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Cephalopods from the Middle Carboniferous of the Donets Basin (Luhansk region, Eastern Ukraine)

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Cephalopods from the middle Carboniferous of the Donets Basin (Luhansk region, Eastern Ukraine). — **V. S. Dernov.** — Six forms of cephalopods are described from middle Carboniferous deposits (Mandrykinka and Mospinska Formations) of the Donets Basin. The collection includes three nautiloids: a new species *Millkoninckioceras udovichenkoi* sp. nov., *Peripetoceras* cf. *globatoides* Shimansky, and *Ephippioceras wildi* Hind. The latter was previously known only from Westphalian deposits of Britain. In the body chamber of *Ephippioceras wildi* a fossil was found that can be a part of the jaw apparatus of this species. *Peripetoceras globatoides*, described by V. M. Shimansky from Serpukhovian deposits of the central part of the East European Platform, was unknown for the Donets Basin before. A new species, *Millkoninckioceras udovichenkoi*, differs from other species of the genus by ornamentation consisting of longitudinal ridges on the ventral-lateral bend, and some other morphological details, among which the most significant are the different shape of sutures, high and narrow whorls, and minor shell size. In addition, three ammonoids were described as *Gastrioceras* cf. *listeri* (Sowerby), *Gastrioceras lupinum* A. Popov, and *Branneroceras branneri* (Smith). The first species was mentioned earlier from the Donets Basin. The second one is probably endemic and it was indicated before from younger deposits. The find of *Branneroceras branneri* is the first reliable indication of its presence in the Carboniferous of the Donets Basin.

Key words: cephalopods, Middle Carboniferous, Donets Basin.

Introduction

Cephalopod remains are widely distributed in the Carboniferous deposits of the Donets Basin (Dernov, 2016; Librovič, 1946, 1947; Popov, 1979; Shimansky, 1967). They were studied by many researchers, including A. V. Gurov, N. I. Lebedev, L. S. Librovič, A. V. Popov, D. E. Aisenverg, T. V. Astakhova, V. I. Poletaev, and L. F. Kuzina. Nevertheless, remains of cephalopods from these deposits require further thorough study. The relevance of such studies is justified by the large value of cephalopods for correlating of remote sections, detailed breaking up of deposits, paleobiogeographical zoning of ancient water areas, and reconstruction of habitat conditions and burial of fossil fauna and flora (Bogoslovskaya et al., 1999).

The purpose of this work is to describe the remains of cephalopods important for the paleobiogeographic research and stratigraphy of the middle Carboniferous deposits of the Donets Basin.

Material and methods

The remains of middle Carboniferous cephalopods of the central part of the Donets Basin (Fig. 1) have been collected during 2004–2016. Because of these works, and due to the help of M. I. Udovichenko (Luhansk), who kindly provided a number of valuable samples and introduced some interesting sites, a representative collection of cephalopod remains from middle Carboniferous deposits was created. In this paper, we describe three nautiloids, including a new species, *Millkoninckioceras udovichenkoi* Dernov, sp. nov., and three ammonoids from the Mandrykinka and Mospinska Formations (Blagodathian and Zujevian Horizons) of the Donets Basin (Table 1).

The nautiloids of the genus *Millkoninckioceras* Kummel, 1963 have evolute, discoidal conchs with a subcentral siphuncle, straight suture, and whorls slowly increasing in height and width (Shimansky, 1967). The genus is known from Carboniferous and Permian deposits of the Urals (Shimansky, 1967), the Moscow Syncline (Makhlina et al., 2001), Western Europe (Kummel, 1967), and North America (Miller, Kemp, 1947; Newell, 1936).

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The studied material comes from the outcrops described in detail below.

- A. A quarry from 1.5 km west from Volnukhine village (Lutugine district, Luhansk region). Yellowish-grey siltstones above the F_1 limestone (Mandrykinka Formation), which is exposed at the uppermost ledge of the quarry. A thin layer of yellow carbonate nodules with remains of pelecypods, gastropods, cephalopods (*Millkoninckioceras udovichenkoi* Dernov, sp. nov.), crinoids, and echinoids (Fig. 2, 1) is observed 0.3 m above the base of siltstones.
- B. Exploratory ditches on the left slope of the Shchetov ravine, 1 km north from Zelenodilske village (Anratsit district, Luhansk region). Grey mudstones and siltstones, lying 1 m above the G_1 limestone. In this layer, the nautiloid *Gzheloceras* (?) sp. and ammonoids *Gastrioceras* cf. *listeri* (Sowerby), *Gastrioceras* sp., and *Pseudobisatoceras* sp. were found (Dernov, 2016). In addition, some remains of pelecypods, gastropods, plant detritus, and trace fossils were observed.
- C. The left slope of the Rebrova ravine, 1.5 km north-west from Makedonivka village (Lutugine district, Luhansk region). There is greyish-brown, fine-grained sandstone 40 m below the G_2 limestone. From this layer some remains of bryozoans, brachiopods, pelecypods, gastropods, cephalopods (*Ephippioceras* sp., *Branneroceras branneri* (Smith)), arthropods, and fishes were collected.
- D. The ravines near Makedonivka village (Fig. 2, 3). The exposed dark grey mudstones contain siderite nodules and remains of a diverse marine fauna: corals, pelecypods, gastropods, cephalopods (*Branneroceras branneri* (Smith), *Gastrioceras* cf. *listeri* (Sowerby)), crinoids, arthropods, and fishes. These mudstones lie 25 m below the G_2 limestone. Light-grey siltstones with siderite nodules and remains of pelecypods, gastropods, cephalopods (*Peripetoceras* cf. *globatoides* Shimansky and *Branneroceras branneri* (Smith)) were found here. These siltstones lie one metre below the G_2 limestone.
- E. A small quarry and excavation of the highway T1320, 0.3 km north from Makedonivka village (Fig. 2, 5). The nautiloid *Ephippioceras wildi* Hind was found at the top of the G_2 limestone. The dark grey, almost black, thick-plated limestone contains remains of corals, bryozoans, brachiopods, pelecypods, gastropods, crinoids, fishes, and often stromatolites (Dernov, 2017).

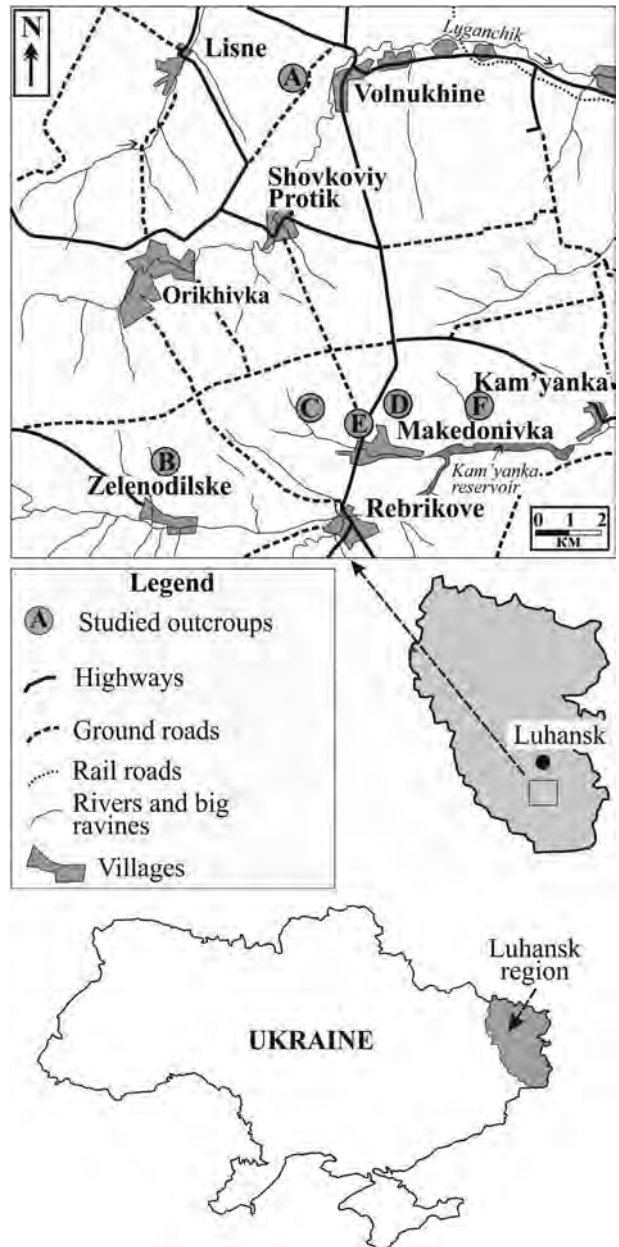


Fig. 1. The research area and the location of studied outcrops.

Рис. 1. Район досліджень та розташування вивчених відслонень.

F. The left slope of the Suha ravine in its middle reaches (3 km east from Make-donivka village). Grey and yellowish-grey siltstone, which lies on the place of G_4^1 limestone. In this layer, the remains of pelecypods, gastropods, cephalopods (*Gastrioceras lupinum* A.Popov) and other fossils (Fig. 2, 2, 4) were found.

The technique and terminology proposed by V. E. Ruzhenzev (Ruzhencev, Bogoslovs-kaya, 1971) were followed during the study and description of ammonoids, while the examination of nautiloids follows Shiman-sky (1967). The studied collection (No. S-4) is stored in the Geological Museum of Taras Shevchenko Luhansk National University and in the National Museum of Natural History at the NAS of Ukraine (Kyiv; No. 2594).

Abbreviations used in this work: Dc — conch's diameter, Wh — whorl's height, Ww — whorl's width, Du — umbilical diameter, Wh/Dc, Du/Dc, Ww/Wh — ratios of parameters.

Systematic palaeontology

Class *Cephalopoda*

Subclass *Nautiloidea*

Order *Nautilida*

Suborder *Rutoceratina*

Superfamily *Koninckiocerataceae*

Family *Koninckioceratidae* Hyatt, 1900

Genus *Millkoninckioceras* Kummel, 1963

Millkoninckioceras udovichenkoi Dernov, sp. nov. (Fig. 3, 1; Fig. 5, 2, 3)

Holotype. National Museum of Natural History, NAS of Ukraine (Kyiv), No. 2594 (Geological Department); Donets Basin, a quarry near Volnukhine village, Mandrykinka Formation, above the F_1 limestone (*Bilinguites-Cancelloceras* Genus Zone); Fig. 3, 1.

Etymology. The species is named in honour of the paleontologist Mykola Ivanovych Udovichenko.

Form. The conch is evolute discoid with a small contact furrow. The cross section of the last whorl is longitudinally oval (Fig. 5, 3). The phragmocone's venter is slightly convex, while the body chamber's venter of is flattened. The ventral shoulders are not pronounced. Flanks are broad, very slightly convex, insignificantly diverge to the middle of the height of the whorl, and slightly converge near by the umbilical shoulders. The greatest width of the whorl is observed approximately on the middle of its height. Whorls are moderately increased in height and width. Umbilical shoulder is wide, but quite clear. The umbilical wall is flat, fairly wide, inclined at an angle of approximately 45° to the symmetry plane of the conch. The dorsal side is narrow, slightly concave. Umbilicus is flattened, relatively wide, about one third of the conch's diameter. The body chamber occupies not less than half of the whorl. Gas chambers are short; there are about 17 these chambers in the whorl. Position of the siphuncle is unknown.



Fig. 2. Some studied outcrops: 1 — quarry in Volnukhine village (outcrop A); 2 — siltstones on the place of limestone G_4^1 (outcrop F); 3 — mudstones 25 metres below of the limestone G_2 (outcrop D); 4 — mudstones under the siltstones on place of the limestone G_4^1 (outcrop F); 5 — limestone G_2 (outcrop E). The height of the limestone wall — 2.5 m.

Рис. 2. Деякі вивчені відслонення:

1 — кар'єр в с. Волнухине (відслонення «А»). 2 — алевроліти на місці вапняку G_4^1 (відслонення «F»); 3 — глинисті сланці в 25 метрах нижче вапняку G_2 (відслонення «D»); 4 — глинисті сланці нижче алевролітів на місці вапняку G_4^1 (відслонення «F»); 5 — вапняк G_2 (відслонення «E»). Висота стінки вапняку — 2,5 м.

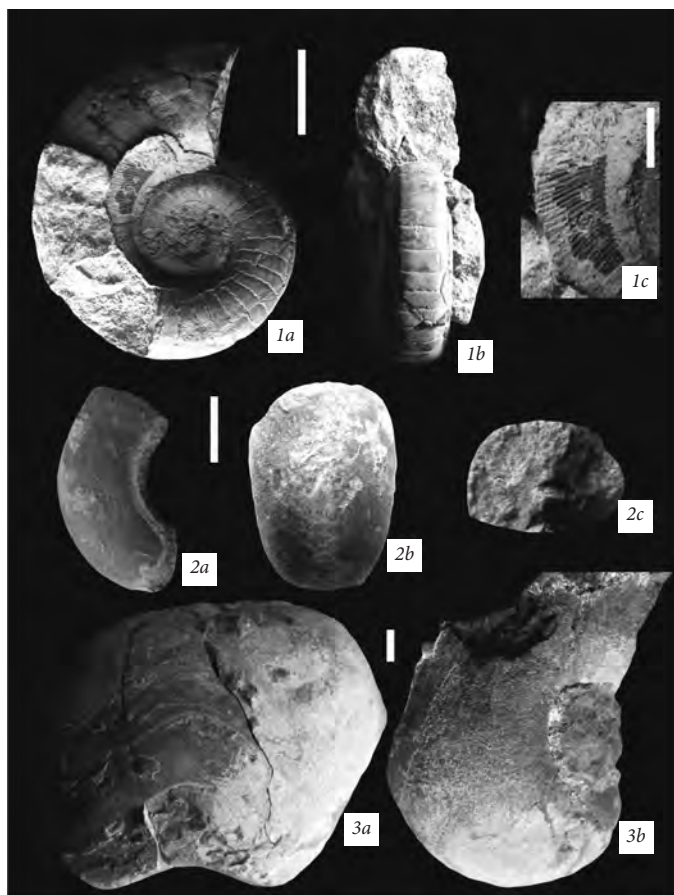


Fig. 3. Studied nautiloids: 1 — *Millkoninckioceras udovichenkoi* Dernov, sp. nov.: 1a — lateral view, 1b — aperture view, 1c — an enlarged portion of the sculpture on the lateral side; sample No. 394–2015, outcrop A; 2 — *Peripetoceras* cf. *globatoides* Shimansky, 1967: 2a — lateral view, 2b — ventral view, 2c — aperture view; sample No. 367, outcrop D; 3 — *Ehippioceras wildi* Hind, 1910: 3a — ventral view, 3b — lateral view, sample No. 1421–2015, outcrop E. Scale bar equals 10 mm in 1a, 1b, 2, 3; 2 mm in 1c.

Рис. 3. Вивчені наутиліди: 1 — *Millkoninckioceras udovichenkoi* Dernov, sp. nov.: 1a — збоку, 1b — зі сторони апертури, 1c — збільшена ділянка скульптури на боковій стороні; зразок № 394–2015, відслонення «А»; 2 — *Peripetoceras* cf. *globatoides* Shimansky, 1967: 2a — збоку, 2b — вентрально, 2c — вигляд зі сторони апертури; зразок № 367, відслонення «Д»; 3 — *Ehippioceras wildi* Hind, 1910: 3a — вентрально, 3b — збоку; зразок № 1421–2015, відслонення «Е». Масштабний відрізок — 10 мм для 1a, 1b, 2, 3; 2 мм для 1c.

Dimensions (in mm) and ratios:

No. sample	Dc	Wh	Ww	Du	Wh/Dc	Ww/Dc	Du/Dc	Ww/Wh
394-2015	37	13	13	13	0.35	0.35	0.35	1.0

Ornamentation. Two well-marked longitudinal narrow ribs are observed on the ventral-lateral bend. They are separated by a groove, which is approximately three times wider than the ribs. These ornamentation elements can be easily visible on both the phragmocone and the body chamber. In addition, there are transverse thin ribs on the sink. In total, five ribs per one millimetre of the whorl's length are recognizable. On the venter, the ribs form a deep sine; they cross the lateral sides directly, and slightly deviate back on the umbilical wall.

Suture. On the venter, there is a poorly visible saddle, on the lateral sides there is a weak visible shallow lobe. On the ventral side, the saddle is small; it seems that the suture is straight (Fig. 5, 2).

Comparison. The characteristic of ornamentation of the longitudinal ribs on the ventral-lateral bend and some other morphological details allow us distinguishing clearly the new species from other representatives of the genus. The new taxon differs from *M. konincki* (Miller and Kemp) whorl's height, the presence of ventral-lateral ribs and bigger size. The species group described by Newell (1936) from the Pennsylvanian of the North America and tentatively attributed by Shimansky (1967) to the genus *Millkoninckioceras* (*M. jewetti*, *M. wyandottense*, *M. eliasi*) significantly differs morphologically from the new species in the greater dissection of the suture line, low and wide whorls, ornamentation, and the considerable size of conchs. From the Permian *M. bibbi* (Miller et Kemp) from Texas (Miller, Kemp, 1947), the new species differs in the shape of the whorl's cross section (in the American species the whorls are rather low and wide, transversely elliptical). In addition, the size of

M. bibbi significantly exceeds that of the *M. udovichenkoi* (for example, the conch's diameter in the first species is almost 7 times greater than in the second one).

Location. Lutugine district, Luhansk region, a quarry 1.5 km to the west from Volnukhine village: concretions 0.3 m above the F₁ limestone, Mandrykinka Formation (sample No. 394-2015). Material was collected by M. I. Udovichenko in 2008.

Stratigraphic and geographical distribution. Upper part of the lower Bashkirian, Donets Basin.

Suborder *Liroceratina*

Superfamily *Lirocerataceae*

Family *Liroceratidae* Miller et Youngquist, 1949

Genus *Peripetoceras* Hyatt, 1894

Peripetoceras cf. *globatoides* Shimansky, 1967 (Fig. 3, 2)

Material. Nine fragments of conchs.

Form. The conch is semi-involute, subspherical, with rapidly increasing whorls. The cross-section of the whorl is sub-trapezoidal. Venter is broad, flat or very slightly convex. The ventral shoulder is roundish. The flanks are convex and slowly diverge from the ventral shoulder to the umbilicus. The umbilical shoulder is almost rectangular, while the umbilical wall is flat. The greatest width of the whorl is near the umbilicus. Dorsal side is concave, about 2.5 times narrower than the whorl's width. The aperture shape is not established. Because of inconsistent preservation, it is not possible to count the number of cameras in the whorl. The siphuncle could not be studied.

Dimensions (in mm) and ratios:

No. sample	Dc	Wh	Ww	Du	Wh/Dc	Ww/Dc	Du/Dc	Ww/Wh
367	≈ 32	14	21		≈ 0.44	≈ 0.66		1.5
414		10	17	8				1.7
415		10	15					1.5
417		11	19	9				1.7
6492		8,5	18					2.1

Ornamentation on the fossils is not observed.

The suture could not be studied.

Remarks. The studied material is very similar to *Peripetoceras globatoides* Shimansky, which is known from the Serpukhovian of the central part of the East European platform (Shimansky, 1967). Nevertheless, we cannot assign the described fossils to the indicated taxon. due to the smaller size of samples in comparison with the holotype, as well as the lack of possibility to compare the shape of the sutures and the position of the siphuncle of our material and type.

Location. Lutugine district, Luhansk region, ravine in northern vicinities of Makedonivka village: siltstones under the G₂ limestone (samples Nos. 367, 414, 415, 416, 418, 419, 420, 6492), Mospin-ska Formation. Material was collected by the author in 2009–2016.

Stratigraphic and geographical distribution. Bashkirian Stage of the Donets Basin.

Family *Ephippioceratidae* Miller et Youngquist, 1949

Genus *Ephippioceras* Hyatt, 1884

Ephippioceras wildi Hind, 1910 (Fig. 3, 3; Fig. 5, 1)

1910 *Ephippioceras wildi* sp. nov.: Hind, p. 104, pl. IV, Fig. 2, pl. V, Fig. 1,2, pl. VI, Fig. 1.

Holotype. Museum of the University of Manchester, No. W.763; UK, Lancashire, Burnley, Hap-ton, Spa Clough, Lower Coal Measures, roof of Bullion Coal.

Material. One fragment of the large conch.

Form. The conch is involute, subspherical, with rapidly increasing whorls. The cross section of the adult whorl is low, kidney-shaped. The ventral shoulder is not pronounced. The venter forms one hemispherical surface together with the lateral. The flanks of the phragmocone are flat, while the flanks of the body chamber are slightly convex. They slowly diverge as they approach the umbilical shoulder. The greatest width of whorl is observed near the umbilicus. The umbilical shoulder rounded, but clear. The umbilical wall is narrow, flat and almost perpendicular relative to the symmetry plane of the shell. Umbilicus is wide and equals about one third of the conch's diameter. The dorsal side of the conch has not been studied. The length of the body chamber is not known, since only its posterior part was preserved. Gas chambers, the available material, are short (about 9–10 chambers for the width of the conch's whorl). The siphuncle is located between the centre and the venter.

Dimensions (in mm) and ratios:

No. sample	Dc	Wh	Ww	Du	Wh/Dc	Ww/Dc	Du/Dc	Ww/Wh
1421-2015	≈ 90	54	95	29	0.6	≈ 1.05	0.32	1.76

There is no ornamentation on the mold.

Suture. The ventral saddle is high, tapers slowly as it comes near the apex. Its height is 2.5 times less than the width of its base. The ventral saddles of adjacent lobes are quite distant from each other. On the flanks, there is a shallow wide lobe (Fig. 5, 1).

Comparison. The described species differs from the closely related species of *Ephippioceras fer-ratum* (Cox, 1857) from the Lower and Middle Carboniferous and *E. clitellarium* (Sowerby, 1840) from the Lower — Upper Carboniferous, in the shape of the suture (in *Ephippioceras wildi* the ventral saddle has a more rounded top and a lesser of height). In addition, the *Ephippioceras wildi* is differs significantly from other species of the genus in the shape of cross section of the whorl and wider umbilicus.

Remarks. Two fragments of the nautiloid mold (sample Nos. 405-2015 and 413-2015) were obtained from the sandstone in 40 m below the G₂ limestone. These specimens resemble *Ephippioceras wildi*. We define the nautiloid from sandstone as *Ephippioceras* sp.

In the body chamber of the described conch, fragments of brachiopod shells and fragments of stems of crinoids, introduced there by the current during its postmortality stay on the surface of the seabed, were found. Moreover, in the last gas chamber there is a small brachiopod shell, which got here because of the violation of the integrity of the last septa. A deformed fossil was also found in the body chamber in the form of a thin plate, presumably oval, on the surface of which frequent thin concentric ribs are observed (Fig. 4). The length of this fragment is 17 mm. The mentioned fossil may be a part of the jaw apparatus of the described nautiloid.

Location. Lutugine district, Luhansk region, a small quarry 0.3 km north from Makedonivka village, G₂ limestone, Mospinska Formation (sample Nos. 1421-2015). Material was collected by the author in 2014.

Stratigraphic and geographical distribution. In addition to the Donets Basin, this species is known from the Westphalian A of Britain.

Subclass *Ammonoidea*

Order *Goniatitida* Hyatt, 1884

Suborder *Goniatitina* Hyatt, 1884

Superfamily *Gastriocerataceae* Hyatt, 1884

Family *Gastrioceratidae* Hyatt, 1884

Genus *Gastrioceras* Hyatt, 1884

Gastrioceras cf. *listeri* (Sowerby, 1812) (Fig. 6, 3)

Material. Two fragments of different conchs and one incomplete mold.

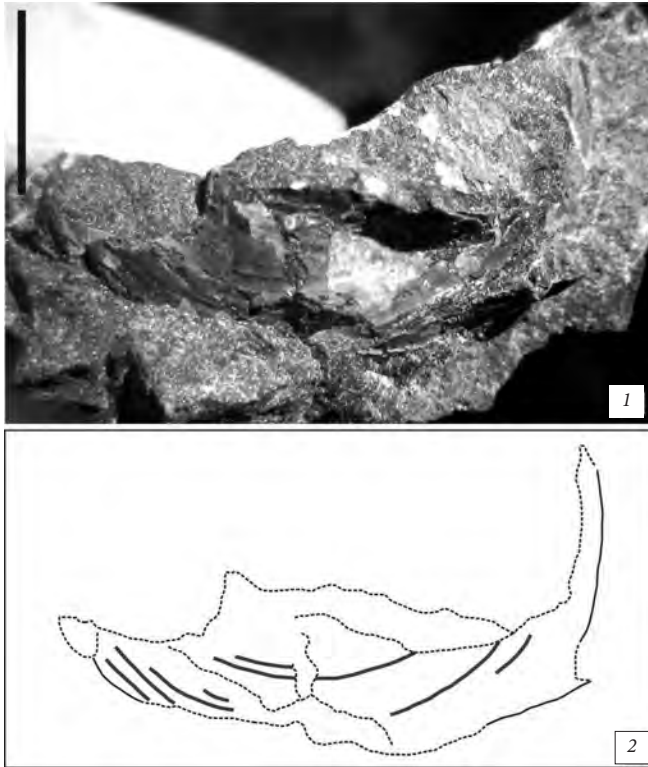


Fig. 4. Fragment of nautiloid jaw apparatus (?) from the body chamber of *Ehippioceras wildi* Hind, 1910; sample No. 1424-2015, outcrop E, scale bar equals 10 mm.

Broken or deformed sides of the fossil are marked by dotted line; extant edges are marked by thin solid lines and concentric sculpture is shown by thick lines.

Рис. 4. Фрагмент щелепного апарату наутиліди (?) із житлової камери *Ehippioceras wildi* Hind, 1910; зразок № 1424-2015, відслонення Е, масштабний відрізок — 10 мм. Пунктиром позначені зламані чи деформовані сторони фосилії; тонкою суцільною лінією — краї фосилії, що збереглися; товстою лінією — концентрична скульптура.

Form. It is difficult to estimate about the shell's shape. The venter is a single convex surface with lateral sides; the ventral shoulder is not expressed. The umbilical shoulder is somewhat angular, while the wall is wide and slightly convex. Cross section of the whorl is low. The greatest width of the whorl is observed near the umbilical shoulder. The umbilicus is deep, wide.

Dimensions (in mm) and ratios:

No. sample	Dc	Wh	Ww	Du	Wh/Dc	Ww/Dc	Du/Dc
655-2015		13.5	25				
827-2015	7.5	2.5		3.5	0.33		0.47

Ornamentation. The conch's surface is covered with gentle striae forming a shallow sine on the venter, and a weak protrusion on the ventral-lateral part of the whorl. The nature of the striae on other parts of the shell is unknown. Sharp tubercles are located on the umbilical shoulder. On 5 mm of the umbilical shoulder account for about two tubercles (whorl height is 13.5 mm). On the conch, there are clearly noticeable constrictions, but it is not possible to count them.

The shape of the suture has not been studied because of poor preservation of the samples.

Remarks. Insufficient preservation of the material did not allow investigating the suture and, accordingly, to attribute the studied material with those of *G. listeri*.

Location. Lutugine district, Luhansk region, 2.5 km north from Zelenodilske village: siltstones over limestone G₁ (No. 827-2015), Dyakivska Series; a ravine 3 km east of Makedonivka village: argillite in 25 m below the G₂ limestone (Nos. 552-2015, 655-2015), Mospinska Formation. Material was collected by the author in 2006–2014.

Stratigraphic and geographical distribution. *Gastrioceras listeri* (Sowerby, 1812) is known from the goniatite zone G₂ of Britain, Portugal, the Netherlands, Belgium, Germany, and Poland. This species was also noted earlier from the Donets Basin (Popov, 1979) in limestones G₁–G₂ and G₄ of the Mospinska Formation and in the roof of coal h₄² layer of the Smolyanynovka Formation.

***Gastrioceras lupinum* A. Popov, 1979 (Fig. 6, 1)**

1979 *Gastrioceras lupinum* sp. nov.: Popov, p. 83–84, plate X, Figs 9–11.

Holotype. Federal State Budgetary Institution "A. P. Karpinsky Russian Geological Research Institute," No. 3223; Donets Basin, Sorochya ravine, Bashkirian Stage, H₅ – I₁ limestones.

Material. Six fragments of moldes and imprints of conchs.

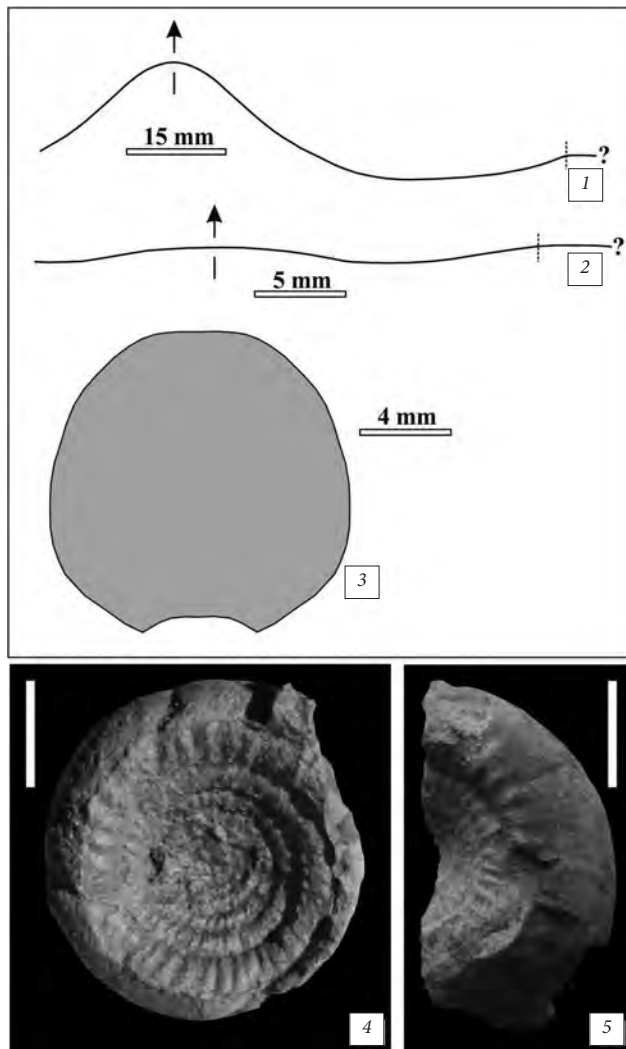


Fig. 5. The shape of the suture and the cross section of the whorl of some studied nautiloids and ammonoids: 1 — suture line of *Ehippioceras wildi* Hind, 1910 (Wh = 54 mm, Ww = 95 mm, sample No. 1424-2015, outcrop E); 2 — suture of *Millkoninckioceras udovichenkoi* Dernov, sp. nov. (Wh = 13 mm, Ww = 13 mm, sample No. 394-2015, outcrop A); 3 — cross section of body chamber of *Millkoninckioceras udovichenkoi* Dernov, sp. nov. (sample and outcrop are the same); 4, 5 — conchs of *Branneroceras branneri* (Smith), 1896 (sample No. 4036 (4), outcrop D, scale bar equals 3 mm; sample No. 502 (5), outcrop D, scale bar equals 5 mm).

Рис. 5. Форма лопатевої лінії та поперечний переріз завитку деяких вивчених наутилоїдей та амоноїдей: 1 — лопатева лінія *Ehippioceras wildi* Hind, 1910 (В = 54 мм, Ш = 95 мм, зразок № 1424-2015, відслонення Е); 2 — лопатева лінія наутилоїди *Millkoninckioceras udovichenkoi* Dernov, sp. nov. (В = 13 мм, Ш = 13 мм, зразок № 394-2015, відслонення А); 3 — поперечний перетин житлової камери наутилоїдеї *Millkoninckioceras udovichenkoi* Dernov, sp. nov. (зразок та відслонення ті самі); 4, 5 — черепашки амоноїдей *Branneroceras branneri* (Smith), 1896 (зразок № 4036 (4), відслонення D, масштабний відрізок 3 мм; зразок № 502 (5), відслонення D, масштабний відрізок 5 мм).

Form. The shape of the conch cannot be established; Popov (1979) pointed out that it is pachyconical, very involute. Flanks are slightly convex; slightly divergent at coming to the umbilicus. The umbilicus has medium size. The umbilical shoulder is sharp and angular.

Dimensions (in mm) and ratios:

No. sample	Dc	Wh	Ww	Du	Wh/Dc	Ww/Dc	Du/Dc
492-2015	≈12.0	6.0		4.0	0.50		0.36
1356-2015	11.0	4.0		3.5	0.36		0.32

The ornamentation is represented by thin ribs forming a small protrusion on the ventro-lateral bend, and wide shallow sinus on the flanks. Between the ribs, there are lines repeating the configuration of the ribs. On the umbilical shoulder, the ribs turn into sharp small tubercles. At 1 mm of the umbilical shoulder (at the whorl's height of 6 mm), there are two or three tubercles. In addition to the transverse ribs, weakly noticeable lyres are observed on the ventral-lateral bend. There are constrictions on the studied fragments of conchs, however it is impossible to calculate exactly their number (Popov (1979) pointed out that there are three of them on the whorl).

Suture is not observed due to insufficient preservation of the material.

Comparison. Due to the characteristic ornamentation, this species differs quite sharply from close taxa.

Location. Suha ravine, Lutugine district, Luhansk region, 3 km east from Makedonivka village: siltstone on the place of the G_4^1 limestone and adjacent slates (sample Nos. 515-2015, 517-2015, 611-2015, 644-2015, 1320-2015, 1356-2015), Mospinska Formation. Material was collected by the author in 2006–2014.

Stratigraphic and geographical distribution. Bashkirian Stage, Donets Basin. Occurs in shales near the G_4^1 limestone. Popov (1979) established this species in the upper part of the Smolyanynovka Formation (limestones $H_5 - I_1$ (?) and H_6). In the shale above the G_3 limestone in Suha ravine, there are remains of ammonoids, very similar to *G. lupinum*. Fragmentation and a small number of materials, as well as minor differences in sculpture, did not allow us to assign these ammonoids to the above-mentioned species.

Superfamily *Schistocerataceae* Schmidt, 1929

Family *Schistoceratidae* Schmidt, 1929

Genus *Branneroceras* Plummer et Scott, 1937

Branneroceras branneri (Smith), 1896 (Fig. 5, 4, 5; Fig. 6, 2, 4, 5)

- 1896 *Gastrioceras branneri* sp. nov.: Smith, p. 257, 258, pl. 23, Figs 1–6.
 1903 *Gastrioceras branneri* Smith: Smith, p. 83, pl. 11, Figs 8–13.
 1923 *Gastrioceras branneri* Smith: Schindewolf, text Fig. 12c.
 1937 *Branneroceras branneri* (Smith): Plummer, Scott, p. 219 – 221, pl. 11, Figs 1–7.
 1938 *Branneroceras branneri* var. *branneri* (Smith): Miller, Moore; pp. 348–350, pl. 44, Figs 5–12.
 1938 *Branneroceras branneri* var. *halense* Miller et Moore: Miller, Moore; pp. 350–351, pl. 44, Figs 13–14.
 1940 *Branneroceras branneri* var. *branneri* (Smith): Bisat, p. 332, Figs 3A, 3B.
 1944 *Gastrioceras branneri* Smith: Miller, Owen, pp. 422–423, pl. 63, Figs 1, 2, pl. 65, Figs 1, 2.
 1948 *Gastrioceras branneri branneri* Smith: Miller, Downs, pl. 103, Figs 10, 11.
 1950 *Branneroceras branneri* (Smith): Руженцев, Fig. 48d.
 1958 *Branneroceras branneri* (Smith): Miller, Furnish, p. 262, pl. 34, Figs 5, 6.
 1960 *Branneroceras branneri* (Smith): Руженцев, Fig. 92b
 1964 *Gastrioceras (Branneroceras) branneri* (Smith): Gordon, p. 253–255, pl. 27, Figs 16–23, 27 – 30, text Fig. 76.
 1968 *Branneroceras branneri* Smith: McCaleb, p. 60 – 65, pl. 8, Fig. 1–16, pl. 9, Fig. 1–19.
 1971 *Branneroceras branneri* (Smith) Plummer et Scott: Wagner-Gentis, p. 348–349, pl. 5, Fig. 16, pl. 6, Fig. 17.
 1975 *Branneroceras branneri* (Smith): Nassichuk, p. 142 – 144, pl. 16, Fig. 1, 3, 4, 7, 9, 10, 15, 16.
 1977 *Branneroceras branneri* (Smith): Saunders, Manger, Gordon, pl. 5, Figs 14–17.
 1980 *Branneroceras branneri* (Smith): Manger, Saunders, text-Fig. 10, D–G.
 1999 *Branneroceras branneri* (Smith): Fujikawa, Ishibashi, Nakornsri, pl. 1, Figs 2–8.

Holotype. United States National Museum, No. 26439; USA, Pilot Mountain, Valley Springs, sandstone of Morrow age (location No. 1275A10).

Material. 15 samples, including molds, conchs and their fragments of different state of preservation.

Form. The conch is subdiskoconic, evolute, with a moderately wide and broad umbilicus. The cross-section of the whorl is low. Venter is slightly convex and wide. The ventral shoulder is roundish. The flanks are convex, moderately divergent at coming to the umbilicus. The greatest value of the whorl's width is observed near the umbilical shoulder. The umbilical shoulder is angular, while the umbilical wall is slightly convex. Umbilicus is moderately broad and wide, deep, stepped. Early whorls had rounded coiling.

Dimensions (in mm) and ratios:

No. sample	Dc	Wh	Ww	Du	Wh/Dc	Ww/Dc	Du/Dc
609	14	5		7	0.35		0.50
656	30	8		14	0.27		0.47
544	30	8	12	14	0.27	0.40	0.47
669	26	8.5	13	13	0.33	0.50	0.50
3776	13	3.5	6	7	0.27	0.46	0.54
710	18	5		10	0.28		0.55
725		7	13.5				
315	25	8	10	12	0.32	0.40	0.48
350	17	5		9	0.29	–	0.53
338	31	10	14	16	0.32	0.45	0.52
335	40	11	15	17	0.28	0.38	0.43

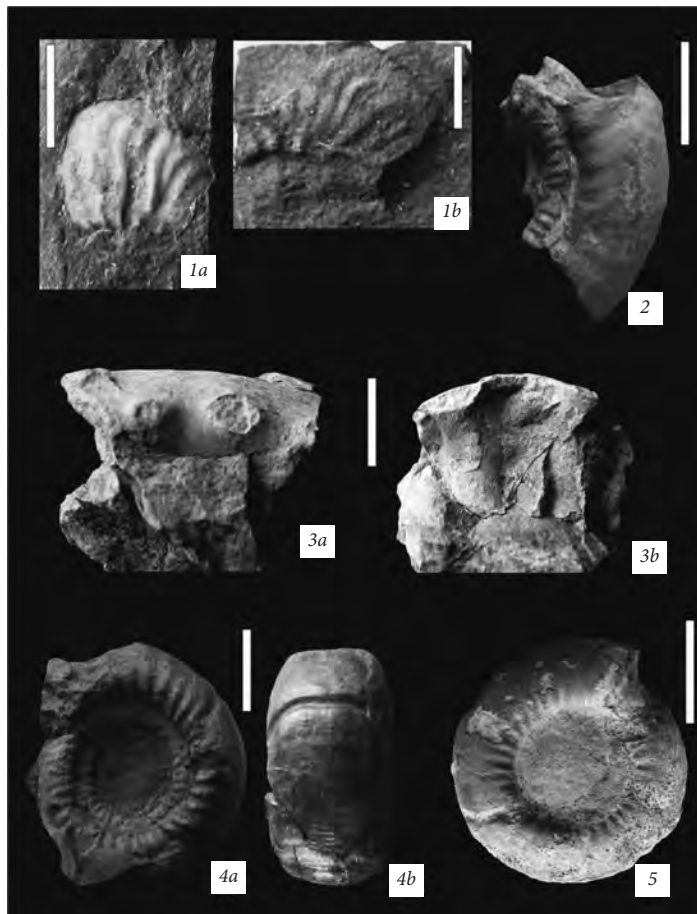
The ornamentation is represented by thin frequent sharp transverse ribs forming a moderate sine on the ventral side, and a weak protrusion on the ventral shoulder. On the flanks, the ribs deviate slightly. There are also single spiral, which when crossing with the transverse ribs, forms a characteristic reticulate ornament. On the umbilical shoulder, the transverse ribs are connecting and form short, massive ribs. At 10 mm of the umbilical shoulder (with a diameter of conch is 26 mm) comes about 6–7 ribs. There are three constrictions per whorl.

Suture. The ventral lobe is wide, splits by a wide siphuncle saddle into two narrow branches; outer saddle rounded, the lateral lobe is wedge-shaped.

Comparison. The described taxon differs from *Branneroceras hillsi* Nassichuk, 1975 by lower whorls, short and massive umbilical ribs, as well as higher and narrower siphuncle saddle of the suture. It differs from *B. nicholasi* Nassichuk, 1975 in form of the whorl and smaller height, as well as more robust umbilical ribs and narrow outer saddle.

Remarks. Librovich (1947) indicated *Branneroceras branneri* (Smith) without a description from the upper part of the Mandrykinka Formation, along with lower Bashkirian ammonoids (e.g., *Bilinigites superbilingue* (Bisat)). The late Bashkirian genus *Branneroceras* was mistakenly defined as genus *Cancelloceras* (early Bashkirian).

Location. Lutugine district, Luhansk region, ravines in the northern vicinities of Makedonivka village: siltstone directly under the G₂ limestone (Nos. 338, 502, 544, 669, 725), Mospinska Formation. In the same place, as well as girders 3 km east and 5 km west from the village: argillite 25 m below limestone G₂ (no. 315, 335, 350, 352, 501, 656, 3776, 4036, 4213), Mospinska Formation. Beams in the northern vicinities of Makedonovka village: sandstone 40 meters below the G₂ limestone (No. 710), Mospinska Formation. Material was collected by the author in 2006–2016.



Stratigraphic and geographical distribution. The upper part of the Bashkirian Stage (*Branneroceras-Gastrioceras* Genus Zone) of Western Europe, China, Japan, Uzbekistan, the Canadian Arctic Archipelago, and the USA.

Fig. 6. Studied ammonoids: 1 — *Gastrioceras lupinum* A. Popov, 1979: 1a, 1b — lateral view, sample No. 611-2015 (1a), No. 611-2015 (1b), outcrop F; 2, 4, 5 — *Branneroceras branneri* (Smith), 1896: 2, 4a, 5 — lateral view, 4b — ventral view, sample No. 725 (2), No. 3776 (4), No. 669 (5), outcrop D; 3 — *Gastrioceras* cf. *listeri* (Sowerby, 1812): 3a — lateral view, 3b — aperture view, sample No. 655-2015, outcrop D. The scale bar equals 5 mm in 1 and 4, and 10 mm in 2, 3, 5.

Рис. 6. Вивчені амоноідеї: 1 — *Gastrioceras lupinum* А. Попов, 1979: 1a, 1b — збоку, зразок № 611-2015 (1a), № 644-2015 (1b), відслонення F; 2, 4, 5 — *Branneroceras branneri* (Smith), 1896: 2, 4a, 5 — збоку, 4b — вентрально, зразок № 725 (2), № 3776 (4), № 669 (5), відслонення D; 3 — *Gastrioceras* cf. *listeri* (Sowerby, 1812): 3a — збоку, 3b — з боку перегородки, зразок № 665-2015, відслонення D. Масштабний відрізок — 5 мм для 1 та 4, 10 мм для 2, 3, 5.

Conclusions

Six species of cephalopods were described from middle Carboniferous deposits of the Donets Basin. The described nautiloids include one newly established species (*Millkoninckioceras udovichenkoi*) and two taxa previously unknown for the Donets Basin (*Peripetoceras* cf. *globatooides*, *Ephippioceras wildi*). Three species of ammonoids were recorded: *Gastrioceras* cf. *listeri*, *Gastrioceras lupinum*, *Branneroceras branneri*. *Gastrioceras lupinum* shows certain details of ornamentation not mentioned in the original description of this taxon. Ornamentation is represented by thin ribs, which form a small protrusion on the ventral-lateral bend, and a wide shallow sinus on the flanks. Between the ribs, there are lines that repeat the configuration of the ribs. On the umbilical shoulder, the ribs turn into sharp small tubercles.

The presence of the genera *Branneroceras* and *Gastrioceras* in the sediments of the Mospinska Formation evidence its belonging to the *Branneroceras-Gastrioceras* Genus Zone. The studied materials confirm the close connection of the Middle Carboniferous water areas of the Donets Basin and the Moscow Syncline, as well as the Donets Basin and Western Europe.

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