UDC 567.3; 551.735(476)

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# ON THE FINDINGS OF THE CARBONIFEROUS ICHTHYOFAUNA IN THE TERRITORY OF BELARUS

In palaeoichthyological terms, the Carboniferous deposits of Belarus have not been specifically studied for a long time. The findings of the ichthyofauna skeletal elements were mostly random and, as a rule, were passed on by geologists to relevant specialists outside Belarus. The results of the study of some of them were published only in a few papers. These few publications provided information on the ichthyofauna stratigraphic distribution in the Carboniferous deposits of Belarus. The author of this article has been engaged in a targeted search and study of the remains of Carboniferous fishes in the country since 2010. Thanks to his targeted research it was possible to significantly replenish the taxonomic composition of the Carboniferous ichthyofauna of Belarus, to clarify its stratigraphic distribution and to provide its detailed description in several papers. It is proposed to include the identified ichthyoassemblages in the regional part of the new stratigraphic chart of the Carboniferous deposits of the territory of Belarus. At present, the research of the remains of the Carboniferous ichthyofauna of Belarus is actively ongoing. Their stratigraphic significance is being clarified for detailed stratification of the Carboniferous deposits of Belarus and for conducting, on their basis, correlations with coeval deposits developed in non-contiguous and far-remote territories.

**Key words:** Belarus; Carboniferous deposits; ichthyofauna; Chondrichthyes; Acanthodii; Actinopterygii; stratigraphy.
Ref.: 31 titles.

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# О НАХОДКАХ КАМЕННОУГОЛЬНОЙ ИХТИОФАУНЫ НА ТЕРРИТОРИИ БЕЛАРУСИ

В палеоихтиологическом отношении каменноугольные отложения Беларуси долгое время специально не изучались. Находки скелетных элементов ихтиофауны носили в основном случайный характер и, как правило, передавались геологами соответствующим специалистам за пределы Беларуси. Результаты изучения некоторых из них были опубликованы только в единичных работах. В этих немногочисленных публикациях были приведены сведения о стратиграфическом распределении ихтиофауны в каменноугольных отложениях Беларуси. Автор данной статьи занимается целенаправленным поиском и изучением остатков каменноугольных рыб на территории страны с 2010 года. Благодаря его целенаправленным исследованиям, удалось существенно пополнить таксономический состав каменноугольной ихтиофауны Беларуси, уточнить ее стратиграфическое распространение и в отдельных работах привести ее детальное описание. Выделенные ихтиокомплексы предлагается внести в региональную часть новой стратиграфической схемы каменноугольных отложений территории Беларуси. К настоящему времени исследование остатков каменноугольной ихтиофауны Беларуси активно продолжается. Выясняется их стратиграфический потенциал для осуществления детальной стратификации каменноугольных отложений Беларуси и проведения на их основе корреляций с одновозрастными отложениями, развитыми на несопредельных и далеко удалённых территориях.

**Ключевые слова:** Беларусь; каменноугольные отложения; ихтиофауна; Chondrichthyes; Acanthodii; Actinopterygii; стратиграфия.
Библиогр.: 31 назв.

**Introduction.** The Carboniferous deposits are distributed within the territory of Belarus in two separate areas: in the southeast — within the Pripyat Trough and in the southwest — within the Volyn Monocline. Within the Pripyat Trough the Carboniferous sediments usually lie with angular

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unconformity on the Upper Devonian deposits, and within the Kulazhin Ledge and in the eastern part of the North Pripyat Fault — on the crystalline basement rocks. The Carboniferous deposits are overlapped most often by the Permian or Triassic deposits, less often by the Jurassic, Cretaceous and Paleogene sediments. The stratigraphic completeness and thickness of their section depend on the structural conditions of their occurrence: these deposits are either absent, or represented by the Lower Carboniferous rocks only on raised salt domes and anticlines, the Middle Carboniferous deposits are also developed in synclines and depressions, and the Upper Carboniferous sediments occur there in some places [1].

In the territory of the Volyn Monocline, the Carboniferous deposits lie on rocks of the Lower Devonian — Upper Silurian and are overlain by formations of the Oxfordian Stage of the Upper Jurassic. According to palaeontological data available, the Carboniferous deposits are represented there by sediments of the Tulian, Aleksinian and Mikhailovian Regional Stages of the Viséan Stage of the Lower Carboniferous only [1]. Accordingly, their stratigraphic completeness and thickness are much less than those of the Carboniferous deposits developed within the Pripyat Trough.

The stratigraphy of the Carboniferous deposits of Belarus is mainly justified by the data obtained from the study of the foraminifera, ostracods, brachiopods and spore-pollen complexes [1]. In addition to the above-mentioned orthostratigraphic groups of organisms, some other representatives of fossil organisms are also often found in these deposits: calcareous algae, plant remains, trilobites, bivalves, gastropods, cephalopods, bryozoans, conodonts and fishes. Of the listed organisms, the ichthyofauna only remained unstudied until the mid-1990s. Since 2010 the author engaged in a targeted search and study of the remains of Carboniferous fishes in the country. A comprehensive information on the findings of the Carboniferous ichthyofauna remains currently known in the territory of the country is presented below. A conclusion about their stratigraphic significance for the Carboniferous deposits of Belarus is also suggested.

**Results and discussion.** The earliest reliable information about the findings of the ichthyofauna remains from the Carboniferous deposits was available from the Pripyat Trough. In a number of publications [2—9] devoted to the stratigraphy of the Lower Carboniferous deposits of the Pripyat Trough findings of the ichthyofauna remains were often mentioned together with the other groups of fossil organisms, but without specific Latin names. Only one short message by D. N. Esin, L. A. Petukhova and O. A. Lebedev [10] published in 1995 included for the first time a fish assemblage found in the territory of the Pripyat Trough in the deposits of the Malevkian Regional Stage of the Tournaisian Stage of the Lower Carboniferous, which listed the following taxa: "*Acanthodes*" sp., Ctenacanthidae gen. 2 and Ctenacanthidae gen. 3, *Protacrodus* sp. nov., *Deltoptychius armigerus* (Traquair, 1888) [11], *Taeniolepis trautscholdi* (Chabakov, 1927) [12], *Strepheoschema fouldensis* White, 1927 [13], *Aetheretmon valentiacum* White, 1927 [13], *Holurus parki* Traquair, 1881 [14], *Mesopoma pulchellum* (Traquair, 1881) [14], *Styracopterus fulcratus* (Traquair, 1881) [14], *Rhizodus* sp. and Osteolepiformes indet.

An extended collective paper by D. N. Esin and the co-authors [15] dedicated to the Late Devonian and Early Carboniferous vertebrates of the East European Platform was published in 2000. This paper presents the more complete information about the ichthyofauna stratigraphic distribution in the Lower Carboniferous deposits of the Pripyat Trough. The skeletal fish material described in this paper was collected from nine boreholes drilled in the region of the towns of Turov and Petrikov. The palaeoichthyological studies of the rocks from these boreholes allowed the authors to establish the most numerous and taxonomically diverse Malevkian fish assemblage of the Tournaisian Stage in the Pripyat Trough which contained the following taxa: Acanthodii indet., Ctenacanthidae gen. 1, Ctenacanthidae gen. 2, "*Listracanthus*" sp., Ctenacanthidae gen. indet., *Strepheoschema fouldensis* White, 1927 [13], *Taeniolepis trautscholdi* (Chabakov, 1927) [12], *Aetheretmon valentiacum* White, 1927 [13], *Elonichthys* sp. 3, *E.* sp. 4, *Rhadinichthys* sp. 1, Osteolepiformes indet., *Rhizodus* sp. and Rhizodontida indet. According to their data, the fish

assemblage of the Upian Regional Stage of the Tournaisian Stage was less diverse: Ctenacanthidae gen. indet., Osteolepiformes indet., Rhizodontida indet., "*Elonichthys*" cf. *pulcherrimus* Traquair, 1881 [14], *Strepheoschema fouldensis* White, 1927 [13], *Medoevia*? sp., *Holurus parki* Traquair, 1881 [14] and *Rhadinichthys* sp. The vertebrate assemblage established in the rocks of the Gostovian Regional Stage of the Viséan Stage of the Pripyat Trough was quantitatively inferior to the Malevian fish assemblage, but superior to the Upian ichthyoassemblage and was represented by twelve taxa: *Acanthodes* sp., Ctenacanthidae gen. indet., *Protacrodus* sp. nov. 1, "*Listracanthus*" sp., *Aetheretmon valentiacum* White, 1927 [13], *Strepheoschema fouldensis* White, 1927 [13], *Holurus parki* Traquair, 1881 [14], *Rhadinichthys* sp., *Elonichthys* sp., Rhizodontida indet., *Styracopterus fulcratus* (Traquair, 1881) [14] and *Mesopoma pulchellum* (Traquair, 1881) [14]. The last two species of fishes were established by D. N. Esin and his co-authors at this stratigraphic level only.

In 2001 O. A. Lebedev in his paper devoted to the palaeontological characteristic of the Middle Carboniferous deposits of the Moscow Syneclise [16] mentioned a finding of *Protacrodus sibiricus* Lebedev, 2001 in the Tournaisian-Viséan deposits from the territory of Belarus.

In 2010 the author discovered fish remains represented by a few scales of *Acanthodes* sp., some ctenacanthid type scales and teeth of Actinopterygii gen. indet. [17; 18] in the deposits of the Tulian Regional Stage of the Viséan Stage from the Lelchitsy 16D borehole drilled in the territory of the Pripyat Trough.

In 2010 the author discovered Early Carboniferous fishes in the Komarovka 91z/10 borehole drilled in the Belarusian part of the Volyn Monocline (southwestern part of Belarus) [17—21]. These were found in carbonate-clayey deposits of the Upper Dregovichi Subformation of the Dregovichi Formation of the Mikhailovian Regional Stage of the Viséan Stage and were represented by rare scales of acanthodians *Acanthodes* sp., single scales and teeth of chondrichthyans Euselachii indet., ctenacanthid and protacrodontid type scales, placoid scale type 1, placoid scale type 2, *Lissodus* sp., Petalodontiformes indet., relatively numerous scales and teeth of actinopterygians *Mesopoma* sp., Actinopterygii gen. et sp. indet. 1, Actinopterygii gen. et sp. indet. 2, Actinopterygii gen. et sp. indet. 3, Actinopterygii gen. et sp. indet. 4, Actinopterygii gen. et sp. indet. 5, Actinopterygii gen. et sp. indet. 6, Actinopterygii gen. et sp. indet. 7, Actinopterygii gen. et sp. indet. 8, Actinopterygii gen. et sp. indet., as well as some indefinable skeletal elements of ray-finned fishes Actinopterygii indet.

In 2018 A. O. Ivanov and D. P. Plax reported some findings of the chondrichthyan scales and teeth in the Devonian and Lower Carboniferous deposits of Belarus [22]. The remains of cartilaginous fishes were taken from the Tournaisian deposits of the Lower Carboniferous of the Pripyat Trough. In particular, the teeth of *Tamiobatis elgae* Ivanov, 2018 [22], *Cladodoides* cf. *wildungensis* (Jaekel, 1921) [23], *Protacrodus* sp., Protacrodontidae indet. and ctenacanthid, hybodontid type scales, *Ohiolepis* type scales, as well as B and C type scales were found in the rocks of the Malevkian Regional Stage. Some teeth of *Tamiobatis* sp., *Cladodoides* cf. *wildungensis* (Jaekel, 1921) [23], *Protacrodus* sp. and ctenacanthid, hybodontid, euselachian type scales, *Ohiolepis* type scales, as well as B and C type scales were found in the deposits of the Upian Regional Stage. A tooth of *Protacrodus* sp. was found in the rocks of the Cherepetian Regional Stage.

Some additional information on cartilaginous fishes from the Famennian deposits of the Upper Devonian, the Tournaisian, Viséan and Serpukhovian sediments of the Lower Carboniferous and the Bashkirian deposits of the Middle Carboniferous was provided in the subsequent publications by A. O. Ivanov and D. P. Plax devoted to the findings of the chondrichthyan remains in the Upper Devonian and Carboniferous deposits of Belarus [24; 25]. In the Tournaisian Stage deposits of the Pripyat Trough, namely, in the rocks of the Malevkian Regional Stage, a finding of a tooth of *Cladodoides* sp., previously unknown findings of teeth of *Thrinacodus ferox* (Turner, 1982) [26], *Denaea* cf. *fournieri* Pruvost, 1922 [27], *Denaea* sp., *Cladodoides* sp., *Protacrodus* sp., *Sphenacanthus* sp., Hybodontiformes indet. A, Hybodontiformes indet. B, ctenacanthid and hybodontid type scales, as well as Chondrichthyes indet. scales in the rocks of the Cherepetian Regional Stage were described in addition to the previously cited chondrichthyan remains [22].

Some teeth of *Reesodus* sp. and Petalodontiformes indet. were found in the deposits of the Dregovichi Formation of the Mikhailovian Regional Stage of the Viséan Stage of the Belarusian part of the Volyn Monocline [24; 25]. The following remains were found in the sediments of the Sozhian Regional Stage of the Serpukhovian Stage of the Pripyat Trough: some teeth of *Bransonella lingulata* Ivanov et Ginter, 1996 [28], *Denaea wangi* Wang, Jin et Wang, 2004 [29], *Cooleyella fordi* (Duffin et Ward, 1983) [30], Helodontiformes indet., buccopharyngeal denticles of Symmoriiformes indet. (*Stemmatias* type) and euselachian type scales [24; 25]. Some ctenacanthid type scales were found in the rocks of the Yastrebkian Regional Stage of the Serpukhovian Stage of the Pripyat Trough [24; 25]. And finally, the chondrichthyan remains represented by teeth of *Bransonella nebraskensis* (Johnson, 1984) [31], *Stethacanthus* sp., Squatinactiformes indet., Protacrodontidae indet. B, buccopharyngeal denticles of Symmoriiformes indet. (*Stemmatias* type), ctenacanthid, hybodontid and euselachian type scales were identified in the deposits of the Dvizhki Formation of the Pripyatian Regional Stage of the Bashkirian Stage of the Pripyat Trough [24; 25].

Many fish remains represented by the scales of *Acanthodes* sp. and fragments of fin spines of Acanthodii gen. indet., scales of Dipnoi indet., teeth of *Strepsodus* sp., Onychodontiformes indet., scales of *Rhadinichthys* sp. and Actinopterygii indet. have been recently discovered in the deposits of the Malevkian Regional Stage from several boreholes drilled relatively close to the town of Petrikov (within the Pripyat Trough).

**Conclusion.** To summarize the above, it can be assumed that targeted searches and systematic studies of fishes from the Carboniferous deposits will significantly improve the understanding of their taxonomic composition and permit us to define the more detailed ichthyozones, which can be a reliable tool for the purposes of stratification of these deposits within the territory of Belarus.

The author of the article expresses deep gratitude to V. G. Filippova for assistance in editing the manuscript text in English.

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Received by the editorial staff 22.02.2026.