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Large chambered sponge borings on a Late Cretaceous abrasion platform at Cracow, Poland

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ABSTRACT

A new ichnospecies of the bioeroding sponge ichnogenus *Entobia*, i.e., *E. cracoviensis* isp. n., is distinguished by having a single, large, isolated chamber and radiating canals. It occurs in a rockground surface on a Turonian or Santonian abrasion platform that is cut into Oxfordian limestones as exposed at Bonarka, Cracow. The morphology of the new ichnospecies is compared with fossil and modern sponge boring morphologies. In every case, the borings lack their upper parts and are roofless. Three models are constructed for the depositional history of the rockground and its colonization by the *E. cracoviensis* tracemaker: (1) that the roof has been removed by physical erosion, causing, or subsequent to, the death of the sponge; (2) that the lack of the roof is primary (biological), the roof having been removed by the sponge itself; and (3) that the boring sponge was psammobiontic, initiating its boring beneath a thin sand deposit, where there was no need to maintain a roof to the boring. The third model, based on living species of *Aka*, fits the details of preservation best, and is considered to represent the most likely scenario.

1. Introduction

Abrasion platforms cut by sea waves in carbonates at the foot of coastal cliffs are a favourite place of intensive shallow-marine bioerosion, in which scraping organisms (mostly gastropods, regular echinoids and chitons) and boring bivalves, polychaetes and sponges play the major role (e.g., Bromley and D'Alessandro, 1987; Watkins, 1990; Bromley and Asgaard, 1993; Domènech et al., 2001).

Although borings are abundant on numerous Cretaceous abrasion platforms in the Cracow area, they were not mentioned in the older literature, as noticed by Marcinowski (1974). Traditionally, the oval holes were interpreted as a result of carbonate pressure-dissolution by quartz pebbles at the base of overlying deposits. Rutkowski (1994) recognized their trace fossil nature at Cracow-Bonarka and interpreted them as possibly polychaete and truncated bivalve borings. Wieczorek et al. (1994) attributed the borings at Bonarka to worms, echinoids and possibly bivalves. Early Cenomanian abrasion platforms in the Cracow region contain various borings, including *Trypanites* ("*Potamilla*"), *Pseudopolydorites*, small *Entobia* and *Gastrochaenolites* (Głazek et al., 1971). In the Wielkanoc quarry, Marcinowski (1974) identified borings of polychaetes on the abrasion surfaces developed on Oxfordian and Turonian limestones. Olszewska-Nejbert (2004) recognized there borings referred to?*Trypanites* and large *Gastrochaenolites* developed on the late Turonian hardground. Borings of polychaetes and oval borings of unknown origin were identified in the top surface of Oxfordian limestones in Zabierzów and Mydlniki by Jasionowski (1995). This last author recognized and illustrated two trace fossils in the topmost Turonian limestones at Zabierzów, which are interpreted in the present paper as *Entobia cracoviensis* isp. n. Bromley et al. (2004) provisionally ascribed the large borings with radiating canals, from the Bonarka quarry, to the ichnogenus *Topsentopsis* Clarke, 1921, but this ichnogenus subsequently has been considered a junior synonym of ichnogenus *Entobia* Bronn, 1838 (Tapanila, 2006).

As summarized above, the Late Cretaceous abrasion platforms cut in Late Jurassic and/or Late Cretaceous in the Cracow area contain numerous borings, although commonly ascribed to other boring organisms than sponges. However, the abrasion platform at Bonarka displays numerous large-chambered borings that can be attributed to large sponges. Their nomenclature, description and interpretation are the main aims of this paper.

2. Geological setting

The described borings have been recognized in an abandoned quarry on Bonarka hill in the southern part of Cracow, which lies in

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the southern part of the Cracow Upland, being a part of the Polish Jura Chain (Fig. 1A). This area is characterized by horsts and grabens resulting from Miocene tectonics close to the thrust front of the Carpathians (Fig. 1B). The horsts and grabens are well marked in the topography. The horsts, bordered by faults having a throw of about 100–200 m, are composed mainly of the Late Jurassic (Oxfordian) limestones. Late Cretaceous sediments cover them locally. The grabens are filled mainly with fine-grained siliciclastic Miocene deposits.

The Late Cretaceous (Cenomanian–Campanian) sediments in the Cracow area are thin and only locally preserved, whereas to the east, in the Miechów Trough, they are about 600 m thick. Turonian deposits at the boundary of the Cracow Upland and Miechów Trough do not exceed 10 m (Walaszczyk, 1992). They cover Cenomanian quartz conglomerates or rest directly on an abrasion surface truncating the Oxfordian limestones. Early Turonian–Late Santonian sedimentation took place on an elevation known as the Cracow Swell. It was divided into several tectonic blocks that controlled sedimentation. As a result, sediments of this age are preserved only locally, and stratigraphic hiati and unconformities are common (Marcinowski, 1974; Walaszczyk, 1992).

The Bonarka quarry (Fig. 1C) uniquely exposes a broad abrasion platform separating the Upper Jurassic and the Upper Cretaceous. Oxfordian limestones representing the so-called bedded limestones, one of the three main facies of the Oxfordian sponge megafacies in the Cracow Upland, crop out in the lower part of the

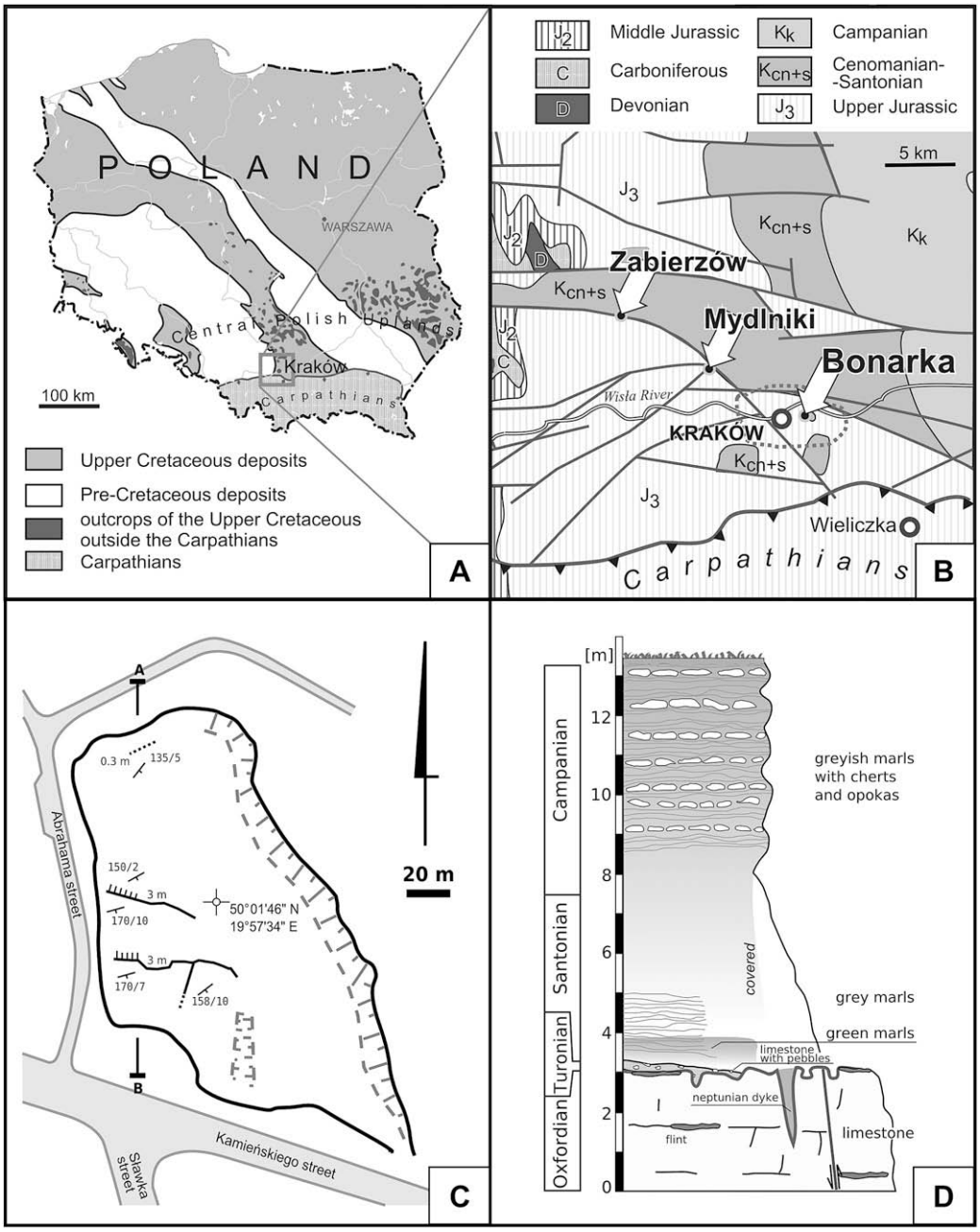

Fig. 1. Location map and section. **A**, Location of the study area on the map showing the Upper Cretaceous of Poland except for the Carpathians. Based on Sokołowski et al. (1976, Fig. 128). **B**, Geological map of the Cracow region showing the location of Bonarka and the discussed sections at Zabierzów and Mydlniki. Based on Dadlez et al. (2000). **C**, Map of the Bonarka quarry; throw of fault escarpments, strikes and dips of the abrasion platform indicated. **D**, Generalized section of the Bonarka quarry. Compilation based on Alexandrowicz (1954), Barczyk (1956) and Wieczorek et al. (1994) and own observations.