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Ediacaran and Cambrian stratigraphy in Estonia: an updated review

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Abstract. Previous late Precambrian and Cambrian correlation charts of Estonia, summarizing the regional stratigraphic nomenclature of the 20th century, date back to 1997. The main aim of this review is updating these charts based on recent advances in the global Precambrian and Cambrian stratigraphy and new data from regions adjacent to Estonia. The term 'Ediacaran' is introduced for the latest Precambrian succession in Estonia to replace the formerly used 'Vendian'. Correlation with the dated sections in adjacent areas suggests that only the latest 7–10 Ma of the Ediacaran is represented in the Estonian succession. The gap between the Ediacaran and Cambrian may be rather substantial. The global fourfold subdivision of the Cambrian System is introduced for Estonia. The lower boundary of Series 2 is drawn at the base of the Sõru Formation and the base of Series 3 slightly above the former lower boundary of the 'Middle Cambrian' in the Baltic region, marked by a gap in the Estonian succession. The base of the Furongian is located near the base of the Petseri Formation.

Key words: Ediacaran, Cambrian, correlation chart, biozonation, regional stratigraphy, Estonia, East European Craton.

INTRODUCTION

The main features of the latest Precambrian and Cambrian stratigraphy in Estonia were summarized in the book *Geology and Mineral Resources of Estonia* (Raukas & Teedumäe 1997). The description of the latest Precambrian strata in this volume (Mens & Pirrus 1997a) is based on the stratigraphic chart of the Vendian Complex, accepted in 1976 at the Baltic Stratigraphic Conference (Resheniya… 1978). The term 'Vendian' was applied to the latest Precambrian of Estonia in this paper, apparently because the International Commission on Stratigraphy ratified a geochronometric subdivision of the Proterozoic but left the terminal Proterozoic period 'for later definition and characterization' (Knoll et al. 2006). More than ten years later, the terminal Proterozoic period called 'Ediacaran' was introduced by a vote in the Subcommission of Precambrian Stratigraphy and defined in accordance with the concept proposed already by Cloud & Glaessner (1982). The proposal was officially ratified by the International Union of Geological Sciences in 2004 (Knoll et al. 2006) and the lower boundary was dated as 635 Ma. These changes in the global Precambrian stratigraphy call for a more detailed discussion of the stratigraphic position and age of the late Precambrian strata of Estonia.

The latest stratigraphic chart of the Cambrian System in Estonia (Mens & Pirrus 1997b, p. 39, table 6) is drawn mainly in accordance with the stratigraphic chart of the Cambrian System ratified in 1983 and published three years later (Reshenie… 1986). Mens & Pirrus (1997b, p. 39) write: 'As the global standard is still in preparation, the boundaries between the Lower/Middle and Middle/Upper Cambrian are not strictly formal.' After the formal definition of the lower boundary of the Cambrian System (Brasier et al. 1994) and the lower boundary of the Ordovician System (Cooper et al. 2001), a fourfold subdivision of the Cambrian System into series was proposed at the 9th International Field Conference of the Cambrian Stage Subdivision Working Group (Babcock et al. 2005).

The aim of this paper is to update the regional stratigraphic charts and apply new global units and correlations to the Estonian Ediacaran and Cambrian succession. The revised correlation and related problems are discussed and the charts are drawn on a timescale.

THE EDIACARAN SYSTEM

Sokolov (1952) proposed the name 'Vendian' for a system and period comprising the uppermost/latest Precambrian.

A year later, this name was introduced for the western part of the East European Craton (Sokolov 1953). The relevant part of the stratigraphic succession was distinguished in its present extent in the correlation chart approved by the Baltic Stratigraphic Conference (Resheniya… 1978) and a commented version of the same chart was published two years later (Mens & Pirrus 1980). An English version (Mens & Pirrus 1997a) summarizes the present subdivision of the Vendian System in Estonia.

The term 'Vendian System' is used in Russia and Belarus for a unit comprising a succession from the upper Cryogenian to the lowermost Cambrian and having a threefold (e.g. Chumakov 2007; Kruchek et al. 2010) or fourfold (e.g. Sokolov 2011) subdivision. The Vendian Complex of the Baltic States is subdivided into two regional stages (Resheniya... 1978; Puura et al. 1982). The lower, Redkino Regional Stage is characterized by a soft-bodied biota and the upper, Kotlin Regional Stage is characterized by acritarchs and algal remains (Pirrus 1992). In some papers, the oldest part of the Vendian Complex is distinguished as the Drevlyan Regional Stage (Jankauskas 1993; Paškevičius 1997; Kruchek et al. 2010). This unit is unfossiliferous, although its suggested equivalent in Belarus, the Lyozno Regional Stage, contains an acritarch assemblage that differs considerably from the assemblages in the overlying strata (Kruchek et al. 2010).

As the term 'Ediacaran System' was formally adopted in 2004, the strata formerly termed 'the Vendian Complex' in Estonia, Latvia and Lithuania should be attributed to the Ediacaran System. The Ediacaran strata in Estonia are correlated with the Kotlin Regional Stage (Resheniya… 1978; Mens & Pirrus 1980, 1997b).

The differences between the lower boundaries of the Ediacaran System and the Vendian Complex are well known (see, e.g., Chumakov 2007; Meert et al. 2011) and do not complicate the use of the term 'Ediacara' for Estonia, where the system is represented by its upper part only. The Gudenieki and Zūra strata comprise the oldest part of the 'Vendian' in western Latvia. The Ediacaran age of these units is proved by the radiometric dating of the Gudenieki alkali basaltic lavas (595 ± 25 Ma) and the fossil content of the Zūra clastic beds (*Laminarites*-type algal laminae, *Leiosphaeridia* sp.) suggesting the Redkino or Kotlin age of these strata (Lukševičs et al. 2012; see also Šliaupa & Hoth 2011). The lowermost 'Vendian' in Lithuania, the Merkys Formation, is attributed to the upper Drevlyan Regional Stage (Paškevičius 1997) and is of Ediacaran age by Lukševičs et al. (2012).

In Belarus, the lower boundary of the Ediacaran may tentatively be drawn within the strata attributed to the Vendian in the most recent stratigraphic chart (Kruchek et al. 2010). The information is contradictory, as the official age of the lower boundary of the Vendian and the Vilchan Group in Belarus (600 Ma – Kruchek et al. 2010) disagrees with several other dates. For example, the Gorbashev Formation (the basal formation of the Volynian Group) is usually dated at ca 630 Ma but occasional dates are reaching 1040–1120 Ma (Zapolnov 1993). At the same time, the proposed age for the base of the Volynian Group is 660 ± 20 Ma (Zapolnov 1993), i.e. the late or latest Cryogenian.

Although Pirrus (1992) suggested a very high sedimentation rate for the clay deposits of the Kotlin Formation (5 m/10 000 yrs), the possible age implications for the whole of the Ediacaran succession in Estonia are not considered in former publications. No radiometric dates are available for the Ediacaran strata in Estonia but the age limits of this succession can still be tentatively specified based on the data from Russia and Belarus. Sokolov (2011) roughly estimated the age of the lower boundary of the Kotlin Regional Stage to be 570–580 Ma, but other dates suggest that this may be far too old. Grazhdankin et al. (2011) demonstrate an indirect but well-argued correlation of the lower boundary of the Kotlin Regional Stage on the Lublin Slope of the craton and constrain the age of this boundary between 551 and 548 Ma, based on U–Pb dates from zircons. Considering these dates, the correlation of Ediacaran strata in Estonia can be preliminarily drawn on a time scale (Fig. 1). This shows that the Ediacaran in Estonia represents the youngest part of the system and likely formed within the last 7–10 Ma of the period.

THE CAMBRIAN SYSTEM IN ESTONIA

The Cambrian System has been traditionally subdivided into three series in Estonia. The strata in the northern Estonian outcrop area were attributed to the Lower Cambrian already by Bekker (1923) and Öpik (1925) and a threefold subdivision of the Cambrian System was adopted for Estonia in the same papers. The lower boundary of the Cambrian System in the western part of the East European Craton is drawn at the base of the Baltic Group (Mens et al. 1987) and the level is marked by a regional unconformity in Estonia. The appearance of the first skeletal fossils and a change among ichno- and phytofossils are recorded at this level (Mens & Pirrus 1997b).

The presence of the Upper Cambrian in Estonia was demonstrated by Volkova (1982) and Kaljo et al. (1986). The occurrence of the Middle Cambrian was clearly argued in the 1970s (Resheniya… 1978; Kala et al. 1984). The lower boundary of the Middle Cambrian on the East European Craton was traditionally drawn near the appearance level of the acritarchs *Baltisphaeridium*

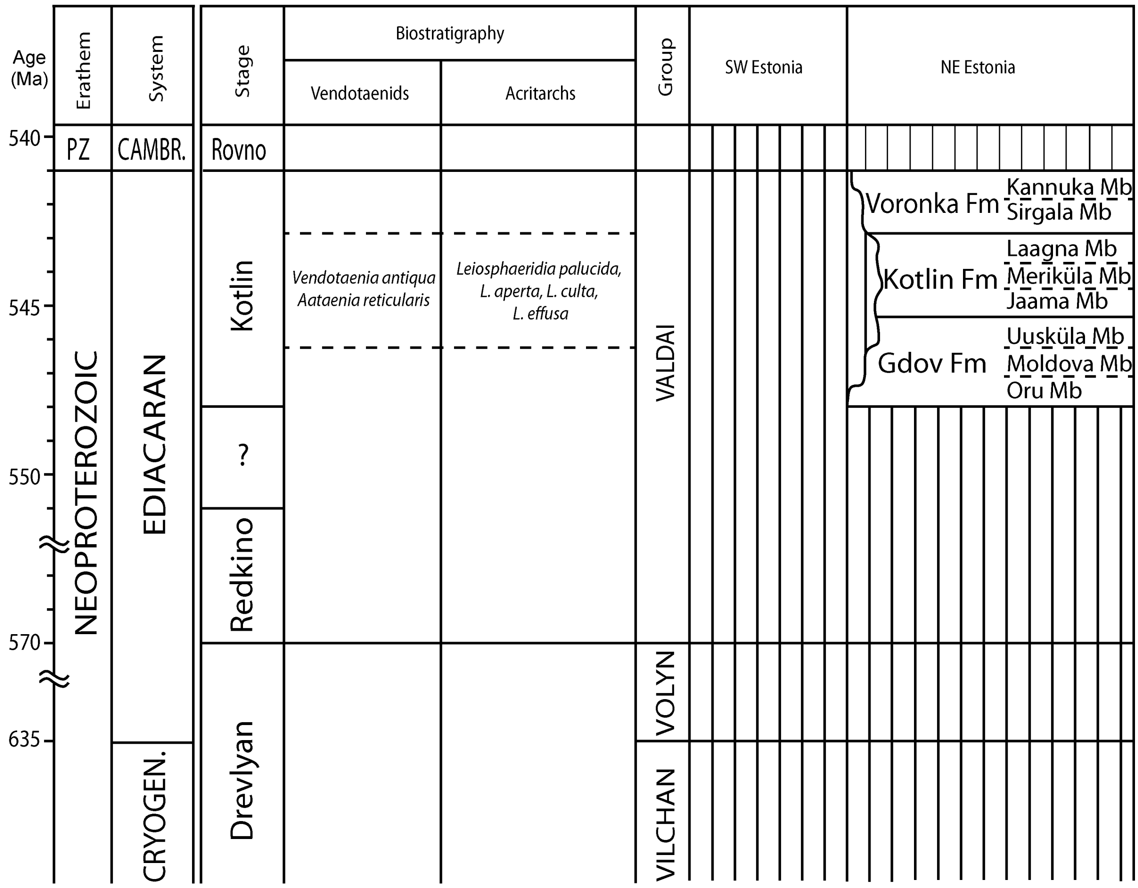

Fig. 1. Ediacaran chronology and stratigraphy in Estonia, based on Mens & Pirrus (1997a).

latviense, *B. pseudofaveolatum*, *Liepaina plana*, *Lophosphaeridium variabile* and rare specimens of the genera *Cristalinium* and *Eliasum* (Mens et al. 1987). This acritarch assemblage was termed ‘the Kybartai assemblage’ by Jankauskas (2002) and corresponds to assemblage 3 by Hagenfeldt & Bjerkeus (1991). The strata are roughly correlated with the *Eccaparadoxides insularis* trilobite Zone, in spite of the fact that the index trilobite species has not been recorded in the respective strata in the eastern Baltic region (Mens et al. 1987; Hagenfeldt & Bjerkeus 1991). However, only the appearance of *B. pseudofaveolatum* and *L. plana* is confined to the Kybartai Regional Stage in the Vergale-50 section (Fridrihsone & Zabels 1992), the type section of the Kybartai Regional Stage (Mens et al. 1987). The other ‘diagnostic’ species make their first appearance earlier (Fridrihsone & Zabels 1992). The same was pointed out also by Jankauskas (2002, p. 73). The disagreements show that the correlation between the trilobite zonation and the acritarch assemblages in this interval needs to be revised.

The boundary of the Upper Cambrian was traditionally drawn at the base of the *Agnostus pisiformis* Zone (Mens et al. 1987; Mens & Pirrus 1997b). The correlation chart of Cambrian strata in Estonia published by Mens & Pirrus (1997b) summarizes the advances in Cambrian stratigraphy in the 20th century and shows that the boundaries of the traditional series are marked by gaps in the Estonian succession (see Fig. 2).

Although the global stratotype section and point for the lower boundary of the Cambrian System was approved in 1992 (Brasier et al. 1994), it did not influence the Cambrian stratigraphy in Estonia substantially. This boundary was drawn near the same horizon that was accepted as the traditional lower boundary of the system in Estonia.

In December 2004, the International Subcommission on Cambrian Stratigraphy held a ballot on the subdivision of the Cambrian System and a fourfold subdivision was approved (Babcock et al. 2005). The global stratotype section and point of the Paibian Stage (and the Furongian Series) was defined at the lowest occurrence of the

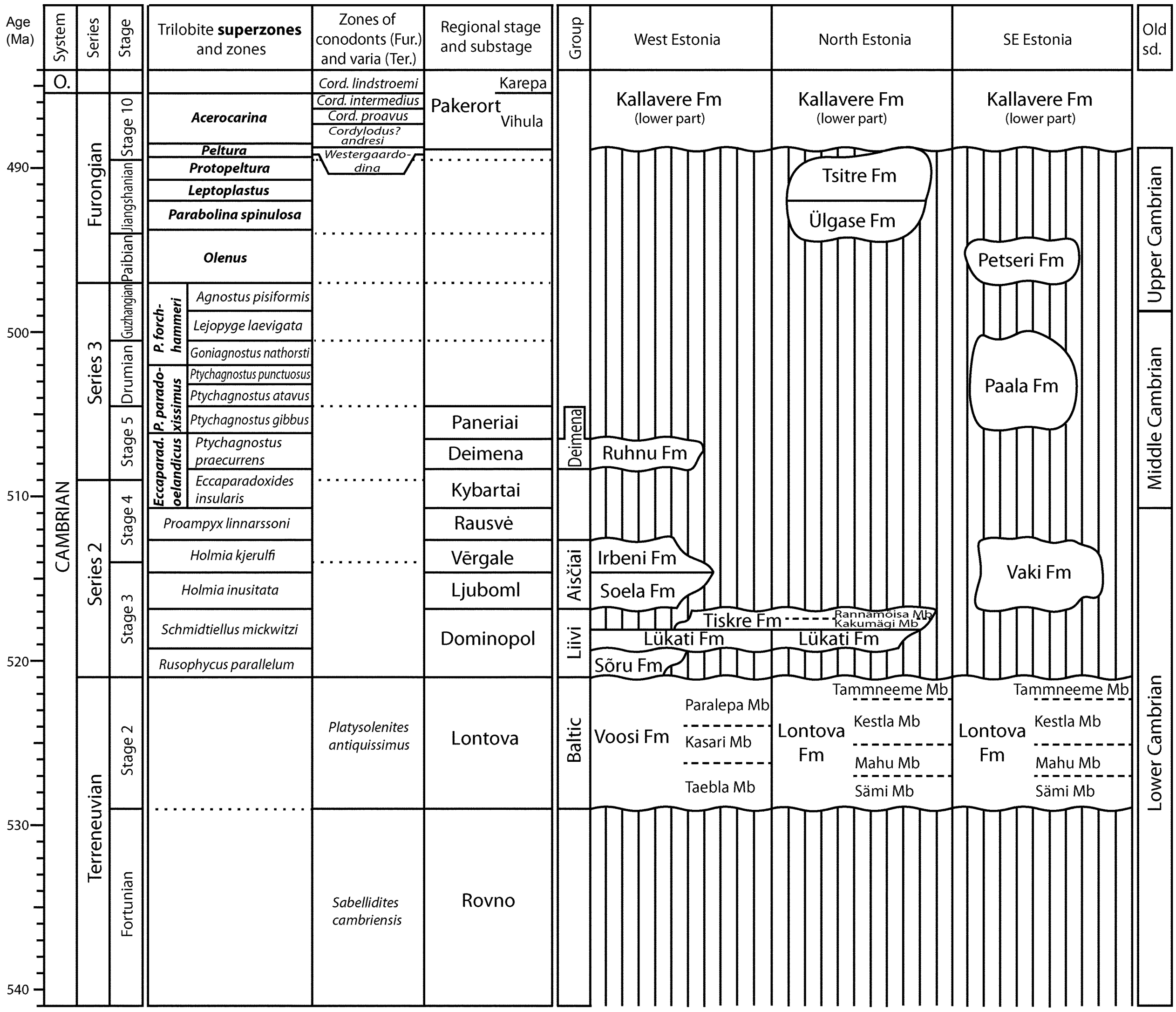

Fig. 2. Cambrian chronology and correlation of the formations in Estonia. Trilobite zones are based on Nielsen & Schovsbo (2006, 2011, 2015), Nielsen et al. (2014) and Babcock et al. (2017), the conodont zonation on Kaljo et al. (1986), Mens et al. (1993) and Bagnoli & Stouge (2014). 'Old sd.' (heading of the right column) – the old, traditional threefold subdivision of the Cambrian in Estonia.

agnostid trilobite *Glyptagnostus reticulatus* by Peng et al. (2004). The lowermost Cambrian series and stage were named in 2007 (Terreneuvian and Fortunian, respectively – see Landing et al. 2007). In the upper part of the third (unnamed) series, the Drumian Stage was introduced in 2007 (Babcock et al. 2007) and the Guzhangian Stage in 2009 (Peng et al. 2009). In 2012, the Jianshianian Stage was established as the middle part of the Furongian (Peng et al. 2012). Hitherto almost none of the listed changes have been adopted for stratigraphy of the Cambrian System in Estonia. Only the name 'Furongian' has been used as a likely synonym of the former Upper Cambrian (e.g. Põldvere et al. 2005).

Due to recent advances in international Cambrian stratigraphy the subdivision of the Cambrian System in Estonia should be discussed. As the appearance levels of stratigraphically important taxa are not documented in sufficient detail, this approach has to rely only on the biozonation of the Cambrian of the East European Craton (Mens et al. 1987 and many subsequent authors), considering recent changes. The improved Scandinavian trilobite zonation (Nielsen & Schovsbo 2011, 2015; Weidner & Nielsen 2013; Nielsen et al. 2014; Babcock et al. 2017) is correlated below with the Cambrian succession of Estonia. The superzones are more easily recognizable and practical for correlation purposes than the polymerid trilobite biozonation in the eastern Baltic area. The polymerid zones are very detailed but the diagnostic species are mostly missing in this area.

The lower boundary of the Cambrian System is formally defined at Fortune Head, Newfoundland, Canada, where it is marked a few metres above the base of the *Treptichnus pedum* Ichnozone (Gehling et al. 2001; Landing et al. 2007), 0.2 m above the strata attributed to the *Harlaniella podolica* Ichnozone (Gradstein et al. 2012). This boundary is nearly coincident with the boundary of the *Sabellidites cambriensis* Zone in the biozonation of the East European Craton (Mens et al. 1987). Although the first *S. cambriensis* has been recorded just a few metres below the first appearance of *T. pedum* in the stratotype section (Gehling et al. 2001), leaving the correlation of the base of the Rovno Regional Stage open, it does not affect the correlation in Estonia where the *S. cambriensis* Zone is absent.

The appearance of the first trilobites in the sedimentary succession of the East European Craton in the strata overlying the Baltic Group means that the Lontova and Voosi formations should be attributed to the Terreneuvian. The upper stage of the Terreneuvian is still undefined and the possible markers considered up to now (appearance of some small shelly fossil or archaeocyathid species – see Babcock et al. 2005) may be difficult to apply to Estonia and adjacent areas. However, there are no obstacles to introducing the term 'Terreneuvian' for the Cambrian stratigraphy of Estonia and adjacent areas.

The position of the lower boundary of the second (unnamed) series of the Cambrian System is not yet fixed with a boundary stratotype, but the level will very likely be related to the appearance of trilobites. This level is not very well documented in Estonia. The first fragmentary trilobites have been recorded in the basal part (0.2 m above the lower boundary) of the Lükati Formation in North Estonia (Mens & Pirrus 1977). However, the earliest trilobite remains in Scandinavia are known from the *Rusophycus parallelum* Zone (Ahlberg et al. 1986; Nielsen & Schovsbo 2011). This allows bringing the boundary of the second series of the Cambrian System tentatively down to the base of the Sõru Formation. Nielsen & Schovsbo (2011) have dated the Sõru Formation as Mid-Dominopolian, based on the suggested correlation of the sedimentary sequences. Still, the impoverished acritarch assemblage in this formation (*Globosphaeridium* cf. *cerinum*, *Lophosphaeridium tentativum*, *Micrhystridium pallidum* – Mens 1986; Mens & Pirrus 1997b) is very similar to the assemblage documented from the Brantevik Member of the Hardeberga Formation in Scania (Vidal 1981; Moczydłowska & Vidal 1986). This member is correlated with the basal *Rusophycus parallelum* Zone by Nielsen & Schovsbo (2006, 2011) and the Lükati and Tiskre formations correspond to the upper part of the Dominopol Regional Stage. The Lükati Formation contains the only trilobite species known in the Cambrian of Estonia – *Schmidtiellus mickwitzi* (Schmidt) recorded in few localities of North Estonia (Mens & Pirrus 1977, 1997b).

The lower boundary of Cambrian Stage 4 will likely be drawn according to the first appearance of the trilobite genera *Olenellus* or *Redlichia* (Peng et al. 2012). Positioning this level in the Scandinavian trilobite zonation is complicated as the zonation in this interval is debated. Nielsen & Schovsbo (2011) proposed a different version of trilobite zonation for Series 2, but it seems not to be generally accepted (e.g. Cederström et al. 2012). For the time being, the traditional zonation is preferred here (see also Fig. 2). The lower boundary of Stage 4 may likely be located within (or at the base of) the *Holmia kjerulfi* Zone (Shergold & Geyer 2003) and tentatively drawn within the Irben and Vaki formations in Estonia (Mens et al. 1987).

The lower boundary of the third (unnamed) series of the Cambrian System will likely be tied to the first appearance of the trilobite *Oryctocephalus indicus* (Peng et al. 2012). According to Geyer (2005), this level is located within the *Eccaparadoxides insularis* Zone, near but still distinctly above the former lower boundary of the Middle Cambrian in Baltoscandia, and is tied to a gap in the Estonian succession. This gap corresponds to the Kybartai Regional Stage in Baltoscandia and may be related to the so-called Hawke Bay Event (Nielsen & Schovsbo 2015).

The lower boundary of the Drumian Stage, the *Ptychagnostus atavus* zonal boundary, could be tentatively drawn within the barren Paala Formation and the base of the Guzhangian Stage, the *Lejopyge laevigata* zonal boundary, between the Vaki and Petseri formations in Estonia (Mens & Pirrus 1997b). Further justification of these boundaries in Estonian sections seems hardly possible as the boundary strata are missing or barren of fossils in Estonia.

Series 3 is represented by the Ruhnu and Paala formations in Estonia. Both formation are unfossiliferous. Their age estimates are based on the correlation with the fossiliferous units in Latvia and Russia. The Ruhnu Formation is considered a local equivalent of the fossiliferous Deimena Formation in northern Latvia that is correlated with the *Ptychagnostus praecurrens* Zone (Mens & Pirrus 1997b). The Paala Formation is tentatively interpreted as an equivalent of the Sablinka Formation in northwestern Russia and is referred to the *Paradoxides paradoxissimus* and *P. forchhammeri* trilobite zones (see Fig. 2). Nielsen & Schovsbo (2015), on the contrary, tentatively regard these two units as coeval, based on sequence stratigraphical considerations.

The term 'Furongian Series' has been occasionally used in Estonia as a synonym of the former Upper Cambrian, but the fossil records in Ahlberg et al. (2009, p. 9 and fig. 2) and Nielsen et al. (2014, fig. 1) demonstrate a distinct difference between these units. The lower boundary of the Paibian Stage is defined by the appearance of the agnostid *Glyptagnostus reticulatus.* In the Andrarum-3 drillcore (southern Sweden) this species appears directly above the *Agnostus pisiformis* Zone, essentially coinciding with the lower boundary of the *Olenus* Superzone (Terfelt et al. 2008). The same difference was pointed out by Żylińska & Szczepanik (2009, fig. 5). In Estonia, this boundary could be tentatively drawn at or below the base of the Petseri Formation. As an acritarch assemblage typical of the *Agnostus pisiformis* Zone has not been recorded in the Petseri Formation (Paalits 1992; Mens et al. 1993; Põldvere & Paalits 1998), it could be equivalent to the lower–middle parts of the *Olenus* Superzone, as already suggested by Mens et al. (1993).

The base of the Jiangshanian Stage is characterized by the first appearance of the agnostid trilobite *Agnostotes orientalis* and the polymerid trilobite *Irvingella angustilimbata* (Peng et al. 2012). Shergold & Geyer (2003) correlate this level with the upper part of the *Olenus* Superzone in Baltica and it may correspond to a level near the base of the Ülgase Formation in Estonia. The partial temporal overlap of the Petseri and Ülgase formations, as indicated in the latest correlation charts (Mens et al. 1987, 1993; Mens & Pirrus 1997b), has no support from acritarch data, as the acritarch assemblages of these formations are very distinct (Paalits 1992, 1995; Põldvere & Paalits 1998).

The uppermost stage of the Furongian is still undefined. Peng & Babcock (2011) state that the selection of a suitable chronostratigraphic marker is in progress and refer to the appearance of the trilobite *Lotagnostus americanus* as a possible marker. At the same time, Miller et al. (2014, 2015) propose the lowest occurrence of *Eoconodontus notchpeakensis* in the House Range, Utah, as a possible GSSP. The appearance level of *Lotagnostus americanus* is tied to the upper part of the *Protopeltura* Superzone and is roughly coinciding with the appearance of *Ctenopyge* (*Mesoctenopyge*) *spectabilis* in Scandinavia (Nielsen et al. 2014). This level may tentatively be located within the Tsitre Formation in Estonia. The acritarch-based correlation (co-occurrence of *Trunculomarinum revinium* and *Dasydiacrodium caudatum*) suggests that the basal part of the Tsitre Formation is correlated with the upper part of the *Parabolina spinulosa* Superzone (Mens & Pirrus 1997b; Nielsen et al. 2014). The appearance level of *Eoconodontus notchpeakensis* seems to have a higher position in the succession as this species is characteristic of the basal Kallavere Formation, co-occurring with *Cordylodus*? *andresi* (Kaljo et al. 1986), and is also present in the Tosno and Lomashka formations of the St. Petersburg region (Mens et al. 1993). The lower boundaries of these formations are likely diachronous (Kaljo et al. 1986) but there is no documented record of *Eoconodontus notchpeakensis* in the underlying Tsitre Formation (Kaljo et al. 1986; Mens et al. 1993). This suggests that the lower boundary of Stage 10 is possibly located within or near the top of the Tsitre Formation in Estonia.

In the most recent correlation chart of the Cambrian of Estonia (Mens & Pirrus 1997b), the youngest Cambrian strata are correlated with the former *Acerocare* Zone (now *Acerocarina* Superzone – Nielsen et al. 2014). Mens et al. (1993) positioned the lower boundary of this superzone in the Estonian succession in the uppermost *Westergaardodina* conodont Zone, slightly below the base of the Kallavere Formation. Recent results by Bagnoli & Stouge (2014) show that the lower boundary of the *Cordylodus*? *andresi* Zone occurs at a lower horizon, in the middle of the *Peltura* Superzone (*sensu* Nielsen et al. 2014).

Mens et al. (1993) considered the upper part of the *Acerocarina* Superzone an equivalent of the *Cordylodus proavus* conodont Zone. According to the definition by Nielsen et al. (2014), the top of the *Acerocarina* *S*uperzone is delimited by the base of the Ordovician and is marked by the first influx of pelagic graptolites (*Rhabdinopora flabelliforme parabola*) in Scandinavia. This graptolite subspecies is absent in Estonia and the succession of graptolites starts here with *R. f. socialis* and *R. f. flabelliforme* (see Heinsalu et al. 2003 and references therein), both appearing well above the lower boundary of the Tremadoc (see, e.g., Cooper et al. 1998). Heinsalu et al. (2003) consider the appearance of the genus *Iapetognathus* as the most important criterion of the lower boundary of the Ordovician System, as the appearance of the first specimens of *Iapetognathus* sp. coincides with the appearance of typical *Cordylodus lindstroemi* in several Estonian sections (Heinsalu et al. 2003). In the present paper, the upper boundary of the Furongian Stage and the *Acerocarina* Superzone is approximated with the lower boundary of the *Cordylodus lindstroemi* Zone in Baltoscandia, the best approximation of the lower boundary of the Ordovician System (Puura & Viira 1999; Heinsalu et al. 2003; Nielsen et al. 2014). This means that the systemic boundary is drawn within the Kallavere Formation.

The modified correlation chart of the Cambrian of Estonia in Fig. 2 is based on the above considerations. An attempt of drawing the chart on a time scale is based on the ages of boundaries of the series and stages, defined or under definition, in accordance with Cohen et al. (2013). The boundary of Stage 2 is tentatively drawn at the base of the Lontova Stage and the boundary of Stage 10 is dropped tentatively to the lower possible horizon, the appearance level of *Lotagnostus americanus* that could be located within the topmost Tsitre Formation.

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Ediacara ja Kambriumi stratigraafia Eestis: ajakohastatud ülevaade

Tõnu Meidla

Käesoleva ülevaate eesmärgiks on ajakohastatud Ediacara ja Kambriumi stratigraafiliste skeemide esitamine Eesti jaoks ning korrelatsioonide üle diskuteerimine. Noorima Eelkambriumi ja Kambriumi stratigraafia 20. sajandi edusammud Eestis võeti kokku 1997. aastal ilmunud artiklites. Viimase kahe kümnendi vältel toimunud muutused globaalses kronostratigraafilises liigestuses mõjutavad oluliselt Eesti Eelkambriumi stratigraafiat ja võimaldavad siin kasutusele võtta uue Kambriumi ladestu rahvusvahelise liigestuse. Globaalse liigestuse üksus “Ediacara ladestu” on sobiv kasutamiseks Eesti noorima Eelkambriumi tähenduses. Ehkki neid kihte ei ole Eestis dateeritud, võimaldab korrelatsioon väljaspool Eestit paiknevate dateeritud läbilõigetega väita, et Eestis on esindatud vaid Ediacara ladestu noorim, ajastu viimase 7–10 miljoni aasta vältel kujunenud osa. Kuigi Kambriumi ladestu kõigi alajaotuste piirid ei ole veel piiristratotüüpidega fikseeritud, on Eestis siiski võimalik juba kasutusele võtta ladestu uus rahvusvaheline liigestus neljaks ladestikuks. Teise (nimetu) ladestiku piir on Eestis seotud lüngaga Voosi ja Sõru kihistu vahel. Kolmanda (nimetu) ladestiku alumine piir paikneb mõnevõrra kõrgemal senisest Kesk-Kambriumi alumisest piirist ja selle asendi täpsustamine Eestis ei ole võimalik piirikihtide puudumise tõttu. Furongi ladestiku alumine piir vastab *Olenus*’e ülemtsooni alumisele piirile.