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A first report of *Sphenothallus* Hall, 1847 in the Cambrian of Variscan Europe

Premier signalement de Sphenothallus *Hall, 1847 dans le Cambrien de l'Europe varisque*

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ABSTRACT

Ten specimens of two phosphatic fossils have been recently discovered in lower and middle portions of Middle Cambrian Jince Formation in the Czech Republic. They are attributed to the genus *Sphenothallus* Hall, 1847 and described as two separate species; comparatively small conchs are described as *S. kozaki* sp. nov., the much larger specimens characterized by its smooth and partly flexible organo-phosphatic walls of shell are determined as ?*S. kordulei* sp. nov. *Sphenothallus* is known to range from Cambrian to Permian and accommodates numerous species. However, its Cambrian distribution is considerably restricted. Generally rare specimens have been described from Lower to Middle Cambrian of Laurentia and from the Lower Cambrian of Gondwana and peri-Gondwana. The new record of *Sphenothallus* from the Jince Biota represents a notable extension of their geographic range.

Mots clés :
Sphenothallus
Cambrien moyen
Formation de Jince
République tchèque
Région de Teplá-Barrandian

RÉSUMÉ

Dix spécimens phosphatés appartenant à deux espèces ont été récemment découverts dans des sections inférieures et supérieures de la Formation de Jince dans le Cambrien moyen de République tchèque. Ils sont attribués au genre *Sphenothalhus* Hall, 1847 et décrits sous deux espèces distinctes ; les plus petites conques sont attribuées à *S. kozaki* sp. nov., les plus grandes, caractérisées par les parois lisses et partiellement flexibles de la coquille organo-phosphatée, sont attribuées à ?*S. kordulei* sp. nov. *Sphenothalhus* est connu du Cambrien au Permien et comprend de nombreuses espèces. Néanmoins, sa distribution au Cambrien est considérablement restreinte. Globalement, de rares spécimens ont été décrits dans le Cambrien inférieur et moyen de la Laurentia et dans le Cambrien inférieur du Gondwana et du péri-Gondwana. Ce nouvel enregistrement de *Sphenothallus* dans la faune de Jince représente une augmentation notable de leur extension géographique.

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1. Introduction

Organo-phosphatic tube-like fossils are relatively common components of the Palaeozoic skeletal fauna. Because of simple morphology, their biological affinity is usually uncertain and several genera have been proposed to accommodate these fossils, e.g. *Torellella* Holm, *Tubulella* Howell, *Byronia* Matthew and *Hyolithellus* Billings. Recently, many of these genera have been revised, including discussion of their possible biological affinities; *Torellella* – see Vinn (2006), *Byronia* – see Zhu et al. (2000), *Hyolithellus* – see Novozhilova (2010), Skovsted and Peel (2011). Some of these genera are supposed to be synonymous (see for example the discussion of *Sphenothallus* Hall by Zhu et al., 2000).

The purpose of the present article is to illustrate the first occurrence of conical phosphatic fossils in the Middle Cambrian Jince Formation of the Příbram-Jince Basin (Teplá-Barrandian region; Fig. 1). They are described as two new species of *Sphenothallus* Hall, 1847 – the small *S. kozaki* sp. nov. and the much larger ?*S. kordulei* sp. nov.

The genus *Sphenothallus* Hall, 1847 is a widespread Palaeozoic (Cambrian to Permian) marine taxon of problematical systematic position. It has been originally described as a marine plant by Hall (1847, p. 261); since the beginning of 20th century, it is usually classified as an invertebrate, either as a "worm" (Fauchald et al., 1986) or as a hydrozoan or scyphozoan cnidarian (e.g. Van Iten et al., 1992). Some other authors prefer to classify it as *incertae sedis* (e.g. Neal and Hannibal, 2000). *Sphenothallus* is characterized by more or less gently tapered, finely lamellar tubes with a pair of longitudinal thickenings developed near the open end of the tube and by a holdfast on the opposite end of the tube.

In the Barrandian area, *Sphenothallus* has been sporadically reported in faunal lists from the Ordovician, Silurian and Devonian of the Prague Basin. However, it has never been systematically investigated (Brabcová and Kraft, 2003, p. 265).

2. Jince formation

The Middle Cambrian Jince Formation of the Příbram-Jince Basin (Fig. 1) is globally renowned as a classical repository of well preserved and diverse skeletal fauna (e.g. Barrande, 1846, 1852; Šnajdr, 1958). Richly diversified associations of trilobites, agnostids, echinoderms, brachiopods, hyoliths, palynomorphs and ichnofossils associated with generally rare bivalved arthropods, molluscs and foraminifers have been studied for nearly two hundred years (summary see Fatka et al., 2004). Recently, rare specimens of poorly biomineralized and/or soft-bodied Burgess Shale-type fauna have been also described (e.g. Chlupáč and Kordule, 2002; Maletz et al., 2005; Mikuláš and Kordule, 1998; Mikuláš et al., in press).

2.1. Tubular and conical fossils

Diverse tubular and conical fossils are locally common at different stratigraphic levels of the Jince Formation.

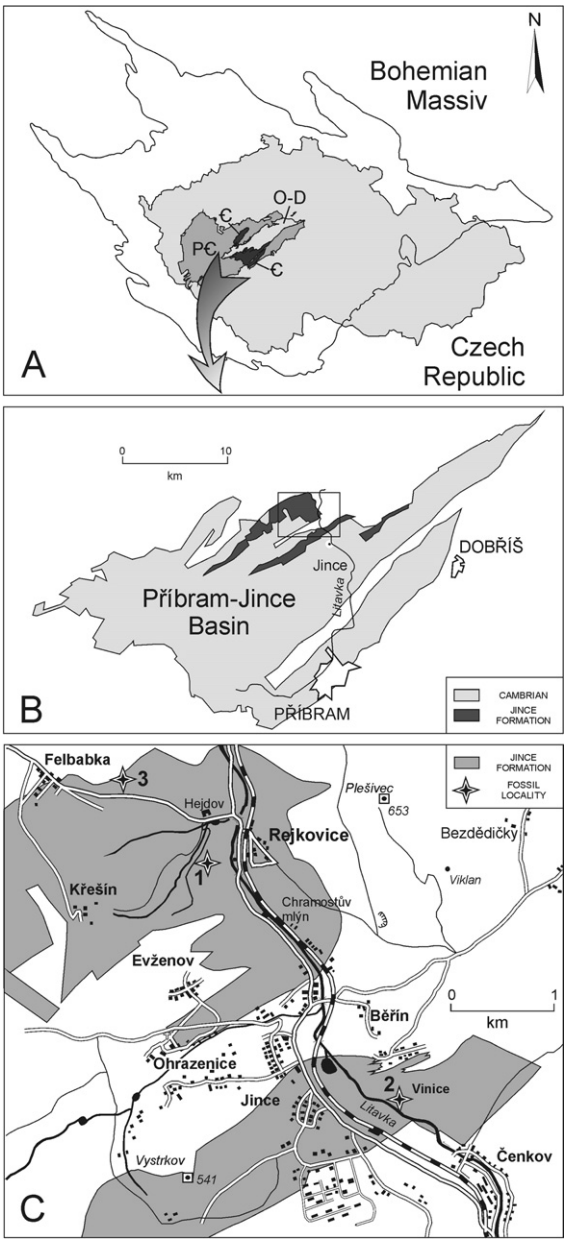


Fig. 1. Maps showing the location of the discovery site of the new material of *Sphenothallus*. A. Czech Republic and the Bohemian Massif with Precambrian, Cambrian, Ordovician, Silurian and Devonian rocks of the Teplá-Barrandian region. B. Cambrian of the Příbram-Jince Basin. C. Detail of the discovery area showing the distribution of the Middle Cambrian Jince Formation and the three localities: 1: Rejkovice–"ve žlutých" locality, 2: slope Vinice near Jince locality, 3: Felbabka–Ostrý vrch Hill locality (geology modified from Havlíček, 1971).

Fig. 1. Cartes indiquant la localisation des gisements où le nouveau matériel de *Sphenothallus* a été découvert. A. République tchèque et Massif Bohémien avec les affleurements du Précambrien, du Cambrien, de l'Ordovicien, du Silurien et du Dévonien de la région du Teplá-Barrandienne. B. Cambrien du Bassin de Příbram-Jince. C. Détail de la zone de découverte indiquant la distribution de la Formation de Jince du Cambrien moyen ainsi que les trois localités : 1 : localité de Rejkovice–"ve žlutých", 2 : versant de Vinice près de la localité de Jince, 3 : localité de la colline de Felbabka–Ostrý vrch (géologie modifiée d'après Havlíček, 1971).

2.1.1. Tubular fossils

Rare findings of macroscopic to submicroscopic nonbiomineralized tubes from the *Ellipsocephalus hoffi – Paradoxides* (*Rejkocephlaus*) *– Lingulella* Biozone, described as *Rhabdotubus robustus* Maletz et al., 2005, represent isolated thecae of pterobranchs (Hemichordata). Fatka et al. (2004, p. 379) reported occurrence of Vermes indet. in lower levels of the *Paradoxides* (*Eccaparadoxides*) *pusillus* Biozone and in the lowest part of the *Onymagnostus hybridus* Biozone.

2.1.2. Conical fossils

All the other biomineralized conical fossils are classified within the orders Hyolithida Sysoev, 1957 and Orthothecida Marek, 1966. At least ten hyolith species are known from the Jince Formation (Barrande, 1867; Marek, 1972, 1983; Valent et al., 2009; Fatka and Valent, unpublished observation). The Jince material supports the earlier speculations that hyolithids belong to epifaunal, rheophilic, and most likely suspension feeding organisms with restricted movement, e.g. to recyclers of organic matter at the water-sediment interface of the Cambrian sea.

S. kozaki and ?*S. kordulei* are the first reported phosphatic conical fossils. Both genera are very rare in the Jince Formation and represent accessory elements in the trilobite-dominated assemblages.

3. Location and stratigraphy

General overviews of the stratigraphy and depositional setting of the Jince Formation are available in Havlíček (1971), Kukal (1971), Geyer et al. (2008) and Fatka and Mergl (2009). Most of the specimens of *S. kozaki* sp. nov. were collected in the lower part of the Jince Formation from an artificial excavation at the Rejkovice–"ve žlutých" locality (= Rejkovice "in yellow" of Fatka and Kordule, 1992), one specimen was found at the Felbabka–Ostrý vrch Hill locality. Both specimens of ?*Sphenothallus kordulei* sp. nov. come from the natural outcrops at the Vinice slope near the Jince locality (Figs. 1 and 2).

3.1. Rejkovice–"ve žlutých" locality (Rejkovice "in yellow")

Purple and grey-green greywackes to fine shales with sandy interlayers are exposed along the left side of a narrow field road east of the Rejkovice village (1 in Fig. 1C).

At this outcrop, the rich fossil association contains common trilobites associated with the rare agnostids, cinctan, ctenocystoid and stylophoran echinoderms and ichnofossils (for a list of all taxa, see Fatka et al., 2004).

3.2. Vinice Slope near the Jince locality

Brown to green graywackes with thin interlayers of sandstones crop out in the slope called Vinice above the Litavka river (2 in Fig. 1C). The very richly diversified fossil association contains common paradoxidid and other trilobites and agnostids associated with common ichnofossils,

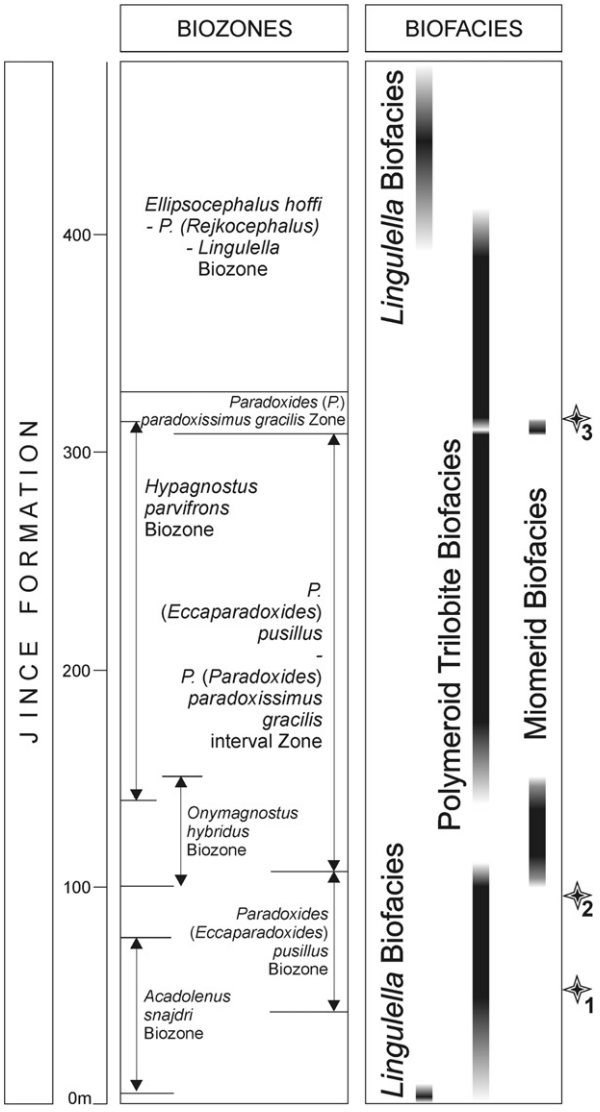


Fig. 2. Biostratigraphy and biofacies of the Jince Formation in the Litavka River Valley with position of the discovery localities (modified from Fatka and Szabad, in press and Fatka and Mergl, 2009). 1: Rejkovice–"ve žlutých" locality, 2: slope Vinice near Jince locality, 3: Felbabka–Ostrý vrch Hill locality.

Fig. 2. Biostratigraphie et biofaciès de la Formation de Jince dans la vallée de la rivière Litavka avec la position des gisements (modifié à partir de Fatka et Szabad, sous presse et Fatka et Mergl, 2009). 1 : localité de Rejkovice–"ve žlutých", 2 : versant de Vinice près de la localité de Jince, 3 : localité de la colline de Felbabka–Ostrý vrch.

hyoliths and rare brachiopods, echinoderms, molluscs and different *incertae sedis* (for a list of all taxa see Álvaro et al., 2004; Fatka et al., 2004).

3.3. Slope of the Felbabka–Ostrý vrch Hill locality

An artificial excavation in grey to green greywackes with shales at the south-eastern slope of the Ostrý vrch Hill near Felbabka (3 in Fig. 1C). The very richly diversified fossil association contains common paradoxidid and

other trilobites, agnostids associated with echinoderms, common ichnofossils, hyoliths and rare molluscs and different *incertae sedis* (for a list of all taxa see Fatka et al., 2004).

The fossil associations are indicative of the Polymeroid Trilobite Biofacies of Fatka and Mergl (2009) at all three localities (Fig. 2). The rich fauna, including ichnofossils, argues for an aerobic environment.

4. Systematic paleontology

Phylum: CNIDARIA Hatschek, 1888
Class, Order, Family Uncertain
Genus ***Sphenothallus*** Hall, 1847
Type species: *Sphenothallus angustifolius* Hall, 1847.

Discussion: Phosphatic tubes of *Sphenothallus* have been documented only rarely from Cambrian sediments. Five occurrences have been published from the Lower Cambrian of China. Li et al. (2004) reported an occurrence of up to 3 mm long specimens of *Sphenothallus* sp. from the Guojiaba and Xiannudong formations in Shaanxi Province of China, which represents the earliest known record of *Sphenothallus*. Zhao et al. (1999) and Zhu et al. (2000) established *S. taijiangensis* Zhu et al., 2000 from the Upper Kaili Formation in Guizhou Province of South China. Nakagavi (2009) briefly discussed morphology and chemical composition of *Sphenothallus* from the Shuijingtuo Formation of the Hubei and Hunan provinces (South China). Peng et al. (2005) described *S. songlinensis* Peng et al., 2005 from the Niutitang Biota (Nangaoan Stage) of eastern Guizhou and reported also *S. taijiangensis*? from the Kaili Formation (Duyuanian Stage). Li et al. (2007) listed occurrences of *Sphenothallus* ranging from the Qiongzhushian to Longwangmiaoan stages of South China. Skovsted and Holmer (2006) briefly reported the presence of *Sphenothallus* in the Lower Cambrian Harkless Formation of Esmeraldina County in southern Nevada. An undetermined species of *Sphenothallus* was recently described by Van Iten et al. (2002) from the Mount Stephen trilobite beds of the lower Middle Cambrian Burgess Shale Formation near Field in British Columbia, Canada.

Remarks: The Lower Cambrian *Cambrovitus* Mao et al., 1992 from Guizhou Province of China, originally classified as a hyolith, is in agreement with Zhu et al. (2000, p. 236) and Li et al. (2007, p. 240), regarded as separate genus. Aceñolaza (2004) figured and briefly discussed *Sphenothallus* sp. from the Late Cambrian Puncoviscana Formation, La Higuera outcrops in the Province of Tucumán, NW Argentina. More recently, this specimen was determined as *Selkirkia* sp. by Aceñolaza and Aceñolaza (2007, p. 8).

Sphenothallus kozaki sp. nov.
Fig. 3, 1–11

Holotype: Almost complete tube L40903± partly flattened, illustrated on Fig. 3-1, 3-2 and 3-11.

Paratype: Incomplete tube L40904± preserved in relief, Fig. 3-3, 3-4 and 3-10.

Material: Nine specimens preserved as internal and external moulds in green and purple fine greywacke to shale.

Occurrence: Příbram-Jince Basin; Jince Formation; Rejkovice–"ve žlutých" locality, lower levels of the *Paradoxides* (*E.*) *pussilus* trilobite Zone, upper levels of the *Acadolenus snajdri* trilobite Zone (corresponding to the Cambrian Stage 5, equal to the *Ptychagnostus gibbus* Biozone) and slope of the Felbabka–Ostrý vrch Hill locality, lower levels of the *Paradoxides* (*P.*) *paradoxissimus gracilis* trilobite Zone (Drumian Stage)

Etymology: In honour of Vladislav Kozák, collector of Lower Palaeozoic fossils of the Barrandian area.

Diagnosis: Several centimeters long, narrow, phosphatic conical tube. Perpendicular cross-section of the shell is circular. Expansion angle 5° to 9°. Longitudinal thickenings are weak and situated on the inner shell surface.

Description: All specimens are incomplete, preserved in purple-green shale and are oriented parallel to bedding. The fragments range from 20 to 35 mm in length and are from 2.8 to 4.3 mm wide at the apertural end (Table 1). The width strongly reflects the degree of flattening. In specimens with the apertural part preserved in high relief, the apertural width is lower, while partly flattened specimens show a slightly wider aperture. The dimensions of complete cones may be envisaged to be more than 40 mm in length and 4.5 mm in maximal width. All cones have been broken at their apexes and thus no holdfast is known. Some specimens are very slightly curved in the proximal portion and straight distally; however most of specimens are straight throughout their length. Aperture is straight and smooth without any distinct structures.

A perpendicular cross-section of the shell is circular or almost circular in its outer outline as is clearly visible in the specimens L40904 (Fig. 3-3, 4, 10) and L40899 (Fig. 3-7), both preserved in a high relief. Longitudinal thickenings are visible in flattened specimens or parts of shells, the apical portions are often slightly more flattened than the apertural ends. Thus, it is inferred that the thickenings were located inside the shell and the inner outline was narrowed in one direction. Very slightly developed imprints of thickenings on the inner casts indicate that they were thin and weak. Remains of the shell wall in the specimen L40901 (Fig. 3-9, 12) illustrate a multilayered, lamellar wall structure.

Remarks: Typical feature of *S. kozaki* is the circular outline of the shell with the internal thickenings, which differentiate the new species from the other known forms of *Sphenothallus*.

?*Sphenothallus kordulei* sp. nov.
Fig. 4, 1–3

Holotype: Fragment of tube L40902+ illustrated on Fig. 4-1a.

Paratype: Fragment of tube L40902+ on the same bedding plane as the holotype illustrated on Fig. 4-1b.

Occurrence: Příbram-Jince Basin; Jince Formation; Vinice slope near Jince locality, higher levels of the *Paradoxides* (*E.*) *pusillus* trilobite Zone, (corresponding to the Cambrian Stage 5, equal to *Ptychagnostus atavus* Biozone).

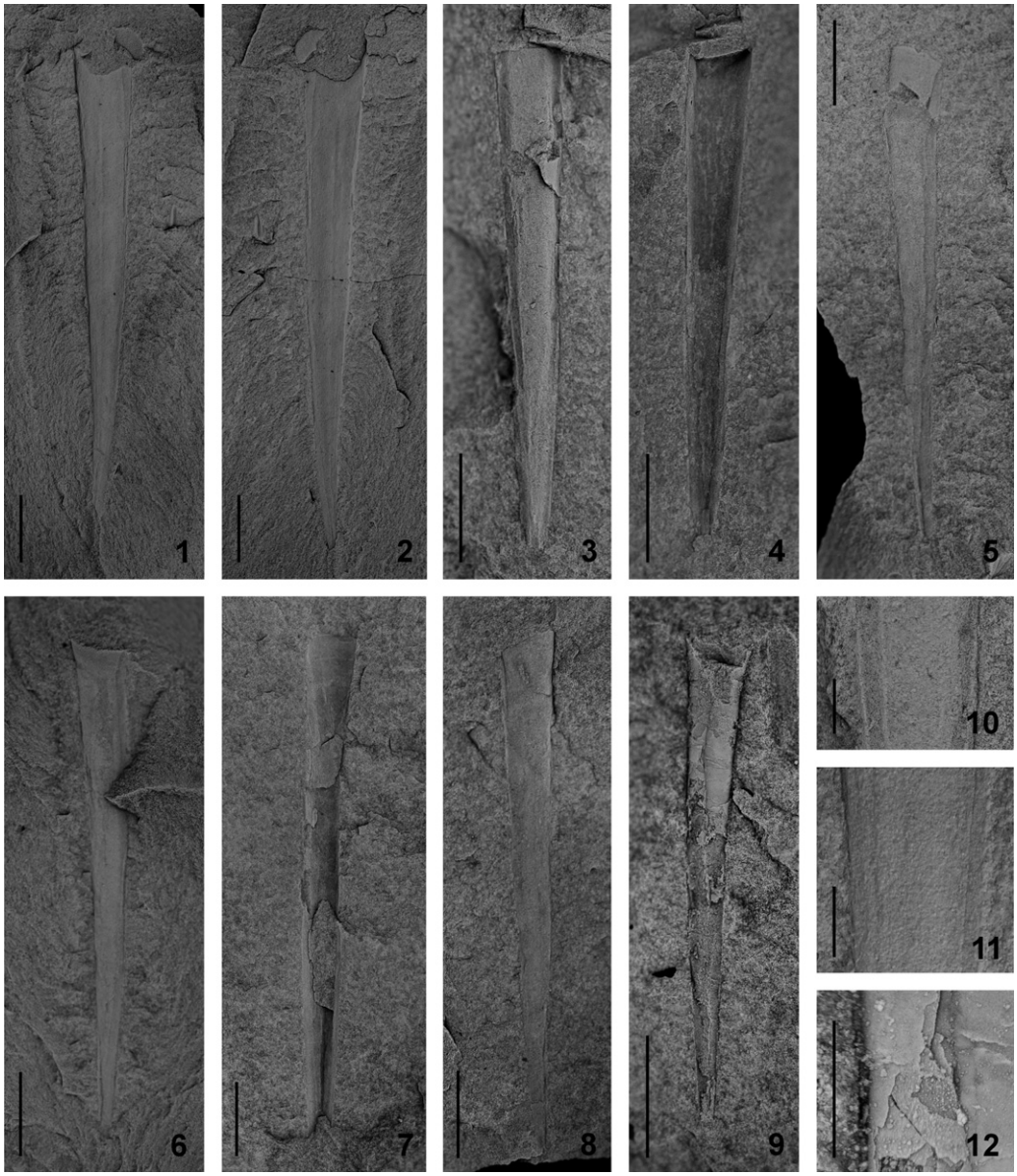


Fig. 3. *Sphenothallus kozaki* sp. nov., Jince Formation, Příbram-Jince Basin, Teplá-Barrandian region, Czech Republic. 1, 2, 11 – partly flattened specimen, holotype, 1, 2– counterparts, 11 – detail of imprints of the thickenings, L40903±; 3, 4, 10 – specimen preserved in relief, paratype, 3, 4 – counterparts, 10 – detail of imprints of the thickenings, L40904±; 5 – almost complete specimen with apertural region broken off, L40897; 6 – flattened specimen with aperture preserved in relief, L40898; 7 – outer cast of the specimen preserved in relief, partly deformed, L40899; 8 – flattened specimen with preserved aperture, L40900; 9, 12 – specimen flattened in apical portion and reliefed in distal one where remains of the shell wall is preserved, 12 – detail of lamellar structure of the shell wall, L40901. 1–8, 10, 11 – Rejkovice–"ve žlutých" locality; 9,12 – Felbabka–Ostrý vrch Hill locality. Scale bars on figs. 1–9 represent 5 mm, on figs. 10–12, it is 1 mm. All specimens coated by ammonium chloride.

Fig. 3. *Sphenothallus kozaki* sp. nov., Formation de Jince, Bassin de Příbram-Jince, région Teplá-Barrandienne, République tchèque. 1, 2, 11 – spécimens partiellement aplatis, holotype, 1, 2 – contre-empreintes, 11 – détail de l'impression des épaississements, L40903± ; 3, 4, 10 – spécimen préservé en relief, paratype, 3, 4 – contre-empreintes, 10 – détail de l'impression des épaississements, L40904± ; 5 – spécimen presque complet avec la région aperturale manquante, L40897 ; 6 – spécimen aplati avec l'ouverture préservée en relief, L40898 ; 7 – moule externe du spécimen préservé en relief, partiellement déformé, L40899 ; 8 – spécimen aplati avec l'ouverture préservée, L40900 ; 9, 12 – spécimen aplati dans la partie apicale et en relief dans la partie distale où des restes de la parois de la coquille sont préservés, 12 – détail de la structure lamellaire de la paroi de la coquille, L40901. 1–8, 10, 11 – localité de Rejkovice–"ve žlutých" ; 9,12 – localité de la colline de Felbabka–Ostrý vrch. Les barres d'échelle des figs. 1–9 représentent 5 mm, pour les figs. 10–12 elles sont de 1 mm. Tous les spécimens ont été recouverts de chlorure d'ammonium.

Table 1
Biometric data and features on measured specimens of *Sphenothallus kozaki* sp. nov. and ?*Sphenothallus kordulei* sp. nov. Width is maximum value in apertural area. Maximum width of thickening is listed in the column labeled Thickening. All length measures in millimeter. Preservation: flattened means flattened to low relief; relief means high relief, only minimum flattening.
Tableau 1
Données biométriques et caractéristiques des spécimens mesurés de *Sphenothallus kozaki* sp. nov. et de ?*Sphenothallus kordulei* sp. nov. La largeur correspond à la valeur maximale de la région aperturale. La largeur maximale de l'épaississement est indiquée dans la colonne Thickening. Toutes les mesures sont en millimètre. Préservation : *flattened* signifie un faible relief ; *relief* correspond à un relief important, avec seulement un aplatissement minimal.

	Inv. number	Type	Preservation	Length	Width	Thickening	Expansion angle – apical	Expansion angle – distal
S. kozaki	L40903+	Holotype	Low relief	35.6	4.3	0.70	8.8°	5.7°
	L40904+	Paratype	High relief	22.8	3.0	0.65	7.1°	4.0°
	L40897		Low relief	27.7	2.9	0.65	6.2°	5.9°
	L40898		Low to high relief	30.0	3.0	0.55	4.5°	4.0°
	L40899		High relief	33.3	3.3	Non-measurable	5.4°	3.8°
	L40900		Low relief	30.2	3.0	0.25	8.1°	4.1°
	L40901		Low to high relief	19.5	2.8	Non-measurable	5.7°	5.4°
?*S. kordulei*	L40902+	Holotype	Flattened	90.7	16.3	1.75	13.5°	
	L40902+	Paratype	Flattened	100.1	17.3	Indistinct		3.5°

***Etymology*:** In honour of the late Vratislav Kordule, collector of Cambrian fossils of the Barrandian area.

Diagnosis: Giant, smooth and partly flexible organophosphatic conical shell, with narrow, slender and thin pair of opposite thickenings. Expansion angle exceeds 10° in the apical portion of the shell; the angle decreases to its minimum distally.

Description: Both known specimens are preserved as flattened moulds in brown-green fine greywacke and are oriented parallel to the bedding. Preserved fragments range from 91 mm to 100 mm in length and from 16 mm to 17 mm in width (Table 1); complete specimens are estimated to reach about 140 mm in length and up to 20 mm in apertural width. The tubes studied are broken at both ends. The expansion angle reaches 13.5° in apical portion of the cone. It decreases to 3.5° distally. The original organo-phosphatic material of the wall is not preserved. The imprints of the inner and outer surfaces show entirely smooth character. The material was flexible and is preserved irregularly rumpled. Thickenings are narrow and thin. They are preserved as poorly distinct low, flat rounded ridges. Their width ranges between 1.3 mm to 1.75 mm. The aperture preserved in the holotype shows no conspicuous structures or swellings. Its rim is smooth, the wall is of the same thickness as in other parts of the cone. The aperture outline is not straight but curved, and expanded in the axial part of the cone forming a low lobe.

Remarks: The new form is typified by a large apical angle forming rapidly widening cone. The angle decreases distally and the cone turns into an almost cylindrical tube. The apertural widening is distally suppressed and increases very gradually. The thickenings are minute related to the shell size in comparison to other Cambrian species of *Sphenothallus*. However, the thickenings were apparently robust enough and/or the body internally structured so firmly that strong reinforcements were not required to keep the shell upright above the substrate.

All studied specimens have been deposited in the collection of the National Museum Prague, numbered sequentially from L40897 to L40904.

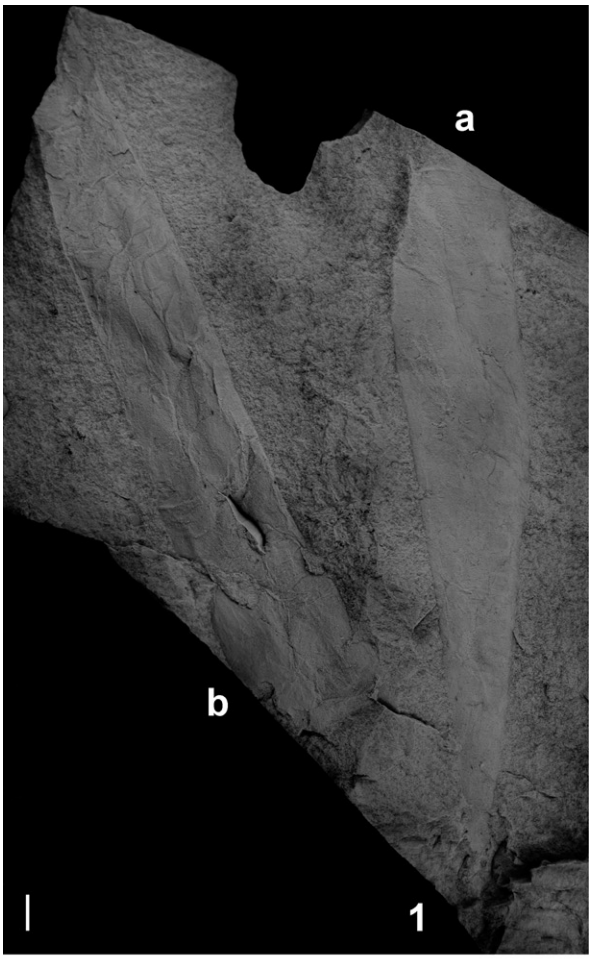
5. Affinities and palaeoecology

Sphenothallus shows a simple morphology and its phylogenetic affinities have been controversial. It was regarded as an annelid or other "worm" tube (e.g. Mason and Yochelson, 1985; Neal and Hannibal, 2000) or to be of a cnidarian affinity (e.g. Peng et al., 2005; Zhu et al., 2000). It also has been interpreted as a sessile predator (Peng et al., 2005). The very simple morphology of sphenothallids makes any interpretation of their affinities difficult.

However, there are some key features that make it possible to distinguish separate species. The organophosphatic composition of cones combined with the smooth surface and marks of weak thickenings indicate some morphological relationship of the Bohemian specimens to the genus *Sphenothallus*.

S. kozaki is typified by its unusual circular cross-section (Fig. 5). We consider ?*S. kordulei* as a giant sphenothallid. It fits with a very wide size range of *Sphenothallus* as large or long specimens are not exceptional in younger material. However, ?*S. kordulei* is the biggest Cambrian sphenothallid and one of the largest altogether. We classify this species provisionally as *Sphenothallus*; we are convinced, that its morphology is so unique to indicate a separate new genus. However, the collected material is not sufficient to erect it now.

Sphenothallus is considered to be an opportunistic generalist inhabiting a wide range of marine environments (Neal and Hannibal, 2000). It was repeatedly documented attached by holdfast to shells of brachiopods (Bolton, 1994; Neal and Hannibal, 2000; Wang et al., 2003), rarely also to the enigmatic genus *Byronia* (Zhu et al., 2000), as well as to cephalopods (Bolton, 1994; Van Iten et al., 1992), to crinoid stems (Mason and Yochelson, 1985) and/or to other sphenothallid tubes (Neal and Hannibal, 2000; reinterpretation of older material of Feldmann et al., 1986). In addition, *Sphenothallus* was able to colonize hardgrounds (Bodenbender et al., 1989) and even soft, muddy bottoms (Wang et al., 2003). Despite the absence of any sphenothallid-like holdfasts, either isolated or attached to



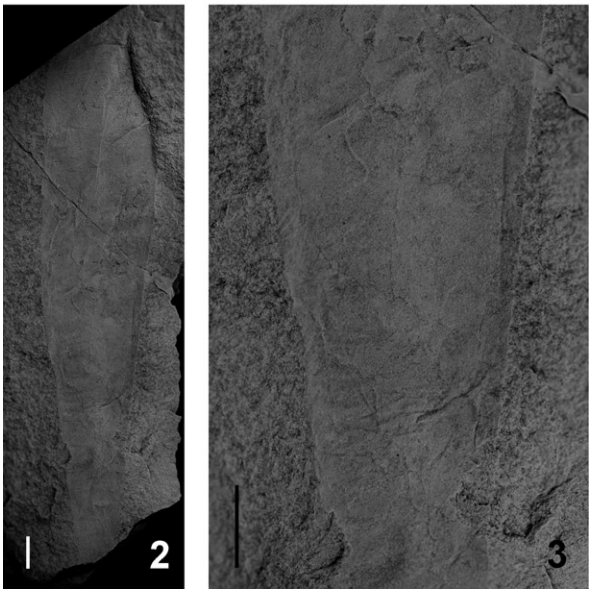


Fig. 4. ?*Sphenothallus kordulei* sp. nov., Jince Formation, Příbram-Jince Basin, Teplá-Barrandian region, Czech Republic. 1 – slab with both know specimens, a – holotype, b – paratype, L40902+; 2 – counterpart of the holotype with preserved part of aperture L40902–; 3 – detail of central portion of the counterpart of the holotype with distinguishable imprints of thickenings, L40902–. Slope Vinice near Jince locality, scale bars represent 5 mm in all cases. Specimens coated by ammonium chloride.

Fig. 4. ?*Sphenothallus kordulei* sp. nov., Formation de Jince, Bassin de Příbram-Jince, région Teplá-Barrandienne, République tchèque. 1 – plaque avec deux spécimens connus, a – holotype, b – paratype, L40902+ ; 2 – contre-empreinte de l'holotype avec une partie de l'ouverture préservée L40902– ; 3 – détail de la portion centrale de la contre-empreinte de l'holotype avec des empreintes perceptibles des épaississements, L40902–.Versant de Vinice près de la localité de Jince, les barres d'échelle représentent 5 mm. Tous les spécimens ont été recouverts de chlorure d'ammonium.

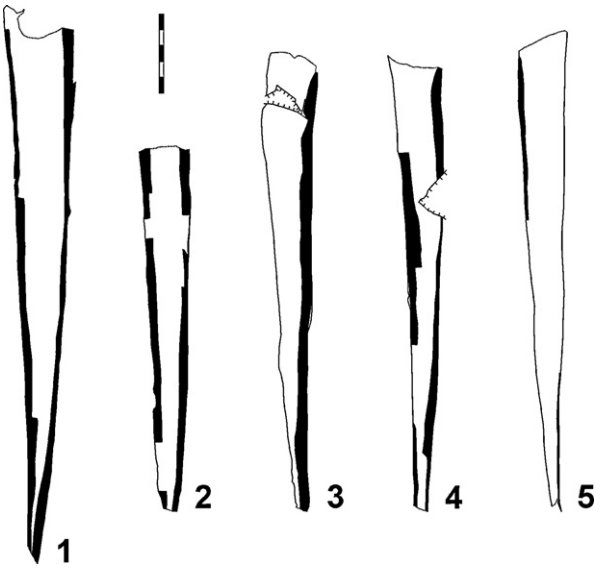


Fig. 5. *Sphenothallus kozaki* sp. nov., Jince Formation, Příbram-Jince Basin, Teplá-Barrandian region, Czech Republic. 1 – drawing of holotype L40903+ (compare Fig. 4-1); 2 – drawing of the paratype L40904+ (compare Fig. 4-3); 3 – drawing of the paratype L40897 (compare Fig. 4-5); 4 – drawing of the paratype L40898 (compare Fig. 4-6); 5 – drawing of the paratype L40900 (compare Fig. 4-8). Scale bar represents 5 mm.

Fig. 5. *Sphenothallus kozaki* sp. nov., Formation de Jince, Bassin de Příbram-Jince, région Teplá-Barrandienne, République tchèque. 1 – dessin de l'holotype L40903+ (voir Fig. 4-1) ; 2 – dessin du paratype L40904+ (voir Fig. 4-3) ; 3 – dessin du paratype L40897 (voir Fig. 4-5) ; 4 – dessin du paratype L40898 (voir Fig. 4-6) ; 5 – dessin du paratype L40900 (voir Fig. 4-8). La barre d'échelle représente 5 mm.

any shell surface in the Jince Formation, *S. kozaki* can be considered to have the usual mode of life.

In the case of ?*S. kordulei*, the discussion on mode of life is quite speculative, because of the limited material and the very simple morphology. However, by analogy to other phosphatic conical fossils, a benthic mode of life may be envisaged for ?*S. kordulei*. The partly flexible material of the cones supports an epifaunal nature rather than a semi-infaunal or infaunal mode of life.

Discovery of *Sphenothallus* in the classical Cambrian of the Příbram-Jince Basin is surprising. Fossil collections, intensively assembled since the end of 18th century did not include, for a long time, any rests of groups with organo-phosphatic shell, e.g. conulariids. The only other groups of organo-phosphatic fossils are represented by the

linguliformean brachiopods (Mergl and Šlehoferová, 1990; Fatka and Mergl, 2009) and the problematic plates (Elicki et al., in preparation), which, however, do not represent conulariids.

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