Lower-Middle Devonian (upper Emsian-Eifelian, *serotinus-kockelianus* zones) conodont faunas from the Prague Basin, the Czech Republic

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Lower-Middle Devonian conodonts (*serotinus-kockelianus* zones) from the Třebotov Limestone (Daleje-Třebotov Formation) and Choteč Limestone (Choteč Formation) were studied. The following sections in the Prague Basin were sampled in an attempt to refine the conodont biostratigraphy of this sequence: Barrandov road cut, Prastav quarry at Holyně, Jelinek mill quarry at Chýnice and Červený quarry near Suchomasty. Another aim was to collect new data from sections which have not been sampled before: Na Škrábku quarry at Choteč, U Němců section at Karlštejn and Na vyhlídce section at Hostím. The main focus was on clarifying ranges of individual conodont taxa and thus enabling more precise correlations to be made. Among the most important findings is the lower occurrence of *Polygnathus costatus partitus* Klapper, Ziegler & Mashkova (the defining species for the Lower-Middle Devonian boundary), recorded in its regional reference section (Prastav quarry) but 2.2 m below the previous boundary. The correlation between the onset of the Basal Choteč event, as well as the occurrence of *Polygnathus* sp. aff. *Polygnathus trigonicus*, with the base of the costatus Zone is supported by the results of this study. • Key words: Lower-Middle Devonian, conodont biostratigraphy, Prague Basin.


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Lower-Middle Devonian conodonts from the Prague Basin are the subject of the present research. The interval studied comprises the Třebotov Limestone (Daleje-Třebotov Formation) and Choteč Limestone (Choteč Formation). The following sections were sampled in order to refine the existing conodont zonal scheme and to provide new data for sections which have not been sampled previously.

**History of conodont studies in the Prague Basin**

The first conodont studies of Lower-Middle Devonian strata from the Prague Basin took place in the 1970s and were focused on sequences from the top of the Zlíchov Formation (Lower Emsian) to the top of the Choteč Limestone (Eifelian), with the emphasis on the position of the Lower-Middle Devonian boundary. The following sections in the Prague Basin had already been studied by preceding authors, especially with respect to Lower-Middle Devonian conodont taxonomy and biostratigraphy: Prastav quarry at Holyně, Jelinek mill quarry at Chýnice, Císařská rokle gorge at Šrbsko, Hlubočepy-Vysoká quarry (Klapper...
Published data at this section. *P. c. costatus*, which has not been found previously, was recorded 2 m above the base of the Choteč Limestone. That is in agreement with Klapper et al.’s (1978) study in which *Polygnathus* sp. aff. *P. trigonicus* was reported 1.75–1.8 m above the base of the Choteč Limestone (for a discussion on correlation of occurrence of the latter mentioned taxon and the base of the costatus Zone see text below). A correlation between the costatus Zone and the presence of *P. sp. aff. P. trigonicus* had been suggested earlier (Klapper et al. 1978, p. 105).

**Barrandov road cut, Fig. 2B (50°02´08˝ N, 14°23´33˝ E).** – The Třebotov Limestone and the base of the Choteč Limestone crop out in this section which was exposed during construction of the main road system in Prague, (Lukeš 1989 and Zusková 1991). Bases of the patulus and the partitus zones were drawn according to data published by Zusková (1991), as occurrences reported in this study are higher. The first occurrence of *P. c. costatus* (two specimens) was reported 1.25 m below the base of the Choteč Limestone in this study. This is the first record of this taxon below the base of the Choteč Limestone in the Prague Basin. The australis Zone is drawn at this section with a question mark on the basis of the lowest occurrence of *P. pseudofoliatus*. The overlap of the base of the australis Zone and the lowest occurrence of *P. pseudofoliatus* is not completely certain, as a lower range of this taxon cannot be ruled out (see text below). The thickness of rocks corresponding to the costatus Zone would be 3.5 m, which is in contrast to other sections in the Prague Basin; however, there is some evidence for condensed sedimentation in this section. Among these are intervals with hardgrounds and from which a higher number of conodont elements were recovered. Furthermore, in this section the Choteč Limestone is only 6 m thick, and is overlain by the Srbsko Formation, however, the contact itself is covered and therefore a physical unconformity cannot be ruled out.

**Na Škrábku quarry, Fig. 3 (49°59´20˝ N, 14°16´45˝ E).** – An abandoned quarry situated at the foot of Škrábek hill in the village of Choteč and stratotype of the Choteč Limestone. The Třebotov and Choteč limestones both crop out in this section. Relevant papers are: Chlupáč (1959), Svboda & Prantl (1948), Buggisch & Mann (2004) and Koptíková (accepted). The following conodont zones have been recognized: serotinus, patulus, partitus, costatus zones. Klapper (1977) and Klapper et al. (1978) provided a first conodont zonation. According to new data, the base of the *partitus* Zone (Lower-Middle Devonian boundary) lies 5 m below the base of the Choteč Limestone, which is 2.2 m lower than the previously reported lowest occurrence of *P. c. partitus*. The first *P. costatus patulus* in this study was found 4.5 m below the base of the Choteč Limestone, which is 1.5 m higher than that reported by Klapper (1977). For that reason, the base of the *patulus* Zone has been drawn according to previously published data.
According to previously compiled data (Weddige 1977, Klapper & Johnson 1980, Wang & Ziegler 1983, Bardashev 1992), the earliest occurrence of *P. trigonicus* is known from the *australis* Zone. Similarly, the lower stratigraphical range of *P. pseudofoliatus* was recorded in the *australis* Zone (Weddige 1977, Klapper & Johnson 1980, Wang & Ziegler 1983, Mawson & Talent 1989, Bardashev 1992) with the exception of its occurrence in the *costatus* Zone as recorded by Belka et al. (1997). Therefore, in this locality, the base of the *australis* Zone was drawn (with the question mark) on the basis of the occurrences of *P. pseudofoliatus* and *P. trigonicus*.

**Figure 2.** A – simplified lithological column of the Prastav quarry with conodont ranges. The bases of the *serotinus* and *partitus* zones are drawn according to data published by Klapper (1977a) (the lower part of the section was not sampled). B – simplified lithological column of the Barrandov road cut section with conodont ranges. The bases of the *partitus* and *costatus* zones were drawn according to data published by Zusková (1991). Abbreviations: pa. – *partitus* Zone, au. – *australis* Zone, kockel. – *kockelianus* Zone.

(see text below) which was found 0.2 m above the base of the Choteč Limestone. According to previously compiled data (Weddige 1977, Klapper & Johnson 1980, Wang & Ziegler 1983, Bardashev 1992), the earliest occurrence of *P. trigonicus* is known from the *australis* Zone. Similarly, the lower stratigraphical range of *P. pseudofoliatus* was recorded in the *australis* Zone (Weddige 1977, Klapper & Johnson 1980, Wang & Ziegler 1983, Mawson & Talent 1989, Bardashev 1992) with the exception of its occurrence in the *costatus* Zone as recorded by Belka *et al.* (1997). Therefore, in this locality, the base of the *australis* Zone was drawn (with the question mark) on the basis of the occurrences of *P. pseudofoliatus* and *P. trigonicus*.

**Na vyhlídce at Hostim** Fig. 4A (49°57´41,9˝ N, 14°07´48˝ E). – Exposures of the Ťebotov Limestone and almost the whole succession of the Choteč Limestone occur in small, abandoned quarries and in the cutting of the path on the left bank of the Loděnice ("Kačák") brook. Close surroundings were studied by Svoboda & Prantl (1953), Chlupáč (1959) and Chlupáč *et al.* (1979). Conodont faunas are scarce in this section, thus more sampling associated with trenching (parts of the section are covered) is necessary. The following conodont zones have been recorded so far: *serotinus*, *partitus*, *costatus* and *kockelianus* zones, the base of the *australis* Zone is questioned here as it is drawn according to the occurrence of *P. pseudofoliatus*. However, as mentioned above, the occurrence
of *P. pseudofoliatus* in the *costatus* Zone as recorded by Belka *et al.* (1997), should be taken into account.

**Jelínek mill at Chýnice, Fig. 4B** (49°59′50.6″ N, 14°16′13.8″ E). – An old quarry situated on the left bank of the Radotínský potok brook, E of the Chýnice village. Almost the whole succession of the Třebotov and Choteč limestones crop out here. This section was studied in detail by Chlupáč (1959), Klapper (1977), Klapper *et al.* (1978) and Chlupáč *et al.* (1979). Klapper (1977) provided the first conodont data from this section, recording *patulus*, *partitus* and *costatus* zones. The following zones have been recorded in this study: *serotinus*, *patulus*, *partitus*, *costatus*, *australis* and *kockelianus* zones. The first *P. c. patulus* was recorded 5.6 m below the base of the Choteč Limestone, the first *P. c. partitus* was recorded 4.7 m below that same datum, thus the thickness of rock corresponding to the *patulus* Zone would be approximately 1 m, which is comparable to the Prastav quarry, where it is even less – 0.5 m and the Barrandov road cut, where it is 1.8 m. However, more detailed sampling should be carried out to confirm this, as taphonomic and sampling biases cannot be ruled out. The first *P. c. costatus* was found 0.9 m above the base of the Choteč Limestone, which is in agreement with Klapper (1977), who recorded this taxon from the interval of 1.03–1.13 m above the base, together with *Polygnathus* sp. aff. *P. trigonicus*. This fact supports the possibility of a correlation between the last mentioned taxon with the base of the *costatus* Zone in the Prague Basin. *Polygnathus* sp. aff. *P. trigonicus* was recorded in this study 6 m above the base of the Choteč Limestone (5 m above FAD of *P. c. costatus*). The first appearance of *Tortodus kockelianus australis* was recorded approximately 30 m above the base of the Choteč Limestone in this study; an exact measurement cannot be given, as parts of the section are covered and inaccessible. The first *T. k. kockelianus* was found 3 m above the first appearance of *T. k. australis*.

**U Němců section at Karlštejn** (N 49°56′37.207″, E 14°11′0.96″). – The whole succession of the Třebotov and Choteč limestones are exposed in this section in Karlštejn village, in the backyard (and surroundings) of a private house, opposite to the small hotel “Pod Dračí skálu”. Svoboda & Prantl (1955), Chlupáč (1959), and Budil (1995) studied the immediate surroundings. The conodont fauna is very scarce here, especially in the Choteč Limestone. *P. serotinus*, *P. linguiformis bulyneki*, *P. c. partitus*, *P. c. costatus* and unidentifiable juveniles only were found. *P. c. partitus* was found 3 m below the base of the Choteč Limestone, represented by only one specimen. One specimen of *P. c. costatus* was found 10 meters above the base of the Choteč Limestone (overlain by the Srbsko Formation) being exposed and therefore the present author continues to seek more data and to construct a more precise conodont zonal scheme for this section.

**Červený quarry near Suchomasty** (49°54′37.54″ N, 14°04′38.35″ E). – A quarry situated SE of the Koněprusy village, near the road from Koněprusy to Suchomasty, the stratotype of the Suchomasty Limestone. The whole succession of the Suchomasty Limestone and the base of the Acanthopyge Limestone are exposed. The following authors considered the stratigraphy, paleontology and sedimentology of this section: Chlupáč (1959), Chlupáč *et al.* (1979), Klapper (1977), Klapper *et al.* (1978), Weddige & Ziegler (1987), Havlíček & Kukal (1990), Galle & Hladil (1991), Ellwood *et al.* (2006) and Koptíková (accepted). Conodont biostratigraphy of the Suchomasty Limestone was provided in detail by Klapper (1977), Klapper & Zikmundová in Chlupáč *et al.* (1977) and Klapper *et al.* (1978). The cited authors recorded the following conodont zones: *laticostatus*, *serotinus*, *patulus* and *partitus* zones. Only the very base of the Acanthopyge Limestone was for-
merly accessible at this quarry and thus this unit has not been sampled, except for its base, where Klapper et al. (1978) recorded \( P. \) sp. aff. \( P. \) \( t \) rigonicus, \( P. \) c. \( p \) artitus and \( P. \) l. \( b \) ulyncki. Conodonts are more common in both the Su-
chomasty and Acanthopyge limestones in comparison to oth-
er studied sections; furthermore, adult specimens are better represented here. The occurrence of \( P. \) \( s \) erotinus in the Acanthopyge Limestone was recorded, which is in contrast to other sections in the Prague Basin where elements of this taxon were not recorded from the Choteč Limestone.

Figure 4. Simplified lithological columns of the Na vyhlíde section at Hostím (A) and Jelinek mill quarry at Chýnice (B) with conodont ranges. See legend in Fig. 2.
Correlation of the costatus Zone, occurrence of Polygnathus sp. aff. *P. trigonicus* and the base of the Choteč Limestone

As mentioned previously, the onset of sedimentation of the Choteč Limestone reflected the effects of the Basal Choteč event, which has been roughly correlated with the base of the *costatus* Zone (Chlupáč & Kuikal 1986). The appearance of *P. c. costatus* in this study was recorded at 1 m above the base of the Choteč Limestone in the Jelinek mill section, 5 m above the base of the Choteč Limestone in Na Škrábku quarry and 2 m above its base in the Prastav quarry. The exception is its occurrence at the Barrandov road-cut section, where its FAD was recorded 1.25 m below the base of the Choteč Limestone (below the first dark crinoidal grainstone). With respect to this, it is necessary to mention that a change in sedimentation had already been observed at the top of the Třebotov Limestone in this section, approximately at the level of the FAD of *P. c. costatus*. The sediments at this level are represented by skeletal wacke-packstones with intercalation of organic rich, bioturbated wackestone with prasinophytes (green algae). Similar algal blooms are also found at the base of the Choteč Limestone elsewhere in the Prague Basin (e.g. Na Škrábku quarry, U Němců section and also, to a lesser extent, Prastav quarry). The level with prasinophyte accumulation in this section is regarded as a first lithological manifestation of environmental changes that took place (the Basal Choteč event), therefore, it seems so far that the supposed correlation of the above mentioned event with the base of the *costatus* Zone can be supported.

The correlation of the base of the Choteč Limestone with the base of the *costatus* Zone (defined by the first appearance of *P. c. costatus*) may not be exactly coincident. As mentioned above, the base of the Choteč Limestone is in most sections represented by graded grainstones, the sedimentation of which may have been very fast. Furthermore, the rate and pattern of sedimentation may have been different in individual sections; therefore the first appearance of this taxon may have been affected by those circumstances. According to both new and previously published data (Klapper, personal communication, Klapper et al. 1978), it seems that the occurrence of *Polygnathus* sp. aff. *P. trigonicus* is characteristic for the base of the *costatus* Zone, not only in the Prague Basin but also elsewhere (Klapper 1971, Perry et al. 1974). For the above-mentioned reason, the base of the *costatus* Zone in the Na Škrábku quarry section is drawn according to the FAD of this taxon. Klapper et al. (1978) described *Polygnathus* sp. aff. *P. trigonicus* 1.75–1.8 m above the base of Choteč Limestone in the Prastav quarry, which is 20 cm below the FAD of *P. c. costatus* (this study). Similarly, in this study this taxon was found 30 cm above the base of the Choteč Limestone at the Barrandov road-cut section (1.6 m above the bed with the first *P. c. costatus*). Klapper et al. (1978) also recorded *P. sp. aff. P. trigonicus and P. c. costatus* from the same sample approximately 1 m above the base of the Choteč Limestone in the Jelinek mill quarry. If this correlation proves to be valid, then it would have important implications for global correlation of the *costatus* Zone and consequently, the Basal Choteč event.

Conodont biostratigraphy

It should be remembered that the Lower-Middle Devonian conodont zonal concept does not mirror the total ranges of the zonally defining taxa. The persistence of a stratigraphically older taxon into a younger zone or zones is common. The principle of using a first appearance datum of a zonal taxon to define the base of a particular zone was followed (Weddige 1977, Weddige et al. 1979, Klapper 1977a). With the exception of *P. serotinus, T. kockelianus kockelianus* and *T. k. australis* the zonal scheme is based on the *P. costatus patulus, P. c. partitus* and *P. c. costatus* lineage, thus on taxa with close phylogenetic affinity. Because of that, certain problems in global correlations may arise as a consequence of different taxonomical approaches. Therefore, significant attention was paid in this paper to the description and photographic illustration of the “*costatus* group” from the Prague Basin, which represents the type area of one of the zonally defining subspecies (*P. c. partitus*). The conodont faunas studied are of very low diversity and also abundance, spanning six zones (*serotinus-kockelianus* zones). Representatives of juveniles in the offshore deposits prevail, which complicated the taxonomic and biostratigraphic assessment to a certain point, as juveniles cannot be identified to the species level with confidence. On the other hand, in the more shallow water settings (Červený quarry, Koněprusy area) adults prevail.

The ranges of zonally defining taxa found in the Prague Basin were as follows: *P. serotinus* (index taxon of the *serotinus* Zone) was recorded in the *serotinus, patulus, partitus* zones and at the very base of the *costatus* Zone (the last *P. serotinus* was found in the sample with the first *P. c. costatus*). *P. c. patulus* (index taxon of the *patulus* Zone) was recorded in the *patulus, partitus* and the base of the *costatus* zones. *P. c. partitus* (index taxon of the *partitus* Zone) was recorded in the *partitus* and *costatus* zones. *P. c. costatus* (index taxon of the *costatus* Zone) was recorded in the *costatus* and *australis* zones. Representatives of *T. k. australis* (index taxon of the *australis* Zone) were not found in sufficient numbers to make a judgment about its stratigraphical range. Only two specimens were found, not however in the sample with *T. k. kockelianus* (index taxon for the *kockelianus* Zone). Only rocks corresponding to the base of the *kockelianus* Zone (upper part of the
with P. l. bultyncki
arance of gnathus serotinus
see Figs 2–4. All above mentioned taxa, except
this paper. For conodont taxa ranges from selected sections,
realis
and several new species, which are not discussed in
rinellina
Serotinus Zone (Třebotov Limestone)
– Weddige (1977)
kockelianus, P. pseudofoliatus, Pelekysgnathus
pinguis, P. trigonicus, Tortodus kockelianus australis, T. k.
borealis
costatus
costatus, P.
gnathus serotinus, P. linguiformis bultyncki, Icriodus beck-
dition, the usage of other stratigraphical methods such as
be taken into consideration, not only conodont taxa but also
lianus
zones). If possible, the accompanying fauna should
taken into consideration, not only conodont taxa but also
other fossil groups (e.g., dacroconarid tentaculites). In addi-
tion, the usage of other stratigraphical methods such as
chemostratigraphy and magnetic susceptibility is very
promising for regional as well as global correlations.

The following genera and species were recovered: Poly-
gnathus serotinus, P. lingiformis bultyncki, Icriodus beck-
manni beckmanni, I. b. sinuatus, Ozarkodina carinhiaca ,
P. cooperi cooperi, P. costatus patulus, P. c. partitus, P.
costatus costatus, P. sp. aff. P. trigonicus, P. lingiformis
pinguis, P. trigonicus, Tortodus kockelianus australis, T. k.
kokelianus, P. pseudofoliatus, Pelekysgnathus sp., Pando-
rinellina sp., Pseudooneotodus beckmanni, P. sp. aff. P. bo-
realis and several new species, which are not discussed in
this paper. For conodont taxa ranges from selected sections,
see Figs 2–4. All above mentioned taxa, except P. sp. aff. P. bo-
realis and Pandorinellina sp., are figured in Figs 5–10.

Serotinus Zone (Třebotov Limestone). – Weddige (1977)
defined the lower boundary on the first appearance of Poly-
gnathus serotinus and the upper boundary on the first ap-
pearance of P. c. patatus. Apart from P. serotinus, this zone
marks the lowest appearance of P. l. bultyncki (together
with P. serotinus being the most common taxa in the Tře-
botov Limestone, very often the only constituents). Other
taxa occurring within this zone are: Ozarkodina carinhi-
aca (rare), Pandorinellina sp. (rare), Pseudooneotodus
beckmanni (very abundant), Icriodus beckmanni beck-
manni and I. b. sinuatus (not abundant).

Patulus Zone (Třebotov Limestone). – Weddige (1977) de-
defined the lower boundary on the first occurrence of P. c. pa-
tulus and the upper boundary by the appearance of P. c.
partitus, (P. c. costatus in the original definition). P. c. pa-
tulus represents a rather rare taxon, most commonly found
in the upper part of the Třebotov Limestone, together with
P. c. partitus, thus already in the partitus Zone. Therefore,
the base of the patulus Zone in the Prastav quarry and in the
Barrandov road cut must be drawn according to previously
published data by Klapper et al. (1978) and Zusková
(1991). Other taxa present in this zone are: P. c. cooperi
(rare), P. serotinus (very abundant), P. l. bultyncki (very
abundant) and Pseudooneotodus beckmanni (abundant).

Partitus Zone (upper part of the Třebotov Limestone-low-
ernmost Choteč Limestone). – Weddige et al. (1979) suggested
this as a new name for the upper patulus Zone of Klapper et
al. (1978). The base of this zone defines the Lower-Middle
Devonian boundary. The lowermost occurrence of P. c. par-
titus was recorded 5 m below the top of the Třebotov Lime-
stone in the Prastav quarry. This section represents the regio-
nal reference section for the Lower-Middle Devonian
boundary; the previously published FAD of this taxon was at
the level of 2.8 m below the top of the Třebotov Limestone
(Klapper et al. 1978, Chlupáč et al. 1979). Other taxa occurr-
ing within this Zone are: P. serotinus (very abundant), P. l.
bultyncki (very abundant) and P. c. patulus (rare).

Costatus Zone (uppermost part of the Třebotov Limestone and
the majority of the Choteč Limestone). – Weddige
(1977) defined the lower boundary of the zone on the first
appearance of P. c. costatus and the upper boundary on the
lowest appearance of Tortodus kockelianus australis (T. k.
kokelianus in the original definition). The base of this
zone roughly coincides with the main lithologic and faunis-
tic changes, known as the Basal Choteč event which oc-
curred in the Prague Basin and elsewhere (see Chlupáč & Ku-
kal 1988 for additional references). The disappearance of
P. serotinus from this area is characteristic for this time in-
terval as no element of P. serotinus has been found in the
Choteč Limestone within this study. The occurrence of
P. serotinus together with P. c. costatus was recorded
1.25 m below the base of the Choteč Limestone in the Bar-
randov section. This finding represents the only record of P.
serotinus in the costatus Zone in the Prague Basin within
this study. According to Klapper (1977), Klapper et al.
(1978) and Klapper (2009, personal communication), the
last P. serotinus in the Prague Basin was found together with
P. c. costatus from 2.28–2.33 m above the base of the Cho-
eteč Limestone in the Jelíněk mill quarry. Thus, in contrast to
other regions, where P. serotinus is common in the costatus
Zone (e.g., Klapper 1977b, Bardashev 1992), in the Prague
Basin the occurrence of P. serotinus is limited just to the
very base of the costatus Zone (the last specimen of P. sero-
tinus was found together with first P. c. costatus). The oc-
currence of Polygnathus sp. aff. P. trigonicus seems to be
characteristic for the base of this zone. Other taxa within this zone comprise *P. c. patulus* (rare), *P. c. partitus* (relatively common in the lower part), *P. linguiformis bulynckii* (abundant), *P. l. pinguis* (rare) and *Pelekysgnathus* sp. (rare).

**Australis Zone (upper part of the Choteč Limestone).** – This zone was designated by Philip & Jackson (1973) as an assemblage and re-defined by Klapper (1977a) as a zone, the base of which coincides with the first appearance of *T. k. australis*, corresponding to the base of the *kockelianus Zone sensu* Weddige (1977). In this study, the base of this zone was drawn on the basis of the occurrence of two specimens in the Jelínek mill section. The *australis Zone* was identified also in the Barrandov road cut and in the Na Škrábku quarry, with a question on the basis of the presence of *P. pseudofoliatus* (Barrandov road cut) and *P. pseudofoliatus* and *P. trigonicus* (Na Škrábku quarry). For an explanation see the text above.

**Kockelianus Zone.** – Weddige (1977) defined the lower boundary of the zone on the first appearance of *T. k. kockelianus* and the upper boundary on the appearance of *Polygnathus xylus ensensis*. In this study the *kockelianus Zone* was identified only in the upper part of the Choteč Limestone in the Jelínek mill quarry in grey bioturbated wackestones. Also in the section situated on the road between Hostím and Srbsko villages, within the interval with tempestite sedimentation and in the Na vyhlídce section in Hostím within dark-grey lime mudstones and wackestones with silicates.

**Conclusions**

Conodonts from the Třebotov Limestone (Emssian-Eifelian) and the Choteč Limestone (Eifelian) of the Prague Basin were studied. Seven sections were sampled in order to refine the existing conodont zonal scheme and to provide new data for sections that have not been included in previous studies. The most important findings can be summarized as follows:

1. The zonal scheme was re-defined in the Jelínek mill quarry, where boundaries of the *partitus* and *patulus* zones are lower than in previous studies (Klapper *et al.* 1978); also the *australis* and *kockelianus* zones were newly recorded here. Furthermore, new data on the lower and/or upper ranges of other taxa were determined.

2. The supposed correlation of the Basal Choteč event with the base of the *costatus Zone* is supported. First representatives of *P. c. costatus* are, with the exception of Barrandov road cut section, always found at the base of the Choteč Limestone (the sedimentation of this unit reflects changes linked to the above mentioned event). In the Barrandov road cut, the base of the *costatus Zone* was recorded 1.25 m below the base of the Choteč Limestone, which represents the first find of this taxon below the base of this unit. However, changes in sedimentation at this section (linked to the Basal Choteč event) have already been observed at this level (prasinophyte blooms recorded about 1 m below the base of the Choteč Limestone).

3. At the regional reference section for the Lower-Middle Devonian boundary, the Prastav quarry at Holyně, the first occurrence of *P. c. partitus* was recorded 5 m below the base of the Choteč Limestone. Thus the Lower-Middle Devonian boundary, which is drawn according to first occurrence of this taxon, is shifted 2.3 m lower. In addition, the *costatus Zone* was identified here on the basis of the nominal species for the first time, 2 m above the base of the Choteč Limestone.

4. The disappearance of *Polygnathus serotinus* at the very base of the *costatus Zone* from this area has been recorded. This taxon represents the most common species in the Třebotov Limestone; no single element of this taxon was found in the overlying unit, namely, the Choteč Limestone, in this study. This is in contrast with other regions, where it is quite common in the *costatus Zone* (e.g., Klapper 1977b, Bardashev 1992).

5. According to new data and previously published data (Klapper 1977a, Klapper *et al.* 1978) it appears possible to correlate the occurrence of *Polygnathus* sp. aff. *P. trigonicus* with the lower part of the *costatus Zone* in the Prague Basin, as elsewhere (Klapper 1971, Perry *et al.* 1974). Both that species and *P. c. costatus* occur close to the base of the Choteč Limestone, which reflects the effect of the Basal Choteč event. Therefore, the occurrence of *P. sp. aff. P. trigonicus* may also have implications for global correlation of this event.

6. Based on data already published and also on the author’s own observations on ranges of zonally defining taxa, the conclusion has been reached that global, as well as regional, correlations of the studied interval (*serotinus-kockelianus zones*) should not be, at best, based only on conodont zonation. Other fossils groups and also other stratigraphical methods (e.g., chemostratigraphy, magnetic susceptibility) should be considered.

**Systematic section**

Conodont elements were extracted using standard techniques, which comprise dissolution of limestones in 6% acetic acid, sieving and drying the residues and handpicking the elements using a Carl Zeiss binocular microscope (magnification of 16–40×). Separation in a heavy liquid (sodium polytungstate) was carried out. SEM documentation was made at the Institute of Geology and Paleontology, Charles University, Prague, using the JEOL JSM-6380. Specimens studied are deposited in the collection of Stanislava Berkyová, at the Czech Geological Survey (SB2).
Genus *Polygnathus* Hinde, 1879

*Type species.* – *Polygnathus dubius* Hinde, 1879.

**Polygnathus costatus** Klapper, 1971

**Polygnathus costatus patulus** Klapper, 1971

Figure 5A–C

1971 *Polygnathus costatus patulus* subsp. nov.; Klapper, pp. 62, 63, pl. 1, figs 1–9, 29, pl. 3, figs 16–18.

1977 *Polygnathus costatus patulus* Klapper 1971. – Węd-
dige, pp. 310, 311, pl. 4, fig. 74.


1980 *Polygnathus costatus patulus* Klapper. – Johnson et al., pl. 4, fig. 13.


1984 *Polygnathus costatus patulus* Klapper. – Feist et al., pl. 1, fig. 78, pl. 2, fig. 718, 719, 21, 22.

1986 *Polygnathus costatus patulus* Klapper, 1971. – Bul- 
ynck, p. 270, pl. 8, figs 1–6.

1986 *Polygnathus costatus patulus* Klapper. – Schönlaub, pl. 4, figs 4, 5, 8, 26, 77.


1986 *Polygnathus costatus patulus* Klapper. – Bardashev & Ziegler, pl. 1, fig. 1.

*non 1989* *Polygnathus costatus patulus* Klapper. – Bardashev, pl. 3, fig. 3 [P. linguiformis bultynkci].

1992 *Polygnathus costatus patulus* Klapper, 1971. – Bar- 
dashev, pl. 1, fig. 11.

1992 *Polygnathus costatus patulus* Klapper, 1971. – Bar- 
dashev & Ziegler, pl. 6, figs 33–34.

1992 *Polygnathus costatus patulus* Klapper, 1971. – Bon- 
cheva, p. 36, pl. 2, figs 74–8 (only lower views).

1994 *Polygnathus costatus patulus* Klapper. – Mawson & Talent, pl. 2, fig. 1.

1995 *Polygnathus costatus patulus* Klapper, 1971. – Maw- 
son et al., pp. 430–431, pl. 3, fig. 8.

2003 *Polygnathus costatus patulus* Klapper, 1971. – Ben- 
frika & Bultynck, pl. 1, fig. 9.

**Material.** – 42 specimens.

**Description.** – Pa elements of *P. c. patulus* from the Prague Basin have an almost symmetrical (outer platform is slightly wider), broad platform. The anterior platform mar-
gins are slightly constricted. Upper view: the carina rea-
ches the posterior end of the platform, at least in the form of
odes. Adcarinal grooves are relatively deep, mainly in the
anterior part of the platform and wide-forming the charac-
teristic shape of the platform, which is widest at about its
midlength. The platform of the Pa element bears short, but
prominent transverse ridges (16–20 ridges on both sides of
platform in mature specimens). Lower view: the centre of
the small pit is situated at the border between the first and
second quarter of the platform (in the anterior part of plat-
form). The keel is straight or only slightly curved.

**Remarks.** – *P. c. patulus* is similar to *P. c. partitus* as they
share some diagnostic features though they are distinguis-
shable on the basis of the platform outline. However, this
applies only to adult specimens. The platform of *P. c. patu-
lus* is widest at about its midlength whereas the platform of
*P. c. partitus* is narrow, and its anterior margins are almost
parallel. *P. c. patulus* also resembles *P. cooperi cooperi*
Klapper, 1971 (*serotinus-patulus* zones). The former differs
by the more asymmetrical development of the platform and
especially by the development of a weak tongue, which
usually bears two transverse ridges.

**Stratigraphical range.** – Late Emsian to early Eifelian
(Lower-Middle Devonian), the first occurrence of this taxon
defines the lower boundary of the *patulus* Zone. In the Prague
Basin, the lowest occurrence is 7.3 m below the base of the
Choteč Limestone in Na Škrabku quarry, the highest occu-
rence is 2.38 m above the base of the Choteč Limestone in the
Jelinek mill section (the lower part of the *costatus* Zone).

**Polygnathus costatus partitus** Klapper, Ziegler & 
Mashkova, 1978

Figure 5D–I

1978 *Polygnathus costatus partitus* subsp. nov.; Klapper et al., p. 109, pl. 2, figs 1–5, 13.


1986 *Polygnathus c. partitus* Klapper, Ziegler & Mash-
kova. – Bardashev & Ziegler, pl. 1, figs 2, 73.

1986 *Polygnathus costatus partitus* Klapper, Ziegler & 

1986 *Polygnathus costatus partitus* Klapper, Ziegler & 
Mashkova. – Schönlaub, pl. 4, figs 9, 10.

1986 *Polygnathus costatus partitus* Klapper. – Schönlaub, 
pl. 4, fig. 11.

1986 *Polygnathus costatus partitus* Klapper. – Bardashev, 
pl. 3, fig. 11.

1986 *Polygnathus costatus partitus* Klapper, Ziegler & 
Mashkova. – Mawson & Talent, pl. 3, fig. 4.

1992 *Polygnathus costatus partitus* Klapper, Ziegler & 
Mashkova. – Mawson & Talent, pl. 1, figs 14–17, 

1992 *Polygnathus costatus partitus* Klapper, Ziegler & 
Mashkova, 1978. – Boncheva, p. 36, pl. 2, figs 2, 73 
[non fig. 1].
Description. – Pa elements of P. c. partitus from the Prague Basin have an almost symmetrical (outer platform is slightly wider), narrow platform, where the inner and outer posterior platform margins tend to be straight, meeting the posterior end of the platform to form a “sagittate” outline. The anterior platform margins are either parallel or only slightly constricted. Upper view: the carina reaches the posterior end of the platform, at least in the form of nodes. The platform of the Pa element bears short but prominent transverse ridges (16–20 ridges on both sides of the platform in mature specimens). Adcarinal grooves are relatively deep in the anterior part of the platform. Lower view: the centre of the small pit is situated on the border between the first and second quarter of the platform (in the anterior part of the platform). The keel is straight or only slightly curved.

Remarks. – Polygnathus c. partitus was described by Klapper et al. (1978) as a phyletic intermediate between P. c. patulus and P. c. costatus from which it can be distinguished essentially by the development of the platform margins, which are characteristically straight and by the narrow platform development. A comparison of all subspecies is given in the section on P. c. costatus.

Stratigraphical range. – Eifelian (early Middle Devonian), first occurrence of this taxon defines the lower boundary of the partitus Zone. In the Prague Basin, the first occurrence of this taxon falls in the upper part of the Třebotov Limestone. The lowest occurrence found is 5 m below the top of the Třebotov Limestone in the Prastav quarry (this study). The highest occurrence is 2.46 m above the base of the Choteč Limestone in the Barrandov road-cut (this study, lower part of the costatus Zone).

Polygnathus costatus costatus Klapper, 1971
Figure 6I–L

1971 Polygnathus costatus costatus subsp. nov.; Klapper, p. 64, pl. 1, figs 30–36, pl. 2, figs 1–7.

1994 Polygnathus costatus partitus Klapper, Ziegler & Mashkova. – Mawson & Talent, pl. 2, figs 2,73.

Material. – 74 specimens.

Description. – Pa elements of P. c. partitus from the Prague Basin have an almost symmetrical (outer platform is slightly wider), narrow platform, where the inner and outer posterior platform margins tend to be straight, meeting the posterior end of the platform to form a “sagittate” outline. The anterior platform margins are either parallel or only slightly constricted. Upper view: the carina reaches the posterior end of the platform to form a “sagittate” outline. The anterior platform margins are either parallel or only slightly constricted. Upper view: the adcarinal grooves are relatively deep in the anterior part of the platform. Lower view: the centre of the small pit is situated on the border between the first and second quarter of the platform (in the anterior part of the platform). The keel is straight or only slightly curved.

Remarks. – Polygnathus c. partitus was described by Klapper et al. (1978) as a phyletic intermediate between P. c. patulus and P. c. costatus from which it can be distinguished essentially by the development of the platform margins, which are characteristically straight and by the narrow platform development. A comparison of all subspecies is given in the section on P. c. costatus.

Stratigraphical range. – Eifelian (early Middle Devonian), first occurrence of this taxon defines the lower boundary of the partitus Zone. In the Prague Basin, the first occurrence of this taxon falls in the upper part of the Třebotov Limestone. The lowest occurrence found is 5 m below the top of the Třebotov Limestone in the Prastav quarry (this study). The highest occurrence is 2.46 m above the base of the Choteč Limestone in the Barrandov road-cut (this study, lower part of the costatus Zone).

Polygnathus costatus costatus Klapper, 1971
Figure 6I–L

1971 Polygnathus costatus costatus subsp. nov.; Klapper, p. 64, pl. 1, figs 30–36, pl. 2, figs 1–7.

1974 Polygnathus costatus costatus Klapper 1971. – Perry et al., p. 1087, pl. 7, figs 1, ?, 2, 3, 4, 5, 7, 7, 10.
1980 Polygnathus costatus costatus Klapper. – Johnson et al., pl. 4, figs 14, 15, 17.
1983 Polygnathus costatus costatus Klapper, 1971. – Sparing, pl. 10, figs AB, AC; pl. 11, figs AB, AC, AF, AG.
1986 Polygnathus costatus costatus Klapper. – Bardashev & Ziegler, pl. 1, figs 4, 5.
1986 Polygnathus costatus costatus Klapper. – Schönlaub, pl. 4, figs 12–15 [non fig. 11 = P. costatus partitus]
1990 Polygnathus costatus costatus Klapper. – Mawson & Talent, pl. 3, fig. 5.
1990 Polygnathus costatus costatus Klapper, 1971. – Laz- req, pl. 1, fig. 10.
1994 Polygnathus costatus costatus Klapper. – Mawson & Talent, pl. 2, figs 9–12.
1995 Polygnathus costatus costatus Klapper, 1971. – Savage, p. 545, pl. 8, fig. 3.
1995 Polygnathus costatus costatus Klapper, 1971. – Sloan et al., pl. 6, figs 1–6.
2003 Polygnathus costatus costatus Klapper, 1971. – Ben- frika & Bultynck, pl. 1, fig. 10.

Material. – 53 specimens.

Description. – Pa elements of P. c. costatus from the Prague Basin have an almost symmetrical (outer platform is slightly wider), long, narrow platform. The anterior platform margins are slightly constricted. Upper view: the adcarinal grooves are relatively deep and narrow in the anterior part of platform. In the last third of the platform, grooves tend to be wider, thus forming the characteristic shape of the platform, which is
widest in its final third (in the posterior part). The carina reaches the posterior end of the platform. The platform of the Pa element bears prominent, densely spaced transverse ridges (25–30 ridges on both sides of the platform in adult specimens). Lower view: the centre of the small pit is situated on the boundary between the first and second third of the platform. The keel may or may not be slightly curved.

Remarks. – P. c. costatus is easily distinguishable from P. c. patulus and P. c. partitus by its long, narrow platform, which is widest in the posterior third of the platform. The platform is longer and bears more densely spaced transverse ridges in comparison with the other two subspecies. The platform outline is regarded here as the most important diagnostic feature. The platform of P. c. patulus is broad and widest at midlength, the platform of P. c. partitus is narrow and the anterior margins of the platform are more or less parallel, the platform of P. c. costatus is long, narrow and expands in the posterior third. As the platform outline depends on the ontogenetic stage of development, it is possible to identify only the adult specimens with confidence. P. c. costatus also resembles the stratigraphically younger Polygnathus parawebbi Chatterton, 1974; the latter has, however, deep adcarinal grooves and a sharply curved outer platform margin. For comparison with P. pseudofoliatus Wittekindt, 1966, see Klapper (1971).

Several morphotypes of this taxon were recognized in material from the Prague Basin and also from the Great Basin, Nevada (collections of M.A. Murphy at the University of California, Riverside).

Stratigraphical range. – Eifelian (early Middle Devonian). First occurrence of this taxon defines the lower boundary of the costatus Zone. The lowest occurrence of this taxon is 1.26 m below the base of the Choteč Limestone in the Barrandov road cut; the highest occurrence is 22 m (only approximate, part of the section is covered) above the base of the Choteč Limestone in the Jelínek mill quarry.

Polygnathus pseudofoliatus Wittekindt, 1966

Figure 8A–G

1966 Polygnathus pseudofoliata n. sp.; Wittekindt, pp. 637, 638, pl. 2, figs 20–23 [non fig. 19 = P. eiflius].
1971 Polygnathus pseudofoliatus Wittekindt. – Klapper, pp. 63, 64, pl. 2, figs 8–13.
1975 Polygnathus pseudofoliatus Wittekindt, 1966. – Telford, pp. 50, 51, pl. 9, figs 1–12.
1986 Polygnathus pseudofoliatus Wittekindt, 1966. – Bulynck, pl. 7, fig. 13.
1986 Polygnathus pseudofoliatus Wittekindt. – Bardashev & Ziegler, pl. 1, figs 22–23.
1986 Polygnathus pseudofoliatus Wittekindt. – Schönlaub, pl. 5, figs 4–7, non fig. 8 [P. angusticostatus].
1990 Polygnathus pseudofoliatus Wittekindt, 1965. – Lair, pl. 2, figs 10, 11, ?12, 113 [=P. eiflius].
1995 Polygnathus pseudofoliatus Wittekindt, 1966. – Sloan et al., pl. 7, figs 11, 13, non fig. 12.
1995 Polygnathus pseudofoliatus Wittekindt, 1966. – Sparling, p. 1136, figs 2.1–2.4, 2.2–2.8.
2003 Polygnathus pseudofoliatus Wittekindt, 1966. – Morgan, pl. 3, figs 15, 16, 23.
2007 Polygnathus pseudofoliatus Wittekindt, 1965. – Benfrika et al., pl. 9, fig. 1.

Material. – 16 specimens.

Description. – Pa elements of P. pseudofoliatus from the Prague Basin have a somewhat symmetrical (outer platform is slightly wider) platform; the anterior platform margins are slightly constricted. The free blade averages 37% of the total length of the platform. Upper view: the adcarinal grooves are relatively deep, mainly in the anterior part of the platform. The degree of ornamentation of the platform shows some variation. The anterior platform is either ornamented with transverse ridges, which become weaker towards the finely nodose posterior part (Fig. 9A, B, G), or only transverse ridges are present (Fig. 9C, E). The Pa element of this taxon is characterized by a significant expansion of the posterior outer platform. Lower view: the pit is of moderate size in mature specimens and is situated between the anterior end of platform and its midlength.
Figure 6. A–C, E–G – upper and lower views of *Tortodus kockelianus kockelianus* (Bischoff & Ziegler, 1957). • A–C, E–F – Jelinek mill quarry, 37 m above the base of the Choteč Limestone. G – Jelinek mill quarry, 35 m above the base of the Choteč Limestone. D – upper and lower view of *Polygnathus trigonicus* Bischoff & Ziegler, 1957, Jelinek mill quarry, 35 m above the base of the Choteč Limestone. • H – upper and lower view of *Tortodus kockelianus australis* (Jackson in Pedder et al., 1970), Jelinek mill quarry, 35 m above the base of the Choteč Limestone. • I–K – upper and lower views of *Polygnathus costatus costatus* Klapper, 1971. I–J, K – Na Škrábku quarry, 5 m above the base of the Choteč Limestone. J, K – Na Škrábku quarry, 8 m above the base of the Choteč Limestone. • L – upper view of *Polygnathus* sp. aff. *P. trigonicus* Bischoff & Ziegler, 1957, Na Škrábku quarry, 0.4 m above the base of the Choteč Limestone. All magnifications are × 65.
Remarks. – Specimens figured as Fig. 8C and E may resemble *P. c. costatus*, however, the platform outline is more typical of *P. pseudofoliatus* and also the free blade to total length ratio corresponds more with *P. pseudofoliatus*. Furthermore, the transverse ridges in *P. c. costatus* are more densely spaced. Specimens figured as Fig. 8A, B and G, are similar to *P. pseudofoliatus* subsp. A sensu Sparkling (1995) with respect to the platform ornamentation; however, conodonts from the Prague Basin are not so constricted anteriorly, and also have better developed transverse ridges. The specimen illustrated by Sparkling (1995) in fig. 3.8, p. 1128 (*P. pseudofoliatus* subsp. D) is similar to the specimen from the Prague Basin figured as Fig. 8F (single specimen from Holyně locality, 11.9 m above the base of the Choteč Limestone) with respect to the anterior platform, which seems to slope upwards towards the free blade.

Stratigraphical range. – Late Eifelian-early Givetian (Middle Devonian). In the Prague Basin, this taxon occurs together with *P. c. costatus* and *P. trigonicus*. As mentioned previously, the base of the australis Zone was drawn with question mark on the basis of the presence of this taxon.

**Polygnathus cooperi** Klapper, 1971

Figure 7A–D

1971 *Polygnathus linguiformis cooperi* subsp. nov.; Klapper, p. 64, pl. 1, figs 12–22; pl. 2, fig. 21.
1977 *Polygnathus linguiformis cooperi* Klapper 1971. – Weddige, pp. 314, 315, pl. 5, figs 93, 94.
1986 *Polygnathus cooperi cooperi* Klapper. – Schönlaub, pl. 3, fig. 22.
1989 *Polygnathus cooperi cooperi* Klapper. – Mawson & Talent, pl. 3, fig. 8.
1992 *Polygnathus cooperi cooperi* Klapper, 1971. – Bardashev, pl. 1, fig. 2, non figs 6–10.
1994 *Polygnathus cooperi cooperi* Klapper. – Mawson & Talent, pl. 2, fig. ?24; pl. 3, fig. 6.

Material. – 8 specimens.

Description. – Pa elements of *P. c. cooperi* from the Prague Basin have a slightly asymmetrical platform (the carina is situated closer to the inner margin). The adcarinal grooves are relatively shallow and broad, thus creating the characteristic broad, flat (mainly in the posterior part) appearance of the platform. The short free blade averages 18% of the total length of the platform. Upper view: widely spaced, prominent transverse ridges cover the platform, with a range of 16–20 ridges (in adult specimens). Neither the carina nor the adcarinal grooves reach the posterior end, where weak transverse ridges cross the tongue of the platform (usually only one or two ridges). Lower view: the centre of the moderate sized pit is situated at the border between the first and second quarter of the platform (in the anterior part of the platform). The keel is only slightly curved.

Stratigraphic range. – *Serotoinus*-lower *partitus* zones, late Emsian-early Eifelian (Lower-Middle Devonian). In the Prague Basin, the lowest occurrence of this taxon is 5.44 m below the base of the Choteč Limestone in the Na Škrábku quarry, the highest occurrence is 3.4 m below the base of the Choteč Limestone in the same quarry.

**Polygnathus trigonicus** Bischoff & Ziegler, 1957

Figure 6D

1957 *Polygnathus trigonica* n. sp.; Bischoff & Ziegler, pp. 97, 98, pl. 5, figs 1–6.
2003 *Polygnathus trigonicus* Bischoff & Ziegler, 1957. – Pyle et al., p. 105, pl. 2, fig. 18.

Material. – 4 specimens.
Descriptions. – Pa elements of *P. trigonicus* from the Prague Basin have an approximately triangular platform outline. The anterior end of the platform meets the free blade at almost a right angle. The free blade averages 45% of the total length. Upper view: Diagonal rows of nodes cover the anterior part of the platform. The adcarinal grooves are broad and very shallow. The carina is formed by a row of distinct denticles and terminates at the posterior end. Lower view: the relatively large pit with rims is located anteriorly, close to the junction of the anterior end of the platform and the free blade.

Remarks. – *P. trigonicus* may resemble *P. sp. aff. P. trigonicus* Klapper, 1971 in platform outline; however, the latter differs mainly by the position of the pit, which is situated closer to the midlength of the platform. The occurrence of *P. sp. aff. P. trigonicus* in the Prague Basin has been recently re-investigated.

**Polygnathus linguiformis** Hinde, 1879

*Polygnathus linguiformis* cf. *pinguis* Weddige, 1977

Figure 9B–C

[cf.] 1977 *Polygnathus linguiformis pinguis* n. ssp.; Weddige, p. 316, pl. 5, figs 88, 89.

[cf.] 1978 *Polygnathus linguiformis pinguis* Weddige, 1977. – Klapper et al., pl. 2, fig. 34.
Tortodus kockelianus kockelianus (Bischoff & Ziegler, 1957)

Figure 6 A–C, E–G

[?] 1986 Polygnathus l. pinguis Weddige. – Bardashev & Ziegler, pl. 1, fig. 716.

Material. – 2 specimens.

Description. – Pa elements of P. l. cf. pinguis have an expanded and somewhat flattened central part of the platform. Upper view: short, transverse ridges, which in the posterior third of the platform cross the tongue, ornamenting the platform. The adcarinal groove of the outer platform is deeper and wider, thus causing a flange-like development from the margin. Only one specimen preserved the free blade, which constituted 36% of the total length. Lower view: the centre of the moderate sized pit is situated just between the first and second quarter of the platform.

Remarks. – The specimens found differ from the holotype in having a longer free blade and lacking the noded ornamentation of the platform described by Weddige (1977). Only two specimens were found, one of them incomplete; therefore further comparisons could not be made.

Stratigraphical range. – Lower-Middle Devonian, late Emsian (upper patulus Zone)-early Eifelian (lower costatus Zone). In the Prague Basin this taxon was found in Na Škrábkу quarry, 0.17 m above the bed that yielded Polygnathus sp. aff. P. trigonicus.

Genus Tortodus Weddige, 1977

Type species. – Tortodus kockelianus (Bischoff & Ziegler, 1957).

Tortodus kockelianus (Bischoff & Ziegler, 1957)

Diagnosis. – See original diagnosis in Bischoff & Ziegler (1957).

Material. – 11 specimens.

Description. – The Pa elements of T. k. kockelianus from the Prague Basin have a posteriorly twisted, smooth platform, which bears only one row of denticles, which are discrete and conical shaped. The free blade averages 40% of the total length. The platform gradually widens towards the anterior end. The flared basal cavity is situated in the anterior part, close to the junction of the platform and the free blade.

Remarks. – T. k. kockelianus is similar to T. k. australis (see Jackson in Pedder et al. 1970); however, the latter can be distinguished by the more restricted platform development.
(the platform is much narrower in *T. k. australis*). Transitional forms between these two subspecies have been observed. The limited material available from the Prague Basin did not allow further comparison between these subspecies.

**Stratigraphical range.** – *Kockelianus* Zone, Eifelian (Middle Devonian). In the Prague Basin this taxon occurs together with *P. trigonicus*.

**Tortodus kockelianus australis** *(Jackson in Pedder et al., 1970)*

Figure 6H


1986 *Tortodus kockelianus australis* Weddige. – Schönlaub, pl. 5, figs 15–19.


2003 *Tortodus kockelianus* Bischoff & Ziegler. – Pyle et al., pl. 2, figs 19, 20.

**Material.** – 2 specimens.

**Stratigraphical range.** – *Australis* Zone, Eifelian (Middle Devonian). In the Prague Basin this taxon occurs together with *P. trigonicus*.
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