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NEW SPECIES OF COILED NAUTILOIDS FROM THE PENNSYLVANIAN OF THE DONETS BASIN, UKRAINE

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Two new species of coiled nautiloids, *Gzheloceras poletaevi* sp. nov. and *Celox oliphanti* sp. nov., are described from the Late Bashkirian and Early Moscovian of the Central Donets Basin, Ukraine. *Gzheloceras poletaevi* sp. nov. differs from *Gzheloceras aisenvergi* in absence of a longitudinal ridge on the ventolateral shoulder and more compressed whorl profile; *Gzheloceras poletaevi* differs from *Gzheloceras striatum* in absence of a spiral lateral ribs and less compressed whorl. *Gzheloceras poletaevi* is distinguished from *Gzheloceras memorandum* by more compressed whorl profile and thinly discoidal conch. *Gzheloceras poletaevi* differs from *Gzheloceras pulcher* in the absence of a thin transverse lateral ribs and longitudinal ridge on the ventolateral shoulder. *Celox oliphanti* sp. nov. differs from *Celox erratica* by delicate growth lines on the conch surface and more rapid whorl's increase in width and height.

Keywords: Ukraine, Donets Basin, Late Bashkirian, Early Moscovian, coiled nautiloids.

Introduction. The Carboniferous non-ammonoid cephalopods of the Donets Basin are poorly studied; Librovitch [16] and Shimansky [23] described several species of Pennsylvanian coiled nautiloids from the Donets Basin. The author [2, 3] described four species of Pennsylvanian coiled nautiloids from the Donets Basin: *Ephippioceras wildi*, *Planetoceras yefimenkoi*, *Knightoceras extorris*, and *Gzheloceras aisenvergi*.

The Carboniferous nautiloids are good tools for detailed studies of palaeogeographic patterns [23]. However, the Carboniferous nautiloids of the Donets Basin have not been sufficiently studied despite their palaeogeographic potential.

Here, a new species of the late Bashkirian coiled nautiloid *Gzheloceras poletaevi* sp. nov. and new species of the early Moscovian coiled nautiloid *Celox oliphanti* sp. nov. from the south part of Luhansk Region (Ukraine) are described. This study significantly expands the paleontological characteristic of the Early and Middle Pennsylvanian sediments of the Donets Basin.

Geological setting. The studied materials were collected at two localities: Shovkova Protoka (Smolyanynivka Formation, Upper Bashkirian) and Lutuhynska-Pivnichna Mine (Kamenskaya Formation, Lower Moscovian) (fig. 1). These localities are briefly described below.

(1) Shovkova Protoka: Ukraine, Luhansk Region, Luhansk District, 1 km to the south of Shovkova Protoka (48.284205, 39.282181); Upper Bashkirian, Smolyanynivka Formation, H_5 limestone layer. Remains of the rugose corals, brachiopods (*Echinoconchus praefasciatus* Aisenverg, *Orthotichia* sp., etc), gastropods, bivalves, nautiloids *Gzheloceras poletaevi* sp. nov. and fishes have been collected from this limestone layer.

(2) Lutuhynska-Pivnichna Mine: Ukraine, Luhansk Region, Luhansk District, the tailings dump of the Lutuhynska-Pivnichna coal mine near Lutuhyne (48.42384, 39.20736): Lower Moscovian, Kamenskaya Formation, roof shale of the k_7^L coal layer. The fossil-bearing rock is a dark grey, carbonaceous, sometimes pyritized siltstone with large carbonate nodules. Numerous fossils such as worm tubes, brachiopods (*Densepustula russiensis* (Semenova), *Derbyia* sp.), bivalves (*Anthraconeilo*, *Phestia*, *Sanguinolites,* etc), gastropods, nautiloids (*Celox oliphanti* sp. nov.), ammonoids (*Wiedeyoceras clarum* Popov, *Winslowoceras* cf. *greelyi* Nassichuk), trilobites (*Paladin* cf. *lutugini* (Weber); identified by Eduard Mychko), fishes (*Symmorim*, *Venustodus*), and bromalites have been collected from this stratigraphic level.

The Smolyanynivka (C_2^3 or H) and the Kamenskaya (C_2^5 or K) formations consists of a succession of sandstones, siltstones, mudstones, coals and limestones. The Smolyanynivka Formation varies in thickness from 250 m to 1400 m. The Kamenskaya Formation varies in thickness from 300 m in the northwestern part of the Donets Basin to 1050 m in the southeastern part of the Donets Basin. The lower limit of the Moscovian in the Donets Basin is at the base of the K_3 limestone layer (lower part of the Kamenskaya Formation) [17].

Material and methods. 10 specimens of the conchs and steinkerns were investigated in this study. This collection (IGSU-4) is stored in the Department of Paleontology and Stratigraphy of the Paleozoic Sediments of Institute of Geological Sciences (National Academy of Sciences of Ukraine, Kyiv). The key for the description of Late Palaeozoic nautiloid species proposed by Dieter Korn [13] is used here. The abbreviations used in the species description are: dm – conch diameter, wh – whorl height, ww – whorl width, ap – apertural height, uw – umbilical width; whorl expansion rate (WER) = $(dm_1/dm_2)^2$ or $[dm_1/(dm_1 – ah)]^2$; imprint zone rate (IZR) = $wh_1 – ah/wh_1$ or $– (wh_1 (dm_1 – dm_2))/wh_1$.

Systematic paleontology.

Order **Nautilida** Agassiz, 1847
Superfamily **Tainoceratoidea** Hyatt, 1883
Family **Tainoceratidae** Hyatt, 1883
Genus ***Gzheloceras*** Ruzhencev et Shimansky, 1954

Type species: *Gzheloceras uralense* Ruzhencev et Shimansky, 1954; original designation.

Diagnosis. Genus of the family Tainoceratidae with weakly depressed, rounded-rectangular or elliptical whorl profile. Ornament with transverse lateral ribs and spiral lateral ribs. Siphuncle small with subcentral position. Suture line with shallow ventral, lateral and dorsal lobes (after [3, 4, 14, 20, 23]).

Included species: *G. aisenvergi* Dernov, 2021, Ukraine; *G. antiquum* Shimansky, 1967, Kazakhstan; *G. biangulare* Ruzhencev et Shimansky, 1954, Kazakhstan; *G. ellipsoidale* Ruzhencev et Shimansky, 1954, Kazakhstan; *G. faticanum* Shimansky, 1967, Russia; *G. memorandum* Shimansky, 1967, Kazakhstan; *G. nikitini* (Tzwetaeva, 1888), Russia; *G. pulcher* (Crick, 1904) (=*Huanghoceras orthocostatum*

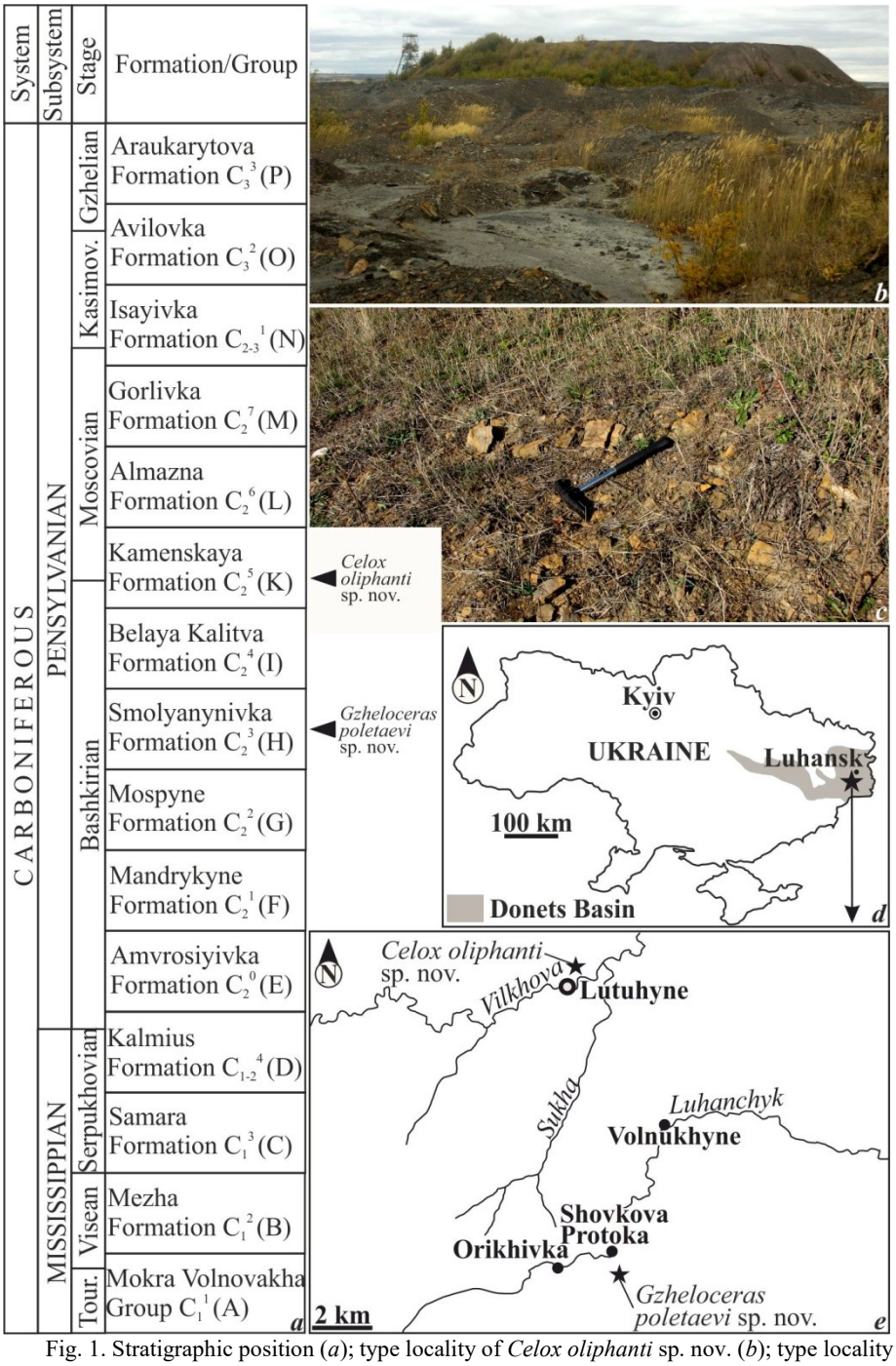

Fig. 1. Stratigraphic position (*a*); type locality of *Celox oliphanti* sp. nov. (*b*); type locality of *Gzheloceras poletaevi* sp. nov. (*c*); geographic situation of the studied localities (*d, e*). Abbreviations: Tour. – Tournaisian; Kasimov. – Kasimovian.

Order **Nautilida** Agassiz, 1847
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Remarks. I refer to the genus *Pseudogzheloceras* Dernov, 2021 part of the species assigned by Shimansky [23] to the genus *Gzheloceras* (e.g., "*G.*" *falcatum* (Sowerby in Prestwich, 1840), "*G.*" *donetzense* (Kruglov in Librovitch, 1939), "*G.*" *tacitum* Shimansky, 1957, etc.) [4]. *Pseudogzheloceras* differs from *Gzheloceras* by square or rectangular whorl profile and massive transverse ribs on flanks.

Stratigraphic range. Viséan to Cisuralian.

Gzheloceras poletaevi sp. nov.

Fig. 2

Etymology. The species is named in honor of the paleontologist Vladyslav Poletaev.

Holotype. Specimen IGSU-4/402 in the Department of Paleontology and Stratigraphy of the Paleozoic Sediments of Institute of Geological Sciences, NAS of Ukraine, Kyiv; illustrated in fig. 2.

Type locality and stratigraphic horizon: Ukraine, Luhansk Region, Luhansk District, 1 km to the south of Shovkova Protoka; H_5 limestone layer, Smolyanynivka Formation, late Bashkirian.

Other material: two fragments of the steinkerns (specimens IGSU-4/538, IGSU-4/812).

Diagnosis. Species of *Gzheloceras* with thinly discoidal (ww/dm ~ 0.35 at ~ 23 mm diameter), subevolute conch (uw/dm ~ 0.39 at ~ 23 mm diameter) with a weakly depressed, almost circular whorl profile (ww/wh = 1.14) and broad, slightly convex venter and moderately broad, slightly convex, almost parallel flanks. The conch ornament consists of straight massive lateral transverse ribs. Suture line has a wide, shallow lateral lobe and narrow, shallow ventral lobe.

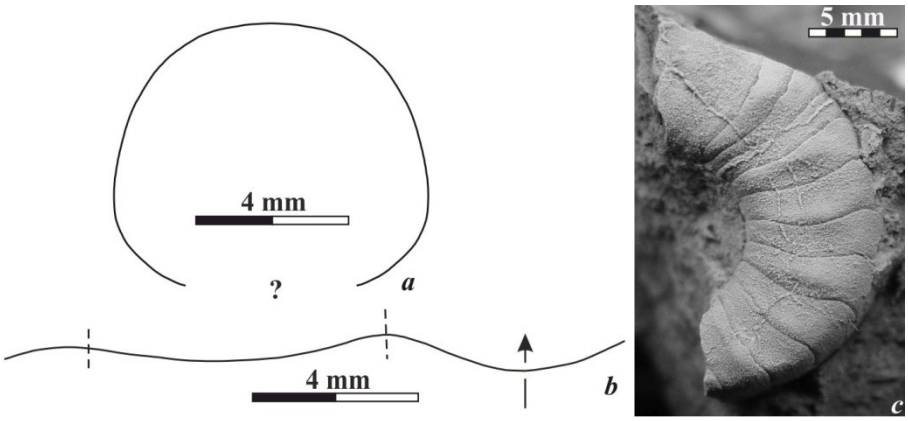

Fig. 2. *Gzheloceras poletaevi* sp. nov.: *a* – whorl profile at ~ 23.0 mm diameter (holotype IGSU-4/402); *b* – suture line at ~ 23.0 mm diameter (holotype IGSU-4/402); *c* – lateral view of the holotype

Description. Holotype IGSU-4/402 is an incomplete specimen ~ 23 mm in diameter (Fig. 2c). It is a thinly discoidal (ww/dm ~ 0.35, uw/dm ~ 0.39), subevolute conch with a weakly depressed whorl profile (ww/wh = 1.14). The whorl profile is circular with a narrowly rounded umbilical margin, narrow, flattened umbilical wall, flattened and weakly converging flanks, a broadly rounded ventrolateral shoulder and broad, slightly convex venter. Ornament with short, slightly slanted lateral transverse ribs, which are expanding slightly on the ventrolateral shoulders (on the midflank these ribs are spaced about 2.5 to 3.5 mm apart). The suture line has a wide, shallow lateral lobe and narrow, shallow ventral lobe.

Table 1.

Conch dimensions (in mm) and ratios of *Gzheloceras poletaevi* sp. nov.

Specimens	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	IZR	WER
IGSU-4/402	~23.0	8.0	7.0	9.0	–	~0.35	1.14	~0.39	–	–

Remarks. *Gzheloceras poletaevi* sp. nov. differs from *G. aisenvergi* in absence of a longitudinal ridge on the ventolateral shoulder and more compressed whorl profile; *G. poletaevi* differs from *G. striatum* in absence of a spiral lateral ribs and less compressed whorl profile (ww/wh = 1.14 at ~ 23.0 mm diameter in *G. poletaevi* and ww/wh = 1.43 at 19 mm diameter in *G. striatum*). *G. poletaevi* is distinguished from *G. memorandum* by more compressed whorl profile (ww/wh = 1.14 at ~ 23 mm diameter in *G. poletaevi* and ww/wh = 1.38 at 21 mm diameter in *G. memorandum*) and thinly discoidal conch (ww/dm ~0.35 at ~ 23.0 mm diameter in *G. poletaevi* and ww/dm = 0.52 at 21 mm diameter in *G. memorandum*). *G. poletaevi* sp. nov. also differs from *G. pulcher* in the absence of a thin transverse lateral ribs and longitudinal ridge on the ventolateral shoulder.

Stratigraphic and geographic distribution. Late Bashkirian, Smolyanynivka Formation; Donets Basin, Ukraine.

*Genus **Celox** Shimansky, 1967*

Type species: *Celox erratica* Shimansky, 1967; original designation.

Diagnosis. Genus of the family Tainoceratidae with moderately depressed, ellipsoidal and subtrapezoidal whorl profile and 3-5 mm diameter umbilical perforation. Ornament with transverse lateral ribs. Siphuncle small with subcentral and central position. Suture line has external lobe, low, broad lateral lobe and deep dorsal lobe (after [23]).

Included species: *C. erratica* Shimansky, 1967, Kazakhstan; ?*C. arctica* Shimansky, 1967, Wrangel Island (Russia).

Remarks. Dzik [7] considered the genus *Celox* Shimansky, 1967 as a junior synonym of *Gzheloceras* Ruzhencev and Shimansky, 1954. It should be noted that the Kazakhstanian representative of the genus *Celox* (*C. erratica* Shimansky, 1967) differs from representatives of the genus *Gzheloceras* only in the shape of the whorl profile, so Dzik [7] may be right. So far, the question of status of the genus *Celox* is unclear.

Stratigraphic range: Viséan to Late Carboniferous or Cisuralian.

Celox oliphanti sp. nov.
Fig. 3

Etymology. After Oliphant, the hunting horn of the knight Roland from the epic poem "The Song of Roland".

Holotype. Specimen IGSU-4/8070 in the Department of Paleontology and Stratigraphy of the Paleozoic Sediments of Institute of Geological Sciences, NAS of Ukraine, Kyiv; illustrated in figs 3a and 3b.

Type locality and stratigraphic horizon: Ukraine, Luhansk Region, Luhansk District, coal mine "Lutuhynska-Pivnichna" nearby Lutuhyne; roof shale of the k_7^L coal layer, Kamenskaya Formation, early Moscovian.

Other material: ten fragments of the conchs (IGSU-4/3200, IGSU-4/9001, IGSU-4/9002, IGSU-4/9002a, IGSU-4/9003, IGSU-4/9004, IGSU-4/9005, IGSU-4/9006, IGSU-4/9008, IGSU-4/9010).

Diagnosis. Species of *Celox* with moderately depressed, subtrapezoidal whorl profile (ww/wh = from 1.47 at 19.1 mm diameter to 1.68 at 10.0 mm diameter); venter and flanks are fused together, umbilicus is moderate (uw/dm = 0.36-0.47), umbilical margin is slightly angular or rounded, umbilical wall flattened. The conch ornament consists of delicate growth lines and two rows of small nodes on the ventrolateral shoulder and umbilical margin; the nodes on the ventrolateral shoulder elongate during ontogenesis and turn into short transverse ribs. Siphuncle small and subcentral in position.

Description. Holotype IGSU-4/8070 is an incomplete specimen 19.1 mm in diameter (Figs 3a, 3b). It is a pachyconic, almost globular (ww/dm = 0.79) with moderate umbilicus (uw/dm = 0.43), weakly depressed whorl profile (ww/wh = 1.47) and a extremely high coiling rate (WER = 3.57). The whorl profile is subtrapezoidal with a narrowly rounded umbilical margin, narrow, flattened umbilical wall and fused together venter and flanks. Aperture has a deep wide ventral sinus and projection on the flank. Ornament with two rows of small nodes on the ventrolateral shoulder and umbilical margin and delicate growth lines, which form a narrow, deep external sinus; they are straight on the flank and on the umbilical wall. The nodes on the ventrolateral shoulder elongate during ontogenesis and turn into short transverse ribs. Siphuncle small with subcentral position (between whorl center and venter: Fig. 3f).

Table 2.

Conch dimensions (in mm) and ratios of *Celox oliphanti* sp. nov.

Specimens	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	IZR	WER
IGSU-4/9008	9.5	7.6	4.8	-	-	0.80	1.58	-	-	-
IGSU-4/9001	10.0	6.9	4.1	4.1	-	0.69	1.68	0.41	-	-
IGSU-4/9010	10.8	7.2	4.3	5.1	-	0.66	1.67	0.47	-	-
IGSU-4/3200	19.0	14.8	10.0	6.9	8.2	0.78	1.48	0.36	0.18	3.46
IGSU-4/8070	19.1	15.0	10.2	8.4	9.0	0.79	1.47	0.43	0.12	3.57

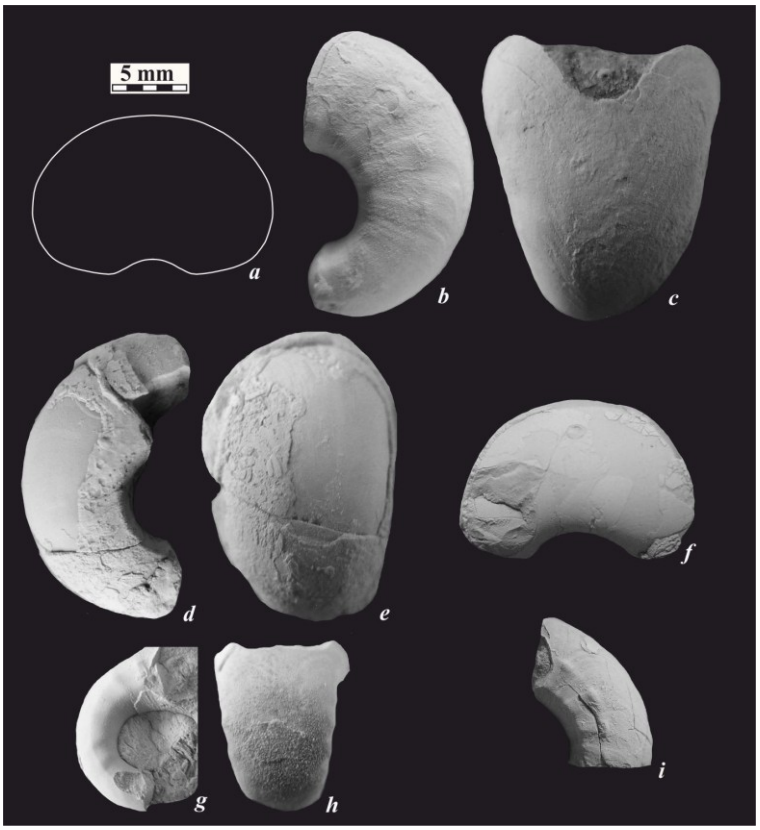

Fig. 3. *Celox oliphanti* sp. nov.: *a–c* – holotype IGSU-4/8070 (*a* – sketch of the whorl profile at 19.1 mm diameter, *b* – lateral view, *c* – ventral view); *d*, *e* – paratype IGSU-4/3200 (*d* – lateral view of the steinkern of the body chamber, *e* – ventral view of the steinkern of the body chamber); *f* – paratype IGSU-4/9002a, whorl profile at ~ 9 mm whorl height; *g*, *h* – paratype IGSU-4/9010 (*g* – lateral view, *h* – ventral view); *i* – paratype IGSU-4/9006, lateral view

Remarks. *Celox oliphanti* sp. nov. differs from *C. erratica* in delicate growth lines on the conch surface and more rapid whorl's increase in width and height. *Celox oliphanti* is distinguished from ?*C. arctica* by absent of the longitudinal ridges on the flanks and more depressed whorl profile. The ornament of the conch of *Celox oliphanti* sp. nov. is very close to the conch surface ornament the species *Valhallites tuberculatus* Niko and Mapes, 2016 (for example, see Fig. 3i in this article and Fig. 5.2 in the work [18]). Shimansky [23] noted the proximity of the species ?*C. arctica* Shimansky, 1967 to the genus *Valhallites* Shimansky, 1959. *Celox oliphanti* sp. nov. differs from genus *Valhallites* in subcentral (between whorl center and venter) position of siphuncle and less depressed whorl profile.

Stratigraphic and geographic distribution. Early Moscovian, Kamenskaya Formation; Donets Basin, Ukraine.

Results. Apparently, the center of origin of the genus *Gzheloceras* Ruzhencev et Shimansky, 1954 is the paleobasin of modern Kazakhstan, where the oldest representatives of this genus are known from the Viséan [5, 23]. The presence of *Gzheloceras aisenvergi* in the Early Serpukhovian of the Donets Basin indicate a direct connection between the water areas of modern eastern Ukraine and Kazakhstan in the Viséan and Serpukhovian (Fig. 4). The connection between the water areas of Kazakhstan and Donets Basin in the late Viséan and Serpukhovian is confirmed by the results of the study of bivalves [12], as well as brachiopods, bryozoans and other groups of marine fauna [8].

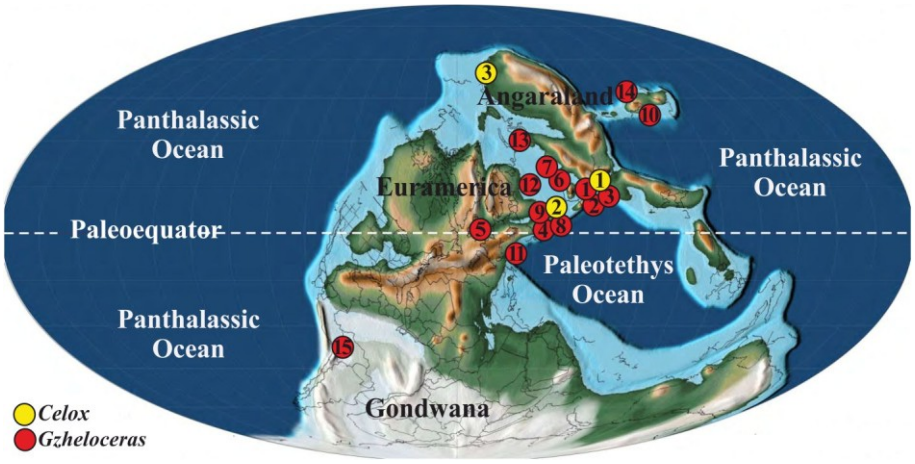

Fig. 4. Geographic distribution of the nautiloid genera *Gzheloceras* and *Celox* in the Carboniferous. Paleogeographic map after [22].
Genus *Gzheloceras*: *1* – *G. antiquum* Shimansky, 1967 (Viséan) [23]; *2* – *G. striatum* Shimansky, 1967 (Viséan) [23]; *3* – *G. memorandum* Shimansky, 1967 (Serpukhovian) [23]; *4* – *G. aisenvergi* Dernov, 2021 (Serpukhovian) [3]; *5* – *G. pulcher* (Crick, 1904) (Serpukhovian and Bashkirian) [1]; *6* – *G. tscheffkini* (Verneuil, 1845) (Bashkirian) [26]; *7* – *G. faticanum* Shimansky, 1967 (Bashkirian) [23]; *8* – *G. pulcher* (Crick, 1904) (Bashkirian) [16]; *9* – *G. poletaevi* sp. nov. (Bashkirian); *10* – *G.* sp. (Bashkirian) [9]; *11* – *G.* sp. (Kasimovian) [15]; *12* – *G. nikitini* (Tzwetaeva, 1888) (Gzhelian) [23, 25]; *13* – *G.* sp. (Late Carboniferous) [24]; *14* – *G.* sp. (Late Carboniferous) [27]; *15* – *G.* sp. (?Late Carboniferous) [11]. Genus *Celox*: *1* – *C. erratica* Shimansky, 1967 (Viséan) [23]; *2* – *Celox oliphanti* sp. nov. (Moscovian); *3* – ?*C. arctica* Shimansky, 1967 (Late Carboniferous or Cisuralian) [23].

In the Serpukhovian, representatives of the genus *Gzheloceras* apparently settled into the Donets Basin (*G. aisenvergi* Dernov), Great Britain (*G. pulcher* (Crick)) and South Urals (*G. tscheffkini* (Verneuil) and *G. faticanum* Shimansky). *Gzheloceras* sp. was identified from the Copacabana Group of Bolivia [11]. Apparently, the age of this group is late Bashkirian to Kungurian (early Pennsylvanian to Cisuralian) [6, 10].

How did genus *Gzheloceras* came to South America is unclear. The genus *Gzheloceras* is not known in the Pennsylvanian and Permian of North America. Along the southeastern and southern coasts of Gondwana, representatives of the genus also could not come into modern South America because of rather cold climate of high paleolatitudes in the late Palaeozoic. It is possible that Bolivian *Gzheloceras* sp. is incorrectly defined.

Conclusion. Two new species of Carboniferous coiled nautiloids, *Gzheloceras poletaevi* sp. nov. and *Celox oliphanti* sp. nov., are described from the Donets Basin. The new data expand the paleontological characteristic of the Pennsylvanian of the Donets Basin and clarify the geographic distribution of the genus *Celox*.

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НОВІ ВИДИ НАУТИЛІД З ПЕНСИЛЬВАНЮ ДОНЕЦЬКОГО БАСЕЙНУ, УКРАЇНА

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З відкладів верхнього башкиру та нижнього московію Центрального Донбасу описано два нові види наутилід – *Gzheloceras poletaevi* sp. nov. та *Celox oliphanti* sp. nov. *Gzheloceras poletaevi* sp. nov. відрізняється від *Gzheloceras aisenvergi* округлою формою поперечного перетину завитку

черепашки та відсутністю валику вздовж вентрального краю; новий представник роду *Gzheloceras* відрізняється від *Gzheloceras striatum* відсутністю латеральних повздовжніх реберець та іншою формою поперечного перетину завитку, а від *Gzheloceras memorandum* – округлою формою поперечного перетину завитку та вузько-дисковидною формою черепашки. Види *Gzheloceras poletaevi* sp. nov. та *Gzheloceras pulcher* розрізняються за наявністю у другого виду тоненьких поперечних латеральних реберець і валика вздовж вентрального краю. *Celox oliphanti* sp. nov. відрізняється від *Celox erratica* присутністю ніжних струмінців росту та більш швидкими темпами зростання черепашки у висоту. *Celox oliphanti* sp. nov. відрізняється від ?*Celox arctica* відсутністю повздовжніх латеральних реберець та іншою формою поперечного перетину завитку.

Ключові слова: Україна, Донецький басейн, пізній башкир, ранній московій, наутиліди.