



CAMBRIAN HYOLITHS OF THE PŘÍBRAM-JINCE BASIN (BARRANDIAN AREA, THE CZECH REPUBLIC): A REVIEW OF RECORDED TAXA

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Abstract: Hyoliths recorded from the middle Cambrian Jince Formation of the Barrandian area in the Czech Republic are reviewed and listed, based on various published papers printed since 1854. Up to now, only five species of hyolithids and three species of orthothecids have been reported, classified within seven genera. The reported material was collected from more than twenty small occasional outcrops and/or sections measuring up to several tens of meters in thickness, all situated exclusively in the area between the villages Felbabka and Čenkov in the Litavka River Valley. From the Paseky Shale member of the Holšiny-Hořice Formation at the Medalův mlýn locality, the first hyolith classified as “Hyolith genus and species indeterminate” is described. The new study of two specimens described and figured by Barrande in 1867 as *Hyolithes primus* made it possible to classify them as *Jincelites vogeli* and *Jincelites* sp. respectively.

Key words: Cambrian, Hyolitha, Jince Formation, Paseky Shale, Příbram-Jince Basin

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Introduction

Cambrian sediments of the Barrandian area are globally renowned as a classical repository of well-preserved skeletal marine fauna (e.g. Geyer et al. 2008). The richly fossiliferous shales and greywackes with spatially restricted sandstone and conglomerate bodies are assigned to the middle Cambrian Buchava Formation in the Skryje-Týřovice Basin, and to the Jince Formation in the Příbram-Jince Basin (Text-fig. 1b). From both these units, abundant and exceptionally diverse hyoliths (both hyolithids and orthothecids) were described by Barrande (1867), Marek (1972, 1975, 1980, 1981, 1983), Valent (2004, 2006), Valent et al. (2009, 2011, 2013, 2015, 2019). At several outcrops situated in numerous stratigraphic levels of both formations, articulated orthothecids with operculum preserved inside of conch as well as hyolithids with conch, operculum and rarely also with helens have been identified (e.g. Martí Mus and Bergström 2005, 2007, Valent et al. 2009, 2012).

The purpose of the present paper is (1) to review all earlier published data on hyolithids and orthothecids from the Jince Formation, and (2) to describe the first hyolith specimen from the Paseky Shale member of the Holšiny-Hořice Formation, which represents the oldest record

of hyoliths in the Barrandian area. The history of hyolith research in the Buchava Formation of the Skryje-Týřovice Basin is much more complex and will be published at some future date.

Geological setting

Extensive outcrops of unmetamorphosed Cambrian sediments and volcanics are known in the Barrandian area, including the Příbram-Jince Basin (Text-fig. 1b). The first stratigraphic scheme was proposed by Barrande (1846, 1852). In this concept, all Palaeozoic sediments were included in the “Silurian System”. The stratigraphically oldest fossiliferous levels named étage C contained “faune primordiale” (= fossils of the Cambrian Series 3 in the current terminology). The Cambrian age of étage C was first recognized by Marr (1880), while the overlying rocks of the étage D to H were included in Ordovician, Silurian and Devonian periods (see Chlupáč 1999b). The proper delimitation of the Cambrian was recognized by Pošepný (1888), who included the underlying non-fossiliferous sequence of conglomerates, classified in Barrande’s scheme in étage B. The current lithostratigraphic framework used

for the Cambrian sequence of the Příbram-Jince Basin has been developed during more than 160 years of continuous research (for earlier reviews see Havlíček 1971, 1998, Chlupáč 1999b, Geyer et al. 2008 and Fatka and Szabad 2014a), and includes nine members grouped in eight formations (Text-fig. 2). Skeletal fossils associated with organic-walled microfossils, rare non-mineralized fossils and ichnofossils have been recorded in two levels, in the Paseky Shale member of the Holšiny-Hořice Formation and in the Jince Formation (Text-fig. 2).

Paseky Shale member

The name “Pasecké břidlice” (= Paseky Shale in the recent English terminology) has been proposed by Havlíček (1950), with the stratotype locality in a small quarry near Medalův mlýn.

Shales and greywackes of the Paseky Shale are known from several natural outcrops and excavations (Chlupáč et al. 1996). The history of research and contained fossils were summarized by Chlupáč et al. (1996), Fatka et al. (2004) and Lamsdell et al. (2013). The apparent absence of the large part of invertebrate groups that normally characterise Cambrian faunas (e.g. trilobites, echinoderms and brachiopods) in the Paseky Shale is not easy to explain; one of possibilities could be a marginal setting corresponding to non-marine to restricted marine conditions (see Park and Gierlowski-Kordesch 2007). The fossils of the Paseky Shale were assigned to the *Kodymirus* Association by Fatka and Szabad (2014a: 414).

Jince Formation

The name “Ginetzer Schichten” (= Jince Formation in the present terminology) was first used by Lipold and Krejčí (1860). Its stratotype locality is the section at the slope Vinice near Jince (Text-fig. 1c). The Jince Formation corresponds to the unnamed Series 3 of the Cambrian System, particularly to the higher levels of the Miaolingian and Drumian stages (Fatka et al. 2014, 2015). The development of biostratigraphic schemes of the Jince Formation was reviewed by Fatka and Szabad (2014a), who proposed a modified subdivision with twelve biozones (Text-fig. 3).

The fossil associations include usually abundant remains of brachiopods, trilobites, agnostids, echinoderms, hyoliths, palynomorphs and ichnofossils associated with occasional occurrences of sponge spicules, bivalved arthropods, molluscs, sphenothallids and foraminifers, and rare, poorly biomimeticized and/or soft bodied Burgess Shale-type fauna (summary in Fatka et al. 2004).

Conical fossils

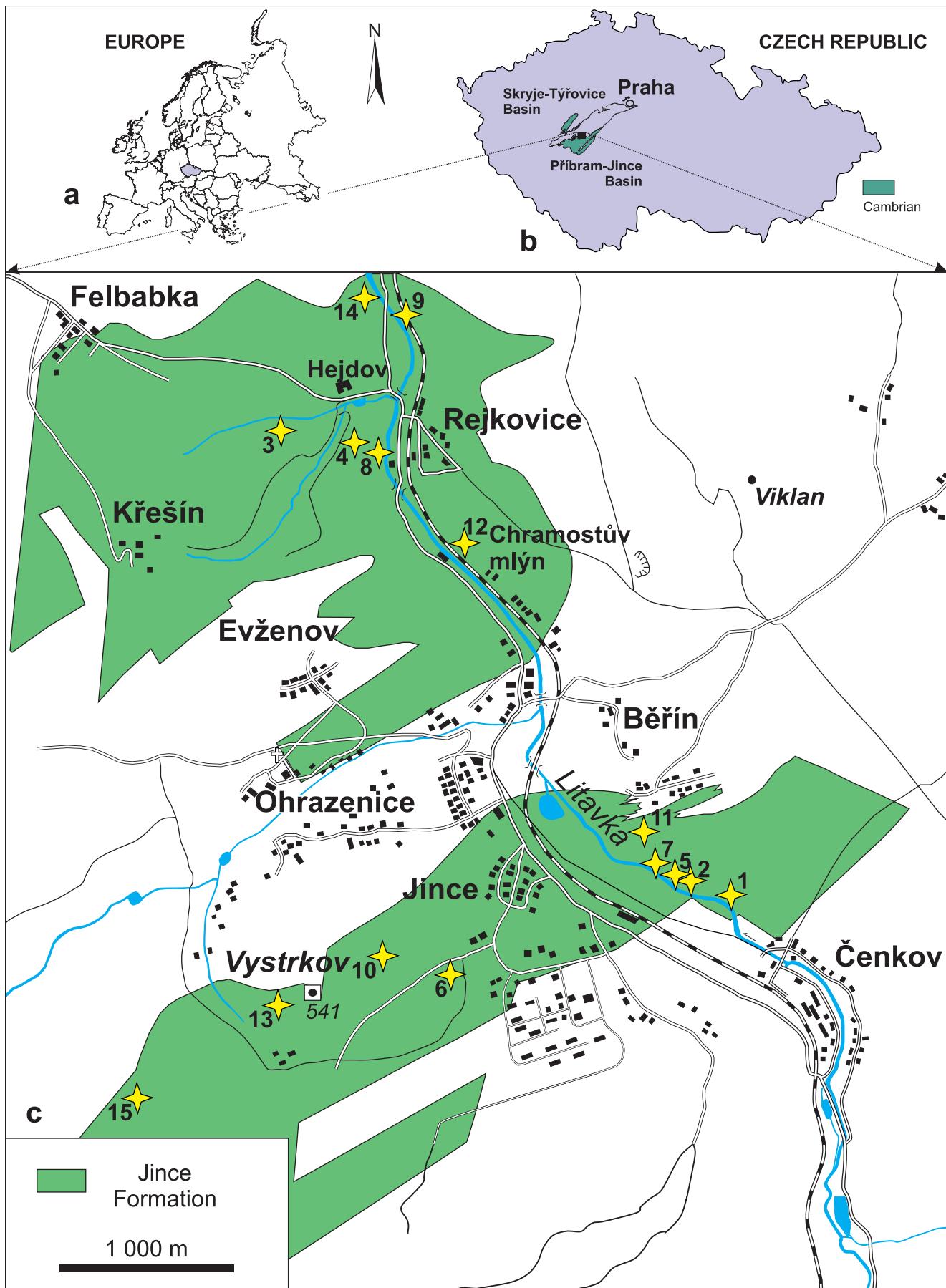
Finds of non-mineralized and mineralized tubular and conical fossils are common in the Jince Formation. Rare specimens showing longitudinal thickenings, elliptical cross-sections and flexible organo-phosphatic tubes belong to sphenothallids (Fatka et al. 2012); other specimens bearing apparent segmentation of wall are tentatively assigned to priapulids (Fatka et al. unpublished data). However, large part of conical conchs shows originally mineralized elements like operculum, and occasionally helens; such specimens are classified within the orders Hyolithida SYSOEV, 1957 and

Orthothecida MAREK, 1966 (see below). About 15 hyolith species are known from the Jince Formation, but only a small part of taxa was formally described (Barrande 1867, Marek 1972, 1983, Valent et al. 2009, 2018, Fatka and Valent unpublished observation).

History of research of hyoliths

From the Příbram-Jince Basin, Barrande (1867: 88, pl. 11, figs 26–28) described and figured only two specimens of the hyolithid species, *Hyolithes primus* (Text-fig. 4a). However, the name of the Cambrian hyolith species *Pugiunculus primus* was preliminarily used at least four times. Krejčí (1854: 67) named *Pugiunculus primus* as the only known pteropod established in sediments at Skryje and Jince. *Pugiunculus primus* is mentioned by Barrande (1852: 66a) as the only hyolith species known from Cambrian sediments in central Bohemia. Barrande (1856: 43) reports *Pugiunculus primus* as a taxon occurring in “Faune primordiale” (= Cambrian) of Bohemia, and an unknown author (Anonymous 1858: 303) mentioned the occurrence of the pteropod *Pugiunculus primus* BARRANDE in the “primordial zone of life” in Bohemia. From Jince, Krejčí (1860: 467) listed one species of pteropods, without providing a species name. Barrande (1863: 480) named *Pugiunculus primus* as a species known solely from Bohemia. Krejčí (1877: 393) reported *Hyolithes* (*Pugiunculus*) *primus* from the Jince area, while Novák (1891), surprisingly, did not provide any information about hyoliths from the Příbram-Jince Basin. In a brief discussion of *Hyolithes primus*, Pompeckj (1896: 517) made the important remark, that the Barrande’s specimens of this species from Jince are shorter in length and transversally wider, and is similar to the species *Hyolithes signatus* NOVÁK. The other two original specimens of Barrande (1867: pl. 11, figs 26–28) are also housed in the National Museum, Prague, and are the only Barrande’s specimens classified as *Hyolithes primus* from the Příbram-Jince Basin. The rock sample of one of them bears the locality name “Ginetz” (Text-figs 5c, 6a; NM-L 46562). Both these specimens from the Jince Formation were classified as “*Hyolithes*” sp. n. by Marek (1975: 67). We assign these two specimens to *Jincelites vogeli* VALENT et al., 2009 and *Jincelites* sp. respectively (see discussion herein in the systematic part).

Krejčí and Feistmantel (1885: 22) reported five species of pteropods from the Jince area. All the species are classified within the genus *Hyolithes*. However, the authors did not name any species in their table on page 120. Želízko (1897: 323, 324) reported a rare occurrence of two taxa, *Hyolithes primus* BARR. and *Hyolithes* sp. from the Chramosta Mühle (= Chramostův mlýn; locality 12 in Text-fig. 1c) and from the Vysrkov Hill near Jince (locality 10 in Text-fig. 1c; Text-fig. 4b); both these taxa occur together with other skeletal fauna apparently belonging to the shales with *Agnostus integer* (compare Text-fig. 3a). This information was once more published by Želízko (1911: 1) who, however, spelled these taxa as *Hyolithus primus* BARR. and *Hyolithus* sp. (Text-fig. 4b). Šuf (1926: 132) mentioned the presence of *Hyolithes* sp. in three pits excavated at the southern and south-western slope of the Vysrkov Hill near the Jince (locality 6 in Text-fig. 1c). The associated fauna



belongs to layers **a** with *P. rugulosus*, upper levels of layers **b** with *Stromatocystites pentangularis* and to layers **c** with *Paradoxides boemicus* (locality 10 in Text-fig. 1c; compare Text-figs 3b, 4c). From the Rejkovice area, Šuf (1927: 121) reported the occurrence of two taxa, *Hyolithes boemicus* from layers **a** with *Paradoxides rugulosus* (locality 4 in Text-fig. 1c; compare Text-figs 3b, 4d) and *Hyolithes* sp. from layers **d** with *Ellipsocephalus Hoffi* (locality 14 in Text-fig. 1c; compare Text-figs 3b, 4d). Identical species with the same stratigraphic range were also reported in the next report of Šuf (1928: 131; compare Text-fig. 3b, 4d) from the slope Vinice near Jince. However, no hyolith species named *Hyolithes boemicus* was ever described as a separate species (see Sinclair 1946).

Bouček (1941: 183, 1951: 209) mentioned *Hyolithus* sp. in the *Paradoxides boemicus* Zone at the southern slope of the Vystrkov Hill (locality 10 in Text-fig. 1c; compare Text-figs 3c, 4e). Prantl (1942: 272) mentioned the presence of *Hyolithus maximus*, a large species described later by Marek (1972) as *Maxilites snajdri* MAREK, 1972 (Text-fig. 4f). However, the exact stratigraphic level and outcrop from which the Prantl's material came is not known; the genus *Maxilites* MAREK, 1972 ranges from the *Acadolenus snajdri* to the *Paradoxides (Eccaparadoxides) pusillus* biozones at the slope Vince Hill near Jince (Text-fig. 4i).

From the *Paradoxides rugulosus* Zone, Havlíček and Šnajdr (1951: 45) reported the presence of four hyolith taxa, particularly *Hyolithus primus* (= *Buchavalites primus* (BARRANDE, 1867) = *Jincelites vogeli*), *Hyolithus boemicus*, *Hyolithus signatus* (classified by Marek (1980) as the type species of the genus *Slapylites* MAREK, 1980), and *Hyolithus parens* (= *Parentilites parens* (BARRANDE, 1867)) (Text-figs 3d, 4g). In comparison, Havlíček and Šnajdr (1951: 185, 188) mentioned the occurrence of *Hyolithus* sp. from the *Stromatocystites pentangularis* Zone and *Ellipsocephalus hoffi* Subzone near Rejkovice (localities 9, 14 in Text-fig. 1c; compare Text-figs 3d, 4g), and *Hyolithus boemicus* was reported from the last named biozone, also from the Vystrkov Hill near Jince (locality 10 in Text-fig. 1c; compare Text-figs 3d, 4g). However, the species *H. boemicus* was never described (see above), while the other three named

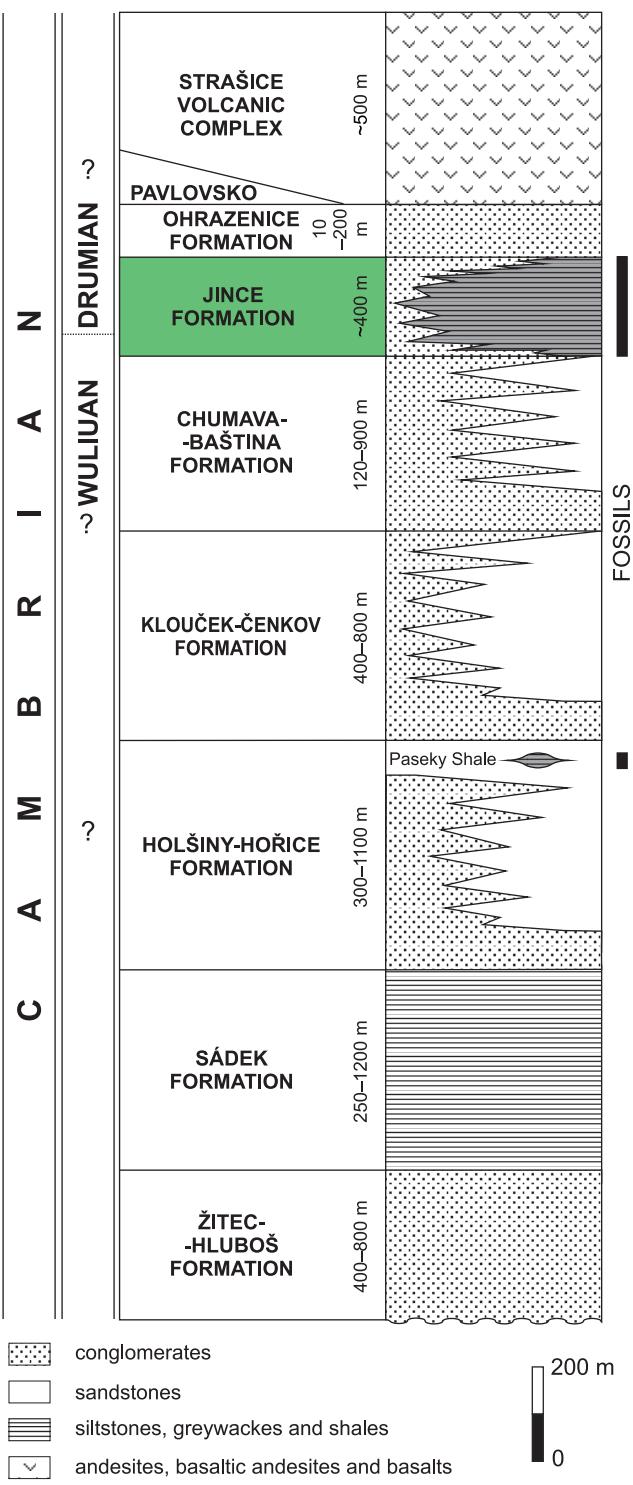
species have been known exclusively from sediments of the Skryje-Týřovice Basin (Marek 1975, 1980, 1981).

Havlíček et al. (1958: 23) listed the presence of *Hyolithus signatus* (= *Slapylites signatus* (NOVÁK, 1891)) (Text-fig. 4g). Prokop (1960: 42) mentioned the occurrence of hyoliths in two different stratigraphic levels. Several specimens collected from the *Paradoxides gracilis* Zone at the Vystrkov Hill (locality 13 in Text-fig. 1c; compare Text-figs 3d, 4h) were designated as hyoliths belonging to several species. It is not, however, possible to assign them to any of the pre-described species. One specimen from lower levels of the *Hydrocephalus lyelli* Zone (*Ellipsocephalus hoffi* Subzone) at the Koníček Hill most probably belongs to the abundant species *Jincelites vogeli* (locality 15 in Text-fig. 1c; compare Text-figs 3d, 4h).

Marek (1972: 72, pl. 2, figs 4, 5) described *Maxilites snajdri* MAREK, 1972 from the *Eccaparadoxides pusillus* Zone at the slope Vinice near Jince (locality 5 in Text-fig. 1c; compare Text-figs 3d, 4i). Marek (1975: 67) designated *H. primus* as the type species of his new genus *Buchavalites* MAREK, 1975 and selected the specimen figured by Barrande (1867: pl. 10, fig. 2) as the lectotype of *Buchavalites primus* (BARRANDE, 1867). This specimen is housed in the National Museum, Prague under the number NM-L 10065 and comes from the Skryje-Týřovice Basin. Based on the study of Marek (1975), both known species of this genus, *B. primus* and *B. pompeckji* MAREK, 1975 are restricted to the Buchava Formation of the Skryje-Týřovice Basin, and are absent in the Jince Formation of the Příbram-Jince Basin.

Fatka and Kordule (1980: 67) reported the occurrence of five hyolithid and orthothecid species in the middle part of the Jince Formation (Text-fig. 4j). Fatka and Kordule (1992: 50) mentioned *Hyolitha* div. gen. et sp. from diverse levels in the lower half of the Jince Formation, particularly from the *Acadolenus snajdri* to upper levels of the *Hypagnostus parvifrons* biozones (localities 2, 3, 5, 6, 8 in Text-fig. 1c; Text-fig. 4k). Chlupáč (1994, 1999a: 38) registered the occurrence of the class *Hyolitha*, but did not name any species. Havlíček (1998: 30) mentioned the occurrence of the genus *Maxilites* without providing any other information. Fatka and Kordule (2001: 189) reported the presence of *Hyolithes* sp. A and

Text-fig. 1. Location map. a – Sketch map of Europe showing the location of the Czech Republic. b – Location of the Příbram-Jince and Skryje-Týřovice basins within the Barrandian area. c – Location of outcrops. (1) foot of the slope Vinice near Jince, lowermost levels of the *Acadolenus snajdri* Biozone (= the locality no. 15 of Fatka and Kordule 1992; studied by Valent et al. 2018), (2) foot of the slope Vinice near Jince, uppermost levels of the *Acadolenus snajdri* Biozone, about 80 cm under the base of the *Paradoxides (Eccaparadoxides) pusillus* Biozone (= the locality no. 16 of Fatka and Kordule 1992; studied by Šuf 1927 and Valent et al. 2018), (3) Rejkovice – Potůček locality, lower levels of the *P. (E.) pusillus* (= the locality No. 12 of Fatka and Kordule 1992; studied by Valent et al. 2018), (4) Rejkovice “ve žlutých” locality (= the locality no. 11 of Fatka and Kordule 1992; studied by Fatka and Kordule 1992 and Fatka and Szabad 2014b), (5) slope Vinice near Jince, outcrop behind the house of Baborský, upper levels of the *P. (E.) pusillus* and lower part of the *Onymagnostus hybridus* biozones (= the locality no. 19 of Fatka and Kordule 1992; studied by Fatka and Szabad 2014b), (6) slope of the Vystrkov Hill, obalovna locality, lower levels of the *Hypagnostus parvifrons* Biozone (studied by Fatka et al. 2009), (7) foot of the slope Vinice near Jince, middle levels of the *Hypagnostus parvifrons* Biozone (= the locality no. 20 of Fatka and Kordule 1992; studied by Valent et al. 2018), (8) left bank of the Litavka River near Rejkovice (studied by Havlíček and Šnajdr 1951), (9) *Stromatocystites pentangularis* Zone of Šnajdr (1958) to *P. (P.) paradoxissimus gracilis* and *Ellipsocephalus hoffi* biozones at the railway cutting near the Rejkovice railway station (studied by Havlíček and Šnajdr 1951), (10) Vystrkov Hill, *P. (P.) paradoxissimus gracilis* Biozone (studied by Želízko 1897, 1911 and Šuf 1926), (11) slope Vinice near Jince, *P. (P.) paradoxissimus gracilis* Biozone (studied probably by Barrande 1867), (12) Chramosta Mühle (= Chramostuv mlýn), *Paradoxides (Paradoxides) paradoxissimus gracilis* Biozone (studied by Želízko 1897), (13) Vystrkov Hill, *Ellipsocephalus hoffi* Biozone (studied by Šuf 1927), (14) *Ellipsocephalus hoffi* Subzone near Rejkovice (studied by Havlíček and Šnajdr 1951), (15) *Ellipsocephalus hoffi* Subzone at the Koníček Hill (studied by Prokop 1960). Geology according to Havlíček (1971).



Text-fig. 2. Lithostratigraphy of Cambrian rocks in the Příbram-Jince Basin with two fossiliferous levels: the Paseky Shale member and the Jince Formation (adapted from Havlíček 1971 and Geyer et al. 2008).

Hyolithes sp. B in middle levels of the *Acadolenus snajdri* Biozone (Text-fig. 4l). Fatka et al. (2004: 379) plotted the occurrence of six forms classified as *Maxilites snajdri*, *Hyolithes* sp. A and *Hyolithes* sp. B, *Buchavalites primus* (= *Jincelites vogeli*) VALENT et al., 2009), *Orthotheca* sp. A and *Orthotheca* sp. B (= *Gracilitheca triangularis*) VALENT et al., 2013) (Text-fig. 4m).

Valent (2006: 184) recorded the presence of four hyolithids, particularly of *Hyolithes* sp. A, and *Hyolithes* sp.

B, *Maxilites snajdri*, *Buchavalites primus* (= *Jincelites vogeli*), and two orthothecids, *Orthotheca* sp. A, and *Orthotheca* sp. B (= *Gracilitheca triangularis*) in the Jince Formation (Text-fig. 4n). Valent et al. (2009) described a small, long ranging and at some outcrops very abundant hyolithid *Jincelites vogeli* VALENT et al., 2009 (localities 9, 11, 13, 15 in Text-fig. 1c; Text-fig. 4o). Fatka et al. (2009) and Fatka and Kozák (2014) figured and described articulated specimens of the agnostid *Peronopsis integra* entombed inside isolated conchs of two hyolithids *Buchavalites* sp. and *Jincelites vogeli*, respectively (locality 6 in Text-fig. 1c; Text-fig. 4p). Fatka and Budil (2010: 39, 2012: 8) reported the occurrence of *Maxilites* and *Jincelites*, without providing information on their geographic or stratigraphic distribution (Text-fig. 4q). Schematic drawings of hyolithids and orthothecids were published by Fatka and Budil (2010: 49, figs 4, 5; 2011: fig. 10/4, 5). Fatka and Szabad (2014b: 162) made reference to orthothecid hyoliths and hyolithid hyoliths from the slope Vinice near Jince, an outcrop behind the house of Baborský (locality 19 in Fatka and Kordule 1992; locality 5 in Text-fig. 1c), and reported the occurrence of *Maxilites snajdri* from the Rejkovice “ve žlutých” locality (locality 11 in Fatka and Kordule 1992; locality 4 in Text-fig. 1c; Text-fig. 4r). Valent et al. (2015: 420) mentioned briefly the occurrence of five taxa, particularly of *Buchavalites primus* (= *Jincelites vogeli*) VALENT et al., 2009), *Jincelites vogeli*, *Maxilites snajdri*, *Hyolithes* sp. A and *Hyolithes* sp. B; stratigraphic range and geographic distribution were not provided for any of these taxa. Recently, Valent et al. (2018) documented hyoliths from the lower stratigraphic levels at the slope Vinice near Jince, and at the Rejkovice – Potůček locality (locality 3 in Text-fig. 1c). This association includes three hyolithid and three orthothecid taxa, particularly *Oboedalites oboediens* MAREK, 1981, *Maxilites* sp., *Slehoferites slehoferi* MAREK in VALENT et al., 2011, *Circotheca* sp., *Gracilitheca triangularis* VALENT et al., 2013 and *Probactrotheca briketa* MAREK in VALENT et al., 2012 (localities 1, 2, 3, 7 in Text-fig. 1c; Text-fig. 4s).

Stratigraphic distribution and localities

It is not known from which outcrops the specimens studied by majority of the earlier authors were collected (Krejčí 1854, 1860, 1877, Barrande 1856, 1863, 1867, Krejčí and Feistmantel 1885, Prantl 1942). However, some of the original rock samples housed in the National Museum, Prague bear remains of other fossils, and thus the origin of such samples could be determined or at least estimated. That is the case of the two samples studied and figured by Barrande (1867: pl. 11, figs 26–27). The samples contain remains of agnostids, trilobites and echinoderms, which are typical for the middle part of the Jince Formation, particularly for the *P. (P.) paradoxissimus gracilis* Biozone. In the 19th century, fossils were collected at the slope Vinice near Jince, and diverse outcrops at slopes of the Vystrov Hill (see Chlupáč 1999b, Fatka and Szabad 2014a). Similarly, the exact outcrop and stratigraphic level of *Maxilites* reported by Prantl (1942) is unknown. However, *Maxilites* has been recorded only in the lower third of the Jince Formation, in two sections, particularly in the area of the village Rejkovice and at the

ŽELÍZKO (1911)	ŠUF (1926-1928)	KETTNER & BOUČEK (1936)	ŠNAJDR (1958)	FATKA & SZABAD (2014a)
	layers e with <i>Lingulella Walcotti</i>	<i>Lingulella walcotti</i>	<i>Hydrocephalus lyelli</i>	<i>Lingulella matthewi</i>
shales with <i>Agnostus integer</i>	layers d with <i>Ellipsocephalus hoffi</i>	<i>Ellipsocephalus hoffi</i>		<i>Ellipsocephalus hoffi</i> - <i>P. (Rejkocephalus)</i> - <i>Lingulella</i>
quartzitic greywacke with common <i>Stromatocystites pentangularis</i>	layers c with <i>Paradoxides bohemicus</i>	<i>Paradoxides bohemicus</i>	<i>Paradoxides gracilis</i>	<i>Paradoxides (P.) paradoxissimus gracilis</i>
	layers b with <i>Stromatocystites pentangularis</i>	<i>Paradoxides spinosus</i> and <i>Stromatocystites pentangularis</i>	<i>Stromatocystites pentangularis</i>	<i>Hypagnostus parvifrons</i>
	layers a with <i>Paradoxides rugulosus</i>	<i>Paradoxides rugulosus</i>	<i>Eccaparadoxides pusillus</i>	<i>Onymagnostus hybridus</i>
				<i>Paradoxides (Eccaparadoxides) pusillus</i>
				<i>Litavkaspis rejkovicensis</i>
				<i>Acadolenus snajdri</i>
				<i>Westonia ? fatkai</i>
				<i>Sternbergaspis</i>

Text-fig. 3. Comparison of the biostratigraphic subdivisions of the Jince Formation published between 1911 and 2014. Adapted from Fatka and Szabad (2014a).

slope Vinice near Jince (localities 3 and 5 in Text-fig. 1c). With the exception of the end of the 19th century, and a short period of research by Šuf (1927), fossils were not collected in the Rejkovice area (Fatka et al. 2018). Consequently, it is possible to suppose that Prantl's information was based on material from the slope Vinice near Jince.

Stratigraphic distribution of hyolith taxa reported by other authors in 20th and 21st centuries is discussed above, in the chapter on the history of hyolith research, and is summarized in Text-fig. 4.

Systematic palaeontology

Class Hyolitha MAREK, 1963
Order Hyolithida SYSOEV, 1957
Family unknown

Genus *Jincelites* VALENT, FATKA, MICKA et SZABAD, 2009

Type species. *Jincelites vogeli* VALENT et al., 2009; middle Cambrian, Drumian Stage, *Paradoxides (Paradoxides) paradoxissimus gracilis* Biozone, Jince Formation, Příbram-Jince Basin, Barrandian area, the Czech Republic.

***Jincelites vogeli* VALENT, FATKA, MICKA et SZABAD, 2009**
Text-figs 5a, c, 6a

1867 *Hyolithes primus* BARR.; Barrande, pp. 88–89, pl. 11, fig. 26.
1975 “*Hyolithes*” sp. n.; Marek, p. 67.

Description. See Valent et al. (2009: 182–183).

Remarks. As discussed above, only four specimens were assigned to *Hyolithes primus* in the original contribution by Barrande (1867: pl. 10, figs 1, 2, from the Skryje-Týřovice Basin; pl. 11, figs 26–28, from the Příbram-Jince Basin). More than one hundred years later, one of the three specimens from the Skryje-Týřovice Basin (Barrande 1867: pl. 10, fig. 2; NM-L 10065; most probably collected

at the Buchava locality) was selected as the lectotype of the species *Hyolithes primus* BARRANDE, 1867 (see Marek 1975: 66–67, pl. 1, fig. 1). In the same paper, *H. primus* was designated as the type species of the newly defined genus *Buchavalites* MAREK, 1975. Barrande figured one specimen (1867: pl. 10, fig. 1), but this figure is based on two specimens (NM-L 22037 and NM-L 22038). All these specimens were assigned to *B. primus* by Marek (1975: 67). The other two Barrande's specimens (pl. 11, figs 26–28) from the locality “Ginetz” were excluded from the synonymy of *Buchavalites primus*, and were preliminarily classified as “*Hyolithes*” sp. n. by Marek (1975: 67). One of these two specimens (Barrande 1867: pl. 11, fig. 26; NM-L 46562; herein Text-fig. 5a) belongs to *Jincelites vogeli* VALENT et al., 2009. Although it lacks remains of the surface sculpture on both sides of the conch, the overall shape of the conch and the very characteristic morphology of both dorsal and ventral sides are sufficient for species determination.

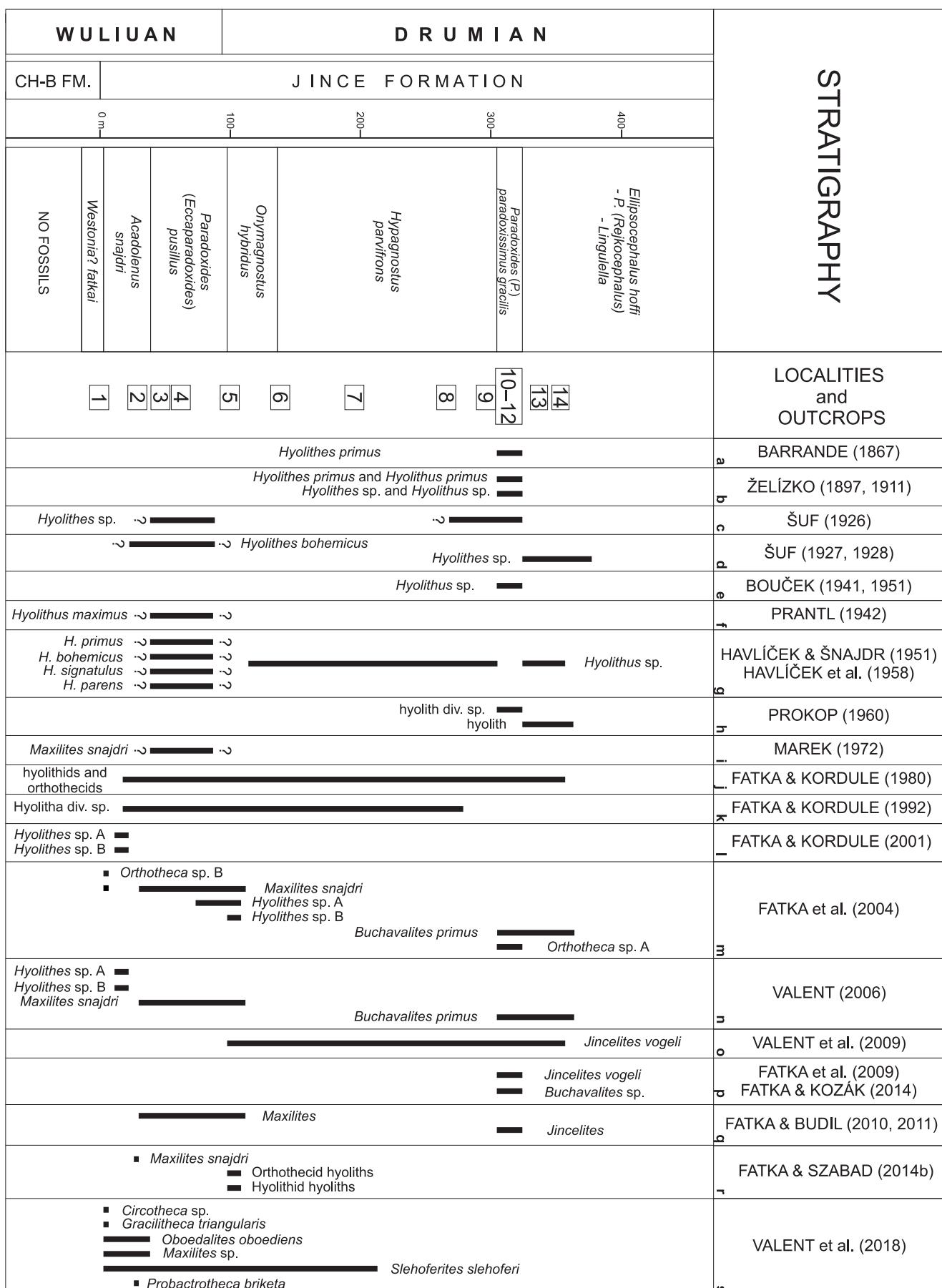
Locality. Wider surrounding of Jince, either the Vysrkov Hill near Jince (locality 10 in Text-fig. 1c), or the slope Vinice near Jince (locality 11 in Text-fig. 1c).

***Jincelites* sp.**
Text-figs 5b, d, 6b

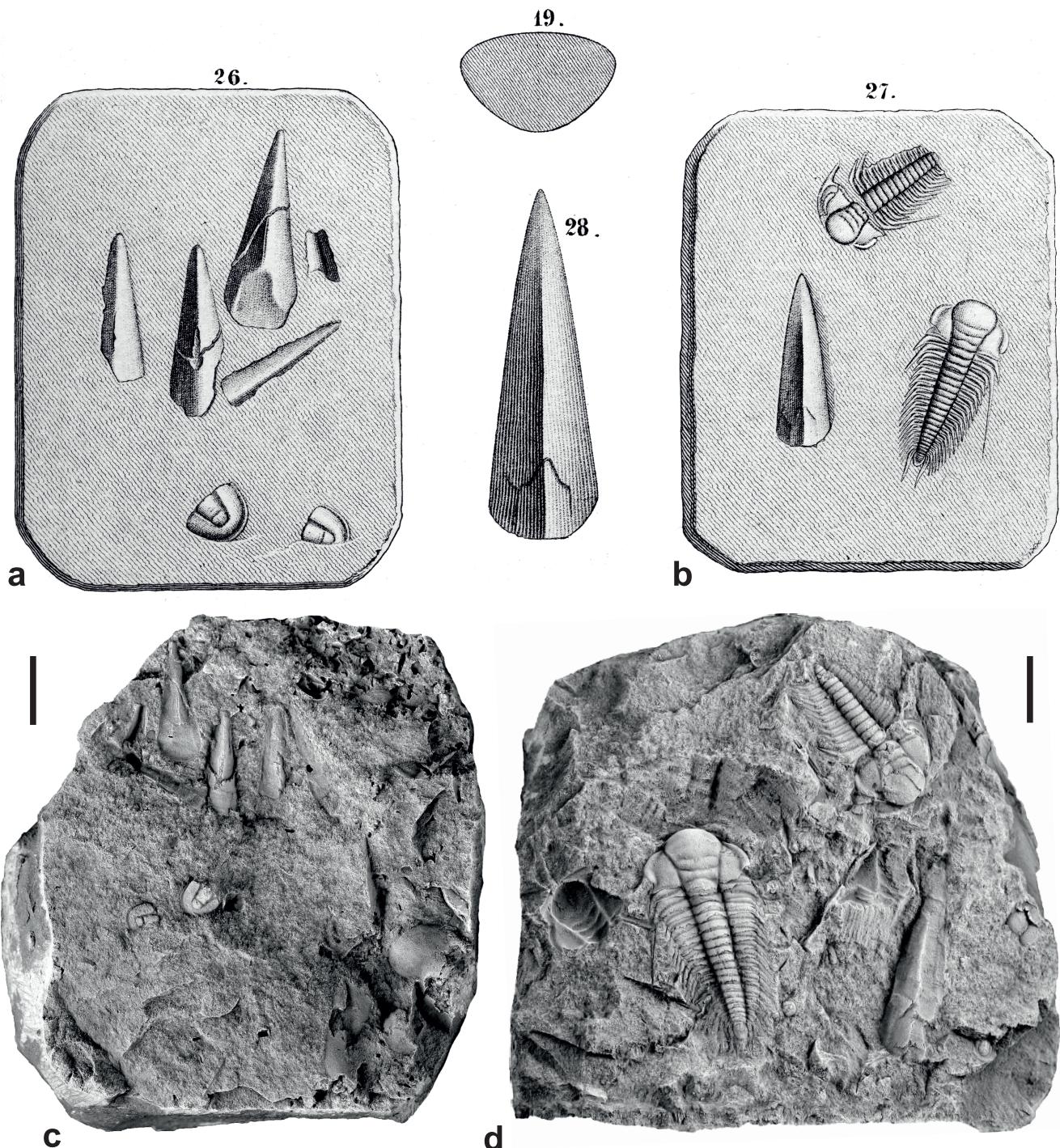
1867 *Hyolithes primus* BARR.; Barrande, pp. 88–89, pl. 11, figs 27–28.
non 1867 *Hyolithes primus* BARR.; Barrande, pl. 10, figs 1, 2, pl. 11, fig. 26.

Description. Hyolithid with a small orthoconic conch, an apical angle of about 20 degrees and a relatively short ligula. The sculpture of the ventral side is composed of fine, less distinct longitudinal elements. The operculum is not present.

Remarks. Also, the specimen figured by Barrande (1867: pl. 11, figs 27–28; NM-L 46563) was initially



Text-fig. 4. Stratigraphic ranges of hyoliths recorded by separate authors between 1867 and 2018. Biostratigraphy according to Farka and Szabad (2014a).



Text-fig. 5. Original figures published by Barrande (1867: pl. 10, figs 26–28) and photographs of surface of both rock samples. *Paradoxides (Paradoxides) paradoxissimus gracilis* Biozone, Jince Formation, the Příbram-Jince Basin, slope Vinice near Jince or slopes of the Vysrkov Hill near Jince. Both were originally determined as *Hyolithes primus*. a, c – *Jincelites vogeli* VALENT et al., 2009 (NM-L 46562); b, d – *Jincelites* sp. (NM-L 46563). Scale bar 5 mm.

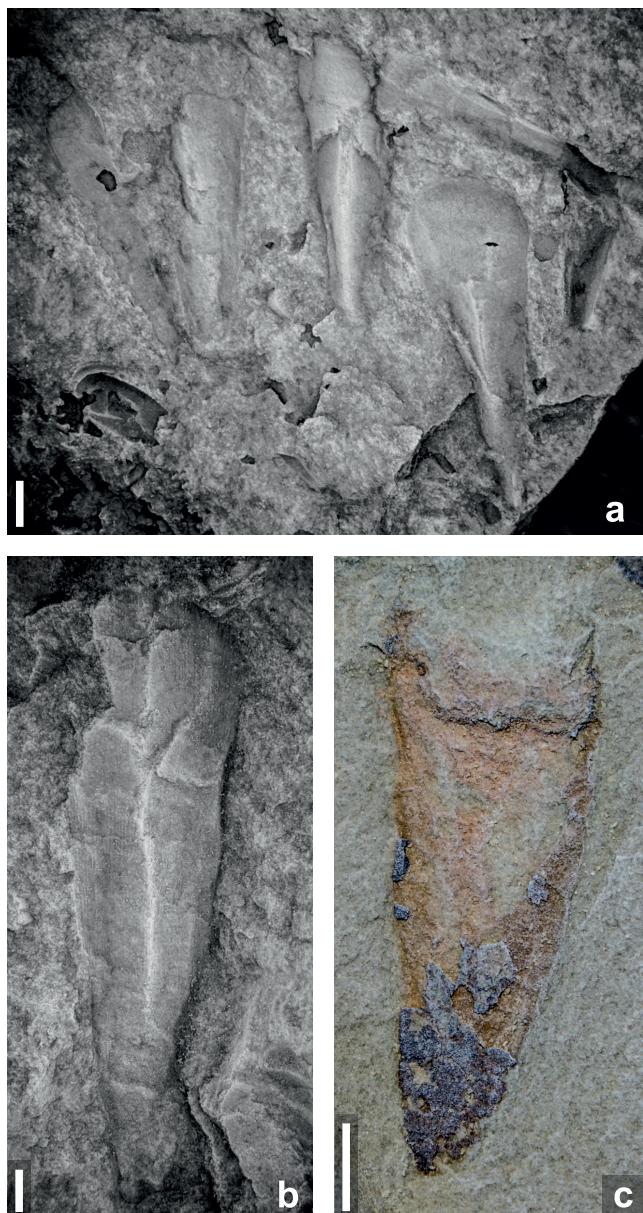
determined as *Hyolithes primus*. This specimen strongly resembles *Jincelites vogeli* VALENT et al., 2009 in the shape of its ventral side, but differs in the presence of longitudinal elements, which are absent in *J. vogeli*. The proper systematic position of *Jincelites* sp. is not possible to determine without a well-preserved conch sculpture or related operculum.

Locality. Jince, probably the slope Vinice near Jince or the Vysrkov Hill near Jince, *Paradoxides (Paradoxides) paradoxissimus gracilis* Biozone.

Hyolith genus and species indeterminate Text-fig. 6c

Description. Small hyolith with an orthoconic conch and an apical angle of around 18 degrees. The apertural region of the hyolith is not preserved. Surface sculpture and muscle scars not present in the specimen.

Remarks. The systematic position of this hyolith even at the order level remains unclear due to its incomplete and compressed preservation. The classification of this specimen



Text-fig. 6. a – *Jincelites vogeli* VALENT et al., 2009, detail of the specimen NM-L 46562 with six specimens showing ventral sides; b – *Jincelites* sp., almost complete venter with distinct longitudinal surface ornamentation; c – Hyolith genus and species indeterminate (NM-L 46891), Medalův mlýn. Scale bar 1 mm.

among hyoliths was made on the basis of the overall shape of the conch with apical angle similar to that of numerous other species, like *Jincelites vogeli* (see Valent et al. 2009).

Locality. Medalův mlýn locality (see Chlupáč et al. 1996, Fatka et al. 2004, Fatka and Szabad 2014a).

Conclusions

(1) The occurrence of hyolithids (“Hyolith genus and species indeterminate”) is for the first time reported from the Paseky Shale; they are interpreted to be deposited under marginal, non-marine to restricted marine conditions. The presence of “Hyolith genus and species indeterminate” indicates possible tolerance by hyolithids to such restricted marine conditions.

(2) Up to now, only five species of hyolithids and three species of orthothecids have been reported from the Příbram-Jince Basin. They are classified within eight genera:

- hyolithids: *Buchavalites* sp., *Jincelites vogeli* VALENT et al., 2009, *Maxilites snajdri* MAREK, 1972, *Maxilites* sp., *Oboedalites oboediens* MAREK, 1981, *Slehoferites slehoferi* MAREK in VALENT et al., 2011.
- orthothecids: *Circotheca* sp., *Gracilitheca triangularis* VALENT et al., 2013, *Probactrotheca briqueti* MAREK in VALENT et al., 2012 (see Appendix).

(3) The occurrence of two taxa mentioned by Havlíček and Šnajdr (1951) and Havlíček et al. (1958), *Parentilites parens* (BARRANDE, 1867) and *Slapylites signatus* (NOVÁK, 1891) remains questionable, because of lack of documentary material in institutional collections as well as absence of figures (see Appendix).

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Appendix

Synonymy of hyolith taxa documented in the Jince Formation of the Příbram-Jince Basin.

Buchavalites MAREK, 1975

Buchavalites sp.

- 2009 *Buchavalites* sp.; Fatka et al., p. 483, fig. 2.
2014 ? *Buchavalites* sp.; Fatka and Kozák, fig. 1.

Jincelites VALENT, FATKA, MICKA et SZABAD, 2009

Jincelites vogeli VALENT, FATKA, MICKA et SZABAD, 2009

- 1867 *Hyolithes primus* Barr.; Barrande, pp. 88–89, pl. 11, fig. 26.
1897 *Hyolithes primus* Barr.; Želízko, pp. 323, 324.
1911 *Hyolithus primus*; Želízko, p. 1.
1951 *Hyolithus primus*; Havlíček and Šnajdr, p. 45.
1975 “*Hyolithes*” sp. n.; Marek, p. 67.
2004 *Buchavalites primus*; Fatka et al., p. 379.
2006 *Buchavalites primus*; Valent, p. 184.
2009 *Jincelites vogeli*; Valent et al., pp. 182–183, figs 3, 4.
2009 *Jincelites vogeli*; Fatka et al., p. 483, fig. 2.
2010 *Jincelites*; Fatka and Budil, p. 39.
2012 *Jincelites*; Fatka and Budil, p. 8.
2015 *Jincelites vogeli*; Valent et al., p. 420.

Maxilites MAREK, 1972

Maxilites snajdri MAREK, 1972

- 1942 *Hyolithus maximus*; Prantl, p. 272
1972 *Maxilites snajdri*; Marek, p. 72, pl. 2, figs 4, 5
2004 *Maxilites snajdri*; Fatka et al., p. 379.
2006 *Maxilites snajdri*; Valent, p. 184.
2014b *Maxilites snajdri*; Fatka and Szabad, p. 162.
2015 *Maxilites snajdri*; Valent et al., p. 420.

Maxilites sp.

- 1998 *Maxilites*; Havlíček, p. 30.
2010 *Maxilites*; Fatka and Budil, p. 39.
2012 *Maxilites*; Fatka and Budil, p. 8.
2018 *Maxilites* sp.; Valent et al., p. 286, fig. 3G, M, N.

Oboedalites MAREK, 1981

Oboedalites oboediens MAREK, 1981

- 2018 *Oboedalites oboediens* Marek, 1981; Valent et al., p. 285.

Parentilites MAREK, 1981

Parentilites parens (BARRANDE, 1867)

- 1951 *Hyolithus parens*; Havlíček and Šnajdr, p. 45.

Slapylites MAREK, 1980

Slapylites signatulus (NOVÁK, 1891)

- 1951 *Hyolithus signatulus*; Havlíček and Šnajdr, p. 45.
1958 *Hyolithus signatulus*; Havlíček et al., p. 23.

Slehoferites MAREK in VALENT, FATKA, SZABAD et VOKÁČ, 2011

Slehoferites slehoferi MAREK in VALENT, FATKA, SZABAD et VOKÁČ, 2011

- 2018 *Slehoferites slehoferi* Marek in Valent et al., 2011; Valent et al., p. 285, fig. 3A, B, H.

Circotheca SYSOEV, 1958

emended Berg-Madsen and Malinky (1999)

Circotheca sp.

- 2018 *Circotheca* sp.; Valent et al., p. 288, fig. 3J.

Gracilitheca SYSOEV, 1968

Gracilitheca triangularis VALENT, FATKA et MAREK, 2013

- 2006 *Orthotheca* sp. B; Valent, p. 184.
2018 *Gracilitheca triangularis*; Valent et al., p. 288, fig. 3K.

Probactrotheca MAREK in VALENT, FATKA, SZABAD, MICKA et MAREK, 2012

Probactrotheca briketa MAREK in VALENT, FATKA, SZABAD, MICKA et MAREK, 2012

- 2018 *Probactrotheca briketa* Marek in Valent et al., 2012; Valent et al., p. 289, fig. 3L.

R e m a r k . Absence of documentary materials in institutional collections excludes the possibility to classify all other mentioned hyolith taxa.