New record of Middle Miocene (Badenian) brachiopods from Moravia, Czech Republic

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Key words:
Carpathian Foredeep, Central Paratethys, Brachiopoda, Middle Miocene, Oslavany, Moravia

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Editor:
Pavla Tomanová Petrová

Abstract

This study presents the new record of brachiopods from the Middle Miocene deposits of the locality of Oslavany, Moravia, Czech Republic. The assemblage contains five species, i.e. Terebratula *sp.,* Megathiris detruncata *(Gmelin, 1791),* Joania cordata *(Risso, 1826),* Argyrotheca cuneata *(Risso, 1826), and* Platidia *sp. Apart from the species* J. cordata, *that dominates in the studied assemblage, the remaining species are reported for the first time from Oslavany. All species recognized here were already recorded from other localities in the Moravian part of the Carpathian Foredeep.*

Abstrakt

V příspěvku jsou prezentovány nové nálezy brachiopodů ze sedimentů středního miocénu na lokalitě Oslavany, Morava, Česká republika. Soubor zahrnuje 5 druhů, a to Terebratula *sp.,* Megathiris detruncata *(Gmelin, 1791),* Joania cordata *(Risso, 1826),* Argyrotheca cuneata *(Risso, 1826), a* Platidia *sp. Kromě druhu* J. cordata, *který ve studovaném materiálu dominuje, byly zbývající druhy zjištěny v Oslavanech poprvé. Všechny nalezené druhy jsou již známy z jiných lokalit moravské části karpatské předhlubně.*

Introduction

Although brachiopods are a common element of the Middle Miocene benthic communities of the Central Paratethys, in Moravia they are scarce and of low diversity. Nevertheless, their presence was often mentioned but without descriptions and/or illustrations (Procházka 1893a; Toula 1893; Hamršmíd 1984; Doláková et al. 2008; Zágoršek et al. 2009). In terms of modern taxonomy, the brachiopods have been so far described from nine Moravian localities (Zágoršek et al. 2012; Bitner et al. 2013a, b; Pavézková et al. 2013; Hladilová et al. 2014; Kopecká et al. 2018) but only the assemblage from Kralice nad Oslavou yielded numerous and diverse brachiopod fauna represented by eight species (Bitner et al. 2013a). In other localities the brachiopods are represented by one to four species.

The aim of the present study is to describe a newly discovered brachiopod fauna from the Middle Miocene of Oslavany, Moravia, Czech Republic (Fig. 1). In 2016, the sand pit at Oslavany was one of the excursion localities of the Molasse Meeting within the 18th Conference on Upper Tertiary (Nehyba 2016).

Geological setting

The sediments of the sand pit at Oslavany (GPS location N 49°06.820′ E 16°20.237′) in southern Moravia, Czech Republic, belong to the Carpathian

Recommended reference:
Bitner, M. A., Hladilová, Š., Hrouzek, S. (2023). New record of Middle Miocene (Badenian) brachiopods from Moravia, Czech Republic. – Geological Research in Moravia and Silesia, 30, 1–2, 38–44.

DOI: https://doi.org /10.5817/GVMS2023-34376

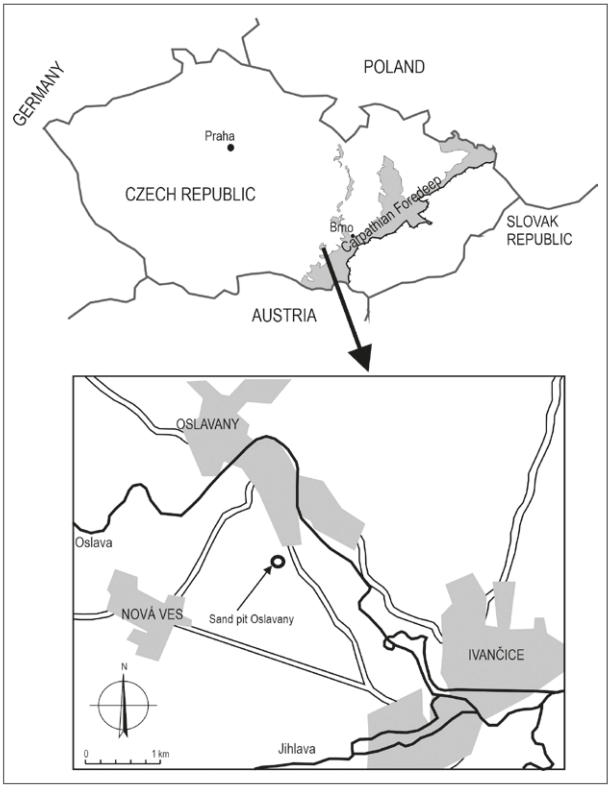

Fig. 1: Geographic location of the Neogene Carpathian Foredeep in the Czech Republic and position of the Oslavany sand pit. Modified after Nehyba et al. (2016).

Foredeep. Exactly from this sand pit, Rzehak (1882a) described for the first time the bivalve genus *Oncophora* (= *Rzehakia* Korobkov, 1954) with the species *O. socialis*, and established here the *Oncophora* (*Rzehakia*) Beds (Rzehak 1882a, b, 1883, 1893). Nevertheless, later research (Cicha et al. 1956; Cicha, Tejkal 1958) demonstrated the Early Badenian age of the sediments at Oslavany and the redeposition of the older (Ottnangian) *Oncophora (Rzehakia)* Beds. The sand pit was proposed as holostratotype of the Moravian (lower Badenian) Substage in the Carpathian Foredeep by Cicha (Papp et al. 1978), reflecting the Early Badenian transgression represented by the local lithostratigraphic unit of Brno Sands. As the sand pit is inactive since long, the original extent of the profile (cf. Cicha in Papp et al. 1978) has been severely reduced representing nowadays only the uppermost part of the former outcrop (Lysý 2007). These sediments were interpreted as a product of deposition in foreshore and shoreface zones (Nehyba et al. 2009), whereas the Brno Sands as a product of coarse-grain delta deposition (Nehyba 2001). The soft-sediment deformations evaluated as „seismites" were recognized in this profile (Nehyba 2014). The new boreholes OSL-1 and OSL-2 were drilled thanks to the project GAČR 205/09/0103: Shallow water ecosystems from the Middle Miocene of the Central Paratethys. They enabled to document in detail the Early Badenian marine transgression and regression along the passive margin (= the south-eastern margin of the Bohemian Massif) of the peripheral foreland basin. This transgressive-regressive cycle was interpreted as induced by the coincidence of global TB 2.4. sea-level cycle and forebulge subsidence, the identified higher-frequency cycles as climatically controlled (Nehyba et al. 2016).

Sands and sandstones in the Oslavany sand pit contain impoverished Early Badenian fossils accompanied with reworked fossils of Ottnangian *Rzehakia* Beds. Up to now, foraminifers, molluscs (bivalves, gastropods, cephalopods), bryozoans, echinoids, fish otoliths and teeth, calcareous nannoplankton, and dinoflagellate cysts have been described (Rzehak 1882a, b, 1883, 1893; Procházka 1893b; Čtyroký 1972; Cicha, Tejkal, Lehotayová – all in Papp et al. 1978; Lysý 2007; Nehyba et al. 2009, 2016; Zágoršek 2010, among others). As for brachiopods, the up to now sole mention related to Oslavany presents one specimen of *Cistella* cf. *cistellula* (see Rzehak 1893).

Material and methods

The sediments in the Oslavany sand pit were studied and collected by one of the authors (S. Hrouzek) in the second half of the 1970s when the sand pit was still active and uncovered to a quite large extent. The material collected and then washed comes from several different places of the sand pit that appeared to be richer in fossils and was taken from each place in the amount of 1–2 bags (approx. 60 kg); the obtained residue has been mixed. The shells of brachiopods were recognized in 2022 within the study of the outwashed residues.

The investigated material is poorly preserved, represented mostly by separate valves. Many specimens are damaged and fragmented. The total number of specimens is 56.

For the SEM study, the selected specimens were coated with platinum and examined using a Philips XL-20 microscope at the Institute of Paleobiology, PAS, Warszawa. The material under study is deposited in the private collection of S. Hrouzek.

Systematic part

Phylum Brachiopoda Duméril, 1805
Order Terebratulida Waagen, 1883
Superfamily Terebratuloidea Gray, 1840
Family Terebratulidae Gray, 1840
Genus *Terebratula* Müller, 1776
Type species: *Anomia terebratula* Linnaeus, 1758, by subsequent designation of Lee and Brunton (1998)
Terebratula sp.
(Fig. 2A)

Material: Five dorsal valves of young individuals.

Remarks: The material is very small and poorly preserved, represented only by dorsal valves of juvenile specimens. Their shell surface is smooth with weakly marked growth lines. The inner socket ridges are massive, high, projecting beyond the margin. No inner hinge plates and median septum are observed. Based on those characters we attributed tentatively the studied specimens to the short-looped genus *Terebratula*.

Occurrence: The extinct genus *Terebratula* is common in the Neogene deposits of the Mediterranean Province (Gaetani, Saccà 1985), being also known from

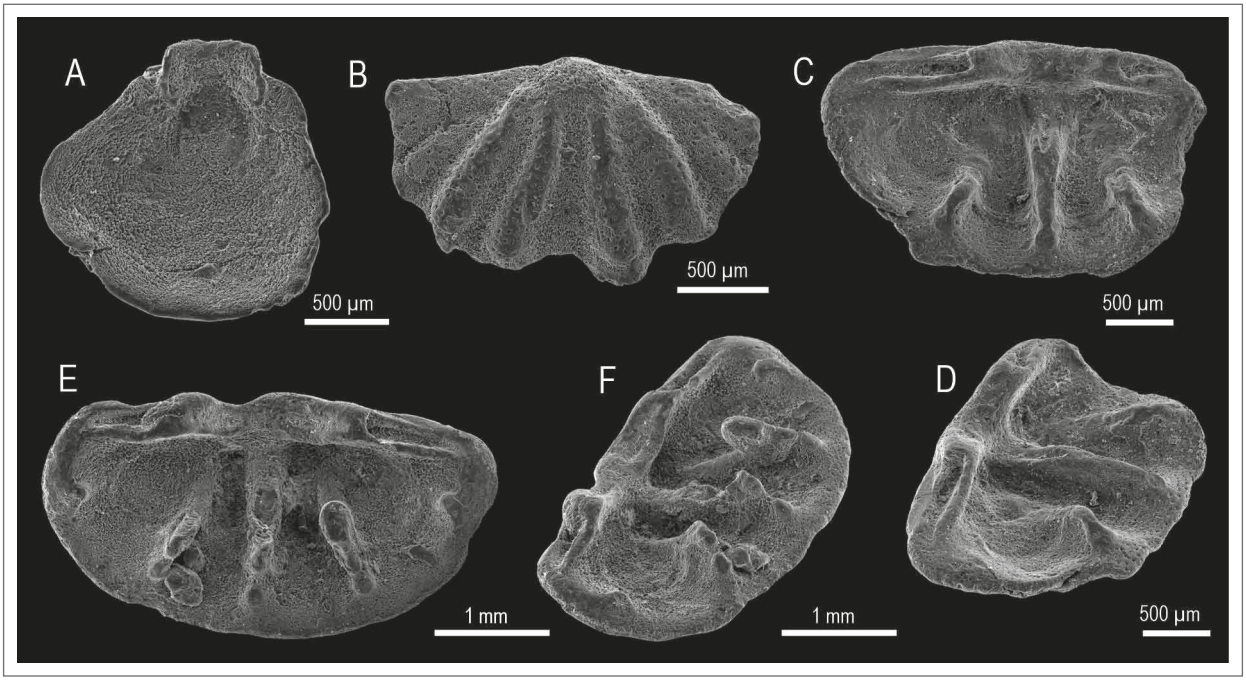

Fig. 2: Brachiopods, Middle Miocene, Oslavany, Moravia, Czech Republic. A: *Terebratula* sp. B–F: *Megathiris detruncata* (Gmelin, 1791), dorsal valves; B outer view of young individual; C–F inner and oblique (D, F) views. All SEM.

the Middle Miocene deposits of the Central Paratethys (e.g. Popiel-Barczyk, Barczyk 1990; Bitner, Pisera 2000; Bitner, Dulai 2004). This genus was also reported from two localities of Moravia, Přemyslovice and Kralice nad Oslavou (Zágoršek et al. 2012; Bitner et al. 2013a).

Superfamily Megathyridoidea Dall, 1870
Family Megathyrididae Dall, 1870
Genus *Megathiris* d´Orbigny, 1847
Type species: *Anomia detruncata* Gmelin, 1791, by subsequent designation of Dall (1920)
Megathiris detruncata (Gmelin, 1791)
(Fig. 2B–F)
1860 *Argiope decollata* Chemn.; Reuss, p. 227–228.
1990 *Megathiris detruncata* (Gmelin, 1791); Bitner, p. 135–138; text-figs 3–4; pl. 3, figs 1–8; pl. 6, figs 1–7 (*cum syn.*).
2022 *Megathiris detruncata* (Gmelin, 1791); Bitner and Müller, p. 93–95, fig. 5A–H (*cum syn.*).

Material: One ventral valve and six dorsal valves, some specimens are strongly broken.

Remarks: This species is very rare in the investigated material. The shell is transversely elongate with a long hinge line. Its surface is covered with a few broad, rounded ribs. Internally it is easily distinguishable by the presence of three septa on a dorsal valve.

Occurrence: *Megathiris detruncata* is one of the most common species in the Middle Miocene deposits of the Central Paratethys (e.g. Bitner 1990; Popiel-Barczyk, Barczyk 1990; Dulai 2007; Bitner, Motchurova-Dekova 2016). In Moravia it was recorded from four localities, Rudoltice, Přemyslovice, Kralice nad Oslavou, and Židlochovice (Reuss 1860; Zágoršek et al. 2012; Bitner et al. 2013a; Pavézková et al. 2013). It is a long-ranging species, known since the Eocene and its Recent representatives live in the Mediterranean Sea and eastern North Atlantic at depth range 5–896 m (Logan 2007).

Genus *Joania* Álvarez, Brunton et Long, 2008
Type species: *Terebratula cordata* Risso, 1826 by original designation of Álvarez et al. (2008)
Joania cordata (Risso, 1826)
(Fig. 3A–I)
1860 *Argiope neapolitana* Scacchi; Reuss, p. 228–229.
1893 *Cistella* cf. *cistellula* S. Wood; Rzehak, p. 153, pl. 1, fig. 1
1990 *Argyrotheca cordata* (Risso, 1826); Bitner, p. 140–143, text-figs 7–8, pl. 5, fig. 1–14, pl. 7, fig. 1 (*cum syn.*).
2016 *Joania cordata* (Risso, 1826); Bitner and Motchurova-Dekova, p. 12, 15, fig. 5A–Q (*cum syn.*).

Material: Six complete specimens, 13 ventral valves, 15 dorsal valves.

Remarks: *Joania cordata* is the most common species in the material from Oslavany. The shell is very small (max. observed length 2.4 mm), smooth or incipiently ribbed. The foramen is large, triangular, of hypothyrid type, bordered by two narrow deltidial plates. The dorsal valve interior with prominent cardinal process and high, triangular in profile median septum. The submarginal tubercles (Fig. 3A–F), present on both valves, are treated as the diagnostic character for the genus (Álvarez et al. 2008). Based on the latter character we include into the synonymy the brachiopod ventral valve described as *Cistella* cf. *cistellula* by Rzehak (1893) from Oslavany.

Occurrence: The species *Joania cordata* is the only species already recorded from the locality of Oslavany (Rzehak 1893). It is very common in the Miocene of the Central Paratethys (e.g. Bitner 1990; Bitner, Pisera 2000; Bitner, Dulai 2004; Bitner, Kaim 2004; Dulai 2007, 2015; Bitner et al. 2014; Bitner, Motchurova-Dekova 2016), being

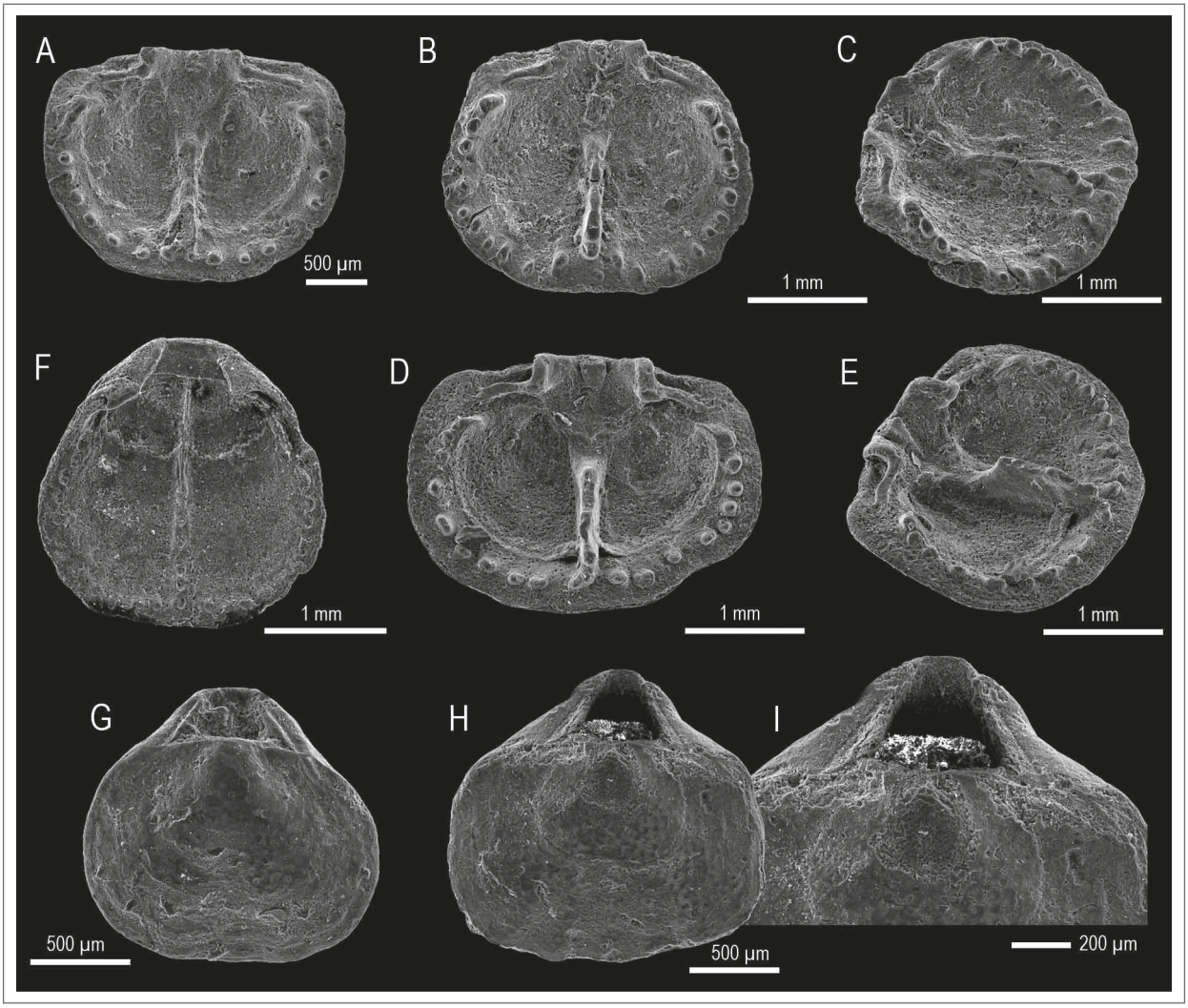

Fig. 3: *Joania cordata* (Risso, 1826), Middle Miocene, Oslavany, Moravia, Czech Republic. A–E: inner and oblique (C, E) views of dorsal valves; F: inner view of ventral valve; G–I: dorsal views of articulated specimens and enlargement (I) of umbonal part to show details of the beak. All SEM.

also reported from several localities in Moravia (Reuss 1860; Zágoršek et al. 2012; Bitner et al. 2013a, b; Hladilová et al. 2014; Kopecká et al. 2018). Known since the Upper Oligocene, in the modern waters *J. cordata* occurs in the eastern North Atlantic, Mediterranean Sea and Red Sea, with a depth range from 3 to 600 m (Logan 2007; Logan et al. 2008).

Genus Argyrotheca Dall, 1900
Type species: *Terebratula cuneata* Risso, 1826, by original designation of Dall (1900)
Argytoheca cuneata (Risso, 1826)
(Fig. 4A, B)
1860 *Argiope squamata* Eichw.; Reuss, p. 228, pl. 6, fig. 1.
1990 *Argyrotheca cuneata* (Risso, 1826); Bitner, p. 138–140, text-figs 5–6, pl. 4, figs l–9 (*cum syn.*).
2016 *Argyrotheca cuneata* (Risso, 1826); Bitner and Motchurova-Dekova, p. 12, fig. 4A–R (*cum syn.*).

Material: Two complete specimens, one strongly damaged, and two partly broken ventral valves.

Remarks: Although the material is very limited and poorly preserved, the observed characters such as shell subrectangular in outline, covered with single, low, rounded ribs validate the attribution to *Argyrotheca cuneata*. One specimen bears a short intercalated rib in the median groove (Fig. 4B). The foramen is large, triangular, hypothyrid with a wide pedicle collar supported by a low, thin septum.

Occurrence: In the Central Paratethys *Argyrotheca cuneata* is among the most common species (e.g. Bitner 1990; Bitner, Pisera 2000; Bitner, Dulai 2004; Bitner, Kaim 2004; Dulai 2007, 2015; Bitner et al. 2014; Bitner, Motchurova-Dekova 2016). It was also reported from some Moravian localities (Reuss 1860; Dreger 1889; Zágoršek et al. 2012; Bitner et al. 2013a, b; Pavézková et al. 2013; Kopecká et al. 2018). Today *A. cuneata* is known from the Mediterranean Sea and eastern North Atlantic living at depth from 5 to 645 m (Logan 2007).

Superfamily Platidioidea Thomson, 1927
Family Platidiidae Thomson, 1927
Genus *Platidia* Costa, 1852
Type species: *Orthis anomioides* Scacchi and Philippi in Philippi, 1844, by original designation (Philippi 1844)

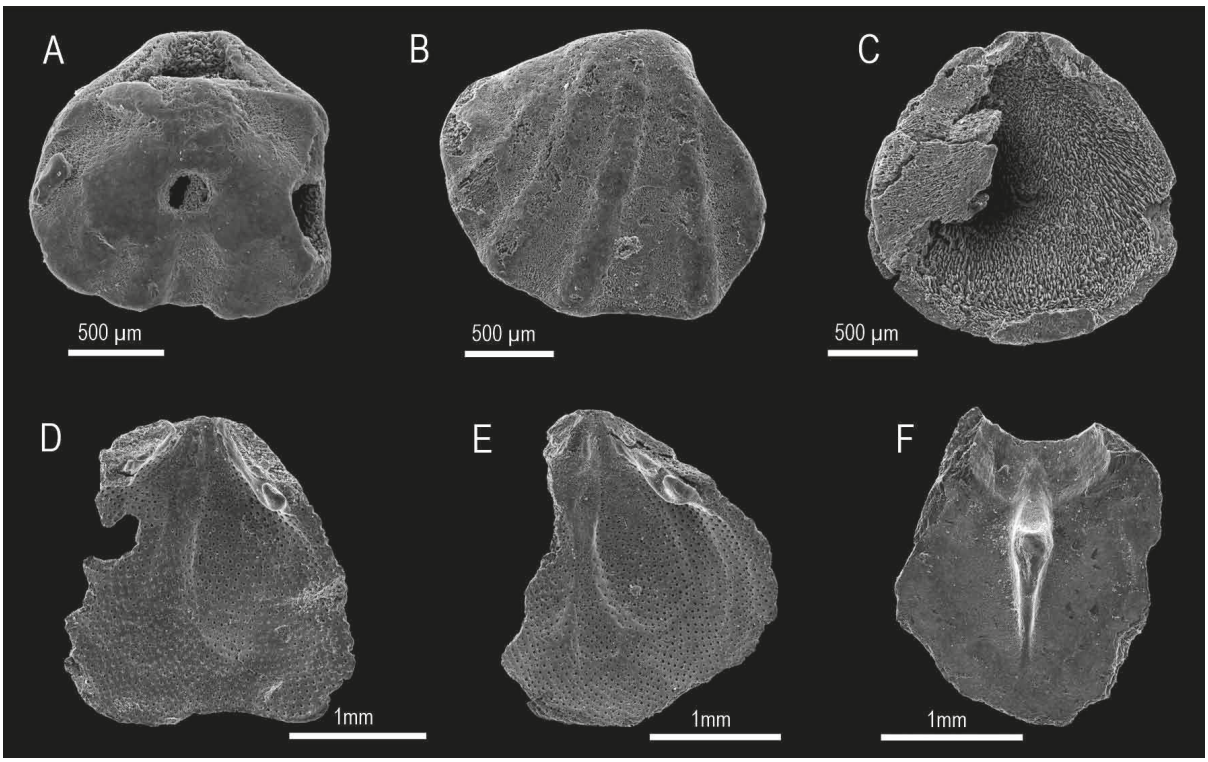

Fig. 4: Brachiopods, Middle Miocene, Oslavany, Moravia, Czech Republic. A–B: *Argyrotheca cuneata* (Risso, 1826); A dorsal view of articulated specimen; B outer view of ventral valve, partly broken. C–F: *Platidia* sp.; C inner view of ventral valve with partly preserved dorsal valve; D–E inner views of ventral valves; F inner view of fragmented dorsal valve, visible high, triangular in profile median septum. All SEM.

Platidia sp.
(Fig. 4C–F)

Material: Six ventral valves, partly broken, one fragment of dorsal valve.

Remarks: This species is very rare and poorly preserved in the Oslavany material. Its shell is small with smooth surface, short hinge line and large foramen. The concave hinge line in the dorsal valve indicates an amphithyrid foramen.

Occurrence: Although not belonging to the common fossil, *Platidia* was reported from many localities of the Central Paratethys (e.g. Bitner 1990; Popiel-Barczyk, Barczyk 1990; Bitner, Dulai 2004; Bitner, Motchurova-Dekova 2016), including three localities in Moravia (Bitner et al. 2013a, b; Hladilová et al. 2014). Today *Platidia* is widespread, having a very wide depth range from 8 to 2 190 m (Logan 2007).

Discussion and conclusions

Here we describe a newly discovered material of the Middle Miocene brachiopods from the Oslavany locality (Fig. 1). The material comprises five species belonging to five genera within three families. The families Terebratulidae and Platidiidae are represented by one species each, *Terebratula* sp. and *Platidia* sp., respectively. The remaining three species, *Megathiris detruncata*, *Joania cordata* and *Argyrotheca cuneata* belong to the family Megathyrididae. Among them *J. cordata* dominates in the material under study. Interestingly, the latter species was already described from Oslavany under the name *Cistella* cf. *cistellula* by Rzehak (1893). The other species described here are reported for the first time from this locality. Due to the sampling method, the brachiopods represent just a mixture of species from the entire locality and cannot be used for detailed stratigraphic or paleoecological interpretations, nevertheless, they do provide an important supplementary information on the occurrence of brachiopods at the locality Oslavany and in Moravia. All those species, well-known in the Middle Miocene of the Central Paratethys, were already recognized in its Moravian part: *Joania cordata* and *Argyrotheca cuneata* seem to be the most frequent species, they occur at the majority of studied localities (*J. cordata* – 7, *A. cuneata* – 8; Zágoršek et al. 2012; Bitner et al. 2013a, b; Pavézková et al. 2013; Hladilová et al. 2014; Kopecká et al. 2018).

Acknowledgements

We would like to express our gratitude to the reviewers Miroslav Bubík (Czech Geological Survey, Brno) and Kamil Zágoršek (Technical University of Liberec, Liberec) for their valuable input, which significantly improved the quality of the paper.

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