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# Conodont assemblages of the Gélava (Lower Silurian) regional stage of Lithuania

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A detailed description of conodont assemblages of the Gélava regional stage of Lower Silurian of Lithuania is provided. The quantitative data on fauna to establish the conodont assemblages have been used. Assemblages were named after one to three dominating species. There were established five conodont assemblages: *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus* sp. n. E, *Pseudooneotodus bicornis* – *Panderodus unicostatus*, *Panderodus unicostatus*, *Ozarkodina e. excavata* – *Panderodus unicostatus*, *Ozarkodina e. excavata* – *O. confluens* and *Ctenognathodus* sp. A.

**Key words:** Silurian, regional stage, conodonts, assemblages, Lithuania

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## INTRODUCTION

The Gélava regional stage of Lithuania corresponds to the upper part of the Wenlockian series and consists of the following graptolite zones: *G. nassa* (upper part), *P. deubeli*, *P. virbalensis* and *C. ludensis* (Brazauskas et al., 2004).

Stratigraphists have always been interested in the distribution peculiarities of conodont fauna in a sedimentary basin. Conodont fauna is very important to biostratigraphy when it comes to biozonation of a certain geological section. The reliability of biozonation in a sedimentary basin depends on the corresponding group of the organic world. Biozonation is also important for a correlation of geological sections formed under different sedimentation environments.

The present study of conodont fauna spatial distribution regularities of the Silurian rocks of Lithuania has revealed that not all conodont species could be used for compilation of biostratigraphical scales.

The distribution of conodont species is strongly related to certain rock types. It indicates that sedimentation factors such as depth and distance from the shoreline influenced the distribution of conodont organisms. In certain places of the Gélava sedimentary basin, different associations of conodonts were found. These associations are named after assemblages in this article.

The core material from the Jakšiai-104, Šiupyliai-69, Gélava-99, Parovėja-9, Sutkai-87, Ledai-179, Pilviškiai-142 and Paežeriai-222 boreholes was used for determination of conodont assemblages and their distribution regularities in the Gélava regional stage (Lower Silurian) (Figure). This material has also been used for the spatial distribution mapping of conodont assemblages.

## METHODS

**Establishment of conodont assemblages.** The quantitative data (percentage of taxa in a sample) on conodont assemblages were taken from A. Brazauskas and P. Musteikis studies (Бразаускас, 1985; 1993; Musteikis, Paškevičius, 1999). The data were statistically treated applying D. Rodionov's criterion and cluster analysis.

Referring to the conodont fauna species quantitative data in the samples, each borehole section was divided into several intervals applying D. Rodionov's criterion.

The average values of single taxa were calculated and a corresponding data set was compiled for each previously established interval. The compiled data set represented a buried conodont assemblage. One or two dominant conodont species of the mentioned assemblages were determined. The dominant species names were used for to name the assemblages.

**The spatial distribution map of conodont assemblages.** The previous methodology of the compilation of sedimentation-paleogeographical maps was applied for the conodont assemblage spatial distribution map (Brazauskas et al., 2004 a, b).

The distribution of each assemblage in an area was drawn according to the established conodont assemblage in the straton. The lateral shift of assemblages in their distribution area is presented as a *nonscaled* continuous section (see Figure).

The height of a section is the same for each assemblage. The strips of the same thickness through the section for each assemblage were used if more than one assemblage was present in the section.

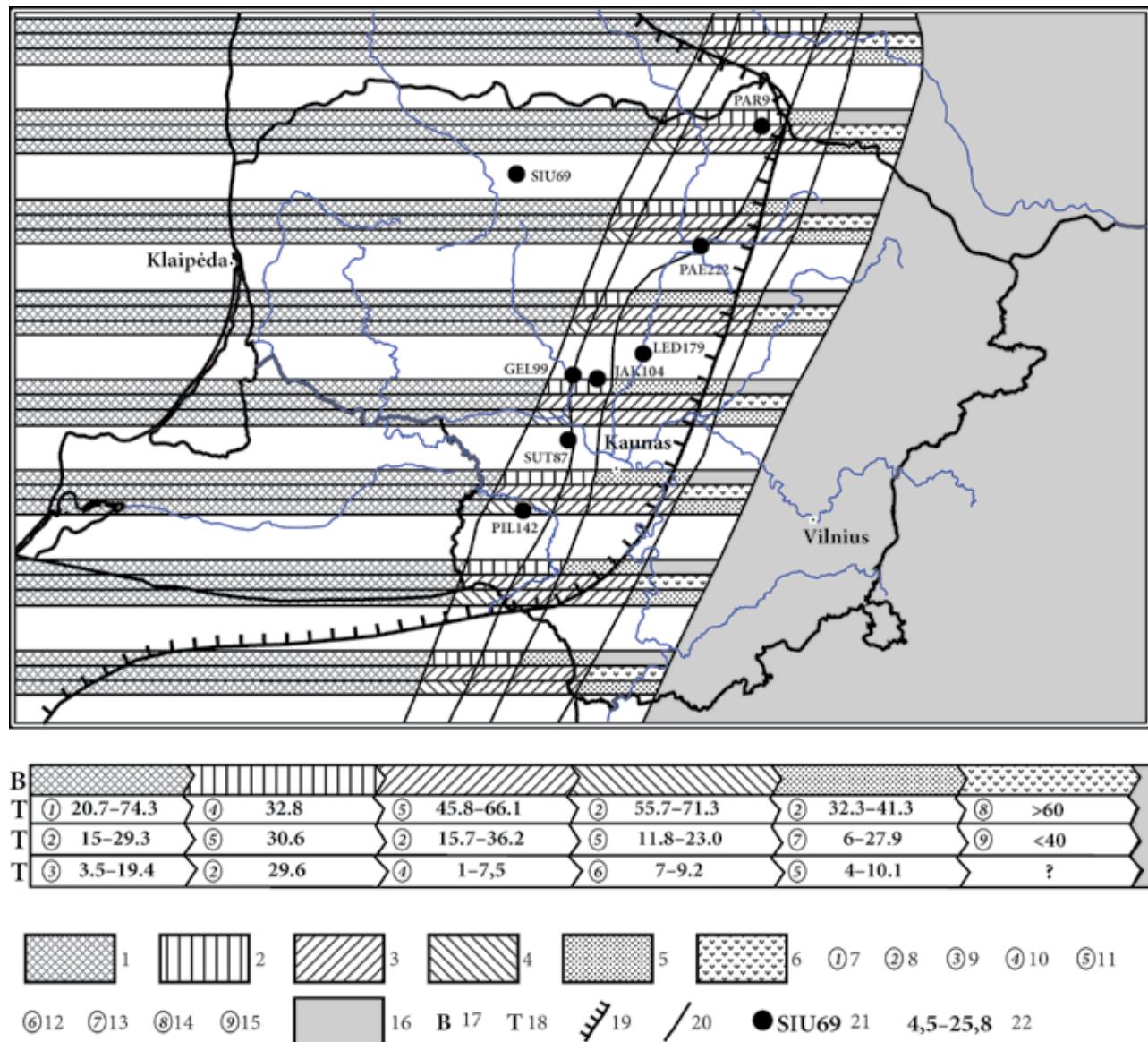
The colour for each assemblage (strip) was chosen optionally. Thus, the shift of assemblages of the straton in the map

is presented by a combination of colour strips, which covers all the distribution area. The assemblages should be read from bottom to top.

The taxon composition of assemblages is presented by a separate block outside the map margins. The block of each assemblage is subdivided into three or more strips. Their number depends on the taxon diversity in the assemblage.

It is desirable that for all corresponding straton assemblages the number of the stripes should be the same, i. e. the same number of the taxa composing the assemblage. The upper stripe corresponds to the name of assemblage in the map and is coloured in the same colour.

The rest downward presented stripes could be coloured optionally but should be strictly specific for each taxon.



**Figure.** The distribution map of conodont assemblages of the Gélava regional stage in Lithuania. Conodont assemblages: 1 – *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus* sp. n. E, 2 – *Pseudooneotodus bicornis* – *Panderodus unicostatus*, 3 – *Panderodus unicostatus*, 4 – *Ozarkodina e. excavata* – *Panderodus unicostatus*, 5 – *Ozarkodina e. excavata* – *O. confluens*, 6 – *Ctenognathodus* sp. A. Predominant taxa of conodont assemblages: 7 – *Dapsilodus hamari*, 8 – *Ozarkodina e. excavata*, 9 – *Panderodus* sp. n. E, 10 – *Pseudooneotodus bicornis*, 11 – *Panderodus unicostatus*, 12 – *Ozarkodina bohemica longa*, 13 – *Ozarkodina confluens*, 14 – *Ctenognathodus* sp. A, 15 – *Ozarkodina svetlanae*. Other signs: 16 – denudation area, 17 – assemblages, 18 – taxa, 19 – boundary of the present distribution of the Gélava regional stage in Lithuania, 20 – boundaries of conodont assemblages, 21 – boreholes and their codes, 22 – percentage of a taxon in the assemblage

**Pav. Lietuvos Gélavos regioninio aukšto konodontų bendrijų paplitimo žemėlapis. Konodontų bendrijos:** 1 – *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus* sp. n. E, 2 – *Pseudooneotodus bicornis* – *Panderodus unicostatus*, 3 – *Panderodus unicostatus*, 4 – *Ozarkodina e. excavata* – *Panderodus unicostatus*, 5 – *Ozarkodina e. excavata* – *O. confluens*, 6 – *Ctenognathodus* sp. A. Konodontų asociacijose vyraujantys taksonai: 7 – *Dapsilodus hamari*, 8 – *Ozarkodina e. excavata*, 9 – *Panderodus* sp. n. E, 10 – *Pseudooneotodus bicornis*, 11 – *Panderodus unicostatus*, 12 – *Ozarkodina bohemica longa*, 13 – *Ozarkodina confluens*, 14 – *Ctenognathodus* sp. A, 15 – *Ozarkodina svetlanae*. Kiti ženklai: 16 – denudacinių sritis, 17 – bendrijos, 18 – taksonai, 19 – Gélavos regioninio aukšto uolienų dabartinio paplitimo riba Lietuvoje, 20 – konodontų bendrijų ribos, 21 – gręžiniai ir jų kodai, 22 – taksono procentinis kiekis bendrijoje

For example, *Ozarkodina e. excavata* should be coloured in the same colour independently of which assemblage it belongs to. Taxa in an assemblage (in this case in the block) are arranged in decreasing order.

## RESULTS

The spatial distribution map of the conodont assemblages along the facial gradient was compiled. It is based on the conodont distribution peculiarities in the Lithuanian Silurian Sedimentary Basin.

Five conodont assemblages were established and one restored within the Gėluva sedimentary basin: *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus* sp. n. E, *Pseudooneotodus bicornis* – *Panderodus unicostatus*, *Panderodus unicostatus*, *Ozarkodina e. excavata* – *Panderodus unicostatus*, *Ozarkodina e. excavata* – *O. confluens* and *Ctenognathodus* sp. A (see Figure).

In some sections, assemblages overlap stratigraphically. Consequently, five overlapping areas from the west to the east were established. The overlapping area of the last two assemblages is apparent and was reconstructed according to the lateral regularity shift of the sedimentation environment.

Unfortunately, the verification of the mentioned fact is complicated due to the scanty number of boreholes in the area. The description of assemblages is presented following their distribution sequence in the sedimentary basin shallowing direction (see Figure).

### Assemblage *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus* sp. n. E

*Name:* suggested for the first time.

*Composition:* Polytaxal assemblage, dominant species in several samples take up 80–95% of all conodonts. In some cases *Dapsilodus hamari* (Branson et Mehl) take 20.7–74.3%, *Ozarkodina e. excavata* (Branson et Mehl) 15–29.6%, *Panderodus* sp. n. E 3.5–19.4% (see Figure).

In addition, the species *Decoriconus fragilis* (Rexroad) and *Dapsilodus obliquicostatus* (Branson et Mehl) were also found. Other species rarely take up 5–10%.

*Age:* Late Wenlock – Early Ludlow.

*Typical locality:* West Lithuania, Šiupyliai-69 borehole, depth 1010.0–974.0 m.

*Geographical distribution:* West and Northwest Lithuania (see Figure).

### Assemblage *Pseudooneotodus bicornis* – *Panderodus unicostatus*.

*Name:* suggested for the first time.

*Composition:* Polytaxal assemblage containing 6 conodont species. Dominant species percentage is presented according to Sutkai-87 borehole data, because the age of the assemblage from the other boreholes was determined as older and its quantitative composition was slightly different. The composition of dominant taxa in the mentioned borehole section is: *Pseudooneotodus bicornis* (Drygant) 32.8%, *Panderodus unicostatus* (Branson et Mehl) 30.6%, *Ozarkodina e. excavata* (Branson et Mehl) 29.6%. The percentage of the other taxa is considerably lower; e.g., *Decoriconus fragilis* (Rexroad) 2.9%, *Oulodus* sp. 1%, *Kockellia amsdeni* (Barrick et Klapper) 1.8%.

*Age:* Early Wenlock and beginning of Late Wenlock.

*Typical locality:* Middle Lithuania, Sutkai-87 borehole, depth 810.5–792.5 m.

*Geographical distribution:* Middle Lithuania (see Figure).

### Assemblage *Panderodus unicostatus*

*Name:* suggested for the first time.

*Composition:* Polytaxal assemblage containing up to 10 species. Dominant species: *Panderodus unicostatus* (Branson et Mehl) 45.8–66.1%, *Ozarkodina e. excavata* (Branson et Mehl) 15.7–36.2%. Rather abundant taxa in this assemblage are *Pseudooneotodus bicornis* (Drygant) – 1.0–7.5%, *Decoriconus fragilis* (Rexroad) – up to 3%. The total percentage of the other taxa doesn't reach 10.0%.

*Age:* Late Wenlock.

*Typical locality:* Middle Lithuania, Ledai-179 borehole, depth 689.6–650.0 m.

*Geographical distribution:* Middle Lithuania (see Figure).

### Assemblage *Ozarkodina e. Excavata* – *Panderodus unicostatus*

*Name:* suggested for the first time.

*Composition:* Polytaxal assemblage containing up to 10 species. Dominant species: *Ozarkodina e. excavata* (Branson et Mehl) 55.7–71.3%, *Panderodus unicostatus* (Branson et Mehl) 11.8–23.0%, *Ozarkodina bohemica longa* 7.0–9.2%, *O. confluens* (Branson et Mehl) 2–4%. Other species in the assemblage take up only 1–2%.

*Age:* Late Wenlock – Early Ludlow.

*Typical locality:* Middle Lithuania, Jakšiai-104 borehole, depth 810.5–794.0 m.

*Geographical distribution:* Middle Lithuania (see Figure).

### Assemblage *Ozarkodina excavata* – *O. confluens*

*Name:* For the first time was used by V. Viira (1982).

The assemblage was described by R. Aldridge and L. Jeppsson (Aldridge, Jeppsson, 1999).

To make the analysis of the assemblages more complete, a full description of the assemblage based on our observations is provided.

*Composition:* Polytaxal assemblage containing up to 8 species. Dominant species: *Ozarkodina e. excavata* (Branson et Mehl) 32.3–41.3%, *O. confluens* 6.0–27.9%, *Panderodus unicostatus* (Branson et Mehl) 4.0–10.1%, *Oulodus ziegleri* (Walliser) 0.0–10.4%, *Ozarkodina bohemica longa* up to 6.7%. In addition, solitary examples of *Pseudooneotodus bicornis* (Drygant), *Oulodus* sp. and other taxa were found.

*Age:* Late Wenlock, Nevėžis Formation.

*Typical locality:* Middle Lithuania, Ledai-179 borehole, depth 650.0–628.7 m.

*Geographical distribution:* Middle Lithuania (see Figure).

### Assemblage *Ctenognathodus* sp. A

*Name:* conditional and is suggested for the first time.

According to our data, this assemblage is almost monospecific. It contains rare solitary specimens which could be described as *Ctenognathodus* sp. A. For a more detailed paleontological description, more core material is needed. In the same sample, rare parts of *Ozarkodina confluens* (Branson et Mehl) were found.

Their quantity is less than 40%. The assemblage perhaps existed in the area close to the shoreline of the sedimentary basin. The age of the suggested assemblage is Late Wenlock – Early Ludlow (see Figure).

## CONCLUSIONS

Investigation of the conodont fauna species distribution of Gélava regional stage rocks in the boreholes studied enabled to reveal certain regularities which reflect the peculiarities of the sedimentary basin development.

According to the established conodont assemblages, the sedimentary basin during the Gélava time was of regressive character.

It is evident that the western part of the Lithuanian sedimentary basin did not suffer significant changes during this time interval. From its beginning to end, interval conodont assemblages *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus sp. n. E* existed in it.

Meanwhile, in Middle and Eastern Lithuania the distribution of conodont assemblages varied significantly, both vertically and horizontally. It suggests an intensive variation of the sedimentary basin development.

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## LIETUVOS GÉLUVOS (APATINIS SILŪRAS) REGIONINIO AUKŠTO KONODONTŲ BENDRIJOS

### Santauka

Nustatant Géluvos regioninio aukšto (silūras) konodontų bendrijas buvo panaudoti tirtos faunos kiekybiniai duomenys, gauti apskaičiavus kiekvieno taksono procentinį kiekį bandinyje. Remiantis D. Rodionovo kriterijumi bei klasterine analize kiekvienas analizuotas grėžinio pjūvis buvo suskaidytas į keletą tarpsnių. Apskaičiuotas visų tarpsnių kiekvieno taksono vidutinis procentinis kiekis, kuris ir atspindi palaidotų konodontų bendrijas. Kiekvienai bendrijai nustatyti 1, 2 arba 3 konodontų dominantinės rūšys, pagal kurias ir pavadiintos konodontų bendrijos.

Géluvos amžiaus sedimentacinio išplitimo areale nustatytos penkios konodontų bendrijos ir viena rekonstruota remiantis konodontų rūšių erdviniuoju paplitimo dėsningumais (pav.): *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus sp. n. E*, *Pseudooneotodus bicornis* – *Panderodus unicostatus*, *Panderodus unicostatus*, *Ozarkodina e. excavata* – *Panderodus unicostatus*, *O. e. excavata* – *Ozarkodina confluens*, *Ctenognathodus sp. A*.

Nurodytos bendrijos analizuotuose pjūviuose stratigrafiškai persidengia. Iš vakarų į rythus nustatyti penki tokie konodontų bendrijų persidengimo arealai, kurie daugiausia sutampa tiek su horizontalia, tiek su vertikalia sedimentacinių aplinkos kaita Géluvos amžiaus paleobaseine.

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## АССОЦИАЦИИ КОНОДОНТОВ ГЕЛУВСКОГО (НИЖНИЙ СИЛУР) РЕГИОНАЛЬНОГО ЯРУСА ЛИТВЫ

### Резюме

Для установления конодонтовых сообществ в гелувском региональном ярусе использованы количественные данные исследованной фауны. Эти данные получены при расчете процентного содержания каждого таксона в образце. Используя статистические методы – критерий Д. Родионова, а также кластерный анализ, каждый проанализированный разрез скважины был разделен на несколько интервалов. Для всякого интервала были подсчитаны средние значения каждого таксона, которые и отражают сообщества захороненных конодонтов. Для каждого сообщества установлены 1, 2 или 3 доминирующих вида конодонтов. По этим видам названы конодонтовые сообщества.

В пределах седиментационного бассейна гелувского времени установлено 5 конодонтовых сообществ и 1 реконструировано согласно закономерностям их пространственного распространения: *Dapsilodus hamari* – *Ozarkodina e. excavata* – *Panderodus sp. n. E*, *Pseudooneotodus bicornis* – *Panderodus unicostatus*, *Panderodus unicostatus*, *Ozarkodina e. excavata* – *Panderodus unicostatus*, *Ozarkodina e. excavata* – *O. confluens* и *Ctenognathodus sp. A*.

В отдельных разрезах указанные сообщества стратиграфически перекрываются. Поэтому (с запада на восток) выделены 5 перекрывающихся ареала конодонтовых сообществ, которые частично совпадают со сменой седиментационных обстановок в палеобассейне гелувского века как в горизонтальном, так и в вертикальном направлениях.