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Fish Assemblage from the Givetian (Middle Devonian) of the Kuznetsk Basin, Russia

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Abstract

A diverse fish assemblage was reported from the Mazalovskiy Kitat and Alchedat beds (Givetian, Middle Devonian) of the Kuznetsk Basin (Siberia, Russia). Ptyctodontid and acanthothoracid placoderms; chondrichthyans such as the phoedodontiforms *Phoebodus fastigatus* and *Ph. sophiae*, the omalodontiform *Omalodus grabaui*, the cladodontomorph *Cladodoides*, euselachian *Protacrodus*, *"Ohiolepis*, and *"Cladolepis"*; *Cheiracanthoides* and acanthodiform acanthodians; actinopterygian *Moythomasia*; and struniiform sarcopterygians occur in the assemblage. The teeth of phoebodontiforms and omalodontiform are dominant among the fish microremains. The assemblage contains widely distributed taxa. The occurrences of *Cladodoides* and *Protacrodus* in the Givetian of Kuznetsk Basin are the oldest in the world.

Keywords: fishes, Middle Devonian, Kuznetsk Basin, Siberia

Introduction

The fish microremains earlier have been recorded in the Givetian Mazalovskiy Kitat and Alchedat formations of Kuznetsk Basin, Siberia [1]. The placoderm "*Ptyctodus*" sp.; the chondrichthyans *Phoebodus floweri* Wells, 1944, *Ph.? bryanti* Wells, 1944, *Protacrodus* sp., *Cladodus* sp., and *Ohiolepis* sp.; the acanthodians *Devononchus* cf. *laevis* Gross and *Nostolepis?* sp. A.; the sarcopterygians *Laccognathus* sp. and *Glyptolepis* sp.; actinopterygians *Moythomasia durgaringa* Gardiner et Bartram, 1977, "M." *antiqua* (Williams, 1886), and *Kentuckia hlavini* Dunkle, 1964 were reported from three sections of these formations. Subsequently, *Phoebodus floweri* was redescribed as *Ph. fastigatus* Ginter et Ivanov, 1992, and *Ph.? bryanti* – as *Omalodus bryanti* Wells, 1944 [2], but *O. bryanti* now is a junior synonym of *O. grabaui* (Hussakof et Bryant, 1918) [3].

In this article, the collection of new and known specimens from the Mazalovskiy Kitat (*Icriodus brevis* conodont Zone (CZ) or *Polygnathus timorensis* standard CZ) and Alchedat (*Icriodus difficiis* CZ or *Polygnathus varcus – "Ozarkodina" semialternans* standard CZ) beds (Mazalovskokitatian Regional Stage, Givetian) was studied.

1. Material and Methods

Fish microremains were collected from the terrigenous-carbonate deposits of three sections (1/89, E8211, and E8212) near Anzhero-Sudzhensk, in the (Mazalovskiy) Kitat River basin (Kemerovo Region, Western Siberia) (Fig. 1).

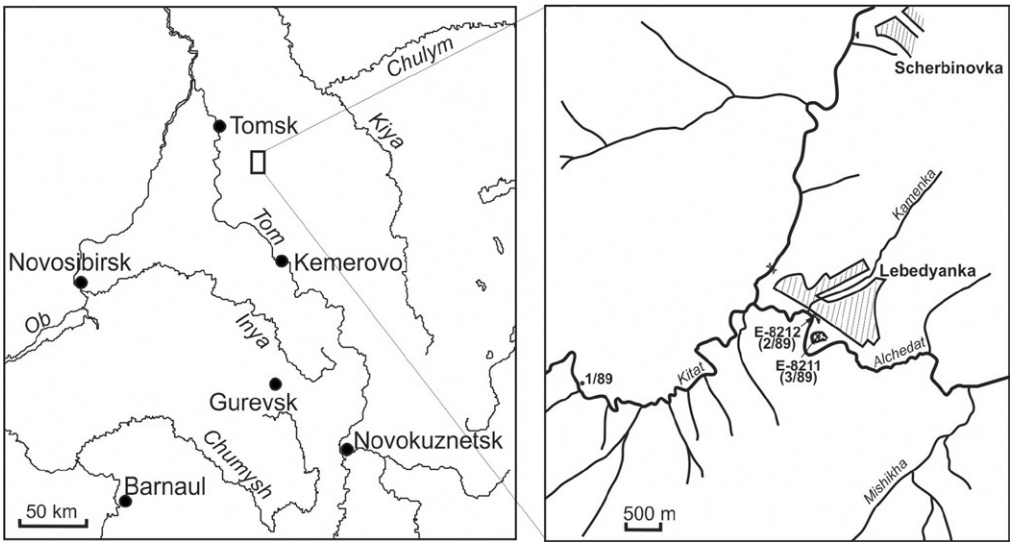

Fig. 1. Maps showing the localities studied for the Givetian fishes

Section 1/89, located about 3 km upstream from the village of Lebedyanka, is an outcrop on the left bank of the Kitat River. Here, the fish microremains were found in one sample (1/89-1-1) from the limestones of the Mazalovskiy Kitat beds, which also contained abundant stromatoporoids, corals, trilobites, ostracods, brachiopods, crinoids, and conodonts [1]. Sections E8211 (3/89) and E8212 (2/89) are situated on the right bank of the Alchedat River, at the southern margin of the village of Lebedyanka [1, 4]. Section E8211 is a small abandoned quarry exposing the deposits of the Mazalovskiy Kitat beds and the lower part of the Alchedat beds (Fig. 2). The fish microremains were collected from five samples of the Alchedat beds. Section E8212 exposes the deposits of the upper part of the Alchedat beds, with the fish microremains found in four samples (Fig. 2).

The fish microremains were obtained from the processed conodont samples and photomicrographed using scanning electron microscopy (S-3400N (Hitachi, Japan), Cambridge CamScan-4 (Cambridge Instruments, UK), and VEGA-II XMU (Tescan, Czech Republic)). The described specimens are housed at the Paleontological Museum of St. Petersburg State University (PMSPU).

2. Fish Assemblage

The fish microremains under study include placoderm plate fragments; chondrichthyan teeth and scales; acanthodian jaw fragment and scales; actinopterygian teeth, tooth plates, jaw fragments, and scales; and sarcopterygian teeth and scale fragments.

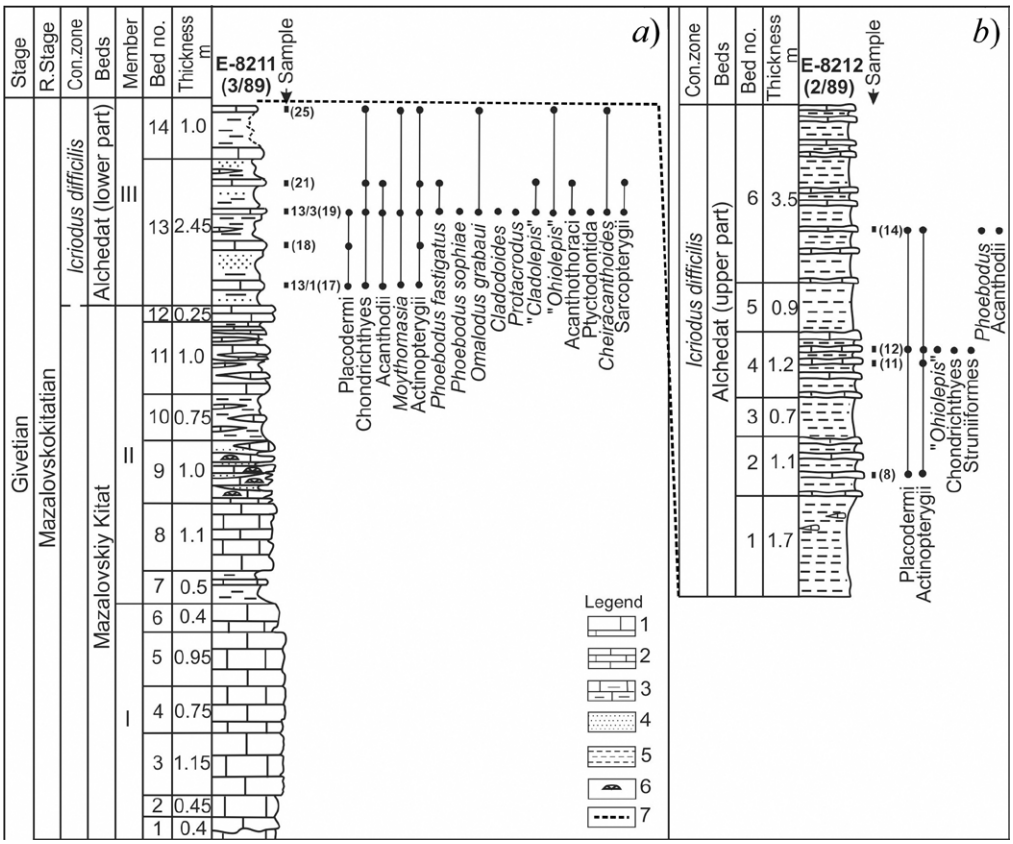

Fig. 2. Distribution of fish taxa in sections E8211 (3/89) (*a*) and E8212 (2/89) (*b*). Stratigraphic columns according to [9]. Abbreviations: Bed no. – bed number, Con. zone – conodont zone, R. Stage – regional stage. Legend: 1 – massive limestones, 2 – bedded limestones, 3 – clayey limestones 4 – sandstones, 5 – mudstones, 6 – tabulat corals, 7 – correlation lines

The placoderm remains are represented by the plate fragments of Ptyctodontida indet. and the tesserae of Acanthothoraci indet. (Fig. 3.1), which resemble the tesserae of *Ohioaspis* [5]. The chondrichthyan microremains are the teeth of the phoebodontiforms *Phoebodus fastigatus* (Figs. 4.5–7) and *Ph. sophiae* (Figs. 4.1–4); the omalodontiform *Omalodus grabaui* (Figs. 4.8–12); the cladodontomorph *Cladodoides* sp. (Fig. 4.13); and the euselachian *Protacodus* sp. (Fig. 4.14). They are also the scales of *"Ohiolepis"* (Figs. 4.18, 19), *"Cladolepis"*, ctenacanthid (Figs. 4.15, 16), and protacrodontid types (Fig. 4.17), as well as unidentified tessera-like scales (Fig. 4.20). The acanthodian scales belong to Acanthodiformes indet. (Fig. 3.3) and *Cheiracanthoides* sp. (Fig. 3.4), resembling the scales of *Cheiracanthoides comptus* Wells, 1944 [6]. The acanthodian jaw fragment (Fig. 3.2) is similar to the dentigerous jaws of some ischnacanthiforms [7, 8]. The actinopterygian scales (Figs. 3.5, 6) were attributed to *Moythomasia* sp., other remains (Figs. 3.7, 8) are undetermined. The sarcopterygian microremains are represented by struniiform teeth and unidentified scale fragments. Among fish microremains, the teeth of phoebodontiforms and omalodontiform are dominant.

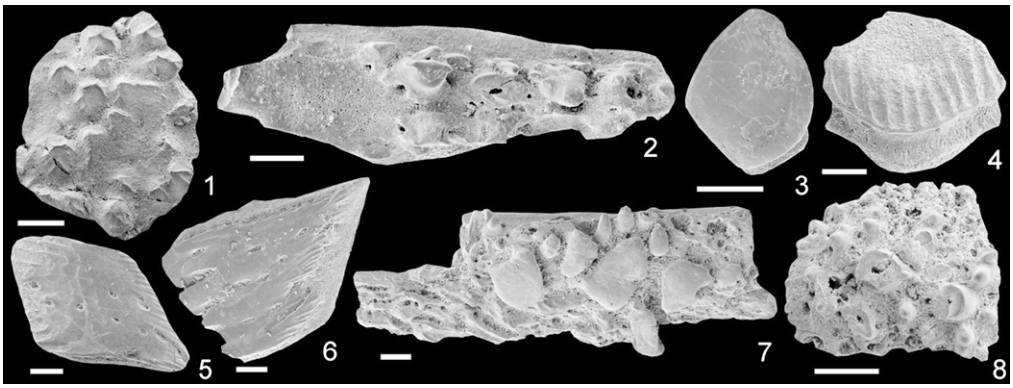

Fig. 3. Fish microremains from the Givetian (Alchedat beds, *Icriodus difficilis* CZ) of the Kuznetsk Basin: 1 – sample 3/89-3-21, 2–5– sample 3/89-3-191, 6 – sample 3/89-3-17, 7, 8 – sample 2/89-5-12. 1 – Placoderm Acanthothoraci indet. (cf. *Ohioaspis*), tessera, crown view, PMSPU 112-18. 2 – 4 – acanthodian remains: 2 – dentigerous jaw fragment, occlusal view, PMSPU 112-19; 3 – acanthodiform scale, crown view, PMSPU 112-20; 4 – *Cheiracanthoides* sp., scale, oblique crown view, PMSPU 112-21. Actinopterygian remains: 5, 6 – *Moythomasia* sp., flank scales, external views, 5 – PMSPU 112-22, 6 – PMSPU 112-23; 7 – jaw fragment, labial view, PMSPU 112-24; 8 – tooth plate, occlusal view, PMSPU 112-25. Scale bars: 200 μm

The results obtained demonstrate that the fish assemblage from section 1/89 of the Lower Givetian Mazalovskiy Kitat beds comprises *Phoebodus fastigatus*, *Ph.* sp., *"Ohiolepis"*, *"Cladolepis"*, Acanthodiform indet., and *Moythomasia* sp. The fishes from the lower part of the Middle Givetian Alchedat beds of section E8211 were assigned to Ptyctodontidae indet., Acanthothoraci indet. (cf. *Ohioaspis*), Placodermi indet., *Phoebodus fastigatus*, *Ph. sophiae*, *Omalodus grabaui, Cladodoides* sp., *Protacrodus* sp., *"Ohiolepis"*, *"Cladolepis"*, Chondrichthyes indet., *Cheiracanthoides* sp., Acanthodiformes indet., Acanthodii indet., *Moythomasia* sp., Actinopterygii indet., and Sarcopterygii indet. (Fig. 2, *a*). The upper part of the Alchedat beds of section E8212 contains Placodermi indet., *Phoebodus* sp., *"Ohiolepis"*, Chondrichthyes indet., Acanthodii indet., Actinopterygii indet., and Struniiformes indet. (Fig. 2, *b*).

Considering the above, the diverse fish assemblage from the Givetian of the Kuznetsk Basin includes widely distributed taxa. Besides the described assemblage, the Givetian species *Phoebodus sophiae* is known from the Middle *varcus–disparilis* CZ of northeastern Australia; central Iran; Southern Mauritania; the Holy Cross Mountains of Poland; the Rhenish Slate Mountains of Germany; Spain; Portugal; the US states of Iowa, Indiana, and New York [10]; as well as from the Upper *varcus*–Upper *disparilis* CZ of the Middle Urals in Russia. *Ph. fastigatus* has been reported from the Givetian–Frasnian (interval of *varcus–rhenana* CZ) of the Kuznetsk Basin and the Middle and Southern Urals of Russia; Poland; Spain; the US states of Iowa, Indiana, New York, and Utah; Western Australia; China; Mauritania; Morocco [10]; and possibly from the *hemiansatus* CZ of the Lower Givetian [11, 12]. The phoedodontiform chondrichthyans first appeared in the Givetian and became very diverse in the Late Devonian.

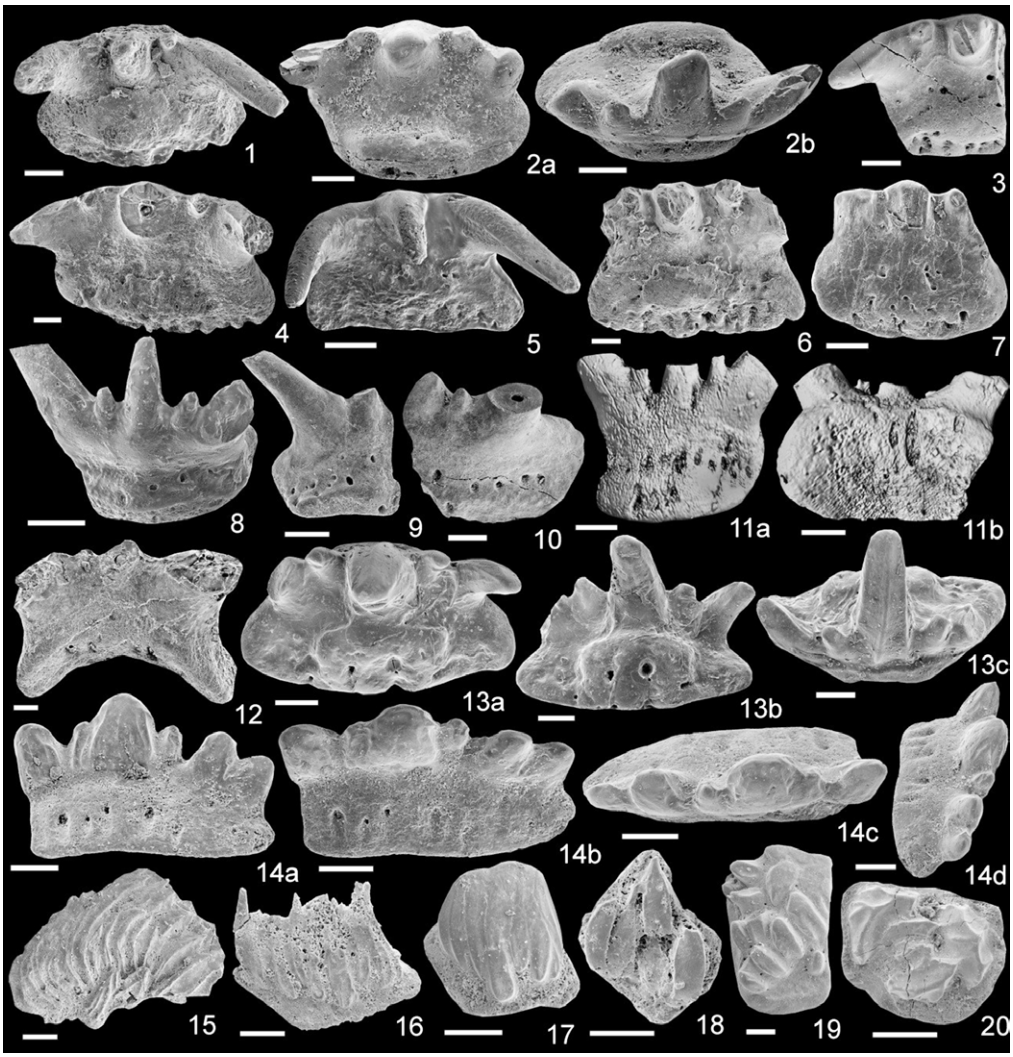

Fig. 4. Chondrichthyan microremains (1–14 – teeth and 15–20 – scales) from the Givetian of the Kuznetsk Basin: 1–4, 6–15, 17–20 – Alchedat beds, *Icriodus difficilis* CZ: 1, 4, 6, 12 – sample E8211-13/3; 2, 3, 7–9, 11, 13, 14, 17, 19, 20 – sample 3/89-3-19; 10, 15 – sample 3/89-3-25; 18 – sample 2/89-5-12; 5, 16 – Mazalovskiy Kitat beds, *Icriodus brevis* CZ, sample 1/89-1-1. 1–4 – *Phoebodus sophiae* St. John et Worthen, 1875, occlusal (1, 2a, 3, 4) and oblique labial (2b) views, 1 – PMSPU 112-1, 2 – PMSPU 112-2, 3 – PMSPU 112-3, 4 – PMSPU 112-4. 5–7 – *Ph. fastigatus* Ginter et Ivanov, 1992, occlusal views, 5 – holotype, PMSPU 5-1, 6 – PMSPU 112-5, 7 – PMSPU 112-6. 8–12 – *Omalodus grabaui* (Hussakof et Btyant, 1918), labial (8–10) and lingual (11, 12) views, 8 – PMSPU 7-4, 9 – PMSPU 112-7, 10 – PMSPU 112-8, 11 – PMSPU 7-3, 12 – PMSPU 112-9. 13 – *Cladodoides* sp., occlusal (13a), lingual (13b), and oblique labial (13c) views, PMSPU 112-10. 14 – *Protacrodus* sp., lingual (14a), occlusal (14b), oblique labial (14c), and oblique lateral (14d) views, PMSPU 112-11. 15, 16 – ctenacanthid type, crown views, 15 – PMSPU 112-12, 16 – PMSPU 112-13. 17 – protacrodontid type, crown view, PMSPU 112-14. 18, 19 – "*Ohiolepis*" type, crown views, 18 – PMSPU 112-15, 19 – PMSPU 112-16. 20 – tessera-like scale, crown view, PMSPU 112-17. Scale bars: 200 μm

Omalodus grabaui was recorded in the Middle Givetian–Lower Frasnian of Poland; Spain; the Kuznetsk Basin of Russia; Morocco; the US states of New York,

Iowa, Indiana, Kentucky, and Ohio [3]. *Cladodoides* has been recorded from the Upper Frasnian of Germany; the Upper Frasnian–Middle Famennian of Poland, Moravia, Morocco, and the South Urals of Russia; the Lower Famennian of France and Armenia; the Upper Frasnian–Middle Famennian of Iran; the Lower Famennian and Tournaisian of Western Australia; possibly from the Lower Carboniferous of Yakutia in Russia; and New Mexico in the USA [3]. This taxon has been also found in the Frasnian–Famennian of the Kuznetsk Basin. *Protacodus* is known from the Upper Devonian–Pennsylvanian of various regions. The occurrences of the cladodontomorph *Cladodoides* and the euselachian *Protacodus* in the Givetian of the Kuznetsk Basin are the oldest in the world.

Conclusions

The fish assemblage from the Givetian of the Kuznetsk Basin contains the microremains of ptyctodontid and acanthothoracid placoderms; chondrichthyans such as the phoedodontiforms *Phoebodus fastigatus* and *Ph. Sophiae*, the omalodontiform *Omalodus grabaui*, the cladodontomorph *Cladodoides*, the euselachian *Protacrodus*, *"Ohiolepis*, and *"Cladolepis"*; *Cheiracanthoides* and acanthodiform acanthodians; the actinopterygian *Moythomasia*; and struniiform sarcopterygians. This fish assemblage includes widely distributed taxa such as *Phoebodus fastigatus*, *Ph. sophiae*, *Omalodus grabaui*, *Cladodoides*, *Protacrodus*, and *Moythomasia*. The occurrences of the cladodontomorph *Cladodoides* and the euselachian *Protacrodus* in the Middle Givetian of the Kuznetsk Basin are the earliest records in the world.

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Conflicts of Interest. The authors declare no conflicts of interest.

References

1. Type sections of boundary deposits of the Middle and Upper Devonian, Frasnian, and Famennian Stages of the Kuznetsk Basin margins. *Mater. V vyezdnoi sessii komissii MSK po devonskoi sisteme, Kuzbass, 16–29 iyulya 1991* [Proc. V Field Sess. ISC Comm. on the Devonian System, Kuzbass, July 16–29, 1991]. Novosibirsk, SNIIGGiMS, 1992, 136 p. (In Russian)
2. Ginter M., Ivanov A. Devonian phoebodont shark teeth. *Acta Palaeontol. Pol.*, 1992, vol. 37, no. 1, pp. 55–75.
3. Ginter M., Hampe O., Duffin C.J. Vol 3D – Chondrichthyes: Paleozoic Elasmobranchii: Teeth. In: Schultze H.-P. (Ed.) *Handbook of Palaeoichthyology*. Munich, Verlag Dr. Friedrich Pfeil, 2010. 168 p.

4. Bakharev N.K., Izokh N.G., Yazikov A.Yu., Shcherbanenko T.A., Anastasieva S.A., Obut O.T., Saraev S.V., Peregoedov L.G., Khromykh V.G., Rodina O.A., Timokhina I.G., Kipriyanova T.P. *Middle-Upper Devonian and Lower Carboniferous Biostratigraphy of Kuznetsk Basin: Field Excursion Guidebook*. Bakharev N.K., Izokh N.G., Obut O.T., Talent J.A. (Eds.). Proc. Int. Conf. "Biostratigraphy, Paleogeography and Events in Devonian and Lower Carboniferous" (SDS/IGCP 596 Joint Field Meeting). Novosibirsk, Izd. Sib. Otd. Ross. Akad. Nauk, 2011. 98 p.
5. Wells J.W. Fish remains from the Middle Devonian bone beds of the Cincinnati Arch region. *Palaeontogr. Am.*, 1944, vol. 3, no. 16, pl. 7–14, pp. 99–160.
6. Gross W. Kleinschuppen, Flossenstacheln und Zähne von Fischen aus europäischen und nordamerikanischen Bonebeds des Devons. *Palaeontographica. Abt. A*, 1973, Bd. 142, Lfg. 4–6, S. 51–155.
7. Burrow C.J., Acanthodian dental elements from the Trundle beds (Lower Devonian) of New South Wales. *Rec. West. Aust. Mus*., 1995, vol. 17, pp. 331–341.
8. Burrow C.J. Microvertebrate assemblages from the Lower Devonian (*pesavis*/*sulcatus* zones) of central New South Wales, Australia. *Mod. Geol*., 1997, vol. 21, pp. 43–77.
9. Izokh N.G. New Givetian conodonts of the genus *Icriodus* from the Kolyvan-Tom Folded Area (South of West Siberia). *Paleontol. J.,* 2023, vol. 57, no. 5, pp. 553–559. https://doi.org/10.1134/S0031030123050027.
10. Ivanov A.O. A new phoebodontid shark from the Devonian of the Urals and the distribution of *Phoebodus* species. *Paleontol. J.*, 2021, vol. 55, no. 3, pp. 301–310. https://doi.org/10.1134/S0031030121030096.
11. Liao J.-C., Ginter M., Valenzuela-Rios J.I. Chondrichthyan microremains from the Givetian of the Aragonian Pyrenees (Spain). *Bull. Soc. Géol. Fr.*, 2007, vol. 178, no. 3, pp. 171–178. https://doi.org/10.2113/gssgfbull.178.3.171.
12. Derycke C. Paléobiodiversité des gnathostomes (chondrichthyens, acanthodiens et actinoptérygiens) du Dévonien du Maroc (NW Gondwana). In: Zouhri S. (Ed.) *Paléontologie des vertébrés du Maroc: état des connaissances*. Mémoires de la Société géologique de France, 2014, no. 180, pp. 44–77. (In French)

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ОРИГИНАЛЬНАЯ СТАТЬЯ

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Комплекс рыб из живетских отложений (средний девон) Кузнецкого бассейна

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Аннотация

В статье рассмотрен комплекс разнообразных рыб из живетских мазаловско-китатских и алчедатских слоев Кузнецкого бассейна Сибири. В комплексе встречены тиктодонтидные и акантоторацидные плакодермы, хрящевые такие как фебодонтиды *Phoebodus fastigatus* и *Ph. sophiae,* омалодонтид *Omalodus grabaui,* кладодонтоморф *Cladodoides*, эвселяхий *Protacrodus*, *"Ohiolepis*, *"Cladolepis"*; акантоды *Cheiracanthoides* и акантодиформ; лучеперая *Moythomasia* и струниформный лопастеперый. Зубы фебодонтид и омалодонтид преобладают в комплексе среди других микроостатков рыб. Комплекс содержит широко распространенные таксоны. Находки *Cladodoides* и *Protacrodus* в живете Кузбасса – древнейшие в мире.

Ключевые слова: рыбы, средний девон, Кузнецкий бассейн, Сибирь.

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