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Lower Cretaceous crinoids (Crinoidea, Echinodermata) from the Pieniny Klippen Belt of Slovakia

Abstract

In this paper I report numerous crinoids belonging to isocrinids (Isocrinida), phyllocrinids (Phyllocrinidae) and sclerocrinids (Sclerocrinidae) from the Lower Cretaceous sediments of the Pieniny Klippen Belt in Slovakia. Taphonomy, palaeoecology and palaeoenvironment of these crinoids have been shortly discussed.

Streszczenie

Niniejsze opracowanie przedstawia wyniki badań, których przedmiotem były liliowce z osadów dolnej kredy Pienińskiego Pasa Skałkowego na terenie Słowacji. W osadach tych stwierdzono bardzo bogatą i zróżnicowaną faunę liliowców, należących głównie do izokrynidów (Isocrinida), fyllokrynidów (Phyllocrinidae) oraz sklerokrynidów (Sclerocrinidae). Pokrótce zostaje również poruszone zagadnienie tafonomii, paleoekologii oraz paleośrodowiska udokumentowanych liliowców.

Keywords: crinoids, Lower Cretaceous, Slovakia

1. Introduction

Early Cretaceous crinoids from Europe are well-known due to a number of extensive studies (details in Rasmussen 1961; Salamon 2009 and literature cited therein). According to these data, the Early Cretaceous is considered a very important phase in articulate crinoid evolution. For example, it has been recently suggested that during this time, marked increases of diversity of motile crinoids and simultaneous decreases of sessile crinoids presumably due to diversification of predatory sea urchins occurred (details in Gorzelak et al. 2012).

Surprisingly, Lower Cretaceous crinoids from Slovakia are poorly known. Their presence in the Berriasian-Albian sediments in this region has been mentioned only in a number of typical geological papers (e.g., Vašiček and Rakús 1993; Vašiček 2002, 2005; Michalík 2007; Józsa and Aubrecht 2008; Aubrecht et al. 2009; Michalík et al. 2009). Here, in order to complement our knowledge on the Early Cretaceous crinoids from this area, preliminary studies have been carried out.

2. Geological setting

The studied area is located within the Slovakian part of the Pieniny Klippen Belt (PKB; cf. Bezák et al. 2011; Figure 1). Slovakian part of the PKB is particularly important in terms of the paleogeographic and sedimentological considerations of the sediments belonging to the so-called Czorsztyn succession, the origin and age of which have been the source of considerable controversy. According to Aubrecht et al. (1997), Slovakian PKB successions generally correspond to those observed in Poland. However, there are also some units, like Orava (Podbiel) succession, characterized by the presence of nodular limestones of Pliensbachian to Toarcian age (Wierzbowski et al. 2006), which is atypical in that they have no equivalent to the Polish units.

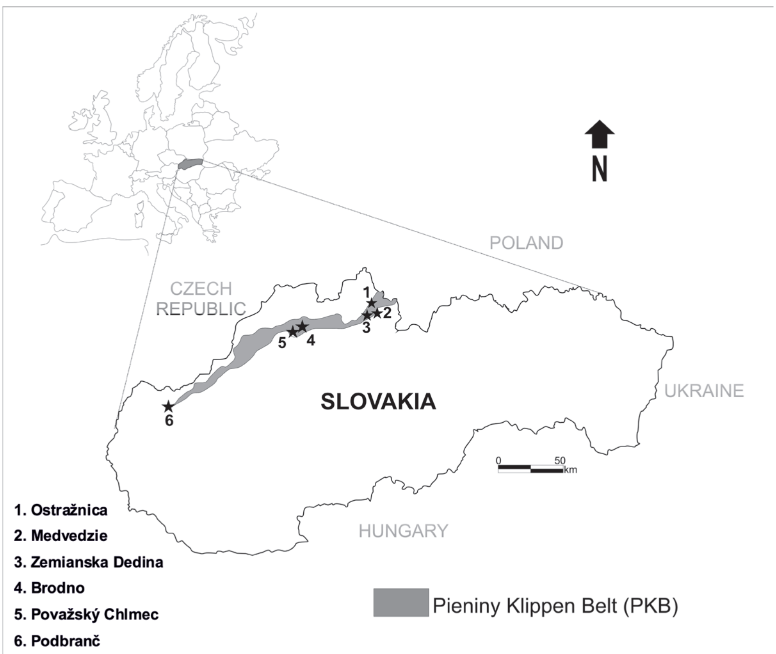

Figure 1. Map of Europe with enlargement of the studied area (after Bezák et al. 2011)

3. Materials and methods

During the preliminary field works six locations of various age were examined. These were: Ostražnica, Medvedzie, Zemianska Dedina, Brodno, Považský Chlmec and Podbranč (Figure 1); 12 rock samples each weighing 15 kg were taken from Berriasian to Albian interval (Figure 2). The samples were macerated at the Department of Paleontology and Stratigraphy of the University of Silesia in Sosnowiec. They were washed, sieved through a sieve with a mesh diameter: 0.315, 0.5 and 1.0 mm and dried at 150 ˚C. The fossils were picked up under a stereoscopic microscope SM 800T. Selected skeletal elements of crinoids were subjected to additional mechanical preparation. The remains of clay material were removed by hydrogen peroxide. Identified crinoid material was photographed by SEM Philips XL 30 ESEM.

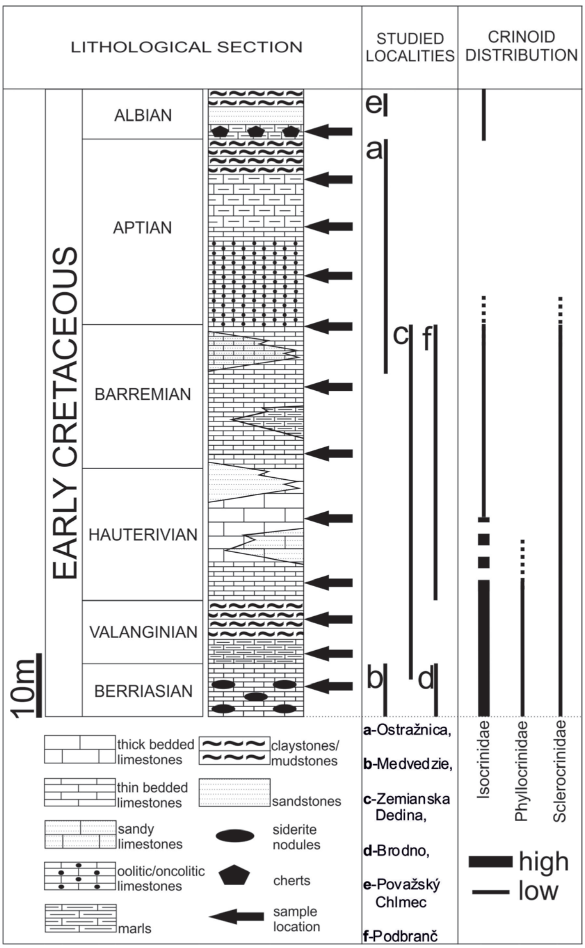

Figure 2. Stratigraphic distribution of crinoids in the Lower Cretaceous sediments in Slovakia (profile compiled after Vašiček and Rakús 1993; Vašiček 2002, 2005; Michalík 2007; Józsa and Aubrecht 2008; Aubrecht et al. 2009; Michalík et al. 2009; simplified)

The investigated material is housed at the Department of Earth Sciences, University of Silesia, Sosnowiec, Poland, and acronymed GIUS.

4. Results

In total, 417 crinoid remains (columnals, cups and brachial plates) were found belonging to Isocrinidae (*Isocrinus annulatus*), Phyllocrinidae (*Phyllocrinus malbosianus*) and Sclerocrinidae (*Ascidicrinus pentagonus, Sclerocrinus* sp.) (Figure 2).

4.1. Systematic palaeontology

Systematic follows Hess and Messing (2011).
1. Order Isocrinida Sieverts-Doreck, 1952
2. Family Isocrinidae Gislén, 1924
PLATE 1A

Material: 7 columnals, 3 cirrals. GIUS 9-3602/I.

Description: The columnals are pentagonal to subpentagonal. The articular facets are covered by poorly visible crenules. The petal floors are ellipsoidal. The columnal lateral surfaces are smooth. The lumen is very small and round. The cirrals are low with small round axial canal.

Isocrinus von Meyer *in* Agassiz, 1836
Type species: *Isocrinites pendulus* von Meyer, 1836
Isocrinus annulatus Roemer, 1836
PLATE 1B, C

Material. 123 columnals, 27 pluricolumnals, 20 cirrals, 18 pluricirraliów, 136 brachials. GIUS 9-3602/Ia.

Description: The columnals are small, up to 4.5 mm in diameter, round and pentagonal. All columnals are low. The nodal columnals are as high as internodal columnals. The facets are covered with drop-like petal floors. All petal floors are surrounded by max. 13 marginal crenulae. The lumen is round and small. The cirrals are ellipsoidal and cylindrical.

Order Cyrtocrinida Sieverts-Doreck *in* Ubaghs, 1952
Suborder Cyrtocrinina Sieverts-Doreck *in* Ubaghs, 1952
PLATE 1D, E

Material: 56 different columnals, 2 basal disks and 4 brachials. GIUS 9-3602/C.

Description: The columnals are round and oval, high or low. The columnals in distal part of stem are long and thin in medial part. The facets could be covered by crenulae extending radially. In a few cases the articular surfaces are smooth. The lateral surfaces are smooth or covered by small nodules. The lumen is round and relatively large. The basal disks are irregular and low. The brachials are small, V-shaped and their lateral surfaces are covered by nodules.

1. Family Phyllocrinidae Jaekel, 1907
Phyllocrinus d'Orbigny, 1850
Type species: *Phyllocrinus malbosianus* d'Orbigny, 1850.
Phyllocrinus malbosianus d'Orbigny, 1850
PLATE 2A–C

Material: 16 cups. GIUS 9-3602/Pm.

Description: The cups are massive and relatively large, hemispherical and with flat base. The radial cavity is quite wide and deep. The interradial processes are high, very narrow, triangular in outline and separated by distinct suture lines.

Family Sclerocrinidae Jaekel, 1918
Sclerocrinus Jaekel, 1891
Type species: *Eugeniacrinites compressus* Goldfuss, 1829.
Sclerocrinus sp.
PLATE 1F

Material: 1 cup. GIUS 9-3602/S.

Description: The cup is partly preserved, it is rounded in outline. The dorsal cavity is round and deep. The lateral surface of the cup is smooth.

Ascidicrinus Hess, Salamon and Gorzelak, 2011
Type species: *Ascidicrinus armatus* Hess, Salamon and Gorzelak, 2011

Ascidicrinus pentagonus (Jaekel, 1891)
PLATE 2D, E

Material: 4 cups. GIUS 9-3602/Ap.

Description: The cups are small and very low with flat basal part. The radial cavity is wide and round. The radials are flat and outwardly deflected to the cup. The interradial outgrowths are thick and with oval swelling at the ends. The dorsal cavity is oval or round and deep.

4.2. Taphonomy

Crinoid remains are mainly represented by stem fragments (above 70%), i.e. columnals, pluricolumnals, cirrals and pluricirrals. Documented pluricolumnals contain 2–9 columnals and pluricirrals possess 2–6 cirrals. Other skeletal elements, i.e. brachials and cup elements (e.g. radials) are very rare. Depending on a sample, about 10–15% of documented crinoids have abrasion traces. Similarly, about 10–15% of examined material yield small holes due to bioerosion.

About 10% of specimens (columnals and pluricolumnals) display evidence of encrustation. The epibionts are represented mainly by bryozoans and somewhat less numerous annelids (serpulids). Epibionts are located on the latera and articular surfaces.

5. Discussion

All collected crinoid taxa were benthic forms. According to the literature data, most of fossil cyrtocrinids preferred deep marine environments (e.g. Hess et al. 1999). They were usually associated with biohermal structures consisting of sponges and brachiopods (Hess 1975). Hess et al. (1999) also reminded that living representatives of cyrtocrinids inhabit hard substrates at depths exceeding 200m. However, the investigated sediments with crinoids in PKB were formed in a relatively shallow sea. Indeed, there is increasing evidence that fossil cyrtocrinids also inhabited shallow sea environments (e.g. Salamon et al. 2007).

Currently documented cyrtocrinid taxa have relatively short stems consisting of a variable number of columnals. Their stems were ended with discoidal basal disks (the so-called holdfast) that attached them to the hard bottom or bioclasts (Ausich et al. 1999). According to Michalík (2007), the bottoms of the Early Cretaceous sea in the Pieniny Klippen Belt of Slovakia were not hard, thus it is clear that these crinoids were attached to some bioclasts.

Indeed, numerous findings of shells of ammonites, brachiopods and bivalves are known from investigated localities (Vašiček 2002, 2005; Józsa and Aubrecht 2008; Aubrecht et al. 2009) which provided an excellent substrate for cyrtocrinids. Within the sediments with crinoids, corals are also quite common (Józsa and Aubrecht 2008). Jaekel (1891) noted that crinoids (mainly cyrtocrinids) from the Štramberk locality in the Czech Republic, lived in association with corals and numerous calcareous sponges. The latter researcher concluded that cyrtocrinids were actually reef forms and that several deformations in these crinoids (also occurring in the material at hand) resulted from increased waving (more details in Žítt 1973, 1974, 1975, 1978a–d, 1979a, b, 1982). This explanation is, however, improbable. As recently stressed by Salamon and Gorzelak (2010) such deformations were likely induced by predators.

The second crinoid group recorded in the Lower Cretaceous sediments of Slovakia are isocrinids. These crinoids possessed a long stem covered with cirri which were used for attachment to the seafloor. Nevertheless, these crinoids were motile forms and were able to move on the seafloor with the aid of their arms (e.g. Baumiller and Messing 2007).

The recorded crinoid assemblages are typical for quiet and non turbulent waters (cf. Głuchowski 1987). Although abrasion traces found on some Slovakian crinoids indicate that some of the recorded crinoids were transported, most of them are relatively well preserved. This suggests that these crinoid assemblages are mostly paraautochthonous. Small holes visible on the crinoid surfaces could have been produced by endolic algaes. Almost all of the mentioned holes are located on the articular surfaces which clearly suggest the postmortem bioerosion. Similarly, no characteristic "swellings" of the stereom clearly indicate a postmortem encrusting. In general, evidence of incrustation and bioerosion points to the fact that at least some of the crinoid remains before their final burial were present for a longer time on the sea bottom. Periodic decreases in sedimentation rates could have been favorable for epibiont colonization.

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Plates:

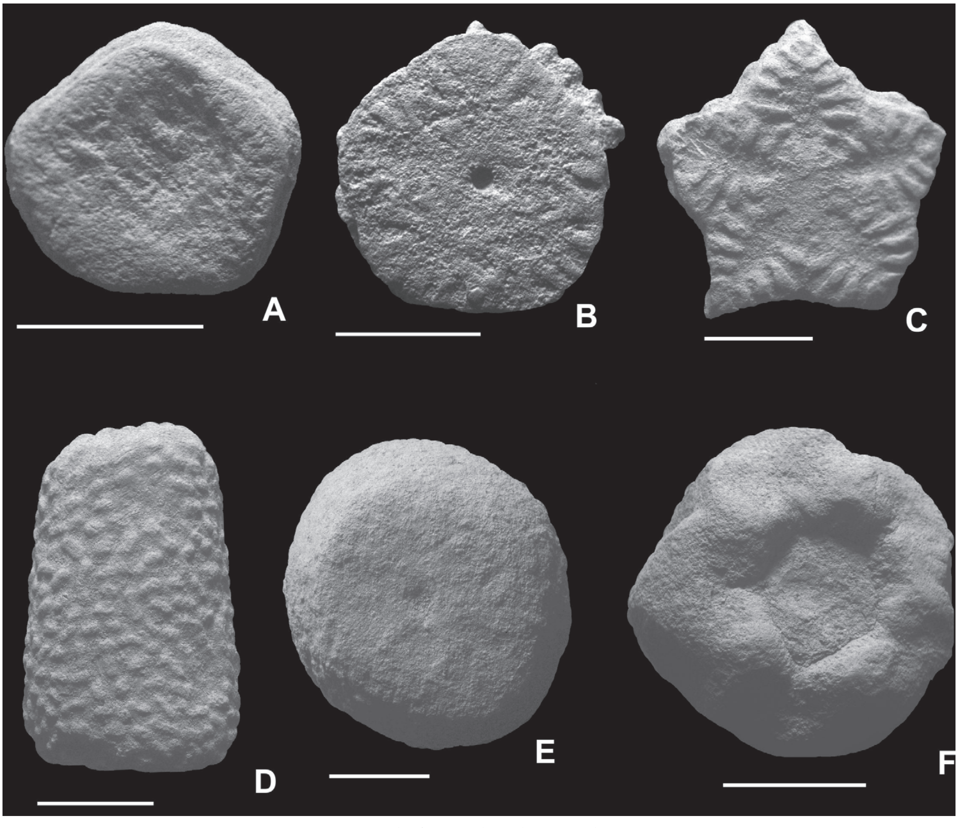

PLATE 1. Lower Cretaceous crinoids from Slovakia. Scale: 1 mm.

A. Isocrinidae Gislén, 1924. Columnal, articular face. Berriasian, Slovakia. GIUS 9-3602/I; B–C. *Isocrinus annulatus* Roemer, 1836. Columnals, A. medial columnal, articular face; B. proximal columnal, articular face. Berriasian, Slovakia. GIUS 9-3602/Ia1, 2; D–E. Cyrtocrinina Sieverts-Doreck *in* Ubaghs, 1952. Columnals. D. side view; E. columnal articular face. Valanginian, Slovakia. GIUS 9-3602/C1, 2;F. *Sclerocrinus* sp. Cup, view from the top. Barremian, Slovakia. GIUS 9-3602/S

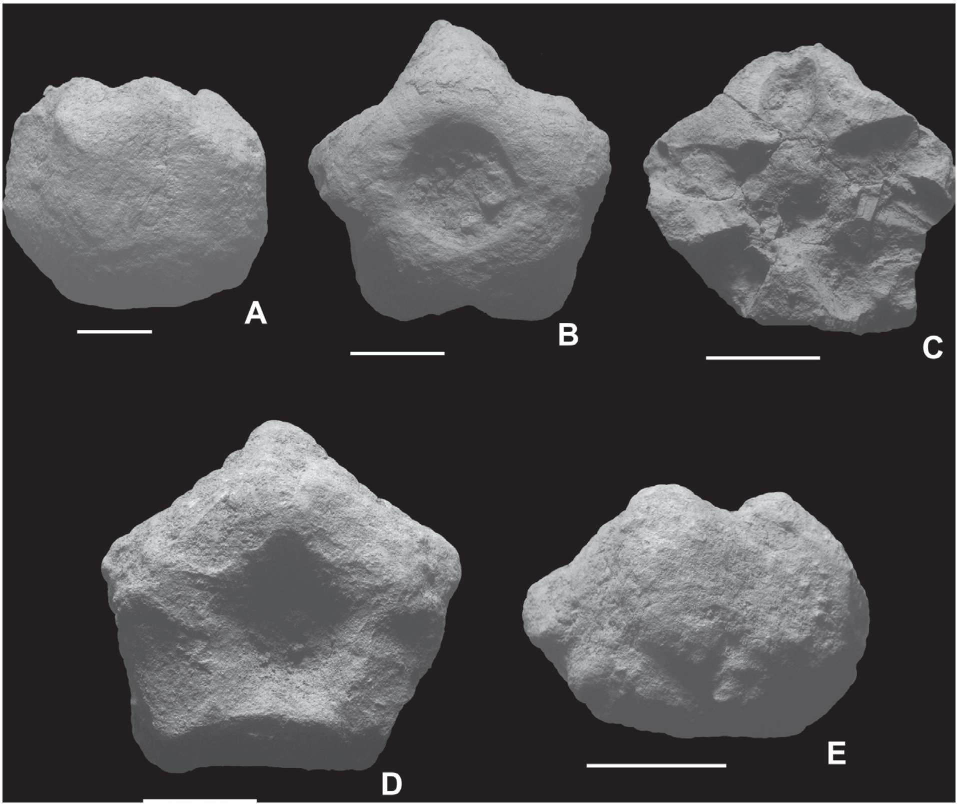

PLATE 2. Lower Cretaceous crinoids from Slovakia. Scale: 1 mm.

A–C. *Phyllocrinus malbosianus* d'Orbigny, 1850. Cup. A. side view; B. view from below; C. view from the top. Berriasian, Slovakia. GIUS 9-3602/Pm1, 2, 3; D–E. *Ascidicrinus pentagonus* (Jaekel, 1891). Cup. D. view from the top; E. view from below. Barremian, Slovakia. GIUS 9-3602/Ap1, 2.