Carboniferous limestone boulder from the Badenian clastics (Carpathian Foredeep, Czech Republic): A useful data source on the Palaeozoic of the Moravosilesian Basin

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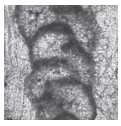

The lower Badenian basal and marginal clastics of the Carpathian Foredeep represent a useful source of information on the Palaeozoic units of the Moravosilesian Basin (Bohemian Massif). This study addresses in detail a Tournaisian limestone boulder from a locality near Kučerov village. Foraminifers indicate a narrow interval within the Mississippian Foraminifer Zone 8, characterized by the co-occurence of *Darjella monilis* Malakhova, 1964 and *Eoparastaffella* ex. gr. *vdovenkoae* Devuyst & Kalvoda, 2007. Fourteen recorded brachiopod taxa include: markedly predominant chonetidines, represented by *Megachonetes zimmermanni* (Paeckelmann, 1930) and other rugosochonetids; less frequent strophomenides (*Leptagonia* M'Coy, 1844) and orthotetides (Pulsiidae, Schuchertellidae); and rather rare spiriferides, athyrides?, orthides and productidines. The brachiopod fauna is generally close to associations known from other European areas. Trilobites are represented by the genus *Cummingella* Reed, 1942. The specimens recorded do not match the species previously known from the Czech Republic and the morphological features preserved suggest similarity with taxa from other European areas (*e.g.* Belgium, Poland). The microfacies correspond to floatstone with a packstone/grainstone matrix and contain crinoids, peloids, foraminifers, intraclasts, cortoids, moravamminids, algae and other allochems. Based on microfacies and foraminifer data, the boulder might originate in the limestone succession of the Líšeň Formation in the vicinity of Mokrá or in the limestone olistoliths in the siliciclastic Culm facies. Accordingly, at least some of the dark grey limestone clasts at the studied locality correspond to the Carboniferous and not only to the Devonian as previously assumed. • Key words: Badenian, Carpathian Foredeep, Tournaisian, Moravian Karst, brachiopods, trilobites, microfacies.

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The upper Tournaisian macrofauna of the Moravian Karst of the Moravosilesian Basin in Czech Republic (Fig. 1) has rarely been documented. Brachiopods have only briefly been discussed or mentioned (*e.g.* Rak *et al.* 2012) and trilobites were depicted and described by Chlupáč (1961, 1966) and Rak *et al.* (2012). The Palaeozoic sequences of the Moravosilesian Basin were exposed to extensive erosion. However, eroded material has been partly preserved in younger sedimentary units, mainly Variscan and Carpathian flysch and molasse sediments.

The composition of basal and marginal coarse clastics deposited during the early Badenian transgression in the Carpathian Foredeep reflects the varied provenance of the source material (Brzobohatý & Cicha 1993). Krystek (1974) has recognized 14 types of rock clasts of these clastics between Brno and Prostějov. Dark grey limestone clasts have generally been considered Devonian (*e.g.* Šob 1940, Krystek 1974), but they have not been studied in detail.

In this study, we share information obtained from a limestone boulder, showing that it is of late Tournaisian age, thereby enabling us to contribute to the discussion regarding the provenance of Badenian basal clastics. Brachiopod and trilobite fauna of this boulder proves valuable with respect to our knowledge of the Palaeozoic macrofauna of the Moravosilesian Basin.

Geological setting

The boulder comes from a striking accumulation of boulders and blocks of dark grey limestone scattered in the fields (area of accumulation *ca* 180 × 120 m) along the road connecting Kučerov and Lysovice (Fig. 1). The locality belongs to the lower Badenian basal/marginal clastics of the Carpathian Foredeep. The geological setting of this area has been described by Rzehak (1897), Zapletal (1934), Šob (1940), Dlabač (1946) and Krystek (1974).

The Carpathian Foredeep represents a peripheral foreland basin developed due to the movement of the Carpathian Front. The western part of the Carpathian Foredeep is situated on the eastern part of the Bohemian Massif and is filled with Neogene (Eggerian–Badenian) sediments (Brzobohatý & Cicha 1993). Lower Badenian deposits are represented by gravels, sandy gravels and gravelly sands ('basal or marginal coarse clastics'), interpreted as deposits of coarse-grained deltas, and dark green, green-grey or brown-grey calcareous pelites/mudstones ('tegels'), interpreted as shallow to deep-water/bathyal deposits (Brzobohatý 1989, Nehyba 2001, Nehyba *et al.* 2008). Basal/marginal clastics are highly variable in composition with respect to their different source areas, and are known under numerous local names (Krystek 1974, Brzobohatý & Cicha 1993).

The studied locality represents so-called Lutrštěk gravels (Šob 1940, Krystek 1974). These gravels are relatively rich in the Palaeozoic sedimentary rocks of the Bohemian Massif (limestones and Culmian siliciclastics) whereas the metamorphic and igneous rocks and material derived from the Western Carpathians are rather rare (Šob 1940). Šob (1940) described Palaeozoic carbonate clasts of the Lutrštěk gravels as light grey-blue Upper Devonian limestones that are perfectly oval, reaching considerable dimensions and containing black silicite nodules.

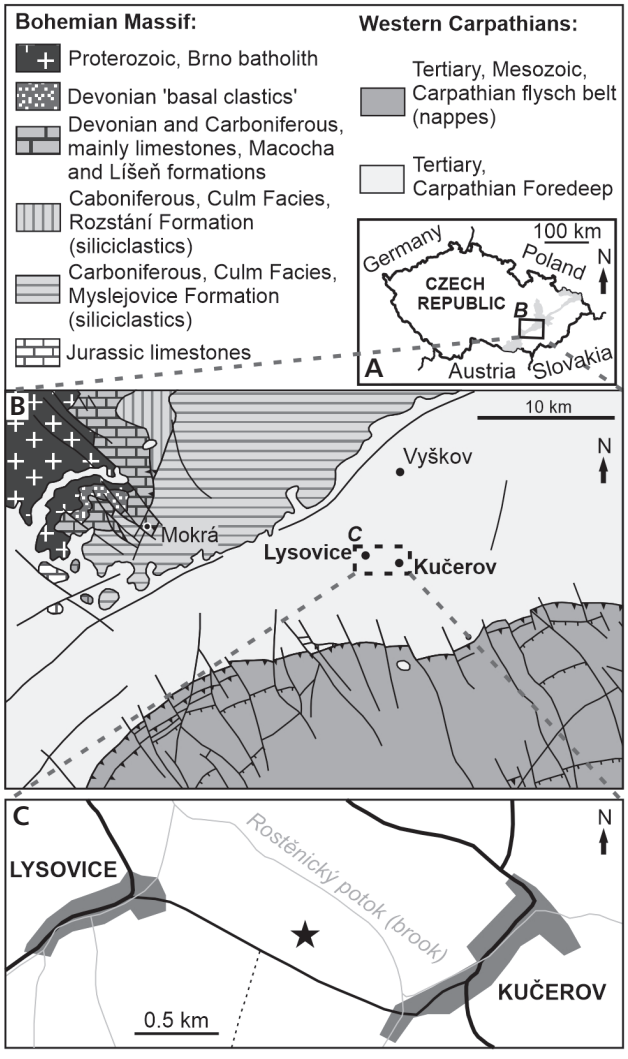


Figure 1. A – geographic position of the Carpathian Foredeep (grey portion) within the Czech Republic. • B – schematic geological map of the south-eastern part of the Czech Republic. • C – schematic map of the area between Kučerov and Lysovice, with a black star marking the boulder's location.

Material and methods

The material comprises a rounded limestone boulder (dimensions *ca* 30 × 20 × 20 cm) covered by a whitish calcareous coating, as is common in the Badenian clastics of the Carpathian Foredeep (see Stráník *et al.* 1999).

The boulder was gradually broken into smaller parts to obtain macrofossils. The microfacies and foraminifers were studied and photographed in two thin-sections (40 × 25 × 0.03 mm) using an Olympus BX51 polarizing microscope connected with an Olympus DP70 camera. Limestone classification followed Embry & Klovan (1971). Quantitative microfacies data were acquired via the point-counting method using the JMicroVision image analysis software (Nicolas Roduit, Switzerland). In total, 1,000 randomly generated points were evaluated. Grain size was measured using JMicroVision software with a 1D measurement application. In total, 1,000 allochems were measured along their longest axis. Grain-size description followed the Udden-Wentworth grain-size scale and the terminology of Flügel (2004). Sorting was computed using a formula based on the Trask correlation coefficient – $S_0 = (Q3/Q1)^{1/2}$ – where Q3 represents the 3rd quartile and Q1 represents the 1st quartile, supposing that grain size values (mm) are ordered from smallest to largest. The results of this formula were classified according to Friedman (1962). Macrofossils were studied under an Olympus SZX16 binocular microscope connected with a Canon EOS 1200D camera. The specimens were coated with ammonium chloride prior to being photographed. Descriptive morphological terms regarding trilobites

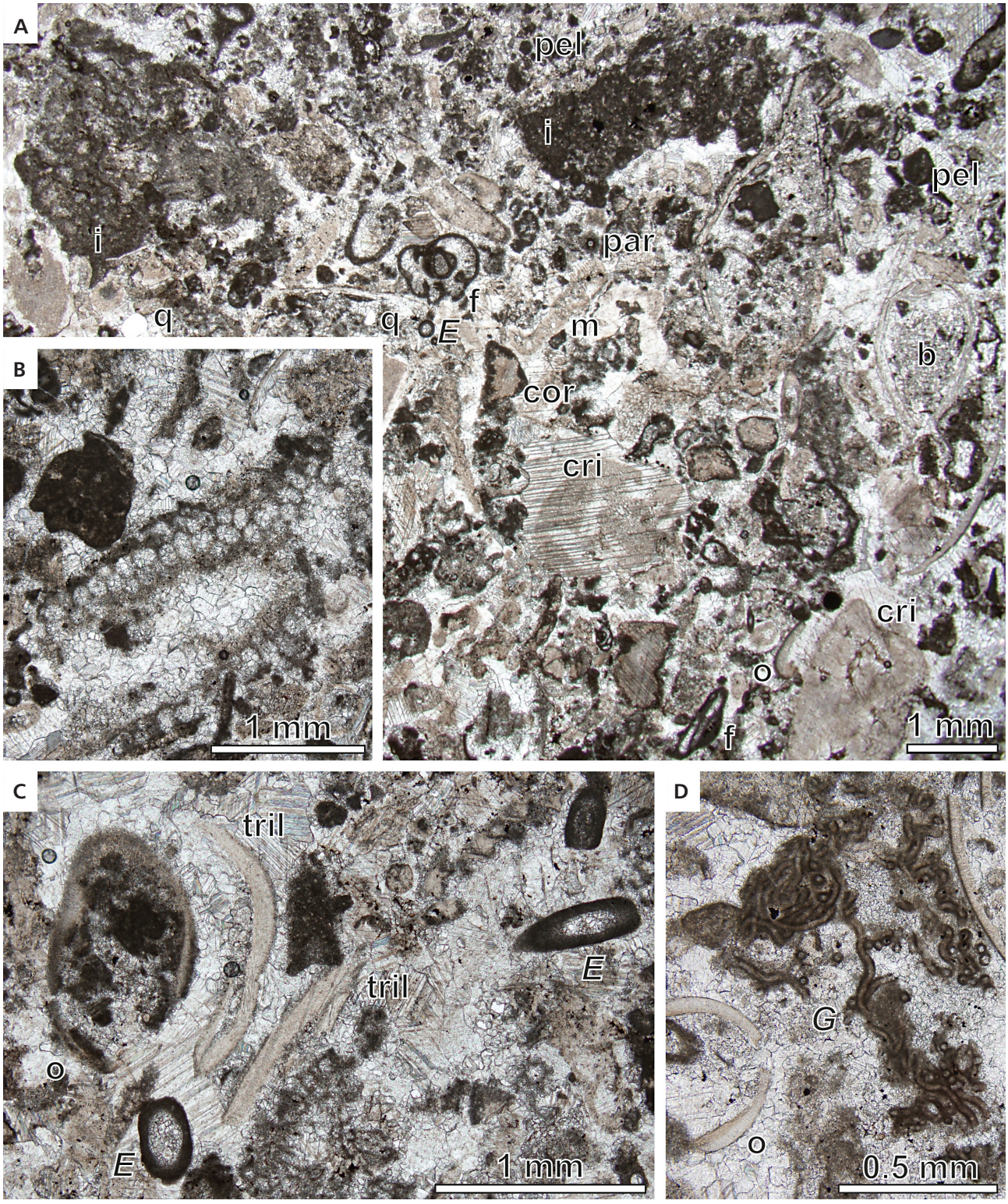


Figure 2. A – floatstone with packstone/grainstone matrix. Allochems include *e.g.* intraclasts (i), peloids (pel), cortoids (cor), crinoids (cri), multilocular foraminifers (f), moravamminids (m), brachiopods (b), ostracods (o), *Earlandia* Plummer, 1930 (*E*) and parathuramminids (par); grains of detrital quartz (q) are also present. • B – dasyclad algae of genus *Koninckopora* Lee, 1912, emend. Wood, 1942. • C – ostracods (o), trilobites (tril) and *Earlandia* Plummer, 1930 (*E*). • D – *Girvanella* Nicholson & Etheridge, 1978 (*G*) and ostracods (o).

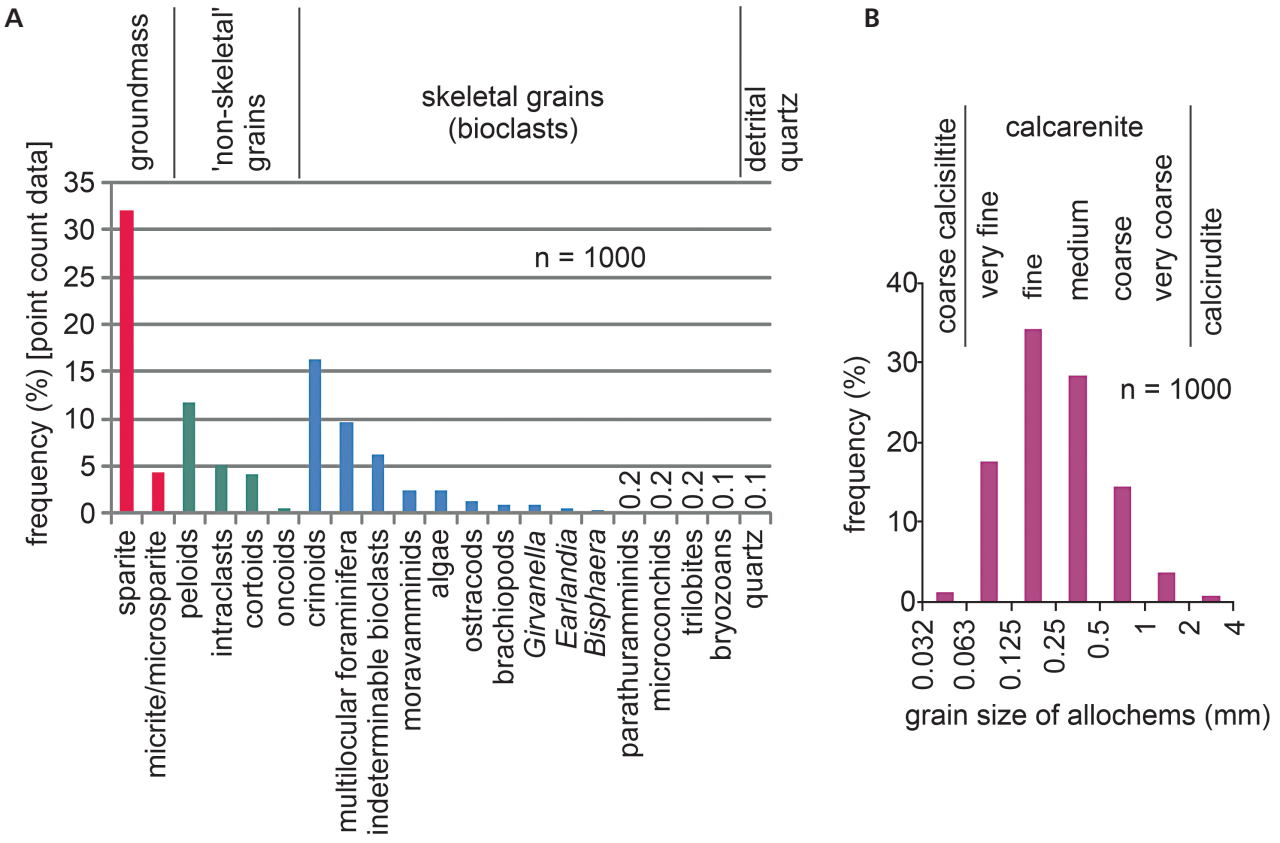


Figure 3. A – quantitative microfacies analysis (point-count data). B – grain-size analysis.

mostly followed Whittington & Kelly (1997), while Greek alphabetic letters, used to describe the facial suture, followed Hahn & Hahn (1975: p. 20, fig. 1) and Müller & Hahn (2018: p. 15, fig. 3a). Subsequently, the figured trilobite and brachiopod specimens were deposited in the palaeontological collections of the Moravian Museum in Brno (MZM), inventory numbers: MZM Ge32915–32945.

Results

Lithology and microfacies

The boulder macroscopically consists of massive, dark grey, medium/coarse-grained calcarenite. Microfacies correspond to packstone/grainstone to floatstone with a packstone/grainstone matrix (Fig. 2A). Grains >2 mm comprise some bioclasts, oncoids and intraclasts. Locally, strong dolomitization obscures the original texture. The non-dolomitized parts are composed of approximately 38% groundmass (32% syntaxial and blocky sparite, 4% micrite/microsparite), 64% allochems (22% 'non-skeletal' grains, 42% skeletal grains) and <1% detrital quartz. Allochems belong to crinoids (16%), peloids (12%), multilocular foraminifers (10%), intraclasts (5%), cortoids, various moravamminids, solenoporacean and dasyclad (*Koninckopora* Lee, 1912, emend. Wood, 1942) algae, medium to thick-walled ostracods with smooth or sculptured shells, various brachiopods and their spines, *Girvanella* Nicholson & Etheridge, 1978, oncoids, *Earlandia* Plummer, 1930, microproblematica (*e.g.* *Bisphaera* Birina, 1948, parathuramminids, *Eotuberitina* Miklukho-Maklay, 1958, calcispheres), microconchids, trilobites, bryozoans (*e.g.* fenestrate) and indeterminate bioclasts (Figs 2A–D, 3A). Bioclasts are commonly fragmented or disarticulated, but articulated ostracod or brachiopod shells rarely occur. Some crinoid ossicles are penetrated by sponge borings.

Intraclasts consist of wackestones/packstones with calcispheres, *Girvanella*, crinoids, moravamminids, foraminifers, peloids, cortoids and fine bioclastic hash, or *Girvanella* accumulations. These wackestones/packstones also infill some bioclasts. Peloids probably originated in the micritization of bioclasts, especially foraminifers, parathuramminids and crinoids, although some may represent small intraclasts. Oncoids have bioclasts as a core whereas *Girvanella* and small calcisperes can be found in their cortexes. Rarely, *Girvanella* strains with a sparite rim and particles composed of radially arranged sparite crystals occur.

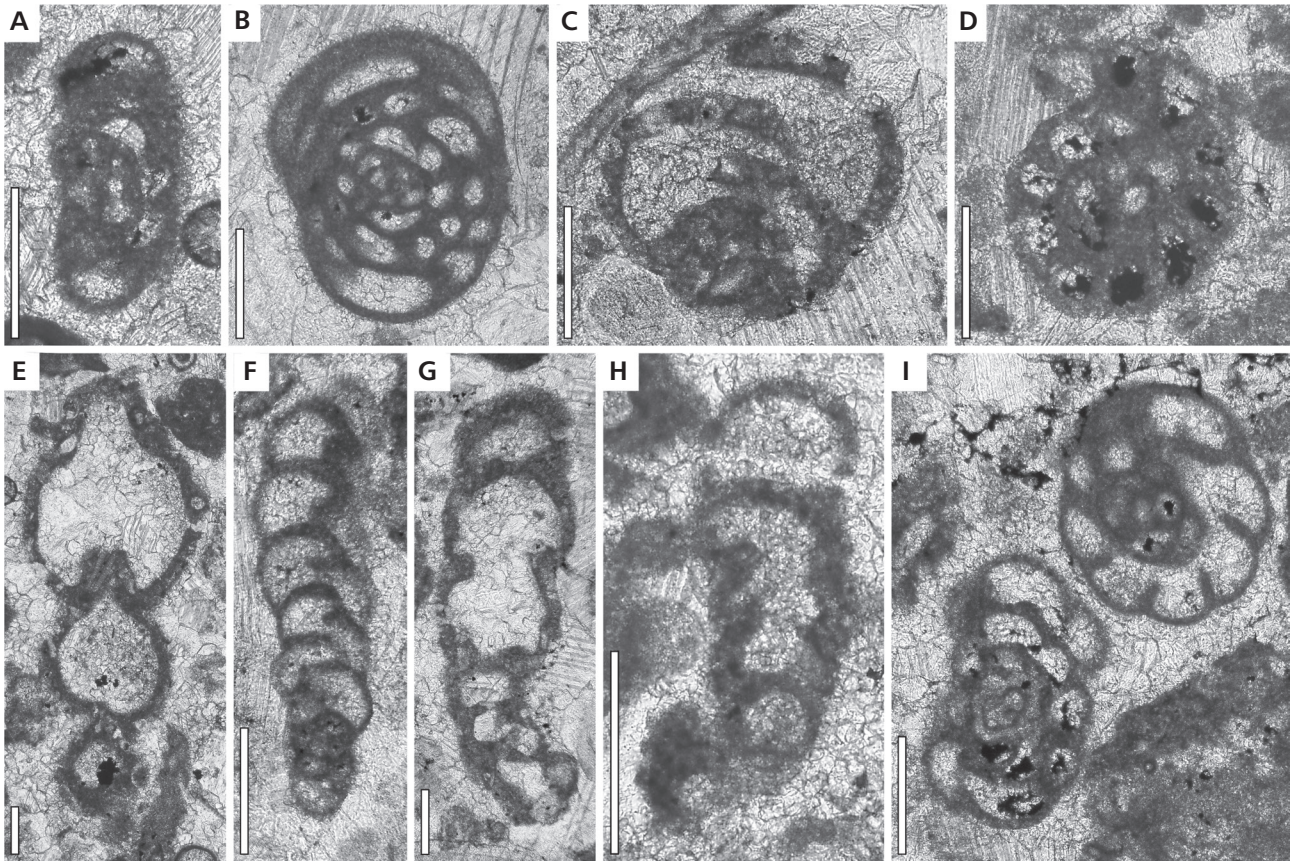


Figure 4. Examples of foraminifers observed in thin sections. • A, D – *Eoparastaffella* sp. • B – *Florenella* sp. • C – *Eotextularia diversa* (Chernysheva, 1948). • E – *Darjella monilis* Malakhova, 1964. • F – *Endospiroplectammina venusta* (Vdovenko, 1954). • G – *Pseudolituotubella* ex gr. *tenuissima* (Vdovenko, 1954). • H – *Elevenella parvula* (Bozorgnia, 1973). • I – *Florennella* ex gr. *fleronensis* (Conil & Lys, 1964) – lower left, *Endothyra* sp. – upper right. Scale bars (all): 200 μm.

The samples correspond to moderately sorted (S_0 = 1.68) calcarenite. Fine- and medium-grained calcarenite constitute the most frequent fractions (together representing 62% of all grains), see Fig. 3B.

Interpretation. – Microfacies contain common foraminifers and moravamminids, which are supposed to inhabit the upper and middle parts of carbonate ramps and be rare below the storm wave base (see Hennebert & Lees 1991, Adams *et al.* 1992, Madi *et al.* 1996, Devuyst & Lees 2001). The relatively shallow-water origin of some allochems is indicated by the presence of dasyclad green algae *Koninckopora*. Also common are products of micritization (peloids, cortoids). On the other hand, some brachiopod taxa may indicate a somewhat deeper-water environment (see below). The presence of large-eyed trilobites might reflect their origin in level-bottom depth within the photic zone. Common bioclast fragmentation and the presence of intraclasts account for sediment reworking or transport. The microfacies probably contain transported material derived from various parts of carbonate ramp**.**

Foraminifer biostratigraphy

In two thin sections the following foraminiferal guides (Fig. 4) can be identified: *Pseudolituotubella* ex gr. *tenuissima* (Vdovenko, 1954), *Florenella* sp., *Latiendothyranopsis* sp., *Brunsia* sp., *Tetrataxis* sp., *Laxoendothyra* sp., *Eotextularia diversa* (Chernysheva, 1948), *Darjella monilis* Malakhova, 1964, *Endospiroplectammina venusta* (Vdovenko, 1954), *Florennella* ex gr. *fleronensis* (Conil & Lys, 1964), *Endothyra* sp., *Eoparastaffella* ex gr. *vdovenkoae* Devuyst & Kalvoda, 2007, *Elevenella parvula* (Bozorgnia, 1973), *Laxoendothyra* sp. and *Brunsia* sp.

Interpretation. – In the past two decades, the search for a new Tournaisian–Viséan (T–V) boundary stratotype in Eurasia has contributed to a substantial improvement in biostratigraphic resolution in this early Carboniferous interval (Devuyst 2006, Poty *et al.* 2006, Devuyst & Kalvoda 2007, Kalvoda *et al.* 2010, Hance *et al.* 2011). In Devuyst & Hance's Mississippian foraminifer zones (MFZ, in Poty *et al.* 2006), the T–V boundary is placed at the base of MFZ9, which is characterized by

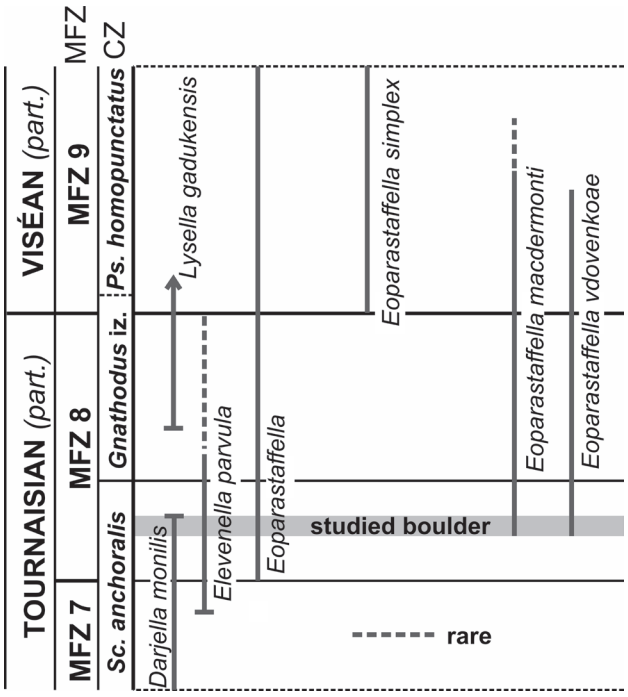


Figure 5. Spans of some stratigraphically significant foraminifers and foraminifer zones around the Tournaisian–Viséan boundary. The stratigraphic interval suggested by foraminifers from the boulder found near Kučerov village is marked by grey belt. Abbreviations: MFZ – Mississippian foraminiferal zones; CZ – conodont zones. Modified according to Devuyst & Hance in Poty *et al*. (2006), Kalvoda *et al*. (2010) and Rak *et al*. (2012).

the appearance of *Eoparastaffella simplex* Vdovenko, 1954. The base of underlying MFZ8 then coincides with the appearance of the first fusulinid *Eoparastaffella* Vdovenko, 1954. In the Mokrá section, *Elevenella parvula* extends up to the entry of *Eoparastaffella simplex* at the very base of the Viséan (Kalvoda *et al.* 2010). The last appearance datum of *Darjella monilis* is in the middle MFZ8, where it occurs together with *Eoparastaffella vdovenkoae* (Devuyst & Kalvoda 2007). In this respect, the foraminiferal fauna of the boulder indicates a very narrow horizon in the lower part of MFZ8 (Fig. 5). This foraminiferal association is very close to the latest Tournaisian foraminiferal association of MFZ8 described by Kalvoda *et al.* (2010) in the Mokrá quarries, where the occurrences of *E. vdovenkoae* and *Darjella monilis* also overlap.

Systematic part

Phyllum Arthropoda von Siebold, 1848
Class Trilobita Walch, 1771
Order Proetida Fortey & Owens, 1975
Superfamily Proetoidea Hawle & Corda, 1847
Family Phillipsiidae Oehlert, 1886,
emend. Hahn *et al.* (1980)
Subfamily Cummingellinae Hahn & Hahn, 1967

Genus *Cummingella* Reed, 1942

Type species. – *Phillipsia Jonesii* Portlock, 1843; Carboniferous, Viséan, Northern Ireland.

***Cummingella* sp.**
Figures 6A–D, 7A–O

Material. – One damaged cranidium with articulated left librigena (MZM Ge32915), four pygidia (MZM Ge32917–32920a).

Description. – Cephalic parts (Fig. 6A–D): The incomplete cephalon measures ~3.5 mm in sagittal length (excluding the broken-off occipital ring and the broken-off anterior part of the cephalon). The damage of the specimen does not allow one to partly or completely observe certain important features, such as the overall outline of the glabella, the morphology of the anterior and lateral border, the relative width of frontal lobe and the posterior portion of the glabella, the overall vaulting of the cephalon and the exsagittal length of the eye (Fig. 6A–C). The eye is relatively large and rather high in lateral view. S1 and S2 are shallow but still recognizable because of the smooth surface, lacking sculpture; the presence/absence of other glabellar furrows (S3, S4) is not possible to evaluate because of this specimen's incompleteness. The course of the facial suture can be traced between δ–ε–ζ–ω. The circumaxial furrow is deep and preserved near δ–ε–ζ only. The occipital ring is almost completely broken off. The relatively deep occipital furrow is observable in the prevailing portion of its course.

Sculpture: With the exception of S1 and S2, the glabella is densely and homogeneously covered by larger distinct (but still relatively fine) pits and smaller indistinct pits. Only few very small granules are present on the posterior margin of the glabella close to the occipital furrow. The preserved part of the librigenal field bears indistinct, fine granulation. Rather sparse and indistinct pits can be observed on the posterior border and the palpebral lobe.

Pygidia: The pygidia measure 2.2 mm (MZM Ge32917, sagittal length), 2.5 mm (MZM Ge32920a, estimated sagittal length including broken portions), 3.2 mm (MZM Ge32918, sagittal length, excluding the broken-off articulating half-ring) and 10.0 mm (MZM Ge32919).

Specimen MZM Ge32917 (Fig. 7A–D): The outline seems to be semicircular. The border is relatively clearly delimited by the border furrow, which is rather shallow and broad but relatively clearly incised. The

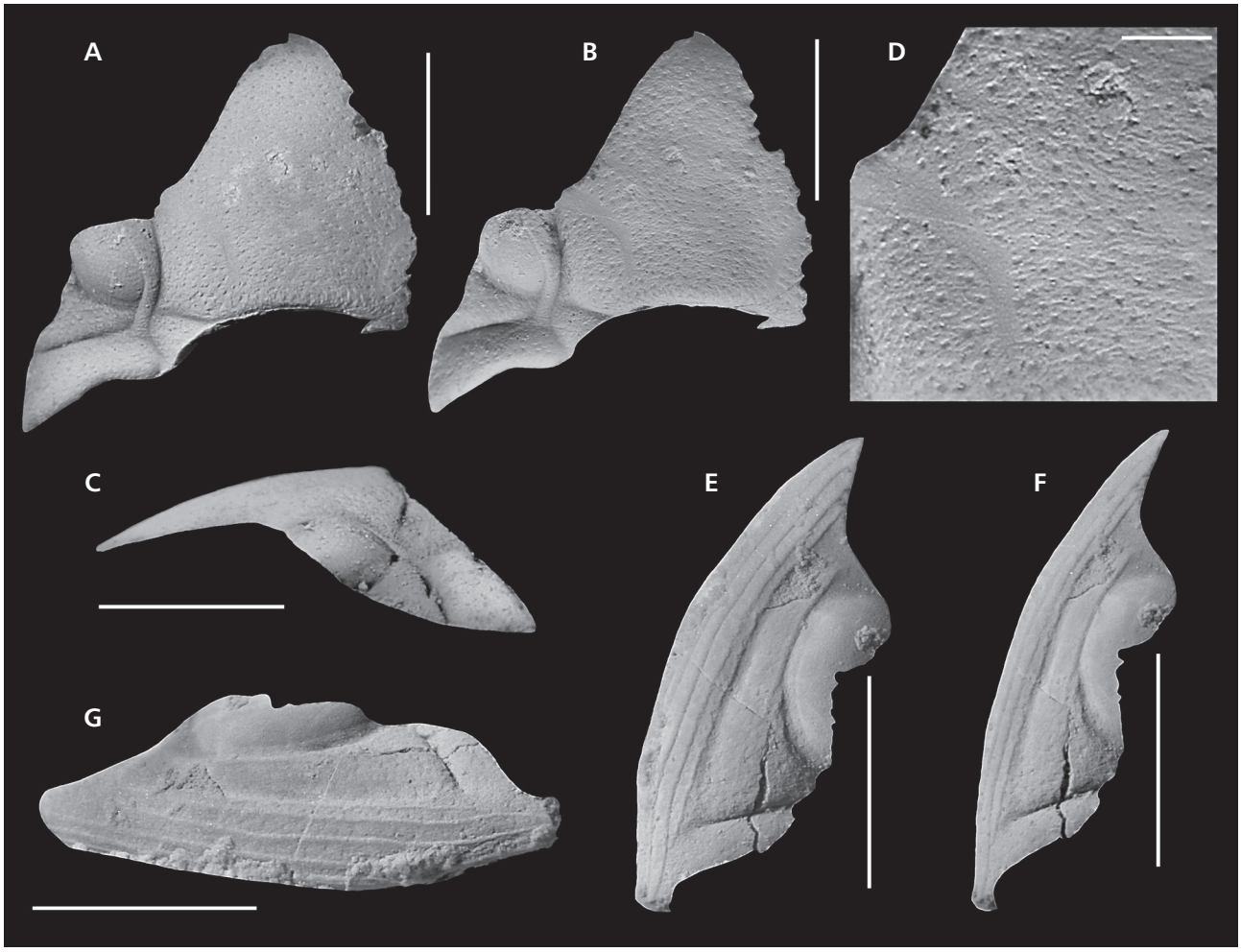


Figure 6. A–D – *Cummingella* sp., incomplete and damaged cephalon, MZM Ge32915. Dorsal views, differently illuminated (A, B), lateral view of silicone rubber (C), detail of posterior part of glabella showing surface sculpture of the exoskeleton (variously sized pits) and glabellar furrows (S1 and S2) (D). • E–G –*Cummingella*? sp., incomplete librigena, inventory number MZM Ge32916. Dorsal to dorsolateral view (E), dorsal view (F), lateral view (G). The specimens were coated with ammonium chloride. Scale bars: A–C, E–G: 2 mm, D: 0.5 mm.

border is flat and slopes by an obliquely steep descent. The pleural field has eight clearly delimited ribs, including posterior ribs, which are also relatively sharply marked. Interpleural furrows are recognizable on anterior one or two ribs only. All pleural furrows are distinctly marked and more clearly developed than interpleural furrows. Ribs are partly and indistinctly extended on the border when observed in specific illumination (Fig. 7A). Axis with ~9+1 or ~10+1 rings which are separated by narrow and relatively deep ring furrows. Sculpture: fine granulation is visible on the border and the pleural field; rings are smooth or almost smooth, with sparse fine granules.

Specimen MZM Ge32920a (Fig. 7E–G): Judging from only the left preserved half of the pygidium, the outline is semioval to indistinctly subtriangular. The pygidium is high in lateral and posterior views. The axis bears 10+1 axial rings. The border is broad. Seven to eight rib pairs are present; almost all ribs (with the exception of the posterior one) enable recognition of the pleural and interpleural furrows, although more posteriorly placed ribs generally show less distinct furrows. The postaxial ridge absent. The specimen is almost entirely covered by granulation, with slightly coarser granules on more abaxial portions of the ribs, whereas very fine to missing granulation can be seen on more adaxially placed portions of the ribs and on lateral portions of the rings.

Specimen MZM Ge92918 (Fig. 7H–K): The pygidium has a semicircular outline. The broad pygidial border is rather weakly separated from the pleural field by an indistinct and shallow border furrow. The border is relatively flat (but not subhorizontal or horizontal) and slopes by an obliquely steep descent. The pleural field bears six to seven rib pairs, with posterior one or two ribs rather indistinct to absent and more anteriorly placed ribs more clearly marked. The pleural furrows are

more sharply marked than the interpleural 'furrows'. The latter clearly recognizable between the anterior two or three ribs and are absent on more posteriorly placed ribs (the interpleural furrows are replaced by rows of granules merging into ridges in such cases, see Fig. 6H, I). With the exception of the anteriormost rib pair, which is weakly extended on the border, the ribs are generally not extended on the pygidial border. Axis bears ~10+1 rings which are separated by narrow and rather deep ring furrows. The external surface of the pygidium is prevalently covered by relatively indistinct fine granulation.

Specimen MZM Ge32919 (Fig. 7L–O): The outline is semioval to indistinctly subtriangular. The border is delimited by a rather narrow and shallow border furrow, which is clearly visible. The border is relatively narrow in dorsal view and broad/high (almost vertical) in lateral and posterior views. The axis bears 10+1 axial rings. Deeply marked pairs of muscle scars on lateral portions of the axial rings are present. The postaxial ridge is not clearly developed or is absent. The pleural field has eight ribs. Four or five anterior rib pairs have visible pleural and interpleural furrows and more abaxial portions of pleural bands bear coarse granules, whereas another three or four posterior rib pairs are marked by indistinctly elevated areas with granules and pleural/interpleural furrows are not visible. Ribs are generally not extended on the border. The specimen is almost completely covered by granulation. The border is relatively homogeneously covered by fine granulation. Somewhat coarser granulation is present on more abaxially situated portions of the ribs and central portions of the axial rings; fine to absent granulation can be observed on more adaxial portions of the ribs and on lateral portions of the axial rings.

Remarks. – The incomplete cephalon described above is similar to the specimen depicted by Osmólska (1970: pl. 6, fig. 3: '*Cummingella brevicauda*' = *C.* (*C.*) *belisama belisama* Hahn, Hahn & Brauckmann, 1985 according to Hahn *et al*. 1985; see also Hahn & Hahn 2008) in the following features: surface sculpture, course of the facial suture between δ–ε–ζ–ω, course of the posterior part of the circumaxial furrow, width of the posterior border and posterior portion of the eye which fairly does not reach posterior border furrow. In general, there are no significant differences, the exception beeing the glabellar furrows (S1, S2), which are shallower in the new specimen discussed here. However, relatively analogous surface sculptures with densely spaced fine pits have been recorded in other similarly large-eyed taxa, such as *C.* (*C.*) *jaroszi jarozsi* Osmólska, 1970 and *C.* (*C.*) *carringtonensis tuberculigenata* Osmólska, 1970. When compared with the new specimen, *C.* (*C.*) *jaroszi jaroszi* seems to have similarly weakly incised glabellar furrows, while *C.* (*C.*) *carringtonensis tuberculigenata* has more deeply marked glabellar furrows (see Osmólska 1970, Hahn & Hahn 2008).

Very similar pygidia to the new pygidia are present in the above-mentioned taxa. The morphology of the smallest specimen (MZM Ge32917), especially in terms of its relatively flat and clearly separated border and the fact that all its ribs are sharply marked, resembles subspecies of *Cummingella* (*C.*) *carringtonensis* (Etheridge, 1884 *in* Woodward 1884) or related forms (see Osmólska 1970; Hahn & Hahn 1987, 2008), whereas its fine to missing granulation and its number of axial rings (10+1) are features closer to *C.* (*C.*) *carringtonensis gaitalensis* Hahn & Hahn, 1987 (Hahn & Hahn 1987, 2008). It must be taken into consideration that the specimen (MZM Ge32917) presented here is a juvenile; a similar morphology resembling subspecies of *C.* (*C.*) *carringtonensis* might be developed in ontogenetically younger (early holaspid or late meraspid) pygidia of other species of *Cummingella*. For example, the similarly sized juvenile paratype pygidium of *C.* (*C.*) *jarozsi jarozsi* depicted by Osmólska (1970: pl. 7, fig. 7) also possesses a clearly separated broad border and sharply marked ribs, although the rhachis is slightly more posteriorly pointed than in the new juvenile specimen. Larger holaspid pygidia relatively similar to the juvenile specimen (MZM Ge32917) have also been recorded in the Australian species *Australokaskia coulteri* (Mitchell, 1918), see Engel & Morris (1994: pl. 1, figs 21, 22). Same authors have discussed this species as belonging to Cummingellinae (Vanderlaan & Ebach 2015).

Affinity to *C.* (*C.*) *jarozsi jarozsi* is also documented by another pygidium (MZM Ge32918), which is morphologically almost identical to that depicted by Osmólska (1970: pl. 8, fig. 9). However, Osmólska's specimen is almost two times larger in sagittal length than the Moravian specimen (~ 3.2 *vs* 5.7 mm). The nearly identical morphology is demonstrated by: width of the border, morphology and number of ribs (with posterior ribs more weakly marked), and the similarly broad axis with the same number of axial rings. The specimen depicted by Osmólska (1970: pl. 8, fig. 9) mainly differs in terms of the sculpture, which is represented by minute pits in *C.* (*C.*) *jaroszi jaroszi* (according to Osmólska's description) instead of fine granulation, as present in the new specimen. A less significant difference pertains to the clearly marked pairs of muscle scars on the lateral portions of the axial rings in Osmólska's specimen (1970: pl. 8, fig. 9). Although the broad border may resemble *C.* (*C.*) *carringtonensis* and related forms (see Hahn & Hahn 2008 for summary), the posterior ribs are relatively weakly marked in the new specimen, whereas all the ribs of *C.* (*C.*) *carringtonensis* and similar forms are rather sharply delimited and the border more clearly separted from the pleural area (see Osmólska 1970; Tilsley 1977; Hahn *et al.* 1985; Hahn & Hahn 1987, 2008).

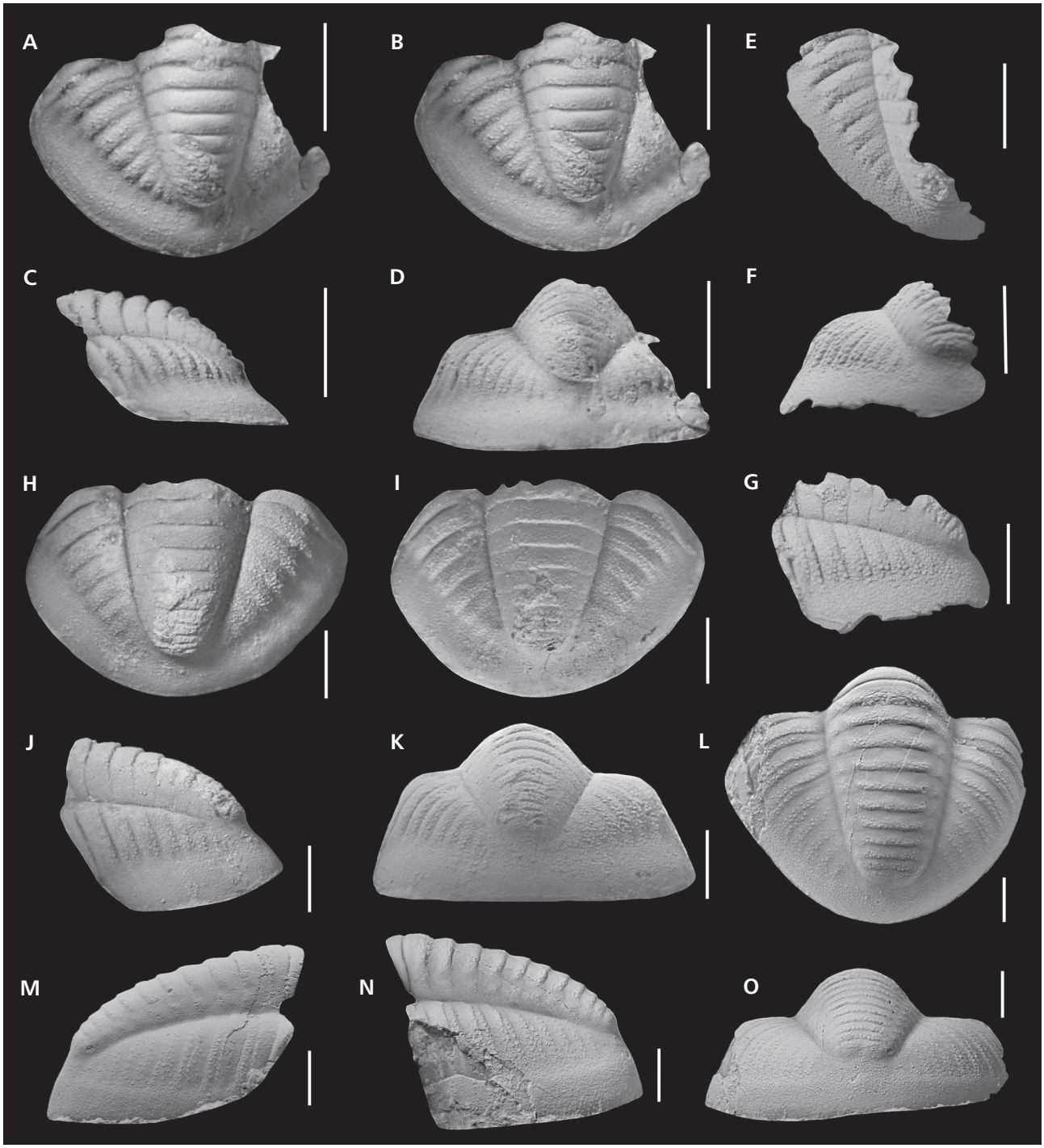


Figure 7. A–O – *Cummingella* sp.; A–D – incomplete pygidium, MZM Ge32917. A, B – dorsal view, differently illuminated (A, B), left lateral view (C), posterior view (D). The specimen was coated with ammonium chloride; E–G – incomplete pygdium, MZM Ge32920a. Dorsal view (D), posterior view (F), left lateral view (G); H–K – pygidium, MZM Ge32918. Dorsal views, differently illuminated (H, I), left lateral view (J), posterior view (K); L–O – pygidium, MZM Ge32919. Dorsal view (L), right lateral view (M), left lateral view (N), posterior view (O). The specimens were coated with ammonium chloride. Scale bars: A–K: 1 mm, L–O: 2 mm.

The morphology of pygidium MZM Ge32920a is close to specimen MZM Ge32918. However, specimen MZM Ge32920a differs in its indistinctly narrower border and its slightly more clearly marked posterior ribs. These differences are relatively subtle and these pygidia are probably conspecific.

The pygidium MZM Ge32919 is similar to some specimens previously assigned to *C.* (*C.*) *belisama* [e.g. *C.* (*C.*)

belisama lug Hahn, Hahn & Brauckmann, 1985 *in* Hahn *et al*. (1985: pl. 1, fig. 10)] in high vaulting, relatively high border (in lateral/posterior views) and morphology of three or four anterior ribs. On the other hand, the 10+1 axial rings, the narrow border (in dorsal view) and the less distinctively marked posterior ribs are features that resemble the relatively large pygidium of *C.* (*C.*) *jaroszi jaroszi* depicted by Osmólska (1970: pl. 8, fig. 6).

Thus, it is possible (but not certain) that the incomplete cephalon and the pygidia described above represent a single species. The morphological variability of pygidia seems to be close with variability of specimens previously assigned to *C.* (*C.*) *jarozsi jarozsi* by Osmólska (1970). Nevertheless, better preserved cephalic parts are necessary to confirm any possible relationship with *C.* (*C.*) *jarozsi jaroszi* or with subspecies of *C.* (*C.*) *belisama*.

From the stratigraphic point of view, the subspecies of *C.* (*C.*) *belisama* have been recorded from the upper Tournaisian of Belgium (upper Ivorian, see Hahn & Hahn 2008: p. 72 for summary) and *C.* (*C.*) *jaroszi jaroszi* is known from the upper Tournaisian of Poland (Osmólska 1970, Hahn & Hahn 2008). Furthermore, subspecies of *C.* (*C.*) *carringtonensis* are known from the upper and middle Viséan of the United Kingdom, Belgium, France, Germany, Poland and Austria (Osmólska 1970; Tilsley 1977; Hahn & Hahn 1987, 2008; Hahn *et al*. 1985), although other representatives supposedly related to *C.* (*C.*) *carringtonensis* occur in the upper Tournaisian (see Hahn & Hahn 2008 and references therein).

***Cummingella*? sp.**
Figure 6E–G

Material. – One damaged librigena (MZM Ge32916).

Description. – The incomplete librigena measures ~4.8 mm (in longest axis, excluding the broken-off portion of the genal spine). The course of the facial suture, the eye, the posterior border and the genal spine are partly damaged. The course of the facial suture is preserved around α–β–γ and prevalently damaged or not clearly visible between δ–ε–ζ–ω. The damaged eye is similarly high or somewhat lower in lateral view than the eye in the incomplete cephalon described above. The eye socle is weakly separated by a shallow eye socle furrow. The narrow ridge near the eye is developed on the librigenal field. This ridge is more clearly developed in its anterior portion and less distinctive and slightly interrupted in its middle to posterior portion. The border furrow is rather narrow and deep. The librigenal spine is partly broken off and was originally probably relatively short. The lateral border is very high in lateral view. The lateral border bears several sparsely spaced terrace ridges (~ five to six), which are separated by broad and almost smooth areas bearing indistinctive sparse pits. The surface is almost smooth. Very diminutive, indistinctive and rather sparse pits are present on the librigenal field and the lateral border.

Remarks. – Assignment of at least some of the above-described specimens of *Cummingella* to this librigena is possible but not certain. The librigena may belong to *Cummingella*, although the definite knowledge of other parts of the exoskeleton is necessary for the closer determination. Assignment to Cummingellinae is possible but also other subfamilies such as Griffithidinae Hupé, 1953 and Ditomopyginae Hupé, 1953 cannot be completely ruled out, either. Some taxa from these subfamilies possess relatively similar librigenae, e.g. *Cummingella* (*C.*) *jonesi jonesi* (Portlock, 1843) (Owens 2000: fig. 4h); *C.* (*C.*) *austriaca* (Hahn & Hahn, 1973) (Hahn & Hahn 1987: pl. 2, fig. 4); *Hesslerides megalops* (Chamberlain, 1977) (Hahn & Hahn 2016: p. 284, fig. 231; Chamberlain 1977: pl.1, fig. 11); *Paladin* (*Neokaskia*) *borealis* (Kobayashi, 1987) (Bruton 1999: pl. 1, fig. 3); *Australokaskia*? *arduennensis* (Hahn & Hahn, 1968) (Hahn & Hahn 1968: pl. 1, fig. 4 – described here as '*Cummnigella jonesi jonesi*', see synonymy in Hahn & Hahn 2008: p. 118).

Phylum Brachiopoda Duméril, 1806
Class Strophomenata Williams *et al*., 1996
Order Strophomenida Öpik, 1934
Superfamily Strophomenoidea King, 1846
Family Rafinesquinidae Schuchert, 1893
Subfamily Leptaeninae Hall & Clarke, 1894

Genus *Leptagonia* M'Coy, 1844

Type species. – *Producta analoga* Phillips, 1836; Carboniferous, Viséan; England.

***Leptagonia* cf. *franca* Mottequin & Simon, 2017**
Figure 8A–C

cf. 2017 *Leptagonia franca* sp. nov.; Mottequin & Simon, pp. 6–11, figs 4–7.

Material. – One ventral valve (MZM Ge32921a).

Description. – The ventral valve is 18 mm wide, subquadrate in outline and widest along the hinge line, which extends into short ears. The valve has a subplanar disc and prominent geniculation along anterior and lateral margins. The transverse profile of the valve is weakly concave, the lateral margins of the valve beeing raised above the disc. Rugae are entire, regularly developed and evenly increasing in size anteriorly, apart from at the ears, where they abruptly bend. The ventral muscle platform

is weakly defined. Narrow radially disposed canals of the vascular system are clearly impressed. Small and sparsely distributed endospines cover the shell interior. Multicostellate ornamentation is weak.

Remarks. – The valve is definitely assigned to *Leptagonia* but its determination at the species level is uncertain. Numerous finds of leptaenids of Tournaisian to Viséan ages from Western Europe, the Ural Mountains, the Moscow Basin and from China to Australia are referred to as *Leptagonia analoga* (Phillips 1836, Demanet 1934, Sarytcheva & Sokolskaya 1952, Sarytcheva *et al.* 1963, Brunton 1968, Thomas 1971, Nalivkin 1979, Sun & Baliński 2008), although Bassett & Bryant (2006) have noted that the true identity of this type species of the genus remains obscure. The mode of preservation of the only specimen available has left the outline of the ventral muscle platform unclear. This feature is taxonomically important (Bassett & Bryant 2006). The subquadrate outline and raised sides of the shell distinguish the Moravian specimens from their counterparts from the Ural Mountains (Nalivkin 1979) and South East Wales (Basset & Bryant 2006), but render them similar to immature specimens of *L. franca* Mottequin & Simon, 2017 from the Tournaisian of Belgium as well as to the early growth stages of the *L. analoga* lectotype (Brunton 1968: pl. 3, fig. 27).

Order Productida Sarytcheva & Sokolskaya, 1959
Suborder Chonetidina Muir-Wood, 1955
Superfamily Chonetoidea Bronn, 1862
Family Rugosochonetidae Muir-Wood, 1962
Subfamily Rugosochonetinae Muir-Wood, 1962

Genus *Rugosochonetes* M'Coy, 1844

Type species. – *Orthis hardrensis* Phillips, 1841; Carboniferous, Viséan; England.

***Rugosochonetes*? sp.**
Figure 8L

Material. – One ventral valve (MZM Ge32930).

Description. – The valve is small, transverse, with rectangular cardinal extremities, covered with fine costellae, numbered six to seven per 2 mm anteromedially. Costellae are rounded, separated by narrow interspaces and most of them bifurcate anteriorly. They are also distinct on the posteriolateral flanks. Spines and interior are unknown.

Remarks. – The specimen differs from the commonest chonetidine in this sample (referred to herein as *Plicochonetes* sp. A) in its weaker shell convexity and its finer, rounded and frequently bifurcating costellae. The ventral valves of *Plicochonetes* sp. A of comparable size (Fig. 8E) are much more convex than the valve of *Rugosochonetes*? sp.

Subfamily Delepineinae Muir-Wood, 1962

Genus *Megachonetes* Sokolskaya, 1950

Type species. – *Chonetes siblyi* Thomas, 1919; Carboniferous, Viséan; England.

***Megachonetes zimmermanni* (Paeckelmann, 1930)**
Figure 8O–T

1930 *Chonetes zimmermanni*; Paeckelmann, pp. 272–274, pl. 17, fig. 23, pl. 18, fig. 1.
1950 *Chonetes* (*Megachonetes*) *zimmermanni* (Paeckelmann). – Sokolskaya, p. 44, pl. 6, figs 7–13.
1971 *Megachonetes zimmermanni* (Paeckelmann). – Roberts, pp. 79–80, pl. 10, figs 11–22.
1979 *Megachonetes zimmermanni* (Paeckelmann, 1930). – Nalivkin, pp. 34–35, pl. 9, figs 6–12.

Material. – Three ventral valves (MZM Ge32921b, Ge32933, Ge32935) and one dorsal valve (MZM Ge32934).

Description. – In the largest specimen examined, the shell is large, 36 mm wide and 20 mm long. It is also thin and rectimarginate. The shell outline is semicircular, with rectangular cardinal extremities. The dorsal valve is very gently concave in its transverse and longitudinal profiles, with subplanar flanks. The sides and the anterior margin are evenly curved. The ventral valve is weakly convex in transverse profile and weekly convex and sloping from the raised apex in longitudinal profile.

The exterior bears a finely capillate ornamentation. The capillae are straight, uniformly sized and separated by similarly sized interspaces. New capillae originate both bifurcation and intercalation in the ventral valve and rapidly reach the size of the parent capillae. Fine concentric lines cross the radial capillae (Fig. 8R). There are four concentric lines per 1 mm. The dorsal interior shows a small cardinal process, a small cardinal pit and small transverse socket ridges. A short and weak median ridge is present. Large elongate endospines form imperfect rows on the flanks of the dorsal interior. Finer and more uniform endospines arranged in radial rows are developed on the interior of the ventral valve.

Remarks. – Observable features allow all Moravian specimens to be assigned to *Megachonetes zimmermanni* (Paeckelmann, 1930). This species has wide geographic distribution in the upper Tournaisian of the Kuznetsk (Sarytcheva *et al.*1963) and Moscow basins (Sarytcheva & Sokolskaya 1952) and the Ural Mountains (Nalivkin 1979).

It is fairly abundant in the Viséan of Western Europe (Paeckelmann 1930) and its geographic range also covers North-West Australia (Roberts 1971). The small specimen in our sample (Fig. 8O) may belong to the same species.

Subfamily Plicochonetidae Sokolskaya, 1960

Genus *Plicochonetes* Paeckelmann, 1930

Type species. – *Chonetes buchianus* de Koninck, 1843 *in* de Koninck (1842–1844); Carboniferous, Viséan; Belgium.

***Plicochonetes* sp. A**
Figure 8E–K

Material. – Seven shells (MZM Ge32923–Ge32929).

Description. – In the largest specimen examined, the shell is medium-sized, 16.5 mm wide and 10 mm long; the maximum width can be seen at the hinge line. Cardinal extremities are oblique in small to medium-sized specimens and become rectangular in large specimens. The anterior commissure is broadly unisulcate. The shell outline is subcircular, with evenly curved lateral and front margins. The dorsal valve is deeply concave in transverse and longitudinal profiles. Furthermore, the posterolateral flanks of the ventral valve are distinctly depressed and the central part of valve is strongly convex in the transverse and longitudinal profiles.

The shell exterior bears prominent straight and weakly expanding costellae separated by deep narrow interspaces. New costellae originate by bifurcation. There are around 25 costellae near the ventral apex, increasing to 95 to 100 in large specimens, numbering four to five costellae per 2 mm anteromedially. The concentric ornament consists of raised fine concentric fila crossing the radial ornamentation (Fig. 8H), numbering 14 to 15 fila per 1 mm.

Regular radial rows of large endospines, numbering four to five per 1 mm, are present on the interior of both valves (Fig. 8G, J, K). The endospines are regularly aligned along the interspaces of the external ornaments. They become less prominent along the internal periphery of the dorsal valve, whereas they are better developed along the internal periphery of the ventral valve. Only small cardinal process pits and trilobate cardinal processes are discernible in the dorsal valve interior, whereas the median septum, accessory septa and anteridia are not developed. A fine myophragm is present in the ventral valve interior.

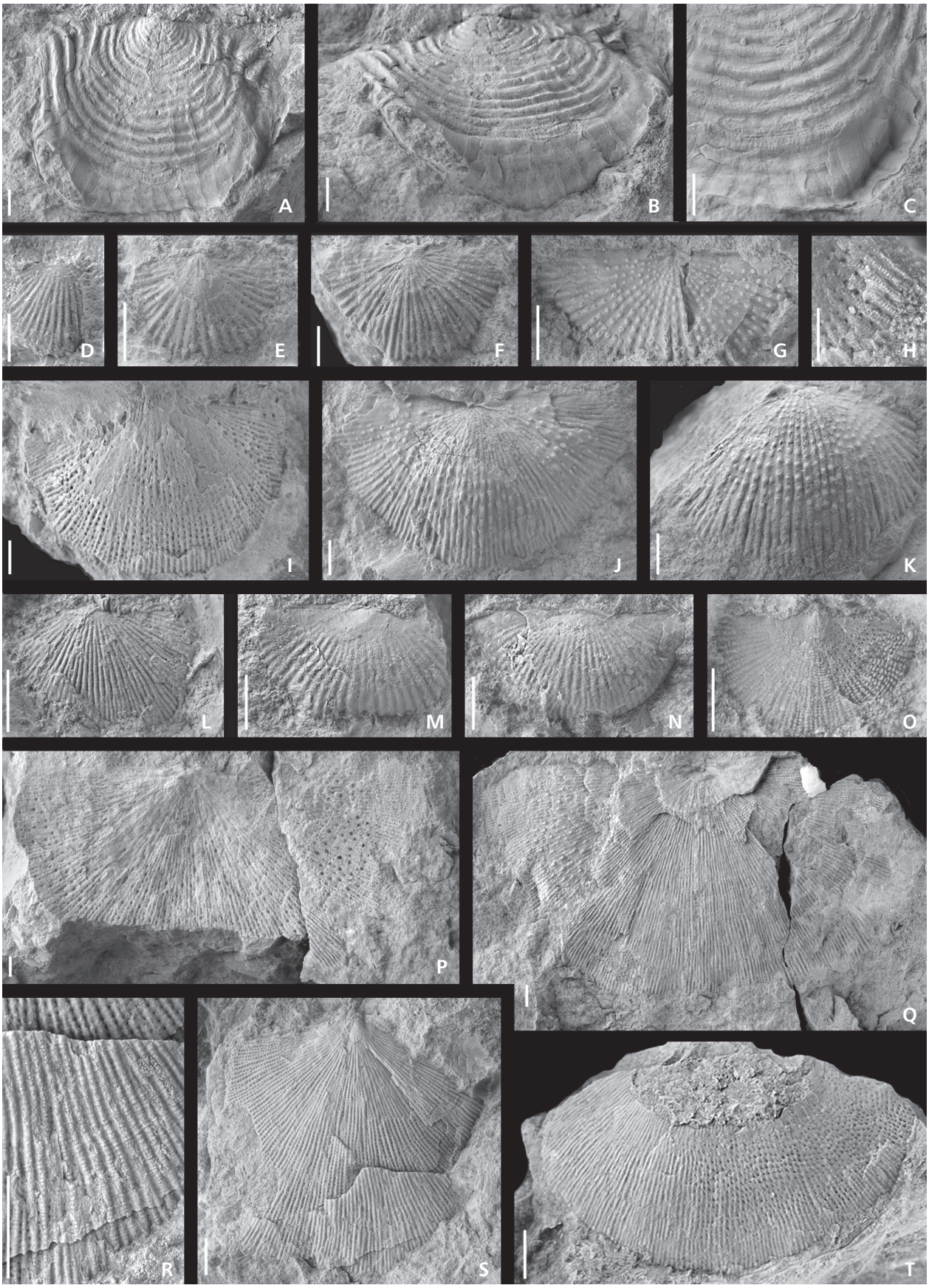
Remarks. – Some important features are not preserved in the material, namely the distribution and the shape of the spines along the posterior margin, and the shaping of the interareas. The specimens are most similar to those referred to as *Plicochonetes tuberculatus* (M'Coy, 1844) from the upper Tournaisian of the Ural Mountains (Nalivkin 1979). The Uralian specimens are also medium-sized, with similarly shaped and sized costellae, rows of coarse endospines and, unlike the type species, cardinal extremities are not smooth but bear a costellate ornamentation. The type species *Plicochonetes buchianus* (de Koninck, 1843 in 1842–1844) from the Viséan (Warnantian) of Visé (Mottequin & Poty 2021) is distinctive in its much smaller size, smooth cardinal extremities, costate shell with fewer costae, presence of a dorsal median septum and weaker endospines (Brunton 1968, Racheboeuf 2000). The presence of elevated concentric fila on the crests of the costellae definitely refers the Moravian species to Rugosochonetidae Muir-Wood, 1962, but elucidation of its affinity to other Tournaisian rugosochonetids requires further and better preserved material.

***Plicochonetes* sp. B**
Figure 8M, N

Material. – Two ventral valves (MZM Ge32931, Ge32932).

Description. – The shell is small-sized, 8 mm wide, distinctly transverse, with a weakly curved anterior margin. Cardinal extremities are acute. The ventral apex is weakly convex. The valve is slightly depressed along the longitudinal axis and weakly convex with flattened flanks in transverse profile. Fine, rounded costellae separated by shallow, rounded interspaces increase in size anteriorly. Costellae frequently bifurcate anteriorly, but they are

Figure 8. A–C – *Leptagonia* cf. *franca* Mottequin & Simon, 2017, ventral valve, and detail of ornamentation MZM Ge32921a. • D –*Plicochonetes*? sp. C, ventral valve, MZM Ge32922. • E–K – *Plicochonetes* sp. A, small ventral valve MZM Ge32923 (E), small dorsal valve MZM Ge32924 (F), interior of dorsal valve MZM Ge32925 (G), detail of microornamentation MZM Ge32926 (H), ventral valve MZM Ge32927 (I), dorsal valve interior MZM Ge32928 (J), and dorsal valve interior MZM Ge32929 (K). • L – *Rugosochonetes*? sp., small ventral valve MZM Ge32930. • M–N – *Plicochonetes* sp. B, ventral valve exterior MZM Ge32931 (M), ventral valve exterior MZM Ge32932 (N). • O–T – *Megachonetes zimmermanni* (Paeckelmann, 1930), juvenile ventral valve MZM Ge32933 (O), dorsal valve interior and its counterpart MZM Ge32934 (P, Q), ventral valve MZM Ge32921b (S), and detail of its microornament (R), incomplete ventral valve MZM Ge32935 (T). The specimens were coated with ammonium chloride. Scale bars (all): 2 mm.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subdued near the apex and the posterolateral flanks. There are four costellae per 1 mm. Concentric ornamentation is not preserved and spines and the shell interior are unknown.

Remarks. – The specimens differ from the associated *Plicochonetes* sp. A in their smaller size, more transverse outline and subdued and rounded costellae.

***Plicochonetes*? sp. C**
Figure 8D

Material. – One ventral valve (MZM Ge32922).

Remarks. – The valve differs from other associated chonetoids in prominent and coarse costate ornament relative to shell size and the considerable convexity of the ventral valve (Fig. 8D). This feature renders the specimen similar to *Plicochonetes buchianus* (de Koninck, 1843 in 1842–1844) and *Globosochonetes parseptus* Brunton, 1968. Although there is insufficient material for a more accurate determination, the specimen highlight the diversity of chonetoid brachiopods in the brachiopod association studied here.

Suborder Productidina Waagen, 1883
Superfamily Productoidea Gray, 1840
Family Productellidae Schuchert, 1929
Subfamily Overtoniinae Muir-Wood & Cooper, 1960
Tribe Avoniini Sarytcheva, 1960

Genus *Avonia* Thomas, 1914

Type species. – *Productus youngianus* Davidson, 1860; Carboniferous, Viséan; England.

***Avonia* sp.**
Figure 9A

Material. – One ventral valve (MZM Ge32920b).

Remarks. – The single valve examined represents a small specimen or an apical part of a larger individual. Weak, irregular and short concentric lamellae and a scattered base of spines can be distinguished, whereas other features are unknown. These features, together with the prominent convexity of the shell, are consistent with the diagnostic features of *Avonia* Thomas, 1914.

Productide gen. et sp. indet.
Figure 9B

Material. – One shell fragment (MZM Ge32923b).

Remarks. – One small fragment showing numerous endospines confirms the presence of another productid among the material, although its affinity is unclear due to insufficient material.

Order Orthotetida Waagen, 1884
Suborder Orthotetidina Waagen, 1884
Supefamily Orthotetoidea Waagen, 1884
Family Pulsiidae Cooper & Grant, 1974

Pulsiid gen. et sp. indet.
Figure 9G

Material. – One shell fragment (MZM Ge32938).

Remarks. – One small shell fragment shows parvicostellate ornamentation, characteristic of the family Pulsiidae Cooper & Grant, 1974. However, its more accurate determination is not possible.

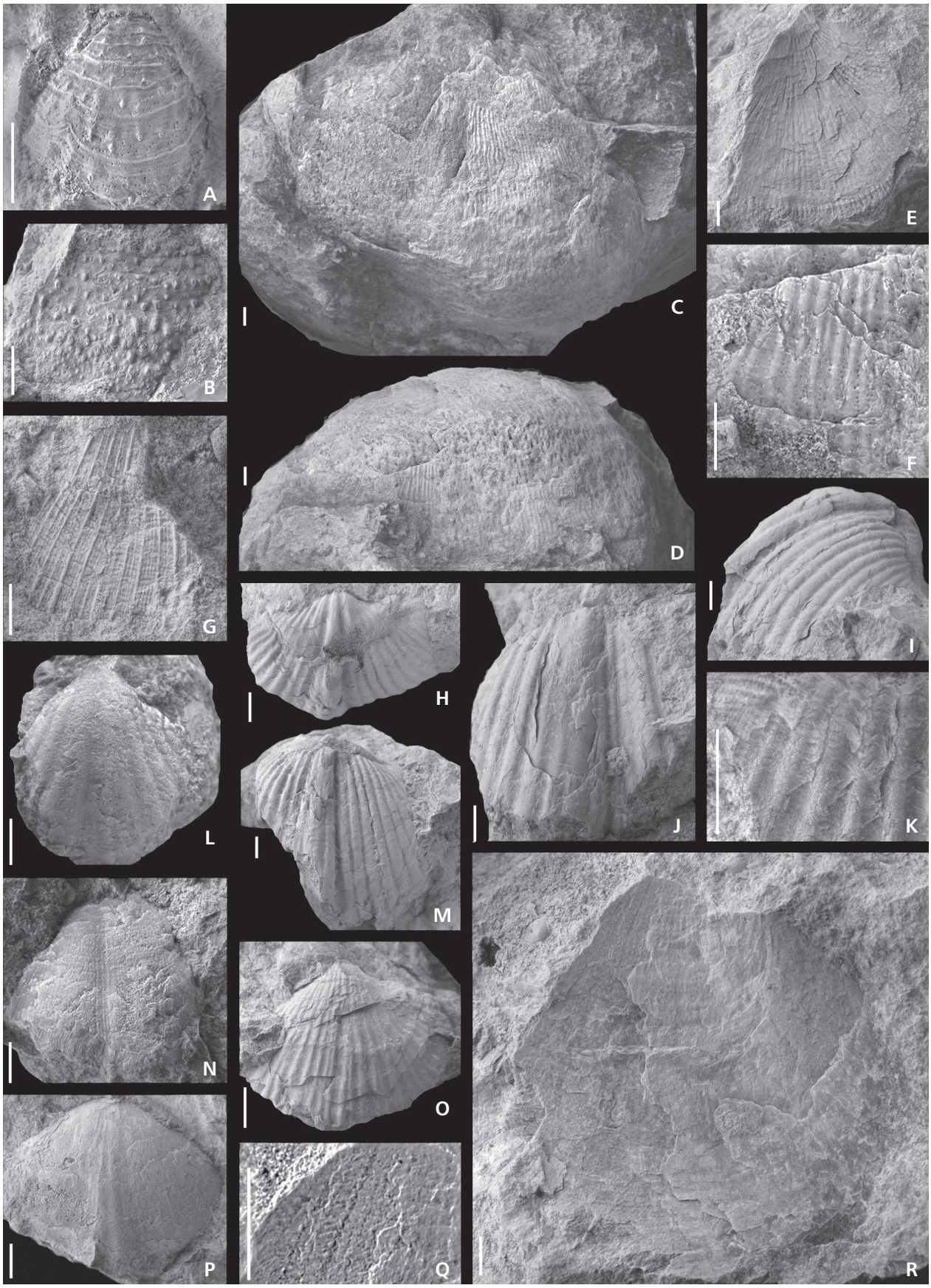
Family Schuchertellidae Williams, 1953

Schuchertellid gen. et sp. indet.
Figure 9C, D, F

Material. – One dorsal? shell (MZM Ge32936).

Remarks. – The shell is large, 50 mm wide and 45 mm long, thin-walled, anteriorly geniculate, slightly asymmetrical in outline and finely costellate over the entire surface. Costellae are uniformly sized, numbered seven to nine per 3 mm and separated by interspaces of similar size (Fig. 9F). The large size, asymmetry and type of ornament and punctation are consistent with attribution to schuchertellids. The assignment to productidines is less probable due absence of the spine bases on shell surface.

Figure 9. A – *Avonia* sp., ventral valve MZM Ge32920b. • B – Productide gen. et sp. indet., fragment of valve MZM Ge32923b. • C, D, F – Schuchertellid gen. et sp. indet., dorsal? valve exterior and its anterior views (C, D) and detail of ornamentation (F), MZM Ge32936. • E – *Rhipidomella* sp., shell exterior, MZM Ge32937. • G – Pulsiid gen. et sp. indet, fragment of valve MZM Ge32938. • H–K, M – *Prospira* sp., dorsal valve in posterior (H), lateral (I) and dorsal (M) views, and detail of its microornament (K), MZM Ge32940, and another fragment of ventral valve (J), MZM Ge32941. • L – *Brachythyris* sp., ventral valve MZM Ge32939. • N, P – Athyridide? gen. et sp. indet.; N – shell fragment MZM Ge32942; P – dorsal valve MZM Ge32944. • O – Spiriferide? gen. et sp. indet., ventral valve MZM Ge32943. • Q, R –Reticulariid? gen. et sp. indet., dorsal? valve exterior (R) and detail of its microornament (Q), MZM Ge32945. The specimens were coated with ammonium chloride. Scale bars (all): 2 mm.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Order Orthida Schuchert & Cooper, 1932
Suborder Dalmanellidina Moore, 1952
Superfamily Dalmanelloidea Schuchert, 1913
Family Rhipidomellidae Schuchert, 1913

Genus *Rhipidomella* Oehlert, 1890

Type species. – *Terebratula Michelini* Léveillé, 1835; Carboniferous, Tournaisian; Belgium.

***Rhipidomella* sp.**
Figure 9E

Material. – External mould of ventral? valve (MZM Ge32937).

Remarks. – Shell is about 15 mm wide and moderately convex. It shows finely multicostellate ornamentation with curved costellae on the flanks, numbering five costellae per 2 mm anteromedially. Shell punctation is discernible along the course of the costellae. Although limited in material, given its size, convexity and costellation, the shell is referred to the cosmopolitan genus *Rhipidomella*. Further specimens are needed to reach a confident specific assignment.

Order Spiriferida Waagen, 1883
Superfamily Spiriferoidea King, 1846
Family Spiriferidae King, 1846
Subfamily Prospirinae Carter, 1974

Genus *Prospira* Maxwell, 1954

Type species. – *Prospira typa* Maxwell, 1954; Carboniferous, Tournaisian; Australia.

***Prospira* sp.**
Figure 9H–K, M

Material. – One dorsal (MZM Ge32940) and one incomplete ventral valves (MZM Ge32941).

Description. – The shell is moderately transverse, about 30 mm wide and has small mucronations in what are otherwise acute cardinal extremities. The dorsal valve is moderately convex, with a narrow fold clearly delimited from the lateral slopes. The ventral valve has a narrow and deep sulcus. Two weak plications on the slopes and a narrow axial plication can be seen at the bottom of the sulcus and the fold, respectively. Lateral slopes are gently convex, with straight, undivided, low, rounded plications, which weakly expand anteriorly and diminish laterally, numbering 15 or more. Concentric lines are evenly spaced (Fig. 9K).

Remarks. – The shell can be referred to the cosmopolitan genus *Prospira* Maxwell, 1954 based on its outline and short mucronations. The closely related genus *Unispirifer* Campbell, 1957 differs in its greater number of plications in the sulcus and bifurcating costa and its lack of mucronate cardinal extremities. The type species *P. typa* Maxwell, 1954 differs in its more transverse shell and wider sulcus, while *Prospira platycosta* Havlíček, 1984 from the upper Tournaisian of Libya (Havlíček & Röhlich 1987) differs in its wider and more rapidly expanding but weaker and shallower sulcus.

Superfamily Brachythyridoidea Frederiks, 1924
Family Brachythyrididae Frederiks, 1924

Genus *Brachythyris* M'Coy, 1844

Type species. – *Spirifera ovalis* Phillips, 1836; Carboniferous, Viséan; England.

***Brachythyris* sp.**
Figure 9L

Material. – One ventral valve (MZM Ge32939).

Remarks. – One poorly preserved, small ventral (width: 8 mm) of the ovate outline valve with rounded cardinal extremities shows a prominent beak and a shallow sulcus with three fine plications. The lateral slopes bear weak rounded plications separated by narrow interspaces. In its shape, the specimen is similar to specimen referred to *B. peculiaris* (Shumard, 1855) from the Tournaisian of the Ural Mountains (Nalivkin 1979). However, due to the limited material available, it is not possible to compare it effectively with other species known in Europe.

Brachiopoda gen. et sp. indet.

Description. – In addition to the species described here, limited material of other brachiopod species can be observed in the sample and remains undetermined. One shell fragment shows a narrow sulcus, smooth adjacent flanks and fine radial striations (Fig. 9N, MZM Ge32942). Another shell (Fig. 9P, MZM Ge32944) has a subpentagonal outline with a narrow fold and smooth lateral slopes. Both specimens may be tentatively referred to as athyridides. The ventral valve (Fig. 9O, Ge32943) may belong to spiriferides *s.l.*, but there is no sign of a sulcus and interarea and its affinity to rhynchonellides cannot be excluded. The poor external mould of a large, smooth-shelled brachiopod (Fig. 9R, Q; MZM Ge32945) shows fine concentric lines associated with radial rows of small pustules. The valve can be tentatively referred to any species of Reticularioidea Waagen, 1883.

Discussion

Microfacies and provenance

Krystek (1974) assumed that the Culmian and Devonian boulders of the 'Lutršték gravels' originated in the area of the so-called Slavkov-Těšín ridge. The former presence of this chain of elevations trending from south-west to north-east, which rose during the Badenian in front of the Outer Carpathian nappes, is supported by borehole, gravimetric and magnetic data (Dlabač & Menčík 1964, Cogan *et al*. 1993, Krejčí *et al*. 2002). Nevertheless, derivation of the studied boulder from the Slavkov-Těšín ridge is improbable because upper Tournaisian sediments were not recorded in the Němčice-Nítkovice platform as a result of its temporary emergence during regression (Zukalová 1976, 1977; Kalvoda 1981).

In the Palaeozoic sequences of Moravia, uppermost Tournaisian limestones are known from the southern part of the Moravian Karst (Conil *et al*. 1971, Friáková & Kalvoda 1982, Dvořák *et al*. 1987, Ondráčková 2001, Kalvoda *et al*. 2010, Rak *et al*. 2012), Hranice Karst (Dvořák & Friáková 1978) and areas along the western margin of the Brno Batholith (Bábek *et al*. 1995, Malovaná 1997, Špaček *et al*. 2002). Tournaisian limestone clasts were also recorded from the Palaeozoic silicilastics of the Březina Formation (Weiner *et al*. 2012), Culm facies (Dvořák *et al*. 1987; Špaček & Kalvoda 1996, 2000; Špaček 1997) and the Boskovice Furrow (Špaček *et al*. 2002).

The foraminiferal fauna and microfacies of the studied limestone boulder show striking similarity to the calciturbidites of the Líšeň Formation near the Tournaisian–Viséan boundary at the Mokrá quarries (Ondráčková 2001, Kalvoda *et al*. 2010). Although clasts of Famennian to earliest Viséan limestones with similar microfacies have been found in the Protivanov, Rozstání and Myslejovice formations, there is again striking resemblance to microfacies of clasts from the Rozstání Formation at Mokrá quarries (Špaček 1997: microfacies IIA, IIG, IIH, fig. on p. 55), where large blocks of Tournaisian limestones have been recorded (see Dvořák *et al*. 1987). Thus, this boulder probably originated in this area, either from the late Tournaisian limestones or from the limestone olistoliths in the Drahany Upland Culm. Similarly, Blaško *et al*. (2014) supposed the Culmian rocks of Drahany Upland and Nízký Jeseník Highland (especially the Myslejovice Formation) to represent the main source area of the Lower Badenian basal clastics in the relatively close Lobodice area.

Trilobites

Trilobites from the eastern part of the Czech Republic, which were previously interpreted as belonging to *Cummingella*, have been recorded in the following areas: (1) the vicinity of Mokrá village in the southern part of the Moravian Karst near Brno [Chlupáč 1966: *Cummingella* sp., 'Hády limestones' (*i.e*. the Hády-Říčka Limestone of the Líšeň Formation), Tournaisian, 'cuIIα–β'; Rak *et al*. 2012: *Cummingella* cf. *auge* Hahn & Hahn, 1968, shales of the Březina Formation in the Mokrá quarry, upper Tournaisian, MFZ 8]; and (2) 'exotic' limestone pebbles, cobbles (or boulders) from the lower Eocene conglomerates of the Outer Western Carpathians near Bystřice nad Olší (Hörbinger *et al*. 1985: *Cummingella jonesi orleiensis* Osmólska, 1970; probably lower Namurian, see Hahn & Hahn 2008: p. 125). However, it can reasonably be assumed that all these trilobites represent different species of *Cummingella* from the specimens discussed in the systematic part of this paper. The specimens previously determined as *Cummingella* sp. or *Cummingella*? sp. coming form the vicinity of Mokrá are currently deposited in the Czech Geological Survey, Prague (Coll. Chlupáč, inventory numbers: CGS ICh1380–1391, 1393, 1394 – *Cummingella* sp.; 6383–6386 – *Cummingella*? sp.). With respect to clear morphological differences and/or insufficient preservation, none of these specimens can be considered as obviously conspecific with the new material discussed in this paper. If the features are sufficiently preserved in particular specimens, most of the pygidia recorded by Chlupáč (1966) differ mainly in the higher number of axial rings (~11–12+1 *vs* ~9–10+1), higher number of ribs [ten or more based on new observations, up to 11–12 (eight clearly marked + three to four less clearly marked) according to description of Chlupáč (1966) *vs* six to eight in new specimens], narrower and subhorizontal/less steeply inclined pygidial border when obsereved from lateral and posterior views, and less vaulted exoskeleton. The damaged pygidium CGS ICh1381 is possibly not conspecific with other Chlupáč's pygidia discussed herein. It has a higher number of ribs (around 14–15, including posterior weakly marked ribs) and similarly high number of axial rings can be estimated; the surface is almost smooth with locally present sparse fine granulation which contrasts with other Chlupáč's pygidia bearing distinctive granulation. The fragmented pygidium CGS ICh1385 also shows smooth or almost smooth surface lacking sculpture. A single considerably damaged cranidium (CGS ICh1389) clearly differs at least in the sculpture of the glabella (fine sparse granulation *vs* fine pits in the new specimen). The new isolated librigena also differs clearly from the librigenae included under the above mentioned inventory numbers in several features (very broad border with sparsely spaced terrace ridges, more vaulted exoskeleton, different sculpture – sparsely distributed pits *vs* locally dense granulation on the librigenal field). The new fragmentary librigena attached to the cranidium cannot be sufficiently compared, especially due to its incompleteness.

Generally, therein studied specimens show closer similarity to taxa from other areas, especially Poland and Belgium.

Brachiopods

The observed brachiopod fauna shows moderate diversity, with 14 brachiopod species recognized. Association is markedly predominated by chonetidines (*Megachonetes zimmermanni* and other rugosochonetids), which are associated with less frequent strophomenides (*Leptagonia*) and likely also orthotetides. Other brachiopods such as the spire-bearers (spiriferides, athyridides?), orthides and productidines are rare. The weak to strong fragmentation and the random orientation of brachiopod shells indicate rapid transport. The unfavourable preservation and rarity of these shells do not allow accurate determination. Due to having a few spiriferides, athyridides?, and productidines, the brachiopod association can be placed in relatively deeper marine environment. Its composition is close to other Tournaisian and Viséan brachiopod faunas known from similar carbonate environments of Western Europe (*e.g.* de Koninck 1887; Demanet 1923, 1934, 1938; Paeckelmann 1930; Brunton 1968; Bassett & Bryant 2006; Mottequin 2010, 2021; Mottequin & Simon 2017; Mottequin & Poty 2021).

Conclusions

The foraminiferal fauna of the boulder clearly documents the relatively narrow stratigraphic interval within the upper Tournaisian (MFZ8). This proves that some grey limestones in Badenian clastics that were generally considered to be Devonian actually belong to the lower Carboniferous.

The late Tournaisian foraminiferal fauna and microfacies of the boulder show striking similarity to those described from Mokrá quarries. The boulder was most probably derived from the late Tournaisian limestones in the Mokrá area or from the limestone olistoliths in the Drahany Upland Culm.

The brachiopod fauna observed shows moderate diversity, with 14 brachiopod species recognized. Association is markedly predominated by chonetidines (*Megachonetes zimmermanni* and other rugosochonetids), which are associated with less frequent strophomenides (*Leptagonia*) and likely also orthotetides. Spire-bearers (spiriferides, athyridides?), orthides and productidines are rare.

The determinable trilobites from the limestone boulder can be assigned to the genus *Cummingella*. The obtained specimens show some similarities to species known outside the Czech Republic, such as *Cummingella* (*C.*) *jaroszi*, *C.* (*C.*) *belisama* and *C.* (*C.*) *carringtonensis*. Additional well-preserved material is needed for more detailed comparison and closer determination.

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