Shallow-Water Occurrence of Wiwaxia in the Middle Cambrian of the Barrandian Area, Czech Republic

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Brief report

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Shallow-water occurrence of *Wiwaxia* in the middle Cambrian of the Barrandian area, Czech Republic

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Isolated sclerites of the genus *Wiwaxia* are reported from shale interlayers in lower levels of middle Cambrian (unnamed 3rd Series of Cambrian) Buchava Formation in the Skryje-Týřovice Basin in the Czech Republic interpreted as shallow-water sediments. Geographic distribution of *Wiwaxia* indicates latitudinal control as all occurrences are obviously restricted to tropical belt.

Introduction

A rich record of specimens with slightly sclerotised skeletal parts or even soft-bodied fossils have been established from several well-known lower and middle Cambrian Lagerstätte, e.g., Burgess Shale of the Stephen Formation, Kinzers, Marjum, and Wheeler formations in North America; Buen Formation in North Greenland; Doushantuo, Chengjiang, and Kaili in China; Emu Bay Shale in Australia and Sinsk Formation in Russia (Conway Morris 1985b; Butterfield 2003, and Ivantsov et al. 2005a, b). Six major types of exceptional preservation have been recently summarised by Butterfield (2003), including the Burgess Shale-type faunas.

Exceptionally preserved fossils have been recently discovered at several stratigraphical levels of middle Cambrian sediments of the Jince and Buchava formations in Barrandian area (Czech Republic). Findings of slightly sclerotised arthropods (e.g., *Tuzoia* Walcott, 1912) were described by Chlupáč and Kordule (2002) from the Jince Formation of Příbram-Jince Basin. Mikuláš and Kordule (1998) discussed a spectacular specimen of unknown non-biomineralised invertebrate. Occurrence of rare graptoloids was published by Maletz et al. (2005) from both Příbram-Jince and Skryje-Týřovice basins.

In this paper we describe the discovery of unmineralised, organic composite invertebrates from the Skryje-Týřovice Basin. The material was collected from fine silty and shaly interlayers within the basal Cambrian clastic sequence exposed at the classical locality called "Orthisový lůmek" (= *Orthis* small quarry) near Skryje situated next to the road between the village of Skryje and Luh at the slope above the Berounka river (Fig. 1).

Isolated scales of *Wiwaxia* were discovered on one slabs of fine grained interlayers (siltstone to shale) originally collected by Karel Žebera in 1937 (see Bouček 1938).

Institutional abbreviations.—CGS, Czech Geological Survey, Prague, Czech Republic.

Geologic setting and stratigraphy

For the first time the lithostratigraphy of Cambrian in the Skryje-Týřovice Basin was studied by Barrande (1846). Fatka et al. (in press) summarised the earlier data and distinguished four separate members within the Buchava Formation in recent terminology (Fig. 1). The locality "Orthisový lůmek" near Skryje exposes lower portion of the sequence, from upper levels of the Mileč Member to lower levels of Skryje Member. Detailed description of the section was published by Kettner (1923: 16).

Fauna of the Mileč and Slapnice members

Sclerites of *Wiwaxia* were discovered in basal clastic sediments referred to the Slapnice Member. Slapnice and Mileč members yielded almost identical faunal assemblages, which strongly differs from fauna of the overlaying Skryje Shale. Current list of taxa known from in the Mileč and Slapnice members (conglomerate, sandstone, and greywacke beds locally with thin intercalations of shale) includes twenty five species belonging to the following groups: gastropods, hyolithids, lingulliformean, acrotretacean, and rhynchonelliformean brachiopods, agnostids, trilobites, and graptoloids (see Havlíček 1971, 1998; Fatka 1990; Mergl and Kordule 2008).

Systematic palaeontology

Discussion on higher systematics see Bengtson and Conway Morris (1984) and Conway Morris and Caron (2007).

Family Wiwaxiidae Walcott, 1911

Genus *Wiwaxia* Walcott, 1911

Type species: *Wiwaxia corrugata* (Matthew, 1899). *Ogygopsis* Shale, Stephen Formation, Campsite Cliff Member, *Bathyuriscus–Ptychoparella* Zone, Canada (see Fletcher and Collins 2009).

Species assigned: *Wiwaxia corrugata* (Matthew, 1899); *Wiwaxia taijiangensis* Zhao, Qian, and Li, 1994; *Wiwaxia* sp. sensu Porter, 2004.

Wiwaxia sp. cf. *W. corrugata* (Matthew, 1899)

Fig. 2.

Material.—Six isolated sclerites, five scales and one supposed spine preserved on one slab of fine grained interlayer (siltstones to shales); all specimens are preserved on the slab CGS XB 800.

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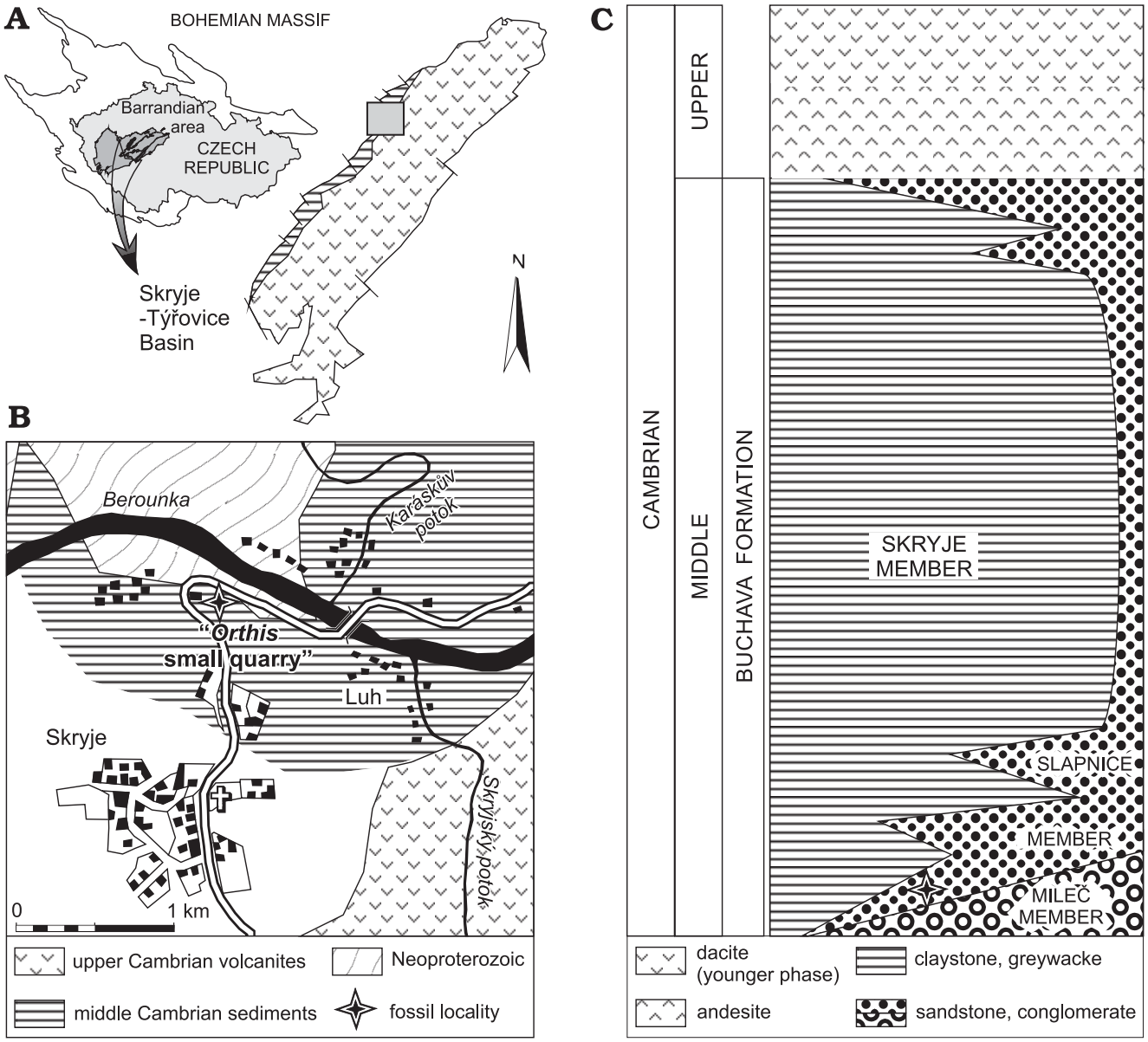

Fig. 1. **A**. Location of the Skryje-Týřovice Basin and the studied area within the Bohemian Massif and Czech Republic. **B**. Geology of the area of "*Orthis* small quarry" (modified after Mašek et al. 1997). **C**. Stratigraphy of the Skryje-Týřovice Basin (according to Fatka et al. 2011).

Description.—All scales were found isolated and all are incompletely preserved. Two most complete and relatively well preserved specimens (Fig. 2B, C, E) display remains of the root-blade transition and traces of four to five longitudinal ribs, respectively. Number of ribs ranges from five to at least seven on the other three scale-like sclerites. The incompleteness and slight deformation of scales exclude more precise reconstruction of their symmetry and thus exact location within the scleritome is impossible to be determined.

The seventh sclerite is poorly preserved but its gross morphology recalls a spiny element rather than a scale. This element also bears traces of at least five longitudinal ribs. Thickness of ribs is usually 0.04–0.05 mm. Distances between separate ribs ranges from 0.12 to 0.21 mm depending on the dimension of scales.

Discussion.—Although detailed study of sclerite morphology is hindered by poor preservation, no obvious difference from the well-known type species were observed and thus the Bohemian material is supposed to be conspecific with *Wiwaxia corrugata*.

Stratigraphy and palaeogeography of *Wiwaxia*

Two species of the genus *Wiwaxia* have been described until now. The most widely distributed is the type species, *Wiwaxia corrugata* (Matthew, 1899), which has been documented from several localities in North America: Burgess Shales of the Stephen Formation in British Columbia (*Bathyuriscus–Elrathina* Zone; Walcott 1911; Conway Morris 1985a); Mount Cap

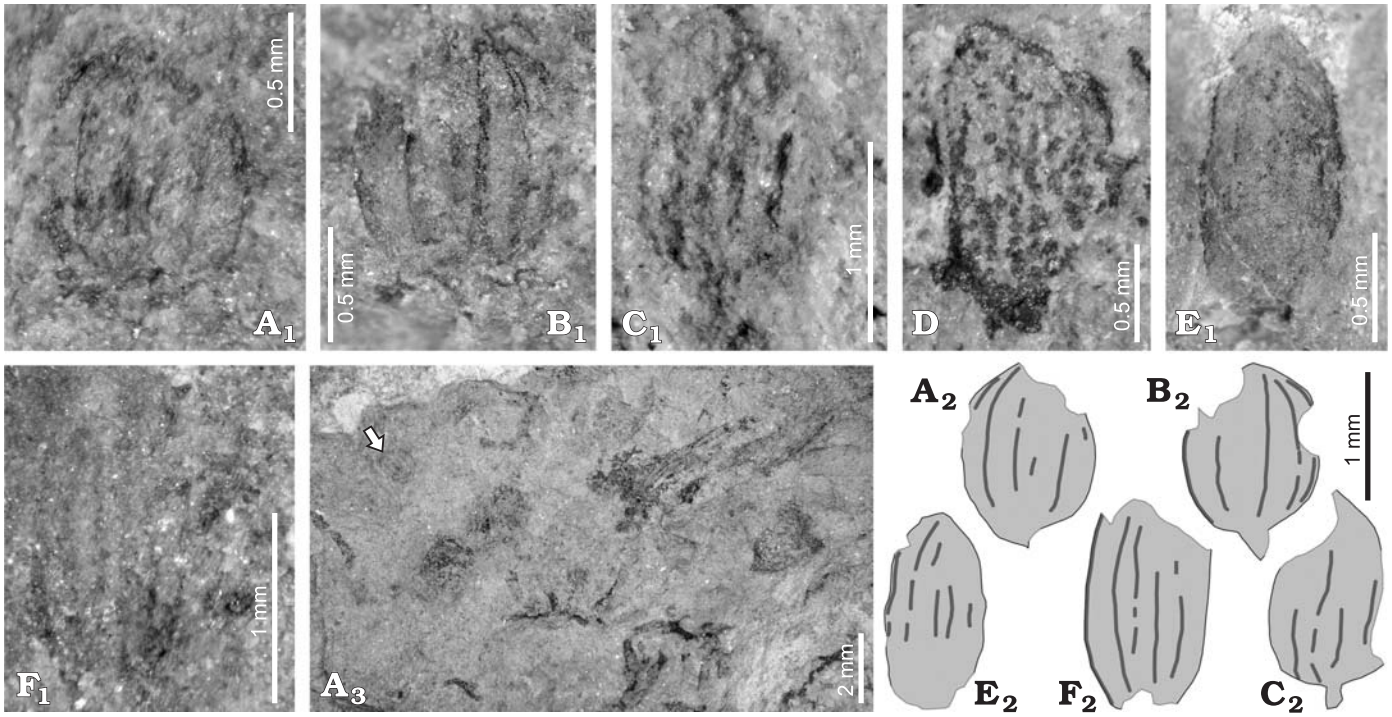

Fig. 2. Isolated sclerites of *Wiwaxia* sp. cf. *Wiwaxia corrugata* (Matthew, 1899), Slapnice Member of the Buchava Formation, Skryje-Týřovice Basin, Barrandian area, Czech Republic. **A**, **B**. Part and counterpart of CGS XB 800a. **C**. CGS XB 800b. **D**. CGS XB 800c. **E**. CGS XB 800d. **F**. CGS XB 800e. A_1–C_1, D, E_1–F_1. Photos of scales. A_2–C_2, E_2–F_2. Drawings of the respective specimens. A_3. Example of a typical assemblage of the sclerite of *Wiwaxia* (arrow) with fragments of graptolites; slab CGS XB 800.

Formation in northwestern Canada (*Bonnia–Olenellus* Zone; Butterfield 1994); Spence Shale in west-central Utah (upper *Glossopleura* Zone; Conway Morris and Robison 1988; Robison 1991).

Isolated sclerites and one articulated specimen were described from the Kaili Formation, *Oryctocephalus indicus* Zone (Guizhou, China) have been described as *Wiwaxia taijiangensis* Zhao, Qian, and Li, 1994.

Specimens determined as *Wiwaxia* sp. have been described from the Emu Bay Shale (South Australia; Porter 2004), Monastery Creek Formation (North Australia, *Ptychagnostus gibbus* Zone; Southgate and Shergold 1991; Porter 2004) and from the Sinsk Formation (Siberian Platform, Russia, *Bergeronellus qurarii* Zone; Ivantsov et al. 2005a, b).

Wiwaxia sp. cf. *Wiwaxia corrugata* (Matthew, 1899) from Czech Republic (Slapnice Member of the Buchava Formation, *Pompeckium kuthani* Zone) represents thus eighth spot in the world occurrence of the genus.

All known occurrences of the genus *Wiwaxia* are located in supposedly tropical to subtropical areas if plotted in Cambrian palaeogeographic map of McKerrow et al. (1992) (Fig. 3). Genus *Wiwaxia* can be considered as an indicator of warm climate, similarly as the demosponge genus *Leptomitus* (see García-Bellido et al. 2007) or the bivalved arthropod genus *Tuzoia* (see Vannier et al. 2007). Consequently, the obvious relation of *Wiwaxia* to tropical to subtropical zones supports the supposed position of the Teplá-Barrandian block in low latitudes during the middle Cambrian.

Palaeoecology of *Wiwaxia*

Rowlan and Gangloff (1988: 129) expressed the indirect interpretation that *Wiwaxia* represents a mobile deposit feeder or herbivore. Dornbos et al. (2005: 63–64) supposed that *Wiwaxia* lived on a muddy substrate crawling along the sediment using muscular contractions while feeding on the surface of the substrate. This mode of life was dependent on a relatively firm Proterozoic-style soft substrate with seafloor microbial mats. They summarised, that *Wiwaxia* belongs to forms well-adapted to a non-actualistic environmental setting. Ivantsov et al. (2005a: 75, 81) classified *Wiwaxia* as grazer of bacterial scum on algal thali. Because of the supposed presence of radula in *Odontogriphus*, *Wiwaxia*, and *Kimberella*, Caron et al. (2006) considered all these genera to be probable grazers feeding on bacterial mats. Caron and Jackson (2008: 226) classify *Wiwaxia* as radula-bearing epifaunal vagile grazer feeding on the co-occurring macrobenthic cyanobacteria.

In the Buchava Formation *Wiwaxia* occurs in an exceptional association, which is very characteristic for the basal Cambrian clastic sequence. These rocks represent shallow water sediments deposited in the early phase of marine transgression. The general composition of the specific association dominated by filtrating brachiopods and filtrating trilobites associated with the common grazing molluscs in the well aerated environment in the photic zone seems to fit well with the proposed grazing life habit of *Wiwaxia*. As sclerites of *Wiwaxia* occur in direct association with fragments of graptolites only, this assemblage can

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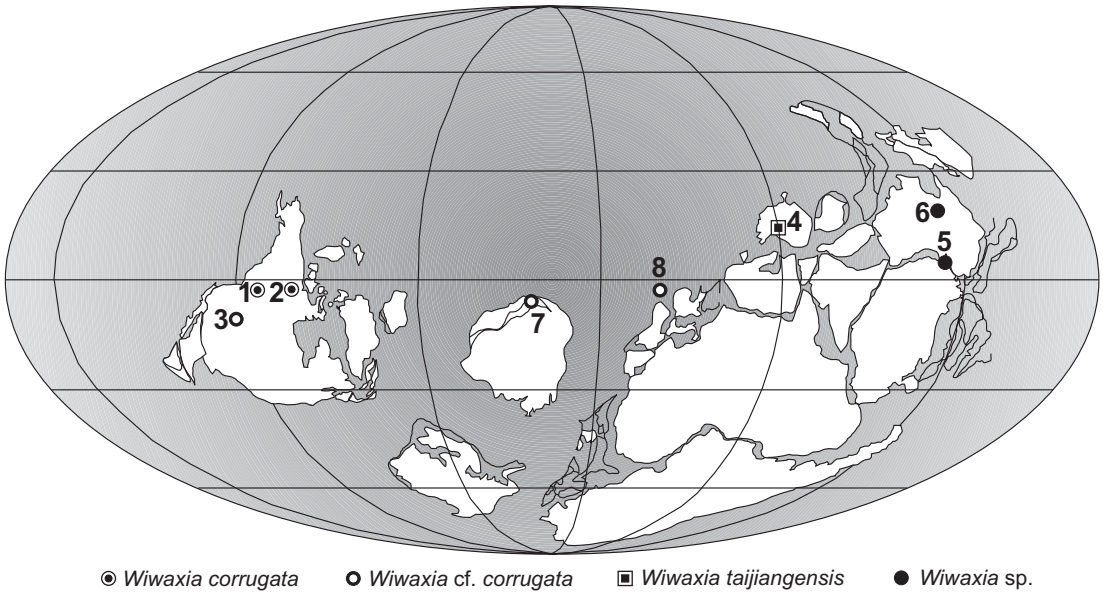

Fig. 3. Palaeogeographical distribution of the genus *Wiwaxia* in the lower and middle Cambrian. 1, *Wiwaxia corrugata* (Matthew, 1899), Burgess Shale of the Stephen Formation, British Columbia, USA (Conway Morris 1985a); 2, *Wiwaxia corrugata* (Matthew, 1899), Mount Cap Formation, northwestern Canada (Butterfield 1994); 3, *Wiwaxia* cf. *corrugata* (Matthew, 1899), Spence Shale, west-central Utah, USA (Conway Morris and Robison 1988; Robison 1991); 4, *Wiwaxia taijiangensis* Zhao, Qian, and Li, 1994, Kaili Formation, Guizhou, China (Zhao et al. 1994); 5, *Wiwaxia* sp., Emu Bay Shale, South Australia (Nedin unpublished material, Porter 2004); 6 , *Wiwaxia* sp., Monastery Creek Formation, North Australia (Southgate and Shergold 1991; Porter 2004); 7, *Wiwaxia* sp., Sinsk Formation, Siberia (Ivantsov et al. 2005a, b); 8, *Wiwaxia* sp. cf. *Wiwaxia corrugata* (Matthew, 1899), Slapnice Member, Buchava Formation, Czech Republic (this paper). Early Cambrian palaeogeography modified after McKerrow et al. (1992).

represent inhabitants of distinct environment restricted to shallow margin of the basin.

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