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**ICHTHYOFAUNA FROM THE LOWER DEVONIAN (LOCHKOVIAN) DEPOSITS
OF THE PODLASIE-BREST DEPRESSION
(FROM THE RESULTS OF THE RATAICHITSY 12 K BOREHOLE SECTION INVESTIGATION)**

Abstract. The paper presents the results of a palaeoichthyological study of the Lochkovian age rocks exposed in the Rataichitsy 12 k borehole within the territory of the Podlasie-Brest Depression in Belarus. To complete the information presented in the papers the author gives besides his personal data the summarized evidences of all the reliable findings of the Lochkovian fish fauna in the territory of the above-named tectonic structure known from the literature. A brief taphonomic description of the Early Devonian ichthyofauna remains is presented. A vertebrate assemblage established in this borehole is compared with the coeval ichthyological assemblages known in the territory of Russia, Ukraine, the Baltic States and Spitsbergen. The data of the Lochkovian ichthyofauna obtained supplement the information on its geographical distribution and systematic composition within the Republic of Belarus.

Keywords: Belarus, Podlasie-Brest Depression, ichthyofauna, Lochkovian deposits, Lower Devonian

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**ИХТИОФАУНА ИЗ НИЖНЕДЕВОНСКИХ (ЛОХКОВСКИХ) ОТЛОЖЕНИЙ ПОДЛЯССКО-БРЕСТСКОЙ ВПАДИНЫ
(ПО РЕЗУЛЬТАТАМ ИЗУЧЕНИЯ РАЗРЕЗА СКВАЖИНЫ РАТАЙЧИЦЫ 12 К)**

Аннотация. Приводятся результаты палеоихтиологического изучения пород лохковского возраста, вскрытых скважиной Ратайчицы 12 к на территории Подляско-Брестской впадины в пределах Беларуси. Для полноты информации в тексте приводятся, помимо собственных исследований автора, также обобщенные сведения обо всех достоверно известных находках лохковской ихтиофауны на территории вышеназванной тектонической структуры на основе литературных данных. Рассмотрена кратко тафономическая характеристика остатков раннедевонской ихтиофауны. Установленный комплекс позвоночных в этой скважине сопоставляется с одновозрастными ихтиокомплексами известными на территории России, Украины, стран Балтии и Шпицбергена. Полученные данные по лохковской ихтиофауне дополняют информацию о ее географическом распространении и систематическом составе в пределах республики.

Ключевые слова: Беларусь, Подляско-Брестская впадина, ихтиофауна, лохковские отложения, нижний девон

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**ІХТЫЯФАЎНА З НИЖНЕДЭВОНСКИХ (ЛОХКАЎСКИХ) АДКЛАДАЎ ПАДЛЯСКА-БРЭСЦКАЙ УПАДЗІНЫ
(ПА ВЫНІКАХ ВЫВУЧЭННЯ РАЗРЭЗУ СВДРАВІНЫ РАТАЙЧИЦЫ 12К)**

Анатацыя. Прыводзяцца вынікі палеаіхтыялагічнага вывучэння парод лохкаўскага ўзросту, ускрытых свідравінай Ратайчыцы 12 к на тэрыторыі Падляска-Брэсцкай упадзіны ў межах Беларусі. Для паўнаты інфармацыі ў тэксце прыводзяцца, акрамя ўласных даследаванняў аўтара, таксама абагульненыя звесткі аб усіх дакладна вядомых знаходках лохкаўскай іхтыяфаўны на тэрыторыі вышэйназванай тэктанічнай структуры на аснове літаратурных даных. Разгледжана каратка тафанамічная характарыстыка рэштак раннедэвонскай іхтыяфаўны. Устаноўлены комплекс хрыбетных у гэтай свідравіне супастаўляецца з іхтыякомплексамі таго ж самага ўзросту вядомых на тэрыторыі Расіі, Украіны, краін Балтыі і Шпіцбергена. Атрыманыя даныя па лохкаўскай іхтыяфаўне дапаўняюць інфармацыю аб яе геаграфічным распаўсюджванні і сістэматычным складзе ў межах рэспублікі.

Ключавыя словы: Беларусь, Падляска-Брэсцкая ўпадзіна, іхтыяфаўна, лохкаўскія адклады, ніжні дэвон

Introduction. The Devonian deposits in the territory of the Podlasie-Brest Depression are described by a small distribution area and are represented by the lower part of the Lochkovian Stage [1, 2]. They were exposed in five boreholes: Rataichitsy 12k (depth range of 366.0–404.0 m), Orlia 28 (depth range of 409.0–450.0 m), Kustin 8 (depth range of 384.0–416.0 m), Yatskovichi 14 (depth range of 386.0–409.0 m) and Lyshitsy 15 (depth range of 394.0–404.0 m) [3]. Their thickness varies from 10 to 41 m. According to the current Stratigraphic Chart of the Devonian deposits of Belarus (2010) these deposits correspond to the Kameniuki Formation (Borshchovo Regional Stage) [2]. They are mainly composed of dolomite limestones and dolomites, with few and thin layers of marls, clays and siltstones. They are lying over the deposits of the Kustin Regional Stage (Formation) of the Pridolian Series of the Upper Silurian and are overlain by the Triassic clays or Permian conglomerates.

This paper is devoted to the study of the micromeric and mesomeric remains of the ichthyofauna originating from the Lower Devonian deposits of the Rataichitsy 12 k borehole, or more precisely, from the marly-dolomitic deposits of the Kameniuki Formation of the Borshchovo Regional Stage of the Lochkovian Stage of the Lower Devonian. The deposits of the Kameniuki Formation in this borehole section occur on the clayey-carbonate sediments of the Kustin Regional Stage (Formation) of the Pridolian Series of the Upper Silurian, and are overlain by the Lower Triassic variegated clays. The deposits of the Kameniuki Formation distinguished in the Rataichitsy 12 k borehole are 39 m thick. This is a stratotype borehole. It was drilled in the late sixties of the twentieth century near the village of Rataichitsy, Kamenets district, Brest region. The core from this borehole preserved to date was given a thorough palaeoichthyological study. This allowed the author to obtain new findings of various Lochkovian ichthyofauna and to supplement significantly its taxonomic composition, which was originally established in the past century on the basis of evidences from just this borehole by V. N. Karatajūtė-Talimaa [4–6] and J. J. Valiukevičius [7].

History of study of the Lower Devonian (Lochkovian) ichthyofauna in the territory of the Podlasie-Brest Depression. The first findings of the ichthyofauna remains from the Lower Devonian deposits in the Podlasie-Brest Depression were made in the early seventies of the past century in two boreholes: Rataichitsy 12 k and Orlia 28. Their study was carried out by V. N. Karatajūtė-Talimaa [4–6]. According to V. N. Karatajūtė-Talimaa the agnathan and fish remains identified in the Rataichitsy 12 k borehole at a depth of 366.7–404.0 m were represented by heterostracan scales, tesseræ, dentine ridges, small plate fragments of *Anglaspis* sp., *Corvaspis* sp., *Tesseraspis* sp., “*Traquairaspis*” sp., single osteostracan scales, thelodont scales of *Turinia* sp., *T. pagei* (Powrie), *T. polita* Karatajūtė-Talimaa, *Nikolivia gutta* Karatajūtė-Talimaa, *N. elongata* Karatajūtė-Talimaa (now *Talivalia elongata* (Karatajūtė-Talimaa) according to [8]), acanthodian scales of *Nostolepis striata* Pander, *N. gracilis* Gross, *Gomphonchus* sp., fin spine fragments of “*Onchus*” sp., sarcopterygian scales of *Porolepis* sp. The ichthyofauna remains were found in greenish-grey carbonate clays and red-brown siltstones with greyish-green spots. According to the vertebrates this part of the section of the Devonian was correlated with the Borshchovo Regional Stage of the Podolia region. The similar vertebrate assemblage was also identified by V. N. Karatajūtė-Talimaa in the Orlia 28 borehole in a depth range of 409.0–445.0 m.

In the nineties of the past century J. J. Valiukevičius performed an additional palaeoichthyological study of the Lower Devonian (Lochkovian) deposits exposed in the Rataichitsy 12 k borehole. J. J. Valiukevičius [7] discovered in grey, light grey and greenish grey clays, siltstones, marls, clayey, organic and dolomite limestones in a depth range of 366.0–404.0 m numerous acanthodian remains represented by the scales of *Nostolepis striata* Pander, *N. minima* Valiukevičius, *N. robusta* (Brotzen) (now *Jolepis robusta* (Brotzen) according to [9]), *Gomphonchus sandelensis* (Pander), *G. sandelensis* (Pander) or *Poracanthodes punctatus* Brotzen, “*Pruemolepis wellsii*” Vieth-Schreiner, *Endemolepis inconstans* Valiukevičius, *Cheiracanthoides planus* Valiukevičius, *Poracanthodes porosus* Brotzen of the acanthodian zone of *Nostolepis minima*. According to the acanthodian assemblage found in this part of the section he assigned it to the Borshchovo Regional Stage and correlated with deposits of the lower and middle part of the Tilžė Regional Stage of the Lochkovian Stage of the Baltic States.

Materials and methods. The skeletal material of the agnathans and fishes presented in the paper was from the core of the Rataichitsy 12 k borehole drilled in the territory of the Podlasie-Brest Depression

(Text-Fig. 1). The ichthyofauna remains obtained by dissolving the dolomites, dolomite limestones and marls by the acetic and formic acids are represented by micro- and mesomeric skeletal elements: the dentine ridges, tesseræ, small plate fragments, scales and fin spine fragments of good or satisfactory preservation. Systematically, the skeletal elements belong to such ichthyofauna groups as the heterostracans, osteostracans, thelodonts, placoderms, chondrichthyans and acanthodians.

The photographs of the agnathan and fish remains took by a scanning electron microscope JSM-5610 LV (JEOL, Japan) and by a Sony A58 camera with an Industar-50 lens are used to illustrate the material. The images were processed with Adobe Photoshop CS6, the figures were created with the CorelDRAW 2019 program. The skeletal elements were studied with microscopes MBS-1 and Axioskop 40 A Pol.

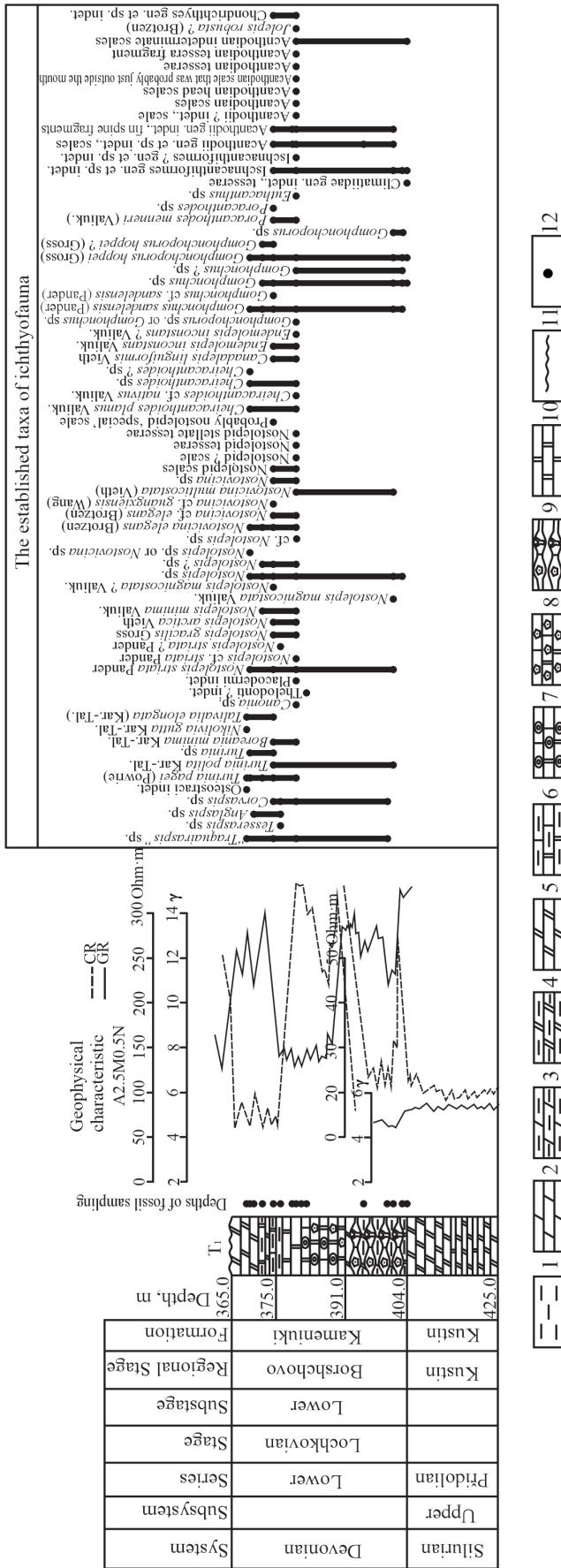
The diagnostics of the skeletal elements of the agnathans and fishes were mainly based on their external morphological features. The histological data were used to determine some acanthodian and thelodont scales. The skeletal material fragmentation and degree of wholeness sometimes did not allow the determination of a specimen to a species or genus; therefore, some vertebrate definitions were left in open nomenclature.

Most of the studied ichthyofauna remains are kept in the author's personal collection, and a small part – in the palaeontological collection of the Geological Institute of the State Enterprise "Scientific Research Center for Geology", Minsk.

The Lochkovian ichthyofauna from the Rataichitsy 12 k borehole rock sequence. According to the author's present-day investigations a lot of various remains of ichthyofauna were found in the deposits of the Kameniuki Formation (depth range of 365.0–404.0 m) in the Rataichitsy 12 k borehole (Text-Fig. 2; Plates I, II, III, IV, V, VI, VII and VIII). These are mainly found in grey, light grey, dense, hard, cryptocrystalline, platy, clayey dolomites, light grey, massive, strong, cryptocrystalline, platy, dolomite limestones, grey, greenish-grey, dense, fragmented, dolomite marls and greenish-grey carbonate clays. Taxonomically, the vertebrate remains found in these rocks belong to the heterostracans, osteostracans, thelodonts, placoderms, acanthodians and chondrichthyans. Among the mentioned



Text-Fig. 1. Map showing the location of the boreholes in the territory of the Podlasie-Brest Depression within Belarus where the Lower Devonian (Lochkovian) ichthyofauna was studied (a) and a site sketch map (b):
 1 – borehole sections where the ichthyofauna was studied; 2 – regional and subregional fractures; 3 – local fractures;
 4 – modern boundary of the Devonian deposit distribution; 5 – studied area outline



Text-Fig. 2. Geological section of the Lower Devonian deposits from the Rataichitsy 12k borehole (from [3]; Text-Fig. 1, with D. P. Plax's refinements and additions) with the ichthyofauna distribution. Legend: 1 – clays; 2 – marls; 3 – clayey marls; 4 – clayey dolomite marls; 5 – dolomite marls; 6 – clayey dolomite limestones; 7 – algal limestones; 8 – crinoidal limestones; 9 – lumpy limestones; 10 – dolomites. Other symbols: 11 – discontinuity surfaces; 12 – fossil sampling sites

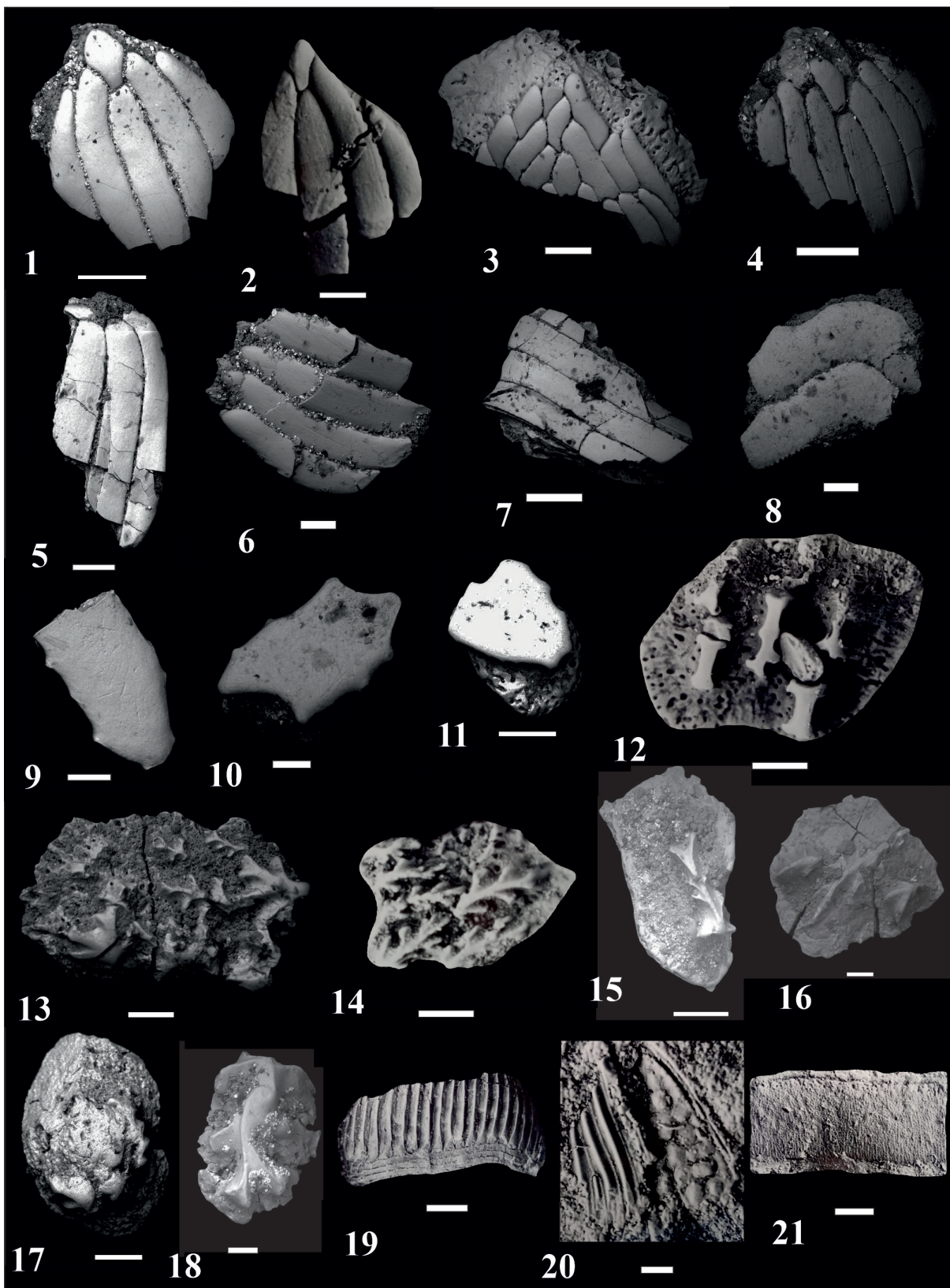


Plate I – Heterostracan and osteostracan skeletal elements from the Rataichitsy 12 k borehole. All skeletal elements of the agnathans come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar 100 μm for Figures 9, 10 and 16; 200 μm for Figures 5, 6, 8, 13, 17 and 18; 500 μm for Figures 1, 2, 3, 4, 7, 11, 14 and 15; 1 mm for Figures 12, 19 and 20; 2 mm for Figure 21.

Figure 1 – *Corvaspis* sp. Specimen № 122/9-50, Rataichitsy 12k borehole, depth 379.5 m, x 45, scale, external view. Figure 2 – *Corvaspis* sp. Specimen № 122/8a-1, Rataichitsy 12 k borehole, depth 376.0 m, x 40, scale fragment, external view. Figure 3 – *Corvaspis* sp. Specimen № 122/9-12, Rataichitsy 12 k borehole, depth 379.5 m, x 35, scale fragment, external view. Figure 4 – *Corvaspis* sp. Specimen № 122/9-18, Rataichitsy 12 k borehole, depth 379.5 m, x 50, scale, external view. Figure 5 – *Corvaspis* sp. Specimen № 122/7-22, Rataichitsy 12 k borehole, depth 374.5 m, x 60, scale fragment, external view. Figure 6 – *Corvaspis* sp. Specimen № 122/9-22, Rataichitsy 12 k borehole, depth 379.5 m, x 75, fragmentary tesseriform unit, external view. Figure 7 – *Corvaspis* sp. Specimen № 122/7-68, Rataichitsy 12 k borehole, depth 374.5 m, x 50, fragmentary tesseriform unit, external view. Figure 8 – *Corvaspis* sp. Specimen № 122/7-35, Rataichitsy 12 k borehole, depth 374.5 m, x 75, piece of tesseriform unit, external view. Figure 9 – *Corvaspis* sp. Specimen № 122/7-11, Rataichitsy 12 k borehole, depth 374.5 m, x 200, fragmentary dentine ridge, external view. Figure 10 – *Corvaspis* sp. Specimen № 122/7-71, Rataichitsy 12 k borehole, depth 374.5 m, x 180, dentine ridge, external view. Figure 11 – *Corvaspis* sp. Specimen № 122/7-23, Rataichitsy 12 k borehole, depth 374.5 m, x 50, fragmentary dentine ridge, external view. Figure 12 – *Tesseraspis* sp. Specimen № 122/8a-2, Rataichitsy 12 k borehole, depth 376.0 m, tessera, external view, (the scale of *Nostolepis striata* Pander is observed in the center between the dentine ridges). Figure 13 – “*Traquairaspis*” sp. Specimen № 122/7-66, Rataichitsy 12 k borehole, depth 374.5 m, x 75, plate fragment, external view. Figure 14 – “*Traquairaspis*” sp. Specimen № 122/20a-1, Rataichitsy 12 k borehole, depth 400.0 m, plate fragment, external view. Figure 15 – “*Traquairaspis*” sp. Specimen № 122/9-61, Rataichitsy 12 k borehole, depth 379.5 m, x 40, plate fragment, external view. Figure 16 – “*Traquairaspis*” sp. Specimen № 122/9-78, Rataichitsy 12 k borehole, depth 379.5 m, x 120, slightly damaged plate fragment, external view. Figure 17 – “*Traquairaspis*” sp. Specimen № 122/7-36, Rataichitsy 12 k borehole, depth 374.5 m, x 90, tessera, external view. Figure 18 – “*Traquairaspis*” sp. Specimen № 122/9-94, Rataichitsy 12 k borehole, depth 379.5 m, x 60, tessera, external view. Figure 19 – *Anglaspis* sp. Specimen № 122/8a-3, Rataichitsy 12k borehole, depth 376.0 m, dorso-lateral scale, external view. Figure 20 – *Anglaspis* sp. Specimen № 122/5a-1, Rataichitsy 12 k borehole, depth 370.0 m, scale fragment, external view. Figure 21 – Osteostraci indet. Specimen № 122/4a-1, Rataichitsy 12k borehole, depth 368.2 m, lateral scale.

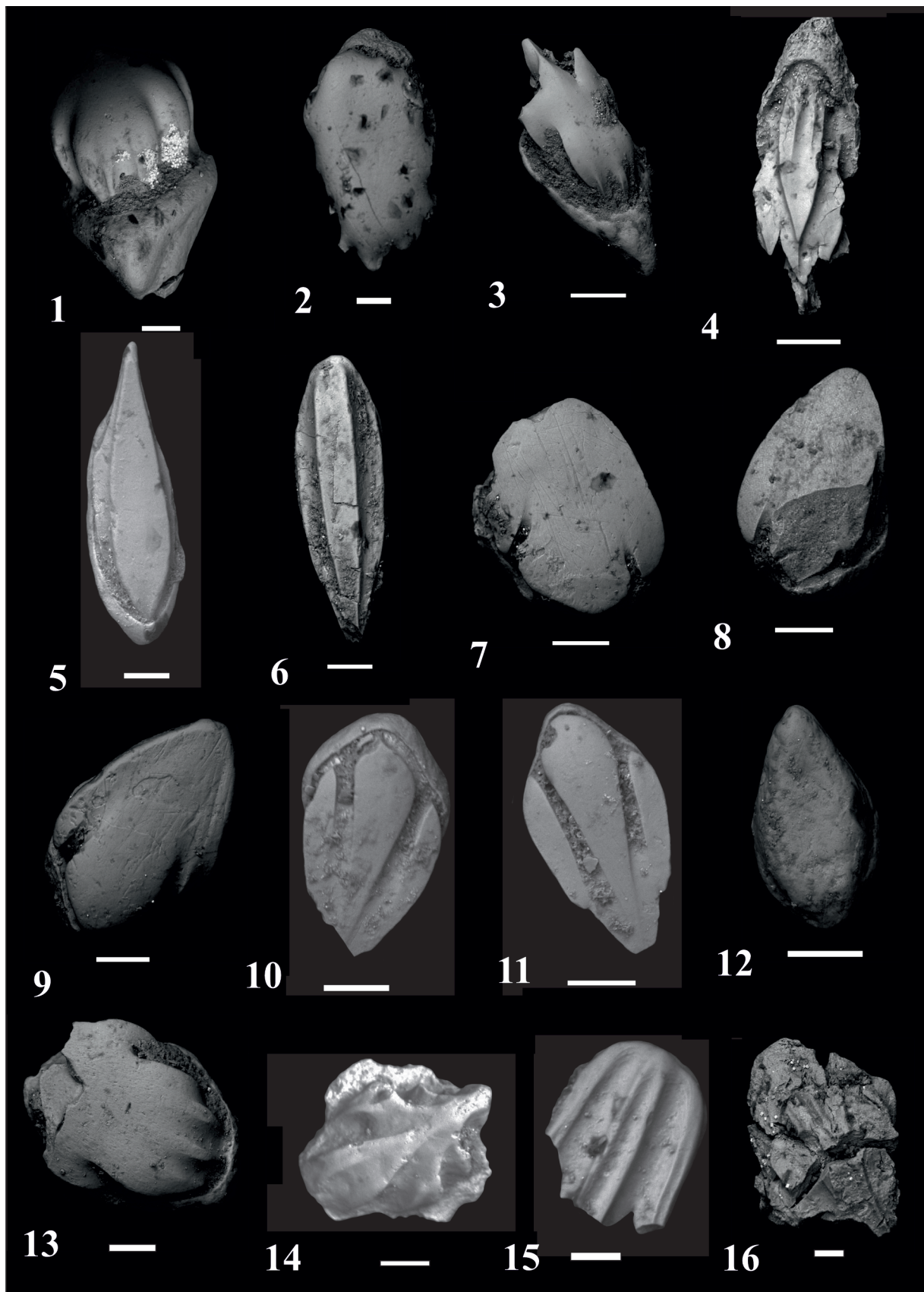


Plate II – Thelodont scales from the Rataichitsy 12 k borehole. The scales come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar of 50 μm for Figure 15; 100 μm for Figures 1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 16; 200 μm for Figures 3 and 4.

Figure 1 – *Turinia pagei* (Powrie). Specimen № 122/5-6, Rataichitsy 12 k borehole, depth 369.0 m, x 100, cephalo-pectoral scale, oblique crown view. Figure 2 – *Turinia polita* Karatajütë-Talimaa. Specimen № 122/7-67, Rataichitsy 12 k borehole, depth 374.5 m, x 100, cephalo-pectoral scale, crown view. Figure 3 – *Turinia pagei* (Powrie). Specimen № 122/9-24, Rataichitsy 12 k borehole, depth 379.5 m, x 85, trunk scale, oblique crown view. Figure 4 – *Turinia pagei* (Powrie). Specimen № 122/7-19, Rataichitsy 12 k borehole, depth 374.5 m, x 90, trunk scale, crown view. Figure 5 – *Turinia pagei* (Powrie). Specimen № 122/9-72, Rataichitsy 12 k borehole, depth 379.5 m, x 120, trunk scale, crown view. Figure 6 – *Talivalia elongata* (Karatajütë-Talimaa). Specimen № 122/7-41, Rataichitsy 12 k borehole, depth 374.5 m, x 120, trunk scale, crown view. Figure 7 – *Boreania minima* Karatajütë-Talimaa. Specimen № 122/7-43, Rataichitsy 12 k borehole, depth 374.5 m, x 200, cephalo-pectoral scale, oblique crown view. Figure 8 – *Boreania minima* Karatajütë-Talimaa. Specimen № 122/7-57, Rataichitsy 12 k borehole, depth 374.5 m, x 200, cephalo-pectoral scale, oblique crown view. Figure 9 – *Boreania minima* Karatajütë-Talimaa. Specimen № 122/7-80, Rataichitsy 12 k borehole, depth 374.5 m, x 200, cephalo-pectoral scale, crown view. Figure 10 – *Boreania minima* Karatajütë-Talimaa. Specimen № 122/9-105, Rataichitsy 12 k borehole, depth 379.5 m, x 200, cephalo-pectoral scale, crown view. Figure 11 – *Boreania minima* Karatajütë-Talimaa. Specimen № 122/9-107, Rataichitsy 12 k borehole, depth 379.5 m, x 200, post-pectoral scale, crown view. Figure 12 – *Turinia polita* Karatajütë-Talimaa. Specimen № 122/7-87, Rataichitsy 12 k borehole, depth 374.5 m, x 250, trunk scale, crown view. Figure 13 – *Turinia* sp. Specimen № 122/5-4, Rataichitsy 12 k borehole, depth 369.0 m, x 160, cephalo-pectoral scale, the posterior part of the crown is broken off, crown view. Figure 14 – *Turinia* sp. Specimen № 122/7-98, Rataichitsy 12 k borehole, depth 374.5 m, x 160, scale, oblique crown view. Figure 15 – *Canonis* sp. Specimen № 122/9-70, Rataichitsy 12 k borehole, depth 379.5 m, x 400, trunk scale, the posterior part of the crown is broken off, crown view. Figure 16 – Thelodonti ? indet. Specimen № 122/13-1, Rataichitsy 12 k borehole, depth 382.0 m, x 120, scale, crown view.

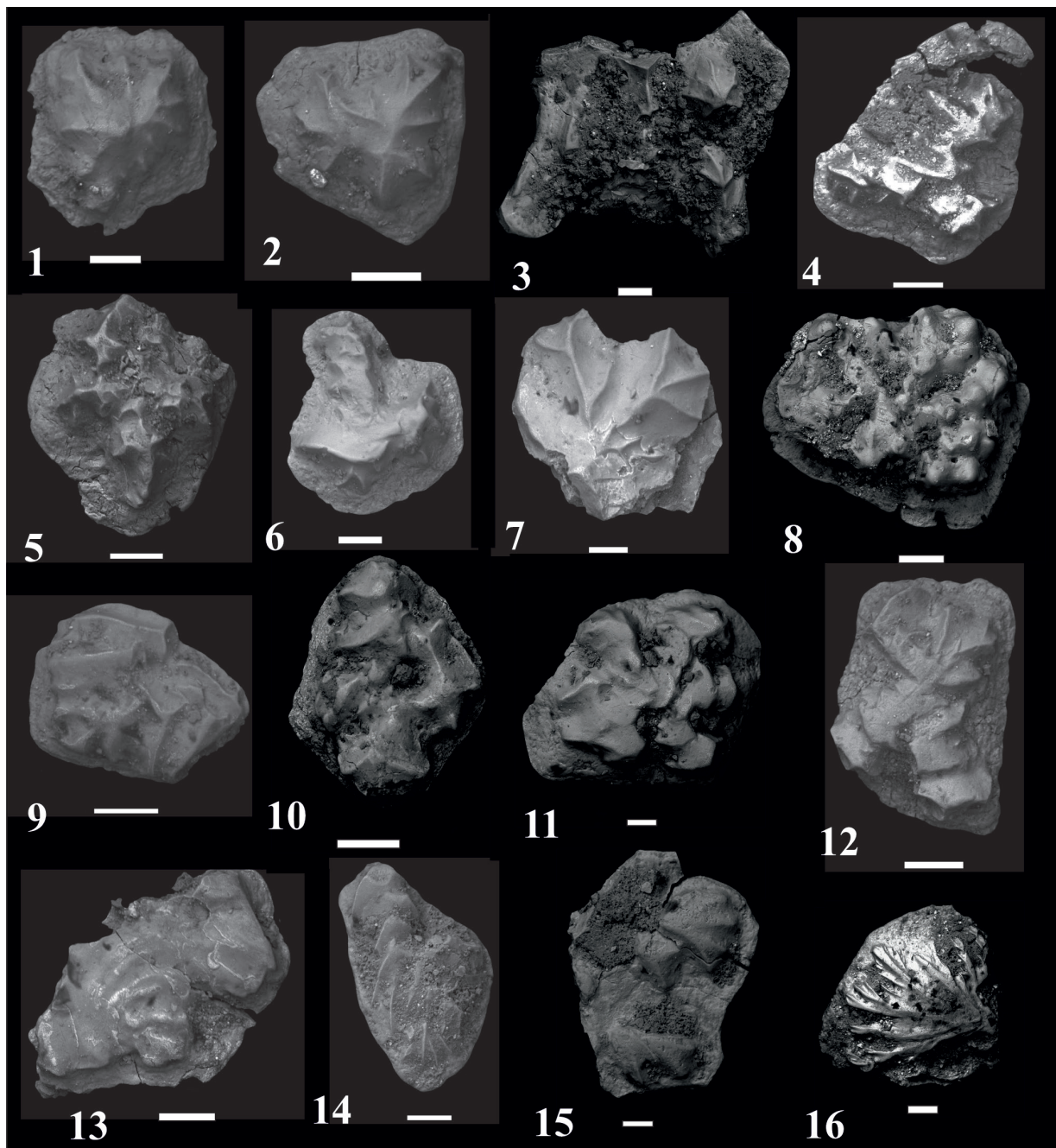


Plate III – Fish remains from the Rataichitsy 12 k borehole. The skeletal elements come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar 100 μm for Figures 1, 2, 3, 4, 5, 6, 7, 9, 11, 12, 13, 14 and 15; 200 μm for Figures 8, 10 and 16.

Figure 1 – Placodermi indet. Specimen № 122/9-77, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, top view. Figure 2 – Acanthodii ? indet. Specimen № 122/9-92, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, top view. Figure 3 – Acanthodian tessera. Specimen № 122/9-15, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, top view. Figure 4 – Acanthodian head scale. Specimen № 122/9-76, Rataichitsy 12 k borehole, depth 379.5 m, x 170, head scale, top view. Figure 5 – Acanthodian head scale. Specimen № 122/9-100, Rataichitsy 12 k borehole, depth 379.5 m, x 170, head scale, top view. Figure 6 – Acanthodian head scale. Specimen № 122/9-90, Rataichitsy 12 k borehole, depth 379.5 m, x 160, head scale, top view. Figure 7 – Acanthodian scale. Specimen № 122/9-88, Rataichitsy 12 k borehole, depth 379.5 m, x 130, scale, top view. Figure 8 – Nostolepid. Specimen № 122/9-47, Rataichitsy 12 k borehole, depth 379.5 m, x 70, tessera, top view. Figure 9 – Nostolepid. Specimen № 122/9-80, Rataichitsy 12 k borehole, depth 379.5 m, x 200, stellate tessera, top view. Figure 10 – Nostolepid. Specimen № 122/9-33, Rataichitsy 12 k borehole, depth 379.5 m, x 90, stellate tessera, top view. Figure 11 – Nostolepid. Specimen № 122/9-21, Rataichitsy 12 k borehole, depth 379.5 m, x 100, stellate tessera, top view. Figure 12 – Nostolepid. Specimen № 122/9-97, Rataichitsy 12 k borehole, depth 379.5 m, x 150, stellate tessera, top view. Figure 13 – Acanthodian tessera fragment. Specimen № 122/9-101, Rataichitsy 12 k borehole, depth 379.5 m, x 200, tessera fragment, top view. Figure 14 – Acanthodian scale that was probably located just outside the mouth. Specimen № 122/9-96, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, top view. Figure 15 – Climaetiidae gen. indet. Specimen № 122/25-6, Rataichitsy 12 k borehole, depth 404.0 m, x 100, tessera, top view. Figure 16 – Probably nostolepid 'special' scale. Specimen № 122/7-14, Rataichitsy 12 k borehole, depth 374.5 m, x 60, 'special' scale, top view.

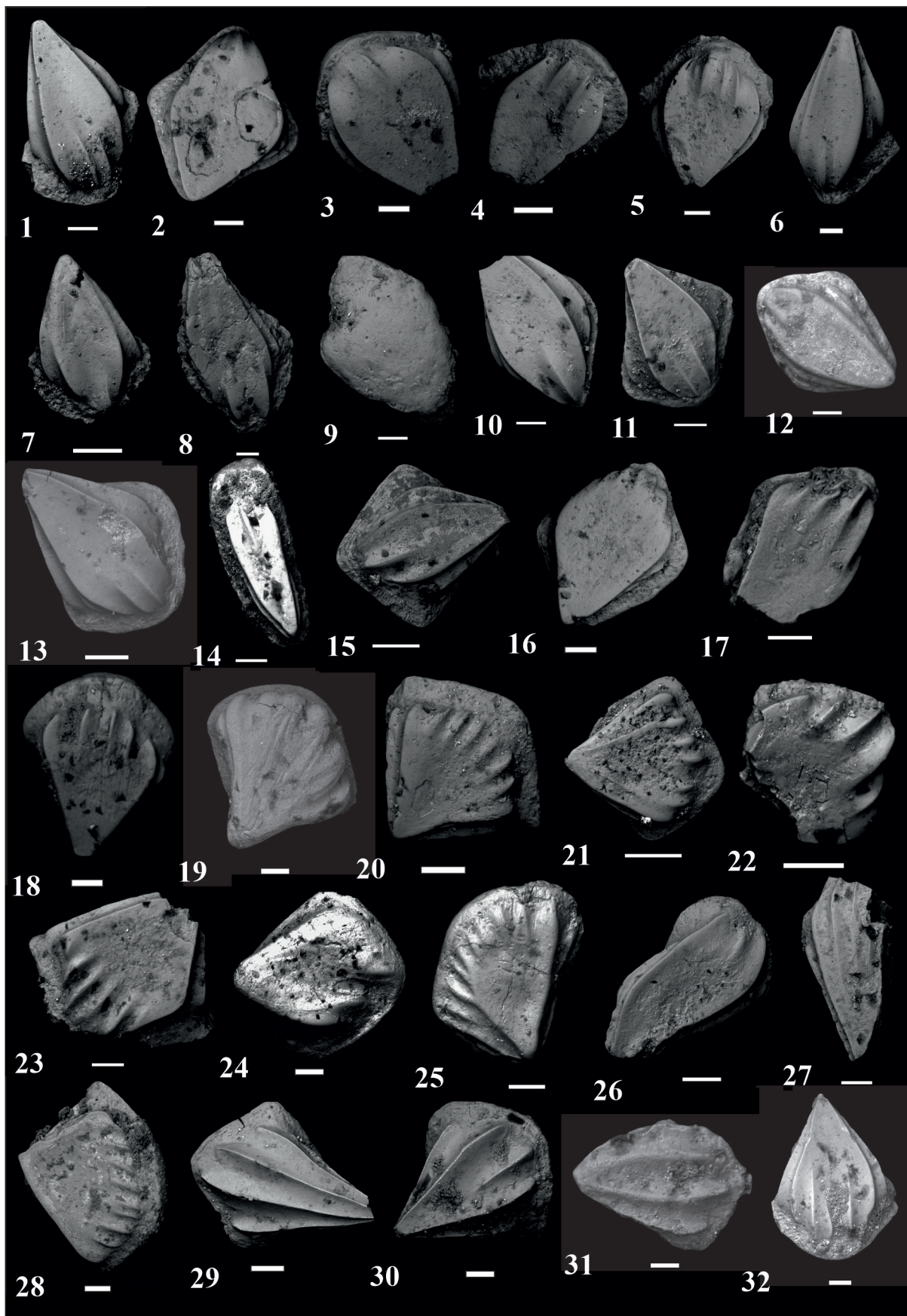


Plate IV – Acanthodian scales from the Rataichitsy 12 k borehole. The scales come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar 50 μm for Figures 9, 12, 17, 30 and 31; 100 μm for Figures 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 14, 15, 16, 18, 19, 20, 22, 23, 25, 27, 28, 29 and 32; 200 μm for Figures 24 and 26; 500 μm for Figure 21.

Figure 1 – *Nostovicina elegans* (Brotzen). Specimen № 122/6-1, Rataichitsy 12 k borehole, depth 371.9 m, x 120, scale, anterior crown view. Figure 2 – *Nostovicina elegans* (Brotzen). Specimen № 122/6-4, Rataichitsy 12 k borehole, depth 371.9 m, x 150, scale, crown view. Figure 3 – *Nostovicina elegans* (Brotzen). Specimen № 122/6-8, Rataichitsy 12 k borehole, depth 371.9 m, x 150, scale, crown view. Figure 4 – *Nostovicina elegans* (Brotzen). Specimen № 122/5-2, Rataichitsy 12 k borehole, depth 369.0 m, x 200, scale, crown view. Figure 5 – *Nostovicina elegans* (Brotzen). Specimen № 122/5-5, Rataichitsy 12 k borehole, depth 369.0 m, x 130, scale, crown view. Figure 6 – *Nostovicina elegans* (Brotzen). Specimen № 122/5-10, Rataichitsy 12 k borehole, depth 369.0 m, x 100, scale, anterior crown view. Figure 7 – *Nostovicina elegans* (Brotzen). Specimen № 122/7-60, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, anterior crown view. Figure 8 – *Nostovicina elegans* (Brotzen). Specimen № 122/7-75, Rataichitsy 12k borehole, depth 374.5 m, x 100, scale, anterior crown view. Figure 9 – *Nostovicina elegans* (Brotzen). Specimen № 122/7-92, Rataichitsy 12 k borehole, depth 374.5 m, x 270, scale, basal view. Figure 10 – *Nostovicina elegans* (Brotzen). Specimen № 122/9-37, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, crown view. Figure 11 – *Nostovicina elegans* (Brotzen). Specimen № 122/9-55, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, crown view. Figure 12 – *Nostovicina elegans* (Brotzen). Specimen № 122/9-71, Rataichitsy 12 k borehole, depth 379.5 m, x 300, scale, crown view. Figure 13 – *Nostovicina elegans* (Brotzen). Specimen № 122/9-106, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, crown view. Figure 14 – *Nostovicina cf. elegans* (Brotzen). Specimen № 122/7-3, Rataichitsy 12 k borehole, depth 374.5 m, x 130, scale, crown view. Figure 15 – *Nostovicina cf. elegans* (Brotzen). Specimen № 122/9-30, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, crown view. Figure 16 – *Nostolepis minima* Valiukevičius. Specimen № 122/6-5, Rataichitsy 12 k borehole, depth 371.9 m, x 150, scale, crown view. Figure 17 – *Nostolepis striata* Pander. Specimen № 122/7-38, Rataichitsy 12 k borehole, depth 374.5 m, x 400, scale, crown view. Figure 18 – *Nostolepis striata* Pander. Specimen № 122/9-4, Rataichitsy 12 k borehole, depth 379.5 m, x 130, scale, crown view. Figure 19 – *Nostolepis striata* Pander. Specimen № 122/9-82, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 20 – *Nostolepis striata* Pander. Specimen № 122/5-3, Rataichitsy 12 k borehole, depth 369.0 m, x 200, scale, crown view. Figure 21 – *Nostolepis striata* Pander. Specimen № 122/7-49, Rataichitsy 12 k borehole, depth 374.5 m, x 50, scale, crown view. Figure 22 – *Nostolepis* sp. Specimen № 122/7-44, Rataichitsy 12 k borehole, depth 374.5 m, x 250, scale fragment, crown view. Figure 23 – *Nostolepis* sp. Specimen № 122/7-42, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, anterior crown view. Figure 24 – *Nostolepis striata* ? Pander. Specimen № 122/7-24, Rataichitsy 12k borehole, depth 374.5 m, x 65, scale, crown view. Figure 25 – *Nostovicina cf. guangxiensis* (Wang). Specimen № 122/7-37, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, crown view. Figure 26 – *Nostolepis arctica* Vieth. Specimen № 122/7-56, Rataichitsy 12k borehole, depth 374.5 m, x 90, scale, crown view. Figure 27 – *Nostolepis* sp. Specimen № 122/6-3, Rataichitsy 12 k borehole, depth 371.9 m, x 140, scale, crown view. Figure 28 – *Cheiracanthoides planus* Valiukevičius. Specimen № 122/9-38, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, oblique crown view. Figure 29 – *Nostolepis* sp. Specimen № 122/9-9, Rataichitsy 12 k borehole, depth 379.5 m, x 160, scale, crown view. Figure 30 – *Nostolepis* sp. Specimen № 122/9-32, Rataichitsy 12 k borehole, depth 379.5 m, x 300, scale, crown view. Figure 31 – *Nostolepis* sp. Specimen № 122/9-102, Rataichitsy 12 k borehole, depth 379.5 m, x 300, scale, crown view. Figure 32 – *Nostolepis* sp. Specimen № 122/9-87, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, anterior crown view.

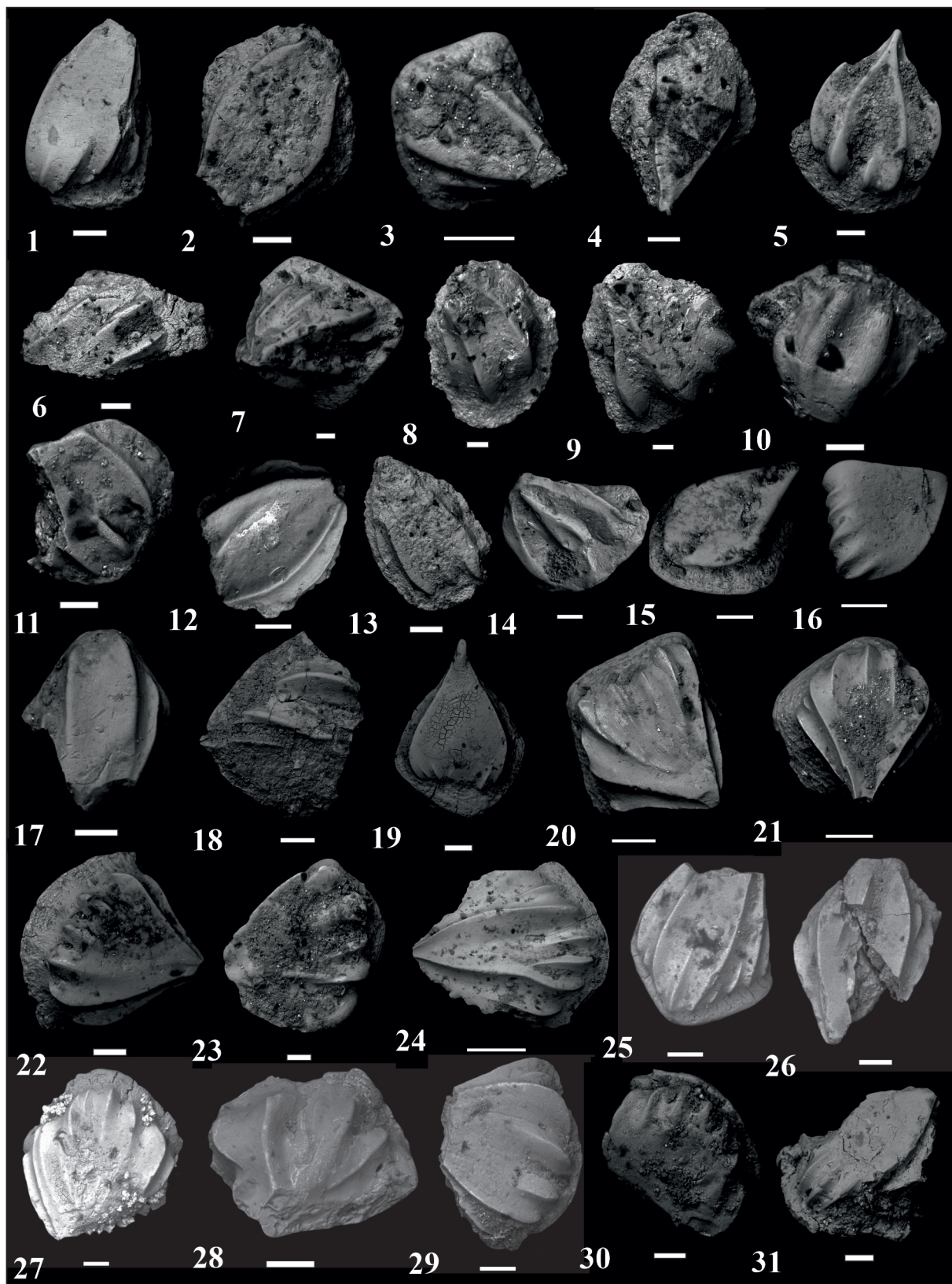


Plate V – Acanthodian scales from the Rataichitsy 12 k borehole. The scales come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar 50 μm for Figures; 10, 11, 12, 17 and 30; 100 μm for Figures 1, 2, 3, 4, 5, 7, 8, 9, 14, 15, 16, 20, 21, 22, 23, 25, 26, 27, 28, 29 and 31; 200 μm for Figures 6, 13, 18 and 19; 500 μm for Figure 24.

Figure 1 – *Nostovicina* sp. Specimen № 122/7-31, Rataichitsy 12 k borehole, depth 374.5 m, x 130, scale, anterior crown view. Figure 2 – *Nostolepis* ? sp. Specimen № 122/7-7, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, crown view. Figure 3 – *Nostolepis* sp. Specimen № 122/7-46, Rataichitsy 12 k borehole, depth 374.5 m, x 250, scale, crown view. Figure 4 – *Nostolepis* ? sp. Specimen № 122/7-27, Rataichitsy 12 k borehole, depth 374.5 m, x 120, scale, crown view. Figure 5 – Nostolepid. Specimen № 122/7-40, Rataichitsy 12 k borehole, depth 374.5 m, x 120, scale, anterior crown view. Figure 6 – *Nostolepis* sp. Specimen № 122/7-15, Rataichitsy 12 k borehole, depth 374.5 m, x 70, scale fragment, crown view. Figure 7 – *Nostolepis* sp. Specimen № 122/5-7, Rataichitsy 12 k borehole, depth 369.0 m, x 100, scale, crown view. Figure 8 – *Nostolepis* sp. Specimen № 122/7-4, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, anterior crown view. Figure 9 – Nostolepid. Specimen № 122/7-25, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, crown view. Figure 10 – *Nostolepis* sp. Specimen № 122/7-47, Rataichitsy 12 k borehole, depth 374.5 m, x 350, scale, crown view. Figure 11 – *Nostolepis* ? sp. Specimen № 122/7-28, Rataichitsy 12 k borehole, depth 374.5 m, x 350, scale fragment, crown view. Figure 12 – *Nostolepis* sp. Specimen № 122/7-48, Rataichitsy 12 k borehole, depth 374.5 m, x 300, scale, oblique crown view. Figure 13 – *Nostolepis* ? sp. Specimen № 122/7-52, Rataichitsy 12 k borehole, depth 374.5 m, x 80, scale, oblique crown view. Figure 14 – Nostolepid. Specimen № 122/7-63, Rataichitsy 12 k borehole, depth 374.5 m, x 130, scale, oblique crown view. Figure 15 – *Nostolepis* ? sp. Specimen № 122/7-72, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, anterior crown view. Figure 16 – *Nostolepis* ? sp. Specimen № 122/7-79, Rataichitsy 12 k borehole, depth 374.5 m, x 250, scale, crown view. Figure 17 – *Nostolepis* sp. Specimen № 122/7-86, Rataichitsy 12 k borehole, depth 374.5 m, x 350, scale, crown view. Figure 18 – *Nostolepis* sp. Specimen № 122/7-88, Rataichitsy 12 k borehole, depth 374.5 m, x 70, scale fragment, crown view. Figure 19 – *Nostolepis* ? sp. Specimen № 122/9-6, Rataichitsy 12 k borehole, depth 379.5 m, x 60, scale, crown view. Figure 20 – *Nostolepis* sp. Specimen № 122/9-10, Rataichitsy 12 k borehole, depth 379.5 m, x 180, scale, crown view. Figure 21 – *Nostolepis* cf. *striata* Pander. Specimen № 122/9-35, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, crown view. Figure 22 – *Nostolepis striata* Pander. Specimen № 122/9-20, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, crown view. Figure 23 – cf. *Nostolepis* sp. Specimen № 122/9-23, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 24 – *Nostolepis* sp. Specimen № 122/9-26, Rataichitsy 12 k borehole, depth 379.5 m, x 50, scale, crown view. Figure 25 – *Nostolepis* sp. Specimen № 122/9-62, Rataichitsy 12 k borehole, depth 379.5 m, x 120, scale, anterior crown view. Figure 26 – *Nostolepis* sp. Specimen № 122/9-83, Rataichitsy 12 k borehole, depth 379.5 m, x 110, scale, crown view. Figure 27 – *Nostolepis* sp. Specimen № 122/9-75, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale fragment, crown view. Figure 28 – Nostolepid. Specimen № 122/9-64, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, crown view. Figure 29 – *Nostolepis* sp. Specimen № 122/9-99, Rataichitsy 12 k borehole, depth 379.5 m, x 140, scale fragment, oblique crown view. Figure 30 – *Nostolepis* sp. Specimen № 122/21-2, Rataichitsy 12 k borehole, depth 401.3 m, x 300, scale fragment, crown view. Figure 31 – *Nostolepis* sp. Specimen № 122/23-3, Rataichitsy 12 k borehole, depth 403.05 m, x 120, scale fragment, anterior crown view.

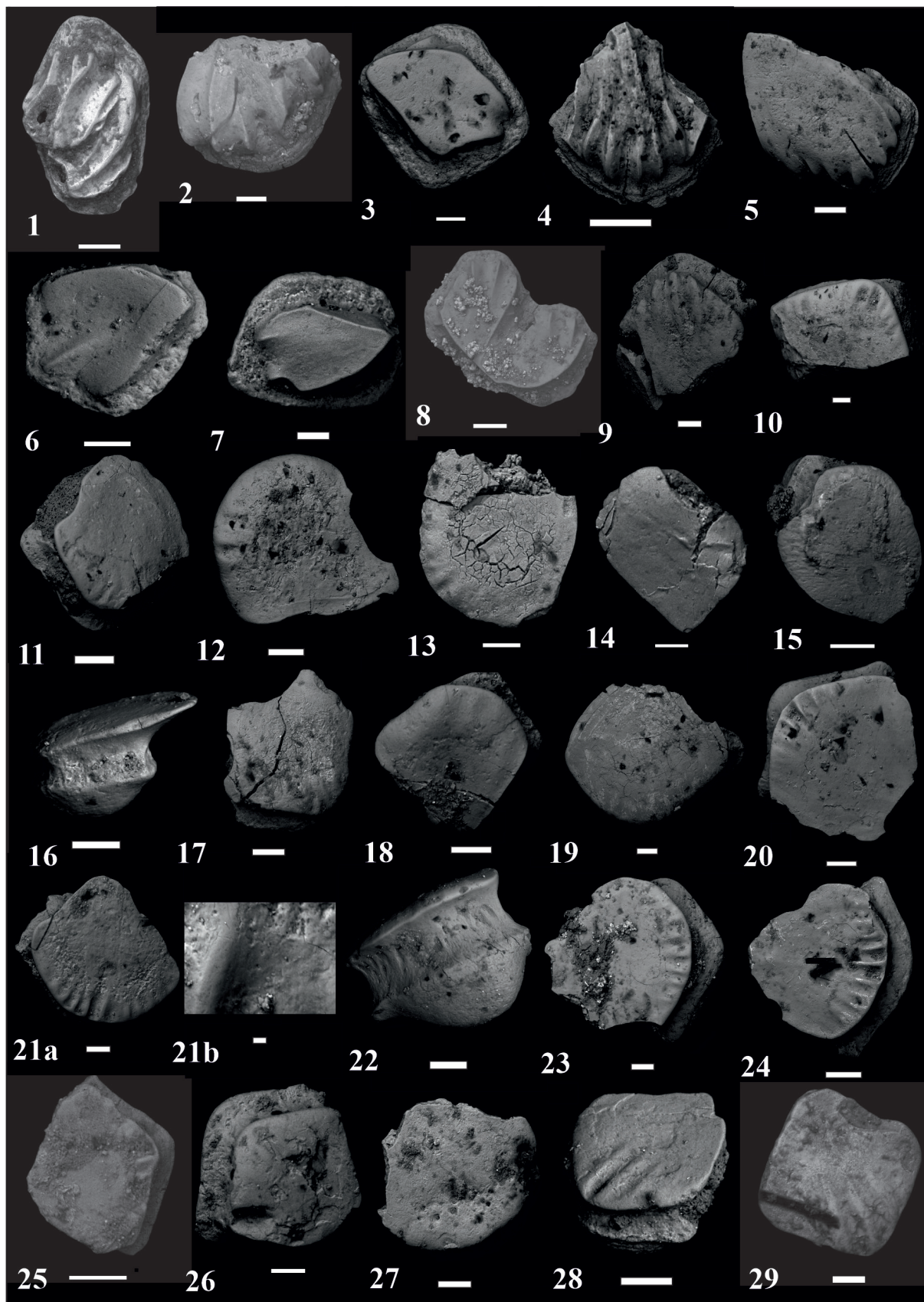


Plate VI – Acanthodian scales from the Rataichitsy 12 k borehole. The scales come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar 10 μm for Figure 21b; 50 μm for Figures 7, 14 and 29; 100 μm for Figures 1, 2, 3, 6, 8, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21a, 23, 24, 25, 26, 27 and 28; 200 μm for Figures 5, 11 and 22; 500 μm for Figure 4.

Figure 1 – *Nostolepid* ?. Specimen № 122/9-104, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, crown view. Figure 2 – *Nostolepis* sp. Specimen № 122/9-89, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale fragment, anterior crown view. Figure 3 – *Nostolepis* sp. or *Nostovicina* sp. Specimen № 122/5-8, Rataichitsy 12 k borehole, depth 369.0 m, x 130, scale, crown view. Figure 4 – *Nostovicina multicostata* (Vieth). Specimen № 122/9-11, Rataichitsy 12 k borehole, depth 379.5 m, x 50, scale, anterior crown view. Figure 5 – *Nostolepis* sp. Specimen № 122/9-13, Rataichitsy 12 k borehole, depth 379.5 m, x 75, scale, crown view. Figure 6 – *Canadalepis linguiformis* Vieth. Specimen № 122/7-50, Rataichitsy 12 k borehole, depth 374.5 m, x 190, scale, crown view. Figure 7 – *Canadalepis linguiformis* Vieth. Specimen № 122/7-64, Rataichitsy 12 k borehole, depth 374.5 m, x 300, double scale, crown view. Figure 8 – *Canadalepis linguiformis* Vieth. Specimen № 122/9-79, Rataichitsy 12 k borehole, depth 379.5 m, x 140, scale, crown view. Figure 9 – *Nostolepis magnicostata* Valiukevičius. Specimen № 122/21-3, Rataichitsy 12 k borehole, depth 401.3 m, x 120, scale, crown view. Figure 10 – *Gomphonchus sandelensis* (Pander). Specimen № 122/6-7, Rataichitsy 12 k borehole, depth 371.9 m, x 100, scale fragment, crown view. Figure 11 – *Gomphonchus sandelensis* (Pander). Specimen № 122/5-9, Rataichitsy 12k borehole, depth 369.0 m, x 85, scale, oblique crown view. Figure 12 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-5, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, crown view. Figure 13 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-8, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, crown view. Figure 14 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-30, Rataichitsy 12 k borehole, depth 374.5 m, x 300, scale, oblique crown view. Figure 15 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-32, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, oblique crown view. Figure 16 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-62, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, lateral view. Figure 17 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-70, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale fragment, oblique crown view. Figure 18 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-93, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, crown view. Figure 19 – *Gomphonchus sandelensis* (Pander). Specimen № 122/9-2, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 20 – *Gomphonchus sandelensis* (Pander). Specimen № 122/9-8, Rataichitsy 12 k borehole, depth 379.5 m, x 130, scale, crown view. Figure 21 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-95, Rataichitsy 12 k borehole, depth 374.5 m, scale: a – crown view, x 100; b – scaled-up part of the crown surface, x 1000. Figure 22 – *Gomphonchus sandelensis* (Pander). Specimen № 122/9-31, Rataichitsy 12 k borehole, depth 379.5 m, x 80, scale, lateral view. Figure 23 – *Gomphonchus sandelensis* (Pander). Specimen № 122/9-36, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, oblique crown view. Figure 24 – *Gomphonchus sandelensis* (Pander). Specimen № 122/9-52, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, oblique crown view. Figure 25 – *Gomphonchus sandelensis* (Pander). Specimen № 122/9-86, Rataichitsy 12 k borehole, depth 379.5 m, x 250, scale, oblique crown view. Figure 26 – *Gomphonchus sandelensis* (Pander). Specimen № 122/7-33, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, oblique crown view. Figure 27 – *Gomphonchus sandelensis* (Pander). Specimen № 122/21-1, Rataichitsy 12 k borehole, depth 401.3 m, x 150, scale, oblique crown view. Figure 28 – *Gomphonchus* cf. *sandelensis* (Pander). Specimen № 122/7-53, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, oblique crown view. Figure 29 – *Gomphonchus* cf. *sandelensis* (Pander). Specimen № 122/9-91, Rataichitsy 12 k borehole, depth 379.5 m, x 300, scale, crown view.

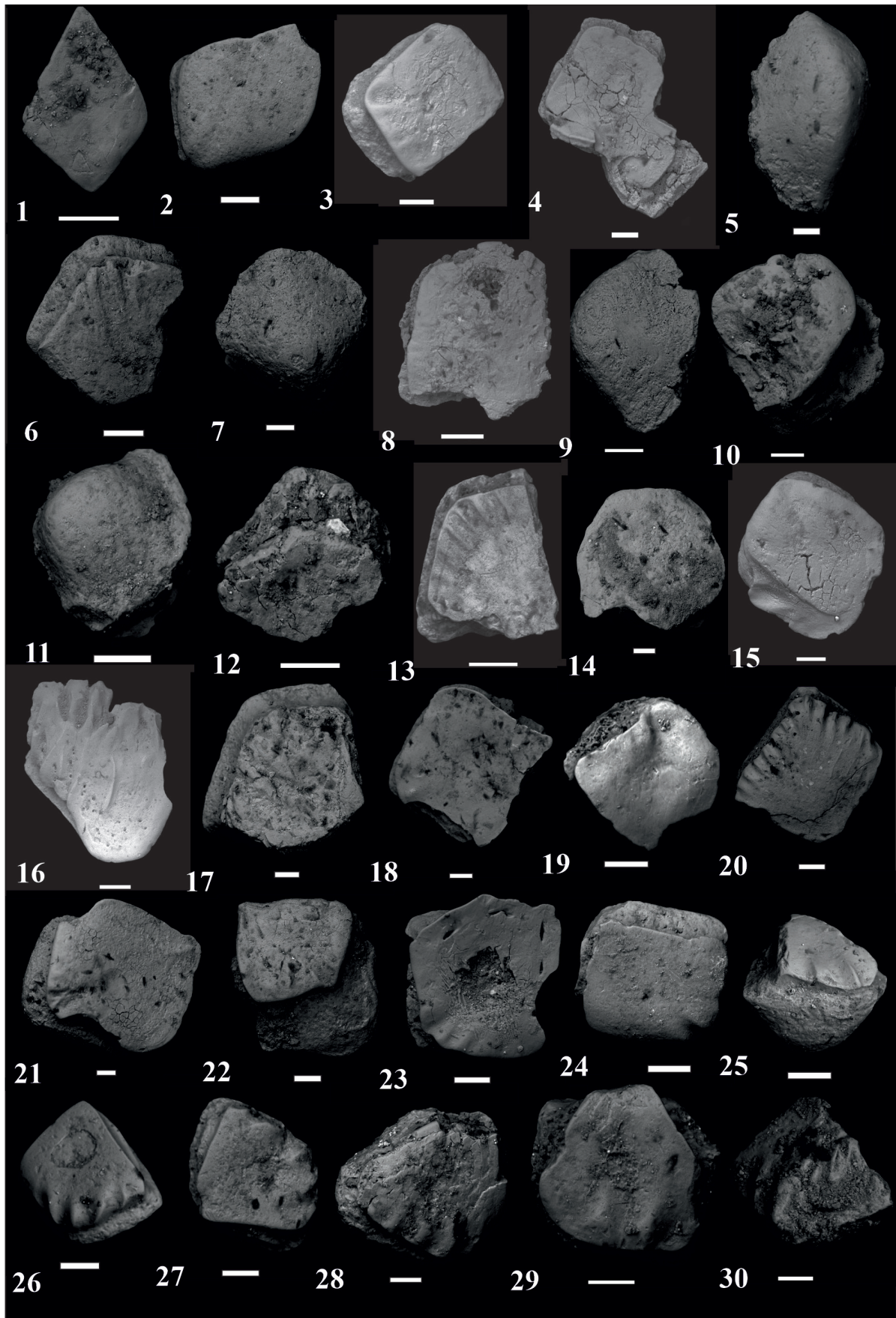


Plate VII – Acanthodian scales from the Rataichitsy 12 k borehole. The scales come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar 50 μm for Figures 19, 28, 29 and 30; 100 μm for Figures 1, 2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 17, 18, 20, 21, 22, 23, 24, 25, 26 and 27; 200 μm for Figures 6, 8 and 16.

Figure 1 – *Gomphonchus* sp. Specimen № 122/7-85, Rataichitsy 12 k borehole, depth 374.5 m, x 250, scale, crown view.
 Figure 2 – *Gomphonchus* sp. Specimen № 122/6-6, Rataichitsy 12 k borehole, depth 371.9 m, x 170, scale, crown view.
 Figure 3 – *Gomphonchus* sp. Specimen № 122/7-97, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, crown view.
 Figure 4 – *Gomphonchus* sp. Specimen № 122/25-10, Rataichitsy 12k borehole, depth 404.0 m, x 100, double scale, crown view.
 Figure 5 – *Gomphonchus* sp. Specimen № 122/7-89, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, basal view.
 Figure 6 – *Gomphonchus* sp. Specimen № 122/21-5, Rataichitsy 12 k borehole, depth 401.3 m, x 90, scale, oblique crown view.
 Figure 7 – *Gomphonchus* sp. Specimen № 122/25-9, Rataichitsy 12 k borehole, depth 404.0 m, x 130, scale, basal view.
 Figure 8 – *Gomphonchus* sp. Specimen № 122/25-11, Rataichitsy 12k borehole, depth 404.0 m, x 85, scale, crown view.
 Figure 9 – *Gomphonchus* sp. Specimen № 122/25-5, Rataichitsy 12 k borehole, depth 404.0 m, x 170, scale, basal view.
 Figure 10 – *Gomphonchus* sp. Specimen № 122/25-2, Rataichitsy 12 k borehole, depth 404.0 m, x 140, scale, oblique crown view.
 Figure 11 – *Gomphonchus* sp. Specimen № 122/21-9, Rataichitsy 12 k borehole, depth 401.3 m, x 250, scale, basal view.
 Figure 12 – *Ischnacanthiformes* gen. et sp. indet. Specimen № 122/21-10, Rataichitsy 12 k borehole, depth 401.3 m, x 250, scale, oblique crown view.
 Figure 13 – *Gomphonchus* ? sp. Specimen № 122/9-63, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, crown view.
 Figure 14 – *Ischnacanthiformes* gen. et sp. indet. Specimen № 122/23-6, Rataichitsy 12 k borehole, depth 403.05 m, x 100, scale, crown view.
 Figure 15 – *Ischnacanthiformes* gen. et sp. indet. Specimen № 122/25-12, Rataichitsy 12 k borehole, depth 404.0 m, x 130, scale, crown view.
 Figure 16 – *Ischnacanthiformes* gen. et sp. indet. Specimen № 122/9-73, Rataichitsy 12 k borehole, depth 379.5 m, x 60, scale, crown view.
 Figure 17 – *Ischnacanthiformes* gen. et sp. indet. Specimen № 122/23-7, Rataichitsy 12 k borehole, depth 403.05 m, x 100, scale, crown view.
 Figure 18 – *Gomphonchoporus* sp. or *Gomphonchus* sp. Specimen № 122/9-3, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view.
 Figure 19 – *Gomphonchus* sp. Specimen № 122/7-18, Rataichitsy 12 k borehole, depth 374.5 m, x 450, scale, crown view.
 Figure 20 – *Cheiracanthoides* ? sp. Specimen № 122/5-1, Rataichitsy 12k borehole, depth 369.0 m, x 130, scale, crown view; Borshchovo Regional Stage, Kameniuki Formation.
 Figure 21 – *Gomphonchoporus hoppei* (Gross). Specimen № 122/7-34, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, oblique crown view.
 Figure 22 – *Gomphonchoporus hoppei* (Gross). Specimen № 122/7-69, Rataichitsy 12 k borehole, depth 374.5 m, x 120, scale, oblique crown view.
 Figure 23 – *Gomphonchoporus hoppei* (Gross). Specimen № 122/25-4, Rataichitsy 12 k borehole, depth 404.0 m, x 150, scale, crown view.
 Figure 24 – *Gomphonchoporus hoppei* ? (Gross). Specimen № 122/6-2, Rataichitsy 12 k borehole, depth 371.9 m, x 200, scale, oblique crown view.
 Figure 25 – *Gomphonchoporus hoppei* (Gross). Specimen № 122/7-82, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, anterior crown view.
 Figure 26 – *Nostolepis* ? sp. Specimen № 122/7-73, Rataichitsy 12 k borehole, depth 374.5 m, x 200, scale, anterior crown view.
 Figure 27 – *Gomphonchoporus hoppei* (Gross). Specimen № 122/7-77, Rataichitsy 12 k borehole, depth 374.5 m, x 150, scale, crown view.
 Figure 28 – *Gomphonchoporus hoppei* (Gross). Specimen № 122/7-6, Rataichitsy 12 k borehole, depth 374.5 m, x 300, scale, crown view.
 Figure 29 – *Gomphonchoporus hoppei* ? (Gross). Specimen № 122/7-91, Rataichitsy 12 k borehole, depth 374.5 m, x 400, scale, crown view.
 Figure 30 – *Gomphonchoporus* sp. Specimen № 122/21-8, Rataichitsy 12 k borehole, depth 401.3 m, x 300, scale, anterior crown view.

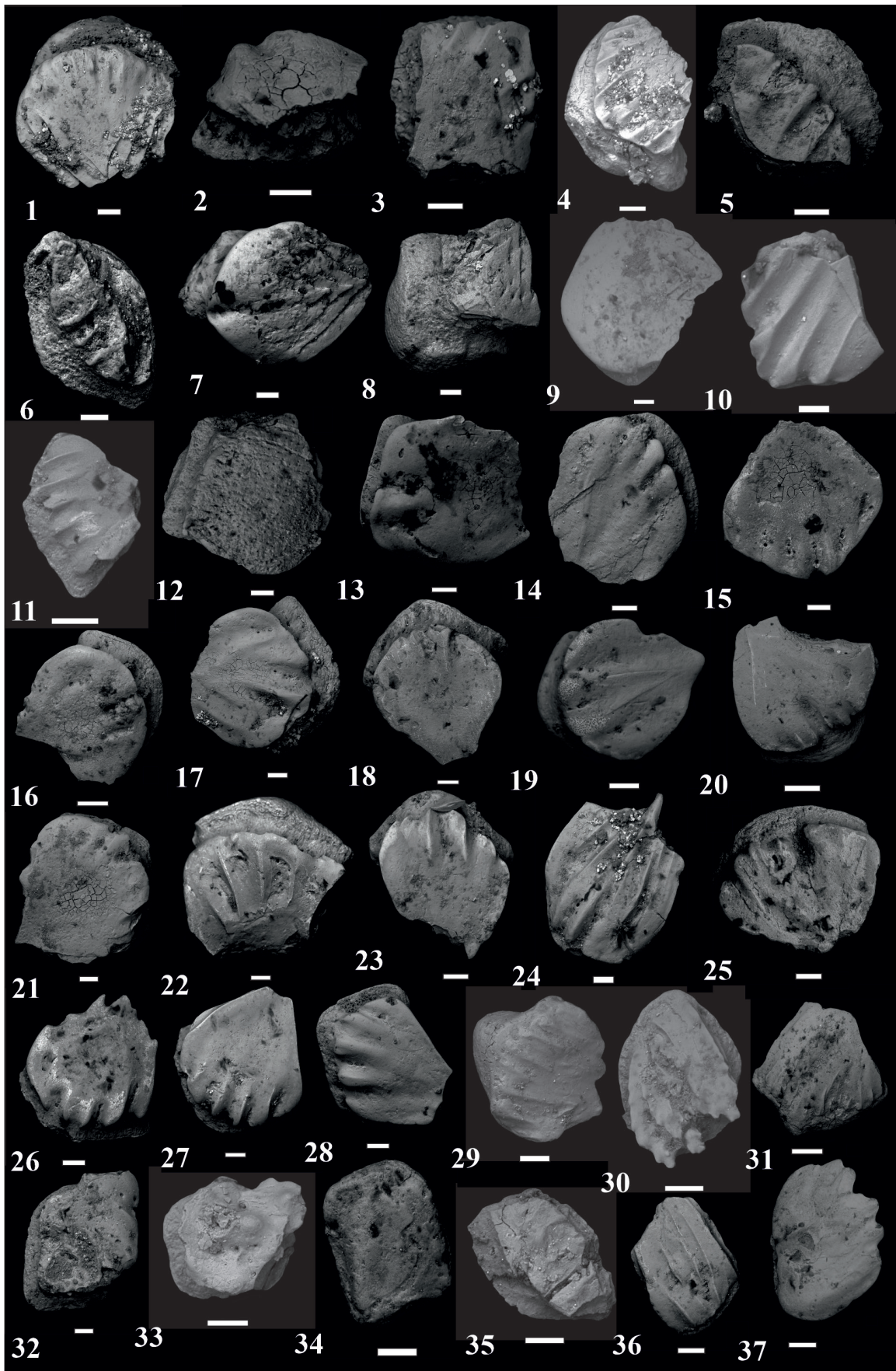


Plate VIII – Fish scales from the Rataichitsy 12 k borehole. The scales come from the Kameniuki Formation, Borshchovo Regional Stage, Lochkovian, Lower Devonian. Scale bar 50 μm for Figure 10; 100 μm for Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 35, 36 and 37; 200 μm for Figures 16, 20 and 31.

Figure 1 – *Gomphonchoporus hoppei* (Gross). Specimen № 122/9-56, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 2 – *Gomphonchus* sp. Specimen № 122/23-5, Rataichitsy 12 k borehole, depth 403.05 m, x 200, scale fragment, posterior crown view. Figure 3 – *Ischnacanthiformes* gen. et sp. indet. Specimen № 122/25-8, Rataichitsy 12 k borehole, depth 404.0 m, x 150, scale, crown view. Figure 4 – *Ischnacanthiformes* ? gen. et sp. indet. Specimen № 122/9-74, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 5 – *Acanthodii* gen. et sp. indet. Specimen № 122/21-4, Rataichitsy 12 k borehole, depth 401.3 m, x 150, scale fragment, crown view. Figure 6 – *Acanthodii* gen. et sp. indet. Specimen № 122/7-12, Rataichitsy 12 k borehole, depth 374.5 m, x 120, scale fragment, crown view. Figure 7 – *Poracanthodes menneri* (Valiukevičius). Specimen № 122/7-2, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, crown view. Figure 8 – *Poracanthodes menneri* (Valiukevičius). Specimen № 122/7-39, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, anterior crown view. Figure 9 – *Poracanthodes menneri* (Valiukevičius). Specimen № 122/9-66, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 10 – *Euthacanthus* sp. Specimen № 122/9-60, Rataichitsy 12 k borehole, depth 379.5 m, x 300, scale fragment, crown view. Figure 11 – *Cheiracanthoides* cf. *nativus* Valiukevičius. Specimen № 122/9-93, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale fragment, crown view. Figure 12 – *Poracanthodes* sp. Specimen № 122/7-94, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, crown view. Figure 13 – *Endemolepis inconstans* Valiukevičius. Specimen № 122/9-14, Rataichitsy 12 k borehole, depth 379.5 m, x 120, scale, crown view. Figure 14 – *Endemolepis inconstans* Valiukevičius. Specimen № 122/7-51, Rataichitsy 12 k borehole, depth 374.5 m, x 100, scale, oblique crown view. Figure 15 – *Acanthodii* gen. et sp. indet. Specimen № 122/9-17, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 16 – *Endemolepis inconstans* Valiukevičius. Specimen № 122/9-25, Rataichitsy 12 k borehole, depth 379.5 m, x 80, scale, crown view. Figure 17 – *Endemolepis inconstans* Valiukevičius. Specimen № 122/9-39, Rataichitsy 12k borehole, depth 379.5 m, x 100, scale, oblique crown view. Figure 18 – *Acanthodian* indeterminate scale. Specimen № 122/9-40, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 19 – *Endemolepis inconstans* Valiukevičius. Specimen № 122/9-51, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, crown view. Figure 20 – *Endemolepis inconstans* ? Valiukevičius. Specimen № 122/9-7, Rataichitsy 12 k borehole, depth 379.5 m, x 85, scale, anterior crown view. Figure 21 – *Acanthodian* indeterminate scale. Specimen № 122/9-44, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 22 – *Endemolepis inconstans* ? Valiukevičius. Specimen № 122/9-29, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 23 – *Acanthodian* indeterminate scale. Specimen № 122/9-34, Rataichitsy 12k borehole, depth 379.5 m, x 120, scale, crown view. Figure 24 – *Acanthodian* indeterminate scale. Specimen № 122/9-58, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 25 – *Acanthodian* indeterminate scale. Specimen № 122/9-1, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, crown view. Figure 26 – *Acanthodian* indeterminate scale. Specimen № 122/9-57, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, anterior crown view. Figure 27 – cf. *Nostolepis* sp. Specimen № 122/9-16, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale, anterior crown view. Figure 28 – *Nostolepis* ? sp. Specimen № 122/7-65, Rataichitsy 12 k borehole, depth 374.5 m, x 120, scale, crown view. Figure 29 – *Acanthodian* indeterminate scale. Specimen № 122/9-98, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, oblique crown view. Figure 30 – *Jolepis robusta* ? (Brotzen). Specimen № 122/9-68, Rataichitsy 12 k borehole, depth 379.5 m, x 180, scale, crown view. Figure 31 – *Acanthodian* indeterminate scale. Specimen № 122/25-3, Rataichitsy 12 k borehole, depth 404.0 m, x 80, scale, anterior crown view. Figure 32 – *Acanthodii* gen. et sp. indet. Specimen № 122/9-27, Rataichitsy 12 k borehole, depth 379.5 m, x 100, scale fragment, crown view. Figure 33 – *Acanthodii* gen. et sp. indet. Specimen № 122/9-95, Rataichitsy 12 k borehole, depth 379.5 m, x 200, scale, crown view. Figure 34 – *Acanthodii* gen. et sp. indet. Specimen № 122/7-96, Rataichitsy 12 k borehole, depth 374.5 m, x 160, scale, crown view. Figure 35 – *Acanthodii* gen. et sp. indet. Specimen № 122/18-1, Rataichitsy 12 k borehole, depth 395.0 m, x 200, scale fragment, crown view. Figure 36 – *Acanthodian* indeterminate scale. Specimen № 122/9-45, Rataichitsy 12 k borehole, depth 379.5 m, x 150, scale, crown view. Figure 37 – *Chondrichthyes* gen. et sp. indet. Specimen № 122/9-54, Rataichitsy 12 k borehole, depth 379.5 m, x 120, scale, crown view.

groups of vertebrates, the acanthodians and chondrichthyans are the nekton representatives, the heterostracans, thelodonts and placoderms form the nektobenthos, and the osteostracans are benthos animals. The heterostracans are found in most rocks as few small fragmentary plates, discrete ridges and tesseræ of "*Traquairaspis*" sp., tesseræ of *Tesseraspis* sp., scales of *Anglaspis* sp., tesseriform elements, separate dentine ridges and scales of *Corvaspis* sp. The remains of *Corvaspis* sp. are the most abundant of the heterostracan taxa. The osteostracans are represented in these deposits by very few small indefinable scales of *Osteostraci* indet. The thelodonts are found mainly in dolomite limestones, dolomite marls and carbonate clays in the form of isolated scales of *Turinia* sp., *T. pagei* (Powrie), *T. polita* Karatajūtė-Talimaa, *Boreania minima* Karatajūtė-Talimaa, *Nikolivia gutta* Karatajūtė-Talimaa, *Talivalia elongata* (Karatajūtė-Talimaa), *Canonis* sp. and *Thelodonti* ? indet. The scales of *Turinia pagei* (Powrie) and *Boreania minima* Karatajūtė-Talimaa are quite abundant among them. The placoderms are represented in the deposits under consideration by two small fragments of the exoskeleton of *Placodermi* indet. The chondrichthyans are represented by few scales of *Chondrichthyes* indet. The acanthodians form the most abundant and dominant group of fishes in this vertebrate assemblage. They are found in all the above rock types and are represented by some isolated scales of *Nostolepis* sp., *N. striata* Pander, *N. cf. striata* Pander, *N. striata* ? Pander, *N. gracilis* Gross, *N. arctica* Vieth, *N. minima* Valiukevičius, *N. magnicostata* Valiukevičius, *N. magnicostata* ? Valiukevičius, *N. ? sp.*, cf. *Nostolepis* sp., *Nostolepis* sp. or *Nostovicina* sp., *Nostovicina* sp., *N. elegans* (Brotzen), *N. cf. elegans* (Brotzen), *N. multicostata* (Vieth), *N. cf. guangxiensis* (Wang), *Canadalepis linguiformis* Vieth, *Cheiracanthoides* sp., *C. planus* Valiukevičius, *C. cf. nativus* Valiukevičius, *C. ? sp.*, *Endemolepis inconstans* Valiukevičius, *E. inconstans* ? Valiukevičius, *Gomphonchus* sp., *G. sandelensis* (Pander), *G. cf. sandelensis* (Pander), *G. ? sp.*, *Gomphonchoporus hoppei* (Gross), *G. hoppei* ? (Gross), *G. sp.*, *Gomphonchoporus* sp. or *Gomphonchus* sp., *Euthacanthus* sp., *Poracanthodes* sp., *P. menneri* (Valiukevičius), *Jolepis robusta* ? (Brotzen), *Ischnacanthiformes* gen. et sp. indet., *Ischnacanthiformes* ? gen. et sp. indet., *Acanthodii* gen. et sp. indet., *Acanthodii* ? indet., as well as nostolepid scales, nostolepid ? scales, probably nostolepid 'special' scale, acanthodian head scales, acanthodian scales, acanthodian indeterminate scales, some small fin spine fragments of *Acanthodii* gen. indet., tesseræ of Acanthodians, Nostolepid stellate tesseræ and *Climatiidae* gen. indet. Among the above-mentioned acanthodian taxa, the dominant ones are *Nostolepis* sp., *N. striata* Pander, *Nostovicina elegans* (Brotzen), *Gomphonchus* sp., *G. sandelensis* (Pander), *Gomphonchoporus hoppei* (Gross) and *Ischnacanthiformes* gen. et sp. indet. *Nostolepis arctica* Vieth, *N. magnicostata* Valiuk., cf. *Nostolepis* sp., *Nostovicina multicostata* (Vieth), *N. cf. guangxiensis* (Wang), *Cheiracanthoides planus* Valiukevičius, *C. cf. nativus* Valiukevičius, *Jolepis robusta* ? (Brotzen), *Euthacanthus* sp., *Poracanthodes* sp., *Gomphonchoporus* sp. or *Gomphonchus* sp., acanthodian head scales, probably nostolepid 'special' scale, tesseræ of *Climatiidae* gen. indet., fin spine fragments of *Acanthodii* gen. indet., are very rarely found. A stratigraphically important species is *Nostolepis minima* Valiukevičius. In addition to the ichthyofauna, the deposits of this part of the section contain calcareous algae, single scolecodonts, rare ostracod valves, some few small fragmentary lingulid shells, single small fragments of shells of articulate brachiopods, very few tentaculite shells, single bryozoans, relatively numerous scattered crinoid segments and some few conodonts.

Correlation of the Lower Devonian (Lochkovian) deposits of the Rataichitsy 12 k borehole.

The deposits of the Kameniuki Formation in the Rataichitsy 12 k borehole correspond to the Borshchovo Regional Stage of the Lochkovian Stage of the Lower Devonian and correspond to the *Nikolivia gutta* thelodont zone [10] and the lower part of the *Nostolepis minima* acanthodian zone [7, 11]. In their ichthyofauna they are correlated with the sediments of the Domachevo Formation of the Borshchovo Regional Stage developed in the territory of the Belarusian part of the Volyn Monocline [12], with deposits of approximately the lower and middle part of the Tilžė Formation (Regional Stage) of the Baltic States [13–15], with rocks of the Borshchovo Formation (Regional Stage) of Volyn-Podolia region [11, 12, 16], with the lower part of the Frenkelrigger Formation of the Red Bay Series of West Spitsbergen [6, 17], with the sediments of the Severnaya Zemlya Formation and the lower half of the Pod'emnaya Formation of the Severnaya Zemlya Archipelago [18–20], approximately with the lower part of the Ovinparma deposits of the Timan-Pechora province [11, 21, 22] and the Belyi Kamen' Beds of the Central Taimyr [11, 23].

Brief taphonomic description of the Lochkovian ichthyofauna remains from the Podlasie-Brest Depression. The vertebrate remains found in the deposits of the Kameniuki Formation of the Rataichitsy 12 k borehole were found at 15 levels in various types of rocks – in siltstones, clays, marls, dolomite marls, dolomites and dolomite limestones. They are represented in these rocks by scattered scales, tesseræ, dentine ridges, small plate fragments of the heterostracans, not numerous discrete scales of the osteostracans, separate scales of the thelodonts, some small fragments of the exoskeleton of the placoderms, some isolated scales, tesseræ and fragments of the fin spines of the acanthodians, as well as some single scales of the chondrichthyans. The most abundant and diverse ichthyofauna taxa were revealed at depths: 369.0 m, 371.9 m, 374.5 m, 379.5 m, 401.3 m, 403.05 m and 404.0 m in marls, dolomites and dolomite limestones. In general, the vertebrate remains found in the deposits of the Kameniuki Formation are fairly well preserved. They occur mainly subhorizontally, somewhat randomly, do not form large group clusters, and have no very obvious signs of roundness. They are all scattered and do not form articulated skeletons. The sizes of various skeletal elements of the agnathans and fishes range from some fractions of a millimeter to one centimeter. The remains show a variety of colours: light grey, light cream, yellow-orange, light brown, dark brown and black. The internal and external structure details of the overwhelming majority of the skeletal elements are well preserved. Some skeletal remains are slightly fractured and broken. Their fossilization degree is different. All of them are secondary mineralized. An analysis of the taxonomic composition of the vertebrates found in this part of the section indicates the predominance of acanthodian scales, to a lesser extent, thelodont scales, as well as the scales, separate ridges, small fragments of the plates and tesseræ of the heterostracans; skeletal remains of the osteostracans, placoderms and cartilaginous fishes are found rarely. The tesseræ and small fragments of the fin spines of the acanthodians are also quite few. Most of the found vertebrate remains belonged, most likely, to the euryfacial species. The invertebrates in this part of the section include single scolecodonts, rare ostracods, not very numerous brachiopod shells, very few tentaculites, some isolated bryozoans, relatively numerous crinoid segments, as well as some miospores and calcareous algae as flora representatives. Some few conodonts were also found in this part of the section. The invertebrates are generally rather well preserved, while the conodonts and plants are relatively well preserved. It can be assumed that the above-mentioned organic remains did not apparently experience very long transportation in the process of their burial, however, their disintegration and fragmentation may suggest their transportation over short distances under the influence of the hydrodynamic processes in the water basin. From the above information it can be concluded that the habitat of the discovered animals and plants could be a coastal shallow sea basin where mainly carbonate sedimentation took place.

Conclusions. 1. The paper provides new data of the ichthyofauna of Lochkovian age established in the deposits of the Kameniuki Formation of the Rataichitsy 12 k borehole, as well as some additional information about all the reliably known findings of the Lochkovian fish fauna identified in the twentieth century in the territory of the Podlasie-Brest Depression within Belarus.

2. The lithological description of the deposits of the Kameniuki Formation identified in the Rataichitsy 12 k borehole, as well as of their underlying and overlying sediments is given.

3. The deposits under consideration are correlated in the ichthyofauna with the well-studied synchronous sediments found in the territories of the Baltic States, Ukraine, Russia and Spitsbergen.

4. The data of the Lochkovian ichthyofauna obtained from the Rataichitsy 12 k borehole significantly improved its systematic composition in the territory of Belarus, supplemented the information of its geographical distribution, and also were used to discuss the taphonomic characteristics of its remains.

5. A number of skeletal elements of the Lochkovian agnathans and fishes are presented in the paper as attached Plates.

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