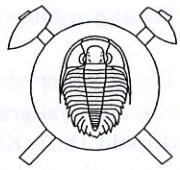
New lingulate brachiopods from the top of the Klabava Formation (Lower Ordovician, Arenig, Bohemia)



Noví lingulátní ramenonožci z nejvyšší části klabavského souvrství (spodní ordovik, arenig, Čechy)

(1 text-fig., 4 plates)

MICHAL MERGL

Západočeská univerzita, Pedagogická fakulta, Katedra biologie, Klatovská 51, 320 13, Plzeň, Czech Republic

New lingulate brachiopod genera *Fagusella* (type species *F. indelibata* sp. n.) and *Lithobolus* (type species *L. plebeius* sp. n.), and associated fauna of genera *Numericoma, Westonia*, and *Elkania* are described from the uppermost part of the Klabava Formation (Arenig, Ordovician). Stratigraphic ranges of the described species are discussed.

Key words: Brachiopoda, Lingulata, Ordovician, Arenig, Bohemia

Introduction

The marginal tuffaceous lithofacies in the upper part of the Klabava Formation contain abundant and often quoted (Havlíček - Šnajdr 1957, Havlíček - Vaněk 1966, Havlíček 1982, 1989) fauna of lingulate brachiopods. These are extremely frequent in finely laminated tuffaceous rocks with abundant dalmanellid *Nocturnellia nocturna*, scarce additional orthid brachiopods (Havlíček 1977, Mergl 1991) and rare, so far undescribed ramose trepostomate bryozoans. However, the lingulate fauna was never taxonomically described and evaluated from this stratigraphic level, except for figured but formally undescribed valve of minute acrotretacean (Havlíček 1980), and a description of acrothelid *Orbithele rimosa* (Mergl 1981). New, favorable preserved material of lingulate brachiopods was obtained from whitish bioclastic limestones and intercalated reddish tuffaceous shales.

Collections

Figured material is deposited in paleontological collections of the Museum of Dr. B. Horák at Rokycany, Czech Republic (No. MR 1/96/1-MR 1/96/26) and in the Paleontological Museum, Uppsala, Sweden (No. TJ 1-TJ 5). Other studied material is deposited in the author's collection deposited in the Department of Biology, University of West Bohemia, Plzeň.

Material

Brachiopod shells (internal, external moulds and original shells) were obtained by hammering but the minute shells were also successfully isolated from the rock by etching. The isolated valves were separated from thin (5-10 mm) intercalations of tuffaceous bioclastic limestone in the grey-green or reddish tuffaceous clayey shale. The carbonate matrix of the intercalations is built up of shell fragments of orthid brachiopod *Nocturnellia nocturna* but minute phosphatic bioclasts are visible by naked eye. The rock was commonly treated by 10 % acetic acid, which dissolved calcareous shells of articulate brachiopods, making the rock pieces porous. Because of partial silicification of calcareous shell fragments, the rock was mechanically broken up into small pieces and phosphatic shells picked up. Part of residuum was cleaned by a weak solution of hydrofluoric acid after drying. The procedure removes siliceous superficial cover on phosphatic shell surfaces but usually leads to fragmentation of the valves.

Localities

All isolated material came from the gangue of an old dump of the Josef gallery at the north slope of the Bukov hill near Zbiroh (Lipold 1863) and from the drilling core of borehole B145 at Sklenná Huť. Additional material was obtained by hammering from several localities (mostly abandoned old ore mines) along the northwestern margin of the Prague Basin (localities Ejpovice, Klabava, Osek, Rač).

The survey of localities.
1) Bukov, the gallery Josef: tuffaceous shales with bioclastic intercalations in an old dump near abandoned Josef gallery in N slope of the Bukov hill near Zbiroh. 2) Rač: tuffites and tuffaceous shales in small dumps at foot of the Rač hillside. 3) Osek: tuffites and tuffaceous shales in an old dump in the fields W of the village. The dump has been recently destroyed by recultivation. 4) Klabava: tuffites and tuffaceous shales in old dump of Kristiánka gallery. 5) Ejpovice: tuffites in E and N part of the open pit and haematite oolith intercalations along lower Ordovician cliff (Mergl 1983, 1991). 6) Mýto: tuffites in an abandoned quarry near the Štěpánský pond (Mergl 1991). 7) Sklenná Huť: whitish bioclastic limestones in drilling core B145, depth 106.6 m.

Stratigraphic setting

The brachiopods came from old dumps material with obscure stratigraphic position. Based on indirect data (Lipold 1863, Klouček 1924, Havlíček - Vaněk 1966), the brachiopod assemblage is restricted to the uppermost part of the Klabava Formation, immediately below the lowermost oolitic iron ores of the Šárka Formation.

In the Bukov locality, the rock material of an old dump contains four slightly different fossil assemblages, which may reflect original stratigraphic succession. There are (in suggested upward sequence of strata): 1) grey fine clayey shales bearing graptolite fauna of *Tetragraptus reclinatus abbreviatus* Biozone with few lingulate brachiopods (mostly large *Eosiphonotreta verrucosa*). 2) Grey and red shales with higher admixture of quartz grains, phosphatic clasts and volcanic glasses contain numerous fragments of lingulate brachiopods, mostly of genera *Celdobolus, Acrotreta, Eosiphonotreta, Orbithele* and *Numericoma.* 3) The grey-green and reddish-brown tuffaceous shales do not contain substantial sandy admixture but thin intercalations of bioclastic limestones with *Nocturnellia nocturna* are common. These shales and limestones, probably the very top of the Klabava Formation, are covered by 4) oolitic iron ores, mined here in the 19th century, which rarely contain macrofossils (*Celdobolus* sp.)

The stratigraphic site of the newly described brachiopod faunule also indicates the topmost position in the Klabava Formation in the locality Ejpovice. The the most common lingulate brachiopods, with *Lithobolus, Orbithele, Elkania, Numericoma* but without *Fagusella* are distributed in the level 5-1 m below the base of the Šárka Formation which is developed as massive oolitic iron ores.

Consequently, the lingulate assemblage can be used as significant stratigraphic marker in marginal inshore lithofacies of the top of the Klabava Formation.

Taphonomy and paleoecology

Lithology and taphonomy of the lingulate brachiopod occurrences indicate very shallow intertidal to the shallowest subtidal environment with shell breakage, abrasion and winnowing processes. The activity of the currents is indicated by formation of lenticular accumulations of shells and thick laminae of size-sorted shells. This is evident mainly in the area between Zbiroh and Březina. In Ejpovice, the fragmental lingulate shells are numerous in layers of oolitic iron ores which form thin irregular intercalations in a tuffaceous sequence. Oolitic material together with clay, sandy grains, small pebbles and phosphatic bioclasts were removed from the foreshore to moderate deeper inshore. Foreshore habitat of lingulate brachiopods is also documented by their presence in the beds of iron ores which immediately cover the ancient cliff of the same age (Mergl 1983).

Taxonomical composition of samples is recurrent, indicating formation of the distinct benthic assemblage. *Numericoma vulcanogena, Lithobolus plebeius* and *Orbithele rimosa* are generally common, *Elkania lineola* is rare, the frequency of *Fagusella indelibata* varies from the abundance to total absence. The quantity of orthid *Nocturnellia nocturna* varies from the absolute abundance to the absence. It seems probable that life assemblages with dominance of lingulate brachiopods and the dominance of orthids, respectively, were spatially separated; the intercalations with *Nocturnellia* contain few lingulates whereas other layers are rich in lingulates but devoid of the carbonate shells. Other characteristic elements are much less frequent in studied samples: the typical *Nocturnellia nocturna* assemblages contain rare orthid brachiopods of genera *Prantlina, Nereidella* and *Poramborthis,* ramose trepostomate bryozoans, whereas lingulate-rich *Lithobolus* assemblage commonly contains *Supinella ovata* and other phosphatic problematica. Pitted phosphatic fragments which could be remains of exoskeleton of a large merostomate (?) arthropod are common.

The *Lithobolus* assemblage is similar to the *Leptembolon-Thysanotos* assemblage in the East European Lower Ordovician as defined by Popov - Holmer (1994, 1995) by a presence of medium-sized lingulate brachiopods and *Orbithele*. However, a rarity of obolids and a higher frequency of minute acrotretid brachiopods and zhanatellids indicate higher dominance of microbrachiopods than is characteristic of the *Leptembolon-Thysanotos* assemblage.

Systematic part

Class *Lingulata* Gorjansky & Popov, 1985
Order *Lingulida* Waagen, 1885
Superfamily *Lingulacea* Menke, 1828
Family *Obolidae* King, 1846
Subfamily *Obolinae* King, 1848

Genus *Westonia* Walcott, 1901

Type species: *Lingula aurora* Hall, 1861

Westonia sp.

Pl. IV, figs. 1-3.

Material: Two valves, several fragments.

Description: Shell large, thick-walled, broadly elongate oval, with acuminate beak, about 15 mm long in the largest specimen available.

Ventral valve 130 % as long as wide, with maxi-

mum width anterior to midlength. Valve gently convex transversally and longitudinally, tending to be depressed anteriorly. Anterior margin semicircular, lateral margins less curved to become straight posteriorly. Beak angle about 100°-110°.

Shell surface with coarse, irregularly spaced growth lamellae, usually arranged into few bands and more crowded anteriorly. The concentric ornamentation of fine concentric fila, about 7 per 1 mm along midline of the valve. The flanks and the umbonal region of the valve are covered by asymmetrical terrace lines, arranged in more or less regular intervals, which taper toward median sector of the valve. As may be inferred from the available material, terrace lines arrangement is rather variable, ranging from the subparallel chevron-like to zig-zag divaricate patterns. Terrace lines never branch out, they run continuously from the shell margin toward smooth median sector of the valve. Anterior edge of terraces is very steep, slightly irregular. There are 4-6 terrace lines along lateral periphery of the large specimens. The boundary between smooth median sector and area bearing terrace lines is quite irregular but symmetrical along the plane of symmetry.

Ventral valve interior with deep, relatively short, strongly expanding pedicle groove. Pseudointerarea of obolid type, orthocline, strongly raised above valve floor, with steep, high anterior slope. Flexure lines are not preserved, but they probably run parallel to sides of pedicle groove, weakly limiting very narrow inner propareas. Such arrangement of flexure lines can be inferred from the shape of adjacent visceral field. The surface of propareas are covered by coarse growth lines which are curved backward in proximity of the pedicle groove. Ventral visceral field about 30% as wide as the valve and less than 25% as long as valve, weakly impressed, indicated by smoother surface than remaining valve floor, subrectangular in outline. Anterior border of the field is formed by a pair of rather small and weakly impressed muscle scars. Other muscle scars are not impressed. The entire valve floor possesses irregularly disposed large, deep circular pits, less numerous in visceral field.

Discussion: As noted previouly, genus *Westonia* probably comprises species derived from different stocks and the terrace lines have appeared independently as a result of similar habitat (Mergl - Šlehoferová 1990). The similar terrace lines are known also on other obolids (*Spinilingula*, *Westonisca*) as well as in glossellids (*Glossella*) (Krause - Rowell 1975, Savazzi 1986). *W. linguloides* (Kobayashi) from the Lower Ordovician of Yukon (Ulrich - Cooper 1938) is rather similar to the Bohemian species but differs by more acuminate valves and narrow, less expanded pedicle groove. Havlíček (1982) assigned three Bohemian species possessing terrace lines to new genus *Westonisca*, with type species *W. lamellosa* (Barrande). While the type species can be well differentiated by almost flat ventral valve, shallow and narrow pedicle groove and undulated concentric rugellae, the species *Westonisca ovata* Havlíček from the Třenice Formation displays higher similarity with flanks having oblique terrace lines. Therefore, the relationship between *W. ovata* and *Westonia* sp. needs supplementary study.

Occurrence: Bukov (rare).

Subfamily *Lingulellinae* Schuchert, 1893

Genus *Lithobolus* gen. n.

Type species: *Lithobolus plebeius* gen. et sp. n.

Diagnosis: Shell dorsi-biconvex, thick-walled, with moderate ventral pseudointerarea and obscure flexure lines; pedicle groove deep, broadly triangular, rapidly widening anteriorly. Visceral area poorly defined, with small umbonal and posterolateral scars posteriorly located, anterolateral muscle scars obscure. Dorsal valve with well defined pseudointerarea gently raised above valve floor; median groove broad. Ornamentation of fine concentric fila.

Comparison: Although the taxonomy of linguloid brachiopods is an intricate problem, the moderate sized pseudointerareas with obscure flexure lines and the broadly triangular shape of pedicle groove of *Lithobolus* are quite dissimilar to pseudointerareas and shape of pedicle groove of *Lingulella davisii* M'Coy. The broad diagnosis of *Lingulella* Salter, as proposed by Krause - Rowell (1975), is not fully accepted here. The present author considers that the combination of the size and shape of pseudointerareas, shell thickness and the internal characters can well define minor generic groups and split a plethora of species included into genus *Lingulella* Salter.

Lithobolus plebeius sp. n.

Pl. I, figs. 1-6

Holotype: Ventral valve figured on Pl. I, fig. 3 (MR 1/96/11).

Type horizon: Arenig, Klabava Formation, the uppermost part.

Type locality: Bukov, old dump near Josef gallery.

Description: Shell of moderate size, dorsi-biconvex, with moderate thick shell wall, 9 mm long in adults.

Ventral valve elongate oval to broadly drop-like in outline, 120-150 % as long as wide, with evenly rounded lateral and front margins, maximum width slightly anterior to midlength. Shell wall thickened anteriorly, forming wide, flat to even feebly convex brim along anterior periphery. Valve slightly convex in transverse and lateral profiles, the maximum depth at posterior third. Ventral pseudointerarea orthocline to slightly apsacline, rather small and short, some 40 %

as wide as valve, without distinct flexure lines. Propareas distinctly raised above valve floor. Pedicle groove large, deep, narrow apically but its sides diverge at 40°-50° anteriorly; its bottom is in the same level as the valve floor. Surface of propareas bears coarse growth lines of uneven size which also cover the bottom of the pedicle grove.

Ventral valve interior with obscure visceral area. Muscle scars poorly impressed; a pair of umbonal muscle scars minute, obliquely elliptical in outline, located laterally to internal opening of the pedicle groove. Posterolateral muscle scars small, located anteriorly to lateral extensions of propareas. Anterolateral muscle scars probably extensive but devoid of distinct borders, situated at midlength of the valve. Pallial markings not preserved. Valve floor bears prominent pits of uneven size, which are irregularly scattered on the visceral area but arranged along concentric rows in anterior half of the valve. The rows seem to correspond to the coarser growth lines on exterior and reflect the interruption of the shell growth.

Dorsal valve elongate oval, with rounded beak, elongate oval in outline, about two times convex than the opposite valve. The beak evenly curved, the maximum width at midlength. Dorsal pseudointerarea gently raised above valve floor, not excavated anteriorly, with transverse anterior edge. The length of pseudointerarea about 10 % of the valve length. Median groove broad, laterally bounded by minute propareas which run gradually into lateral margins. Surface of the pseudointerarea with fine, distinct transverse growth lines. Dorsal valve interior is devoid of distinct muscle scars and median ridge. A pair of oblique muscle scars is located anterolaterally to the sides of median groove. Central muscle scars obscure. Fine radial lines extend from the visceral field in the median sector of the valve. Pallial markings not impressed.

Ornamentation of fine concentric fila alternating with evenly spaced, weak concentric lamellae.

Occurrence: Bukov (frequent), Ejpovice (frequent).

Family *Elkaniidae* Walcott & Schuchert, 1908

Genus *Elkania* Ford, 1886

Type species: *Obolella desiderata* Billings, 1862

Elkania lineola (Havlíček, 1982)

Pl. I, figs. 7, 8

1982 *Elkanisca lineola* sp. n.; Havlíček, p. 52, Pl. 1, fig. 9, 12, Pl. 15, figs. 1, 3.

Remarks: In revision of *Elkania,* few specimens, previously attributed to *Elkanisca klouceki* by Havlíček (1982), were re-assigned to species *Elkania lineola* by Mergl (1994). However, the shells from the earlier part of the Klabava Formation (*Corymbograptus v-similis* and *Hologroptus tardibrachiatus* Biozones) probably belong to other species than elkaniid from the top of the Klabava Formation. Unfortunately, the holotype and topotypic specimens of *E. lineola*, coming from *Tetragraptus reclinatus abbreviatus* Biozone are not preserved enough and do not show undeformed outline and shape of the pallial markings.

Two specimens from the top of the Klabava Formation (figured here in Pl. I, figs. 7, 8) as well as the holotype differ from the stratigraphically older Bohemian specimens of the same genus by less circular shell, with maximum width in posterior third whereas stratigraphically older specimens are almost circular with maximum width at midlength. Also, pallial markings in ventral valve interior of the earlier specimens are more divergent (cf. Mergl 1994; Pl. 2, figs. 2a, 5, 6a). Nevertheles, more extensive new material is necessary to confirm differences between these specimens.

Occurrence: Klabava (Old castle locality) (rare), Ejpovice (rare), Bukov (rare).

Family *Zhanatellidae* Koneva, 1986

Genus *Fagusella* gen. n.

Type species: *Fagusella indelibata* sp. n.

Diagnosis: Shell dorsi-biconvex to convexo-concave, thick walled, with geniculate flanks of dorsal valve. Ventral valve thick walled both apically and anteriorly, subrectangular, with extremely broad and deep pedicle groove, and ventral beak cutted by large triangular emarginature. Ventral pseudointerarea short, steeply apsacline, highly raised above valve floor, with cavities anteriorly. Ornamentation of distinct concentric rugellae. Visceral fields large, feebly marked but bordered by a complex of deeply impressed muscle scars in both valves.

Comparison: Family *Zhanatellidae* is characterized, among others, by deep semicircular emarginature in ventral beak and deep pedicle groove (Koneva 1986, Popov - Holmer 1994). The new genus, although in external shape resembles genus *Zhanatella* Koneva, can be differentiated by extremely broad and deep pedicle groove and short ventral pseudointerarea with minute propareas. Dorsal visceral field of *Zhanatella* is small and short whereas it is large, deeply impressed in the new genus. Dorsal valve of the new genus is geniculate in a transverse profile but such geniculation is unknown in *Zhanatella.* Genus *Rowellella* Wright is similar to the new genus but the former differs by lamellose external ornamentation, thin-shelled ventral beak and always dorsi-biconvex shell. *Fagusella* can be derived from the same ancestor as *Rowellella* but unlike the latter genus, posterior part of the shell is

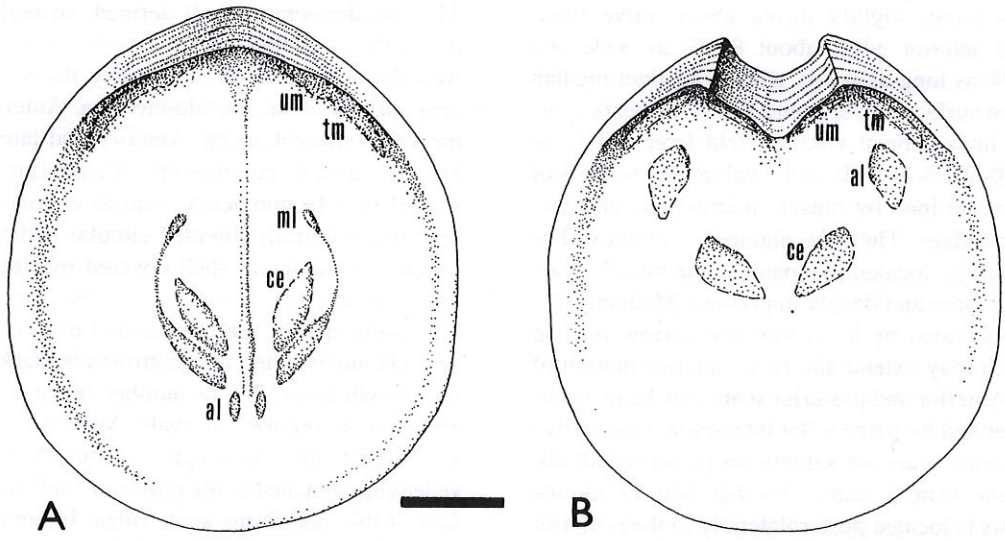


Fig. 1. *Fagusella indelibata* sp. n.
Schematic drawing of dorsal valve interior (A) and ventral valve interior (B). Scars: al - anterior lateral muscles, ce - central muscles (in ventral valve together with middle and outside lateral muscles), ml - middle lateral muscles, ol - outside lateral muscle scars, tm - transmedian muscles, um - umbonal muscles. Bar 1 mm

thickened, morphologically modified by extremely stout pedicle and external rugellae are never extended into lamellae. The pitted postlarval microornamentation which is a significant feature of the family *Zhanatellidae* is unknown in *Fagusella*, but this could be due to preservation.

Fagusella indelibata sp. n.

Pl. I, fig. 9; Pl. II., figs. 1-11; Text-fig. 1

Holotype: Ventral valve figured on Pl. II, fig. 11 (MR 1/96/12b).
Paratypes: Ventral valve figured on Pl. II, fig. 9 (MR 1/96/12a) and dorsal valve figured on Pl. II, fig. 5 (MR 1/96/16).
Type horizon: Arenig, Klabava Formation, the uppermost part.
Type locality: Bukov, old dump near the Josef gallery.
Material: Several dozen specimens, many fragments.

Description: Shell of medium size, 6-6.5 mm in a length, dorsi-biconvex, convexo-plane to convexo-concave, thick-walled, rather variable in convexity and outline.

Ventral valve thick-walled posteriorly but even more thickened anteriorly, subrectangular to even transversally oval in minute sized specimens, but always elongate oval with subparallel lateral margins in large specimens. Anterior margin semicircular, evenly curved, posterior margin with deep emargination at the beak. The valve usually flat to weakly convex in lateral profile, but rarely the slightly concave valves are present in samples. Valves almost flat to slightly convex in median part but with geniculate flanks in a transverse profile. Ventral pseudointerarea apsacline, formed by highly raised minute propareas, with cavities beneath their anterior edge. Pedicle groove extremely large, broad, about 40 % as wide as valve but rather short, distinctly elevated above adjacent valve floor. An outline of the groove is broadly V-shaped, with median part remarkably extending anteriorly. The bottom of the groove bears coarse growth lines parallel to its anterior edge. Ventral visceral field poorly defined, broadly rhomboidal in outline, not extending behind the midlength of the valve. Anterolateral muscle field rather large, deeply impressed, separated from each other by a long, tongue-like extension of the visceral field. Posterolateral muscle scars poorly defined, large, narrowly crescentic, with their posterior points hidden in umbonal cavities and extending just anteriorly to propareas. A pair of narrow transverse umbonal muscle scars lie in front of sides of pedicle groove. Other pair of muscle scars is impressed posterolaterally to anterolateral scars in some specimens. Vascula lateralia obscure, their proximal parts are broad and flat.

Dorsal valve moderately thick posteriorly but thick-walled anteriorly, with prominent changes of the outline during the ontogeny; neanic valves (up to length 2.5 mm) are subcircular to slightly longer than wide, strongly convex. Medium sized specimens become elongate oval, with parallel or feebly curved lateral margins but the adult specimens (6.5 mm in a length) are elongate oval, about 130 % as long as wide, with slightly curved sides. Adult valves highly convex in a transverse profile, lateral profile strongly convex, with maximum height posterior to midlenght. Dorsal pseu-

dointerarea large, slightly raised above valve floor, with sharp anterior edge, about 80 % as wide and about 10 % as long as valve, without distinct median groove. The surface of the pseudointerarea bears coarse growth lines. Dorsal visceral field large, 80 % as long and 50-60 % as wide as the valve. The borders of the field are defined by muscle impressions and thin but distinct ridges. The musculature is complex. The largest, centrally located two pairs of the muscle scars are oblique, large and deeply impressed. Medianly, the scars are separated by long, low and narrow median ridge, which may extend almost to anterior margin of the valve. Anterior and posterior scars may be in a contact or separated by narrow flat interspace. One or two pairs of minute scars are sometimes preserved anteriorly to large central scars. Another pair of minute muscle scars is located posterolaterally to the posterior central scar; low curved ridges connect to posterior corner of anterior central muscle scars and these posterocentral scars. Poorly impressed two pairs of muscle scars are disposed in front of lateral edges of pseudointerarea. The thickened shell wall forms a wide convex brim along anterior and lateral periphery of the dorsal valve.

Ornamentation of regularly spaced fine rounded rugellae of uniform size, 16-18 per 1 mm, which never extend into lamellae.

Occurrence: Bukov (frequent), Rač (frequent).

Order *Acrotretida* Kuhn, 1949
Superfamily *Acrotretacea* Schuchert, 1893
Family *Acrotretidae* Schuchert, 1893
Subfamily *Ephippelasmatinae* Rowell, 1965

Genus *Numericoma* Popov, 1980

Type species: *Numericoma ornata* Popov, 1980

Numericoma vulcanogena sp. n.

Pl. III, figs. 1-5; Pl. IV, figs. 4-7

1980 *Conotreta turricula* sp. n., Havlíček, p. 298, Pl. I, fig. 4 (partim).

Holotype: Ventral valve, figured on Pl. IV, fig. 4 (MR 1/96/24).

Type horizon: Arenig, Klabava Formation, the uppermost part.

Type locality: Bukov, dump near the Josef gallery.

Material: Several hundreds of specimens preserved in shales (internal and external moulds, often with remains of original shell), 30 isolated ventral valves, 15 isolated dorsal valves and many fragments.

Description: Ventral valve acute, high, asymmetrical and straight cone, in the largest valves (about 1.4 high), the height is equal to its maximum width. Shell thick-walled, with more thickened pseudointerarea. The pseudointerarea well defined, strongly flattened, distinctly apsacline in all growth stages. Interridge well defined, rather broad, poorly raised above adjacent surface of the pseudointerarea. Anterior slope of the valve straight, steep. Anterior and lateral margins evenly curved, commissure rectimarginate. Larval shell 0.18-0.19 mm across, almost circular, perforated by posteroventrally directed circular pedicle foramen. Surface of the larval shell covered by fine protegular pits of double size. Surface of postlarval shell covered by closely spaced fila intercalated by finer growth lines. The interruption of the growth is marked by coarser growth lines, 3-5 in number in large specimens, arranged in regular intervals. Ventral valve interior with pedicle tube (its length is about 25 % of the valve length), attached to the posterior shell wall. Anterior face of the tube forms acute ridge. Internal surface of pseudointerarea bears two slightly diverging ridges extending from the apical chamber, corresponding to borders of interridge. Muscle scars not recognized in the material available.

Dorsal valve transversally elliptical, relatively thick-walled, 65-66 % as long as wide. Maximum width immediately posterior to midlength. Lateral margins evenly curved, passing gradually into less curved anterior margin, and posteriorly passing into straight posterior margin. Valve weakly convex, with broadly triangular flattened median sector and dorsally slightly raised posterolateral parts. Larval shell subcircular, weakly convex, with distinct borders raised above surface of postlarval shell.

Dorsal pseudointerarea elongate subtriangular, with distinct median groove narrower than adjacent propareas. Dorsal median septum high, extending from thick callus in front of median groove to 75-80 % of the valve length. The shape of median ridge changes prominently during ontogeny. The neanic specimens have septum formed as high vertical plate, at the crest with a few spinose, asymmetrically arranged projections. The adult specimens have strongly thickened base of massive septum. About 15 spinose projections at the top of the septum projections are directed anteriorly in an irregular circle. Dorsal cardinal muscle scars weak in neanic shells but extensive, elongate oval, 75 % as long as wide in gerontic specimens.

Surface of larval shell with fine, circular protegular pits. The diameter of pits varying, there are two main size groups (up to 1.8 μm across). The size of pits rapidly diminishes toward borders of larval shell and raised border is even smooth. Dorsal larval shell with poorly defined posteriorly situated central mode. Neanic and adult dorsal valve covered by concentric rugellae of uniform size.

Comparison: New species differs from specimens from the Lower Ordovician Holen Limestones assigned by Holmer (1989) to *Numericoma*? *spinosa* (Biernat) by much thickened base of median septum,

more robust median septum supported anteriorly by a stout callosity and more transverse outline of the dorsal valve. Ventral valves of the Swedish specimens are curved in lateral view and pedicle foramen is smaller and situated more apically compared with *N. vulcanogena*. *N. perplexa* from the Furundal Limestone of Dalarna (Holmer 1989) has more circular outline of dorsal valve, coarsely rugellate ornamentation, gracile funnel-shaped dorsal median septum and different shape of ventral protegular shell. Typical specimens of *N. spinosa* (Biernat 1973) from Llanvirn of north-eastern Poland differ by less massive dorsal septum and funnel-shaped arrangement of septal spines. Specimens assigned by Bednarczyk & Biernat (1978) to *N. spinosa* from the Arenig of the Kielce region of the Holy Cross Mountains are more similar to Bohemian species, but the neanic specimens of *N. vulcanogena* never have developed surmounting plate.

Remarks: Havlíček (1980) figured dorsal valve exterior and attributed it to the species *Conotreta turricula*. Transversally oval outline and shape of ornamentation, together with locality data make assignment to species *N. vulcanogena* highly probable, although no data about interior of Havlíček's specimen are known.

Fossil occurrences of *N. vulcanogena* are highly dependent on lithofacies and, consequently, on the paleoenvironment. *N. vulcanogena* is an index species of relatively shallow water environment of the basin. Tuffaceous shales, tuffaceous limestones and tuffs are locally very rich in shells. The deeper basinal facies contain the shells of *Numericoma vulcanogena* only in a belt along the contact with the shoreward tuffaceous lithofacies. The oldest stratigraphic occurrence of *N. vulcanogena* in Bohemia is not well known but probably is coeval with occurrence of a graptolite *Tetragraptus reclinatus abbreviatus*, the index species of *Tetragraptus reclinatus abbreviatus* Biozone. *N. vulcanogena* is very frequent in the top of the Klabava Formation and crosses the Klabava and Šárka Formations boundary. It dissappears with the first records of the biserial graptolites (*Climacograptus novaki* Perner) above the base of the Šárka Formation.

Occurrence: Bukov (frequent), Rač (frequent), Sklenná Huť (frequent), Mýto, highway cut (uncommon), Ejpovice (rare to frequent), Klabava (frequent), Osek (frequent), Komárov (uncommon).

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References

Bednarczyk, W. - Biernat, G. (1978): Inarticulate brachiopods from the Lower Ordovician of the Holy Cross Mountains, Poland. - Acta paleont. pol., 23, 293-316. Warszawa.

Biernat, G. (1973): Ordovician inarticulate brachiopods from Poland and Estonia. - Palaeont. pol., 28, 1-120. Warszawa.

Havlíček, V. (1977): Brachiopods of the order Orthida in Czechoslovakia. - Rozpr. Ústř. Úst. geol., 44, 1-327. Praha.

- (1980): Conotreta Walcott (Brachiopoda) in the Lower Ordovician of Bohemia. - Věst. Ústř. Úst. geol., 55, 5, 297-299. Praha.
- (1982): Lingulacea, Paterinacea, and Siphonotretacea (Brachiopoda) in the Lower Ordovician sequence of Bohemia. - Sbor. geol. Věd, Paleont., 25, 9-82. Praha.
- (1989): Climatic changes and development of benthic communities through the Mediterranean Ordovician. - Sbor. geol. Věd, Geol., 44, 79-116. Praha.

Havlíček, V. - Šnajdr, M. (1957): Faciální vývoj skidavu, llanvirnu a llandeila v Barrandienu. - Sbor. Ústř. Úst. geol., Geol., 23, 1, 549-600. Praha.

Havlíček, V. - Vaněk, J. (1966): The biostratigraphy of the Ordovician of Bohemia. - Sbor. geol. Věd, Paleont., 8, 7-69. Praha.

Holmer, L. (1989): Middle Ordovician phosphatic inarticulate brachiopos from Västergotland and Dalarna, Sweden. - Foss. and Strata, 26, 1-172. Oslo.

Klouček, C. (1924): Nové zprávy z vrstev komárovských dß (Dd$_1$ß). - Sbor. Stát. geol. Úst., 4, 199-204. Praha.

Koneva, S. P. (1986): Novoje semejstvo kembrijskich bezzamkovych brachiopod. - Paleont. Ž., 49-55. Moskva.

Krause, F. F. - Rowell, A. J. (1975): Distribution and systematics of the inarticulate brachiopods of the Ordovician carbonate mud mound of Meiklejohn Peak, Nevada. - Palaeont. Contr., 14, 1-74. Lawrence.

Lipold, M. V. (1863): Die Eisensteinlager der Silurischen Grauwackenformation in Böhmen. - Jb. geol. Reichanst., 13, 3. Praha.

Mergl, M. (1981): The genus Orbithele (Brachiopoda, Inarticulata) from the Lower Ordovician of Bohemia and Morocco. - Věst. Ústř. Úst. geol., 56, 5, 287-292. Praha.

- (1983): Rocky-bottom fauna of the Ordovician in Bohemia (Arenigian, Prague Basin, Barrandian area). - Věst. Ústř. Úst. geol., 58, 6, 333-348. Praha.
- (1991): Arenig (Lower Ordovician) orthide brachiopods from Prague Basin, Bohemia. - Čas. Mineral. Geol., 36, 1, 1-13. Praha.
- (1994): Inarticulate brachiopod genera Elkania Ford and Elkanisca Havlíček in the Lower Ordovician of Bohemia. - Věst. Čes. geol. Úst., 69, 4, 47-55. Praha.

Mergl, M. - Šlehoferová, P. (1990): Middle Cambrian inarticulate brachiopods from Central Bohemia. - Sbor. geol. Věd, Paleont., 31, 65-10. Praha.

Popov, L. E. - Holmer, L. (1994): Cambrian-Ordovician lingulate brachiopods from Scandinavia, Kazakhstan, and South Ural Mountains. - Foss. and Strata, 35, 1-156. Oslo.

- (1995): Distribution of brachiopods across the Cambrian-Ordovician boundary on the East European plate and adjacent areas. - In: *J. D. Cooper - M. L. Droser - S. C. Finney:* Ordovician Odyssey, 117-120. Las Vegas.

Savazzi, E. (1986): Burrowing sculptures and life habits in Paleozoic lingulacean brachiopods. - Paleobiology, 12, 1, 46-63. Chicago.

Ulrich, E. O. - Cooper, G. A. (1938): Ozarkian and Canadian Brachiopoda. - Bull. Geol. Soc. Amer., 13, 1-323. Baltimore.

Noví lingulátní ramenonožci z nejvyšší části klabavského souvrství (spodní ordovik, arenig, Čechy)

V práci jsou popsány nové rody *Fagusella* (typický druh *F. indelibata* sp. n.) a *Lithobolus* (typický druh *L. plebeius* sp. n.) spolu s doprovodnou brachiopodovou faunou, patřící rodům *Numericoma, Westonia* a *Elkania* ze svrchní části klabavského souvrství českého spodního ordoviku (arenig). Diskutováno je stratigrafické rozpětí sledovaných druhů.

Explanation of the plates

Plate I

Lithobolus plebeius sp. n.
1. Ventral valve, internal mould, x8, MR 1/96/8+.
2. Ventral valve, internal mould (a) and latex cast of external mould (b), x8, MR 1/96/9±.
3. Ventral valve, internal mould, x8, MR 1/96/11+.
4. Dorsal valve exterior, x8, MR 1/96/6+.
5. Dorsal valve interior, x10, MR 1/96/7.
6. Ventral and dorsal valves, internal moulds, x8, MR 1/96/10+.

Elkania lineola (Havlíček 1982)
7. Dorsal valve, internal mould, x6, MR 1/96/5.
8. Dorsal valve exterior, x8, MR 1/96/1+.

Fagusella indelibata sp. n.
9. Dorsal valve exterior, oblique (a) and ventral (b) views, x32, x21. MR 1/96/19.

Localities: Ejpovice (quarry) (1, 2, 7) and Bukov (Josef gallery) (3-7, 8, 9).

Plate II

Fagusella indelibata sp. n.
1. Dorsal valve exterior, ventral (a) and oblique (b) views, x35, x35. MR 1/96/20.
2. Dorsal valve interior, oblique view, x20. OMR 1/96/21.
3. Dorsal valve, internal mould, x10, MR 1/96/14.
4. Ventral valve exterior, x10, MR 1/96/18.
5. Dorsal valve interior (a) and internal mould (b), x10, MR 1/96/16±.
6. Dorsal valve, internal mould, x10, MR 1/96/15b.
7. Dorsal valve, internal mould, x10, MR 1/96/15a.
8. Dorsal valve, internal mould, x10, MR 1/96/17.
9. Ventral valve interior, x10, MR 1/96/12a-.
10. Ventral valve interior, x10, MR 1/96/13+.
11. Ventral valve interior (a) and internal mould (b), x10, MR 1/96/12b±.

Locality: Bukov (Josef gallery).

Plate III

Numericoma vulcanogena sp. n.
1. Dorsal valve exterior (a) and detail of larval shell (b), x60, x340, TJ 1.
2. Dorsal valve interior of young individual (a), and anterolateral view (b), x30, x38, TJ 2.
3. Dorsal valve exterior, x40, MR 1/96/22.
4. Dorsal valve interior of incomplete young individual (a) and posterolateral (b) view, x50, x50, MR 1/96/23.
5. Dorsal valve interior, lateral (a), dorsal (b) and anterior (c) views, x42, x48, x70, TJ 3.

Locality: Bukov (Josef gallery).

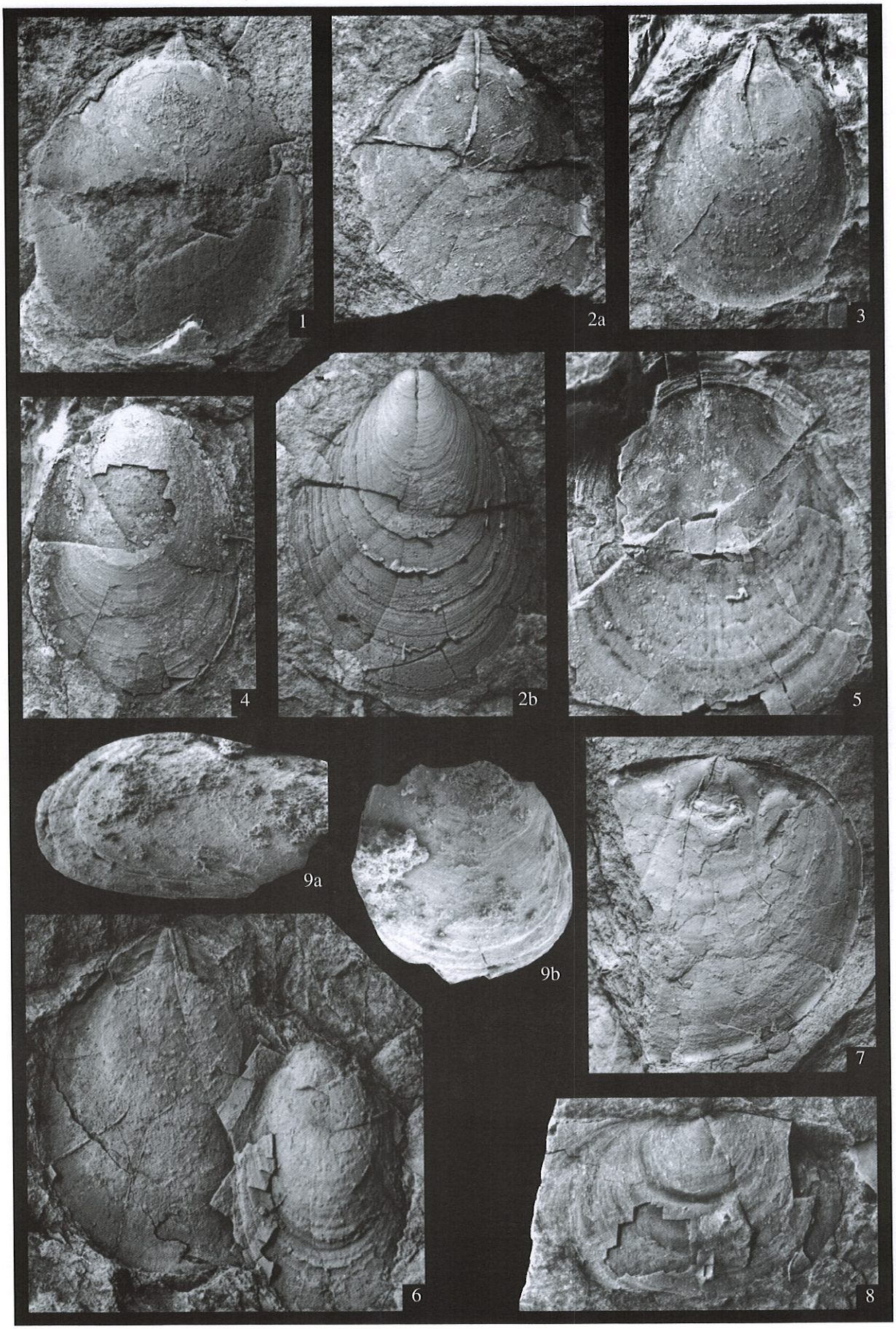
Plate IV

Westonia sp.
1. Ventral valve, internal mould with part of original shell substance, x5, MR 1/96/3+.
2. Probably ventral valve, exterior, x5, MR 1/96/2.
3. Fragment of valve with terrace lines, x13. MR 1/96/4.

Numericoma vulcanogena sp. n.
4. Ventral valve exterior, anteroventral view, x40, MR 1/96/24.
5. Ventral valve exterior, dorsal view, x50, MR 1/96/25.
6. Ventral valve interior showing pedicle tube, x45, MR 1/96/26.
7. Ventral valve exterior, lateral view, larval shell in dorsal (a) and posterolateral views (b,c), x75, x265, x340, TJ 4.

Locality: Bukov (Josef gallery).

M. Mergl: New lingulate brachiopods from the top of the Klabava Formation (Lower Ordovician, Arenig, Bohemia) (Pl. I)



For explanation see p. 50

M. Mergl: New lingulate brachiopods from the top of the Klabava Formation (Lower Ordovician, Arenig, Bohemia) (Pl. II)

M. Mergl: New lingulate brachiopods from the top of the Klabava Formation (Lower Ordovician, Arenig, Bohemia) (Pl. III)

M. Mergl: New lingulate brachiopods from the top of the Klabava Formation (Lower Ordovician, Arenig, Bohemia) (Pl. IV)