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New kingenoid (Terebratellidina) brachiopods with larger body sizes from the Early Cretaceous of Zengővárkony (Mecsek Mountains, Hungary)

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Abstract.—The small, Lower Cretaceous, iron ore deposit at Zengővárkony (Mecsek Mountains, southern Hungary, Europe) contains new brachiopod taxa of kingenoid relationships. *Dictyothyropsis vogli*, *Zittelina hofmanni*, and *Smirnovina ferraria* are described as new species from late Valanginian to earliest Hauterivian strata. The new taxa strengthen the presence of Early Cretaceous biogeographical connections with the Western Carpathians and the Pieniny Klippen Belt of southern Poland. The newly described taxa have significantly larger dimensions than their closest relatives from the type localities, which is in line with previous research on brachiopods from this environment. These brachiopods lived in a nutrient-rich, unique environment related to iron-ore deposition linked to former hydrothermal activity on the seafloor that might have contributed to the large size of these brachiopods. Larger than normal rhynchonellide and terebratulidine brachiopods have previously been recorded from this locality.

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Introduction

Cretaceous sediments and their fauna were first reported from the Mecsek Mountains by Hofmann (1907) from a shallow marine, littoral sedimentary environment around the Kisújbánya Basin, eastern Mecsek Mountains (Fig. 1). Hofmann (1912) had started to describe the bivalve and gastropod fauna, but due to his death, Vadász (see Hofmann and Vadász, 1912) finalized his manuscript. The remaining faunal elements were listed by Vadász (1935), who reported 14 shallow marine and littoral brachiopod species. According to Vadász (1935), this nearshore marine fauna is Hauterivian. Based on ammonites, Bujtor (1993) recognized the lower Valanginian *Thurmanniceras pertransiens* Zone for the Kisújbánya locality. From this locality, Bujtor (2006) reported the brachiopods *Lacunosella hoheneggeri* (Suess, 1858), *Lacunosella ?spoliata* (Suess, 1858), *Lamellaerhynchia multiformis* (Roemer, 1839), *Pygites diphyoides* (d'Orbigny, 1849), and *Nucleata veronica* Nekvasilova, 1977. Cretaceous sediments are known from other localities in the Mecsek Mountains, but brachiopods are rarely reported.

The other interesting locality from which Cretaceous brachiopods have been reported is situated 9.5 km SE of Kisújbánya in the neighborhood of an abandoned iron ore mine in the vicinity of Zengővárkony (NE from the village); in the 1950s, active mining took place (Molnár, 1961) traversing the 1 m thick ore bed that is 600 m wide along the strike. From the spoil bank of the ore mine, Fülöp (in Hetényi et al., 1968) collected some macrofossils among which were brachiopods: *Rhynchonella malbosi* Pictet, 1867, *R. sparsicostata* 'Opp.' = *Lacunosella sparsicostata* (Quenstedt, 1852), and *Terebratula* aff. *T. salevensis* Loriol 1862 (= *Praelongithyris* cf. *P. salevensis* Middlemiss, 1984). Bujtor (2006) reported a rich brachiopod assemblage dominated by *Lacunosella hoheneggeri* and *Nucleata veronica* with other, previously unknown brachiopods from the Mecsek Mountains: *Moutonithyris* aff. *M. moutoniana* (d'Orbigny, 1849), *Karadagithyris* sp., and *Zittelina pinguicula* (Zittel, 1870). The dominant taxa *Lacunosella hoheneggeri* and *N. veronica* presented a 30–70% average size increase compared to specimens from their type localities (Bujtor, 2006, 2007), therefore Bujtor (2007) proposed a hydrothermal vent -related environment in which these brachiopods grew to a remarkably large size (in the case of *N. veronica*, 36% larger and for *Lacunosella hoheneggeri*, 71% larger than the mean values of the populations at their type localities; Bujtor, 2007). Stable-isotope analysis (Bujtor, 2007) did not support the vent/seep origin, and the interpretation of this unique environment is still ambiguous. Although the vent/seep origin is not supported, volcanic activity played a role in forming this special environment. Viczián (1966) reported peperite from the Lower Cretaceous section of a borehole at Kisbattyán. This rare mixed rock is a by-product of the hot magma intruding into unconsolidated sediment with high water content (Skilling et al., 2002). The volcanism equivocally refers to continental crust origin (Embey-Isztin, 1981). For the moment, it seems most plausible that this former environment was similar to that of the Recent Milos Island hydrothermal activity field (Morri et al., 1999), which is in line with the rich and diverse crustacean microcoprolite ichnofauna described from this locality by Palik (1965) and Bujtor (2012b).

Bujtor (2007, 2011) summarized earlier researches and placed the Zengővárkony locality in a broader geological framework in which the iron ore formation is linked to Late Jurassic–Early Cretaceous continental rifting and volcanism of the region.

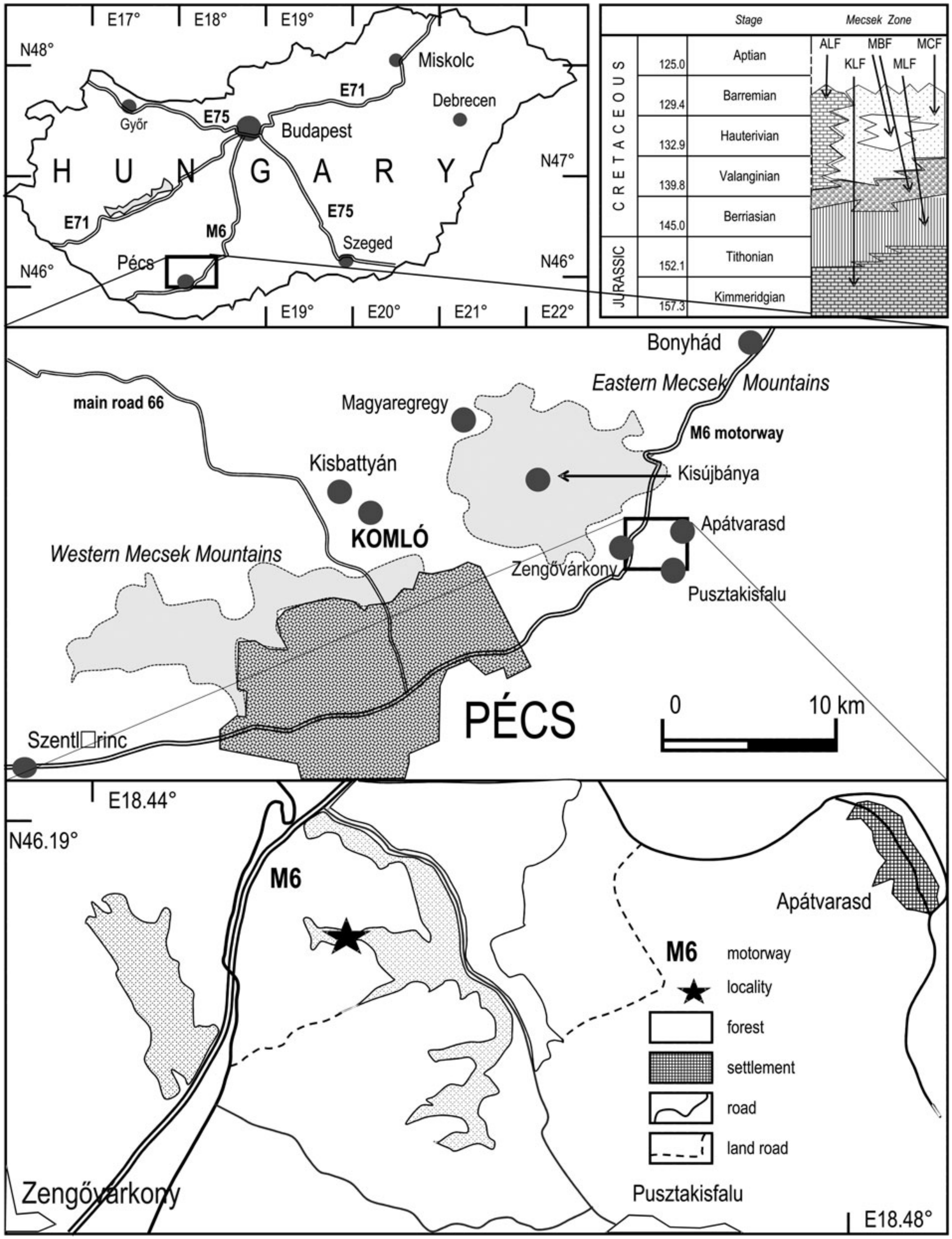

Figure 1. Locality map showing location of the Zengővárkony section both locally and more regionally within Hungary with the stratigraphic distribution of the related formations. ALF = Apátvarasd Limestone Formation; KLF = Kisújbánya Limestone Formation; MBF = Mecsekjános Basalt Formation; MCF = Magyaregregy Conglomerate Formation; MLF = Márévár Limestone Formation. Numerical ages after Cohen et al. (2013).

Bujtor et al. (2013) defined the age of the sequence. Based on dinoflagellates and belemnites, the age of the fossiliferous layers is upper Valanginian–lower Hauterivian, which strengthens the conclusions of Fülöp (in Hetényi et al., 1968). Regarding the microfauna, Bujtor and Szinger (2018) described diactine-type criccorhabd sponge spicules from the same locality. During serial sectioning of the present material, sponge spicules also appeared frequently inside the brachiopod shells.

Continuous sampling from the same locality and the scree from the floor of the valley from 1988 until today have provided ~100 specimens of brachiopods out of which some are considered new species. The aim of this paper is to describe new taxa of Early Cretaceous kingenoid brachiopods from the Mecsek Mountains from the iron-ore related sediments at Zengővárkony.

Geologic setting

The southern Hungarian Mecsek Mountains belong to the Tisza Mega-Unit (Haas and Péró, 2004), which is considered a Mesozoic microplate (Csontos and Vörös, 2004). During the Late Jurassic, this microplate (Fig. 2) detached from the European Plate initiated by continental rifting (Huemer, 1997). The intraplate alkaline basaltic volcanism interrupted the continuous basinal carbonate sedimentation and produced mixed volcanosedimentary deposits (Nagy, 1967), which have been reported from boreholes in distant areas (200 km from the volcanic center in the Great Hungarian Plain) of the Tisza Mega-Unit (Bilik, 1983). The volcanic activity built up an ankaramite-alkaline basaltic paleovolcano in the Mecsek Mountains (Császár and Turnšek, 1996). The center of the paleovolcano was situated northwest of Magyaregregy (Wein, 1961, 1965), forming a volcanic island (Császár and Turnšek, 1996). Submarine volcanic bodies were reported from other places in the eastern Mecsek Mountains and have been thoroughly investigated (Mauritz, 1913, 1958; Bilik, 1974, 1983). Simultaneously with the volcanism, a sedimentary iron ore body was deposited (Sztrókay, 1952; Pantó et al., 1955; Molnár, 1961) southeast of the volcanic center that hosted a rich marine fauna (Fülöp in Hetényi et al., 1968; Bujtor, 2006, 2007; Bujtor and Szinger, 2018; Bujtor et al., 2013).

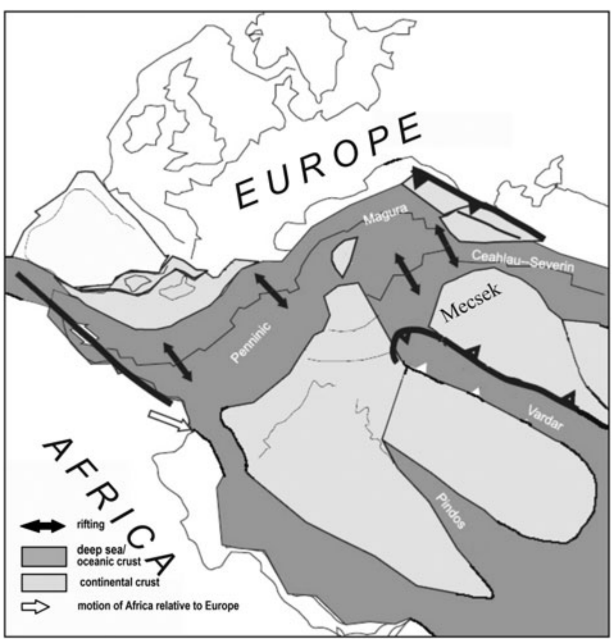

Figure 2. Palaeogeographic position of the Tisza Mega-Unit microplate including the Mecsek Mountains in the earliest Cretaceous. Map after Csontos and Vörös (2004), simplified.

Studied section.—The section (Fig. 3) is an artificial cut prepared for fossil collecting on the western slope of the Dezső Rezső Valley reported in detail by Bujtor (2006, 2007, 2012b), Bujtor and Szinger (2018), and Bujtor et al. (2013). The section traverses the volcano-sedimentary succession of the Mecsekjános Basalt Formation and the overlying Apátvarasd Limestone Formation. Coordinates: 46.18545°N, 18.45299°E.

The lower part of the section exposes the fully altered volcanic pillow lava and hyaloclastite version of the Mecsekjánosi Basalt Formation. A submarine origin is revealed by vesicles (1–6 mm in diameter) in the chilled margin of the pillows. A red, fossiliferous limestone bed rests concordantly upon the volcanic surface and alternates with the iron ore beds and provided large but fragmentary and reworked phylloceratid and lytoceratid ammonites, e.g., *Lytoceras subfimbriatum* (d'Orbigny, 1841) (Bujtor, 2012a), belemnite rostra (Bujtor et al., 2013), a rich and almost monotypic brachiopod assemblage (Bujtor, 2006, 2007, 2011, 2012a, b), echinoid spines (Bujtor, 2012a), and some internal molds of poorly preserved gastropods. Thin sections (Fig. 4) of ammonite body chambers reveal microfaunal elements, such as foraminiferans, echinoderm remains, sponge spicules, and rarely crustacean microcoprolites (Bujtor, 2012b; Bujtor and Szinger, 2018). The intercalating and metasomatized limestone bed provided a rich foraminiferan assemblage of *Glomospira* spp., *Lenticulina* spp., *Spirillina* spp., *Nodosaria* spp., *Epistomina* spp., *Trocholina* spp., and *Hedbergella* spp. (Bujtor and Szinger, 2018). The fossil content decreases upward in number of individuals and diversity: toward the top of the section, only badly preserved echinoid spines are present. The top of the section is covered by debris and soil.

Materials and methods

The classification of the brachiopods follows the revised Treatise on Invertebrate Paleontology (Williams et al., 2006). The principal dimensions of the appropriate (more or less complete) specimens have been measured by a caliper. The measurements (L = length, W = width, T = thickness, Ch = height of the deflection in the anterior commissure) are given in millimeters. Serial sectioning of brachiopods was prepared by a CutRock Croft-grinder grinding machine. Drawings of sections were prepared by a camera lucida and a Zeiss stereomicroscope. Specimens were coated with ammonium chloride for photographic purposes.

Repositories and institutional abbreviations.—Types, figured, and other specimens examined during this study are deposited in the following institutions: HNHM = Department of Paleontology and Geology of the Hungarian Natural History Museum, Budapest, Hungary, with the figured specimens under the

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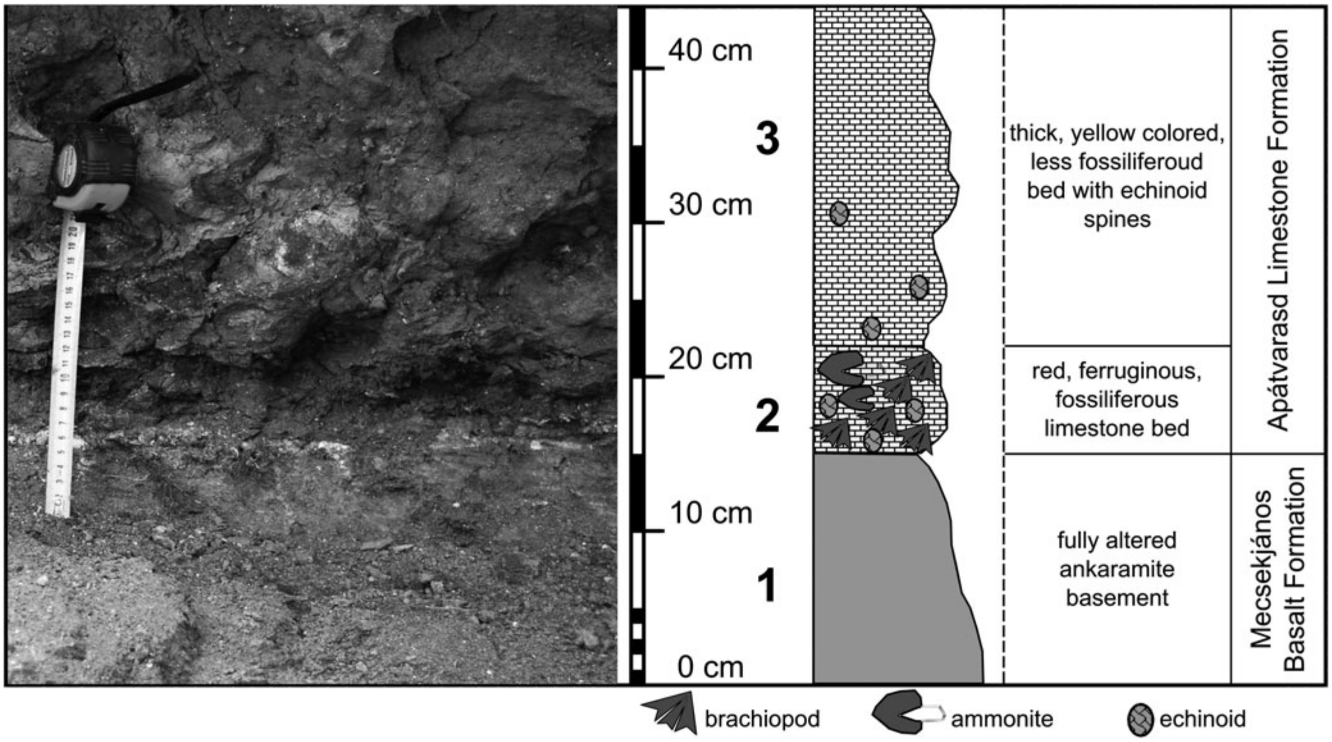

Figure 3. The upper Valanginian–lower Hauterivian Zengővárkony section traversing the Mecsekjánosi Basalt Formation and the Apátvarasd Limestone Formation. Fossil symbols indicate the bed from which the brachiopods were collected. This bed contains the allochtonous fauna that are deposited on the volcanic surface. Fragmentary ammonite shells refer to reworking or transportation. 1 = fully altered surface of the Mecsekjános Basalt Formation; 2 = basal, ferruginous, fossil-rich bed of the Apátvarasd Limestone Formation with transported allochtonous megafaunal elements; 3 = typical massive, unstratified, yellowish-brown bed of the Apátvarasd Limestone Formation.

inventory numbers prefixed by PAL, INV, and/or M; MGSH = the paleontological collection of the Mining and Geological Survey of Hungary, Budapest, under the inventory numbers prefixed by K.

Systematic paleontology

Phylum Brachiopoda Duméril, 1806
Subphylum Rhynchonelliformea Williams et al., 1996
Class Rhynchonellata Williams et al., 1996
Order Terebratulida Waagen, 1883
Suborder Terebratellidina Muir-Wood, 1955
Superfamily Kingenoidea Elliott, 1948
Family Kingenidae Elliott, 1948
Subfamily Kingeninae Elliott, 1948
Genus *Dictyothyropsis* Barczyk, 1969

Type species.—*Terebratulites loricatus* Schlotheim, 1820.

Dictyothyropsis vogli new species
Figure 5.1–5.5, Table 1

Holotype.—Internal mold partly covered by shell remains (HNHM, PAL 2019.2.1) upper Valanginian–lower Hauterivian, Apátvarasd Limestone Formation, east of Zengővárkony, Mecsek Mountains, Hungary.

Diagnosis.—Medium-sized *Dictyothyropsis* with subpentagonal outline. Beak erect, truncated. Lateral commissures straight; anterior commissure unisulcate. Sinus shallow, wide. Shell biconvex, entirely and strongly costate; secondary riblets intercalating anteriorly.

Occurrence.—Basal, red ferruginous limestone bed of the Apátvarasd Limestone Formation in the northwestern part of the Dezső Rezső Valley, east of Zengővárkony, Hungary. Coordinates: 46.18545°N, 18.45299°E.

Description
External characters.—This is a medium-sized *Dictyothyropsis*, with a rather isometric, subpentagonal, flabelliform outline. The lateral margins are nearly straight and diverge with an apical angle of 65°. The maximum width lies at the approximate anterior third of the length. The valves are moderately convex; the ventral valve is slightly more convex than the dorsal valve. After a dominant biconvex stage, a weak and wide sulcus develops in the dorsal valve, which results in an unisulcate anterior margin. The maximum thickness of the double valve is attained in the posterior third. The beak is erect, massive, and truncated. The pedicle opening is wide but its rim is partly incomplete. The delthyrium is barely seen, but its lateral sides form a wide and low triangle. The beak ridges are rounded but distinct; the characters of the interarea are not seen. In lateral view, the lateral commissures are nearly straight. The anterior commissure is widely unisulcate and shows a series of rather sharp zigzag deflections. The unisulcation is low trapezoidal and occupies the central two-thirds of the anterior commissure. The valves are multicostate throughout; eight

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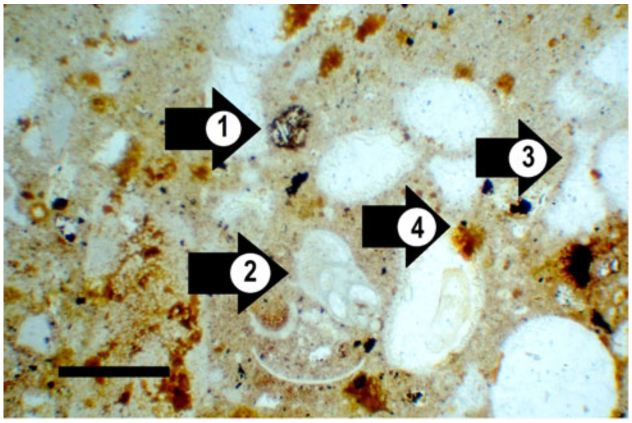

Figure 4. Thin section through body chamber of *Lytoceras* sp. from the basal, ferruginous, fossil-rich bed. The micritic matrix filling the body chamber of the ammonite contains various clasts: 1 = volcanic rock fragment with well visible plagioclase crystal rod fragments; 2 = foraminifera particle; 3 = fragment of lithistid demospongiae; 4 = goethite flake. Scale bar = 0.1 mm.

strong but rounded ribs start at the umbones, four of which are present in the medial sulcus. These primary ribs become somewhat stronger anteriorly. In the anterior third, secondary ribs of various strength are inserted by intercalation; their number reaches nine at the anterior margin. In the lateral sectors of the valves, the ribs follow a flabelliform pattern, i.e., they are gently arched laterally. Very weak comarginal (growth) lines also appear; a poorly developed reticulate pattern results where they cross the secondary ribs.

Internal characters.—These were not studied because of the paucity of the material (single specimen).

Etymology.—The species name honors Ferenc Vogl, landowner of Dezső Rezső Valley (containing the Zengővárkony locality).

Materials.—One specimen (Table 1).

Remarks.—*Dictyothyropsis vogli* n. sp., besides an overall similarity, is markedly different from *D. loricata*, type species of the genus, and the other Late Jurassic species *D. roemeri* (Rollier, 1919); both were excellently illustrated by Barczyk (1969, p. 66–69, pl. 14, figs. 11–14, pl. 15, figs. 1–6). In addition to the considerable difference in age, *D. vogli* n. sp. has fewer and much stronger ribs than these Late Jurassic species and shows a lesser degree of reticulation.

Dictyothyropsis tatrica (Zittel, 1870), as figured by Zittel (1870, pl. 14, figs. 21, 22), Barczyk (1979, pl. 2, figs. 1–3), and Krobicki (1994, pl. 1, fig. 1), is much more convex than *D. vogli* n. sp., and is Tithonian in age.

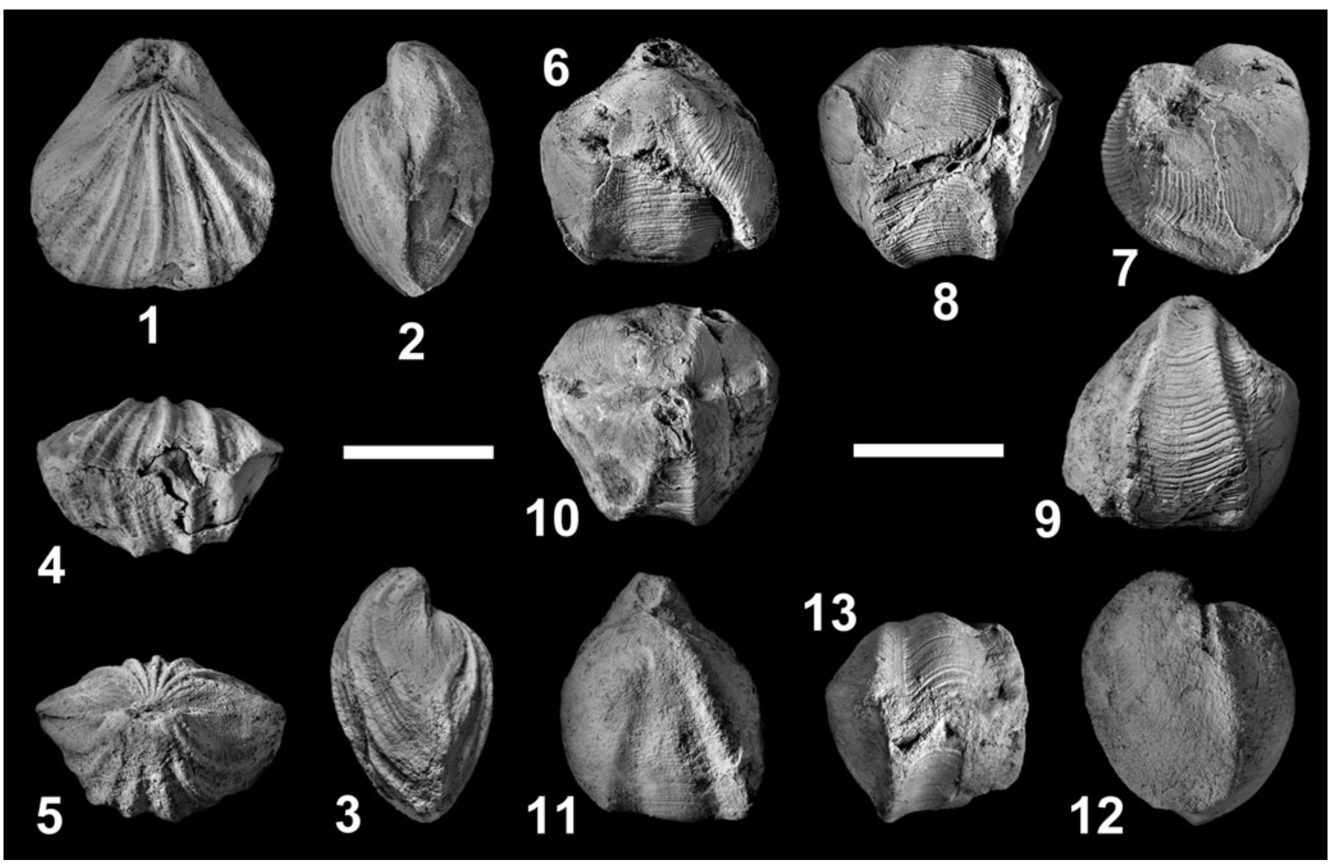

Figure 5. Brachiopods from the basal, red, ferruginous bed of the Apátvarasd Limestone Formation, upper Valanginian–lower Hauterivian, Dezső Rezső Valley, Zengővárkony, Mecsek Mountains, Hungary. (**1–5**) *Dictyothyropsis vogli* n. sp., holotype HNHM, PAL 2019.2.1: (**1**) dorsal view; (**2, 3**) right and left lateral views; (**4**) anterior view; (**5**) posterior view; (**6–10**) *Smirnovina ferraria* n. sp., holotype HNHM, PAL 2019.3.1: (**6**) dorsal view; (**7**) lateral view; (**8**) anterior view; (**9**) ventral view; (**10**) posterior view; (**11–13**) *Smirnovina* sp., MGSH, K 2019.5.1: (**11**) dorsal view; (**12**) lateral view; (**13**) anterior view. All specimens dusted with ammonium chloride. Scale bars = 10 mm.

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Table 1. Measurements (in mm) of examined specimens of *Dictyothyropsis vogli* n. sp., *Zittelina hofmanni* n. sp., *Smirnovina ferraria* n. sp., and *Smirnovina* sp.

Species	Type status	Repository	Specimen	L	W	T	Ch
Dictyothyropsis vogli n. sp.	holotype	HNHM	PAL 2019.2.1	17.3	16.3	10.7	∼2.0
Zittelina hofmanni n. sp.	holotype	HNHM	PAL 2019.4.1	19.3	18.1	12.5	3.9
	paratype	HNHM	PAL 2019.5.1	24.7	20.9	17.9	∼2.5
	paratype	HNHM	PAL 2019.6.1	19.1	17.6	13.2	∼2.0
	paratype	HNHM	PAL 2019.7.1	22.6	18.9	15.2	∼3.0
	paratype	MGSH	K 2019.1.1	17.9	19.3	12.8	3.1
	paratype	MGSH	K 2019.2.1	17.7	15.3	11.1	?
		HNHM	INV 2019.1	22.3	18.7	13.4	∼3.0
		HNHM	INV 2019.2	18.5	16.8	12.9	∼3.5
Smirnovina ferraria n. sp.	holotype	HNHM	PAL 2019.3.1	**15.1**	**15.5**	**14.8**	**7.9**
	paratype	HNHM	PAL 2019.8.1	16.4	14.2	13.5	6.6
	paratype	HNHM	PAL 2019.10.1	18.0	14.1	14.9	7.0
Smirnovina sp.		MGSH	K 2019.5.1	16.3	∼13	12.9	6.8

Dictyothyropsis lilloi Calzada, 1985, described from the early Hauterivian of Spain (Calzada, 1985, p. 86, pl. 2, figs. 7, 8; Garcia Ramos, 2005, pl. 1, fig. 16) and illustrated also from the same age from Serbia (Radulović et al., 2007, p. 122, fig. 6.8, 6.9), seems more closely related to *D. vogli* n. sp. but its primary ribs are fewer and much shorter and show distinct capillate ornament.

Considering the general similarity in external features of *Dictyothyropsis vogli* n. sp. to the above-mentioned species, the attribution of this new species to the genus *Dictyothyropsis* seems justified even in the absence of information on its internal morphology.

Genus *Zittelina* Rollier, 1919

Type species.—*Terebratula orbis* Quenstedt, 1858.

Zittelina hofmanni new species
Figures 6–9, Table 1

v 2006 *Zittelina pinguicula* (Zittel, 1870); Bujtor, p. 140, figs. 12.9, 15.

Type specimens.—Holotype, internal mold partly covered by shell remains (HNHM, PAL 2019.4.1), upper Valanginian–lower Hauterivian, Apátvarasd Limestone Formation, east of Zengővárkony, Mecsek Mountains, Hungary. Paratypes, internal molds partly covered by shell remains (HNHM, PAL 2019.5.1–2019.7.1 and MGSH, K 2019.1.1–2019.2.1).

Diagnosis.—Large *Zittelina* with subcircular outline. Beak erect, high. Lateral commissures straight; anterior commissure gently unisulcate. Shell biconvex, smooth, with occasional fine capillation. Pedicle collar strong; septal pillar short; loop reflected, diploform.

Occurrence.—Basal, red ferruginous limestone bed and overlying gray limestone of the Apátvarasd Limestone Formation, northwestern part of the Dezső Rezső Valley, east of Zengővárkony, Hungary. Coordinates: 46.18545°N, 18.45299°E.

Description
External characters.—Medium to large, globose *Zittelina* with a very rounded, subcircular to oval outline. The apical angle varies between 80–90°. The maximum width is attained at the approximate midlength or a little more anteriorly. The valves are moderately to strongly convex; the maximum convexity lies somewhat posteriorly. The ventral valve is much more convex than the other. The beak is rather high, erect to slightly incurved. The foramen is circular and mesothyrid, but poorly seen. The delthyrium is not visible. The beak ridges are blunt. In lateral view, the lateral commissures are almost straight; they transition to the weakly unisulcate anterior commissure. The sinus is very shallow, uniformly arched, and wide; it usually occupies the major part of the width of the anterior margin. A definite dorsal sulcus or ventral fold is not developed. The surface of the shells is almost smooth, except for fine growth lines and occasional radial capillation.

Internal characters (Figs. 7–9).—Ventral valve: The delthyrial cavity is subquadrate in cross section, with a variable amount of callus and a definite myophragm on the ventral floor. The umbonal cavities are semicircular. The dental plates are strong and subparallel. A well-developed pedicle collar connects the middle portion of the dental plates and the myophragm. Deltidial plates were not recorded. The hinge teeth are moderately strong and diagonally oriented; denticula are poorly seen. Dorsal valve: The notothyrial cavity is narrow and lanceolate in cross section. It passes into a deep, V-shaped septalium formed by the hinge plates and attached to the dorsal median septum. The median septum, reinforced by callus, forms a septal pillar that supports the posterior end of the reflected loop. Hereafter, the median septum reduces abruptly, diminishes rapidly (Fig. 7, 5.3–5.9 mm; Fig. 8, 5.5–6.1 mm; Fig. 9, 6.5–7.1 mm), and disappears. The outer socket ridges are very wide and massive. The inner socket ridges are moderately thick and overlap a little over the sockets. The hinge plates are inclined dorsally. The crural bases emerge from the medial thickenings of the hinge plates, close to the median septum. The crura are subvertical and subparallel. The crural processes are high and crescentic in cross section. The loop is diploform; it attains ∼0.7 times the length of the dorsal valve. The descending branches are slightly divergent. The ascending branches are very high, ventrally divergent, and irregularly ruffled; their posterior transverse band is hood-like. In one specimen (Fig. 8), the posterior end of the hood is subcircular in cross section and is connected to the descending branches with a transverse element. Spinosity was recorded at the distal termination of the loop.

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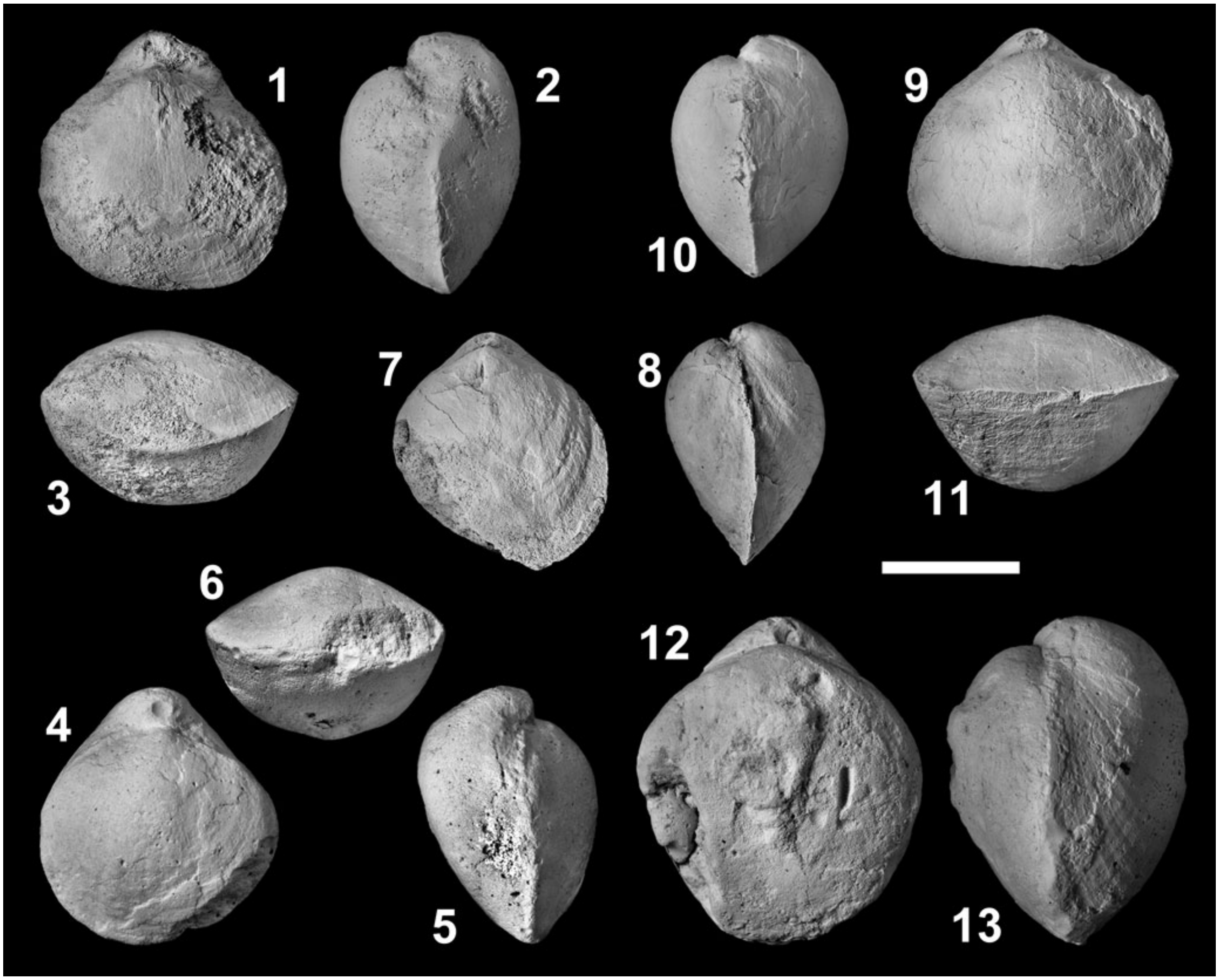

Figure 6. *Zittelina hofmanni* n. sp. from the basal, red, ferruginous bed of the Apátvarasd Limestone Formation, upper Valanginian–lower Hauterivian, Dezső Rezső Valley, Zengővárkony, Mecsek Mountains, Hungary: (**1–3**) holotype HNHM, PAL 2019.4.1: (**1**) dorsal view; (**2**) lateral view; (**3**) anterior view; (**4–6**) paratype plaster cast of a sectioned specimen, HNHM, PAL 2019.6.1: (**4**) dorsal view; (**5**) lateral view; (**6**) anterior view; (**7, 8**) paratype MGSH, K 2019.2.1: (**7**) dorsal view; (**8**) lateral view; (**9–11**) paratype MGSH, K 2019.1.1: (**9**) dorsal view; (**10**) lateral view; (**11**) anterior view; (**12, 13**) plaster cast of a sectioned specimen, HNHM, PAL 2019.5.1: (**12**) dorsal view; (**13**) lateral view. All specimens dusted with ammonium chloride. Scale bar = 10 mm.

Etymology.—The species name is honors the outstanding Hungarian geologist, Károly Hofmann.

Materials.—Eight specimens (Table 1).

Remarks.—On the basis of its simple external morphology, our species is rather similar to representatives of several kingenoid genera. Its circular outline is reminiscent of *Kingena* Davidson, 1852 and *Zittelina*; the globose appearance recalls *Tulipina* Smirnova, 1962 or even *Coriothyris* Ovtsharenko, 1983. However, the latter two genera have different types of loop—bilacunar and teloform, respectively. On the other hand, *Kingena* and *Zittelina* bear diploform loops, comparable to the loop of our sectioned specimens. Considering the stratigraphic position of our species (late Valanginian–early Hauterivian), the Tithonian *Zittelina* was preferred as the most closely related genus.

The type species of *Zittelina*, *Z. orbis*, has external similarity to *Z. hofmanni* n. sp.; however, the latter is more globose and reaches greater (nearly double) size. For this reason, we defined it as a new species.

One specimen of our present material was described by Bujtor (2006) as *Zittelina pinguicula*. The generic attribution is endorsed here. On the other hand, we do not confirm the species name, because the anterior commissure of the species *Z. pinguicula* is parasulcate, in contrast to the straight or gently sulcate commissure of our specimens. Moreover, *Z. pinguicula* was designated as type species of the genus *Oppeliella* Tchorszhevsky, 1989.

Family Aulacothyropsidae Dagys, 1972
Subfamily Aulacothyropsinae Dagys, 1972
Genus *Smirnovina* Calzada, 1985

Type species.—Smirnovina smirnovae Calzada, 1985.

Smirnovina ferraria new species
Figures 5.6–5.10, 10, Table 1

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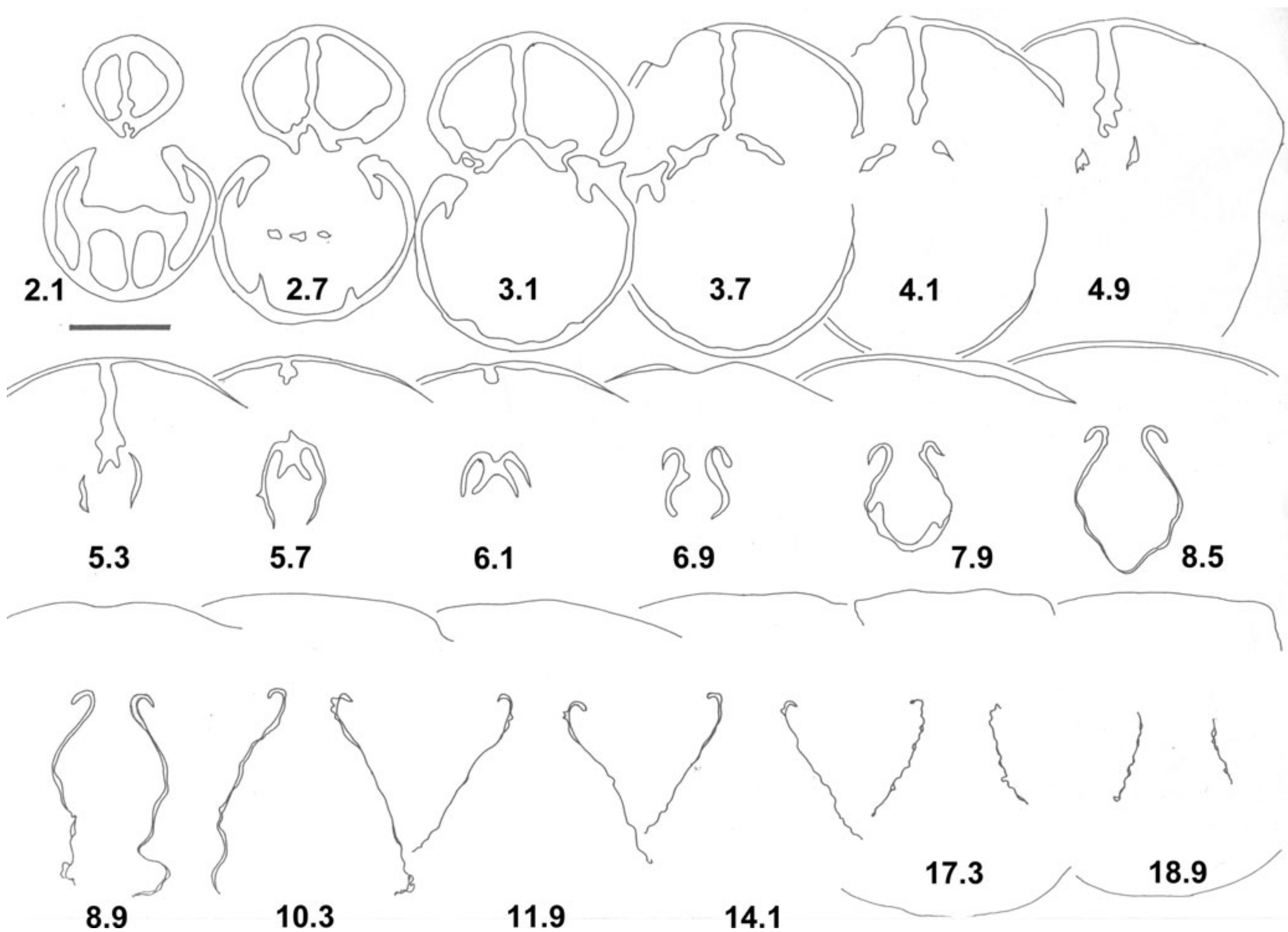

Figure 7. Transverse serial sections of *Zittelina hofmanni* n. sp., paratype HNHM, PAL 2019.5.1, from red, ferruginous limestone, Apátvarasd Limestone Formation, upper Valanginian–lower Hauterivian, Dezső Rezső Valley, Zengővárkony, Mecsek Mountains, Hungary. Original length of specimen = 24.7 mm. Numbers indicate distance from the ventral umbo (in mm). Scale bar = 10 mm.

Type specimens.—Holotype, shelly specimen (HNHM, PAL 2019.3.1) and paratypes (HNHM, PAL 2019.8.1–2019.10.1), upper Valanginian–lower Hauterivian, Apátvarasd Limestone Formation, east of Zengővárkony, Mecsek Mountains, Hungary.

Diagnosis.—Large, globose *Smirnovina*; outline circular to subpentagonal. Beak massive, incurved, depressed. Anterior commissure plicosulcate. Dorsal sinus wide. Ventral valve bicarinate with sharp crests. Shell covered with dense, comarginal imbrications. Septal pillar short; loop reflexed, diploform.

Occurrence.—Basal, red ferruginous limestone bed of the Apátvarasd Limestone Formation, northwestern part of the Dezső Rezső Valley, east of Zengővárkony. Coordinates: 46.18545°N, 18.45299°E.

Description

External characters.—This is a large, globose *Smirnovina*, with a circular to subpentagonal outline. The lateral margins are convex, almost continuously arched; the apical angle is ~90°. The maximum width lies at the approximate midlength. The valves are very strongly convex; the ventral valve attains maximum convexity at midlength; the maximum convexity of the dorsal valve lies posteriorly, near the umbo. After a short biconvex stage, a wide sulcus with a central plica develops on the dorsal valve, which results in a plicosulcate anterior margin. The ventral valve is markedly 'bicarinate' throughout, i.e., the two longitudinal folds, corresponding to the sulci of the dorsal valve, bear distinct crests. The beak is incurved, massive, and depressed. The pedicle opening is poorly seen; delthyrium are not seen. There are no distinct beak ridges. In lateral view, the lateral commissures are nearly straight and gently arched dorsally. The anterior commissure is deeply and widely plicosulcate. The sulcus occupies the central three quarters of the anterior commissure. Except at the ventral crests, the valves have no longitudinal ribbing. The ornamentation consists of numerous, fine comarginal elements; these imbricated growth lines are very regularly and densely spaced and traverse the ventral crests.

Internal characters.—Ventral valve: The delthyrial cavity is oval to subpentagonal in cross section, with some amount of callus. The umbonal cavities are semicircular. The dental plates are strong and laterally arched. A well-developed pedicle collar connects the ventral portion of the dental plates. Deltidial plates were not recorded. The hinge teeth are moderately strong and vertically inserted; denticula are poorly recorded. Dorsal valve:

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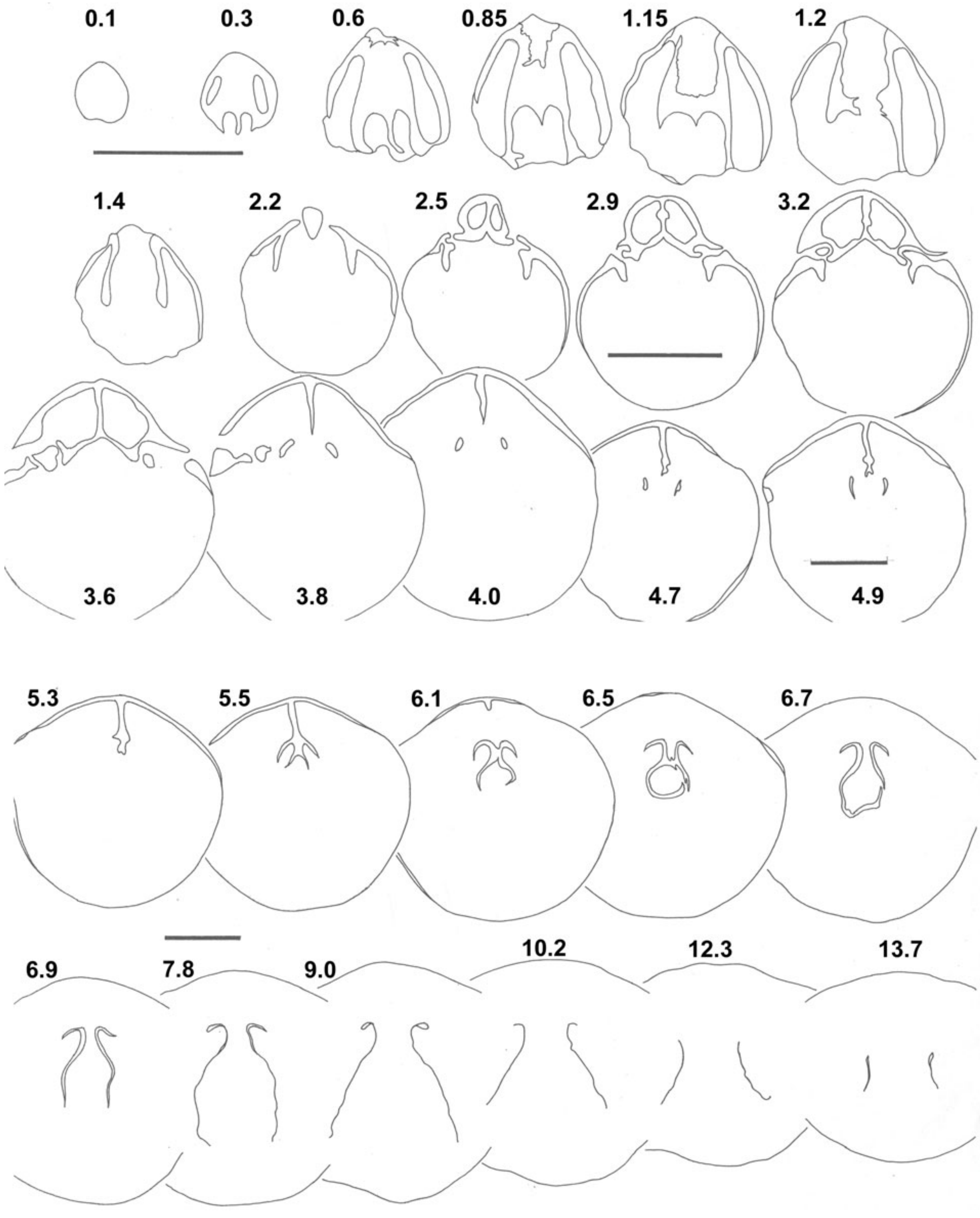

Figure 8. Transverse serial sections of *Zittelina hofmanni* n. sp., paratype HNHM, PAL 2019.6.1, red, ferruginous limestone, upper Valanginian–lower Hauterivian, Zengővárkony, Mecsek Mountains, Hungary. Original length of specimen = 19.1 mm. Numbers indicate distance from the ventral umbo (in mm). Scale bars = 10 mm.

The moderately deep, inverted U-shaped septalium is formed by the hinge plates attached to the ventral median septum. The median septum forms a reinforced septal pillar that almost supports the posterior end of the reflexed loop. Thereafter, the median septum abruptly becomes reduced and disappears. The outer socket ridges are narrow but high. The inner socket ridges are moderately thick and wrap a little around the sockets. The hinge plates are inclined dorsally. The crura are subvertical. The crural processes are high and crescentic in cross section. The loop is diploform; it attains >0.7 times the length of the dorsal

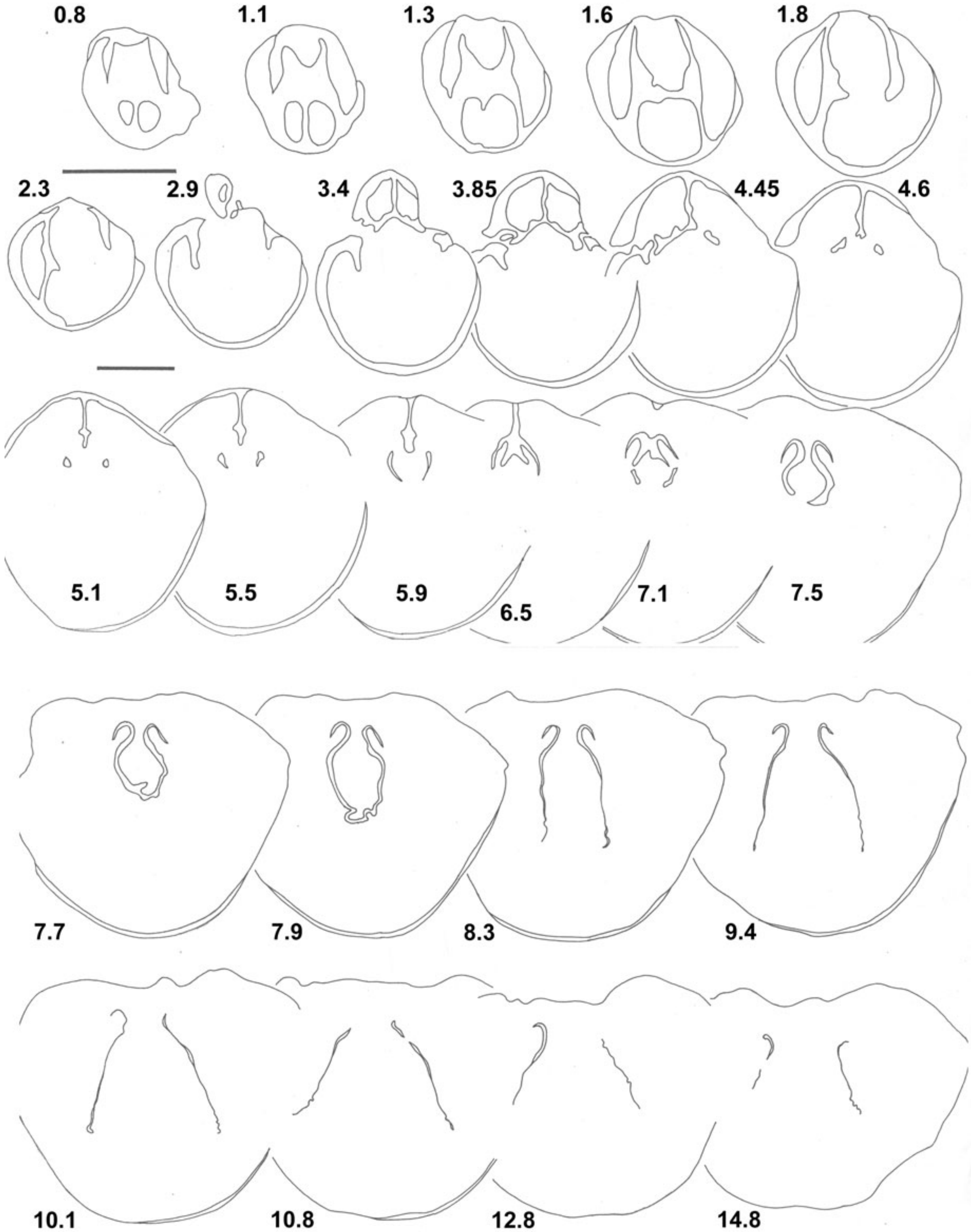

Figure 9. Transverse serial sections of *Zittelina hofmanni* n. sp., paratype HNHM, PAL 2019.7.1, red, ferruginous limestone, upper Valanginian–lower Hauterivian, Zengővárkony, Mecsek Mountains, Hungary. Original length of specimen = 22.6 mm. Numbers indicate distance from the ventral umbo (in mm). Scale bars = 10 mm.

valve. The descending branches are only slightly divergent. The ascending branches are very high, ventrally divergent, and irregularly corrugated; their posterior transverse band is hood-like. The posterior end of the hood is subcircular in cross section and is connected to the descending branches with a transverse element. Signs of flaring and spinosity were seen at the distal termination of the loop.

Etymology.—The species name is derived from the Latin word *ferraria* after the nature of the locality—an abandoned iron ore mine.

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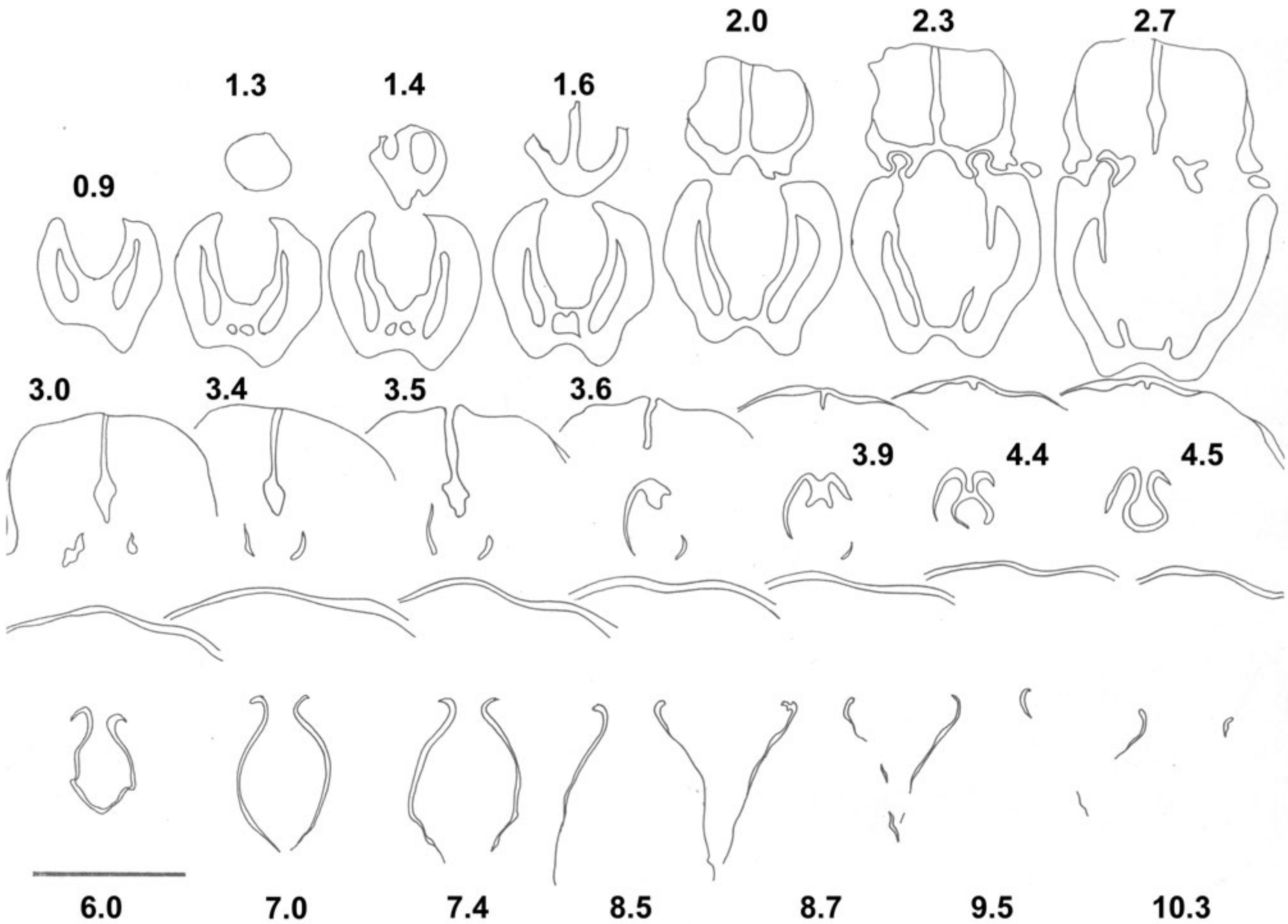

Figure 10. Transverse serial sections of *Smirnovina ferraria* n. sp., paratype HNHM, PAL 2019.8.1, red, ferruginous limestone, upper Valanginian–lower Hauterivian, Zengővárkony, Mecsek Mountains, Hungary. Original length of specimen = 16.4 mm. Numbers indicate distance from the ventral umbo (in mm). Scale bar = 10 mm.

Materials.—Three specimens (Table 1).

Remarks.—*Smirnovina ferraria* n. sp. is rather similar to the type species of the genus, *S. smirnovae* (see Calzada, 1985, pl. 2, figs. 3, 6; also illustrated by Garcia Ramos, 2005, pl. 1, fig. 1), but differs in its greater convexity and size, its more significant comarginal imbrications, and its sharp dorsal crests. Moreover, it is late Valanginian in age whereas the type species was described from the Hauterivian. The apparent discrepancy between the serial sections published by Calzada (1985, fig. 5) and our sections (Fig. 10) are probably due to different orientations of the sectioned specimens.

A single ventral valve, illustrated as ?*Dictyothyropsis* sp. by Krobicki (1996, fig. 8.2), seems to belong to *Smirnovina*, but its comarginal imbrications are much more widely spaced than those of *S. ferraria* n. sp.

Smirnovina sp.
Figure 5.11–5.13, Table 1

Description.—External characters: This is a large *Smirnovina* with elongated subpentagonal outline. The lateral margins are convex; almost continuously arched; the apical angle is ∼80°. The maximum width lies at the approximate midlength. The valves are strongly convex; the dorsal valve attains maximum convexity at midlength; the maximum convexity of the ventral valve lies nearer to the umbo. After a short biconvex stage, a sulcus with elevated central plica develops on the dorsal valve, which results in a plicosulcate anterior margin. The ventral valve is markedly 'bicarinate' throughout, i.e., the two longitudinal folds, corresponding to the sulci of the dorsal valve, start from the umbo. The beak is erect and rather elevated. The pedicle opening is wide and oval. The delthyrium is not seen. There are no distinct beak ridges. In lateral view, the lateral commissures are almost straight. The anterior commissure is deeply plicosulcate. The sulcus occupies a little more than half of the width of the anterior commissure. Except at the ventral crests, the valves have no longitudinal ribbing. The ornamentation consists of irregularly spaced, fine comarginal elements. These imbricated growth lines are best developed near the anterior margin.

Internal characters.—These were not studied because of the paucity of the material (single specimen).

Materials.—One specimen (Table 1).

Remarks.—*Smirnovina* sp. differs from *S. smirnovae* and *S. ferraria* n. sp. by its greater length and more elevated, erect

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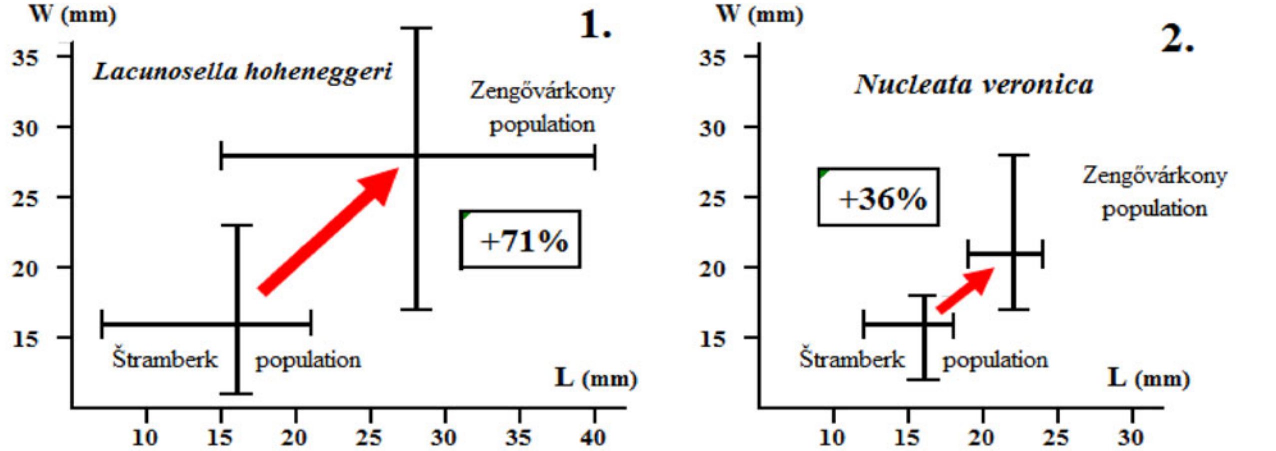
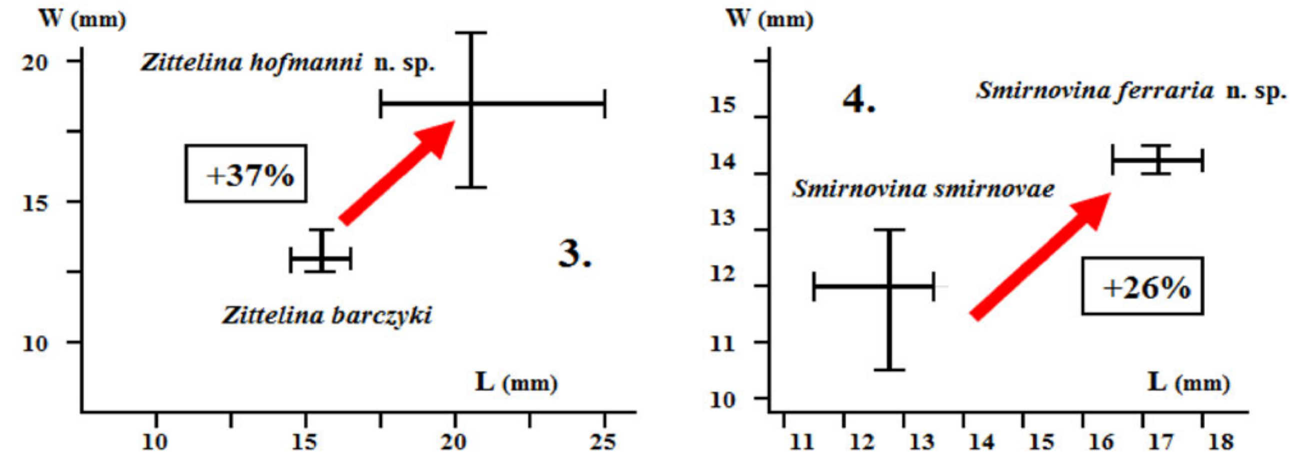


	L_{min}	L_{max}	W_{min}	W_{max}	L_{aver}	W_{aver}	N
Zengővárkony	15.4	39.6	17.0	36.9	26.8	28.0	**34**
Štramberk	7.3	21.2	10.7	22.6	15.7	16.3	**1101**

	L_{min}	L_{max}	W_{min}	W_{max}	L_{aver}	W_{aver}	N
Zengővárkony	18.6	24.2	17.0	28.0	21.8	21.0	**17**
Štramberk	11.6	17.8	11.3	19.0	16.0	16.3	**5**



	L_{min}	L_{max}	W_{min}	W_{max}	L_{aver}	W_{aver}	N
***Z. hofmanni* n. sp.**	17.7	24.7	15.3	20.9	20.6	18.4	**9**
Z. barczyki	14.8	16.4	12.8	13.5	15.4	13.1	**3**

	L_{min}	L_{max}	W_{min}	W_{max}	L_{aver}	W_{aver}	N
***S. ferraria* n. sp.**	16.4	18.0	14.1	14.2	17.2	14.2	**2**
S. smirnovae	11.4	13.6	10.6	13.0	12.8	12.1	**4**

Figure 11. Representation of the general size-increase trend for the Zengővárkony Early Cretaceous brachiopod taxa: (**1**) *Lacunosella hoheneggeri* (Suess, 1858), after Bujtor (2007); (**2**) *Nucleata veronica* Nekvasilova, 1980, after Bujtor (2007); (**3**) *Zittelina hofmanni* n. sp. compared to *Z. barczyki* (Calzada, 1985, p. 88); (**4**) *Smirnovina ferraria* n. sp. compared to *S. smirnovae* Calzada, 1985 (Calzada, 1985, p. 88).

beak. Moreover, its dorsal sulcus bears a marked medial fold. It is probably a different species of *Smirnovina*, but being represented by a single, partly worn specimen in our material, the introduction of a new species is not advisable here.

Results

New material combined with an investigation of older collections derived from the Lower Cretaceous sediments from Zengővárkony (Mecsek Mountains, Hungary) resulted in the recognition of three new brachiopod taxa: *Dictyothyropsis vogli* n. sp., *Zittelina hofmanni* n. sp., *Smirnovina ferraria* n. sp., and *Smirnovina* sp.

Discussion

The described brachiopod taxa show remarkable size increases compared to the mean dimensions of their closest relatives (Fig. 11). This phenomenon is not new for the brachiopods collected from the Lower Cretaceous strata of the Zengővárkony region. Bujtor (2006, 2007) already reported the significant size increase (30–70%) of brachiopods from the unique paleoenvironment at Zengővárkony. The iron ore-related deposit linked to a former hydrothermal sea-floor activity is proven, however, its interpretation is still ambiguous. Jáger and Molnár (2009) reported continental rift-type black smoker chimney remnants from the floor of the Dezső Rezső Valley, however later, these authors (Jáger et al., 2012) changed the interpretation and referred to hydrothermal sediments and the colonization of shrimps around sunken wood debris. Although this possible environmental explanation did not interpret the intimate connection between the sessile brachiopod fauna and the seafloor hydrothermal activity, the peperite and pillow lavas suggest an environment in which both brachiopods and mud shrimps co-occur and lived. Shrimps were living in their burrows in soft calcareous muds and the magma that traversed the soft calcareous sediments provided hard surfaces as pillow lava blocks for brachiopods to attach. That seafloor landscape provided a nutrient-rich environment in which the constituents of the fauna lived. Another similar environment was described by Agirrezabala and López-Horgue (2017) from the Albian of Cantabria (Spain), where hot fluid upwelling provided special ammonoid ecotopes with large-sized ammonite remains—also the case at Zengővárkony. However, further data are needed to compare these localities. The better than average environmental conditions could be responsible for the size increases in the brachiopod fauna. This study strengthens previous observations on the remarkable size increases of the brachiopods linked to the iron-ore deposit around seafloor hydrothermal activity.

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