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Palaeoenvironment of the Upper Cretaceous (Coniacian) concretion-bearing Lagerstätten from Poland

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ABSTRACT

Abundantly fossiliferous Upper Cretaceous sediments including decapod remains in the region of Stary Waliszów (Southern Poland) have been known for many years. To date, however, no study has dealt specifically with detailed palaeoenvironmental and palaeoecological reconstruction. The origin of these sediments is still uncertain and has been the source of considerable confusion and controversy, mainly due to the strong bioturbation and decalcification of these sediments. By using the fossil record, comparative taphonomy and geochemical analyses of concretions, we provide new insights into the paleoenvironment and the paleoecology of this unique Coniacian ecosystem.

On the basis of ichno- and body fossil assemblages composed almost exclusively of benthic organisms such as decapods, molluscs and echinoderms, which are commonly disarticulated but rarely abraded, we suggest that the fossiliferous sediments in Stary Waliszów were formed in shallow, normal saline and well-oxygenated waters of the upper sublittoral zone with moderate sedimentation rate and low turbulence of waters. The presence of angular terrigenous clasts, well-preserved delicate land flora and the near absence of planktonic and nektonic fossils strongly imply proximity to the land. Recorded taxa inhabited a soft-bottom environment. Some organisms were fossilized inside siderite concretions. These concretions were formed within the sediment below the zone of active bioturbation during the early stage of diagenesis. Remarkable preservation of decapod remains is due to phosphatization, which replaced the cuticle.

1. Introduction

For many years marine sediments with concretions have attracted the attention of different research groups, in particular palaeontologists. This is because concretions act as a taphonomic window and commonly contain exceptionally preserved fossils. Among the most spectacular examples are the Carboniferous fauna from the Mazon Creek and Francis Creek (e.g., Carpenter and Richardson, 1978), Montceau-Les-Mines (e.g., Charbonnier et al., 2008; Germain, 2008), Dudley and Bickershawe Formations (Anderson, 1994; Anderson and Horrocks, 1995) and from the Late Cretaceous Bearpaw Shale, Montana of the United States (Feldmann et al., 2012). In Poland, similar concretions containing exceptionally preserved Xiphosura and flora have been described from the Carboniferous (Filipiak and Krawczyński, 1996) and from the Middle Jurassic (e.g., Zatoń and Marynowski, 2006; Zatoń et al., 2006; 2011; Salamon and Zatoń, 2008). Siderite concretions were also of great interest for other researchers because of their economic importance (e.g., Gedl and Kaim, 2012). Not accidentally, their origins have been the subject of numerous studies (e.g., Coleman, 1993; Mozley, 1996; Sellés-Martínez, 1996; Raiswell and Fisher, 2000; Hendry et al., 2006 and literature cited therein).

The Upper Cretaceous concretion-bearing sediments in the region of Stary Waliszów (Southern Poland) contain abundant fossils, including decapods (Raczyński, 1997a; fig. 1). These concretions have been mentioned in a number of typical geological works (e.g., Radwański, 1966; Jerzykiewicz, 1971; Raczyński, 1997a,b), but so far they have not been thoroughly investigated. Surprisingly, no recent study has dealt with detailed palaeoenvironmental and palaeoecological reconstruction of these sediments. In this paper we present results of interdisciplinary research which aims to provide new insights into the paleoenvironment and the paleoecology of this unique Coniacian ecosystem.

2. Geological framework

Stary Waliszów is located within the geological unit called Nysa Trough (or Upper Nysa Kłodzka Graben; Fig. 1A, C) which lies in the middle part of the Sudetic Block that is located in the northern part of

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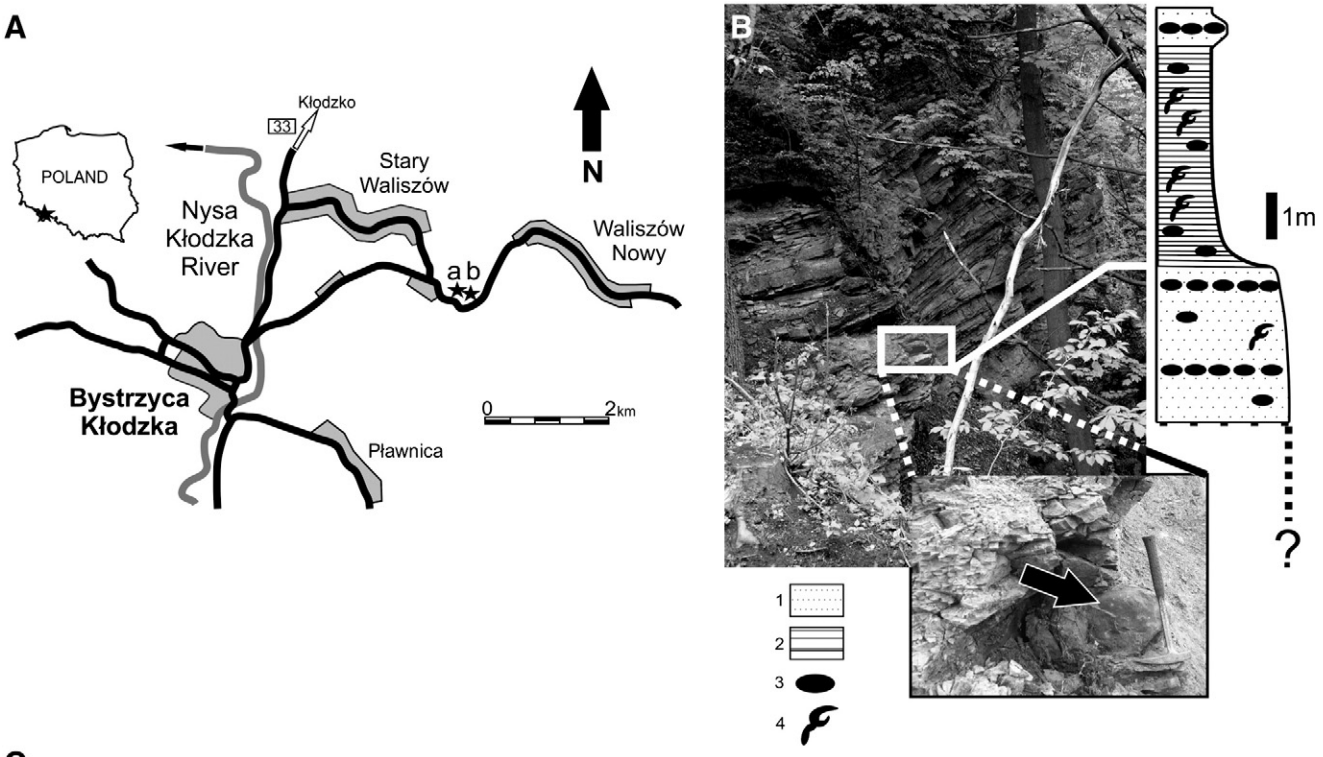
the larger unit — Bohemian Massif (Wojewoda, 1997a; Żelaźniewicz et al., 2011). In this area, the sediments of upper Cenomanian–middle Coniacian (Wojewoda, 1997a) and also probably upper Coniacian (Niedźwiedzki and Salamon, 2005) are exposed. They are represented by up to about 1200 m of shallow-water siliciclastic sediments with carbonate cements (Fig. 1B) (Wojewoda, 1997a). During the Cretaceous, the Nysa Trough Basin was situated within the northern peripheral part of the Bohemian Basin (Walaszczyk et al., 2008).

The investigated abandoned quarry (50° 18′ 37.14″; 16° 42′ 13.05″) is located in the eastern outskirts of Stary Waliszów along the road to the Waliszów Nowy locality (Fig. 1A, outcrop "a"). This quarry exposes thin-layered (3–8 cm thick) mudstones, muddy sandstones, polymictic sandstones (greywacke) and very thinly layered (2–5 mm thick) mudstones (Fig. 1B). The polymictic sandstones and muddy sandstones are typically fine-grained. All lithological types are mostly poorly lithified, and strongly bioturbated. This bioturbation largely obliterates sedimentary structures and leads to homogenization of the sediment. Throughout the section, siderite concretions are abundant. They are usually irregularly distributed within the section, although some of them form a few discrete horizons within sandstones.

The thickness of the investigated section is as much as 9 m; however, its upper part was not accessible for our studies. Investigated sediments belong to the upper part of the so-called Lower Idzików Beds (Raczyński, 1997b). This lithostratigraphic unit is present in the southern and eastern parts of the Nysa Trough. Inoceramid species *Volviceramus involutus* (Radwański, 1966) is indicative of a middle



C

LITHOLOGY	STRATIGRAPHY	INOCERAMID SPECIES	FACIES	RESEARCH AREA POSITION
UPPER IDZIKÓW BEDS sandstones and conglomerates 85m	UPPER CONIACIAN ?		Beach deposits, fan delta deposits, nearshore bars	Stary Waliszów
LOWER IDZIKÓW BEDS heterolitic succession: claysones mudstones and sandstones with siderite concretions 450-600 m	MIDDLE CONIACIAN	*Volviceramus involutus*	Shallow-marine turbidites	
spongiolites 25 m	LOWER CONIACIAN	*Cremnoceramus crassus crassus*	Basin facies	
calcareous mudstones 40 m		*Cremnoceramus crassus inconstans*		
calcareous sandstones 25 m		*Cremnoceramus deformis erectus*		

Fig. 1. A) Map of Poland with enlarged (below) investigated area. Stary Waliszów outcrops marked with asterisks: "a" — quarry studied in this paper; "b" — exposures with decapods described by Raczyński (1997b). B) Lithological section. 1 — sandstones, 2 — mudstones and muddy sandstones, 3 — concretions, and 4 — decapods. The black arrow shows a calcareous concretion. C) Cretaceous lithostratigraphy of the Nysa Trough.
Modified from Niedźwiedzki and Salamon, 2005 and literature cited therein.