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First record of *Traumatocrinus* stem in the Triassic basinal deposits of the Western Carpathians, Slovakia

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Abstract

Traumatocrinus stem fragments are reported from two localities in the Slovak part of the Western Carpathians in Triassic (Upper Ladinian and Lower Carnian) basinal deposits of the Hronicum Unit. The stem of *Traumatocrinus* consists of columnals with articular facets typically composed of V-shaped crenulae arranged in rows which extend from the center to the rim of each columnal. If weathered, the space between columnals may be revealed which leaves the stem of lattice like appearance. Both the V-shaped ribs and the lattice like structure are highly characteristic for the *Traumatocrinus* stem. All samples reported from the Upper Ladinian Reifling Limestone and Lower Carnian black shales of the Svarín Formation are here tentatively placed to *Traumatocrinus* sp. Finally, *Traumatocrinus* life style is also discussed.

Key words: *Traumatocrinus*, stem morphology, Upper Ladinian/Lower Carnian, Triassic, Western Carpathians

Introduction

In the last few years several papers have dealt with spectacular findings of entirely whole colonies of *Traumatocrinus* still attached to fossilized driftwood from the Lower Carnian black shales of Southwest China (Hagdorn et al., 2005; Hagdorn et al., 2007; Wang et al., 2006; Wang et al., 2008). Such favorable preservation has allowed to study articulated *Traumatocrinus* specimens and to reconstruct their life style. Unfortunately, many localities in Europe including Salzkammergut in Northern Calcareous Alps (Austria) from which this crinoid was described for the first time by Dittmar (1866), contain only isolated ossicles and stem fragments. This is also the case of Ladinian–Carnian facies in the Western Carpathians which yielded several stem fragments with a different state of preservation.

Triassic crinoids from the Western Carpathians are generally poorly known and have been often mentioned without any descriptions or illustrations. Most of the data concerning with the Middle and Upper Triassic crinoids are from the Polish Tatra Mountains (Goetel, 1917; Lefeld, 1958; Kotański, 1959, 1963). Recently, these data were largely supplemented by Niedźwiedzki and Salamon (2006) who provided a detailed description of the crinoid fauna coming from three tectonic units (Tatricum, Fatricum and Hronicum), recognized in the Polish Tatra Mountains. They have also focused on stratigraphical significance of the Middle Triassic crinoids and applied the Triassic crinoid zonation, originally established by Hagdorn and Głuchowski (1993) in the Muschelkalk, in the Tatra Mountains. Another detailed data on Triassic crinoids from the Western Carpathians was given by Kristan-Tollmann and Spendlingwimmer (1975) who described two Anisian species *Encrinus liliiformis* and *Dadocrinus gracilis* from the Hainburg Hills in the northeast Austria. Data concerning *Traumatocrinus* in the Western Carpathians are restricted to single fragment from a proximal stem found in the Polish Tatra Mountains in the Lower Ladinian black shales (Głuchowski, 2002).

Studied area and material

The material for this study comes from two localities: Svarín and Zámostie–Štefánka, both situated in the Nízke Tatry Mountains (Fig. 1A). The former one lies at the northern slope of the mountains and is characteristic by outcropping sequence of Middle Triassic Reifling Limestone covered by Lower Carnian black shales of the Svarín Formation. The black shales formerly assigned to the Aon- or Trachyceras Beds (Kollárová-Andrusovová and Bystrický, 1974; Bystrický, 1982) yielded two stem fragments from the most basal part of the corresponding section at Svarín. Besides the poor crinoid fauna the black shales also contain abundant ammonites and thin shelled bivalves. The latter locality represents an abandoned quarry situated at the southern slope of the mountains. Its well exposed Middle Triassic sequence consists of pelagic carbonates (for detailed description see Kochanová and Michalík, 1986), predominantly of grey Reifling Limestone deposited in the intraplatform basin (Michalík, 1993; Michalík, 1994).

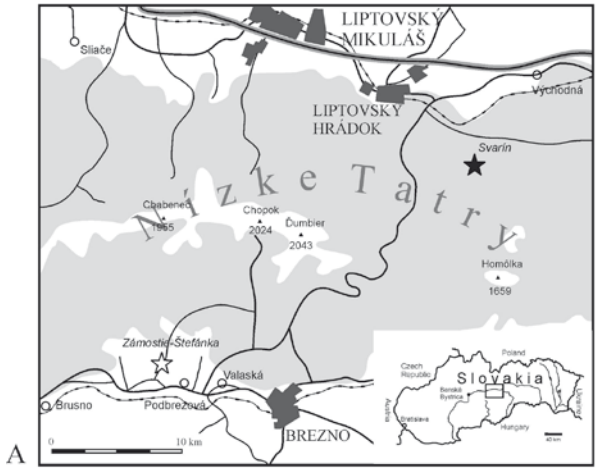

Fig. 1. Geographical map showing position of two examined localities marked by stars (A) and stratigraphical distribution of investigated material within Middle-Upper Triassic sequence of the Hronicum Unit (modified after Lexa et al., 2000) (B). Black stars represent Svarín; white stars represent Zámostie–Štefánka.

In Zámostie–Štefánka large *Traumatocrinus* stem fragments were obtained from a single Reifling Limestone bed all arranged on its lower bedding plane. Corresponding bed contains Upper Ladinian (Longobardian) microfauna (Jendrejáková et al., 1981; Masaryk et al., 1993). Both, the Reifling Limestone and the black shales of the Svarín Fm. are characteristic mainly for the Biely Váh Succession of the Hronicum Unit (Fig. 1B).

All specimens were found by Dr. Sándor Kovács and Dr. Jozef Michalík during field work in the Nízke Tatry Mountains in the 1980s. They are currently housed in the Slovak National Museum under SNM Z 35 285–35 289.

Morphological characters and preservation

One of the most significant characters of *Traumatocrinus* is the unique morphology of its stem columnals which have articular facets characteristic only for this crinoid (Klikushin, 1983; Kristan-Tollmann, 1991). They are composed of V-shaped crenulae extending from the central lumen to the rim of each column (Fig. 2A). Crenulae are arranged in rows which bifurcate distally and are separated from neighboring rows by distinct furrows (the so-called fossulae). Each furrow is connected to a channel opening at its most proximal part. Corresponding arrangement is beautifully preserved on the columnals from Svarín (2B, C). They are relatively large up to 15 mm in diameter, having facets with numerous and closely spaced rows of ribs. Moreover columnals are also very thin and have convex and smooth latera. These characters suggest the position of columnals more distally in the stem of a large adult individual (Kristan-Tollmann, 1991). However, the development of the rows and their dense arrangement obscure the most of the fossulae openings. On the other hand, these morphological features are well visible on the stem fragments from Zámostie–Štefánka all arranged on the lower surface of a limestone block (Fig. 3). Columnals here are significantly smaller with diameter from 3 to 15 mm. They are affected by weathering which makes the channel openings more visible (Fig. 4A). Considering the high degree of weathering the most stem fragments from Zámostie–Štefánka are highly corroded leaving the suture lines between columnals almost invisible. A recrystallization of columnals is also noticeable. Nevertheless few small fragments were only slightly affected by weathering, leaving their lateral surface of lattice-like appearance (Fig. 4B; see also Klikushin, 1983). It results from the weathering of the external wall which reveals the furrows (fossulae) in the facets. This is also a characteristic feature of *Traumatocrinus* stem, but seen only by small or by weathered specimens.

Discussion and conclusion

Morphology and systematic

As previously noted the development of columnal facets in *Traumatocrinus* stem is highly characteristic and thus provide easy determination even from a single columnal. However, these features alone can not provide

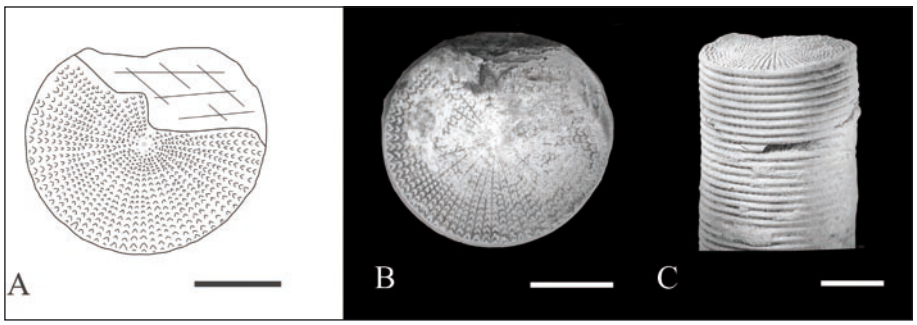

Fig. 2. Stem fragment of *Traumatocrinus* sp. from black shales of Svarín Fm. (SNM Z – 35 285). (A) camera lucida drawing of columnal facet, (B) facet view, (C) pluricolumnal lateral view. Scale bars equal 5 mm.

Fig. 3. Block of Reifling Limestone with numerous stem fragments of *Traumatocrinus* sp. (SNM Z – 35 287), Late Ladinian; Zámostie–Štefánka (Slovakia).

classification into species level. In the past, many authors established new species by erroneous interpretation of isolated ossicles from different parts of *Traumatocrinus* skeleton (Bather, 1929) or considered small ossicles of juvenile individuals as separate taxa (Dittmar, 1866). Only Mu (1949) was dealing with whole specimens of *Traumatocrinus* coming from Southwest China and established several new species including *Traumatocrinus hsui*. His work was unnoticed by western paleontologists for many years until Kristan-Tollmann (1991), who provided a revision of the most known species from Europe and Asia and considered *Traumatocrinus caudex* to be the only valid. While no detailed comparisons between Chinese and European material was made so far, it is still unclear whether they represent one or more species. Until more comprehensive analyses will be made, Wang et al. (2006) proposed to use *Traumatocrinus* sp. for Chinese specimens.

Present material from the Western Carpathians morphologically well correspond with *Traumatocrinus* columnals coming from all over the world. However, while no cup and arm elements have been found in association with the stem fragments, the taxonomical status of *Traumatocrinus* must be left in the open nomenclature: *Traumatocrinus* sp.

Except the first mention of a single columnal of *Traumatocrinus* cf. *caudex* from the Polish Tatra Mountains by Głuchowski (2002) it is the only known occurrence in the Western Carpathians.

Lifestyle and distribution

According to the present knowledge, *Traumatocrinus* lived attached to a drifting log hanging downwards under the sea level (Hagdorn et al., 2006; Wang et al., 2006). This pseudoplanktonic lifestyle allowed *Traumatocrinus* to spread over the entire Paleo-Tethys and to prosper during the Late Ladinian and Early Carnian. However, the earliest finds of *Traumatocrinus* are already known from the Early Ladinian (Głuchowski, 2002). As *Traumatocrinus* was largely dependent on driftwood, it is surprising that this type of lifestyle appeared during the Ladinian, a period with global arid climate. Probably the answer to that question we can find in Italy, in dolomites of the Wengen Formation, which contain rich assemblage of Ladinian flora (Wachtler and van Konijnenburg-van Cittert, 2000). Unlike other formations in Europe and Asia with Ladinian flora primarily composed of ferns and horsetails, the flora of the Wengen Fm. is composed predominantly of conifers and pteridosperms. Lignified tissue of conifers and pteridosperms is more durable in comparison with unlignified fern and horsetail stems. If swept from the land to the sea, such trees could have been suitable substratum for attachment of pseudoplanktonic organisms. Although

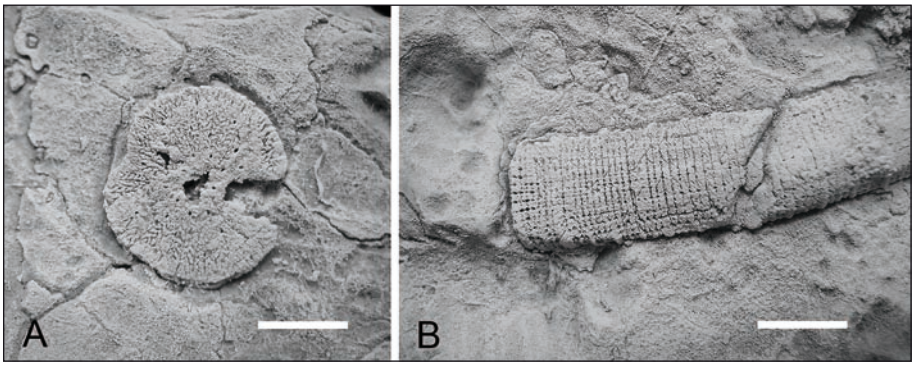

Fig. 4. *Traumatocrinus* sp. from Reifling Limestone, Late Ladinian; Zámostie–Štefánka (Slovakia). (A) Articular facet of small columnal (SNM Z – 35 288). (B) Lateral view of proximal stem fragment (SNM Z – 35 289). Scale bars equal 2 mm.

the Ladinian is considered to be a global arid period, the land flora was probably well adapted to such conditions and widespread at least in areas with more suitable conditions (Wachtler and van Konijnenburg-van Cittert, 2000).

In the fossil record *Traumatocrinus* typically occurs in the basinal sediments like the Hallstatt Limestone in Austria (Dittmar, 1866) and Turkey (Kristan-Tollmann and Tollmann, 1983) or black shales in the Southwest China mentioned above. Similar occurrence is also provided here from two localities in Slovakia. Even stem columnals of *Traumatocrinus* are reported from many localities in Europe and Asia (Hagdorn et al., 2007), they belong to rather rare elements of the fossil record.

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