Contributions of International Symposium

13th ISOS

NOVOSIBIRSK 2019

TROFIMUK INSTITUTE OF PETROLEUM GEOLOGY AND GEOPHYSICS
RUSSIAN ACADEMY OF SCIENCES
SIBERIAN BRANCH
NOVOSIBIRSK NATIONAL RESEARCH STATE UNIVERSITY

13TH INTERNATIONAL SYMPOSIUM ON THE ORDOVICIAN SYSTEM NOVOSIBIRSK, RUSSIA (JULY 19-22, 2019)

Contributions

Edited by
O.T. Obut, N.V. Sennikov and T.P. Kipriyanova

Novosibirsk
Publishing House of SB RAS
2019

УДК 551.733
ББК 26.323
Т67

DOI 10.15372/INTERNATIONAL2019OOT

13th International Symposium on the Ordovician System: Contributions of International Symposium. Novosibirsk, Russia (July 19-22, 2019) / Eds O.T. Obut, N.V. Sennikov, T.P. Kipriyanova; Trofimuk Institute of Petroleum Geology and Geophysics SB RAS; Novosibirsk National Research State University. – Novosibirsk : Publishing House of SB RAS, 2019. –263 p.

13-й Международный Симпозиум по Ордовикской системе: Материалы Международного симпозиума. Новосибирск, Россия (19–22 июля, 2019) / Ред. О.Т. Обут, Н.В. Сенников, Т.П. Киприянова; Институт нефтегазовой геологии и геофизики им. А.А. Трофимука СО РАН; Новосибирский национальный исследовательский университет. Новосибирск : Изд-во СО РАН, 2019. – 263 с.

Organization

International Commission on Stratigraphy

Subcommission on Ordovician Stratigraphy

IGSP 653 “The onset of the Great Ordovician Biodiversification Event”

Trofimuk Institute of Petroleum Geology and Geophysics SB RAS

Novosibirsk National Research State University

Siberian Branch of Russian Academy of Sciences

Russian Foundation for Basic Research (RFBR)

Translated by N.N. Mzhel’skaya, O.T. Obut, N.V. Sennikov

Reviewers:
Doctor of Sciences in Geology A.V. Dronov
Doctor of Sciences in Geology S.V. Rozhnov

ISBN 978-5-7692-1657-2

EARLY DIVERSIFICATION OF CHITINOZOANS ON BALTICA: NEW DATA FROM NORTHERN ESTONIA AND LATVIA

Y. Liang[1,2], J. Nõlvak[1], O. Hints[1]

[1] Department of Geology, Tallinn University of Technology, Ehitajate tee 5, Tallinn 19086, Estonia; liangyan@nigpas.ac.cn, jaak.nolvak@taltech.ee, olle.hints@taltech.ee
[2] CAS Key Laboratory of Economic Stratigraphy and Palaeogeography, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing 210008, China

Key words: *chitinozoans, Middle-Late Ordovician, North Estonia, Latvia.*

Cryptic chitinozoans originated and diversified during the Great Ordovician Biodiversification Event (GOBE). They are abundant and diverse in the Ordovician and Silurian succession of Baltoscandia – the region where they were first reported by Alfred Eisenack in 1930s. Chitinozoans from eastern Baltoscandia, including Estonia, are generally well-known by excellent and often three dimensional preservation in the late Middle and Late Ordovician limestones. Due to the abundance and biostratigraphic utility, chitinozoans from this interval are extensively studied and their diversification history is rather well documented (Paris et al., 2004; Hints et al., 2018). However, the early diversification of chitinozoans from Tremadocian to Dapingian is rather poorly known in Baltoscandia, and the previous diversity estimates for these stages are notably lower compared to the values from other regions (Achab and Paris, 2007; Liang and Tang, 2016; Liang et al., 2018). Hints and Nõlvak (2006) reported a diverse late Tremadocian chitinozoan assemblage from a single sample, suggesting that the previously reported low diversity during the Early and early Middle Ordovician of Baltica was primarily due to sampling bias and lack of studies. In order to fill this gap and more fully document the early diversification of chitinozoans on Baltica, we collected new samples and re-studied older, hitherto unpublished collections, in total 80 samples. The bulk of new data were recovered from two sections, the Jägala waterfall section, northern Estonia (Nõlvak et al., 2019), and the Baldone drill core, central Latvia. Combining these data with additional new samples from northern Estonia and previously published reports, allows better understanding of the early diversification of chitinozoans in Baltoscandia and assessing their biogeographic affinities. The studied sections are briefly characterized as follows.

The Jägala waterfall section in northern Estonia represents a shallow-shelf part of the Baltoscandian basin. In total, 11 genera and 47 species of chitinozoans were identified from the 7.5 m succession of sandstones, marls and carbonates. The fossiliferous strata range from the Hunneberg to Kunda regional stages, corresponding to the upper Tremadocian to lower Darriwilian. A barren interval in the Floian is largely due to poor preservational conditions, but may also indicate a low diversity period after the late Tremadocian diversity peak. Full details on this section are provided in Nõlvak et al. (2019).

The Baldone borehole, central Latvia, represents a deeper shelf mud-supported facies comprising marls and argillaceous limestones. Compared to northern Estonia, the upper Tremadocian to the lower Darriwilian succession is ca ten times thicker; however, the Floian and Dapingian strata are represented by redbeds which are barren of organic-walled microfossils. Twenty samples, 100–500 g each were processed from the section and 12 yielded chitinozoans. Altogether, 13 genera and 37 species were identified. Two species, *Conochitina raymondii* and *Clavachitina grandicula* were obtained from the lowermost part of the Zebre Formation, corresponding to the upper Tremadocian or lower Floian. Diverse chitinozoan assemblage was recovered from the Šakyna and Baldone formations, lower Darriwilian.

The Uuga and Leetse cliffs, Pakri peninsula, northern Estonia, were studied by eight new samples from the Türisalu, Varangu and Leetse formations, Tremadocian to Floian. Two species, *Pellichitina*? sp. and *Rhabdochitina* sp., were identified from the Varangu Formation at Uuga, reminding the lower productive samples from the Jägala section (Nõlvak et al. (2019). In Leetse cliff, the uppermost sample from the Varangu Formation yielded a different chitinozoan assemblage from that in Uuga, including *Conochitina* cf. *raymondii*, *Eremochitina* sp. A aff. *baculata*, *Lagenochitina esthonica* and *Lagenochitina* cf. *longiformis.* The Leetse Formation at the Uuga cliff contained *Conochitina decipiens*, *Desmochitina* sp. gr. *minor*, *L. esthonica*, *L.* cf. *longiformis*, *Conochitina* sp., *E.* sp. A aff. *baculata* and *Euconochitina* sp.

The Mäeküla outcrop in Tallinn, northern Estonia, was studied by two samples from the Leetse Formation and both of them yielded chitinozoans, including *Conochitina decipiens* and *Desmochitina* sp. gr. *minor*, *Eremochitina* sp. A aff. *baculata*, *Lagenochitina* cf. *longiformis* and *Lagenochitina ovoidea*, which are quite similar to the assemblage in the same formation at Uuga. One new species, *Desmochitina* sp. n., which is characterized by an ovoid chamber and lack of neck and collar was recovered and a questionable form resembling *Cyathochitina calix* was observed in the upper part of the formation roughly corresponding to the middle part of Floian.

The results based on the above five sections shed new light on the chitinozoan diversification during the Early and early Middle Ordovician (Tremadocian to Dapingian) in Baltoscandia. During this interval, strata from the stratigraphically more complete deeper shelf sections of the Baltic palaeobasin are mainly occupied by redbeds, which are devoid of chitinozoans (Nõlvak, 2002). Thus the condensed strata in northern Estonia are more promising for studying the early diversification of chitinozoans in Baltoscandia.

As illustrated in Nõlvak et al. (2019), the chitinozoans recovered from the middle and upper Floian at Jägala waterfall increased the diversity value significantly, about a three-fold to five-fold compared to the previous estimates for Baltica (Paris et al., 2004), whereas the data from the Floian and lowermost Dapingian are still rare. However, the additional samples from northern Estonian outcrops added some supplementary data to this interval. The late Tremadocian assemblage of *Desmochitina* sp. gr. *minor*, *Lagenochitina* cf. *longiformis*, *Lagenochitina esthonica* and *Lagenochitina ovoidea*, recorded from the Jägala waterfall section, is now known to occur in the Floian too, if the correlations are correct. In addition, four species, *E*. sp. A aff. *baculata*, *Conochitina* sp., *Euconochitina* sp. and *Desmochitina* sp., are newly identified from the Floian. Thus, at least 8 species, excluding the questionable *Cyathochitina calix*, were present in the Floian interval. Furthermore, three species, *Conochitina* cf. *raymondii*, *Pellichitina*? sp. and *Rhabdochitina* sp. can be added to the interval of late Tremadocian. These data, combined with the report of Hints and Nõlvak (2006), suggest that chitinozoans experienced a short and distinct bloom in the late Tremadocian with more than 20 species present. Notably, a similar late Tremadocian diversity acme has also been recognized in South China (Liang and Tang, 2016), and the regions share a number oIn summary, chitinozoan diversity in the Early and early Middle Ordovician appears to have been notably higher on Baltica than estimated in previous works. Although the biodiversity estimates during this interval are still low, with the only exception of late Tremadocian, the trend is still in rise through the Floian to Dapingian and then reaches its acme in the early Darriwilian. Further studies focusing on this interval, particularly the Floian, are still required to fully understand the chitinozoan diversification on Baltica.

This is a contribution to IGCP 653 project.

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