

Trace fossils from the Ordovician-Silurian boundary beds of Estonia (Baltica)

Ogechukwu Ann Moghalu*, Olle Hints and Ursula Toom

Department of Geology, Tallinn University of Technology, Ehitajate tee 5, 19086, Tallinn, Estonia

* Corresponding author, ogechukwu.moghalu@taltech.ee



The transition from the Ordovician to the Silurian Period marks a crucial time in Earth history. Associated with the Late Ordovician Mass Extinction (LOME), rocks of this age have been characterised by low diversity in body fossil assemblages. Until recently, studies associated with the Ordovician-Silurian boundary in Estonia were mostly restricted to drill cores. The exposure of this boundary in the Reinu Quarry has led to new research interests, one of which is ichnology, as the trace fossils of this stratigraphic interval have not been systematically studied before. The Reinu Quarry provides unique material for such research.

This study documents the trace fossils from the Ordovician-Silurian boundary beds in Estonia, specifically the Kamariku Member of the Ärina Formation (Porkuni Regional Stage) and the Koigi Member of the Varbola Formation (Juuru Regional Stage). Lithological characterisation of the samples collected from the section revealed two broad but distinct limestone facies: sandy limestone and carbonate mudstone facies, interpreted as the Kamariku and Koigi members, respectively. Nine ichnogenera, representing seven categories of architectural designs and five categories of ethological classification, are recognised from ichnological studies of the Ordovician-Silurian boundary beds. The Kamariku Member hosts ichnogenera, such as *Chondrites*, *Multina*, *Planolites*, and *Thalassinoides*. Horizontal components of *Thalassinoides* dominate the Kamariku Member. Bio-erosional traces such as *Trypanites?* also occur in lithic substrates. Six ichnogenera are observed in the Koigi Member, including *Chondrites*, *Multina*, *Pilichnus*, *Planolites*, *Sinusichnus*, and *Treptichnus*. Overprinting is quite common in the Koigi Member, and there is repeated occurrence of *Chondrites* in association with *Planolites* burrows. Compared to the patchy occurrence of *Chondrites* in the Kamariku Member, the ichnogenus is relatively better preserved in the Koigi Member. This provides material on *Chondrites* in Palaeozoic carbonate sediments, which has been virtually lacking as the ichnogenus has been studied mostly in younger sediments.

The trace fossil assemblages in the Ordovician-Silurian boundary beds belong to the *Cruziana* ichnofacies. The assemblage and the dominance of horizontal traces reflect deposition in moderate to low-energy settings. The relatively high ichnodiversity suggests that organism-sediment interactions did not decrease despite the reduced biodiversity associated with the Hirnantian extinction. The dominance of traces that reflect feeding behaviour indicates that nutrient availability was likely a key environmental factor during the deposition of these beds. Other peculiar environmental factors also came into play. The Kamariku Member was likely deposited under relatively higher hydrodynamics than the Koigi Member. However, the hydrodynamics likely fluctuated. This is bolstered by the dominance of the horizontal component of *Thalassinoides* and the occurrence of substrate-controlled traces in the Kamariku Member, which suggests that colonisation occurred during periods of low-energy or non-deposition. The waters were also likely more oxygenated, considering the moderate abundance of shelly fossils and the low occurrence of *Chondrites* in the Kamariku Member.

On the other hand, the trace fossil assemblage in the Koigi Member reflects relatively quieter energy conditions. The dominance of *Chondrites* reflects stressful levels of oxygenation conditions. The trace makers likely inhabited dysoxic waters, where only opportunistic endo-benthos thrived. The moderate to intense bioturbation in the Koigi Member is likely due to low sedimentation rates.

Keywords: Ichnology, Ordovician-Silurian boundary, Baltica, Kamariku Member, Koigi Member.