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PALEOZOIC CONODONT STUDIES IN UKRAINE
ВИВЧЕННЯ ПАЛЕОЗОЙСЬКИХ КОНОДОНТІВ В УКРАЇНІ

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The study of Ukrainian Paleozoic conodonts began in the 1960s in western Ukraine, when Danylo Drygant (State Museum of Natural History, L'viv) started to investigate the Silurian and Devonian conodonts of the Podolian and Volhynian sections. The Carboniferous conodonts of the Donets Basin, Dnieper-Donets Depression and L'viv-Volhyn Basin began to be studied in the early 1970s by four students of Prof. Dr. David Ye. Aisenverg: Oleg Ye. Kotlyar, Oleg M. Lipnyagov, Raisa I. Kozitska and Tamara I. Nemyrovska (Institute of Geological Sciences NASU). Carboniferous conodonts from the boreholes of the south-western part of the Donets Basin were studied by Zoya A. Kossenko from "Artemgeology" in the town of Artemovsk, now Bakhmut. During their investigations a great number of new Carboniferous genera and species were described and the Carboniferous conodont zonation of the Donets Basin was constructed. In addition, Carboniferous conodonts from different areas of Europe and Asia were studied to provide reliable correlation to the Donets Basin, resulting in publication of many pertinent taxonomic and biostratigraphic papers. Several conodont species established in the Donets Basin were proposed as markers for the global Bashkirian/Moscovian and Moscovian/Kasimovian boundaries. A significant extinction of Early Carboniferous conodonts was defined for the first time in Eastern Europe at the Mississippian–Pennsylvanian boundary in the Kal'miuss section of the Donets Basin. It was one of the first sections proposed as a candidate for the Mid-Carboniferous boundary GSSP.
Key words: conodonts, Silurian, Carboniferous, stratigraphy, zonal scheme, correlation

В Україні вивчення палеозойських конодонтів бере початок із середини 1960-х років. Першим дослідником конодонтів із розрізів ордовику, силуру та девону Подолії і Волині був Д.М. Дригант (Державний Природознавчий музей НАНУ, м. Львів). Кам'яновугільні конодонти Донецького басейну, Дніпровсько-Донецької западини та Львівсько-Волинського басейну України почали вивчати на початку 70-х років минулого століття чотири аспіранти проф..Д.Є. Айзенверга: Олег Є.Котляр, Олег М. Ліпнягов, Раіса Й. Козицька та Тамара І.Немировська (Інститут геологічних наук НАНУ, Київ). Конодонти московського яруса карбону Донбасу із керна свердловин, пробурених у південно-західній частині Донбасу, вивчала Зоя А. Косенко ("Артемгеологія", м. Артемівськ, нині – м. Бахмут).
В результаті проведених досліджень були детально вивчені та монографічно описані силурійські та девонські конодонти Волино-Подолії та кам'яновугільні конодонти Донбасу та Дніпровсько-Донецької западини, установлено ряд нових таксонів. Складені перші зональні схеми за конодонтами карбону Донбасу. Вивчалися конодонти карбону різних регіонів Європи та Азії, що дозволило провести надійну кореляцію карбону Донбасу з кам'яновугільними басейнами інших регіонів світу. Результати досліджень опубліковані в великій кількості статей і монографій з конодонтів. Декілька видів конодонтів, установлених у карбоні Донбасу, запропоновано в якості видів-індексів для встановлення GSSPs на границях башкирського і московського та московського і касимовського ярусів Глобальної Шкали карбону. Вперше для Східної Європи було виявлено значну подію вимирання ранньокам'яновугільних конодонтів на межі міссісіпської та пенсильванської підсистем у Кальміуському розрізі Донбасу. Цей розріз Донбасу був запропонований як один із перших кандидатів на стратотип серединної границі карбону.
Ключові слова: конодонти, силур, карбон, стратиграфія, зональна схема, кореляція.

INTRODUCTION

Conodonts are microscopic phosphatic fossils that occur in almost every kind of Paleozoic and Triassic marine rocks. Although they were discovered and described for the first time in the middle of the 19th century, their nature and relationship to other marine fossils were unknown almost until the end of the 20th century. Their importance for stratigraphy was determined only in the 1920s when they were successfully used in petroleum geology in the United States. They have shown much better results for stratification and correlation of the Silurian oil-bearing deposits in the Midcontinent of the USA than the other groups of fossils.

Nowadays conodonts are considered an orthostratigraphic group of fossils. Almost all of the stage boundaries in the Paleozoic and the Triassic System are defined by conodont evolution.

Conodonts were first discovered by Russian naturalist Christian Heinrich Pander in 1833 and later described by him in 1856. He recovered them from residues taken from Lower Ordovician

and Silurian clastic rocks in Estonia as well as from surface collections on Carboniferous rocks in the Moscow Basin. Pander thought that he was dealing with the denticles and jaws of an unknown group of fishes. The discussions on the nature of these fossils spanned over a century until their classification as protochordates near the end of the 20th century.

Conodonts began to be systematically studied in Europe after the Second World War and in the USSR since the 1950s. The first Soviet studies dealt with Early and Middle Paleozoic conodonts (Cambrian–Devonian) of Siberia, Volga-Urals, Central Asia and the Baltic states. The first studies of Early Paleozoic (Ordovician–Devonian) conodonts in Ukraine began in the mid-1960s in Podolia and Volhynia (western Ukraine). Carboniferous conodont investigations of the Dnieper-Donets Depression and the Donets Basin began a little later in the early 1970s and still continue today. In the 1980s Late Mississippian and Early Pennsylvanian conodonts were studied from borehole cores in the L'viv-Volhyn Basin, but not in as much detail as in the Donets Basin and the Dnieper-Donets Depression.

In general the conodont studies in the former Soviet Union were active, enthusiastic and successful. Areas covered by conodont research extended from the Baltic to the Far East, including Belarus, Ukraine, Uzbekistan, Tadzhikistan, Kazakhstan, Volga-Urals area, Urals and Siberia. The first President of the Conodont Society of the USSR was Academician Oleg S. Vyalov (Institute of Geology and Geochemistry of Combustible Minerals NASU, Lviv, Ukraine) from 1966 until the end of the 1980s. After he passed away, Prof. Dr. Igor Barskov, Chief of the Paleontological Department of Moscow State University, Russia,) took his position. Academician Oleg Vyalov and Prof. Igor Barskov organized annual conodont symposiums and colloquiums, as well as field trips to the most stratigraphically important areas for conodont study. That was a time of great interest in conodont paleontology, evolution, stratigraphy and paleogeography, and many students started and still continue their conodont research covering all Paleozoic systems and the Triassic.

ORDOVICIAN–DEVONIAN CONODONT STUDIES IN UKRAINE

Paleozoic conodonts in Ukraine were first studied by in the mid-1960s by Dr. Danylo M. Drygant (Institute of Geology and Geochemistry of Combustible Minerals NASU, State Museum of Natural History, L'viv)., who examined conodonts from the Silurian, Devonian and part of the Ordovician in Podolia, as well as from Volhyn, the Foredeep Carpathians and L'viv Depression. He created a great number of new Early Paleozoic species and two genera, including *Pseudooentodus* Drygant, 1974 and *Petalognathus* Drygant, 1974. Some of his new species are as follows: *Spathognathodus podolicus* Drygant, 1971, *Ozarkodina modesta* Drygant, 1984, *Polygnathus auriformis* Drygant, 1986, *Zieglerodina podolica* Drygant, 2010, *Caudicriodus ruthmawsoniae* Drygant, 2010, *C. schoenlaubi* Drygant, 2010, *Pandorienellina*? *formosa* Drygant, 2010, *P. parva* Drygant et Szaniawski, 2012, *Polygnathus lennarti* Drygant, 2010, *P. brevi* Drygant, 2010 and *Polylophodonta talenti* Drygant, 2010. He is the author of many papers and two books dedicated to the Silurian and Devonian conodonts of western Ukraine (Drygant, 1971, 1974, 1984a, 1984b, 1991, 2000, 2010; Drygant and Szaniawski, 2012). His research also covered partly the Triassic conodonts of the Foredobrudja (Drygant, 1984c). He constructed the Lochkovian regional conodont zonal scheme of Podolia and correlated the regional zones to the Western European ones. He refined the Silurian and Devonian Stratigraphical Scale of western Ukraine and also made correlation to the Lublin Basin and other areas. He took part in international projects and still guides field excursions in Podolia to the Silurian and Silurian-Devonian boundary beds. Dr Danylo Drygant is an honorary member of the Polish Geological Society.

CARBONIFEROUS CONODONT STUDIES IN UKRAINE

The main area of Carboniferous deposits in Ukraine is the Don-Dnieper Downwarp located at the southern margin of the East European Platform. The downwarp consists of the Dnieper-Donets Depression and the Donets Basin (Donets folded belt). The Donets Basin is the only area in Eastern Europe where the whole Carboniferous is well exposed. In the early 1970s Carboniferous conodonts began to be studied in the world's most complete Carboniferous succession–the Donets Basin–and later in the Dnieper-Donets Depression. The first conodonts discovered in the Donets Basin were Late Devonian and Early Carboniferous ones. Their occurrence and characteristics were described by Dr Oleg Ye.

Fig. 1. The Ukrainian paleontologists studied the Paleozoic conodonts of Ukraine

Kotlyar (Institute of Geological Sciences NASU, Kyiv) in 1971. After that he served in the Army and later changed his research interests to Devonian foraminifers and brachiopods.

Systematic conodont studies of the complete Carboniferous succession of the Don-Dnieper Downwarp were initiated by Prof. Dr David Ye. Aisenverg. He proposed several conodont projects, which were carried out by three of his postgraduate students: O.M. Lipnyagov, R.I.Kozitska and T.I. Nemyrovska (Institute of Geological Sciences, NASU, Kyiv). The goal was to prepare the conodont data for presentation at the 1975 International Carboniferous Congress held in Moscow and for the two congress geological excursions to the Carboniferous successions in the Donets Basin. The Tournaisian and Visean (Mississippian) conodonts were studied by Dr Oleg M. Lipnyjagov (Lipnyagov, 1975, 1978, Lipnjyagov, 1979; Kononova and Lipnyagov, 1976; Lipnyagov in Kozitskaya et al., 1978; Lipnyagov in Kozitskaya et al., 1979; Lipnjagov in Tchighova et al., 1979). Dr Raisa Kozitska examined the Kasimovian and Gzhelian (Late Pennsylvanian) conodonts (Kozitskaya in Kozitskaya et al., 1978; Kozitskaya in Kozitskaya et al., 1979; Shchogolev and Kozitskaya, 1984). The Moscovian (Middle Pennsylvanian) conodonts from borehole cores of the southwestern Donets Basin were studied by Ms. Zoya A. Kossenko from “Artemgeology” in the town of Artemovsk (now Bakhmut), Donets Basin

(Kossenko, 1975, 1979; Kossenko in Kozitskaya et al., 1978; Kossenko in Kozitskaya et al., 1979). Serpukhovian and Bashkirian conodonts and later the Moscovian conodonts (Upper Mississippian, Lower and Middle Pennsylvanian) were studied by the present author (Nemirovskaya, 1974, 1982, 1987, 1990, 1999, 2005, 2006, 2008, 2011a, 2011b; Nemirovskaya in Kozitskaya et al., 1978, Nemirovskaya in Kozitskaya et al., 1979; Nemirovskaya et al., 1991, Nemirovskaya et al., 1994, Nemirovskaya and Nigmadganov, 1992, 1994; Nemyrovska in Fohrer et al., 2007, Nemyrovska and Ueno, 2008) The abovementioned specialists later studied the Carboniferous conodonts of the Dnieper-Donets Depression (Kozitskaya, 1983; Lipnyagov, 1985; Nemirovskaya, 1983, 1985). The present author also studied the Late Mississippian and Early Pennsylvanian conodonts of the L'viv-Volhyn Basin (Nemyrovska, 2012).

As a result of these studies almost all Carboniferous conodonts of the Donets Basin were monographically described, illustrated and published (Kozitskaya et al., 1978, Lipnyagov, 1985; Nemirovskaya, 1990; Nemyrovska, 1999, Nemyrovska, 2011a; Nemyrovska in Fohrer et al., 2007). Several new species were established by Dr. O.M. Lipnyagov from the Tournaisian of the Donets Basin, including *Patrognathus donbassicus* Lipnjagov, 1978, *Polygnathus communis stylensis* Lip[njagov, 1978, and *Polylophodenta businovensis* Lipnjagov, 1978 (Lipnyagov in Kozitskaya et al. (1978); *Siphonodella semikhatovae* Kononova and Lipnjagov, 1976 (Kononova and Lipnjagov, 1976). He discovered; a new genus *Antognathus* with one species, *Antognathus volnovachensis* Lipnjagov, 1978 (Lipnyagov in Kozitskaya et al. 1978); and some morphs in open nomenclature from the Visean rocks of the Donets Basin. A preliminary conodont zonation for the Tournaisian and Visean stages of the Donets Basin was worked out by O.M. Lipnjyagov (Poletaev et al., 1990) Ref?). A number of new species were established by Dr T.I. Nemyrovska from the Bashkirian and Moscovian of the Donets Basin: *Declinognathodus donetzianus* Nemirovskaya, 1990, *Idiognathoides tuberculatus* Nemirovskaya, 1978, *Id. lanei* Nemirovskaya, 1978, *Id. postsulcatus* Nemyrovska, Decl. *pseudolateralis* Nemyrovska, 1999, *Idiognathodus praedelicatus* Nemirovskaya, 1978, *I. praeobliquus* Nemyrovska, 1999, *I. izvaricus* Nemyrovska, 2007, *Swadelina gurkovaensis* Nemyrovska, 2011 and a number of species in open nomenclature belonging to *Idiognathodus* and "*Streptognathodus*" (.Nemirovskaya in Kozitskaya et al., 1978; Nemirovskaya, 1990; Nemirovskaya et al., 1994; Nemyrovska, 1999, 2011a; Meischner and Nemyrovska, 1999; Nemyrovska et al., 1999) Some of them served as zonal index-species and three of them – *Lochriea ziegleri* Nemirovskaya, Perret and Meischer, 1994, *Decl. donetzianus* Nemirovskaya, 1990, and *Id. postsulcatus* Nemyrovska, 1999 – were proposed to the Carboniferous Subcommission of the IUGS for defining the Visean-Serpukhovian and Bashkirian-Moscovian boundary GSSPs (Nemirovskaya et al., 1994; Nemirovskaya, 1990; Skompski et al., 1995; Nemyrovska, 1999; Groves and Task Group, 2004; Nemyrovska et al, 2011; Qi et al., 2014.).

The Serpukhovian and Bashkirian conodont studies resulted in the first discovery of a major extinction event at the Mississippian-Pennsylvanian subsystem boundary in the Donets Basin followed by a conodont radiation (Nemirovskaya, 1982). The reorganizanition of biota was observed at this level in other groups of fauna as well. . The Kal'miuss section in the Donets Basin was proposed as one of the first GSSP candidates for this boundary (Nemirovskaya et al., 1990, Nemirovskaya and Nigmadganov, 1994). Later a 10-cm ferruginous zone was discovered at the boundary (Skipp et al., 1989), and the section was rejected for the stratotype. But due to the abundance and great diversity of different fossils the Kal'miuss beds remain a key section for the Mid-Carboniferous boundary. The stratotype of the Mid-Carboniferous boundary was established later at Arrow Canyon, Nevada, U.S.A. The study in detail the conodonts of the Mid-Carboniferous boundary interval in deep water sections of the South Tianshan, Central Asia, and correlation to the European sections was the basis to propose another hypothetical model of evolution of conodonts around the Mississppian-Pennsylvanian boundary (Nemirovskaya and Nigmadganov, 1994).

The investigation of the Serpukhovian and Bashkirian conodonts in detail permitted construction of the conodont zonation for this part of the Donets Basin Carboniferous. It allowed reliable correlation with other Carboniferous successions and conodont zones of Europe, Asia and North America (Nemyrovska, 1999).

The Middle and Late Pennsylvanian conodonts were less studied than the Mississippian and Early Pennsylvanian ones. That was a time of a vast regression in the Northern Hemisphere. After the Aegiranum Flooding Event (at the beginning of the Moscovian or the Bolsovian), which distributed a number of cosmopolitan species, marine basins of Western Europe were closed and the evolution of conodont faunas took place independently, probably in parallel, in various isolated basins. That promoted the appearance of endemic species and the development of provincialism in conodont associations (Barrick, Alekseev and Nemyrovska, 1999). Kossenko's borehole studies in the southwestern part of the Donets Basin (Kosssenko, 1975, 1979; Kossenko in Kozitskaya et al., 1978) uncovered several stratigraphically important new species in the Moscovian: "*Streptognathodus" transitivus* Kosseno, 1978, *Mesogondolella donbassica* (Kossenko, 1975), *M. laevis* (Kossenko, 1975), *Swadelina dissecta* (Kossenko, 1975) and *Sw. concinna* (Kossenko, 1975). These species were found later in exposed Moscovian successions in other places of the Donets Basin and in the Moscow Syneclise (Nemirovskaya, in Kozitska et al., 1978, Nemyrovska, 1999, 2011a; Nemyrovska et al., 1999). During the last two decades the present author continued to study the Middle and Late Pennsylvanian conodonts from the most complete sections of the Donets Basin, which allowed minor a taxonomic revision of previously established species established before and creation of some new species (*Sw. gurkovaensis* and others). A Moscovian conodont zonation for the Donets Basin has been proposed recently (Nemyrovska, 2011b). Three of Kossenko's species and three created by the present author were selected as zonal indices for the Moscovian Stage of the Donbas (Nemyrovska, 2011b).

Dr R.I. Kozitska describedKozitska described a number of stratigraphically important new species from the Kasimovian and Gzhelian (Kozitskaya in Kozitskaya et al., 1978). They include *Idiognathodus sagittalis* Kozitskaya, 1978, *I. lobulatus* Kozitskaya, *I. bachmuticus* Kozitskaya, 1078, *I. toretzianus* Kozitskaya, 1978, *Streptognathodus firmus* Kozitskaya, 1978, *Str. kalitvensis* Kozitskaya, 1978, and *Str. luganicus* Kozitskaya, 1978.

There are also several important new species established by Kozitska and Kossenko in Kozitskaya et al. (1978) from the upper Moscovian deposits. These are: *Neognathodus inaequalis* Kozitskaya and Kossenko, 1978, *Idiognathodus obliquus* Kossenko and Kozitskaya, 1978, and *I. robustus* Kossenko and Kozitskaya, 1978. Some of these species are used as the zonal markers.

Kozitska made the first attempt to zonate the Kasimovian and Gzhelian deposits bydeposits by conodonts (Shchogolev and Kozitskaya, 1984).

The holotypes of the new species described in Kozitskaya et al. (1978) were re-illustrated by the present author with an SEM in the Netherlands. They were provided with diagnoses and published in the U.S.A (Nemyrovska and Kozitska, 1999).

In the 1970s the Carboniferous conodonts of the South Urals were studied by the Ukrainian worker Dr. Rostislav S. Furduj (Kyiv State University, Kyiv) (Furduj , 1979) and later by the present author (Nemirovskaya and Alekseev, 1994; Groves et al., 1999).

Since the beginning of the 1990s, Carboniferous conodonts of the Donets Basin were studied only by the present author. A number of international multidisciplinary projects were organized since the mid-1990s [when?] mainly to investigate the Upper Mississippian and Pennsylvanian in the Donets Basin. Those projects included annual field trips, which successfully continued up to the end of 2013. Mostly old and new Pennsylvanian sections were studied in detail (Fohrer et al., 2007, Nemyrovska et al., 2010, Nemyrovska, 2011a, 2011b), and new paleontological, sedimentological and paleoclimatological data were obtained (Heckel et al., 1998; Fohrer et al., 2007, Eros et al., 2011) that enabled refinement of the conodont zonation of the Serpukhovian and Bashkirian stages, which was constructed in 1970–1980s by the present author (Nemyrovska, 1999). That zonation was the regional conodont scale for the Don-Dnieper Downwarp and later it was partly used in the global Carboniferous conodont scale. Most of the conodont zones created in the Donets Basin and Central Asia were recognized in the Upper Visean, Serpukhovian and Bashkirian successions in Spain, France, Germany and China (Nemyrovska, 2005; Meischner and Nemyrovska, 1999; Nemyrovska et al., 2011; Hu et al, 2016a,b; Qi et al., 2016). The study of the European and Asian Carboniferous conodonts and sections permitted development of a reliable Carboniferous correlation scheme for Eurasia (Nemyrovska, 1999). The

present author was awarded the medal of the German Geological Society and the Teichmuellers Prize in 2000. for her work on the correlation of the Carboniferous in Europe and Asia. Since that time Dr T. Nemyrovska has beenis a member of German Geological Society.

The conodont zonation for the Moscovian Stage of the Donets Basin was constructed and later updated (Nemyrovska, 2010, 2011a, 2011b, 2015) but but the latest Moscovian and the Kasimovian and Gzhelian conodont zonations are still in progress. The studies of Carboniferous conodonts of Ukraine continue due to a great amount of material, which was collected from the Donets Basin during annual multidisciplinary field trips supported by international projects.

CONCLUSION

The study of Paleozoic conodonts in Ukraine was successful and effective. A large number of conodonts have been monographically described and a number of new species created. The Carboniferous conodont zonation was partly constructed for the greater part of the succession, and correlation to other Carboniferous basins was done. The Mid-Carboniferous extinction event was determined for the first time in Eastern Europe in the Donets Basin. The Kal'miuss section was proposed as a candidate for the stratotype of the Mid-Carboniferous boundary, boundary between the Mississippian and Pennsylvanian subsystems (Nemirovskaya et al., 1991; Nemirovskaya and Nigmadganov, 1994).

The conodont research covered the greater part of the most complete Ukrainian Paleozoic sections, which include the Lower Paleozoic strata of western Ukraine and the Carboniferous succession of eastern Ukraine. These studies confirmed the enormous importance of conodonts for Paleozoic stratigraphy, paleogeography and paleoclimatology. They provided the paleontological description of the Paleozoic conodont genera and species and helped to understand their evolution and to identify the events leading to their extinctions during the Paleozoic and the patterns of their recoveries after those extinctions. The Carboniferous regional conodont zonation was constructed for the first time for the Donets Basin (Nemyrovska, 1999, 2007, 2011b). A number of these zones were used in the global Carboniferous Conodont Scale. Several conodont species established in the Donets Basin were proposed as index-species for the definition of GSSPs at the base of the Moscovian and Kasimovian... The Carboniferous conodonts studies results of the Carboniferous conodont studiesdone by the Ukrainian conodont workers – Dr O.M. Lipnyagov, Dr O.Ye. Kotlyar, Miss Z.A. Kossenko, Dr R.I. Kozitska and Dr habil. T.I.Nemyrovska refined and modernized contributed to the refinement and modernization of the Carboniferous Stratigraphic Scale of Ukraine. The investigations of all of the Ukrainian conodontologists (including Dr D.M. Drygant and Dr R.S. Furduj) contributed a lot to the geology of Ukraine and in general to history of life.

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Изучение палеозойских конодонтов в Украине

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В Украине изучение палеозойских конодонтов началось в начале 1960-х. Первым исследователем конодонтов из разрезов ордовика, силура и девона Подолии и Волыни (Западная Украина) был Д.М. Дрыгант (Государственный Природоведческий Музей НАН Украины, г. Львов). Каменноугольные конодонты Донецкого бассейна, Днепровско-Донецкой впадины и Львовско-Волынского бассейна Украины начали изучать в начале 1970-х четыре аспиранта проф. Д.Е. Айзенверга: Олег Е. Котляр, Олег М. Липнягов, Раиса И. Козицкая и Тамара И. Немировская (Институт геологических наук НАН Украины, г. Киев). Конодонты московского яруса карбона Донбасса из керна скважин, пробуренных в юго-западной части Донбасса, изучала Зоя А. Косенко (“Артемгеология”, г. Артемовск, сейчас – г. Бахмут).
В результате проведенных исследований были детально изучены и монографически описаны силурийские и девонские конодонты Волыно-Подолии и каменноугольные конодонты Донбасса и Днепровско-Донецкой впадины, был установлен ряд новых таксонов. Составлены первые зональные схемы по конодонтам карбона Донбасса. Изучались конодонты карбона различных регионов Европы и Азии, что позволило провести надежную корреляцию карбона Донбасса с каменноугольными бассейнами других регионов мира. Результаты исследований опубликованы в многочисленных статьях и монографиях по конодонтам. Несколько видов конодонтов, установленных в карбоне Донбасса, предложены в качестве видов-индексов для установления GSSPs на границах башкирского и московского и московского и касимовского ярусов Глобальной Шкалы Карбона. Впервые для Восточной Европы було установлено значительное событие вымирания раннекаменноугольных конодонтов на рубеже миссисипской и пенсильванской подсистем в Кальмиусском разрезе Донбасса. Этот разрез предлагался в качестве одного из первых кандидатов на стратотип срединной границы карбона.
Ключевые слова: конодонты, карбон, силур, стратиграфия, зональная схема, корреляция.