

An enigmatic early ?palaeocope ostracode from the Arenig of NW Russia

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Tinn, O. and Meidla, T. 2002. An enigmatic early ?palaeocope ostracode from the Arenig of NW Russia. *Acta Palaeontologica Polonica* 47 (4): 685–690.

The ostracode *Lavachilina evae* gen. et sp. nov. is described from the Arenig of Western Russia. Its carapace possesses a unique discontinuous velum, developed at both ends as a narrow spinose ridge. The systematic position of *L. evae* is uncertain. Its character set shows mostly palaeocope affinities but also some features of leiocopes. *L. evae* is tentatively assigned to the palaeocope family Oepikellidae, possibly representing an early member of that family. Although *L. evae* existed contemporaneously with palaeocopes such as *Laccochilina*, it does not appear to be closely related to these early eurychilinoideans.

Key words: Ordovician, Arenig, Volkhov Stage, Ostracoda, Russia, Baltoscandia.

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Introduction

The Arenig ostracodes of Baltoscandia have been well studied. Analysis of the Early and Middle Ordovician species dates back to the studies of fossils from the erratic boulders of Central Europe by Bock (1867), Krause (1889, 1891, 1892) and Kummerow (1924). They were followed by systematic studies of the Scandinavian Lower and Middle Ordovician ostracodes by Hessland (1949) and Henningsmoen (1953, 1954). The systematics and distribution of the early ostracodes in the Baltic countries and St. Petersburg area of Russia were studied by Sarv (1959, 1960, 1963), Sidaravičienė (1992) and Melnikova (1999). Ostracodes from Ordovician erratic boulders in Germany have been described by Schallreuter (1988, 1993, 1994, 1998).

About 50 ostracode species from six suborders have been recorded from the Arenig of Baltoscandia. Of these, palaeocopes are predominant. The second largest group is the eridostracans, they represent the largest number of specimens. Binodicopes, leiocopes, metacopes and kloedenellocoptes are represented by single species only. The eurychilinoidean record is poor, comprising only rare *Laccochilina* (Eurychilinoidea). The new species is of uncertain systematic position but is tentatively assigned to the eurychilinoideans. The material of the new species described herein was collected from the Upper Volkhov Substage (basal Middle Ordovician) in the St. Petersburg Region. Other groups (Oepikellidae etc.) are known to appear later (Vannier et al. 1989).

Material.—The material of *Lavachilina evae* gen. et sp. nov. consists of 10 specimens of satisfactory preservation from the Putilovo Quarry and the Lava River Section, St. Petersburg Region, Russia (Fig. 1). The specimens were collected from a clay layer in the upper part of the *Frizy* traditional unit

(*sensu* Dronov et al. 2000; see also Tolmacheva et al. 2001) of the Volkhov Stage (B_{II}), Arenig. According to palaeogeographic interpretations, during the Arenig, the eastern part of the Baltic-Ladoga Klint area was an offshore area (Dronov et al. 2000), probably within the sublittoral zone. The *Frizy* layers in the upper part of the Volkhov Stage were formed during a highstand episode (Dronov et al. 1998).

Lavachilina evae is a member of a high-diversity ostracode assemblage in the Lava section. The species occurs together with the abundant eridostracan *Conchoprimitia* sp., the tetradellids *Ogmoopsis bocki* (Öpik, 1935), *Glossomorphites digitatus* (Krause, 1889), *G. grandispinosus* (Hessland, 1949), *Aulacopsis simplex* (Krause, 1892) and the ctenonotellids *Protallinnella grewingkii* (Bock, 1867), *Tallinnellina murus* Schallreuter, 1993 and *Tallinnella marchica* (Krause, 1889). This kind of ostracode assemblage, predominated by tetradellids and ctenonotellids, is typical of the upper part of the Volkhov Stage (Meidla et al. 1998).

L. evae may be considered a rare species. The bed-by-bed ostracode sampling of the Volkhov Stage at several sections of the Baltic-Ladoga Klint area has yielded occasional complete specimens and a few more or less identifiable fragments. In part this may also be due to the different preparation methods applied. Disintegration of hard carbonate rocks with sodium hyposulphite tends to yield mostly smaller specimens and might be destructive to larger specimens.

The studied specimens are deposited in the palaeontological collections of the University of Tartu (TUG), Estonia.

Terminology.—The terminology and function of lobal and ornamental structures of the Palaeozoic ostracodes were discussed extensively by Jaanusson (1957), Martinsson (1962), Henningsmoen (1965), Schallreuter (1973), and Hinz-Schallreuter and Schallreuter (1999). However, the specific

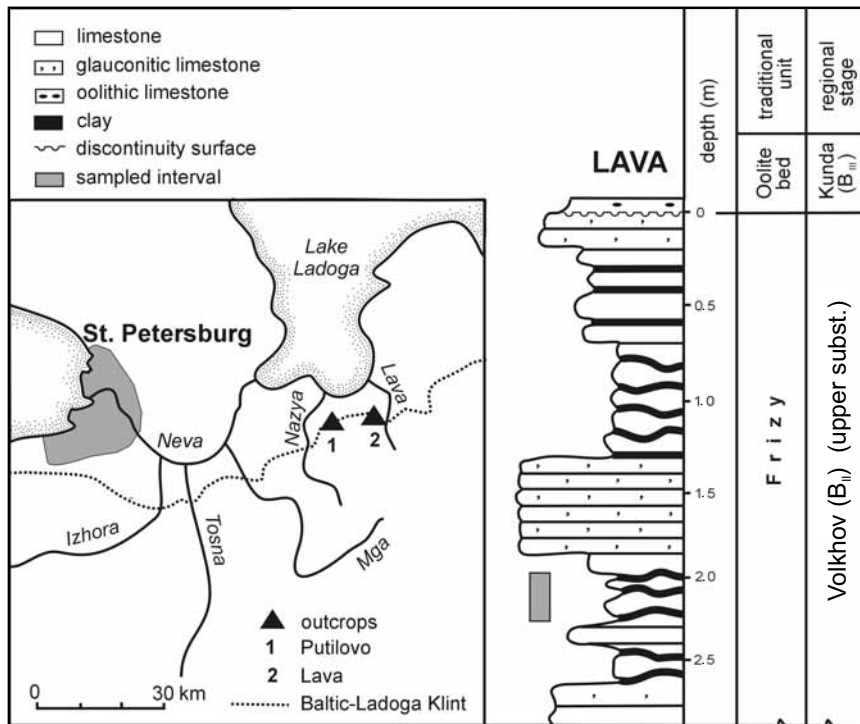


Fig. 1. Location of the studied sections in the St. Petersburg region, Russia and stratigraphic section of the upper part of the Volkhov Stage from the Lava River locality.

morphology of structures near the free edge of the valve of *L. evae* raises some terminological problems. It is uncertain whether the spinose sculpture matches Jaanusson's (1957: 188) definition of the *velar structure*, identified as "an ornamental ridge, flange, or frill which in quadrilobate valves lies ventral of the connecting lobe, and assumes the corresponding position in the non-sulcate valves". Martinsson (1962: 70–75) considered both the *marginal* and *velar structures* as the *adventral structures*.

The morphological terminology used herein is illustrated in Fig. 2. For the present paper, we consider the admarginal structure above the well-defined marginal sculpture as a tentative non-dimorphic *velum*. This is in accordance with its position at the junction of the lateral and marginal surfaces. As other features of *Lavachilina evae* do not refer unambiguously to the eurychilinoidean morphology, other possible affinities are discussed below.

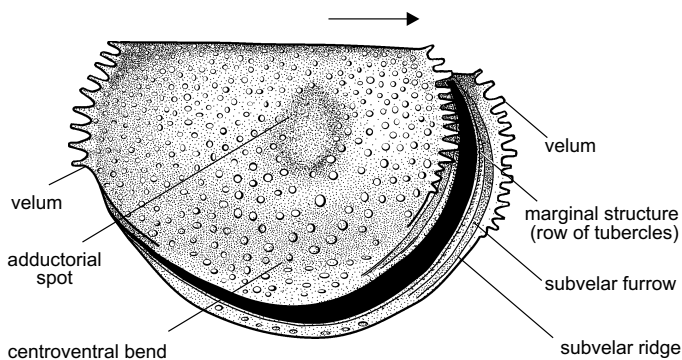


Fig. 2. Schematic reconstruction of *Lavachilina evae* sp. nov.

Systematic palaeontology

Subclass Ostracoda Latreille, 1802

Order Beyrichiocopa Pokorný, 1954

?Suborder Palaeocopa Henningsmoen, 1953

?Superfamily Eurychilinoidea Ulrich and Bassler, 1923

?Family Oepikellidae Jaanusson, 1957

Genus *Lavachilina* nov.

Type species: Lavachilina evae sp. nov.

Derivation of name: The genus is named after the Lava River near St. Petersburg, Russia, with the suffix "-chilina", used for several ostracode genera.

Diagnosis.—Preplete to nearly amplete, valves moderately convex, non-sulcate. Velum discontinuous, developed at both ends of the valve as a narrow spinose ridge.

Lavachilina evae sp. nov.

Fig. 3.

Holotype: Right valve TUG1/1099; Lava River, Russia; Volkhov Stage (about 2 m from the upper boundary of the Volkhov Stage; see Fig. 1), Arenig, Middle Ordovician.

Derivation of the name: The species is named in honour of Eva Egerquist, a Swedish palaeontologist, who donated the specimens for this study.

Diagnosis.—Length of the largest specimen reaches 3.0 mm. Valves sub-triangular, faintly convex and non-sulcate; strongest valve convexity in the mid-ventral region. Whole valve surface, except for the muscle field, ornamented with fairly

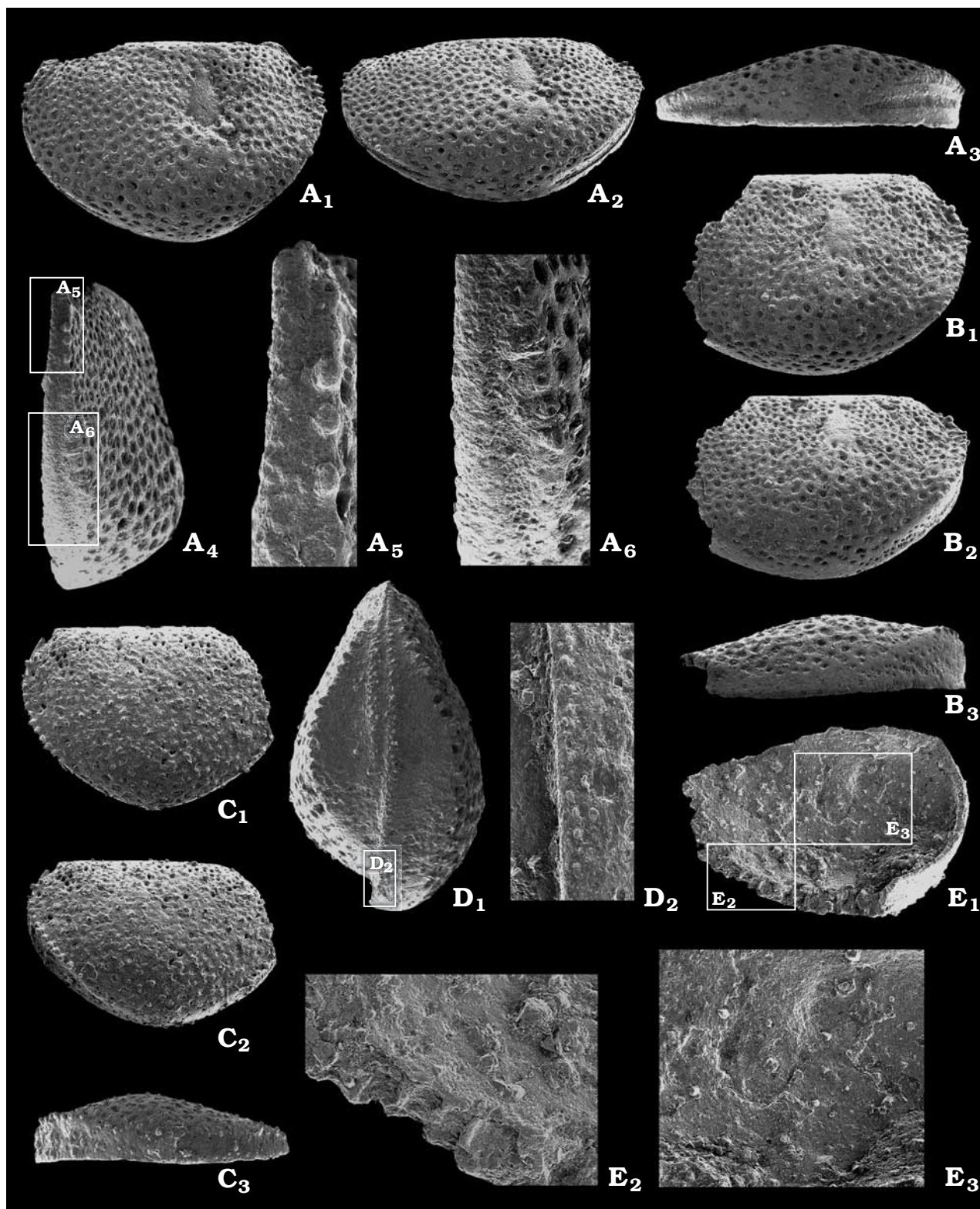


Fig. 3. *Lavachilina evae* sp. nov. **A.** TUG 1/1099, Lava River, Russia, Volkhov Stage. Right valve. In lateral (A₁), × 17; oblique ventral (A₂), × 17; ventral (A₃), × 17; posterior (A₄) views, × 23; detail of posterior view (A₅), × 85; and detail of posterior view (A₆), × 54. **B.** TUG 5/1099, Lava River, Russia, Volkhov Stage. Right valve. In lateral (B₁), × 17; oblique ventral (B₂), × 17; and ventral (B₃) views, × 17. **C.** TUG 3/1099, Lava River, Russia, Volkhov Stage. Left late preadult valve. In oblique lateral (C₁), × 19; lateral (C₂), × 19; and ventral (C₃) views, × 19. **D.** TUG 4/1099, Putilovo, Russia, Volkhov Stage. Deformed carapace. In anterior (D₁), × 17; and antero-ventral, detail (D₂) views, × 89. **E.** TUG 2/1099, Putilovo, Russia, Volkhov Stage. Left valve. Interior view (E₁), × 19; cross-section of the valve (E₂), × 61; adductor muscle scar area (E₃), × 42.

large punctae. Adductorial muscle scar large, smooth and drop-shaped. Discontinuous velum developed antero- and posterodorsally as a spinose ridge.

Morphology

Valve structure.—The general valve structure of *Lavachilina evae* is simple. The carapace is preplete to nearly amplete, of subtriangular shape, with straight long hinge-line and antero-dorsally positioned distinct adductorial muscle field. In the anterior and posterior regions, the velum is confined to the distinct subvelar area which in ventral direction merges with the lateral surface.

The carapace of *L. evae* is thick, mostly about 0.1 to 0.2 mm, but reaching 0.3 mm at the lateromarginal bend. Most of the valve surface is covered with punctae, but these are missing over the area of the adductorial muscle scar and in the anterodorsal and posterodorsal marginal regions. The punctae in the ventral area are slightly finer and more sparsely situated than those on the lateral valve surface. The broken margins of several valves reveal the inner structure of the punctae (Fig. 3E₁, E₂), which are cylindrical, with a flat bottom, reaching about 1/2 to 2/3 of the thickness of the shell. However, the absence of inner openings may also be due to diagenetic calcification.

The adductorial muscle field of *L. evae* is smooth and drop-shaped, the largest diameter being 0.6 mm. One specimen in the collection (the holotype, Fig. 3A) shows a slightly depressed muscle field. In the interior the large adductorial muscle scar is clearly distinguishable (Fig. 3E), and in addition to this, several smaller scars, expressed as slight depressions can also be seen behind the large scar. These structures must have functioned as attachment areas for smaller muscles. The structures are not expressed on the exterior valve surface where the corresponding area is covered with punctae. A large depression on the internal surface, situated anterodorsally of the adductor muscle field, is probably homologous to the preadductorial node of the palaeocopes.

Rows of spines, velar structure?—A distinct feature of the valves of *Lavachilina evae* are the rows of short hollow spines in the anterodorsal and posterodorsal marginal areas. Anteriorly they form a ridge-like structure at the base, reaching from the cardinal angle to the anteroventral margin. Posteriorly a low, poorly distinguishable ridge-like structure extends from the posteroventral to the posterodorsal margin. In adults of *L. evae* the spinose structure is missing ventrally. It is longer in late preadults but still absent centroventrally.

The spinose ridge lies in the position of a typical eurychilinoidean velar frill, separating the lateral and marginal surface in the antero- and posterodorsal regions of the valve. The eurychilinoidean velum consists of narrow radial tubules surrounded by the radial septa and covered by the external layer (see Jaanusson 1957). The septae and external layer are absent in *L. evae*.

The tubulose velum is considered a key feature of eurychilinoidean morphology (Schallreuter 1975), but may show considerable variation. In *Eurychilina* Ulrich, 1889, the tubules may sometimes be very thick and a connecting layer may be missing (Swain 1962). The tubulose velar frill has also been described by Kesling (1955) and Jaanusson (1957) in several species of the genus *Oepikium* Agnew, 1942. It was stated (Jaanusson, 1957), that the hollow tubules were probably not in contact with the interior of the carapace and always end blindly at the proximal end. The inner opening of the tubules in *L. evae* cannot be established. Several spines show the open outer end of the tubules (Fig. 3A₅, A₆) but this may also be due to breakage of the distal part of the spines.

Valve contact and marginal area.—The valves of *Lavachilina evae* are asymmetrical, the single bivalved strongly deformed carapace of *L. evae* shows left valve overlap (Fig. 3D₁). The contact region is rimmed with a row of low tubercles in both valves (Fig. 3D). The tuberculate marginal structure is clearly seen in the anterodorsal region, but the present material does not give any clues to the marginal structure along the posterior margin. The length of the centroventral bend varies among the studied specimens. The punctae in the ventral area tend to be slightly finer and more sparsely situated on average than those on the lateral surface.

The subvelar field on both ends is of distinctive morphology and slightly longer than the spinose velar structure, reaching the antero- and posteroventral margins of the valve. Anteroventrally, a narrow subvelar ridge separates a short narrow furrow from the remaining subvelar field (Fig. 3A₂, A₃). The furrow reaches from the middle velar structure to the last anteroventral small spines.

Ontogeny and dimorphism.—The ontogeny of *Lavachilina evae* is poorly known. The present collection contains two late preadult (stage A-1) specimens. The general carapace morphology of the late preadults—with a slightly convex subtriangular carapace—does not differ substantially from that of the adult specimen. The adductor muscle scar, large and slightly depressed in the adults, is vague and almost indistinguishable in the preadults.

The character of the spinose velar ridge seems to alter during ontogeny. In adults it is present in the anterior and posterior margins, whereas in juveniles it reaches more anteroventrally and posteroventrally and is extended by ridge-like structures still separated ventrally. The mid-ventral marginal field in the preadults of *L. evae* is shorter than in adults. A subvelar ridge in the anterior part of the valve is missing in preadults.

Taxonomic affinities.—The systematic position of *Lavachilina evae* gen. et sp. nov. is uncertain. The characters of the new species include elements which may occur in different suborders, particularly the palaeocopes and leiocopes. However, the discovery of *L. evae* might necessitate a revision of definitions of these suborders.

The straight long hinge-line, distinct adductorial muscle field and contact margin features (with the left valve overlap

and the specific tuberculate admarginal sculpture in the anteroventral area) distinguish *L. evae* as a possible palaeocope species. However, the midventrally discontinuous marginal structures have not been described before in palaeocope ostracodes.

Some morphological features of *L. evae* also resemble the Middle Ordovician leiocope genera *Baltonotella* Sarv, 1959 and *Sacclatia* Kay, 1940. The unequal sized convex valves and punctate carapace are typical of these taxa. Some *Baltonotella* species show various admarginal structures running close and parallel to the free margin of the valve (e.g., Kraft, 1962; Williams and Vannier 1993), suggested to function as stop-ridges to prevent excessive overlap of the valves (Williams and Vannier 1995). Similar structures are present but not so distinct in *L. evae*; they are also discontinuous ventrally. The structure tentatively classified as a velum in *L. evae* has no equivalents in leiocope morphology.

The general valve morphology of the new species is also reminiscent of the genera *Pinnatulites* Hessland, 1949 and *Ostpreussensia* Schallreuter, 1993, both of which are of uncertain taxonomic affinities. The valves of *P. procerus* (Kummerow, 1924) possess an angled bend slightly below the mid-height, dividing the lateral surface into a flat to slightly convex upper part and a flattened ventral area. The bend is distinctly angled in the anterior and posterior parts, and rounded in the mid-ventral valve area. Anterior and posterior parts of the lateral surface are punctate (Schallreuter 1993: fig. 37B: 1). In *Ostpreussensia*, the flattened ventral area is better defined antero- and posteroventrally, being indistinct/narrow centroventrally (Schallreuter 1993: fig. 3B: 1). In *L. evae*, the punctuation covers the whole valve surface and its velum-like structure has no equivalents in *Pinnatulites* and *Ostpreussensia*.

If the single bivalved specimen (TUG 4/1099), in spite of deformation, still reflects the real overlap features of *L. evae*, it differs from leiocopes and the above mentioned problematic genera, in that it is clearly of “palaeocope” type (“left-over-right”).

The overall evidence supports a palaeocope affinity for *Lavachilina evae* although the total set of features characteristic of the species is not typically palaeocope.

Early eurychilinoids in the Baltoscandian area

The tubulose velar structure allows tentative assignment of *L. evae* to the superfamily Eurychilinoidea Ulrich and Bassler, 1923. The stratigraphical and geographical distribution of eurychilinoids suggests their Baltoscandian origin. The stem-group probably arose in the Baltoscandian palaeobasin during the early Arenig and remained endemic until the spread of the eurychilinoid species to other continents during the Llanvirn.

In the Baltoscandian region, published records of eurychilinoids indicate their origins in the Upper Volkhov Substage, with the appearance of the first Eurychilinoidea (*Laccochilina estonula*: Sarv 1959: 8–9; Schallreuter 1993: 99–100; *Laccochilina* aff. *decumana*: Tinn and Meidla 2001). The appearance of Oepikiidae is documented from the Kunda Stage (*Oepikium novum*: Sarv 1959: 154–155). The appearance of Oepikellidae seemingly took place much later, as the earliest record comes from the Uhaku Stage (mid-Llanvirn) of the Baltoscandian Region (Vannier et al. 1989).

Families within the Eurychilinoidea are mainly distinguished on the basis of velar and sulcal characters (Jaanusson 1957; Benson et al. 1961; Schallreuter 1975). The family affinities of *L. evae* are suggested by the non-sulcate valve morphology, well defined large adductor muscle scar and ornamentation, which all resemble Oepikellidae Jaanusson, 1957. But, the discontinuous velar structure of *L. evae* remains unique within the superfamily. In many papers (e.g., Schallreuter 1969; Sarv 1959) the shortening of the eurychilinoid velar frill is described and Schallreuter (1975) proposed it as a phylogenetic trend for Eurychilinoidea. He remarked, that the earlier species of *Laccochilina* Hessland, 1949 showed longer velar structures than the later ones, in which the posterior part of the velum was turned into a spinose ridge. However, in all cases this leads to the disappearance of the velar structure posteriorly and the remaining velum is still continuous anteroventrally and ventrally.

Conclusions

Lavachilina evae is tentatively assigned to the Oepikellidae and may represent an early member of this family. Although *L. evae* existed contemporaneously with early eurychilinoids, it was a species of highly specialized carapace morphology having no obvious relationships to *Laccochilina*. The stratigraphic gap in the distribution of the Oepikellidae (Kunda-Lasnamägi stages) remains temporarily unfilled.

Acknowledgements

Many thanks are due to Eva Egerquist for donating the specimens for investigation and to Roger Schallreuter and Ivar Puura for discussions. The authors are grateful to Mark Williams and Ewa Olempska for critically reviewing the manuscript and for useful comments. The research was supported by the Estonian Science Foundation grant 4574. This paper is a contribution to the IGCP Project 410 “The Great Ordovician Biodiversification Event”.

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