian base and continue upwards serving thus as a good Pragian index.

Some new taxa of dacryoconarid tentaculites have been found at different levels of the upper Lochkovian: *Paranowakia lochkoviana* and *P. grandis* above the last occurrences of *Homoctenowakia bohemica, Nowakia kosorensis, N. vesta* and *N. gemina* within the range of *P. intermedia* and *N. praesororcula* in the topmost part of the *P. intermedia* range-zone (LUKEŠ, 1985).

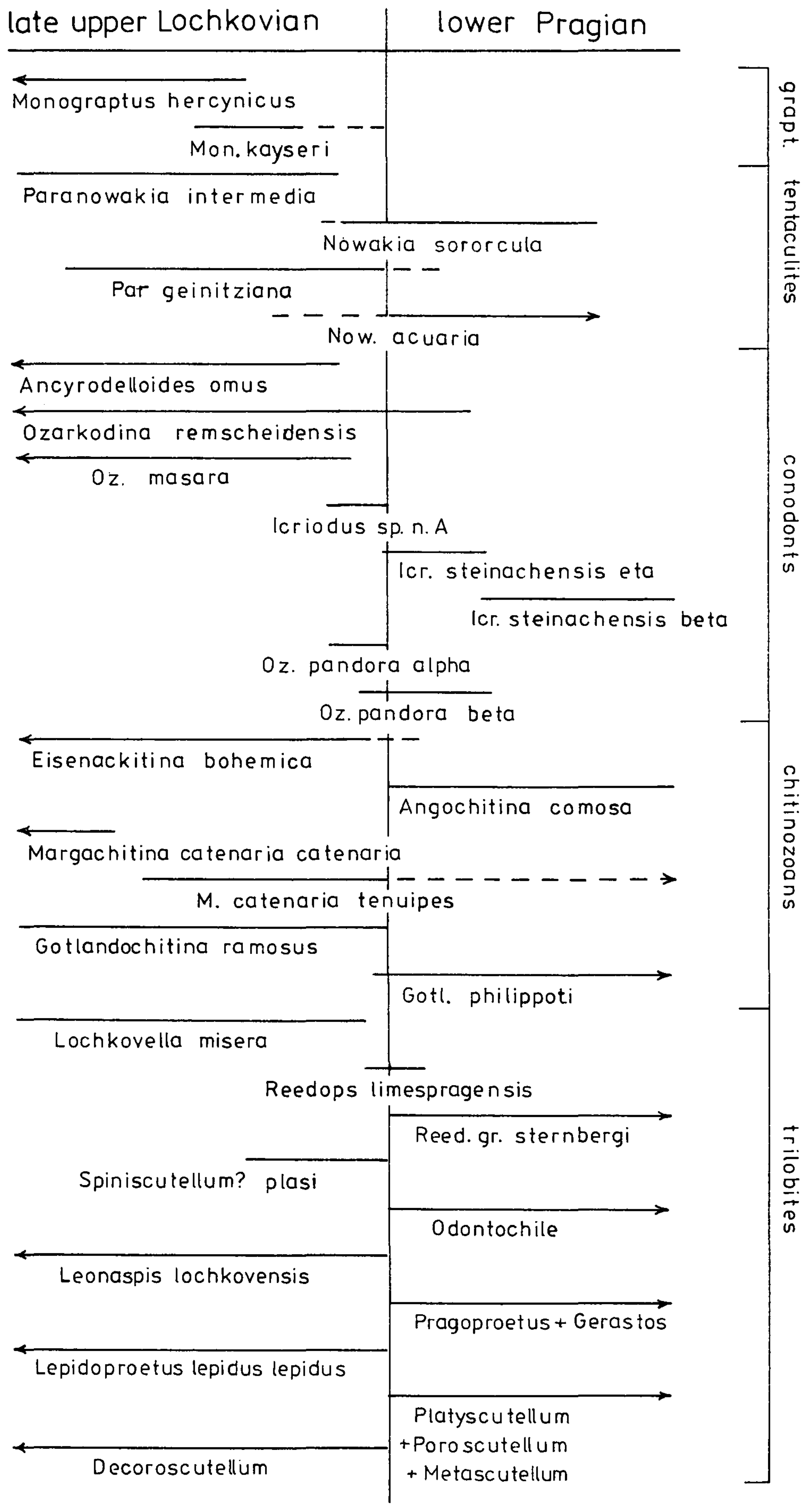


Fig. 16: Summarized occurrences of some fossils which may serve as auxiliary indicators of the Lochkovian-Pragian boundary or its proximity. About 20 m thick interval of the late upper Lochkovian and lowest Pragian involved, arrows indicate occurrences continuing in older or younger beds.

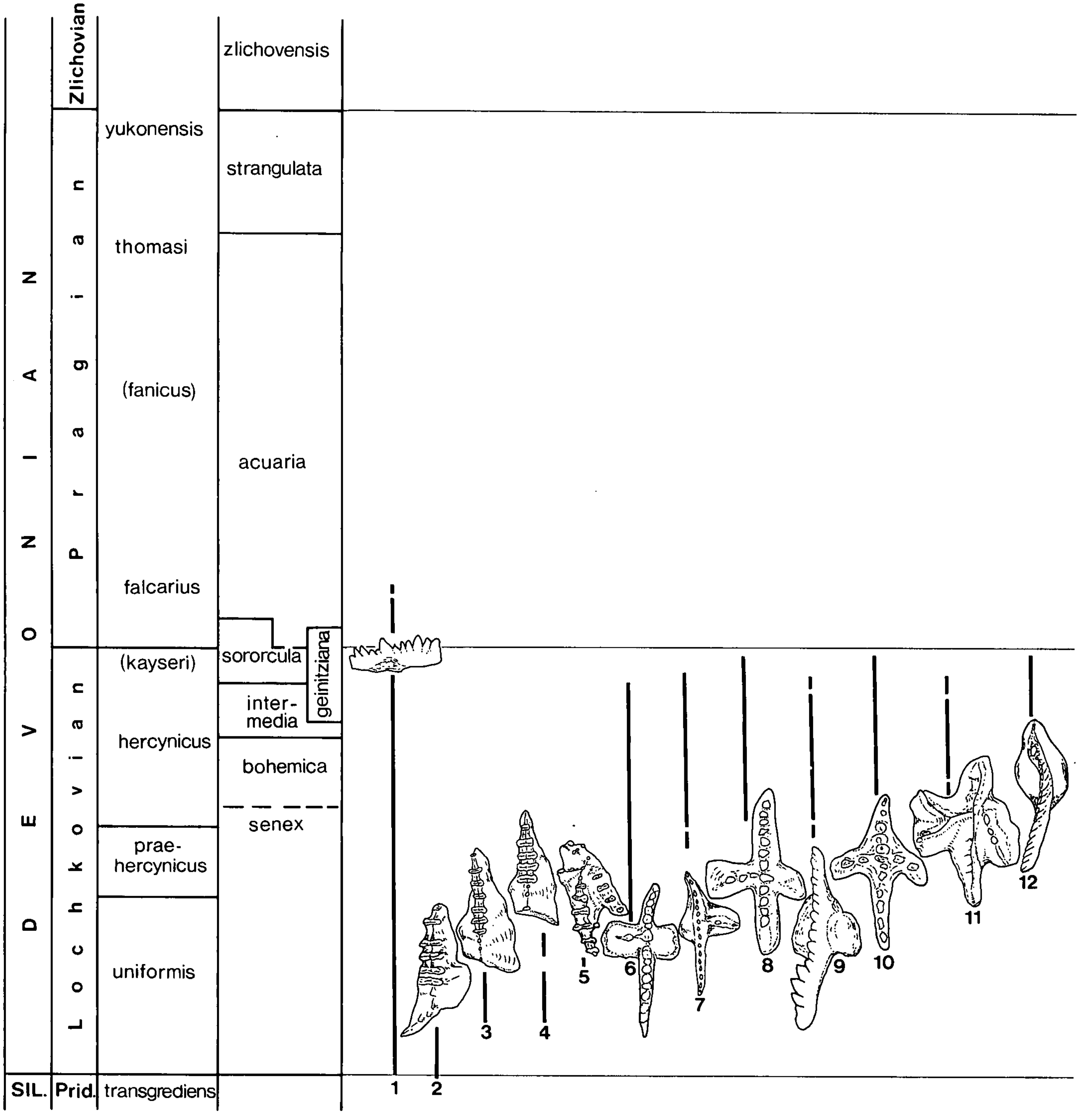


Fig. 17: Graptolite-dacryoconarid-conodont-correlation chart in the Lochkovian and Pragian of the Barrandian and the Carnic Alps.

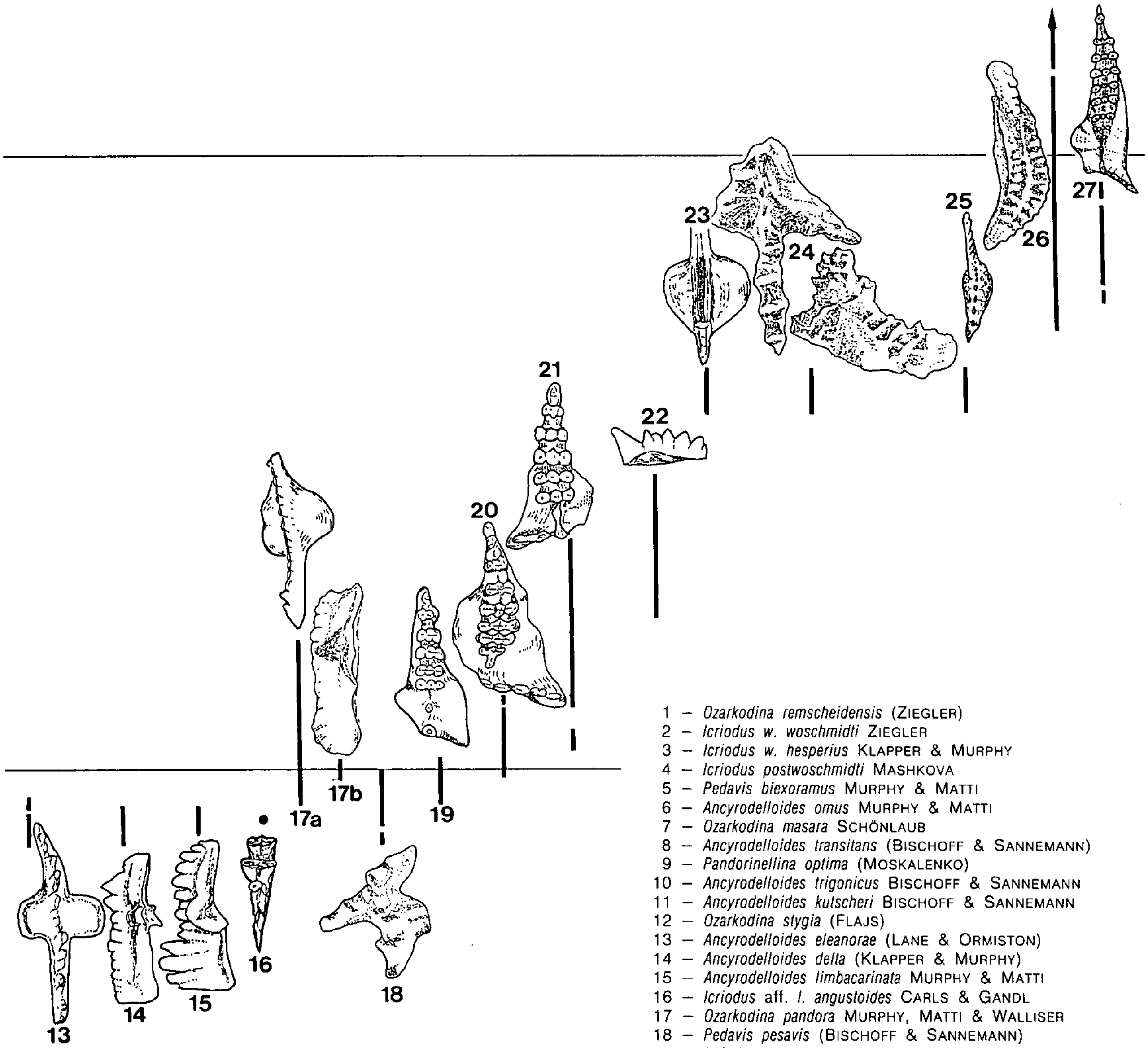
In general, three biostratigraphic zones based on dacryoconarid tentaculites may be clearly distinguished within the upper Lochkovian: the *Homoctenowakia bohemica*, the *Paranowakia intermedia* and the *Nowakia sororcula* Zones. These zones seem to be not overlapping, whilst the formerly reported zone with *Paranowakia geinitziana* strongly overlaps in range of the index species the *P. intermedia* and *N. sororcula* Zones. Although *N. sororcula* continues its development in the lower Pragian, the marked onset of typical specimens of *Nowakia acuaria* close above the Lochkovian-Pragian boundary may well be used for stratigraphic purposes.

Our data on distribution of dacryoconarid tentaculites in the Barrandian sections agree in general with the zonal scheme recently published by ALBERTI (1984). The presence of newly discovered taxa points to possibilities of future refinement.

3.2. Conodonts

(Plate 2 – H. P. SCHÖNLAUB)

According to ODIN (1982) the whole Lower Devonian had a duration of 15 million years and lasted from 400



1 – *Ozarkodina remscheidensis* (ZIEGLER)
2 – *Icriodus w. woschmidti* ZIEGLER
3 – *Icriodus w. hesperius* KLAPPER & MURPHY
4 – *Icriodus postwoschmidti* MASHKOVA
5 – *Pedavis biexoramus* MURPHY & MATTI
6 – *Ancyrodelloides omus* MURPHY & MATTI
7 – *Ozarkodina masara* SCHÖNLAUB
8 – *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN)
9 – *Pandorinellina optima* (MOSKALENKO)
10 – *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN
11 – *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN
12 – *Ozarkodina stygia* (FLAJS)
13 – *Ancyrodelloides eleanorae* (LANE & ORMISTON)
14 – *Ancyrodelloides delta* (KLAPPER & MURPHY)
15 – *Ancyrodelloides limbacarinata* MURPHY & MATTI
16 – *Icriodus* aff. *I. angustoides* CARLS & GANDL
17 – *Ozarkodina pandora* MURPHY, MATTI & WALLISER
18 – *Pedavis pesavis* (BISCHOFF & SANNEMANN)
19 – *Icriodus* sp. n. A.
20 – *Icriodus steinachensis* AL-RAWI eta morph
21 – *Icriodus steinachensis* AL-RAWI beta morph
22 – *Pelekysgnathus serratus* JENTZSCH
23 – *Eognathodus sulcatus* PHILIP
24 – *Pedavis* sp.
25 – *Polygnathus pireneae* BOERSMA
26 – *Polygnathus dehiscens* PHILIP & JACKSON
27 – *Icriodus curvicauda* CARLS & GANDL

to 385 million years. In pelagic sequences representing this time span – reduced by the greater part of the Emsian – in the Barrandian and the Carnic Alps 27 more or less short ranging conodont taxa were recognized that provide a basis for a further subdivision of strata as well as for the correlation with coeval sequences elsewhere in the world, in particular for those areas in which a conodont based zonation has already been established.

The conodont subdivision for the Lower Devonian was first discussed by KLAPPER (1969), and later updated and improved by ZIEGLER (1971), KLAPPER et al. (1971), FAHRAEUS (1971), SPASSOV (1971), PERRY et al. (1974) and KLAPPER & MURPHY (1975). BULTYNCK (1976), MASHKOVA (1978, 1979), BULTYNCK & HOLLARD (1980) followed and partly changed this zonation based on informal faunal units. They were replaced by KLAPPER (1977) by standardized formal zones with the rank of biostratigraphic zones. Originally in western North America and Alaska, in the Lower Devonian 11 conodont zones were recognized (KLAPPER & ZIEGLER, 1979; SANDBERG, 1979; KLAPPER & MURPHY, 1980; KLAPPER & JOHNSON, 1980) but LANE & ORMISTON (1979) introduced one more, i. e. the pireneae Zone below the dehiscens Zone.

Yet this comprehensive zonation has not fully been tested to be applicable in the pelagic sequence of central Europe. Whether or not it merely reflects a local succession of conodont occurrences or if the diagnostic species have a wider geographic distribution has not been satisfactorily demonstrated in Europe. In fact in the past a number of the definitive species and many of the accompanied conodonts recognized in North America have not been identified or described in Europe. So it was not fully clear if and to what extent counterparts of the sequence in Europe correspond to that in North America and vice versa. This poor knowledge of conodont distribution in the European Lower Devonian affected also recognition and identification of the traditional European stage names which worldwide became in use in recent times. They are based and defined on the zonal succession of different (animal) groups. In the Barrandian in particular the graptolite and dacryoconarid zonal sequences are well developed and have been well known for the Lower Devonian. Yet the conodont sequence was less well documented to enable a more accurate correlation of the type Lower Devonian stages.

We now believe that there are enough data for a zonal synthesis of Lower Devonian conodonts from the Barrandian and the Carnic Alps. In this report we present a range chart (fig. 17) which covers the interval from the base of the Lochkovian to the end of the Pragian. Special emphasis has been given to the passage between these two stages. Our results permit a clear distinction between a Lochkovian and a Pragian conodont association in each region. 16 conodont taxa are confined to the Lochkovian and one ranges through the entire stage into the basal Pragian, two appear in the uppermost 3 m of the Lochkovian and cross the boundary with the Pragian to persist a few cm or metres into the next stage, and 7 are confined to the Pragian Stage.

Our range chart is a compilation of conodont data from the following sections and sources:

Lower Lochkovian:
- ○ Klonk (ZIKMUNDOVÁ in CHLUPÁČ, 1972)
- ○ Karlštejn – Budňany Rock (ZIKMUNDOVÁ in CHLUPÁČ, 1972)
- ○ Radotín Valley, U topolu (SCHÖNLAUB in CHLUPÁČ et al., 1980; MURPHY & MATTI, 1982)
- ○ Požáry quarries near Řeporyje (MEHRTENS & BARNETT, 1976)
- ○ Čertovy Schody (ZIKMUNDOVÁ in CHLUPÁČ, 1972) Praha – Podolí (SPASSOV, 1971; ZIKMUNDOVÁ in CHLUPÁČ, 1972)
- ○ Cellon (WALLISER, 1964)

Upper Lochkovian/Lower Pragian:
- ○ Černa rokle near Kosoř (SCHÖNLAUB in CHLUPÁČ et al., 1980, this report)
- ○ Praha – Velká Chuchle – Přídolí (this report)
- ○ Cikánka quarry (this report)
- ○ Hvížďalka quarry (this report)

Pragian:
- ○ Černa rokle near Kosoř (SCHÖNLAUB in CHLUPÁČ et al., 1980)
- ○ Srbsko (SCHÖNLAUB in CHLUPÁČ et al., 1980)
- ○ Červený lom near Klukovice (this report)
- ○ Stydlé vody near Svatý Jan pod Skalou (this report)

Lochkovian + Pragian:
- ○ Oberbuchach II (JAEGER & SCHÖNLAUB, 1980; SCHÖNLAUB, 1980; ALBERTI, 1985 and this report)
- ○ Rauchkofelboden (SCHÖNLAUB, 1980; ALBERTI, 1985 and this report)
- ○ Seekopfsockel (SCHÖNLAUB, 1980; ALBERTI, 1985 and this report)

Confined to the lower Lochkovian graptolite Zone of *Monograptus uniformis* are *Icriodus woschmidti woschmidti*, *I. woschmidti hesperius* and *I. postwoschmidti*. Probably all three taxa form a phyletic lineage. *Pedavis biexoramus* enters in the upper part of the range of these species. Graptolites at Oberbuchach II indicate an uniformis Zone age.

In the Barrandian, a *M. praehercynicus* Zone is difficult to recognize. We believe that the low occurrence of *Ancyrodelloides omus* at section Hvížďalka markedly below the Lochkovian-Pragian boundary testifies its appearance in the uppermost uniformis Zone. At section Oberbuchach II in the Carnic Alps the *M. praehercynicus* Zone is represented by less than 2 m of limestones and interbedded shales. No diagnostic conodonts are known from this horizon.

Ancyrodelloides transitans, *A. trigonicus*, *A. kutscheri*, *Ozarkodina masara* and *Pandorinellina optima* all enter in strata correlatable with the hercynicus Zone or with the dacryoconarid zone of *Homoctenowakia bohemica*. Their upper range is in strata containing *Paranowakia geinitziana* or the first *Nowakia sororcula*. There is no indication that any of these species persist into the basal Pragian. In the chart there is no sharp termination of the range of individual species. This indeed reflects differential appearance and disappearance of conodont taxa in relation to associated graptolites and dacryoconarid tentaculites and considers rock thicknesses in our studied sequences. Effects of litho- and biofacies may also influence their ranges.

A third conodont association is recognized at the upper range of the *Monograptus hercynicus* Zone. It consists of *O. stygia*, *A. eleanorae*, *A. delta*, *A. limbacarinata* and a single occurrence of *Icriodus* aff. *angustoides*. All five taxa appear in an interval between the tentaculite zones of *H. bohemica* and *P. geinitziana*. Their upper range shortly overlap with *N. sororcula* (except *I.* aff. *angustoides*). At section Oberbuchach II the upper limit of *O. stygia* is 5 m below the presumed boundary between the Lochkovian and Pragian stages.

Pedavis pesavis, the index conodont of the pesavis Zone of North America, is restricted to the uppermost Lochkovian. Most problably it enters at the same level as *O. stygia* in strata shortly below the base of the sororcula Zone in the presumed *P. intermedia* zone.

Ozarkodina pandora and its morphs are diagnostic forms for the Lochkovian/Pragian boundary in the Barrandian and in the Carnic Alps. The alpa morph appears at following levels below the boundary:

Hvížďalka: minus 3 m
Cikánka: minus 1.00–0.50 m
Přídolí: minus 2 m
Oberbuchach II: minus 6–7 m
Seekopfsockel: minus approx. 1 m

The beta morph is even more restricted:

Hvížďalka: minus 1 m
Cikánka: boundary bed 11
Oberbuchach II: plus 1–2 m
Seekopfsockel: approx. at the boundary

The gamma, epsilon and zeta morphs occur at section Cikánka in bed 10 below the boundary and at the boundary respectively (bed 11).

Associated with the forementioned representatives of *O. pandora* is a distinctive species of *Icriodus* which has not formally been named (*Icriodus* sp. n. A). At Cikánka it enters 1 m below the boundary, at Přídolí 1.20 m, at Černa rokle 3.00 m and at Hvížďalka 2.30 m below the boundary. This species also has been recorded from the Carnic Alps sections Seekopfsockel and Oberbuchach II.

At Cikánka *Icriodus* sp. n. A ranges up to the boundary bed 11. At this level it is replaced by *I. steinachensis* eta morphotype. Between both species and ancestor-descendant relationship seems obious. Most probably this phylogenetic lineage includes *I. steinachensis* beta morph which starts only some metres higher in the sequence.

Between *Icriodus* sp. n. A and *I. steinachensis* eta morph a short overlap was found. There is, however, no indication that the eta morph occurs as low as the delta Zone in the Nevada sections. The range of variability from the boundary bed and the succeeding samples is relatively high. Thus the angle of the lateral process, the denticulation as well as the outline of the spur and the width of the basal cavity can vary to a certain extent, these variants are, however, connected by the typical lenticular, spindle-like shape of the platform in oral views.

The last occurrences of *I. steinachensis* eta morph was found from 3 to 5 m above the base of the Pragian in both the Barrandian and the Carnic Alps. At the Frankenwald type locality the eta morph may range higher as is indicated by the presence of *P. serratus* which in our samples first occurs approx. 20 m above the base of the Pragian. In association with the eta morph in the Frankenwald the beta morph of *Icriodus steinachensis* occurs. This contrasts with the Barrandian and the Carnic Alps where both are separated.

Icriodus steinachensis beta morph, the youngest species of this lineage was found at the following horizons:

- Černa rokle: plus 35 m above the base of the Pragian
- Srbsko: plus 32–48 m
- Červený lom near Klukovice: Loděnice Limestone (middle Pragian)
- Oberbuchach II: plus 15–20 m
- Rauchkofelboden: plus 11–20 m
- Seekopfsockel: plus 1 m.

The early appearance at Seekopfsockel led us to assume the low and early income as shown in the range chart.

We tentatively conclude an evolutionary relationship between *Icriodus steinachensis* and *I. curvicauda* found in the uppermost Pragian. Yet, we are unable to prove this assumption due to the fact that at present no information is available about icriodids form this critical interval between both occurrences.

Pelekysgnathus serratus was proved as another diagnostic conodont for the middle Pragian. In the lower part of its range it overlaps with *I. steinachensis* beta morph.

In the upper Pragian we recognized three diagnostic conodont faunas: *Polygnathus pireneae* is associated with *Eognathodus sulcatus* ssp. indet. and *Pedavis* sp. This assemblage is succeeded by *P. dehiscens* 5 m higher up in the sequence at Oberbuchach. *Icriodus curvicauda* probably represents a co-occurring species although it was never found together with *P. dehiscens*. On the other side, this taxon has a great stratigraphic potential as it is associated with graptolites of the Yukonensis Zone and dacryoconarids like *Guerichina strangulata* (section Stydlé vody).

At this level other conodonts, i. e. *Icriodus bilatericrescens, Pandorinellina steinhornensis miae* and possibly *I. huddlei* first appear. Like *P. dehiscens*, they persist into the Zlíchovian.

3.3. Chitinozoans

(Plate 3 – F. Paris)

The investigations carried out on chitinozoans only concern a few metres of the sequence immediately below and above the Lochkovian-Pragian boundary in five sections of the Barrandian. Consequently, the stratigraphical distribution of the chitinozoans reported in this paper is limited to a short time-interval and cannot be used for extensive biostratigraphical conclusions. This is particularly true for the Pragian species which for the most part were collected in the first three metres above the base. Nevertheless, when completed by previous results on the Silurian-Devonian boundary assemblages (Paris, Laufeld & Chlupáč, 1980; Paris, 1981), the present data provide accurate information concerning the total range of the important Lochkovian species (e. g. *Eisenackitina bohemica*).

In the Lower Devonian of Bohemia, the most favourable material for Chitinozoa is represented by dark-grey, platy limestones of the Radotín type, as demonstrated by the very large collection of chitinozoans yielded by the Radotín Limestone in the Třebotov-Solopysky section. The nodular micritic Dvorce-Prokop Limestone also provides abundant material, even if poorly diversified. On the contrary, the Kotýs, Slivenec and Vinařice Limestones are very unfavorouble for investigations on chitionozoans. The absence of chitinozoans in the Vinařice Limestone (lower Pragian) of the Oujezdce section could be related to the occurrence of corals in this sequence in so far as the vicinity of reefs is known to have a negative effect on the distribution of chitinozoans (Laufeld, 1974).

Obviously, in Bohemia the distribution of chitinozoans near the Lochkovian-Pragian boundary shows a facies control. However, this control is more pronounced for the abundance than for the range biozone itself. From a general point of view the low diversity of these chitinozoan assemblages has to be pointed out, when compared to that of contemporaneous SE Polish, North African or West European assemblages. On the other hand it is worthy of noting that several taxa (e. g. *Cingulochitina, Armoricochitina, Urochitina*) of stratigraphical interest in the Lochkovian of the Sahara, Spain, France, Poland, are lacking or very poorly represented in the Lower Devonian of Bohemia.

Until now, no standard zonation of the Lower Devonian chitinozoans is available. However, local or regional zonations have been proposed for Spain (Cramer & Diez, 1978; Diez & Cramer, 1978) or France (Paris, 1981), and some important components of the Bohemian assemblages are index fossils for these West European zonations (e. g. *E. bohemica, Margachitina catenaria tenuipes*).

3.3.1. Upper Lochkovian chitinozoans

In the five investigated sections two subfamilies, namely the *Eisenackitininae* and the *Angochitininae* are dominant in the upper Lochkovian. Typical *Eisenackitina bohemica*, a species which first occurs less than 1 m above the Silurian-Devonian boundary in Klonk and Karlštejn sections (PARIS, 1981), is still present up to 1 or 2 metres below the base of the Pragian. Its disappearance does not seem to be related to the lithology, as in the Kosoř and Třebotov-Solopysky sections there is no strong lithological change in the upper Lochkovian. Consequently, *E. bohemica* has to be regarded as a good index fossil for the whole Lochkovian. Occurring with typical *E. bohemica* are closely related forms such as *Eisenackitina* sp. A (characterized by its peculiar ornamentation), *E. elongata* (a large species described from Bohemia by EISENACK 1972) and *Eisenackitina* cf. *cupellata*. Because of its badly preserved outer layer, this latter is tentatively referred to the species described by WRONA (1980) from the upper Bostovian of SE Poland (subsurface material).

Typical representatives of *Margachitina catenaria catenaria* have been recorded about 16 metres below the base of the Pragian at Kosoř. This subspecies does not reach the uppermost Lochkovian, as documented by the data from other investigated Bohemian sections and from France (PARIS, 1981). *M. catenaria catenaria* is replaced in the uppermost Lochkovian (and lower Pragian) by another subspecies *M. catenaria tenuipes*, provided with a significantly thinner peduncle. Both species belong to the same lineage. The absence of *M. catenaria tenuipes* in the lower Pragian of the investigated sections is not surprising at all, as its acme development is situated higher in the Pragian (PARIS, 1976, 1980, 1981).

The decay of *E. bohemica* in the uppermost Lochkovian is gradually counterbalanced by an increased representation of the genus *Gotlandochitina*, misidentified as *Angochitina devonica* in many previous papers. The *Gotlandochitina* specimens are often poorly preserved in the uppermost Lochkovian of Bohemia. As the ornamentation is necessary for a precise identification of these forms, the real range of each species is difficult to define. However, among the very numerous specimens yielded by our samples, *Gotlandochitina ramosus* seems to be the predominant *Gotlandochitina* in the upper Lochkovian.

In addition to these taxa, a species, provisionally identified as *Urnochitina* sp. A, occurs in a few beds of the uppermost Lochkovian (except the Oujezdce section). *Urnochitina* sp. A closely resembles the Pridolian index species *Urnochitina urna*. The outline is quite similar but when well preserved, the vesicle of this upper Lochkovian species bears tiny and densely distributed tubercles.

3.3.2. Lower Pragian chitinozoans

Despite a rather small number of fossiliferous samples in the lower Pragian, significant differences exist between the upper Lochkovian and lower Pragian assemblages of chitinozoans. One of the main features of the lower Pragian populations is the absence of *E. bohemica* and the appearance of *Angochitina comosa*, one metre (or less in the Kosoř section) above the base of the Pragian. It is worthy to note that this typical lower Pragian species has a very short range-zone (a few metres) as documented in the Saint Cénéré section in Brittany (PARIS, 1976, 1981). Another common component of the lower Pragian microfauna is the richly ornamented *Gotlandochitina philippoti*; the range of this goes on higher in the Pragian.

Gotlandochitina philippoti and *G. ramosus* seem to overlap during a very short time in the topmost Lochkovian. *A. comosa* and *G. philippoti* are nearly mutually exclusive as illustrated by the data from the Kosoř and Třebotov-Solopysky sections. This pattern of distribution is not lithologically controlled, as *A. comosa* occurs in light-grey micritic and platy limestones (Kosoř section) as well as in typical nodular micritic limestones (Dvorce-Prokop Limestone).

3.4. Graptolites

Graptolites of the upper Lochkovian Barrandian sections are clearly concentrated in intercalations of dark calcareous mudstones; their finds in limestones are merely sporadic.

According to the new materials collected in the sections studied and kindly determined by Dr. H. JAEGER (Berlin), the index upper Lochkovian zonal graptolite *Monograptus hercynicus* does not reach the upper Lochkovian boundary. Its acme-development falls within the tentaculite Zone with *Paranowakia intermedia* (in the Kosoř section in its lower part) and last specimens tentatively identified with it were found 4–5 m below the Pragian base at Kosoř. *Monograptus kayseri* seems to reach somewhat higher: it is the last graptolite found in the Hvížďalka section and incomplete specimens from the Kosoř section possibly belonging to it derive from a level approx. 4 m below the Pragian base and still higher. The last graptolite from the Lochkovian at Kosoř found in bed 77 (i. e. only 40 cm below the Pragian base) has been determined by Dr. H. JAEGER as *Monograptus aequabilis notoaequabilis* vel *M. kayseri*. *M. aequabilis* is otherwise a long-ranging species reaching from the lower Lochkovian up to the upper Pragian (comp. JAEGER, 1979).

3.5. Trilobites

(Plate 4)

Trilobites are a common component of the fauna collected in the studied sections and their high diversity allows some biostratigraphic conclusions to be made.

Some species widely distributed within the whole upper Lochkovian persist until the end of the Lochkovian, as is the case of *Lepidoproetus lepidus lepidus*, *L. microgranulatus*, *Scharyia angusta*, *Otarion novaki*, *Leonaspis lochkovensis*, *Crotalocephalina chlupaci*, *Gravicalymene hornyi*, *Ranunculoproetus heteroclytus*, *Coniproetus affinis paraffinis* and probably also representatives of *Decoroscutellum*.

Lochkovella misera – the index upper Lochkovian species – disappears in the topmost Lochkovian beds and seems to be replaced by common *Reedops limespragensis*, which passes across the Lochkovian-Pragian boundary into a few lowermost Pragian beds. Already below the first occurrence of *R. limespragensis*, *Spiniscutellum* ? *plasi* is currently present and seems to replace *S. umbelliferum*, common in the underlying upper Lochkovian interval. From the phyletic viewpoint, *S. umbelliferum*, however, cannot be regarded as an ancestor of *S.* ? *plasi* and morphological features of both species do not point to the same lineage. *S. umbelliferum* may evidently locally persist up to the lowest Pragian (comp. its sporadic occurrence in the Slivenec Limestone reported by CHLUPÁČ, 1955 and ŠNAJDR, 1960). *S.* ? *plasi* does not pass the Lochkovian-Pragian boundary and constitutes a true index of the topmost Lochkovian, being less facies-dependent (known from dark microsparitic Radotín, coarser sparitic Kosoř and light bioclastic Kotýs Limestones).

The base of Pragian drawn according to its original definition, is marked by the first occurrence of the genus *Odontochile* which is known to appear just above the boundary proper, being one of the most important features in trilobite biostratigraphy of the boundary beds. Within the lower Pragian, *Odontochile* is represented by such characteristic species as *O. hausmanni* and *O. cristata*. Close above the boundary, a prolific occurrence of large-eyed phacopids of *Reedops cephalotes-sternbergi* group begins, namely *R. prospicens, R. sternbergi* a. o., which are accompanied by small-eyed phacopids, such as *Phacops (Prokops) hoeninghausi* limited to the micritic facies. All these trilobites are commonly represented in the deep-water *Reedops-Odontochile* Assemblage but may be traced even in other biofacies units (CHLUPÁČ, 1983b).

Among the scutelloids, the base of Pragian is marked in different facies and assemblages by the onset of *Platyscutellum*, especially the *formosum* and *viator* groups (*P. formosum formosum, P. formosum slivenecense, P. viator, P. kutorgai* a.o.). The same is true of the representatives of *Poroscutellum* and *Metascutellum*, which are specially common within the shallow-water bioclastic facies (*P. infaustum, P. expectans, P. indocile, P. agathon, M. pustulatum*, etc.). *Kolihapeltis, Bojoscutellum, Radioscutellum, Microscutellum* and *Cornuscutellum* start to occur within the lower Pragian but they have not been found so far in the lowermost layers.

Proetids are the most diversified trilobites of the Pragian. The Pragian base is characterized in the shallow-water bioclastic facies, in particular by the onset of *Pragoproetus* (e. g. *P. menaniensis, P. pragensis*) and *Gerastos*. *Lepidoproetus, Dalejoproetus* and *Coniproetus* persist from the older units, being represented in the Pragian by many species. Some of them are closely related to the Lochkovian species differing only in the subspecies rank, e. g. *L. lepidus, L. diademifer*, or *C. eurysthenes*. Within the deeper-water facies containing the *Reedops-Odontochile* Assemblage, the development of *Vicinoproetus, Prodrevermannia, Centriproetus, Bojocoryphe, Tropicoryphe* and *Podoliproetus* is known to begin close above the Lochkovian-Pragian boundary.

Among odontopleurids, *Ceratonurus* appears first in the uppermost Lochkovian, whilst *Dicranurus* with the index *D. monstrosus* starts in the lower Pragian. *Leonaspis* shows a marked persistence and the prolific upper Lochkovian species *L. lochkovensis* is in a close proximity of the boundary replaced by very similar *L. confluens* – evidently a member of the same lineage and abundant in the shallow-water bioclastic facies containing the *Lepidoproetus-Coniproetus* Assemblage.

Less facies dependent cheirurids are equally useful in the Lochkovian-Pragian boundary beds: the evolution of the group *Crotalocephalina gibba – globifrons* and *Pilletopeltis albertii* starts close above the boundary; *Crotalocephalina chlupaci* survives from the Lochkovian into the lower Pragian.

Many other trilobites appear in the lower Pragian for the first time and evolve in younger beds. They, however, have not been found so far in the lowest Pragian, as is also the case of *Koneprusia, Acanthopyge, Perunaspis* a. o.

3.6. Brachiopods

The richly diversified brachiopod faunas represented in the Lochkovian by more than 50 species and in the Pragian by more than 200 species was subjected to modern revisional studies by HAVLÍČEK (1956–1983); they would deserve a special analysis which surpasses the scope of the presented paper.

The characteristic and common assemblage of the upper Lochkovian in the Radotín and Kosoř Limestones consists of *Howellella inchoans* (acme development in earlier upper Lochkovian), *H. digitatoides, Iridistrophia iris, Areostrophia interjecta* (common), *A. nigra, Plectodonta mimica, Leptagonia relicta, Glossoleptaena emarginata, Strophochonetes lanx, Lingula nigricans, Orbiculoidea intermedia* etc.

In the biodetrital Kotýs Limestone, different strophomenids, orthids and rhynchonellids are prolific but in the topmost Lochkovian layers a decrease in the brachiopod representation is obvious and some persisting species dominate, e. g. *Eoglossinotoechia cacuminata, Howellella konieprusensis* and some atrypids.

In the deeper-water facies, *Plectodonta mimica, Rugoleptaena zinkeni, Caplinoplia pragensis* and the prolific *Eoglossinotoechia cacuminata* pass the Lochkovian-Pragian boundary, according to the determinations of new finds kindly made by Dr. V. HAVLÍČEK.

The lowest Pragian strata are rich in brachiopods, especially in the biodetrital facies of the Koněprusy region (Vinařice Limestone) where a characteristic assemblage with *Eoglossinotoechia surgens surgens, Stenorhynchia pseudolivonica, Sieberella sieberi, Myriospirifer myriofila, Kyrtatrypa canalibalda, Tastaria lenis, Pholidostrophia lunetta* a. o. has been collected close above the lower Pragian boundary (see the Oujezdce quarry section).

The lowest Pragian brachiopod fauna of the micritic facies (Dvorce-Prokop Limestone) contains a fairly larger number of species that appear already within the uppermost Lochkovian, and the boundary is less marked.

3.7. Some other groups

Orthocone nautiloids are common chiefly in the shale-rich and microsparitic development (Radotín Limestone tone) of the upper Lochkovian, where *"Orthoceras" deletum* and *"O." nobile* seem to be characteristic and not passing the Lochkovian-Pragian boundary. The Pragian nautiloids are, in general, more diversified and evidently containing good index species (e. g. in *Ptenoceras*), but the state of their systematic elaboration does not allow the forms described so far to be used for biostratigraphic purposes.

Gastropods are markedly less diversified in the Lochkovian than in the Pragian, particularly in the shallow-water and reefal facies. In the boundary beds proper, the upper Lochkovian assemblage with *Praenatica proeva, Raphistomina tarda, Stylonema solvens* and the representatives of *Platyceras* has its analogies in Pragian deposits, but a lesser degree of systematic elaboration hinders any more exact conclusions to be made.

Bivalves are common in the shale-rich and locally also biodetrital facies of the upper Lochkovian. A common assemblage represented mostly in the Radotín Limestone and consisting of *Leiopteria (Actinopteria) migrans migrans, Lunulacardium analogum* and allied forms, numerous *Neklania, Panenka* etc. does not continue into the Pragian, where different bivalve assemblages occur. The genus *Kralovna* starts developing in different facies (particularly micritic) of Pragian and a rich bivalve fauna of the Koněprusy Limestone in the reefal development has no analogies within the Lochkovian.

The representatives of *Hercynella* show their acme-development in the upper Lochkovian: *H. nobilis = bohemica* (one species, different names applied to right and left valves) is common up to the upper part of the *Paranowakia intermedia* Zone and in the topmost Lochkovian it seems to be replaced by *H. paraturgescens = radians*. At the Lochkovian-Pragian boundary, the representatives of the *paraturgescens = radians* group become markedly less common, although some specimens were found still in the lowest Pragian (Kosoř, Třebotov-Solopysky).

Of the Rostroconchia, *Conocardium aptychoides* is known so far from the Lochkovian (rather common in the Radotín Limestone), whilst the Pragian contains different and diversified representatives of *Conocardium* abundant particularly in reefal facies.

The class Hyolitha involves some index fossils: *Orthotheca intermedia*, common in the Radotín and Kosoř Limestones up to the Lochkovian-Pragian boundary, does not continue into the Pragian, where e. g. *Hyolithus tardus* is the most characteristic species of the micritic limestone facies (Dvorce-Prokop Limestone).

Crinoids represent the most important rock-forming organisms in the Lochkovian and Pragian strata, but their fragmentary preservation hinders their stratigraphic application. In spite of that the stratigraphic value of some crinoids cannot be overlooked: *Kerrycrinus gratiosus* (now under description by R. PROKOP) occurs in different facies of lower Pragian already close above the lower Pragian boundary and other crinoids are also known in lower Pragian, e. g. *Edriocrinus ata, Eohalysiocrinus cylindricus, E. reticulatus, Junocrinus globulus, Parapisocrinus olula grandis, Pygmaeocrinus kettneri, Ramacrinus brevis, Eohalysiocrinus tuberosus* a. o. The same is true of cyclocystoids *Sieverteia tartas* and the cystoid *Bulbocystis mirus* (most part of echinoderms described by PROKOP, 1970–1980).

Concerning other faunal groups, the following may be added: The Lochkovian phyllocarids found even in the late upper Lochkovian layers, are totally different from those of the Pragian but the environmental control is demonstrable (Lochkovian phyllocarids concentrated in pelagic facies, Pragian in the reef ones). Among fishes, *Machaeracanthus bohemicus* continues from the topmost Lochkovian into the Pragian in different facies and *Radotina* is present in the both stages discussed; *Kosoraspis* seems to be restricted to upper Lochkovian.

4. Proposal for a conodont based Lochkovian-Pragian boundary

(H. P. SCHÖNLAUB)

By means of conodonts the base of the Pragian can be defined within a segment of an obviously phyletic lineage represented by different species of *Icriodus* (A) or by the appearance of distinctive variants of *Ozarkodina pandora* (B). Whatever will be selected in the future it is of great value that both procedures characterize an event that is closest to the traditionally drawn boundary based on other fossil groups. Accordingly, this conodont defined lower boundary of the Pragian Stage corresponds to the lower boundary of the oldest Pragian conodont zone.

For the boundary between the Lochkovian and the Pragian Stages in the type area we propose the first appearance of *Icriodus steinachensis* eta within the evolutionary lineage from *Icriodus* sp. n. A to *Icriodus steinachensis* beta morph. This has been best documented at section Cikánka in bed 11.

An alternative proposal for a conodont based boundary is the beginning of the radiation of morphs of *Ozarkodina pandora*. At section Cikánka this horizon coincides with the boundary based on *Icriodus*.

As yet replication of our data obtained in the Barrandian at other sequences had only been demonstrated for the Carnic Alps. This, however, seems a matter of matching the critical passage from the Lochkovian to the Pragian in other regions and in particular in the Rhenish facies.

According to KLAPPER (1977) *Icriodus steinachensis* eta appears in Nevada sections in the pesavis Zone. MURPHY & MATTI (1982) recorded the first occurrence at Copenhagen Canyon Section V–IV from above the range of *O. stygia* associated with rare occurrences of *P. pesavis*. At Mill Canyon Section there is a significant overlap of approx. 10 feet between *I. steinachensis* eta, *O. stygia* and representatives of the genus *Ancyrodelloides*. On the other side *I. steinachensis* eta is the dominating species above the ranges of typical Lochkovian conodonts. Furthermore, at this level it is associated with different morphs of *O. pandora* which, by comparison with our data suggests a Lochkovian-Pragian boundary at an approx. 100 ft level of Mill Canyon Section in Nevada.

5. Conclusion

The Lochkovian-Pragian boundary drawn according to its original definition (1958, 1960) falls in the Barrandian type area within a comformable succession of marine carbonate rocks developed as fine-grained pelagic up to coarser biodetrital and peri-reefal carbonates. The Lochkovian-Pragian boundary interval proper shows generally a rather discrete and gradual change in lithology and colour with a clear trend from dark to light sediments.

The boundary beds are generally rich in fossils among which benthic, planktic and nektic elements are represented. Although the faunal change at the Lochkovian-Pragian boundary is distinctly expressed in many fossil groups, the traceable lineages of different groups demonstrate continuity in faunal evolution (comp. especially development of dacryoconarid tentaculites, conodonts, chitinozoans, trilobites, brachiopods, etc.).

The Lochkovian-Pragian boundary in its original definition is drawn within the tentaculite Zone with *Nowakia sororcula* (somewhat above the upper limit of the *Paranowakia intermedia* Zone) and is characterized by the onset of typical specimens of *Nowakia acuaria* which dominates in the Pragian strata.

By means of conodonts the Lochkovian-Pragian boundary can be defined by the first appearance of *Icriodus steinachensis* eta morphotpye within the evolutionary lineage from *Icriodus* sp. n. A to *Icriodus steinachensis* beta morphotype. The beginning of the radiation of morphs of *Ozarkodina pandora* corresponds to the same level and coincides with the boundary based on *Icriodus*.

In the chitinozoan biostratigraphy the Lochkovian-Pragian boundary interval is marked by extinction of *Eisenackitina bohemica* (index for the whole Lochkovian) and the onset of *Angochitina comosa*. As auxiliary means the evolution from *Margachitina catenaria catenaria* to *M. catenaria tenuipes* and the beginning development of *Gotlandochitina philippoti* in the topmost Lochkovian may be used.

Graptolites are less common in the late upper Lochkovian of the Barrandian. *Monograptus hercynicus* – the zonal upper Lochkovian index fossil – does not reach the Lochkovian-Pragian boundary proper and disappears in the Barrandian sections several metres below. *Monograptus kayseri* seems to be an index of late upper Lochkovian strata, but the topmost Lochkovian layers yielded only the long-ranging taxon *Monograptus aequabilis*.

Among trilobites the Lochkovian-Pragian boundary is marked by the onset of the genera *Odontochile, Platyscutellum, Poroscutellum, Metascutellum, Pragoproetus, Dicranurus*, phacopids of the *Reedops sternbergi-cephalotes* groups a. o. Many lineages of Lochkovian trilobite are traceable across the Lochkovian-Pragian boundary and continue in younger beds. Among common upper Lochkovian trilobites the disappearance of *Lochkovella misera* and *Spiniscutellum ? plasi* close below or at the boundary itself may serve as a co-indicator of the boundary.

Brachiopods, bivalves and some other fossil groups show a similar pattern of evolution and distribution in the Lochkovian-Pragian boundary beds: apart from changing elements persisting lineages are demonstrable.

The Lochkovian-Pragian boundary beds are exposed in the Barrandian at many places and particularly the old quarries offer solid and readily accessible outcrops. A great majority of outcrops is situated in natural reserves and other areas protected by law, the future conservation being insured.

Table 1: Occurrence of fossils in the Lochkovian-Pragian boundary beds.
Only those fossils are listed which were found by recent collections in the late upper Lochkovian (about 20 m thick interval) and early lower Pragian (about 15 m thick interval).
R = Radotín and Kosoř Limestones; Ko = Kotýs Limestone; Dp = Dvorce-Prokop Limestone; Sl = Slivenec and Koněprusy Limestones (outside the Koněprusy area); V = Vinařice; Ř = Řeporyje and Loděnice Limestones; luL = late upper Lochkovian; elP = early lower Pragian.

	luL	elP
Graptolithina		
Monograptus hercynicus PERNER, 1899	R	
Monograptus kayseri PERNER, 1899	R	
Monograptus aequabilis aequabilis (PŘYBIL, 1941)	R	
Monograptus aequabilis cf. *notoaequabilis* JAEGER & STEIN, 1969	R	
Palaeodictyota rotundatum BOUČEK, 1957	R	
Thallograptus sp.	R	

Table 1 (continued).

	luL	elP
Conodonta		
Ozarkodina wurmi BISCHOFF & SANNEMANN, 1958	R, Ko	Sl
Ozarkodina e. excavata (BRANSON & MEHL, 1933)	R	Sl, Dp
Ozarkodina remscheidensis (ZIEGLER, 1960)	R, Ko	
Ozarkodina pandora MURPHY et al., 1981	R, Ko	Sl
Ozarkodina pandora alpha morphotype	Ko	Dp
Ozarkodina pandora beta morphotype	R, Ko	Sl
Ozarkodina pandora gamma morphotype	Ko	Sl
Ozarkodina pandora epsilon morphotype	Ko	
Ozarkodina pandora zeta morphotype	Ko	Sl
Icriodus sp. n. A	R, Ko	Sl
Icriodus steinachensis AL-RAWI, 1977 eta morphotype		Sl
Pandorinellina steinhornensis miae (BULTYNCK)		Sl
Ancyrodelloides omus MURPHY & MATTI	R	
Ancyrodelloides sp.	R	
Pedavis sp. aff. *breviramus* MURPHY & MATTI	R	
Belodella sp	R	
Neopanderodus sp.	R	
Trilobita		
Lochkovella misera (BARRANDE, 1852)	R	
Reedops limespragensis CHLUPÁČ, 1985	R, Ko	Dp, Sl
Reedops sternbergi (HAWLE & CORDA, 1947)		Dp, Sl
Reedops prospicens CHLUPÁČ, 1977		Dp, Sl
Reedops cf. *bronni* (BARRANDE, 1846)		Sl, V
Reedops cephalotes (HAWLE & CORDA, 1847)		Dp, Ř, V
Reedops cf. *sternbergi* (HAWLE & CORDA, 1847)		Sl
Phacops (Prokops) hoeninghausi (BARRANDE, 1846)		Dp, Ř
Odontochile hausmanni (BRONGNIART, 1822)		Dp, Ř
Odontochile cristata HAWLE & CORDA, 1847		Dp
Odontochile rugosa HAWLA & CORDA, 1847		Dp, Sl, Ř
Odontochile sp.		Dp, Sl, Ř, V
Cheirurus (Pilletopeltis) albertii PŘYBIL & VANĚK, 1984		Dp, Sl
Crotalocephalina chlupaci (PŘYBIL & VANĚK, 1962)	R, Ko	V
Crotalocephalina globifrons (HAWLE & CORDA, 1847)		Dp, Sl,V
Crotalocephalina cf. *gibba* (BEYRICH, 1845)		Dp, Ř, Sl
Otarion convexum (HAWLE & CORDA, 1847)		Dp, Sl
Otarion novaki BOUČEK, 1935	R, Ko	
Cyphaspides comatus (BARRANDE)		Dp, Ř
Cyphaspides svobodai PRANTL & PŘYBIL, 1950		Dp
Gravicalymene affinis (HAWLE & CORDA, 1847)		Sl
Gravicalymene hornyi ŠNAJDR, 1980	R, Ko	
Leonaspis lochkovensis (PRANTL & PŘYBIL, 1949)	R, Ko	
Leonaspis confluens PŘYBIL & VANĚK, 1967		Sl, K
Ceratonurus sp. n.	R	
Ceratocephala sp. n.	R	
Dicranurus monstrosus (BARRANDE, 1852)		Dp, Sl, Ř
Lobopyge branikensis (BARRANDE, 1872)		Dp, V, Sl
Lobopyge richteri VANĚK, 1959	Ko	
Perunaspis minuta (BARRANDE, 1846)		Sl
Spiniscutellum umbelliferum (BEYRICH, 1845)	R	Sl?
Spiniscutellum ? plasi (ŠNAJDR, 1960)	R, Ko	
Decoroscutellum div. sp.	Ko	
Platyscutellum viator (BARRANDE, 1852)		Sl, V
Platyscutellum formosum formosum (BARRANDE, 1846)		Dp
Platyscutellum formosum slivenecense ŠNAJDR, 1960		Sl
Platyscutellum div. sp.		Sl, V, Ř, Dp
Poroscutellum infaustum (BARRANDE, 1852)		Sl
Poroscutellum exspectans (BARRANDE, 1872)		Sl
Poroscutellum indocile (BARRANDE, 1872)		Sl
Poroscutellum acupunctatum (BARRANDE, 1872)		Sl, Dp
Poroscutellum agathon VANĚK, 1970		Sl
Metascutellum pustulatum (BARRANDE, 1846)		Dp, V
Metascutellum multiverrucatum (ŠNAJDR, 1960)		Sl, Ř
Gerastos (Longiproetus) confusus (HAWLE & CORDA, 1847)		V
Gerastos (Gerastos) div. sp		V, Sl
Coniproetus affinis paraffinis (ŠNAJDR, 1976)	Ko	
Pragoproetus menaniensis (PŘYBIL, 1949) div. subsp.		Sl, V
Pragoproetus pragensis (PŘYBIL, 1964)		Sl

Table 1 (continued).

	luL	elP
Centriproetus concentricus concentricus (PŘYBIL, 1965)		Dp
Bojocoryphe splendens ŠNAJDR, 1976	Dp, Sl	
Ranunculoproetus heteroclytus (BARRANDE, 1852)	R	
Scharyia angusta PŘYBIL, 1966	R	
Lepidoproetus lepidus lepidus (BARRANDE, 1846)	R, Ko	
Lepidoproetus lepidus latiannulatus (PŘYBIL, 1971)		Sl
Lepidoproetus diademifer diademifer (CHLUPÁČ & VANĚK, 1965)	K	
Lepidoproetus diademifer dimifer ŠNAJDR, 1960		Sl
Lepidoproetus microgranulatus ŠNAJDR, 1980	R	
Prodrevermannia occulta (PŘYBIL, 1969)		Dp
Vicinoproetus div. sp.		Dp
Dalejeproetus dalejensis (PŘYBIL, 1971) div. subsp.	?	Sl, Dp, V
Phyllocarida		
Ceratiocaris cornwallensis damesi CHLUPÁČ, 1963	R,Ko	
Montecaris antecedens CHLUPÁČ, 1960	R	
Aristozoe parabolica PERNER, 1919	R	
Pygocaris schuberti PERNER, 1919	R	
Echinodermata		
Edriocrinus ata PROKOP, 1976		Dp
Codiacrinus procerus (PROKOP, 1973)		Dp
Eohalysiocrinus cylindricus PROKOP, 1970		Dp
Eohalysiocrinus reticulatus PROKOP, 1970		Dp
Junocrinus globulus PROKOP, 1977		Dp
Pygmaeocrinus kettneri BOUŠKA, 1946		Dp, Sl, Ř
Ramacrinus brevis LEMENN & PROKOP, 1980		Dp
Eohalysiocrinus tuberosus PROKOP, 1970		Sl, Ř
Coryoblastus bohemicus BREIMER et al., 1968		Sl
Bulbocystis mira RUŽIČKA, 1939		Sl, Ř
Sievertia tartas (PROKOP, 1980)		Dp, Ř
Dacryoconarida		
Paranowakia intermedia (BARRANDE, 1867)	R	
Paranowakia geinitziana (RICHTER, 1854)	R, Ko	Dp
Paranowakia lochkoviana LUKEŠ, 1985	R	
Paranowakia grandis LUKEŠ, 1985	R	
Nowakia acuaria (RICHTER, 1854)		Dp, Sl, Ř, V
Nowakia cf. *acuaria* (RICHTER, 1854)	R	
Nowakia sororcula LUKEŠ, 1983	R, Ko	Dp, Sl
Nowakia kosorensis LUKEŠ, 1985	R	
Nowakia vesta LUKEŠ, 1985	R	
Nowakia gemina LUKEŠ, 1985	R	
Nowakia praesororcula LUKEŠ, 1985	R	
Mollusca + other groups		
"Orthoceras" bacchus BARRANDE, 1870	R	
"Orthoceras" deletum BARRANDE, 1868	R	
"Orthoceras" nobile BARRANDE, 1868	R	
Parakionoceras sp.	R	
Praenatica proeva PERNER, 1907	R	
Praenatica gregaria (PERNER, 1903)		Sl
Raphistomina tarda PERNER, 1903	R	Dp?
Stylonema solvens (PERNER, 1907)	R, Ko	
Orthonychia ex. gr. *bohemica* PERNER, 1903		Sl, V
Platyceras div. sp.	R, Ko	Sl, V, Ř
Hercynella bohemica PERNER, 1903	R	
Hercynella nobilis PERNER, 1903	R	
Hercynella paraturgescens PERNER, 1903	R	Dp
Hercynella radians PERNER, 1903	R	Dp
Kralovna div. sp.		Dp, Ř
Panenka expansa BARRANDE, 1881	R	
Panenka grata BARRANDE, 1881	R	
Panenka div. sp.	R, Ko	Dp, Ř
Leiopteria (Actinopteria) migrans migrans (BARRANDE, 1881)	R	
Lunulacardium analogum (BARRANDE, 1881)	R	
Neklania insignis (BARRANDE, 1881)	R	
Neklania div. sp.	R, Ko	
Sluzka bohemica BARRANDE, 1881	R	
Conocardium aptychoides BARRANDE, 1881	R	
Conocardium ex. gr. *bohemicum* BARRANDE, 1886		Sl, Dp

Table 1 (continued).

	luL	elP
Orthotheca intermedia NOVÁK, 1886	R	
Hyolithus tardus BARRANDE, 1867		Dp
Brachipoda (selected species)		
Howellella inchoans (BARRANDE1879)	R, Ko	
Howellella digitatoides HAVLÍČEK, 1959	R	
Howellella koneprusensis HAVLÍČEK, 1959	Ko	V, Sl
Myriospirifer myriofila HAVLÍČEK, 1978		V
Cingulodermis cinctus HAVLÍČEK, 1971		Dp, Ř
Cingulodermis fortissimus HAVLÍČEK, 1971		V, Sl
Eoglossinotoechia cacuminata HAVLÍČEK, 1959	R, Ko	Dp, Sl, V
Astutorhyncha simulans (BARRANDE, 1879)		V, Sl
Stenorhynchia pseudolivonica (BARRANDE, 1879)		V
Glossinotoechia surgens surgens (BARRANDE, 1879)		V
Sieberella sieberi (BUCH, 1847)		V
Cryptonella sp. n. aff. *melonica* (BARRANDE, 1847)	Ko	
Cycladigera palliata (BARRANDE, 1848)		V
Merista passer (BARRANDE, 1848)		Dp
Kyrtatrypa canalibalda HAVLÍČEK MS		V
Kyrtatrypa sp.	R	Sl
Rugosatrypa sulcifrons HAVLÍČEK MS		V
Oglu sp.		V, Sl
Eoglossinotoechia cikanea HAVLÍČEK, 1983		Sl
Tastaria lenis HAVLÍČEK, 1967		V
Plectodonta mimica BARRANDE, 1879	R, Ko	Dp
Dalejodiscus subcomitans (HAVLÍČEK, 1956)		Dp, Sl
Pholidostrophia lunetta (HAVLÍČEK, 1967)		V
Leptagonia goldfussiana (BARRANDE, 1848)		V
Gorgostrophia neutra (BARRANDE, 1848)		V
Gladistrophia verneuili (BARRANDE, 1848)		Sl, V
Protoleptostrophia mollis HAVLÍČEK, 1967		Dp, V
Bojodouvillina phillipsi (BARRANDE, 1848)		V, Sl
Rugoleptaena zinkeni (ROEMER, 1843)	R	Dp, Ř, Sl
Glossoleptaena emarginata (BARRANDE, 1879)	R	
Iridostrophia iris (BARRANDE, 1879)	R, Ko	
Areostrophia interjecta (BARRANDE, 1879)	R	
Caplinoplia pragensis HAVLÍČEK & RACHEBOEUF, 1979	R	Dp, Sl, Ř, V
Caplinoplia embryo (BARRANDE, 1848)		V, Sl
Leptochonetes tardus (BARRANDE, 1879)		Dp, Sl, Ř
Strophochonetes sp. n.		Sl
Lingula nigricans BARRANDE, 1879	R	
Orbiculoidea intermedia (BARRANDE, 1879)	R	
Orbiculoidea signata (BARRANDE, 1879)	R	
Some other fossils		
Machaeracanthus bohemicus BARRANDE, 1872	R, Ko	Dp, Sl, Ř, V
Radotina kosorensis GROSS, 1950	R	
Pterygotus (Acutiramus) bohemicus BARRANDE, 1872	R	
Plectoconularia proteica (BARRANDE, 1867)	R, Ko	
Pleurodictyum div. sp.	Ko	Sl

References

ALBERTI, G. K. B.: Beitrag zur Dacryoconarida-(Tentaculiten-) Chronologie des älteren Unter-Devons (Lochkovium und Pragium) . – Senckenbergiana lethaea, **65**, 27–49, Frankfurt a. M., 1984.

ALBERTI, G. K. B.: Zur Tentakulitenführung im Unter- und Mittel-Devon der Zentralen Karnischen Alpen (Österreich). – Cour. Forsch.-Inst. Senckenberg (in press).

AL-RAWI, D.: Biostratigraphische Gliederung der Tentakuliten-Schichten des Frankenwaldes mit Conodonten und Tentakuliten (Unter- und Mittel-Devon, Bayern, Deutschland). – Senckenbergiana lethaea, **58**, 25–79, Frankfurt a. M. 1977.

BARRANDE, J.: Système silurien du centre de la Bohême. 1. Trilobites. – 935 p., Prague – Paris 1852.

BOUČEK, B.: The tentaculites of Bohemia. – 215 p., Praha 1964.

BULTYNCK, P.: Le Silurien Supérieur et le Devonien Inférieur de la Sierra de Guadarrama (Espagne Centrale). – Bull. Inst. r. Sci. nat. Belg., **49**, 1–74, Bruxelles 1976.

BULTYNCK, P. & HOLLARD, H.: Distribution comparée de conodontes et goniatites dévoniens des plaines du Dra, du Ma'der et du Tafilalt (Maroc). – Aardkundige Mededelingen, **1**, 1–73, Leuven 1980.

CHLUPÁČ, I.: Stratigraphical investigation of the border strata of the Silurian and the Devonian in Central Bohemia. – Sbor. Ústř. Úst. geol., **20**, 277–380, Praha 1953.

CHLUPÁČ, I.: Stratigraphical study of the oldest Devonian beds of the Barrandian. – Sbor. Ústř. Úst. geol., **21**, 91–224, Praha 1955.

CHLUPÁČ, I.: Facial development and biostratigraphy of the Lower Devonian of Central Bohemia. – Sbor. Ústř. Úst. geol., **23**, 369–485, Praha 1957.

CHLUPÁČ, I.: Phyllocarid crustaceans from the Silurian and Devonian of Czechoslovakia. – Palaeontology, **6**, 97–118, London 1963.

CHLUPÁČ, I.: Zu einigen Fragen der Stratigraphie, Faziesentwicklung und Parallelisierung des Unterdevons von Böhmen. – N. Jb. Geol. Paläont. Mh., **4**, 193–208, Stuttgart 1969.

CHLUPÁČ, I.: Stratigraphical position of Barrande's palaeontological localities in the Devonian of Central Bohemia. – Časop. Mineral. Geol., **28**, 261–275, Praha 1983a.

CHLUPÁČ, I.: Trilobite assemblages in the Devonian of the Barrandian area and their relations to palaeoenvironments. – Geologica et Palaeontologica, **17**, 45–73, Marburg 1983b.

CHLUPÁČ, I.: Two index trilobites from the Lochkovian-Pragian boundary beds of the Barrandian area, Czechoslovakia. – Věst. Ústř. Úst. geol., **60** (in press).

CHLUPÁČ, I. (with contributions by H. JAEGER & J. ZIKMUNDOVÁ): The Silurian-Devonian boundary in the Barrandian. – Bull. Canad. Petrol. Geol., **20**, 104–174, Calgary 1972.

CHLUPÁČ, I., KŘÍŽ, J. & SCHÖNLAUB, H. P. (with contributions by G. KLAPPER & J. ZIKMUNDOVÁ: Silurian and Devonian conodont localities of the Barrandian. – Abh. Geol. B.-A., **35**, 147–180, Wien 1980.

CRAMER, F. H. & DIEZ, M. del C. R.: Iberian chitinozoans. I. Introduction and summary of Pre-Devonian data. – Palinologia, num. ext. 1, 149–201, Leon 1978.

DIEZ, M. del C. R. & CRAMER, F. H.: Iberian chitinozoans II. Lower Devonian forms (La Vid Shales and equivalents). – Palinologia, num. ext., 203–217, Leon 1978.

EISENACK, A.: Beiträge zur Chitinozoen-Forschung. – Palaeontographica, Abh. A., **140**, 117–130, Stuttgart 1972.

FAHRAEUS, L.: Lower Devonian conodonts from the Michele and Prongs Creek Formations, Yukon Territory. – J. Palaeont., **45**, 665–683, Tulsa 1971.

HAVLÍČEK, V.: The brachiopods of the Bráník and Hlubočepy Limestones in the immediate vicinitiy of Prague. – Sbor. Ústř. Úst. geol., **22**, 535–665, Praha 1956.

HAVLÍČEK, V.: The Spiriferidae of the Silurian and Devonian of Bohemia. – Rozpr. Ústř. Úst. geol., **25**, 1–261, Praha 1959.

HAVLÍČEK, V.: Rhynchonelloidea des böhmischen älteren Paläozoikums. – Rozpr. Ústř. Úst. geol., **27**, 1–211, Praha 1961.

HAVLÍČEK, V.: Brachiopods of the Suborder Strophomenidina in Czechoslovakia. – Rozpr. Ústř. Úst. geol., **33**, 1–235, Praha 1967.

HAVLÍČEK, V.: Brachiopoda of the Order Orthida in Czechoslovakia. – Rozpr. Ústř. Úst. geol., **44**, 1–327, Praha 1977.

HAVLÍČEK, V.: New Eospiriferinae (brachiopoda) in Bohemia. – Sbor. geol. Věd, Paleont., **23**, 7–48, Praha 1980.

HORNÝ, R.: Stratigraphy and tectonics of the western closures of the Silurian-Devonian Synclinorium in the Barrandian area. – Sbor. Ústř. Úst. geol., **26**, Geol., 459–530, Praha 1960.

JAEGER, H.: Devonian Graptolithina. – Spec. Pap. Palaeont., **23**, 335–339, London 1979.

JAEGER, H. & SCHÖNLAUB, H. P.: Silur und Devon nördlich der Gundersheimer Alm in den Karnischen Alpen (Österreich). – Carinthia II, **170/190**, 403–444, Klagenfurt 1980.

KLAPPER, G.: Lower Devonian conodont sequence, Royal Creek, Yukon Territory, and Devon Island, Canada. – J. Palaeont., **43**, 1–27, Tulsa 1979.

KLAPPER, G. (with contributions by D. B. JOHNSON): Lower and Middle Devonian conodont sequence in Central Nevada. – In: Western North America: Devonian (eds. M. A. MURPHY, W. B. N. BERRY and C. A. SANDBERG). – Univ. California, Campus Mus. Contr., **4**, 33–54, Riverside 1977.

KLAPPER, G. et al.: North American Devonian conodont biostratigraphy. – In: Symposium on conodont biostratigraphy (eds. W. C. SWEET & S. M. BERGSTRÖM). – Mem. geol. Soc. Am., **127**, 285–316, Boulder 1971.

KLAPPER, G. & JOHNSON, J. G.: Endemism and dispersal of Devonian conodonts. – J. Paleont., **54**, 400–455, Tulsa 1980.

KLAPPER, G. & MURPHY, M. A.: Silurian-Lower Devonian conodont sequence in the Roberts Mountains Formation of Central Nevada. – Univ. California Pub. Geol. Sci., **111**, 1–62, Berkeley 1975.

KLAPPER, G. & MURPHY, M. A.: Conodont zonal species from the delta and pesavis Zones (Lower Devonian) in central Nevada. – N. Jb. Geol. Paläont., Mh., **1980**, 490–504, Stuttgart 1980.

KLAPPER, G. & ZIEGLER, W.: Devonian conodont biostratigraphy. – Spec. Pap. Palaeont., **23**, 199–224, London 1979.

KODYM, O. & KOLIHA, J.: Excursion géologique dans la vallée de Radotín et à Přídolí. – Věstník Stát. geol. Úst., **4**, 84–115, Praha 1928.

LANE, H. R. & ORMISTON, A. R.: Siluro-Devonian biostratigraphy of the Salmontrout River area, east-central Alaska. – Geologica et Palaeontologica, **13**, 39–96, Marburg 1979.

LAUFELD, S.: Silurian Chitinozoa from Gotland. – Fossils and Strata, **5**, 130 p., Oslo 1974.

LUKEŠ, P.: Dacryoconarid tentaculites of the Lochkovian Stage (Lower Devonian) of the Barrandian. – Čas. Mineral. Geol., **30** (in press).

MASHKOVA, T. A.: Drevnejšie konodontovye kompleksy devona SSSR. – Sov. geol., **1978**, 3–14, Moskva 1978.

MASHKOVA, T. A.: Conodont zones of the Lower Devonian in the U. S. S. R. – Geologica et Palaeontologica, **13**, 97–102, Marburg 1979.

MEHRTENS, C. J. & BARNETT, S. G.: Conodont subspecies from the Upper Silurian–Lower Devonian of Czechoslovakia. – Micropalaeontology, **22**, 491–500, New York 1976.

MURPHY, M. A. & MATTI, J. C.: Lower Devonian conodonts (hesperius-kindlei Zones), Central Nevada. – Univ. California Pub., Geol. Sci., **123** 1–82, Berkely 1982.

ODIN, G. S.: The Phanerozoic time scale revisited. – Episodes, **1982**/3, 3–9, Ottawa 1982.

PARIS, F.: Les Chitinozoaires. In: Les schistes et calcaires éodévoniens de Saint-Céneré (Massif armoricain, France). – Mém. Soc. géol. minéral. Bretagne, **19**, 93–133, Rennes 1976.

PARIS, F.: Les Chintinozoaires. In: Les schistes et calcaires de l'Armorique (Dévonien inférieur, Massif armoricain). – Mém. Soc. géol. Minéral. Bretagne, **23**, 111–128, Rennes 1980.

PARIS, F.: Les Chitinozoaires dans le Paléozoique du sud-ouest de l'Europe (Cadre géologique, Étude systématique, Biostratigraphie). – Mém. Soc. géol. minéral. Bretagne, **26**, 426 p., Rennes 1981.

PARIS, F., LAUFELD, S. & CHLUPÁČ, I.: The Chitinozoa of the type sections of the Silurian-Devonian boundary in Bohemia. – Sver. Geol. Unders., **51**, 1–29, Uppsala 1981.

PERRY, D., KLAPPER, G. & LENZ, A. C.: Age of the Ogilvie Formation (Devonian), northern Yukon: based primarily on the occurrence of brachiopods and conodonts. – Can. J. Earth Sci., **11**, 1055–1097, Montreal 1974.

PRAGER ARBEITSTAGUNG über die Stratigraphie des Silurs und des Devons (ed. J. SVOBODA). – 518 p., Praha (Ústřední Ústav geologický) 1960.

PROKOP, R.: Family Calceocriniodae MEEK & WORTHEN, 1869 (Crinoidea) in the Silurian and Devonian of Bohemia. – Sbor. geol. Věd, P., **12**, 79–134, Praha 1970.

SANDBERG, C. A.: Devonian and Lower Mississippian conodont zonation of the Great Basin and Rocky Mountains. In: SAND-

BERG, C. A. & CLARK, D. I. (eds.): Conodont biostratigraphy of the Great Basin and Rocky Mountains. – Brigham Young Univ. Geology Studies, **26**, 87–106, Provo 1979.

SCHÖNLAUB, H. P., with contributions by H. JAEGER, M. R. HOUSE, J. D. PRICE, B. GÖDDERTZ, H. PRIEWALDER, O. H. WALLISER, J. KŘÍŽ, W. HAAS & G. B. VAI: Carnic Alps. – In: Second European Conodont Symposium ECOS II (ed.: H. P. SCHÖNLAUB), Abh. Geol. B.-A., **35**, 5–57, Wien 1980.

SPASSOV, C.: Die Conodontenchronologie des Unterdevons im Mittelteil der Balkanhalbinsel. – Bull. Geol. Inst., Ser. Stratigr. Lithol., **20**, 5–13, Sofia 1971.

ŠNAJDR, M.: A study of the family *Scutelluidae* (Trilobitae). – Rozpr. Ústř. Úst. geol., **26**, 263 p., Praha 1960.

ŠNAJDR, M.: Bohemian Silurian and Devonian Proetidae (Trilobita). – Rozpr. Ústř. Úst. geol., **45**, 324 p., Praha 1980.

WALLISER, O. H.: Conodonten des Silurs. – Abh. Hess. Landesamt Bodenforsch., **41**, 106 p., Wiesbaden 1964.

WRONA, R.: Upper Silurian–Lower Devonian Chitinozoa from the subsurface of southeastern Poland. – Palaeontologica Polonica, **41**, 103–165, Warszawa 1980.

ZIEGLER, W.: Conodont stratigraphy of the European Devonian. In: Symposium on Conodont Biostratigraphy (eds. W. C. SWEET & S. M. BERGSTRÖM). – Mem. Geol. Soc. Am., **127**, 227–284, Boulder 1971.

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Plate 1

Some dacryoconarid tentaculites from the upper Lochkovian of the Barrandian.

Localities: 1 = Praha-Podolí (quarry of the former cement plant); 2–6,8,10 = Černá rokle near Kosoř; 7,9 = Praha – Velká Chuchle (Přídolí).

Fig. 1: *Homoctenowakia bohemica* (BOUČEK), specimen (PL870), ×29.
Fig. 2: *Paranowakia intermedia* (BARRANDE), specimen (PL1103), ×20.
Fig. 3: *Nowakia kosorensis* LUKEŠ, specimen (PL1083), ×24.
Fig. 4: *Nowakia sororcula* LUKEŠ, specimen (PL 833), ×33.
Fig. 5: *Nowakia praesororcula* LUKEŠ, specimen (PL1104A), ×36.
Fig. 6: *Paranowakia geinitziána* (RICHTER), specimen (PL1079), ×20.
Fig. 7: *Paranowakia grandis* LUKEŠ, specimen (PL1059), ×20,5.
Figs. 8–10: *Paranowakia geinitziana* (RICHTER).
8: specimen (PL1088), ×19.
9: specimen (PL1056), ×18.
10: specimen (PL1108), ×29.

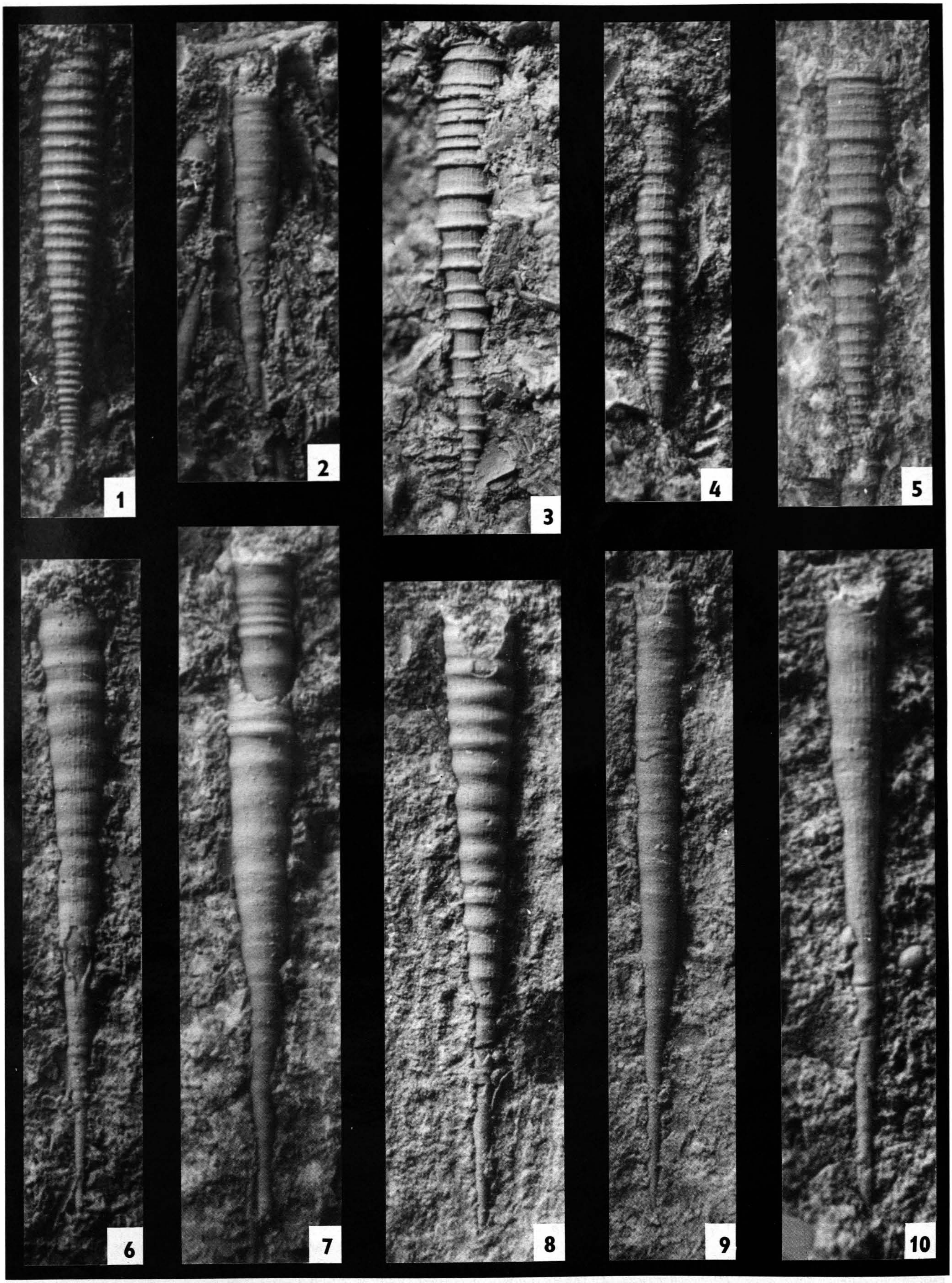
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Plate 2

Conodonts from the Lochkovian-Pragian boundary interval (Barrandian and Carnic Alps).

Fig. 1: *Eognathodus sulcatus* PHILIP ssp. indet.; section Oberbuchach II, sample no. 85, some 30 m above the base of the Pragian; fragmentary specimen associated with *Polygnathus pireneae* BOERSMA; ×120.
Fig. 2: *Ozarkodina pandora* MURPHY et al. alpha morphotype; section Oberbuchach II, sample no. 72, some 4 m above the presumed Lochkovian-Pragian boundary; ×80.
Fig. 3: *Pedavis* sp. aff. *P. brevicauda* MURPHY & MATTI; section Oberbuchach II, sample no. 85, some 30 m above the base of the Pragian and associated with *Polygnathus pireneae* BOERSMA and *Eognathodus sulcatus* PHILIP; ×75 (fragmentary).
Fig. 4: *Icriodus steinachensis* AL-RAWI beta morphotype; section Červený lom near Klukovice in the Barrandian, approx. 1 m above the base of the Pragian in the Lodenice Lst.; ×60.
Fig. 5: *Icriodus steinachensis* AL-RAWI eta morphotype; section Oberbuchach II, sample no. 73, 5–6 m above the presumed Lochkovian-Pragian boundary; ×45.
Figs. 6,7,9: *Ozarkodina pandora* MURPHY et al. zeta morphotype; section Cikánka, bed no. 10 (= F); ×50, ×100 (detail).
Figs. 8,12: *Ozarkodina pandora* MURPHY et al. beta morphotype.
Fig. 8: Section Hvížďalka, approx. 1 m below the base of the Pragian; ×100.
Fig. 12: Section Cikánka, boundary bed 11 (= G); ×60.
Fig. 10: *Ozarkodina pandora* MURPHY et al. beta morphotype – gamma morphotype; section Hvížďalka, approx. 1 m below the base of the Pragian; ×45.
Figs. 11,18: *Ozarkodina pandora* MURPHY et al. alpha morphotype; section Cikánka, bed no. 10 (= F) (fig. 11), section Přídolí, sample no. 14, 1.50 m above the base of the Pragian; ×80, ×80.
Fig. 19: *Ozarkodina pandora* MURPHY et al. alpha morphotype – zeta morphotype transition; section Cikánka, bed no. 10 (= F); ×55.
Figs. 13–16: *Icriodus steinachensis* AL-RAWI eta morphotype; figs. 13–16 from section Cikánka, sample W 376 immediately above the base of the Pragian show variation of basal cavity width but also connecting main character of the spindle shaped platform; ×45.
Figs. 17,20–26: *Icriodus* sp. n. A.
Fig. 17: Černá rokle, sample no. 63, approx. 3.20 m below the base of the Pragian; ×90.
Fig. 20: Section Hvížďalka, 2.50 m below the base of the Pragian; ×70.
Fig. 21: Section Přídolí, 0.20 m above the base of the Pragian; ×50.
Fig. 22: Section Cikánka, sample W 376 immediately above the base of the Pragian; ×40.
Fig. 23: Section Cikánka, sample no. 7 (= C); ×50.
Fig. 24: Section Cikánka, sample no. 5 (= B); ×65.
Fig. 25: Section Cikánka, sample no. 11 (= G); ×60.
Fig. 26: Section Cikánka, sample no. 5 (= B); ×100.
Figs. 27,29: *Ancyrodelloides omus* MURPHY & MATTI.
Fig. 27: Section Černá rokle, sample no. 64, approx. 3 m below the base of the Pragian; ×80.
Fig. 29: Section Přídolí, sample no. 6, approx. 1.20 m below the base of the Pragian; ×50 (fragmentary).
Both types represent the noded beta morph.
Fig. 28: *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN); section Oberbuchach II; sample no. 58, 5–6 m below the presumed Lochkovian-Pragian boundary; ×40.
Fig. 30: *Ozarkodina remscheidensis remscheidensis* (ZIEGLER); section Cikánka, sample no. 8 (=D); ×80.
Fig. 31: *Pedavis* sp. aff. *P. breviramus* MURPHY & MATTI; a fragmentary specimen from section Přídolí, sample no. 9, approx. 0.30 m below the base of the Pragian; ×100.


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Plate 3

Lochkovian and lowermost Pragian chitinozoa from Bohemia.

Fig. 1: *Eisenackitina bohemica* (EISENACK); Kosoř section, bed no. 10/11, IGR 53901, (R.40), Lochkovian; ×250.

Fig. 2: *Margachitina catenaria catenaria* OBUT; Kosoř section, bed no. 21, IGR 53905, (T.37.2), Lochkovian; ×300.

Fig. 3: *Eisenackitina* cf. *cupetella* WRONA; Kosoř section, bed no. 63, IGR 53919, (P.46), upper Lochkovian; the outer layer is corroded; ×250.

Fig. 4: *Gotlandochitina ramosus* (PARIS); Kosoř section, bed no. 54, Lochkovian; the chamber processes are partially destroyed in this poorly preserved specimen (lost after scanning observation); ×400.

Fig. 5: *Margachitina catenaria tenuipes* PARIS; Kosoř section, bed no. 65, IGR 53921, (P.42.1), uppermost Lochkovian; the chamber diameter/pedoncle diameter ratio is significantly higher than those of *M. catenaria catenaria* (see fig. 2); ×500.

Fig. 6: *Urnochitina* sp. A; Cikánka section, bed no. 5, IGR 53840, (S.33), uppermost Lochkovian; note the tiny tubercles covering the chamber; ×400.

Fig. 7: *Urnochitina* sp. A; Cikánka section, bed no. 5, IGR 53840, (N.31), uppermost Lochkovian; the ornamented outer-layer of this specimen is destroyed by the corrosion; ×400.

Fig. 8: *Eisenackitina bohemica* (EISENACK); Třebotov section, bed no. 13, IGR 53812, (P.34), uppermost Lochkovian; elongate specimen with a peculiar pattern of ornamentation on its oral part; ×200.

Fig. 9a–b: *Eisenackitina* sp. A; Kosoř section, bed no. 21, IGR 53905, (M.41), Lochkovian.
9a: ×300.
9b: Detail of the peculiar ornamentation of this form; ×1500.

Fig. 10: *Eisenackitina elongata* EISENACK; Kosoř section, bed no. 10/11, IGR 53901, (P.40), Lochkovian; the oral part of this large specimen is partially broken, while the outer layer is erroded; ×200.

Fig. 11: *Gotlandochitina philippoti* PARIS; Kosoř section, bed no. 87 (70 cm above the base of this bed), IGR 53936, (P.43), lowermost Pragian; ×400.

Fig. 12: *Gotlandochitina philippoti* PARIS; Kosoř section, bed no. 87 (70 cm above the base of this bed), IGR 53936, (M.38.4), lowermost Pragian. Well preserved specimen showing branched processes; ×400.

Fig. 13a–b: *Angochitina comosa* TAUGOURDEAU & JEKHOWSKY; Třebotov section, 180 cm above the base of the Pragian, IGR 53835, (R.35).
13a: ×500.
13b: Detail of the spiny ornamentation (note the occurrence of some λ-spines); ×200.

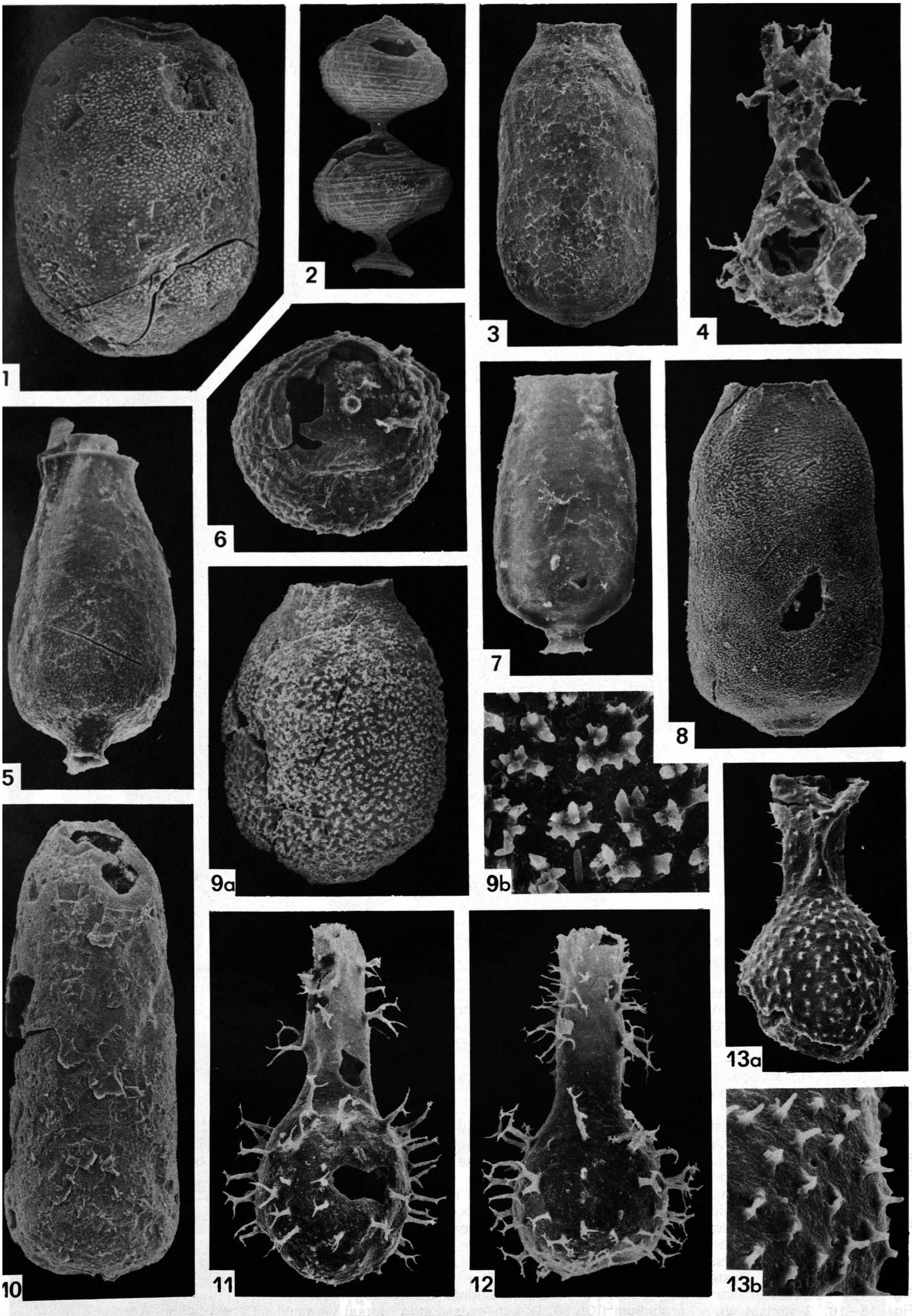
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Plate 4

Some trilobites from the late upper Lochkovian of the Barrandian.

Localities: 2–5,8–13 = Černá rokle near Kosoř; 6,14–16 = Solopysky – Třebotov; 7 = Praha – Velká Chuchle (Přídolí).

Figs. 1– 3: *Lochkovella misera* (BARRANDE).
- Fig. 1: Cephalon, lectotype (IT 393), internal mould; ×4.
- Fig. 2: Thorax and pygidium (ICh 6979), negative counterpart; ×2.5.
- Fig. 3: Pygidium of a young specimen (ICh 4558); ×7.

Figs. 4– 5: *Spiniscutellum umbelliferum* (BEYRICH).
- Fig. 4: Specimen without librigenae (private coll.); ×1.5.
- Fig. 5: Pygidium (ICh 6924); ×2.5.

Figs. 6– 7: *Spiniscutellum? plasi* (ŠNAJDR).
- Fig. 6: Almost complete specimen (ICh 6925); ×2.
- Fig. 7: Pygidium (ICh 6926a); ×2.

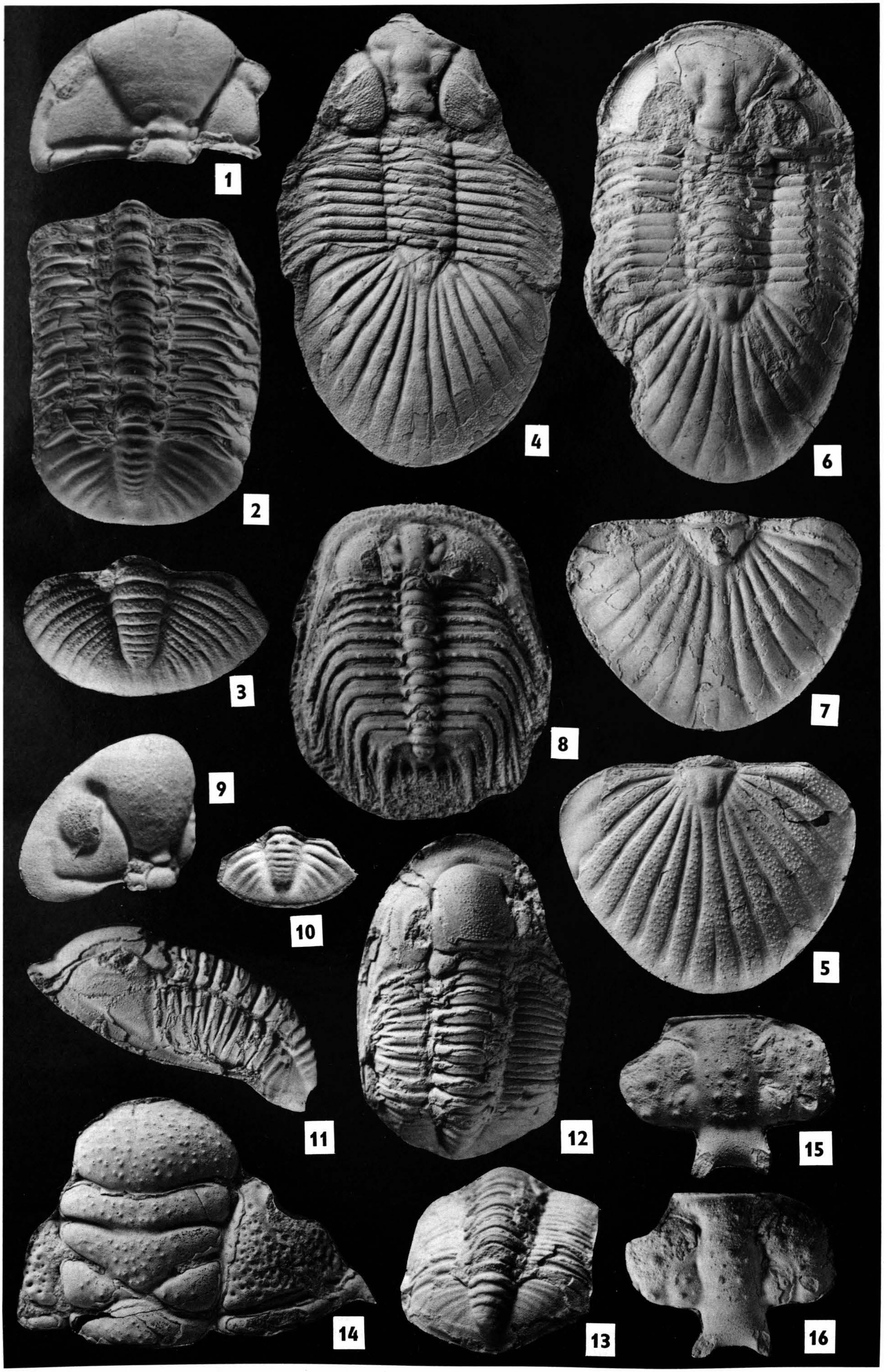
Fig. 8: *Leonaspis lochkovensis* (PRANTL & PŘIBIL); complete exoskeleton (L 1773) with partly broken spines; ×2.5.

Figs. 9–10: *Reedops limespragensis* CHLUPÁČ.
- Fig. 9: Cephalon, holotype (ICh 6910), internal mould; ×3.5.
- Fig. 10: Pygidium (ICh 6970), internal mould; ×4.

Figs. 11–13: *Lepidoproetus lepidus lepidus* (BARRANDE); almost complete specimen.
- Fig. 11: Lateral view; ×4.
- Fig. 12: Dorsal view; ×4.
- Fig. 13: Posterodorsal view; ×4.

Fig. 14: *Crotalocephalina chlupaci* (PŘIBYL & VANĚK); cranidium (ICh 6923); ×2.5.

Figs. 15–16: *Ceratonurus* sp. n.; cranidium (ICh 6921) with exoskeleton, dorsal views in different lights; ×4.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