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Revision of the BARRANDE's specimen "Tige d'une Cystidée indéterminée" (Cambrian, Echinodermata, Eocrinoidea)

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Abstract: Reexamination of the type specimen described by BARRANDE in 1887 as *"Tige d'une Cystidée indéterminée"* shows that this unique specimen represents an articulated but incomplete remnant of the gogiid eocrinoid *Akadocrinus jani* PROKOP. The specimen is preserved as an external mould in shale from the mid-Cambrian Jince Formation, and comprises a proximal part of a stem associated with a slightly disarticulated distal portion of a theca, composed of over twenty polygonal plates. With the exception of the basal-most plates, all other preserved thecal plates bear ellipsoidal marginal epispires, and substantiate assignment of this specimen to the epispire-bearing phase in ontogenetic development of *Akadocrinus*.

Key-words:

- Echinodermata;
- Blastozoa;
- Eocrinoidea;
- Drumian;
- Cambrian;
- Barrandian area;
- Příbram–Jince Basin;
- Czech Republic

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Résumé : *Révision de la* "Tige d'une Cystidée indéterminée" *décrite par BARRANDE (Cambrien, Echinodermata, Eocrinoidea).-* La réétude du spécimen-type décrit par BARRANDE en 1887 comme une *"tige de Cystidée indéterminée"* montre que ce spécimen unique pourrait être attribué à l'espèce d'éocrinoïde gogiidé *Akadocrinus jani* PROKOP. Ce spécimen correspond à une empreinte préservée dans une argilite de la Formation de Jince (Cambrien moyen, République Tchèque). Il présente la partie proximale de la tige articulée à un fragment de thèque distale, composée d'une vingtaine de plaques polygonales. À l'exception des plaques basales, les plaques thécales portent des épispires ellipsoïdales. Cet indice morphologique suggère que ce spécimen pourrait représenter les prémices d'un stade adulte.

Mots-clefs :

- Echinodermata ;
- Blastozoa ;
- Eocrinoidea ;
- Cambrien ;
- Drumien ;
- aire barrandienne;
- Bassin de Příbram-Jince Basin ;
- République tchèque

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1. Introduction

Remains of disarticulated echinoderm skeletons are quite common in Cambrian and Ordovician sediments of the Barrandian area (BARRANDE, 1887; HAVLÍČEK & VANĚK, 1966; HAVLÍČEK, 1971; MERGL & PROKOP, 2006). However complete specimens are more rare (BARRANDE, 1887; POMPECKJ, 1896; PROKOP, 1964; FATKA & SZABAD, 2014a; ZAMORA *et al.*, 2015; NOHEJLOVÁ & FATKA, 2016). After more than a century of intensive research, the Czech scientists HAVLÍČEK & VANĚK (1966) and more recently PROKOP & PETR (2000) brought together a list of all Ordovician echinoderm taxa in the Prague Basin, including their stratigraphic ranges. Similarly, UBAGHS (1967a, 1967b, 1967c), FATKA (1990) and FATKA *et al.* (2004) compiled exhaustive lists of Cambrian echinoderm species for the Skryje-Týřovice and Příbram-Jince basins. One of the known groups of blastozoan echinoderms is a paraphyletic class Eocrinoidea, which ranges from the Cambrian to the Silurian (SPRINKLE, 1995).

From the Barrandian area, nine Cambrian and Ordovician species assigned to eocrinoids were known in the second half of the 19th century (BARRANDE, 1846, 1887). Seven species were based on specimens from the Ordovician of the Prague Basin, particularly: *Archaeocystites medusa* BARRANDE, 1887; *Ascocystites drabowensis* BARRANDE, 1887; *Ascocystites micraster* BARRANDE, 1887; *Ascocystites* cf. *micraster* BARRANDE, 1887; *Cardiocystites bohemicus* BARRANDE, 1887; *Mimocystites bohemicus* BARRANDE, 1887; and *Macrocystella* sp., two last named taxa are recently classified as rhombiferans by PAUL (1968) and other authors (see PROKOP & PETR, 2000; MERGL & PROKOP, 2006). The scarce material collected from the Cambrian of the Příbram-Jince and Skryje-Týřovice basins allow the description of only two species, *Acanthocysties briareus* BARRANDE, 1887 and *Lichenoides priscus* BARRANDE, 1846 (see UBAGHS, 1967a; SPRINKLE, 1973).

Continuing discoveries of new material combined with revisions of already described species have resulted in a clearer understanding of eocrinoid systematics. Four mid-Cambrian eocrinoid genera are now known: *Acanthocystites* BARRANDE, 1887; *Akadocrinus* PROKOP, 1962; *Lichenoides* BARRANDE, 1846 and *Luhocrinus* PROKOP & FATKA, 1985 (see NARDIN *et al.*, 2017), while only two genera of the Barrandian area, *Ascocystites* BARRANDE, 1887 and *Cardiocystites* BARRANDE, 1887, are currently accepted as Ordovician eocrinoids.

However, BARRANDE (1887) also described and figured several incompletely or quite poorly preserved echinoderm remains. The morphology of some of these imperfectly known taxa has been properly reconstructed only recently, and an understanding of systematic position of these previously poorly-known forms is now possible (*e.g.*, CHLUPÁČ & KORDULE, 2002; FATKA *et al.*, in press). The aim of this contribution is to revise an original specimen, based on this new understanding, erroneously described by BARRANDE. He classified it as the *"Tige d'une Cystidée indéterminée"*. It comes from the mid-Cambrian Jince Formation of the Příbram-Jince Basin.

2. Material and methods

The original description of *"Tige d'une Cystidée indéterminée"* by BARRANDE (1887) was based on a single specimen, housed in the original collection of Joachim BARRANDE in the National Museum Prague (inventory number L9052). This specimen is preserved as an external natural mould of the original calcite ossicles in fine greywacke. It was collected from an unknown site in the mid-Cambrian Jince Formation in the Příbram–Jince Basin (Fig. 1). The original external mould was photographed with a digital Canon EOS 70 D camera. New latex casts were made, coated with ammonium chloride and also photographed as part of the current research.

3. Geologic setting, presumed origin of the specimen

The mid-Cambrian Jince Formation of the Příbram–Jince Basin (Fig. 1) is well-known as a classical source of diverse and usually well-preserved skeletal fauna (*e.g.*, BARRANDE, 1846; ŠNAJDR, 1958; GEYER *et al.*, 2008), including echinoderms (see above). Rich associations of disarticulated as well as articulated trilobites, agnostids, echinoderms, brachiopods, hyoliths, organic-walled microfossils and ichnofossils associated with remains of bivalved arthropods, helcionelloid molluscs, and foraminifers have been studied from this locality for nearly two hundred years (summary see FATKA *et al.*, 2004).

3.1. Presumed origin of the specimen

The exact site at which the studied specimen was collected is not known. The associated label bears the name *"Ginetz"*. BARRANDE and his collectors used the cumulative designation *"Ginetz"* for several sites near the town of Jince (= *Ginetz* – German transcription used in maps in 19th century; ŠNAJDR, 1958; CHLUPÁČ, 1999). However, lithology of the rock sample combined with knowledge of outcrops excavated by BARRANDE and his collectors provided enough evidence to assess probable localities. The lithological character of the rock sample and the occurrence of an internal mould of a prone, well-articulated exoskeleton of the agnostid *Peronopsis integra* BEYRICH, 1845, at the sample surface (Fig. 2) indicate that the sample originates from the range from upper levels of the *Hypagnostus parvifrons* Biozone through the middle part of the *Paradoxides* (*P.*) *paradoxissimus gracilis* Biozone of FATKA & SZABAD (2014a). These are the levels of richly fossiliferous sha-

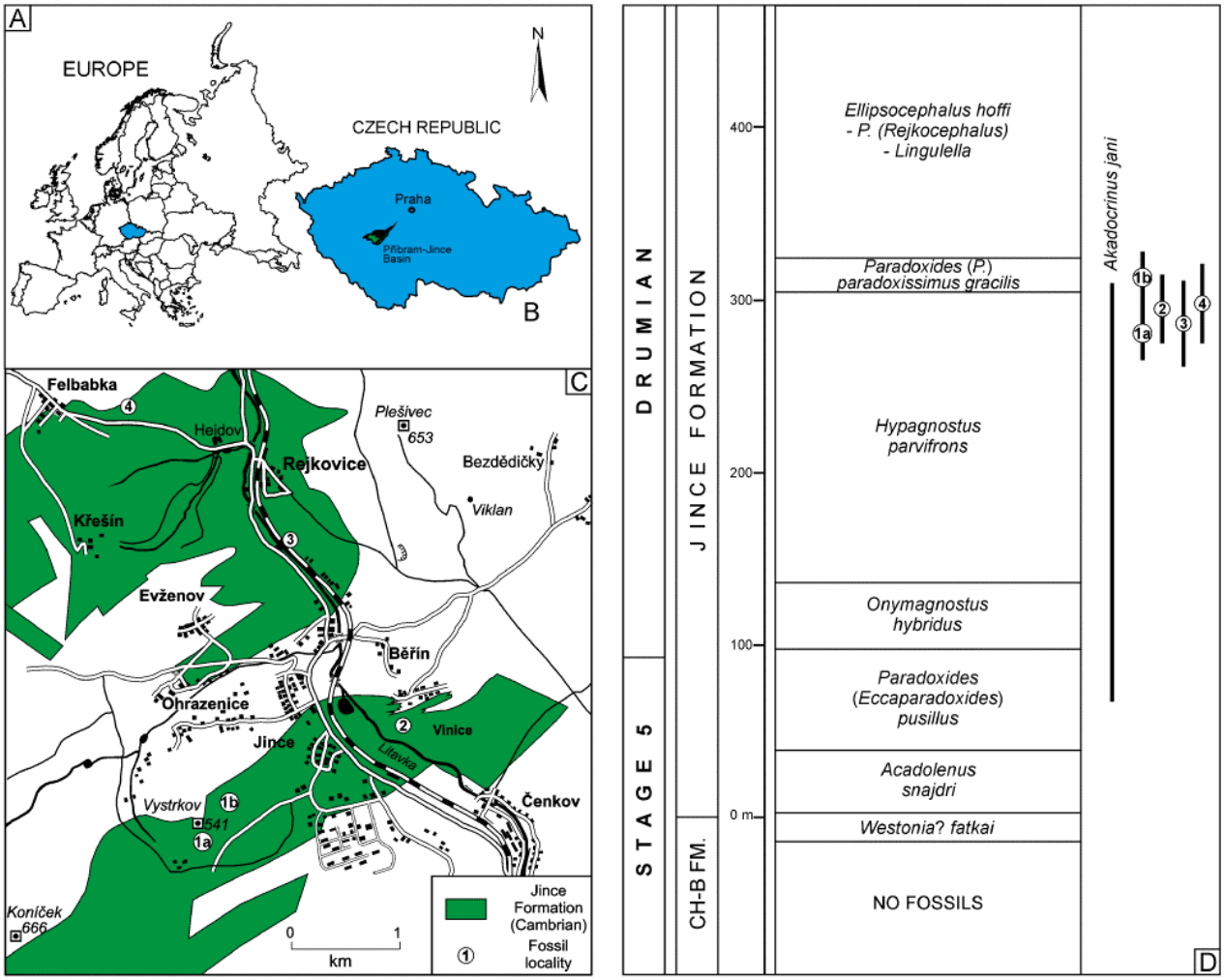

Figure 1: Maps showing location of fossil sites. A – Czech Republic and Cambrian rocks of Příbram-Jince Basin. B – Simplified geological maps showing distribution of mid-Cambrian Jince Formation and location of fossil sites. C – Stratigraphic distribution of *Akadocrinus jani* sequence accessible at four localities within Jince Formation of Příbram–Jince Basin. 1, Vystrkov Hill locality; 2, slope Vinice near Jince (= östlicher Ende von Vinice, in der Nähe von Jinec in ŽELÍZKO, 1897, p. 323); 3, Chramostův mlýn (= Chramosta-Mühle in ŽELÍZKO, 1897, p. 323); 4, Felbabka within Příbram–Jince Basin. Geology modified from HAVLÍČEK (1971); biostratigraphic zones after FATKA & SZABAD (2014a).

les and fine greywackes that have been intensively quarried since the middle of the 19th century (ŠNAJDR, 1958). Fossils were collected from four major areas in the Příbram-Jince Basin (CHLUPÁČ, 1999, p. 11):

1. at diverse pits at the southern and eastern slopes of Vystrkov Hill near Jince (ŽELÍZKO, 1911, p. 2) (1 in Fig. 1.C-D);
2. at several pits on the southern slope Vinice above the Litavka River (= Am östlichen Ende von Vinice, in der Nähe von Jinec of ŽELÍZKO, 1897, p. 321) (2 in Fig. 1.C-D);
3. near Chramostův mlýn at Jince (= Chramosta-Mühle of ŽELÍZKO, 1897, p. 323) (3 in Fig. 1.C-D); and
4. in several pits east of the village of Felbabka (4 in Fig. 1.C-D).

3.2. Age

The occurrence of the agnostid *Hypagnostus parvifrons* indicates an age corresponding to middle and higher levels of the Baltic *Paradoxides* (*P.*) *paradoxissimus* Biozone (see AXHEIMER & AHLBERG, 2003). These levels are supposed to be equivalent to the Caesaraugustan Regional Stage in the West Gondwanan chronostratigraphic sequence (see GEYER *et al.*, 2008; GOZALO *et al.*, 2011), and thus correspond to the Drumian Stage of Cambrian Series 3 (see discussion in FATKA *et al.*, 2014).

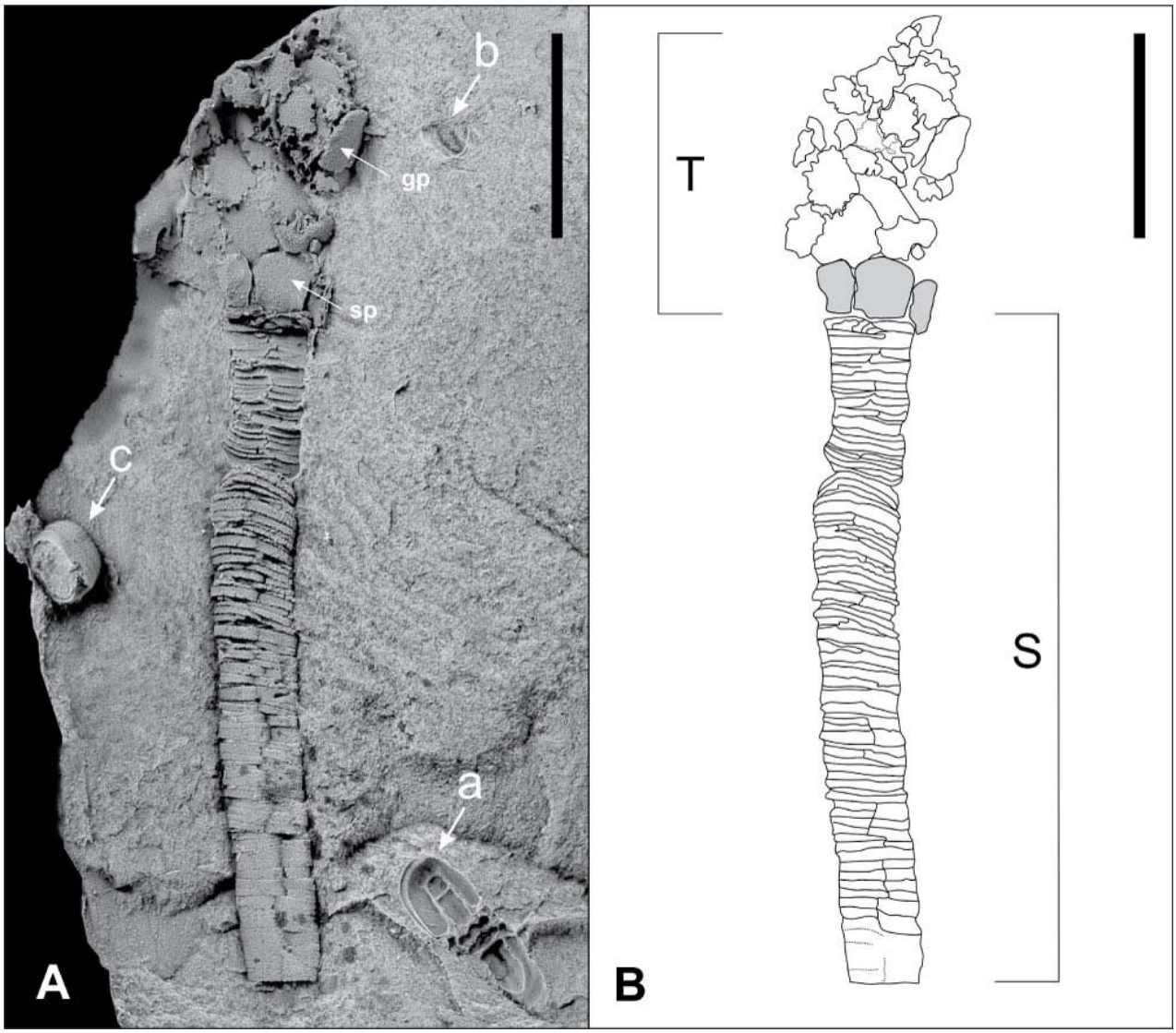

Figure 2: *Akadocrinus jani* PROKOP, 1962 (specimen L9052); Drumian, Jince Formation, Příbram–Jince Basin, exact locality and stratigraphical level unknown (= "Tige d'une Cystidée indéterminée" of BARRANDE, 1887). Scale bar 5 mm. **A** – Photograph of latex casts whitened with ammonium chloride. Abbreviations: sp – smooth internal surface of thecal plate, gp – external surface of thecal plate with fine granulation, a – holaspid agnostid *Peronopsis*, b – valve of the bradoriid *Konicekion*, c – part of the eocrinoid stem. **B** – Drawing of specimen L9052 made in CorelDraw X6 showing in grey color the most basal thecal plates. Abbreviations: T – theca, S – stem.

4. Systematic palaeontology

Phylum Echinodermata
BRUGIÈRE, 1791 (*ex* KLEIN, 1734)
Subphylum Blastozoa SPRINKLE, 1973
Class Eocrinoidea JAEKEL, 1918
Order Gogiida BROADHEAD, 1982
Family Eocrinidae JAEKEL, 1918

Akadocrinus PROKOP, 1962

Type species. *Akadocrinus jani* PROKOP, 1962. Jince Formation, *Hypagnostus parvifrons* Biozone, Drumian, Příbram–Jince Basin, Barrandian area, Czech Republic.

Occurrence. The genus *Akadocrinus* is known from three localities in the Příbram–Jince Basin; (1) the slope named Vinice (near Jince), (2) north-eastern slope of Vystrkov Hill near Jince, and (3) the Felbabka locality. All these localities are situated in the range from the *Paradoxides* (*E.*) *pusillus* through the *Paradoxides* (*P.*) *paradoxissimus gracilis* biozones of FATKA & SZABAD (2014a), from the latest Cambrian Stage 5 into the Drumian in age (Fig. 1.D).

Remarks. The endemic eocrinoid genus *Akadocrinus* includes two separate species: *A. jani* PROKOP, 1962, and *A. knizeki* FATKA & KORDULE, 1991, both known from the middle part of the Jince Formation (FATKA *et al.*, 2004). The species

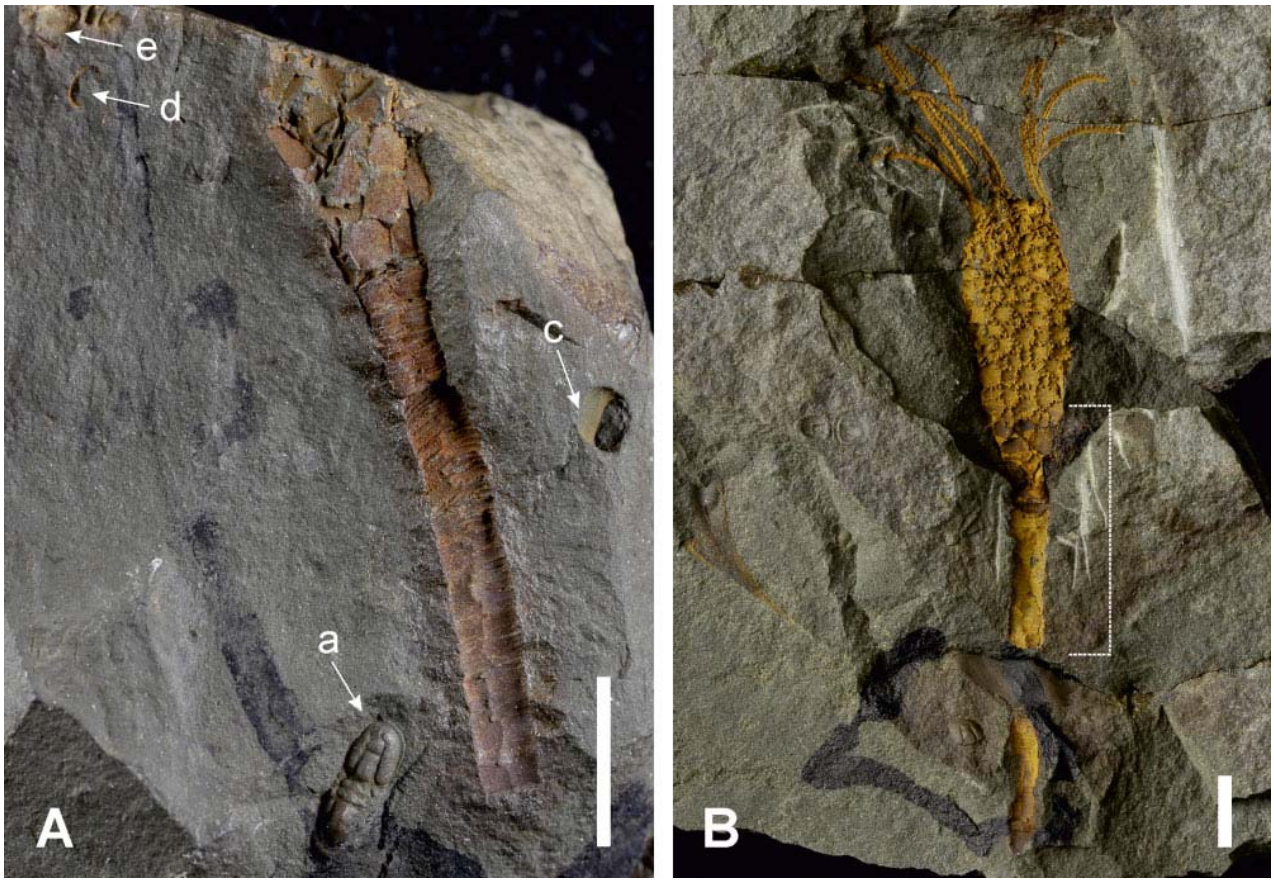

Figure 3: Photographs of external moulds. Scale bar 5 mm. **A** – *Akadocrinus jani* PROKOP, 1962 (specimen L9052) (= "Tige d'une Cystidée indéterminée" of BARRANDE, 1887). Abbreviations: a – holaspid specimen of the agnostid *Peronopsis*, c – part of the eocrinoid stem, d – cross-section of an isolated eocrinoid columnal, e – indeterminable echinoderm plate. **B** – Well preserved specimen of *Akadocrinus jani* PROKOP, 1962 (specimen L42231); Drumian, Jince Formation, Příbram–Jince Basin, slope Vinice near Jince. Dashed line represents preserved part of the specimen L9052.

A. nuntius PROKOP, 1962, is considered to be synonymous with the type species *A. jani* PROKOP, 1962 (SPRINKLE, 1973, p. 106; NOHEJLOVÁ & FATKA, 2016, p. 142).

Akadocrinus jani PROKOP, 1962
(Figs. 2-3)

1887 "Tige d'une Cystidée indéterminée"; BARRANDE, p. 189, pl. 2, fig. 33.
(full synonymy see NOHEJLOVÁ & FATKA, 2016, p. 143-144)

Material. The type specimen housed in the National Museum Prague under number L9052; exact locality unknown.

Description. The rock slab measures 34.2 x 22.8 mm; its thickness ranges around 14 mm. On the slab, few complete and incomplete fossils are seen; only the largest remnant was described and figured by BARRANDE (1887). It is 23 mm long and from three to five mm wide, an incompletely preserved fossil composed of two distinct parts, (1) a longer and narrower, transversally segmented and well-articulated section (S in Fig. 2.B) around 16.7 mm in length, and (2) a shorter and wider, bottle-shaped section composed of more than twenty irregularly polygonal plates, which are slightly disarticulated. Almost all these plates (except the plates nearest to the narrow section) show distinctive undulate margins. Nearly all plates with straight margins show a smooth surface (sp in Fig. 2.A), while plates with distinctive undulate margins bear fine granulation (gp in Fig. 2.A). All well-preserved plates have quite similar dimensions; average sizes range around 1.51 mm in diameter.

Remark. On the rock surface, five other skeletal remains are preserved; they represent a cross-section of an isolated eocrinoid columnal (d in Fig. 3.A), a broken part of an eocrinoid stem (c in Figs. 2.A & 3.A), an indeterminable echinoderm plate (e in Fig. 3.A), an isolated valve of a tiny bradoriid arthropod *Konicekion* (b in Fig. 2.A), and an articulated prone exoskeleton of a holaspid agnostid *Peronopsis* (a in Figs. 2.A & 3.A).

Discussion. The morphology and dimension of the partially preserved fossil agrees well with an incomplete medial part of an eocrinoid echinoderm (Fig. 3.B). The wider section composed of

slightly disarticulated polygonal plates we interpret here as the distal part of the theca (T in Fig. 2.B). Almost all thecal plates, except the most-basal, bear roundish to ellipsoidal epispires, bounded by a low rim. The narrower, transversally segmented section we assign to partially preserved proximal part of stem, composed of well-articulated columnals (S in Fig. 2.B). BARRANDE's preserved echinoderm remnant is consistent with the morphology of the eocrinoid echinoderm *Akadocrinus* PROKOP, 1962 (Fig. 3.B). Mature specimens of *Akadocrinus* have thecal plates, around 1.69 mm in largest surface dimension, which is only slightly larger than the diameter of plates in BARRANDE's specimen.

Similar also is the length of the stem fragment; in mature specimens of *A. jani*, the length of observed parts of the stem is quite variable. Although we do not have a specimen with a complete stem at our disposal, preserved remains of stems are usually more than 20 mm long (see NOHEJLOVÁ & FATKA, 2016). This preserved part is only slightly shorter, composed of several tens of low columnals; their heights range around 0.16 mm.

5. Conclusions

The specimen classified by BARRANDE (1887) as *"Tige d'une Cystidée indéterminée"* belongs to the proximal part of stem associated with the basal part of the theca of an eocrinoid *Akadocrinus jani* PROKOP, 1962. The presence of irregularly shaped marginal epispires in most thecal plates assigns this specimen to the epispire-bearing phase in eocrinoid ontogeny (see NOHEJLOVÁ & FATKA, 2016).

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