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Arenig (Middle Ordovician) ostracods from Baltoscandia: Fauna, assemblages and biofacies

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Abstract

The Arenig ostracod fauna of Baltoscandia is the oldest known and amongst the most thoroughly studied ostracod faunas in the world. The fauna is dominated by eridostracans and palaeocopes, and comprises altogether about fifty species from seven suborders. The ten most abundant ostracod species make up 90% of the total Arenig fauna. Overall ostracod diversity estimates in the Arenig of the Baltoscandian Palaeobasin are low, but show gradual increase in diversity at younger horizons. Low diversity may be due to unfavourable climate conditions in the Baltoscandian Palaeocontinent during the earlier Arenig and may also be due to the early stage of evolution of ostracod faunas (i.e. pre their main diversification during the Llanvirn). Thirteen facies related Arenig ostracod assemblages are distinguished in the Baltoscandian Palaeobasin. In early- and mid-Volkhov time, the assemblages show almost basinwide distribution suggesting many ostracod species were environmental generalists. Major distinctions between different ostracod biofacies zones can be seen from the late Volkhov onwards, when the differentiation of ostracod biofacies in the Palaeobasin marks the onset of major depth differences. Ostracod assemblage-based reconstruction of sea-level changes in the studied area agrees well with the sequence stratigraphic interpretation of the succession and with a sea level curve determined on the basis of sedimentological data.

Keywords: Ordovician; Arenig; Baltoscandia; Ostracods; Palaeoecology; Biofacies

1. Introduction

Ostracods are an important component of fossil assemblages in the Arenig of Baltoscandia, being also one of the oldest thoroughly studied ostracod faunas in the world. The extensive data of the Arenig ostracods of Baltoscandia covers their taxonomy and stratigraphy at different outcrops and sections (Öpik, 1935, 1939; Hessland, 1949; Henningsmoen, 1953a,b, 1954; Sarv, 1959, 1960, 1963; Schallreuter, 1983, 1988, 1989, 1993, Gailīte, 1982a; Sidaravičienė, 1992; Vannier et al., 1989; Põldvere et al., 1998; Melnikova, 1999). The major objective of the present paper is to give a comprehensive taxonomic overview of the early ostracod fauna and its diversity through the Arenig of Baltoscandia.

Fossil ostracods, like modern species, were probably highly sensitive to environmental conditions and are thus increasingly used for palaeoecologic studies all over the world (Boomer et al., 2003). Systematic sampling for ostracods in different parts of the Baltoscandian area during recent years has lead to several papers dealing with ostracod facies analysis (Meidla et al., 1998; Tinn and Meidla, 1999, 2001). However, these papers have

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analysed ostracod faunas of single localities only, with some references to adjacent regions. The second objective of this paper is to define ostracod assemblages by statistical methods and to demonstrate palaeoecological relationships between Arenig ostracod taxa. Numerous studies have shown that the distribution of benthic ostracod assemblages can be controlled by several environmental and sedimentological parameters, like water depth, substrate, salinity, temperature, etc. (Siveter, 1984). Detailed data on temporal and geographical distribution of ostracod assemblages are used for defining ostracod biofacies in the Arenig Baltoscandian Palaeobasin by presence–absence data and cluster analysis.

2. Geological setting

Palaeomagnetic data and palaeontological evidence (Scotese and McKerrow, 1990; Torsvik et al., 1991; Torsvik, 1998; Cocks and Torsvik, 2005) suggest that the Baltica palaeocontinent occupied temperate southern palaeolatitudes (about 45–60°) during the Early Ordovician. The Early and Middle Ordovician sediments of Baltoscandia were deposited in a sediment-starved epicontinental sea with extremely flat sea bottom topography, on a gently tilted ramp (Nestor and Einasto, 1997). Low-rate deposition of carbonates replaced the siliciclastic-dominated sedimentation of the Baltoscandian epicontinental sea during latest Early Ordovician time. The Middle Ordovician skeletal debris-rich carbonates with numerous discontinuity surfaces are lacking in evidence for tropical conditions (e.g. pelletal and oolitic deposits, coral–stromatoporoid reefs etc.) and have been interpreted as cool-water sediments (Jaanusson, 1973; Lindström, 1984; Nestor and Einasto, 1997).

The Ordovician strata of the Palaeobasin developed in an array of distinct facies belts, characterized by specific sedimentological and palaeontological features (Männil, 1966; Jaanusson, 1973, 1976, 1982) and maintaining a fairly constant relative position within the depositional area through time. Jaanusson (1976) termed this type of composite facies unit "confacies belt" and suggested that they reflect a broad ecologic zonation, controlled by environmental factors that also influenced depositional conditions (Jaanusson, 1982). The confacies pattern apparently reflects a general depth zonation of the Palaeobasin (Männil and Meidla, 1994). The North Estonian Confacies Belt (Fig. 1) is regarded as the marginal area of the epicontinental sea, where micritic skeletal calcarenites, sometimes containing silt and goethite ooids, abundant glauconite grains and numerous impregnated hardgrounds, indicate a middle to inner ramp zone near the fair-weather wave base (Männil, 1966; Nestor and Einasto, 1997; Meidla et al., 1998).

Opinions vary with respect to the Central Baltoscandian Confacies Belt, but it is generally thought to represent outer ramp or basinal facies near storm wave base. However, the red-coloured or variegated argillaceous limestones and marls of this unit are considered to be of shallow-water origin by Jaanusson (1982) and Nielsen (1995), who attribute the numerous unconformities to either emergence of the basin due to repeated sea level fluctuations or to submarine non-deposition. In contrast, Lindström (1963, 1971, 1979, 1984) has attributed the extremely low sedimentation rate to deep sea conditions,

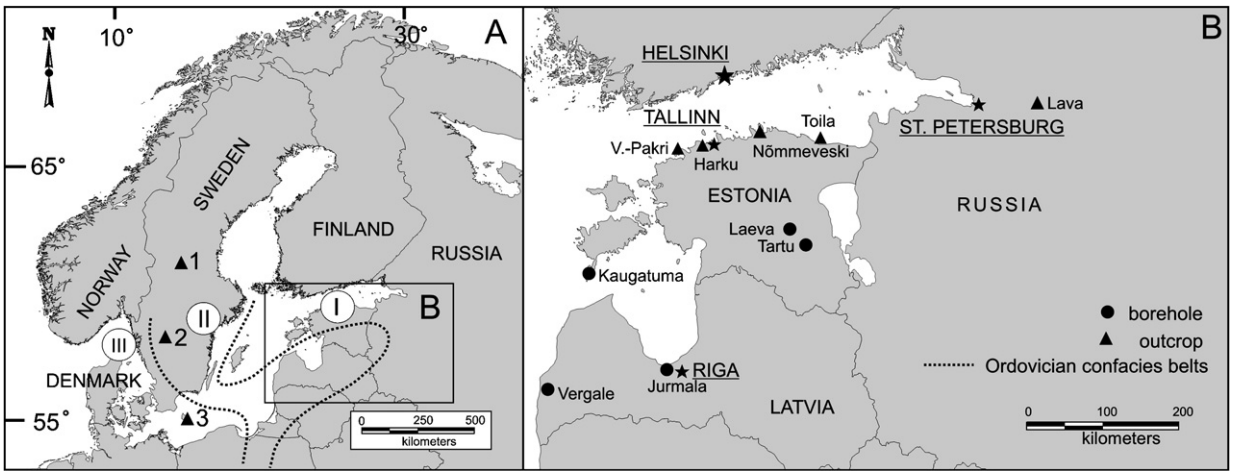

Fig. 1. Schematic map of the study area. Roman numerals mark Ordovician confacies belts (after Jaanusson, 1976): I — North Estonian Confacies Belt; II — Central Baltoscandian Confacies Belt; III — Scanian Confacies Belt. Arabic numerals mark studied sections: 1 — Siljan composite section (Hessland, 1949); 2 — Hällekis; 3 — Skelbro.