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Lower Devonian conodonts from the Karlík Valley and Na Branžovech sections in the Barrandian area, Czech Republic, and their significance for Pragian conodont zonation

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ABSTRACT:

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Two Early Devonian sections used for this study display a markedly different facies development and lie on opposite limbs of the central Barrandian synform, in the stratotype area of the Pragian Stage. The present biostratigraphical information based on 18 species with a total of 350 conodont specimens is mostly related to the late Lochkovian and early Pragian, whilst the remaining parts of the Pragian involve mostly long-range conodont species. The late Lochkovian conodonts correspond to two zones *eurekaensis* and *delta*. The latest Lochkovian zone *pesavis* was found in the northwestern limb, but not on the opposite side. The absence of *pesavis* Zone in the south (Koněprusy) and, as it has been newly shown, in the south-east of the central Barrandian synform (Karlík Valley) suggests that a prominent lowstand sedimentary starvation affected much larger areas than only the tops of elevated ridges. The lower two thirds of the Pragian sequences can be zoned using two newly suggested conodont zones *steinachensis* and *serratus*, respectively, that are defined by the first and last occurrences of these taxa. The occurrence of *Latericriodus steinachensis* (AL-RAWI) eta morph. marks the lower third and the entry of *Pelekysgnathus serratus serratus* JENTZSCH corresponds to the base of the middle third of the Pragian. The newly suggested stratigraphical applicability of these two species can effectively substitute the pre-existing *sulcatus* and *kindlei* subdivisions that have no zonal species representation in the stratotype area. The first occurrence of *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER) seems to indicate the base of the Emsian in the Na Branžovech section. The entry of this taxon is connected with the black-shale Graptolite Event within the latest Dvorce-Prokop Limestone that is several beds higher than the levels usually considered for entry of a debatable taxon *Polygnatus pireneae*. The base of the Graptolite Event gives better chance for the correlation of the Pragian-Emsian boundary than any of the underlying levels. Evolution of the Barrandian conodont assemblages shows many parallels with those of Morocco and Carnic Alps.

Key words: Conodonts, Biozones, Barrandian area, Early Devonian, Pragian.

INTRODUCTION

The complicated evolution of Early Devonian sedimentary environment in the Barrandian area is documented by great facies diversity of Lower Devonian sediments (CHLUPÁČ 1956, CHLUPÁČ & *al.* 1998), and, what is very distinctive, expressed also in composition of conodont assemblages. The conodont facies and thanatocoenoses considerably vary between the sections in close neighbourhood. This situation concerns also biozones or index taxa between the Lochkovian and Pragian.

A conodont-based subdivision of the Lower Devonian into several zones, initiated by KLAPPER (1969), has been refined by subsequent workers, e.g. ZIEGLER (1971), FAHRAEUS (1971), KLAPPER & MURPHY (1975), BULTYNCK (1976), BARDASHEV & ZIEGLER (1992), MAWSON & TALENT (1994) and MAWSON (1995, 1998). Earlier subdivision of the Lower Devonian, especially the Pragian, was based on informal faunal units until KLAPPER (1977) suggested formal zones. However, application of these standard zones is connected with many problems related to the absence of index taxa or their stratigraphical uncertainty. These complications also imply the uncertainty in correlation with dacryoconarids, macrofauna, as well as geochemical and physical events.

The generally used conodont zonation of the Pragian is a three-fold one, operating with the *sulcatus*, *kindlei*, and *pireneae* zones, for the lower, middle and upper parts of the Pragian, respectively. Application of this three-fold subdivision in the Barrandian area is hampered by the fact that all index taxa are extremely scarce to absent at many places and, which is much worse, cross stratigraphically the expected ranges of occurrence (cf. early entries of *Polygnathus pireneae* in Na Požárech section). Scarcity with unclear ranges cause a considerable bias in the Pragian conodont stratigraphy that implies a practical inapplicability of these zones in the Barrandian, as well as Moroccan, Mediterranean or Cantabrian and Palentinese facies (a significant part of peri-Gondwanan sea).

Each of these three zones has significant problems as regards discrimination of the lower limits and their interregional correlation. Differences between the North American and European conodont assemblages may exemplify these problems. All worldwide reviews of Lower Devonian conodont distribution and biostratigraphy provided evidence for culmination of endemism during the Pragian, when profound global eustatic fall of sea level appeared (JOHNSON & SANDBERG 1989). In addition, many Pragian conodonts are either sparsely distributed in rocks of these ages or dominated by long-ranging taxa of little value for refining of stratigraphical scale. This unlikely conjunction of biotic evolution (low abundance, high endemism and preference of long-range opportunists) with geographical barriers in aquatic environments (lowstands), and of course a dearth in information from other significant world areas as well, seriously constrain attempts towards arriving at a useful standard zonation.

The Devonian of the Barrandian area has still primary stratigraphic significance, due to international acceptance of the so-called Hercynian (or Bohemian) stages. The worldwide accepted S/D and Lo/Pg GSSPs lie in the Barrandian area and the Lochkovian and Pragian stages were also derived from this area. The Significance of the Zlichovian and Dalejan as equivalents of the Lower and Upper Emsian seems to be appreciated again, mostly due to their capacity in global correlations, which is connected with open-sea characters of the biotic and sedimentary records. The underpinning tools for global biostratigraphy are chitinozoans (mainly for the early Lochkovian) and dacryoconarids (mainly for the Zlichovian and Dalejan), but conodonts considered to be the main biostratigraphical tool for the Devonian are still poorly known in the stratotype area, with the exception of several studies about the boundaries (Pr/Lo, Lo/Pg, Pg/Em, and lastly Em/Ei, which is of a very high quality) (cf. JEPPSSON 1988, WEDDIGE 1987, SCHÖNLAUB in CHLUPÁČ *& al.* 1985, KALVODA 1995 and KLAPPER *& al.* 1978, respectively). Only two papers dealing with continuous conodont sections throughout the stages (Lo/Pg and Pragian) were published (HLADIL & SLAVÍK 1997; SLAVÍK 1998). In spite of the fact that Pragian conodonts are scarce worldwide, the lacunae in our knowledge about conodonts from the classical Barrandian area can be improved using new data. This possibility really exists. Otherwise we could hardly correlate details of the Pragian biostratigraphy missing in any reasonable zones and markers within the sedimentary sequences of this stage.

The purpose of this short report is to suggest some solutions for the Pragian conodont zonation, which are exemplified by conodont faunas from two constituent Barrandian sections. These two Early Devonian sections lie in opposite limbs of the central Barrandian synform (Text-fig. 1). Whilst the Na Branžovech section displays the most complete sequence of the Pragian facies (Koněprusy, Slivenec, Loděnice, Řeporyje and Dvorce-Prokop limestones) and lies within the north-western limb of this synform, the Karlík Valley section in the opposite limb consists exclusively of the Dvorce-Prokop Limestone.

Fig. 1. Location of the studied area; the studied sections lie in opposite limbs of the central Barrandian synform

Karlík Valley section

This section is located on the southeastern slope of the valley in the close neighbourhood of Karlík village near Dobřichovice about 15 km southwest of Prague. As indicated above, it lies in the south-eastern limb of the Pragian outcrops in the synform (Text-fig. 1; for more details about sequences and outcrops see CHLUPÁČ *& al.* 1998, and MELICHAR & HLADIL 1999). A low ridge extends to the valley, and the base of the section lies close above the signpost of the Protected Landscape Area, which is visible from the road. Small abandoned pits and karstified rocks in the Lochkovian limestones at the base of the ridge pass upslope into a continuous section only occasionally interrupted by a thin cover of soil and vegetation. The ridge exposes the Lochkovian, Pragian and Zlichovian sediments. I. CHLUPÁČ covered the primary documentation of this section in 1987 (unpublished data).

SAMPLE No. / TAXON	*Caudicriodus w. postwoschmidti*	*Ozarkodina r. remscheidensis*	*Ozarkodina e. excavata*	*Latericriodus steinachensis eta*	*Pelekysgnatus s.serratus*	*Belodella triangularis*	*Belodella resima*	*Belodella devonica*
1K	1			-	-	-	2	3
2K	-	8	-	-	-	2	4	-
3K	-	-	3	1	-	-	5	-
4K	-	-	3	-	-	-	3	2
5K	-	-	4	-	2	-	-	2
6K	-	-	4	-	2	-	2	-
7K	-	-	5	-	3	-	5	-
8K	-	-	3	-	-	-	-	-
9K	-	-	18	-	-	-	3	3
10K	-	-	2	-	-	2	-	-

Fig. 2. Quantity and occurrence of conodont taxa in samples from the Karlík Valley section

The first conodont sample *1K* was taken at a distance 40 m from the signpost, in well-bedded light grey biodetrital limestones with uneven bedding planes (Kotýs Limestone). The sample provided relatively rich conodont fauna (cf. Text-fig. 2). *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) and *Caudicriodus woschmidti postwoschmidti* (MASHKOVA) indicate Lochkovian age. According to KLAPPER & JOHNSON (1980), *Caudicriodus woschmidti postwoschmidti* ranges within the *eurekaensis* Zone, which characterises a thick lower part of the Lochkovian. This subspecies was documented approximately at the same stratigraphical level in Podolia on Ukraine (MASHKOVA 1968, 1971), in Guadarrama (BULTYNCK 1976; CARLS & GANDL 1969), Carnic Alps (SCHÖNLAUB 1980) and SW Sardinia (OLIVIERI & SERPAGLI 1990). In the Barrandian area, two records of *C.*

TAXON / SAMPLE No.	1B	2B	3B	4B	5B	6B	7B
Ozarkodina e. excavata	2	16	32	15	6	3	12
Ozarkodina r. remscheidensis	15	28	-	-	-	-	-
Ozarkodina r. repetitor	-	-	6	-	-	-	-
Pedavis pesavis	-	1	-	-	-	-	-
Latericriodus steinachensis eta	-	1	-	-	-	-	-
Latericriodus b. beckmanni	-	-	-	-	-	-	3
Latericriodus b. bilatericrescens	-	-	-	-	-	2	2
Caudicriodus angustoides alcoleae	2	-	-	-	-	-	-
Caudicriodus celtibericus	-	-	-	-	11	3	9
Ancyrodelloides trigonicus	1	-	-	-	-	-	-
Ancyrodelloides transitans	3	4	-	-	-	-	-
Belodella devonica	-	11	-	2	-	-	-
Belodella resima	-	26	-	8	-	-	-
Pandorinellina steinhornensis miae	-	-	-	-	-	2	1
Pelekysgnathus s. serratus	-	-	2	-	-	-	-
Polygnathus pireneae	-	-	-	1	-	-	-
Panderodus unicostatus	-	4	4	6	-	-	-

Fig. 3. Quantity and occurrence of conodont taxa in samples from the section of the Na Branžovech Quarry

w. postwoschmidti were documented: in the Klonk section near Suchomasty this taxon occurs together with the first Lochkovian graptolite *Monograptus uniformis*. However, the U topolů section allows to trace this taxon in association with *Icriodus woschmidti woschmidti* ZIEGLER, *Icriodus woschmidti hesperius* KLAPPER & MURPHY and even higher in the section together with *Pedavis pesavis* (BISCHOFF & SANNEMANN), as it was described by SCHÖNLAUB *in* CHLUPÁČ *& al.* (1980). All the above mentioned species indicate very wide stratigraphic range, involving even three Lochkovian conodont biozones – from the lowermost *hesperius* Zone, if considered, through the *eurekaensis* Zone, up to the uppermost Lochkovian *pesavis* Zone. This zonal succession is not compatible with the standard occurrence of *C. w. postwoschmidti* MASHKOVA in the lower Lochkovian *eurekaensis* Zone. No other stratigraphically significant species except for a few simple cone elements were found in the sample *1K*.

The next conodont sample *2K* taken 8.5 m above the first one along the inclined beds of the Lochkovian limestones of the Kotýs Member also provided the Lochkovian fauna with significant *Ozarkodina remscheidensis remscheidensis* (ZIEGLER). The lithological boundary between the Lochkov and Praha formations lies ca. 5 m above this level, but cannot be traced well due to the soil cover.

Another sample comes from the basal beds of Pragian (Text-fig. 3), which are represented here by a direct onset of the Dvorce-Prokop Limestone. Sets of light grey micritic beds with uneven bedding surfaces (dissolution) alternate with 0.2 m thick banks of lime-mud-supported very fine distal calciturbidites. Alternation of these two types of the beds, i.e. Dvorce and Prokop, respectively, continues throughout the entire 60 m thickness of the Praha Formation at the Karlík Valley section but the Dvorce rock type dominates in the middle part of the section. *Latericriodus steinachensis* (AL-RAWI) eta morphotype KLAPPER & JOHNSON from this sample *3K* is usually regarded a species indicative of the lower Pragian *sulcatus* Zone. Long-range species *Ozarkodina excavata excavata* (BRANSON & MEHL) and *Belodella resima* PHILIP are of low stratigraphic value at least in the present state of their study. The change from dark grey grainstone and shaly successions formed by turbidity flows of upper Lochkovian to relatively light but often micritic Pragian limestones is connected with a considerable decrease in the abundance of conodonts. Another depression in abundance of conodonts appeared also later, during the late Pragian. This is likely a consequence of two global sea-level falls. These two depressions in abundance, connected with prograding shoreline and a number of hiatuses, were also observed in the shallow-water environment of the Konnprusy area (HLADIL & SLAVÍK 1997, SLAVÍK 1998).

Further sampling continued throughout the section in 10-m intervals. Only a single element of *Pelekysgnathus serratus serratus* JENTZSCH has a certain stratigraphical importance in this remaining part of the Dvorce-Prokop Limestone (Text-figs 2 and 3). *P. s. serratus* usually ranges within the middle part of the Pragian sedimentary sequences, here in samples *5K* to *7K*.

The onset of the Zlichov strata is marked by the appearance of light grey banks with smooth bedding planes characterised by litho- to bioclastic grainstones to calcisiltites and grey to brown cherts (irregular patches with positive weathering relief). Sample *10K* from these beds after a lithological change contained only long-ranging taxa, like *Ozarkodina e. excavata* (BRANSON & MEHL) and *Belodella triangularis* (STAUFFER) (cf. Text-figs 2 and 3).

Na Branžovech section

This section is located in a large active quarry about 2 km SE of Loděnice village in the vicinity of Beroun. A rampart of weathered stones and soil on an elevated part of a peneplain is visible from both Bubovice and Loděnice roads. The rock faces of the Na Branžovech quarry show the upper part of the Lochkovian, the entire Pragian and the lower Zlichovian. The beds in this north-western limb of central Barrandian synform dip to the southeast. A great advantage of this section is the continuation of the Lo/Pg and Pg/Em transitions, where usual bedding-parallel detachments of lithological units are absent. Only the middle part of the Pragian section is partly complicated due to the presence of normal faults (locally with tectonic breccias). Because of the fact that the Na Branžovech section lies in the north-western limb, all Pragian facies are arranged in a characteristic succession from the base to the top of the Praha Formation (Koněprusy, Slivenec, Loděnice, Řeporyje and Dvorce-Prokop limestones). The Koněprusy Limestone at the base differs from that in the Koněprusy area by the absence of reef structures and typical reef organisms. The Loděnice Limestone wedges out in the western part of the quarry in microbial mud-mounds with big scullellulids and *Odontochille* trilobites. Although the coquinas or shelly layers of gastropods, trilobites and brachiopods locally fill the truncated surface of these bioherms, long-term presence of shallow-water environment is unlikely as indicated by the absence of shallow-water corals, stromatoporoids or algae. This is a very typical phenomenon for the entire north-western limb from Na Požárech to Svatý Jan (MELICHAR & HLADIL 1999) that the late

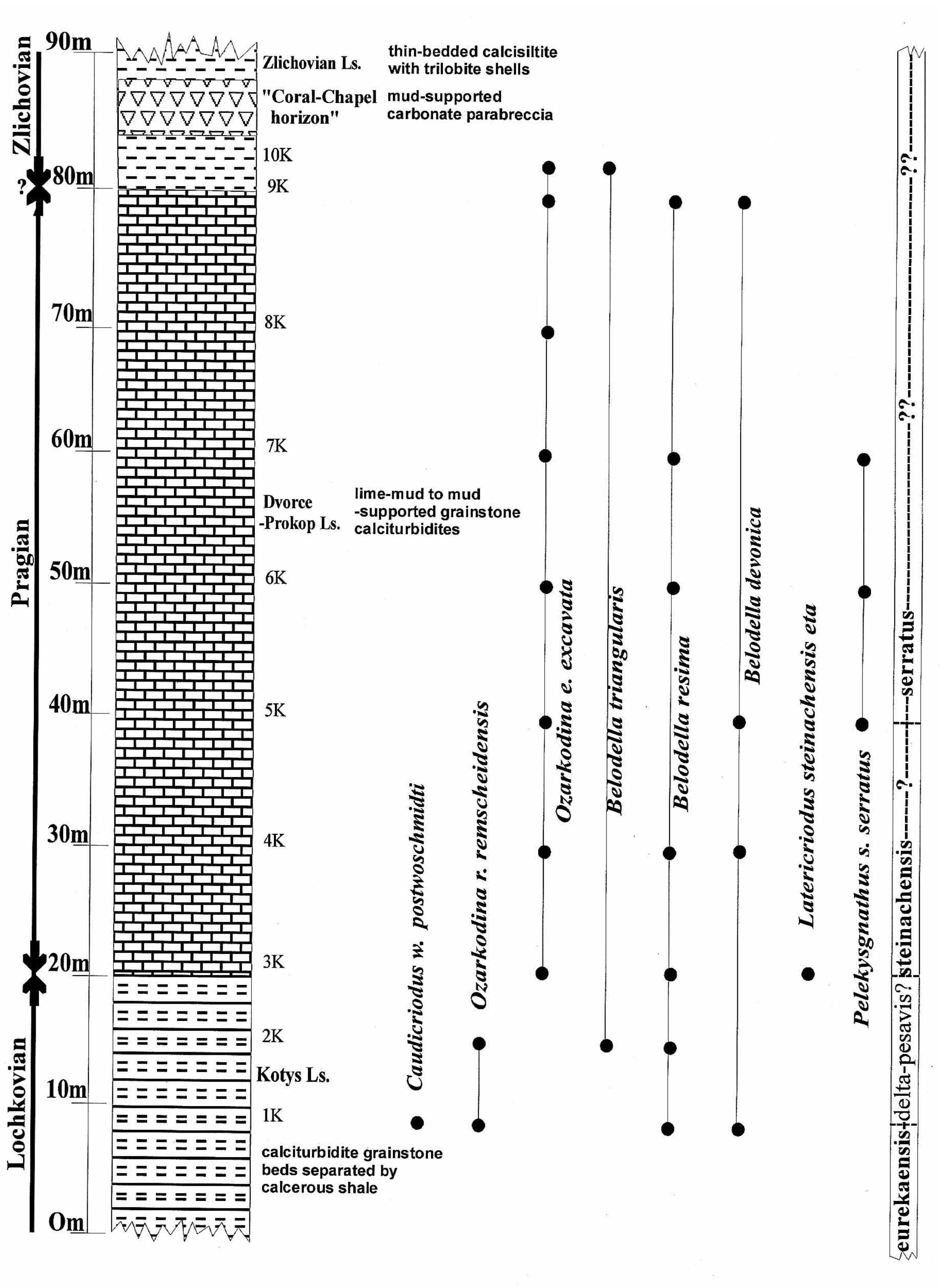

Fig. 4. Stratigraphical distribution of conodont taxa in the Karlík Valley section

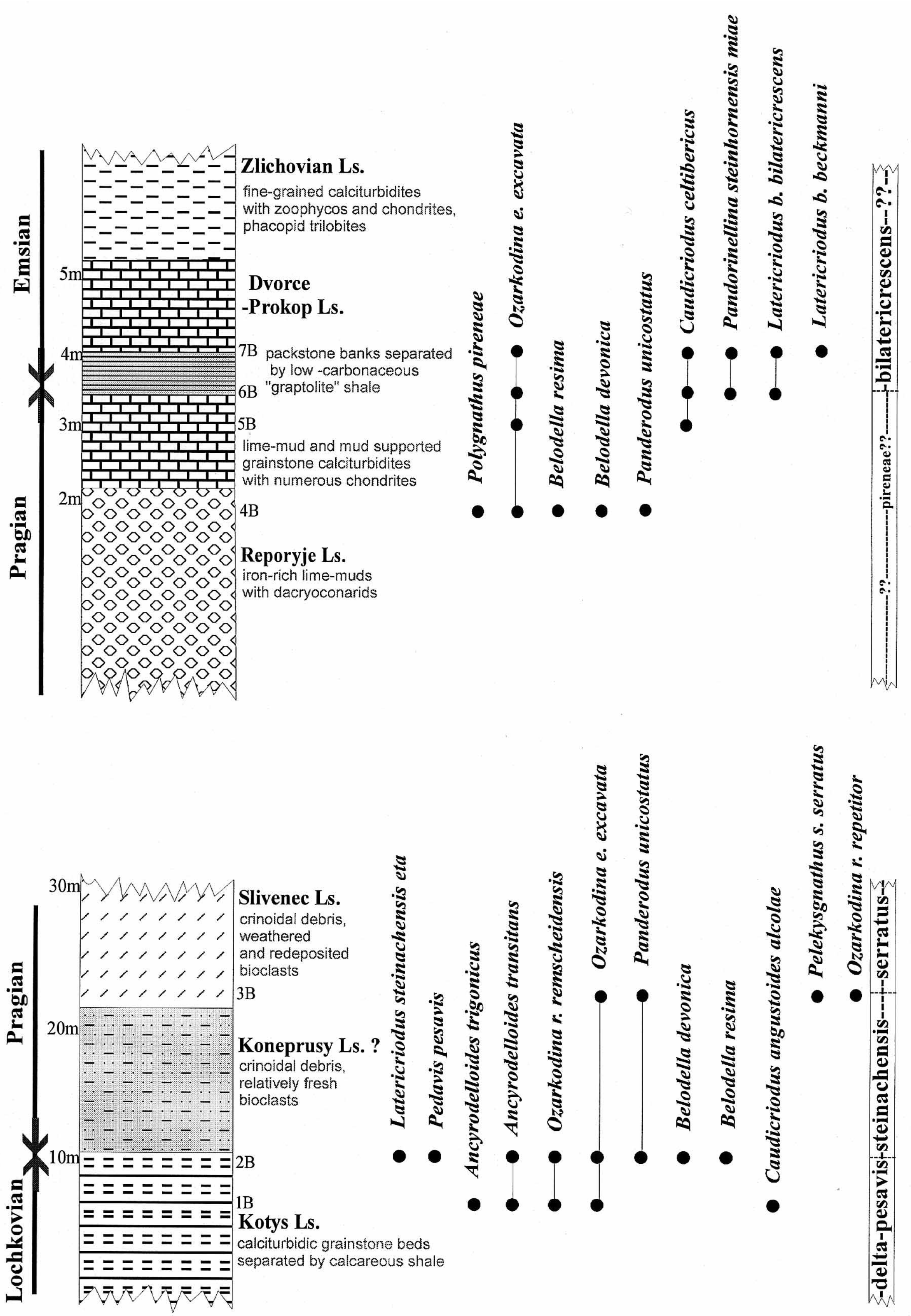

Fig. 5. Stratigraphical distribution of conodont taxa in the Na Branžovech section

Pragian Dvorce-Prokop Limestone is intercalated by a series of 7 to 8 beds of the so-called Graptolite Shaly Event (cf. HLADIL *& al.* 1996, HLADIL & KALVODA 1997).

Seven samples were picked up in order to recognise the lower and upper sequence boundary, Lo/Pg and Pg/Em respectively. The 1999 conodont sampling in the middle part of the Pragian was complicated by the presence of a normal fault but this inconvenience was eliminated by the advance of the quarry face in this year. The first sample comes from the Kotýs Limestone, about 5 m below the lower boundary of the Praha Formation. It provided three stratigraphically significant taxa *Caudicriodus augustoides alcolae* (CARLS), *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN and *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN). These taxa suggest that the corresponding age is late Lochkovian *delta* Zone. The typical Lochkovian conodont *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) was also found in *1B* (Text-figs 4 and 5) but the find of *Caudicriodus augustoides alcolae* is particularly important because it is the first time that this taxon is reported from the Barrandian area. The previous literature involves only two references related to this conodont species from other world areas, i.e. from Guadarrama, Spain (CARLS 1969) and SW Sardinia, Italy (MASTANDREA 1985a).

Sample *2B* yielded relatively rich conodont fauna marking the levels which are very close below the lithological change from late Lochkovian Kotýs facies to crinoidal limestone of the basal Praha Formation. *Pedavis pesavis* (BISCHOFF & SANNEMANN) suggests the presence of the *pesavis* Zone in sample *2B* (Text-figs 4 and 5). Two times larger than usual mass of the sample (ca. 8 kg) corresponds to increased number of elements, for instance the presence of *Latericriodus steinachensis* (AL-RAWI) eta morph. and/or relative abundance of *Ozarkodina remscheidensis remscheidensis* (ZIEGLER). Abundance of *Ancyrodelloides transistans* (BISCHOFF & SANNEMANN) is roughly the same as in sample *1B*, but smaller as for the amount of dissolved limestone (Text-fig. 4).

In contempt of 3-m distance between samples *1B* and *2B*, this might indicate relatively precise position of the change from the *pesavis* to *sulcatus* Zone, from Lochkovian to Pragian, respectively. Of course the *sulcatus* Zone is inferred indirectly here, from the presence of *Latericriosus steinachensis* eta morph. According to the previous investigations of CHLUPÁČ *& al.* (1985), the first occurrence of this taxon might indicate the real base of the Pragian.

Ca. 10 m above the base of the Pragian, the light grey crinoidal limestones are gradually changing to rose coloured Slivenec Limestone. Its lowermost part, actually sample *3B*, contains *Pelekysgnathus serratus serratus* JENTZSCH and *Ozarkodina remscheidensis repetitor* (CARLS & GANDL). The middle Pragian interval with the Loděnice Limestone was not involved in the 1999 sampling from the above mentioned reasons (normal faults) and the gap in sampling still persist.

The ca. 15-m thick Řeporyje Limestone is exposed especially in the southwestern part of the quarry. Densely spaced, uneven bedding planes are common but massive and thick dismicritic banks are also involved (S corner of quarry). This intensively red coloured rock corresponds mostly to lime-mud, dacryoconarids-bearing calciturbidites (cf. HLADIL *& al.* 1996 at Stydlé Vody, Svatý Jan). Another sample (*4B*) comes from the upper beds of this limestone. It involves an index species for the recognition of the *pireneae* Zone (*Polygnathus pireneae* BOERSMA). However, the worldwide delimitation of the *pireneae* Zone implies many stratigraphic and taxonomic difficulties, which were listed in detail by VALENZUELA-RIOS (1997).

Gradual transition to the Dvorce-Prokop Limestone is connected mainly with a decreased content of iron whilst the sedimentary character of limestone remains roughly unchanged. This transition occurs within ca. 0.5 to 1 m in the section. The lower part of the Dvorce-Prokop Limestone ends with the onset of the so-called Graptolite Shaly Event. Seven relevant limestone beds are separated by slightly calcareous shaly interbeds (total thickness of 0.7 m). One bed is missing in comparison to Mramorka Quarry near Chýnice or Stydlé vody Quarry near Svatý Jan (cf. HLADIL *& al.* 1996). These event-related series of dark-grey to black beds was again covered by the Dvorce-Prokop Limestone 1.5 m thick.

The change from the limestones of the uppermost Praha Formation to the Zlichov Limestone is sharp but very slightly expressed in lithology. The first beds of the Zlichov Formation are thinner, slightly enriched in dispersed chalcedony quartz and display more plain bedding surfaces than the underlying beds of the Praha Formation. Conversely, the contents of micrite, colour of the rock or the presence of *Zoophycos-Chondrites* ichnoassemblage do not represent good tools for differentiation of these two units at Na Branžovech, because both these successions of beds are calciturbidites, and the basal Emsian equivalents of the Chapel Horizon are rarely present on these very distant places. The source of sliding material that fed the gravitational density currents of channellized debris could have been located several tens of kilometres SSE, now eroded, of course, in the present configuration of the Barrandian terrane (cf. HLADIL *& al.* 1996, CHLUPÁČ *& al.* 1998).

The taxa obtained from samples *5B* and *7B* in the Dvorce-Prokop Limestone – *Caudicriodus celtibericus* (CARLS & GANDL), *Pandorinellina steinhornensis miae* (BULTYNCK) and *Ozarkodina excavata excavata* (BRANSON

& MEHL) – have wide stratigraphical range and continue through the upper Pragian to the lower Emsian beds. The early Emsian occurrence of *Latericriodus beckmanni beckmanni* (ZIEGLER) at Na Bran?ovech extremely exceeds the common range of this mid-Emsian species (cf. BULTYNCK 1976). *L. b. beckmanni* enters this section immediately above the Graptolite Shaly Event. The most significant species to mark the Emsian base is *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER), which entered the section with the first bed of the Graptolite Shaly Event. Of course, it is slightly higher than suggested by KALVODA (1995) according to the *kitabicus* concept of the Pg/Em boundary that is related to a mid-level in the underlying succession of Dvorce-Prokop Limestone.

SYSTEMATIC PART

Family *Icriodontidae* MÜLLER & MÜLLER, 1957
Genus Caudicriodus BULTYNCK, 1976

TYPE SPECIES: *Icriodus woschmidti* ZIEGLER, 1960

Caudicriodus angustoides alcoleae (CARLS, 1969)
(Pl. 3, Fig. 5)

Pa element

1969. *Icriodus angustoides alcoleae* n. subsp.; P. CARLS, pp. 326-327, Pl. 1, Fig. 12; Pl. 2, Figs 1-2.
1976. *Caudicriodus angustoides alcoleae* (CARLS); P. BULTYNCK, pp. 34-35, Pl. 4, Figs 14, 18-28.
1985a. *Icriodus angustoides alcoleae* CARLS; A. MASTANDREA, p. 248, Pl. 4, Figs 7-20.

MATERIAL: 2 specimens

DESCRIPTION: The I element is characterised by narrow spindle-shape. The ultimate denticle of the median row (the cusp) is much higher than the other ones. *Caudicriodus angustoides alcoleae* has a few transverse rows consisting of nodes, which are to a great extent fused to form transverse ridges. The element bears a distinct undenticulated costa on the outer lateral or posterior process, that extends beyond the posterior margin of the basal cavity. The narrow basal cavity is gradually expanded from the mid-length of the main axis to the posterior end of the unit.

REMARKS: *Caudicriodus angustoides alcoleae* is distinguishable from *Caudicriodus angustoides angustoides* (CARLS & GANDL) by having not so high posteriormost denticle as does the latter one. Unfortunately, the specimen figured is not complete as it is broken in posterior part. The transversal ridges are not so much distinctive in *C. a. alcoleae*. These two taxa are regarded here to fall clearly within the genus *Caudicriodus* introduced by BULTYNCK (1976). The described species was previously referred only from Guadarrama (CARLS 1969, BULTYNCK 1976) and from southwestern Sardinia (MASTANDREA 1985a).

STRATIGRAPHIC RANGE: The *eurekaensis* and *delta* zones (KLAPPER & JOHNSON 1980, Tab. 2).

Caudicriodus woschmidti postwoschmidti (MASHKOVA, 1968)
(Pl. 1, Fig. 1)

Pa element

1962. *Icriodus woschmidti* ZIEGLER; I. JENTZSCH, Pl. 1, Figs 17?, 20-21.
1968. *Icriodus woschmidti postwoschmidti* n. subsp.; T.V. MASHKOVA, pp. 943-944, Pl. 1, Figs 1-3.
1968. *Icriodus eolatericrescens* n. sp.; T.V. MASHKOVA, p. 942. Pl. 1, Figs 4-5.
1968. *Icriodus woschmidti* ZIEGLER; R. SCHULZE, pp. 191-192, Pl. 16, Fig. 9.
1969. *Icriodus woschmidti transiens* n. subsp.; P. CARLS & J. GANDL, pp. 174-176, Pl. 15, Figs 1-7.
1971. *Icriodus postwoschmidti* MASHKOVA; T.V. MASHKOVA, Pl. 3, Figs 1, 8-9.
1971. *Icriodus eolatericrescens* MASHKOVA; T.V. MASHKOVA, Pl. 3, Figs 2, 6-7.
1976. *Caudicriodus postwoschmidti* (MASHKOVA); P. BULTYNCK, pp. 26-28, Pl. 6, Figs 1-2.
1980. *Icriodus woschmidti woschmidti* ZIEGLER; J.W. PICKETT, p. 70, Fig. 3D (non Figs 3B or 3C).
1980. *Icriodus postwoschmidti* MASHKOVA; I. CHLUPÁČ *& al.*, Pl. 19, Figs 2-3.
1980. *Icriodus* cf. *postwoschmidti* MASHKOVA; H.P. SCHÖNLAUB, Pl. 6, Fig. 8.
1980. *Icriodus postwoschmidti* MASHKOVA; H.P. SCHÖNLAUB, Pl. 7, Fig. 1.
1990. *Icriodus woschmidti postwoschmidti* MASHKOVA; R. OLIVIERI & E. SERPAGLI, p. 63, Pl. 1, Figs 15-16.
1994. *Caudicriodus postwoschmidti* (MASHKOVA); M. BENFRIKA, pp. 118-119, Pl. 9, Fig. 3.

MATERIAL: 1 specimen.

REMARKS: The specimen figured represents a mature Pa element of *Caudicriodus woschmidti post-*

woschmidti. Even though the lateral processes are not complete, the depicted element shows all diagnostic traits defined on Podolian specimens (MASHKOVA 1968). The platform is considerably expanded posteriorly and the posteriormost denticle of the median axis is more distinct than the main cusp. The transverse ridges of the main platform are almost transformed into three rows of nodes. *Caudicriodus woschmidti postwoschmidti* is distinguishable from *Caudicriodus woschmidti woschmidti* (ZIEGLER) by having somewhat more expanded basal cavity and three rows of nodes instead of transverse ridges. The scarcity of *C. w. postwoschmidti* in the Barrandian area is exemplified by only two finds that are related to the Karlík Valley section (this paper) and U topolů section (CHLUPÁČ *& al.* 1980).

STRATIGRAPHIC RANGE: *eurekaensis* Zone (KLAPPER & JOHNSON 1980, Tab. 2).

Caudicriodus celtibericus (CARLS & GANDL, 1969)
(Pl. 2, Fig. 7)

Pa element

1967. *Icriodus latericrescens huddlei* n. subsp.; G. KLAPPER & W. ZIEGLER, p. 75, Pl. 8, Figs 3-4, 6-8.
1969. *Icriodus huddlei celtibericus* n. subsp.; P. CARLS & J. GANDL, pp. 182-183, Pl. 16, Figs 18-20.
1972. *Icriodus huddlei huddlei* KLAPPER & ZIEGLER; P. BULTYNCK, p. 75, Fig. 4.
1975. *Icriodus huddlei* KLAPPER & ZIEGLER; W. ZIEGLER in ZIEGLER (*Ed*.), pp. 117-119, Icriodus - Pl. 4, Fig. 4.
1976. *Caudicriodus celtibericus* (CARLS & GANDL); P. BULTYNCK, pp. 29-31, Pl. 6, Figs 7-19; Pl. 7, Figs 27-29.
1980. *Icriodus celtibericus* CARLS & GANDL; G. KLAPPER & D.B. JOHNSON, p. 447, Pl. 2, Figs 12-17.
1988. *Latericriodus celtibericus* (CARLS & GANDL); J. GRÖTSCH, p. 166, Pl. 13, Figs 19-20; 1-2.
1990. *Icriodus celtibericus* CARLS & GANDL; R. OLIVIERI & E. SERPAGLI, p. 62, Pl. 1, Figs 1a-5, 19.
1995. *Caudicriodus celtibericus* (CARLS & GANDL); J. KALVODA, pp. 35-36, Pl. 1, Figs 5-9, 11; Pl. 2, Figs 1, 4.

MATERIAL: 23 specimens

REMARKS: Pa element of *Caudicriodus celtibericus* (CARLS & GANDL, 1969) described from the section Na Branžovech well corresponds to the material from the Eastern Iberian Chains of CARLS & GANDL (1969) and from the Sierra de Guadarrama of BULTYNCK (1976). In this paper, I agree with BULTYNCK (1976), that the holotype of *Icriodus huddlei* KLAPPER & ZIEGLER figured by ZIEGLER (1956) represents a juvenile specimen that shows juvenile traits of *Latericriodus bilatericrescens* (ZIEGLER). Thus, *Caudicriodus celtibericus* is a separate species and cannot be treated as a subspecies of *I. huddlei* KLAPPER & ZIEGLER, 1967. In the upper view, the specimen figured herein is characterised by a narrow shape of the main platform and its incurvation in the posterior end. However, it is difficult to distinguish the juvenile and incomplete specimens from their possible successor *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER). The occurrence of *C. celtibericus* is still restricted to the so-called Palaeotethyan realm, i.e. actually to several of the Laurussian/Gondwanan sea passages. Missing evidence from North America, Australia and Asia considerably constrain possible correlation potential of this species.

STRATIGRAPHIC RANGE: The elements of *Caudicriodus celtibericus* were reported by KALVODA (1995) from the Barrandian sections from the upper part of the Pragian. In the section of Na Branžovech, this species co-occurs together with *Latericriodus bilatericrescens bilatericrescens*, *Latericriodus beckmanni* and *Pandorinellina steinhornensis miae* that indicate upper Pragian – lower Emsian ages. *C. celtibericus* ranges mostly within the *dehiscens* Zone, but might be assumed also in slightly older beds in Moroccan Messeta (BENFRIKA 1994; the *kindlei* Zone).

Genus: *Latericriodus* MÜLLER, 1962

TYPE SPECIES: *Icriodus latericrescens* BRANSON & MEHL, 1938.

Latericriodus beckmanni beckmanni (ZIEGLER, 1956)
(Pl. 2, Fig. 2 and 4)

Pa element

1956. *Icriodus latericrescens beckmanni* n. subsp.; W. ZIEGLER, p. 102, Pl. 6, Figs 3-5.
1967. *Icriodus latericrescens beckmanni* ZIEGLER; W. ZIEGLER, Pl. 8, Fig. 5.
1970. *Icriodus latericrescens beckmanni* ZIEGLER; E.C. DRUCE, Pl. 5, Figs 7a-b.
1976. *Latericriodus beckmanni* (ZIEGLER); P. BULTYNCK, p. 72, Pl. 9, Figs 1-6.
1985. *Latericriodus beckmanni beckmanni* (ZIEGLER); P. BULTYNCK, Pl. 5, Fig. 8.
1980. *Icriodus beckmanni* subsp.; I. CHLUPÁČ *& al.*, Pl. 21, Fig. 5.
1980. *Icriodus beckmanni beckmanni* ZIEGLER; I. CHLUPÁČ *& al.*, Pl. 24, Fig. 12.

1988. *Latericriodus beckmanni* (ZIEGLER); J. GRÖTSCH, p. 165, Pl. 14, Figs 39-40.
1989. *Latericriodus beckmanni* (ZIEGLER); P. BULTYNCK, p. 187, Pl. 7, Fig. 12.
1994. *Latericriodus bilatericrescens bilatericrescens – beckmanni beckmanni*; S. GARCIA-LOPEZ & C. ALONSO-MENENDEZ, Pl. 3, Figs 4-5.
1994. *Latericriodus beckmanni* (ZIEGLER); M. BENFRIKA, p. 121, Pl. 11, Figs 15, 20.
1998. *Latericriodus beckmanni* (ZIEGLER), L. SLAVÍK, pp. 160-161, Pl. 3, Fig. 7.
1999. *Icriodus beckmanni beckmanni* ZIEGLER; F.W. LUPPOLD & R. WOLFART, Pl. 6, Fig. 2; Pl. 7, Fig. 3.

MATERIAL: 3 specimens.

REMARKS: *Latericriodus beckmanni beckmanni* is known to differ from *Latericriodus bilatericrescens bilatericrescens* by having two distinct and one indistinct lateral processes and a much more expanded posterior basal cavity. Two specimens figured from the Na Branžovech section correspond well with the typical representatives of this species. Well-developed and a strong outer process meets the median row of denticles at its posterior end at an angle less than 90°. Distinct inner process projects from the platform more anteriorly than the outer one. Both specimens figured also bear the third spur, lying on the outer side farther anteriorly of the position of the strong outer process.

STRATIGRAPHIC RANGE: In the Hercynian (Bohemian) facies, the elements of *L. b. beckmanni* have been described from upper part of the Pragian as well as from the Zlichovian. They occur together with *Nowakia acuaria* and *Nowakia barrandei* (e.g. KALVODA 1995, CHLUPÁČ *& al.* 1986, SLAVÍK 1998). However, this species is mostly reported from many other areas of the world from the lower and upper parts of the Emsian.

Latericriodus bilatericrescens bilatericrescens (ZIEGLER, 1956)
(Pl. 3, Fig. 6; Pl. 4, Fig. 2)

Pa element
1956. *Icriodus latericrescens bilatericrescens* n. subsp.; W. ZIEGLER, p. 101, Pl. 6, Figs 6-13.
1976. *Latericriodus bilatericrescens* (ZIEGLER); P. BULTYNCK, p. 48, Pl. 9, Figs 11-16 (*cum syn*.).
1977. *Icriodus bilatericrescens* cf. *bilatericrescens* ZIEGLER; D. AL-RAWI, Pl. 7, Fig. 55.
1980. *Icriodus bilatericrescens* ZIEGLER; H.P. SCHÖNLAUB in CHLUPÁČ *& al.*, Pl. 18, Fig. 4, Pl. 21, Fig. 1, Pl. 23, Figs 5-9, 13, Pl. 24, Figs 6-11.
1980. *Icriodus bilatericrescens* ZIEGLER; G. KLAPPER & D.B. JOHNSON, p. 447, Pl. 2, Figs 13-16, tab. 5.
1980. *Latericriodus bilatericrescens bilatericrescens* (Ziegler); P. BULTYNCK & H. HOLLARD, p. 40, Pl. 1, Figs 14-21.
1982. *Icriodus bilatericrescens* Ziegler; P. MORZADEC & M. WEYANT, p. 32, Pl. 1, Fig. 11.
1985. *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER); P. BULTYNCK, Pl. 5, Figs 5, 9-10.
1985. *Icriodus bilatericrescens* ZIEGLER; R. FEIST, H.P. SCHÖNLAUB & P. BULTYNCK, Pl. 2, Figs 16-17.
1988. *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER); J. GRÖTSCH, p. 165, Pl. 15, Figs 32-34.
1989. *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER); P. BULTYNCK, Pl. 7, Figs 13, 15.
1990. *Icriodus bilatericrescens bilatericrescens* ZIEGLER; R. OLIVIERI & E. SERPAGLI, p. 60, Pl. 1, Figs 11, 17.
1994. *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER); M. BENFRIKA, pp. 121-122, Pl. 11, Figs 16-17.
1995. *Latericriodus bilatericrescens* (ZIEGLER); J. KALVODA, pp. 36-37, Pl. 1, Figs 2, 6, Pl. 2, Figs 5, 7.
1999. *Icriodus bilatericrescens bilatericrescens* ZIEGLER; F.W. LUPPOLD & R. WOLFART, Pl. 6, Figs 8, 10.
1999. *Icriodus* sp. aff. *Icriodus bilatericrescens bilatericrescens* ZIEGLER; F.W. LUPPOLD & R. WOLFART, Pl. 6, Figs 13-14; Pl. 7, Figs 1-2.

MATERIAL: 4 specimens.

REMARKS: The main traits of this form are slightly biconvex outline of the platform and the character of ornamentation on the upper side of the element that both are varying from widely to closely set transverse rows of nodes or ridges. Each of the rows has at least 7 denticles. Two lateral processes, the inner one directed anteriorly and the outer one directed posteriorly, form an angle of almost 180°. However, in juvenile specimens, the processes are weakly developed. Thus, some of the juvenile forms can be hardly assigned directly to *Latericriodus bilatericrescens bilatericrescens* because they share many features with *Latericriodus beckmanni beckmanni* and *Caudicriodus celtibericus.*

STRATIGRAPHIC RANGE: According to KLAPPER & JOHNSON (1980), *L. b. bilatericrescens* widely occurs within the range of *dehiscens – serotinus* Zones. In the Barrandian sections, this species seems to indicate the first Emsian strata.

Latericriodus steinachensis (AL-RAWI) eta morph. KLAPPER & JOHNSON, 1980
(Pl. 4, Fig. 7)

Pa element

1965. *Icriodus bilatericrescens* ZIEGLER; G.M. PHILIP, p. 103, Pl. 9, Figs 30-31.
1971. *Icriodus latericrescens* BRANSON & MEHL; G. KLAPPER & G.M. PHILIP, Fig. 8.
1980. *Icriodus steinachensis* AL-RAWI eta morphotype; G. KLAPPER & D.B. JOHNSON, Pl. 2, Figs 25-27.
1982. *Icriodus steinachensis* AL-RAWI eta morphotype KLAPPER & JOHNSON; M.A. MURPHY & J.C. MATTI, pp. 58-59, Pl. 5, Fig. 36.
1985. *Icriodus steinachensis* AL-RAWI eta morphotype; I. CHLUPÁČ *& al.*, Pl. 2, Figs 5, 13-16.
1985. *Icriodus steinachensis* AL-RAWI eta morphotype; H.P. SCHÖNLAUB, Pl. 3, Fig. 3.
1994. *Icriodus steinachensis* AL RAWI eta morphotype; R. MAWSON & J.A.TALENT, pp. 47-48, Figs 9K-N.
1994. *Latericriodus steinachensis* (AL-RAWI); M. BENFRIKA, pp. 124-125, Pl. 9, Fig. 7.
1995. *Icriodus steinachensis* AL-RAWI eta morphotype. G.M.S. DONGAL, p. 137, Figs 5A-B.

MATERIAL: 2 specimens.

REMARKS: Two morphotypes of *Latericriodus steinachensis* were separated by KLAPPER & JOHNSON (1980) and by MURPHY & MATTI (1982: pp. 58 to 59) on the basis of the outline of the platform, mainly on the width of its widest part. Beta morphotype has a more slender outline, whilst the eta morphotype has a more spindle-like shape and almost lenticular outline of the platform. The Pa elements from the material of the Na Branžovech section correspond well with the holotype of *I. steinachensis* AL-RAWI, which represents, according to MURPHY & MATTI (1982) an eta morphotype. The widest part of the platform is approximately in the midpoint of the main axis of the element.

STRATIGRAPHIC RANGE: Although the Nevadan specimens of eta and beta morphotypes stratigraphically range within the *delta* and *kindlei* Zones, these forms are undoubtedly of exceptional values in their relationship to palaeogeographically distant Barrandian basins. The materials collected from the Na Branžovech section as well as from other sections in Barrandian area or Carnic Alps (see CHLUPÁČ *& al.* 1985, Fig. 17) shows that *Latericriodus steinachensis* eta morphotype occurs very close to the lower Pragian boundary. Its upper range is often followed by immediate successors of beta morphotype a few metres higher. Thus the range of the morphotypes of *Latericriodus steinachensis* might be resuming the concept of the *sulcatus* Zone in the Barrandian.

Genus: *Pedavis* KLAPPER & PHILIP, 1971

TYPE SPECIES: *Icriodus pesavis* BISCHOFF & SANNEMANN, 1958.

Pedavis pesavis (BISCHOFF & SANNEMANN, 1958)
(Pl. 2, Fig. 6)

Pa element

1958. *Icriodus pesavis* n. sp.; G.C.O. BISCHOFF & D. SANNEMANN, pp. 96-97, Pl. 12, Figs 1, 4, 6-7.
1982. *Pedavis pesavis* (BISCHOFF & SANNEMANN); M.A. MURPHY & J.C. MATTI, p. 49, Pl. 7, Figs 13, 20 (*cum. syn.*).

MATERIAL: 1 specimen.

REMARKS: Pa element of *Pedavis pesavis* is characterized by having long posterior process of sigmoidal shape. This zonally diagnostic species has a worldwide distribution. However, the specimen figured from the Na Branžovech section is incomplete, bearing only two lateral processes.

STRATIGRAPHIC RANGE: *pesavis* Zone (upper part of the Lochkovian).

Genus *Pelekysgnathus* THOMAS, 1949

TYPE SPECIES: *Pelekysgnathus inclinatus* THOMAS, 1949.

Pelekysgnathus serratus serratus JENTZSCH, 1962
(Pl. 1, Fig. 2 and 11)

Pa element

1962. *Pelekysgnathus serrata* n. sp.; I. JENTZSCH, pp. 970-971, Pl. 2, Figs 7-8; Pl. 3, Figs 6, 9, 15.
1969. *Pelekysgnathus serrata elata* n. subsp.; P. CARLS & J. GANDL, pp. 192-193, Pl. 19, Figs 10-14 .
1969. *Pelekysgnathus serrata elongata* n. subsp.; P. CARLS & J. GANDL, pp. 191-192, Pl. 19, Figs 15-19.
1969. *Pelekysgnathus serratus* JENTZSCH; G. KLAPPER, p. 12, Pl. 2, Figs 10-11.
1969. *Pelekysgnathus serratus* JENTZSCH; P. PÖLSLER, p. 419, Pl. 2, Figs 21-22.
1969. *Pelekysgnathus serrata* cf. *serrata* JENTZSCH; P. CARLS, p. 335, Pl. 2, Figs 16-17.
1979. *Pelekysgnathus serratus serratus* JENTZSCH; H.R. LANE & A.R. ORMISTON, p. 60, Pl. 5, Figs 4-6.
1980. *Pelekysgnathus serratus serratus* JENTZSCH; I. CHLUPÁČ *& al.*, Pl. 5, Fig. 21; Pl. 7, Fig. 22; Pl. 18, Figs 1-2.

1980. *Pelekysgnathus serratus* JENTZSCH; G. KLAPPER & D.B. JOHNSON, p. 451, Tabs 3, 4, 5.
1985. *Pelekysgnathus serratus* JENTZSCH; H.P. SCHÖNLAUB, Fig. 3.
1990. *Pelekysgnathus serratus serratus* JENTZSCH; R. OLIVIERI & E. SERPAGLI, p. 64, Pl. 2, Figs 10-12, 15-16.

MATERIAL: 9 specimens.

REMARKS: The material from the Karlík valley and Na Branžovech sections provided typical representatives of pelekysgnathiform Pa elements. Typical traits on *Pelekysgnathus serratus serratus* elements are related to deep blade bearing 7 to 9 strong but short denticles. The elements have somewhat higher cusp than usual, with slightly expressed inclination at the posterior end. In typical specimens, the lower margin is straight in lateral view and the upper outline of the Pa elements is slightly arched. The basal cavity is excavated along the entire length of the unit and becomes wider just below the cusp. Only few acodiniform (Pb) elements were recognised in the conodont assemblage. However, no drepanodiformis (S) elements related to reconstruction of 3-element apparatus by SAVAGE, CHURKIN & EBERLEIN (1977) have been found in the most recently studied Barrandian sections.

STRATIGRAPHIC RANGE: *Pelekysgnathus serratus serratus* has been reported from many sites of the world from the Lochkovian onwards. However, the Barrandian range of *P. s. serratus* is likely only middle Pragian, being practically the most relevant Barrandian taxon to characterise this time.

Family Polygnathidae BASSLER, 1925
Genus *Ancyrodelloides* BISCHOFF & SANNEMANN, 1958

TYPE SPECIES: *Ancyrodelloides trigonica* BISCHOFF & SANNEMANN, 1958.

Ancyrodelloides trigonicus BISCHOFF & SANNEMANN, 1958
(Pl. 4, Fig. 8)

Pa element
1958. *Ancyrodelloides trigonica* n. sp.; G.C.O. BISCHOFF & D. SANNEMANN, p. 92, Pl. 12, Figs 9, 12-14, 16.
1969. *Ancyrodelloides trigonica* BISCHOFF & SANNEMANN; P. CARLS, p. 325, Pl. 1, Fig. 1.
1978. *Ancyrodelloides trigonica* BISCHOFF & SANNEMANN, E. SERPAGLI *& al*., p. 301, Pl. 27, Figs 4a-b.
1979. *Ancryodelloides trigonicus* BISCHOFF & SANNEMANN; H.R. LANE & A.R. ORMISTON, p. 52, Pl. 2, Figs 16-17.
1980. *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN; G. KLAPPER & D.B. JOHNSON, p. 447, tab. 2.
1980. *Ancryodelloides trigonicus* BISCHOFF & SANNEMANN; H.P. SCHÖNLAUB, Pl. 4, Fig. 15; Pl. 5, Fig. 14.
1982. *Ancryodelloides trigonicus* BISCHOFF & SANNEMANN; M.A. MURPHY & J.C. MATTI; p. 21, Pl. 3, Figs 3-6, 11.
1985a *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN; A. MASTANDREA, p. 244, Pl. 2, Figs 7-8, 11-13, 15.
1986. *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN; S. BARCA *& al*., Pl. 31, Figs 1, 5.
1990. *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN, S. GARCIA-LOPEZ *& al.*, Pl. 1, Figs 17-18.
1998. *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN; L. SLAVÍK, pp. 158-159, Pl. 1, Fig. 2.

MATERIAL: 1 specimen.

DESCRIPTION: In the upper view, the Pa element has a typical arrow-like shape of the platform. Basal cavity is restricted to a small deep pit beneath the cusp. The narrow platform bears keels running medially along the blade. Two almost symmetrical lateral processes meet the main axis of the element at an angle of less than 90°.

REMARKS: Characteristic complex of traits related to stratigraphically significant Pa elements of the genus *Ancyrodelloides* BISCHOFF & SANNEMANN, 1958 consists of the shape of the platform, number of lateral processes, smooth platform surface and a small basal pit. *A. trigonicus* and *A. kutscheri* BISCHOFF & SANNEMANN differ from each other only in the presence of one bifurcated lateral process in the latter one. The figured specimen of *A. trigonicus* corresponds exactly to the specimens from Frankenwald (BISCHOFF & SANNEMANN 1958; p. 92, Pl. 12, Figs 9, 12-14, 16) as well as from the Čertovy schody Quarry in Koněprusy area (SLAVÍK 1998, pp.158-159, Pl. 1, Fig. 2).

STRATIGRAPHIC RANGE: *delta* Zone (KLAPPER & JOHNSON 1980, MURPHY & MATTI 1982).

Genus *Polygnathus* HINDE, 1879

TYPE SPECIES: *Polygnathus dubius* HINDE, 1879.

Polygnathus pireneae BOERSMA, 1973
(Pl. 3, Fig. 2)

Pa element
1973. *Polygnathus pireneae* n. sp.; K.T. BOERSMA, p. 287, Pl. 2, Figs 1-12
1977. *Polygnathus boucoti* n. sp.; N.M. SAVAGE, Pl. 1, Figs 13-28; Text-figs. 2a-d.

1977. *Polygnathus pireneae* BOERSMA.; G. KLAPPER in ZIEGLER, pp. 489-490, *Polygnathus* Plate 8, Fig. 6.
1979. *Polygnathus pireneae* BOERSMA; H.R. LANE & A.R. ORMISTON, p. 62, Pl. 3, Figs 15 to 17; Pl. 5, Figs 2-3, 9-10, 27-34, 37.
1980. *Polygnathus pireneae* BOERSMA; R. OLIVIERI, A. MASTANDREA & E. SERPAGLI, tab. 2.
1982. *Polygnathus pireneae* BOERSMA; M.A. MURPHY & J.C. MATTI, p. 39, Pl. 1, Figs 33-38.
1985b *Polygnathus pireneae* BOERSMA; A. MASTANDREA, p. 265, Pl. 1, Figs 6a-b.
1985. *Polygnathus pireneae* BOERSMA; N.M. SAVAGE, R.B. BLODGETT & H. JAEGER, Pl. 1, Figs 21-26.
1989. *Polygnathus pireneae* BOERSMA; E.A. YOLKIN *& al.*, p.238, Pl. 1, Figs 1-6.
1990. *Polygnathus pireneae* BOERSMA; R. OLIVIERI & E. SERPAGLI, p. 72, Pl. 3, Figs 3-6.
1992. *Polygnathus pireneae* BOERSMA; R. MAWSON *& al.*, pp. 48-49, Figs 7A-F.

MATERIAL: 1 specimen.

DESCRIPTION: Only one representative of *Polygnathus pireneae* has been found at Na Branžovech. The whole unit is almost straight and the nodes on the anterior part of the platform are not fused. The carina is almost as high as the lateral margins of the platform. The element has a greatly excavated and deep basal cavity. In upper view, the lateral margins of the basal cavity protrude beneath the platform. In cross-section, the upper platform surface is flat and slightly convex. Reduced adcarinal troughs, which are better evolved in younger representatives of the genus *Polygnathus*, pose a very significant trait observed on *Po. pireneae* elements. The specimen figured in this paper is a juvenile platform element of *P. pireneae*.

REMARKS: This species, as the youngest representative of the genus *Polygnathus*, was widely used as an index for the uppermost standard conodont zone of the Pragian for a long time. However, the information from many sites in the world suggests that stratigraphic range of this species is much wider than formerly assumed. *P. pireneae* first appears in the lower rather than in the upper Pragian levels. The ancestor of *Polygnathus pireneae* is actually unknown and its origin has not been demonstrated yet. There exist two main concepts of the evolution of the genus *Polygnathus*: it evolved gradually either from *Ozarkodina* (LANE & ORMISTON 1979, Sweet 1988), or from *Eognathodus* (cf. KLAPPER & PHILIP 1972, KLAPPER & JOHNSON 1975, COOPER 1973 and MAWSON 1995). Therefore, it is hard to consider the *pireneae* Zone as a standard by means of the successive-appearance zonation.

STRATIGRAPHIC RANGE: *sulcatus*? Zone – ?*kindlei* Zone – ?*pireneae* Zone (in their original definitions).

CORRELATION OF CONODONT FAUNA WITH IMPLICATIONS FOR PRAGIAN ZONES

The composition of conodont fauna and its indicative value for zonal subdivision of the Pragian showed some interesting aspects. The presence of several index taxa allowed correlation with several standard conodont zones (figures 4 and 5). Ranges of other zones are rather unclear as they are derived indirectly from the superposition of assemblages as well as their general character (broken lines with question marks). Range-zones in the Karlík Valley and Na Branžovech sections have only regional significance and were applied in this form especially due to scarcity of conodonts in the Pragian. Both the ranges and definitions must be exactly fixed during the future investigations.

The *delta* and *pesavis* Zones at Na Branžovech were interpreted on the basis of the occurrence of *Ancyrodelloides trigonicus* and *Pedavis pesavis*, respectively. The presence of these two zones indicates an almost uninterrupted sedimentation from the late Lochkovian to the earliest Pragian, which is here proved by the occurrence of *Latericriodus steinachensis* eta morph.

In the Karlík valley section only one standard conodont biozone was reliably documented – the *eurekaensis* Zone. This zone marks older than the latest parts of the Lochkovian sequences. Thus, on condition that this sequence developed continuously, the *delta* and *pesavis* Zones should follow the *eurekaensis* Zone in the several remaining metres of the Lochkovian sediments. Such unusual rate of condensation is very rare in the Kotýs Limestone and can be hardly suggested for the Karlík Valley section, because this sequence of strata is not markedly thinning upward. Thus the reduction of the section should be rather seen in the pronounced effect of submarine corrosion and erosion than only simple sedimentary starvation.

Another missing part of the latest Lochkovian record was documented in Koněprusy area (HLADIL & SLAVÍK 1997, SLAVÍK 1998 and studies in progress). At Koněprusy, the corrosion and erosion of the Lochkovian surface is beyond any doubt. Corroded surfaces in fissures as well as truncations of the latest Kotýs Limestone are well-exposed in the northern wall of the Čertovy schody quarry on the 3rd bench (HLADIL 1997). These surfaces were covered by sediment of approximately mid-Pragian age (HLADIL & SLAVÍK 1997).

However, the Karlík Valley section was lying far from Koněprusy (probably much farther than the present 9 km; MELICHAR & HLADIL 1999, HLADÍKOVÁ *& al.* 1999). Composition of the Pragian beds at Karlík is relatively uniform and indicates the existence of relatively deep depression in sea floor, because nearly all components of the sediment were redeposited from the slope (slides and gravitational turbidity flows). In spite of this difference in environments, possible absence of the *pesavis* Zone at Karlík may also be connected with lowstand hiatuses. It has been demonstrated that a prominent sea-level fall during the *pesavis* Zone corresponds to widely recorded Euro-American regression that marks the boundary between the pre-Ia and Ia cycles (JOHNSON & SANDBERG 1989).

SCHÖNLAUB (in CHLUPÁČ *& al.* 1985) suggested the entry of *Latericriodus steinachensis* (AL-RAWI) as a good marker for the base of the Pragian in the Barrandian area. His conclusions were based on five Lo/Pg sections, including the Lo/Pg GSSP at Velká Chuchle. All finds of *L. steinachensis* come from levels close to the base of the Pragian. WEDDIGE (1987), however, focused mainly on the entry of the zonally diagnostic *Eognathodus sulcatus* PHILIP. He also studied the GSSP at Velká Chuchle. But the *E. s. sulcatus* is so rare in other Barrandian sections that only this scarcity controls its randomly distributed finds (SLAVÍK 1999). Although the present sampling at Karlík Valley and Na Branžovech sections does not bring new evidence of this species, WEDDIGE (1987) first drew attention of palaeontologists to the scarcity of *E. sulcatus* in the Barrandian area, remembering also the older than Lo/Pg entries of this taxon.

Therefore he also resumed the chance to use the *Latericriodus steinachensis* eta morph as an indicator of the Lo/Pg boundary (cf. also CHLUPÁČ *& al.* 1985, in this connection). *L. steinachensis* occurs in other Barrandian sections almost at the same stratigraphic level as *E. sulcatus*. The present work at Na Branžovech and in the Karlík Valley sections gives more evidence that *L. steinachensis* is more abundant and applicable than the usually missing or unreliable *E. sulcatus*.

Therefore the middle parts of the Pragian underpopulated conodont communities with long-range taxa complicate the conodont studies. It means that this trend is not specific only for the area of the Koněprusy elevation (SLAVÍK 1998), but should be traced in all other Barrandian sections, and even worldwide. Endemism of the Early Devonian conodont species appears to be in connection with two evolutional characteristics: 1. The Early Devonian Conodont Crisis (CARLS 1987) and 2. The Low Diversity Episode (ZIEGLER & LANE 1987).

The most significant species of the middle Pragian should be *Pelekysgnathus serratus serratus* JENTZSCH. Its stratigraphic range may start in the *pesavis* Zone (e.g. Guadarrama; CARLS 1969), but in many areas of the world it marks particularly the middle Pragian. This can be exemplified by finds at the Salmontrout River (Alaska; LANE & ORMISTON 1979) or on Sardinia (OLIVIERI & SERPAGLI 1990). *P. s. serratus* seems to be a good candidate for co-indication of any future or emended middle Pragian conodont zones. This species occurs together with *Ozarkodina remscheidensis repetitor* (CARLS & GANDL). In the Barrandian area, *O. r. repetitor* has been first recognised in Koněprusy area (SLAVÍK 1998), where it enters with the top of the *sulcatus* Zone. The same position has the first appearance of this species at the Na Branžovech section. To conclude, the ranges of *P. s. serratus* and *O. r. repetitor* probably follow the strongest mid-Pragian sea level maximum, which was usually connected with the *kindlei* Zone. This zone, however, has no direct evidence in the Barrandian. Following these facts, a preliminary and informal introduction of the *serratus* taxon-range Zone is suggested in this paper. The introduction of this zone probably cannot directly substitute the role of the *kindlei* Zone, because its base is still somewhere within the upper part of the *sulcatus* Zone and its upper limit might be at middle levels of the classically ranged *kindlei* Zone. Better correlation is impossible at the moment, especially because of remarkably diffuse and climbing boundaries of the pre-existing standard zones in the global correlation.

Samples from the upper part of the Pragian section at Na Branžovech yielded several elements of *Caudicriodus celtibericus* (CARLS & GANDL), *Polygnathus pireneae* BOERSMA, *Latericriodus beckmanni beckmanni* (ZIEGLER), *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER) and *Pandorinellina steinhornensis miae* (BULTYNCK). As it was manifested in the systematic part of this paper, the stratigraphic significance of *Polygnathus pireneae* is doubtful because random cross-correlations can be also found from lower to upper Pragian within the Barrandian area (Na Požárech and Na Branžovech, in the same tectonic and facies settings). The delimitation of the *pireneae* Zone would therefore pose a completely useless and wrong concept. If no other candidates for the late Pragian index species are found, the upper Pragian interval would be treated as an inter-zone.

The base of the Emsian can be inferred at the Na Branžovech section on the basis of the first occurrence of *Latericriodus bilatericrescens bilatericrescens*, which enters regularly within the *dehiscens* Zone and continues to *serotinus* Zone. Other taxa in the late Pragian are typically of long-range character and occur both in the upper Pragian and lower Emsian, with the exception of *Latericriodus beckmanni beckmanni,* which is really Emsian with only a little doubts. The upper part of the Karlík Valley sections tells us almost nothing about the stratigraphy due to the dominance of *O. excavata* and simple-cone elements.

The conodont assemblages from these two investigated sections suggest that facies difference between the northwestern and southeastern limbs of central Barrandian synform were significant in early Devonian times, but particularly in the Pragian. On one side, a continuous sedimentary changeover is present at Lo/Pg and Pg/Em at Na Branžovech. On the other side, we face a real possibility of the late Lochkovian stratigraphical lacunae in the Karlík Valley as well as general scarcity of conodonts in this section.

This confirms an unpublished observation by J. KALVODA (pers. comm. 1998) that the abundance of Pragian conodonts rapidly decreases with increasing depth of the marine basin behind the Koněprusy reef. Conditions unfavourable for life of nectonic and necto-benthic fauna in this separate marine depression behind the Koněprusy reef have been also suggested on the basis of geochemical data (Pragian to Eifelian, HLADÍKOVÁ *& al.* 2000).

However, the new data complete the existing information from other Barrandian sections (such as Praha-Hlubočepy, SCHÖNLAUB 1980, or Mramorka Quarry near Chýnice and Stydlé vody Quarry near Svatý Jan p.S., KALVODA 1995, etc.). In comparison with other areas of the world, the maximum faunal similarity can be seen in Moroccan Messeta and partly also in Anti-Atlas and Carnic Alps. It parallels other sedimentological and palaeobiological evidence suggesting that these three parts formed a really inter-connected sub-region during the early Devonian times.

CONCLUSIONS

1. Eight conodont taxa were described from the Karlík Valley but seventeen from the Na Branžovech section.

2. First record of The European species *Caudicriodus angustoides alcolae* (CARLS) in the Barrandian area.

3. Recognition of standard conodont zones – *eurekaensis*, *delta*, *pesavis*.

4. The most significant species for the early and middle Pragian of the Barrandian area are *Latericriodus steinachensis* (AL-RAWI) eta morph. *and Pelekysgnathus serratus serratus* JENTZSCH, respectively.

5. Emerging concepts of *steinachensis* and *serratus* regional range-zones, for the early and middle Pragian, respectively. Suggested possibility of *serratus*/*bilatericrescens* interzone and *bilatericrescens* regional range-zone for the late Pragian.

6. No elements of zonally diagnostic species *Eognathodus sulcatus sulcatus* and *Eognathodus sulcatus kindlei* were found. The occurrence of *Polygnathus pireneae* in the Na Branžovech section is of a little stratigraphic significance due to stratigraphical and taxonomical difficulties related to this species. To conclude, the standard Pragian biozones are almost inapplicable within the stratotype area.

7. First appearance of *Latericriodus bilatericrescens bilatericrescens* (ZIEGLER) serves the best biostratigraphic indication of the Emsian base.

8. The northwestern limb of the central Barrandian synform (Na Branžovech) is characterised by continuous Lo/Pg and Pg/Em sedimentation, whereas the opposite limb (Karlík Valley) may possess sedimentary lacunae at these levels (most likely submarine erosion).

9. The conodont assemblages link the Na Branžovech section with Morocco and the Carnic Alps.

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PLATE 1

Pelekysgnathus serratus serratus JENTZSCH, 1962
1 – Pa element × 39 – lateral view of 058KA, samp. 7K
2 – Pa element × 36 – lateral view of 057KA, samp. 6K

Ozarkodina excavata excavata (BRANSON & MEHL, 1933)
3 – Pb element × 48 – lateral view of 054KA, samp. 6K
4 – Pa element × 34 – lateral view of 061KA, samp. 8K
9 – Pb element × 50 – lateral view of 056KA, samp. 7K
11 – Pb element × 51 - lateral view of 070KA, samp. 9K
13 – Pb element × 36 - lateral view of 101B, samp. 2B
14 – Pa element × 37 - lateral view of 100B, samp. 3B
15 – M element × 38 - lateral view of 103B, samp. 7B

Caudicriodus woschmidti postwoschmidti (MASHKOVA, 1968)
6 – Pa element × 50 – upper view of 051KA, samp. 1K

Belodella devonica (STAUFFER, 1940)
7 – ?M element × 42 – lateral view of 053KA, samp. 5K

Belodella resima PHILIP, 1965
8 – × 65 - lateral view of 071KA, samp. 9K
19 – ?Sa element × 41 - lateral view of 106B, samp. 2B

Ozarkodina remscheidensis remscheidensis (ZIEGLER, 1960)
5 – ?Sb element × 49 – lateral view of 060KA, samp. 1K
10 – Sa element × 52 – lateral view of 059KA, samp. 2K
12 – ?Sc element × 48 – lateral view of 052KA, samp. 2K

Latericriodus bilatericrescens bilatericrescens (ZIEGLER, 1956)
16 – I element × 45 - upper view of 108B, samp. 6B

Polygnathus pireneae BOERSMA, 1973
17 Pa element × 53 - upper view of 105B, samp. 4B

Caudicriodus angustoides alcolae (CARLS, 1969)
18 – I element × 52 - upper view of 107B, samp. 1B

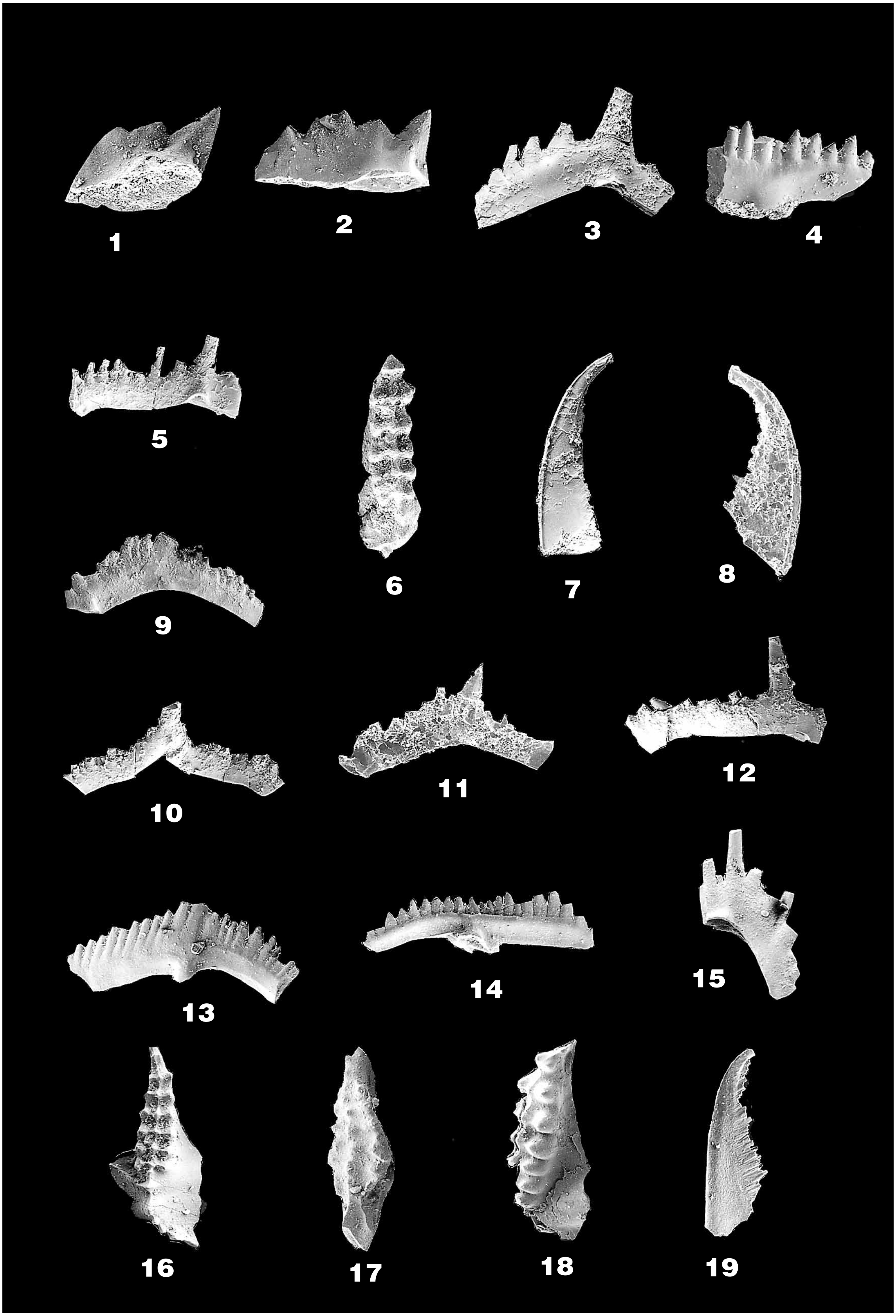
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PLATE 2

Latericriodus beckmanni beckmanni (ZIEGLER, 1956)
1 – I element × 46 - upper view of 096B, samp. 7B
2 – I element × 47 - upper view of 097B, samp. 7B

Latericriodus bilatericrescens bilatericrescens (ZIEGLER, 1956)
3 – I element × 52 - upper view of 112B, samp. 7B

Latericriodus steinachensis (AL-RAWI) eta morph. KLAPPER & JOHNSON, 1980
4 – I element × 51 - upper view of 116B, samp. 2B

Caudicriodus celtibericus (CARLS & GANDL, 1969)
5 – I element × 52 - upper view of 098B, samp. 5B
6 – I element × 59 - upper view of 053B, samp. 5B

Ozarkodina remscheidensis repetitor (CARLS & GANDL, 1969)
7 – Pa element × 34 - upper view of 115B, samp. 3B
14 – Pa element × 42 - lateral view of 114B, samp. 3B

Pandorinellina steinhornensis miae (BULTYNCK, 1971)
8 – Pa element × 43 - upper view of 124B, samp. 6B
10 – Pa element × 33 - upper view of 093B, samp. 7B
12 – Pa element × 47 – upper view of 092B, samp. 6B

Ozarkodina remscheidensis remscheidensis (ZIEGLER, 1960)
9 – Pa element × 42 - upper view of 095B, samp. 1B

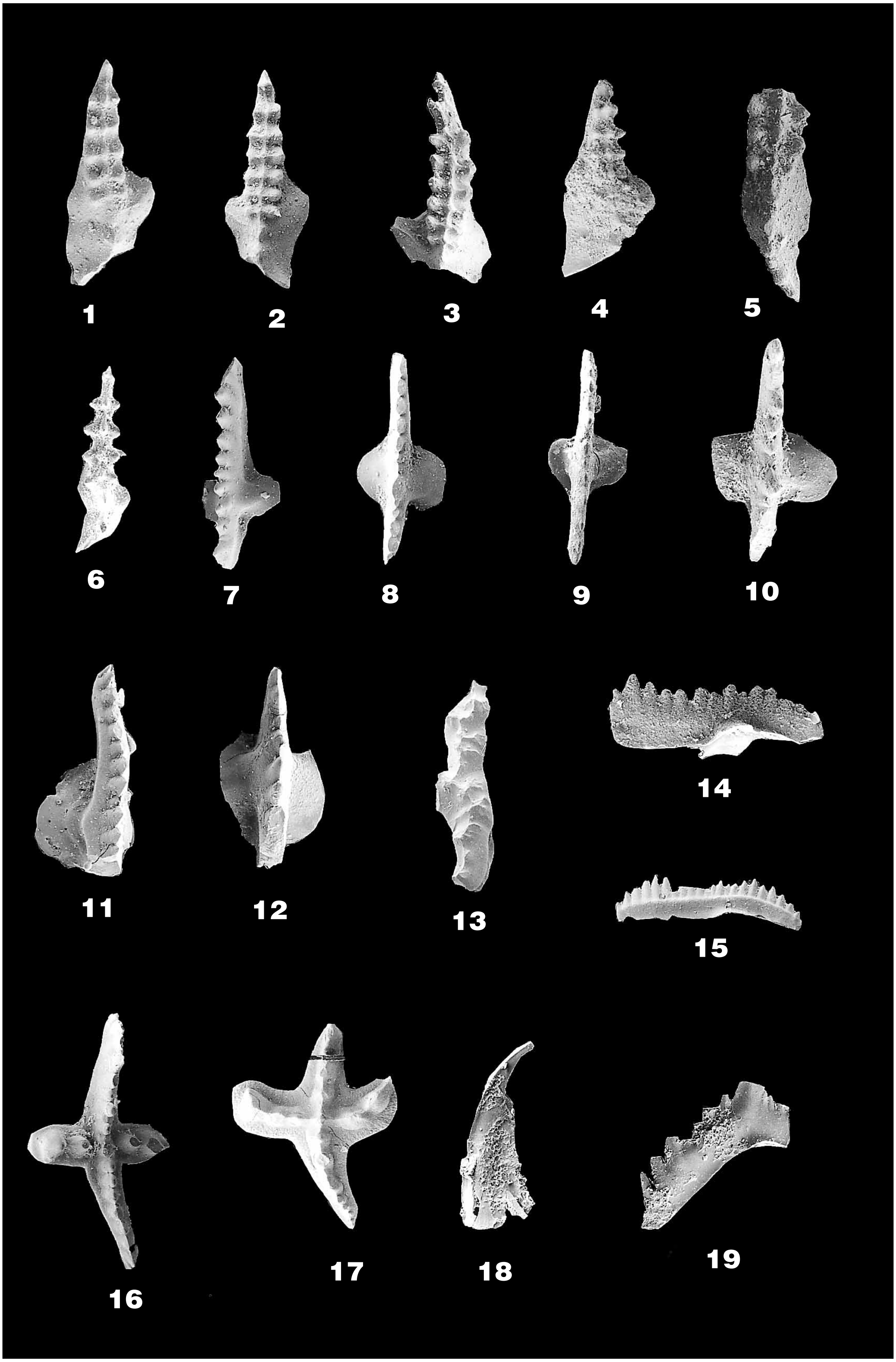
Ozarkodina excavata excavata (BRANSON & MEHL, 1933)
11 – Pa element × 40 – upper view of 091B, samp. 3B
15 – Pa element × 41 - lateral view of 109B, samp. 4B
19 – Pb element × 42 - lateral view of 111B, samp. 5B

Pedavis pesavis (BISCHOFF & SANNEMANN, 1958)
13 – I element × 46 - upper view of 099B, samp. 2B

Belodella devonica (STAUFFER, 1940)
18 – Sb element × 53 - lateral view of 113B, samp. 2B

Ancyrodelloides transitans (BISCHOFF & SANNEMANN, 1958)
16 – Pa element × 33 - upper view of 173B, samp. 2B

Ancyrodelloides trigonicus BISCHOFF & SANNEMANN, 1958
17 – Pa element × 42 - upper view of 117B, samp. 1B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