

# New records of ammonoids (Cephalopoda) in the Serpukhovian and Bashkirian (Carboniferous) strata of the Donets Basin, Ukraine

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## abstract

The Carboniferous-aged Kalmius and Krynka River sections, located in the southwestern Donets Basin (eastern Ukraine), are of a great significance for the biostratigraphy and correlation of the Mississippian–Pennsylvanian boundary interval within the palaeoequatorial belt of Euramerica. These sections are also important for study of the course and consequences of the global “minor” mass extinction event at the Mississippian–Pennsylvanian boundary, probably caused by the onset of the Gondwana continental glaciation in the Southern Hemisphere. A low-diversity ammonoid assemblage is described from the late Serpukhovian–early Bashkirian (Starobeshovian and Olmezovian regional stages, Kalmius and Amvrosiyivka formations) of the sections in the Kalmius and Krynka River basins. *Anthracoceras* sp. and *Richardsonites baccans* Popov, 1979 are described from the Kalmius Formation, and *Homoceratoides stenus* Popov, 1979, *Cancelloceras tenerum* Popov, 1979 and *Bilinguites* sp. are described from the Amvrosiyivka Formation. *Richardsonites baccans*, *Homoceratoides stenus*, and *Cancelloceras tenerum* are endemic species of the Donets Basin, the original description of which is based on insufficiently preserved limited material (juvenile conchs in which the suture lines are not preserved). The morphological studies of ammonoids helps to clarify the details of the conch morphology of these species and therefore refine the original diagnosis of these taxa. The discovery of *Anthracoceras* sp. in a shale above the D<sub>5</sub><sup>7</sup> limestone of the Kalmius Formation expands the range of this genus in the Carboniferous succession of the Donets Basin. In the Carboniferous sections of the Donets Basin, the upper Serpukhovian–lower Bashkirian interval is best characterised by ammonoids. Currently, 17 genera are recognised from the Kalmius and Amvrosiyivka formations. These data enabled previous researchers to assign the interval of the Kalmius Formation above the D<sub>5</sub><sup>8</sup>Upper limestone to the *Homoceras*–*Hudsonoceras* genus zone, and the interval E<sub>1</sub>–E<sub>9</sub> of the Amvrosiyivka Formation to the *Reticuloceras*–*Bashkortoceras* genus zone. A considerable proportion of endemic species within the late Serpukhovian–early Bashkirian ammonoid assemblage may indicate a certain degree of geographic isolation of the palaeo-aquatory of the Donets Basin.

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# Нові знахідки амоноїдей (Cephalopoda) у серпуховських та башкирських (кам'яновугільна система) відкладах Донецького басейну (Україна)

Віталій Дернов

**Резюме.** Кам'яновугільні розрізи в басейнах річок Кальміус і Кринка, що розташовані у південно-західній частині Донецького басейну (Схід України), мають велике значення для біостратиграфії та кореляції прикордонного міссісіпсько-пенсильванського інтервалу в межах палеоекваторіального поясу Євразії. Ці розрізи також важливі для вивчення перебігу та наслідків глобальної події «малого» масового вимирання на межі міссісіпію та пенсильванію, ймовірно спричиненої так званим Гондванським материковим зледенінням у Південній півкулі. Невеликий комплекс амоноїдей описано з верхньосерпуховського–нижньобашкирського (старобешівський та олмезівський регіонари, кальміуська та амвросіївська світи) стратиграфічного інтервалу розрізів в басейнах річок Кальміус і Кринка. Із кальміуської світи описано *Anthracoceras* sp. та *Richardsonites baccans* Popov, 1979, а з амвросіївської світи — *Homoceratoides stenius* Popov, 1979, *Cancelloceras tenerum* Popov, 1979 та *Bilinguites* sp. *Richardsonites baccans*, *Homoceratoides stenius* і *Cancelloceras tenerum* є ендемічними видами Донецького басейну, первинний опис яких ґрунтується на обмеженому та недостатньо збереженому матеріалі (ядра юних черепашок, на яких не збереглася лопатева лінія). Морфологічні дослідження нових знахідок допомогли уточнити деталі морфології цих видів і, відтак, доповнити оригінальний діагноз цих таксонів. Виявлення *Anthracoceras* sp. у сланцях над вапняком D<sub>5</sub><sup>7</sup> кальміуської світи розширює стратиграфічний діапазон цього роду у кам'яновугільній осадовій послідовності Донецького басейну. У кам'яновугільних розрізах Донбасу верхньосерпуховський–нижньобашкирський інтервал найкраще охарактеризовано амоноїдами. Нині з кальміуської та амвросіївської світи відомо 17 родів цих молюсків. Ці дані дозволили попереднім дослідникам віднести інтервал кальміуської світи вище вапняку D<sub>5</sub><sup>8Верхній</sup> до родової зони *Homoceras*–*Hudsonoceras*, а інтервал E<sub>1</sub>–E<sub>9</sub> амвросіївської світи — до родової зони *Reticuloceras*–*Bashkortoceras*. Значна частка ендемічних видів в комплексі пізньосерпуховських–ранньобашкирських амоноїдей може свідчити про незначну географічну ізолюваність палеоакваторії Донецького басейну.

Ключові слова: амоноїдеї, серпуховський ярус, башкирський ярус, Донецький басейн, морфологія.

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## Introduction

The Kalmius River section, located near the town of Starobesheve (southwestern Donets Basin, Ukraine), is a stratotype section for the Voznesenskian and Zapaltyubian horizons of the East European Platform (Poletaev *et al.*, 2011). It is also of a great significance for the correlation of the Mississippian–Pennsylvanian boundary within the palaeoequatorial belt of Laurussia. This section, along with other significant outcrops (e.g., the Kryinka River section in the south-eastern part of the Donets Basin), is important for study of the global mass extinction event at the Mississippian–Pennsylvanian boundary, probably caused by the onset of continental glaciation in the Southern Hemisphere, which started during the Visian and extending into the Early Permian (Raymond *et al.*, 1990; Bonelli & Patzkowsky, 2011; Griffis *et al.*, 2023).

This paper presents the results of a study of a small collection of ammonoids from the Serpukhovian–lower Bashkirian deposits exposed mainly in the Kalmius River basin in the southwestern Donets Basin, eastern Ukraine.

The aims of this study are to: (1) detail the morphology of some endemic late Serpukhovian and early Bashkirian ammonoid species using describing method proposed by Korn (2010), and (2) clarify the stratigraphic range of ammonoids in the Serpukhovian and lower Bashkirian strata of the Donets Basin. The data obtained extends the palaeontological characteristics of the Upper Mississippian and Lower Pennsylvanian strata of the Donets Basin.

## Materials and methods

The studied collection consists of 38 moderately preserved specimens of ammonoids, which were collected by researchers from the Department of Stratigraphy and Palaeontology of Paleozoic Sediments of the Institute of Geological Sciences, National Academy of Sciences of Ukraine, mainly by Drs David Ye. Aisenverg and Vladyslav I. Poletaev. The examined material is stored in the Department of Geology of the National Museum of Natural History, National Academy of Sciences of Ukraine, Kyiv (collection number NMNHU-G 8637).

For a scheme of dimensions of ammonoid conchs, see the article of Korn (2010: fig. 1). The key for the description of morphology of the ammonoid conchs proposed in Korn (2010) and Klug et al. (2015) is used in this paper. The abbreviations used in the ammonoid species description are: dm = conch diameter, wh = whorl height, ww = whorl width, 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  $(wh_1 - (dm_1 - dm_2))/wh_1$  (Korn, 2010; Klug et al., 2015).

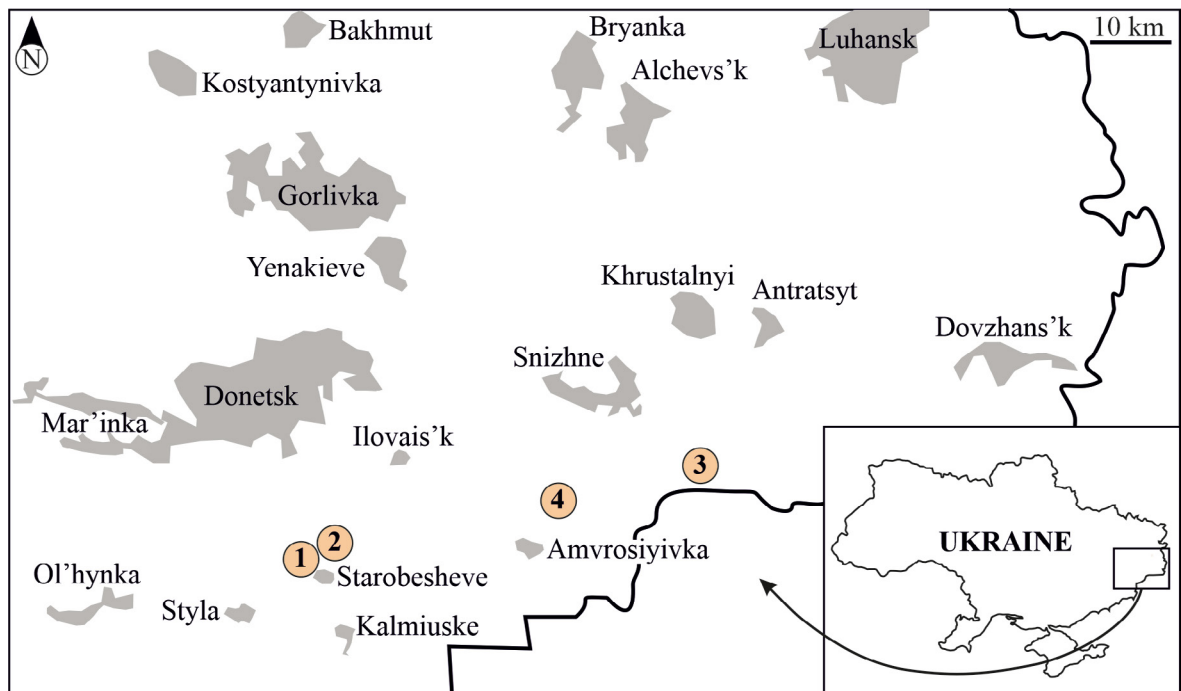
The studied material comes from four fossil localities in the Donetsk Basin (Fig. 1):

(1) Zhelvakova Valley: Donetsk Oblast, Kalmiuske Raion, slopes of the Zhelvakova Valley near the town of Starobesheve; Kalmius Formation, oncolites in a shale just above the D<sub>5</sub><sup>7</sup> limestone. This level bearing ammonoids *Anthracoseras* sp., *Richardsonites baccans* Popov, 1979, and *Nuculoceras donbassicum* Popov, 1979.

(2) Chorna Skelya: Donetsk Oblast, Kalmiuske Raion, Chorna Skelya area at the mouth of the Berestova River near the town of Starobesheve; Amvrosiyivka Formation, E<sub>1</sub> limestone with *Homoceratoides stenus* Popov, 1979.

(3) Kysla Valley: Donetsk Oblast, Amvrosiyivka Raion, Kysla Valley near the town of Dmytrivka; Amvrosiyivka Fm., E<sub>9</sub> limestone with *Cancelloceras tenerum* Popov, 1979.

(4) Blahodatne village: Donetsk Oblast, Amvrosiyivka Raion, the eastern bank of the Krynka River near the village of Blahodatne; Amvrosiyivka Formation, E<sub>9</sub><sup>1</sup> limestone with *Bilinguites* sp.



**Fig. 1.** Geographical location of ammonoid fossil localities (marked by the orange circles). The number of localities: 1 – Zhelvakova Valley, 2 – Chorna Skelya, 3 – Kysla Valley, 4 – village of Blahodatne.

**Рис. 1.** Географічне положення місцезнаходжень амоноїдів (позначено помаранчевими кругами). Номери місцезнаходжень: 1 – Балка Желвакова, 2 – Чорна Скеля, 3 – Балка Кисла, 4 – село Благодатне.

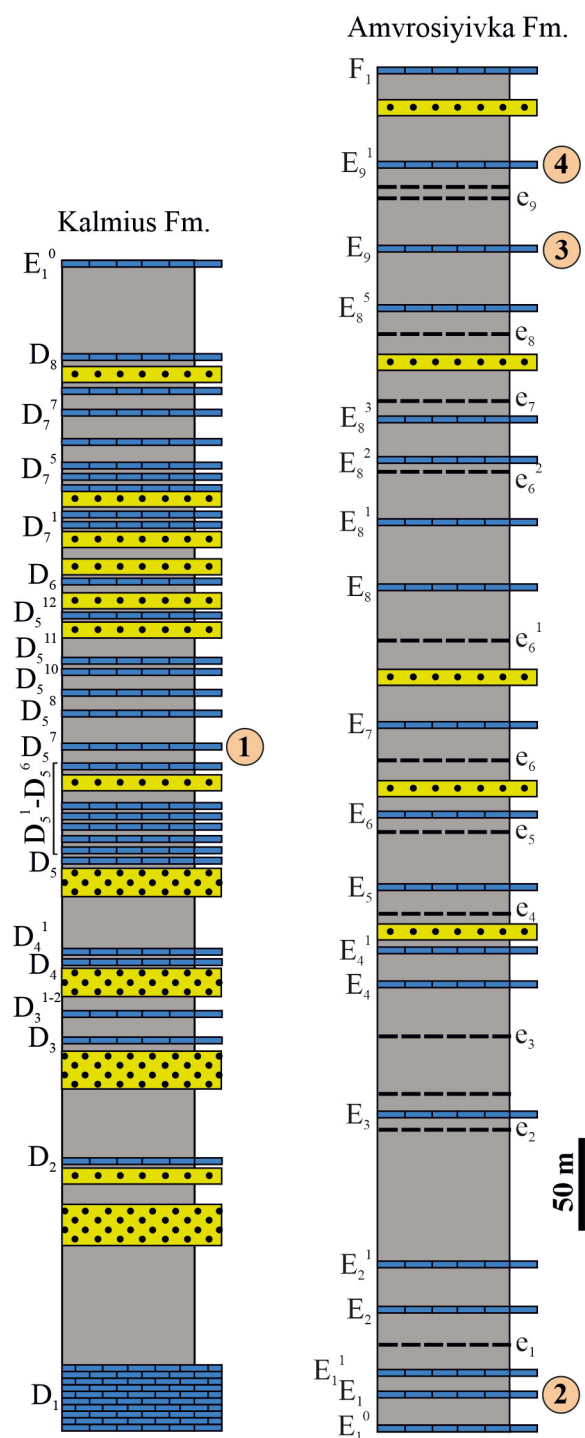
# Geological setting

The studied material originates from the upper Serpukhovian–lower Bashkirian Kalmius and Amvrosiyivka formations (Fig. 2). The Kalmius Formation is a 530 to 800-m-thick paralic succession of sandstone, siltstone, mudstone, coal, and limestone beds (Poletaev *et al.*, 2011; Poletaev & Vdovenko, 2013) (Fig. 3). The marker of the mid-Carboniferous boundary, the conodont species *Declinognathodus noduliferus* (Ellison & Graves, 1941), was recorded in the D<sub>5</sub><sup>8Upper</sup> limestone (Nemirovskaya *et al.*, 1990, 1992). The Amvrosiyivka Formation consists of a 250 to 900-m-thick paralic succession of sandstone, siltstone, mudstone, coal, and limestone beds (Poletaev *et al.*, 2011; Nemyrovska & Yefimenko, 2013) (Fig. 3). The formation contains ammonoids of two early Bashkirian genus zones, the *Reticuloceras*–*Bashkortoceras* genus zone (the stratigraphic interval between the E<sub>1</sub> and E<sub>9</sub> limestones) and the *Bilinguites*–*Cancelloceras* genus zone (E<sub>9</sub>–G<sub>1</sub> limestones) (Popov, 1979; Dernov, 2022a). The formation corresponds to the Manuilivkian and Feninian horizons of the Donets Basin and contains conodonts of the *Idiognathoides sinuatus*–*Id. sulcatus sulcatus* Zone, which is correlated with the Krasnopolyanian and Severokeltmenian regional substages of the East European Platform and the early–middle Morrowan of North America (Nemyrovska, 2017).

| System        | Subsystem     | Stage         | Horizon     | Lithostratigraphic unit | Ammonoid genozones           |                            |                              |
|---------------|---------------|---------------|-------------|-------------------------|------------------------------|----------------------------|------------------------------|
|               |               |               |             |                         |                              |                            |                              |
|               |               |               |             |                         |                              |                            |                              |
| CARBONIFEROUS | PENNSYLVANIAN | Gzhelian      | Vyskrivian  | Kartamysh Fm. (part)    | Not zoned                    |                            |                              |
|               |               |               | Luhanian    | Araukarytova Fm.        |                              |                            |                              |
|               |               |               | Troitskian  |                         |                              |                            |                              |
|               |               |               | Klyuchovian |                         |                              |                            |                              |
|               |               |               | Kasimovian  | Svitlanovian            |                              | Avilovka Fm.               |                              |
|               |               | Kartanashian  |             |                         |                              |                            |                              |
|               |               | Sanzharivkian |             | Isayivka Fm.            |                              |                            |                              |
|               |               | Moscovian     | Sabivkian   | Horlivka Fm.            |                              | Paralegoceras-Eowellerites |                              |
|               |               |               | Mar'ivkian  | Almazna Fm.             |                              |                            |                              |
|               |               |               | Kam'iankian | Kamensk Fm.             |                              |                            | Diaboloceras-Winslowoceras   |
|               |               |               | Bashkirian  | Krasnodonian            | Belaya Kalitva Fm.           | Diaboloceras-Axinolobus    |                              |
|               |               |               |             | Makiivkian              | Smolyanynivka Fm.            | Gastrioceras-Branneroceras |                              |
|               |               | Zuyivkian     |             | Mospyne Fm.             |                              |                            |                              |
|               |               | Blagodatnean  |             | Mandrykyne Fm.          |                              |                            | Cancelloceras-Bilinguites    |
|               |               | Manuilivkian  |             | Amvrosiyivka Fm.        | Reticuloceras-Bashkortoceras |                            |                              |
|               |               | Feninian      |             |                         |                              |                            |                              |
|               |               | MISSISSIPPIAN |             | Serpukhovian            | Voznessenkian                | Kalmius Fm.                | Homoceras-Hudsonoceras       |
|               |               |               |             |                         | Zapaltyubean                 |                            | Fayettevillea-Delepinoceras  |
|               |               |               |             |                         | Novolyubivkian               |                            | Uralopronorites-Cravenoceras |
|               | Prokhorivkian |               |             |                         | Samara Fm.                   |                            |                              |
|               | Samarian      |               |             |                         |                              |                            |                              |
|               | Visean        |               | Mezhovain   | Mezhova Fm.             | Not zoned                    |                            |                              |
|               |               |               | Donetsian   | Mokra Volnovakha Group  | Hypergoniatites-Ferganoceras |                            |                              |
|               |               |               | Stylian     |                         | Beyrichoceras-Goniatites     |                            |                              |
|               |               |               | Sukhynian   |                         | Merocanites-Ammonellipsites  |                            |                              |
|               |               |               | Glybokynian |                         |                              |                            |                              |
| Dokuchaivian  |               |               |             |                         |                              |                            |                              |
| Karpivian     |               |               |             |                         |                              |                            |                              |
| Volnovakhian  |               |               |             |                         |                              |                            |                              |
| Karakubian    |               |               |             |                         |                              |                            |                              |
| Bazaliivkian  | Not zoned     |               |             |                         |                              |                            |                              |

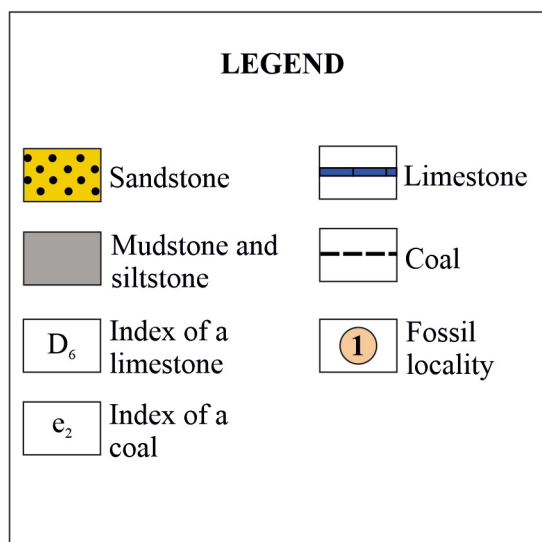
**Fig. 2.** Stratigraphic position of the Kalmius and Amvrosiyivka formations and ammonoid biostratigraphy of the Carboniferous succession of the Donets Basin (modified after Popov, 1979).

**Рис. 2.** Стратиграфічне положення кальміуської та амвросіївської світ та біостратиграфія кам'яновугільних відкладів Донбасу за амоноідеями (взято зі змінами з Роров (1979)).



**Fig. 3.** Stratigraphic position of the ammonoid localities. Lithological columns modified after Nemyrovska & Yefimenko (2013) and Poletaev & Vdovenko (2013). Numbers of localities: 1 – Zhelvakova Valley, 2 – Chorna Skelya, 3 – Kysla Valley, 4 – village of Blahodatne.

**Рис. 3.** Стратиграфічне положення місцезнаходжень амоніоїд. Літологічні колонки взято зі змін з Nemyrovska & Yefimenko (2013), Poletaev & Vdovenko (2013). Номери місцезнаходжень: 1 – Балка Желвакова, 2 – Чорна Скеля, 3 – Балка Кисла, 4 – село Благодатне.



## Systematic palaeontology

### Order Goniatitida Hyatt, 1884

### Superfamily Pericycloidea Hyatt in von Zittel, 1900

### Family Anthracoceratidae Plummer & Scott, 1937

#### Genus *Anthracoceras* Frech, 1899

Type species: *Nomismoceras (Anthracoceras) discus* Frech, 1899; by original designation.

***Anthracoceras* sp.**

Fig. 4, a–c

**Material.** Specimen NMNHU-G 8637/83 from the Zhelvakova valley fossil site.

**Description.** Specimen NMNHU-G 8637/83 is a moderately well-preserved limestone mould with a diameter of 20.8 mm. It is thinly discoidal ( $ww = 7.8$  mm,  $wh = 11.1$  mm,  $ww/dm = 0.38$ ), weakly compressed ( $ww/wh = 0.70$ ), with moderately embracing whorls ( $IZR = 0.16$ ). The venter is convex; the flanks are slightly convex, wide and converging to a broadly rounded ventrolateral shoulder; the umbilical margin is angularly rounded; the umbilicus is moderate ( $uw = 3.8$  mm,  $uw/dm = 0.38$ ). The conch ornament is not preserved. The suture line has a high, wide, rounded lateral saddle, a wide, rounded lateral lobe, and a narrow, high ventrolateral saddle (Fig. 4, c).

**Superfamily Neodimorphoceratoidea Furnish & Knapp, 1966**

**Family Ramositidae Ruzhencev & Bogoslovskaya, 1969**

**Genus *Homoceratoides* Bisat, 1924**

Type species: *Homoceratoides prereticulatus* Bisat, 1924; by original designation.

***Homoceratoides stenus* Popov, 1979**

Fig. 4, d, e; Table 1

1979 *Homoceratoides stenus* sp. nov.; Popov, p. 67, pl. 5, fig. 5.

**Holotype.** Specimen VSEGEI-3030/04, which is stored in the A. P. Karpinsky All-Russian Research Geological Institute, St. Petersburg; illustrated in Popov (1979: pl. 5, fig. 5).

**Type locality.** Ukraine, Donetsk Oblast, right bank of the Kalmius River near the former village of Fenine (Starobesheve town area).

**Type stratigraphic level.** Early Bashkirian Amvrosiyivka Formation (more precise stratigraphic position is not known).

**Diagnosis.** Species of *Homoceratoides* with a pachyconic ( $ww/dm = 0.57$ – $0.64$  at 7.7–12.0 mm conch diameter), weakly depressed conch ( $ww/wh = 1.18$ – $1.32$  at 7.7–12.0 mm conch diameter), which has a convex venter, slightly convex flanks, converging to a broadly rounded ventrolateral shoulder and narrowly rounded umbilical margin and a narrow umbilicus ( $uw/dm = 0.24$ – $0.30$  at 7.7–12.0 mm conch diameter). Ornamentation consists of coarse growth lines, extending with a broad, shallow lateral sinus, a low, relatively narrow ventrolateral projection, and a deep, narrow ventral sinus.

**Material.** Sixteen limestone moulds from the Chorna Skelya fossil site (NMNHU-G 8637/01, 44–46, 62, 64–70, 71a–71c).

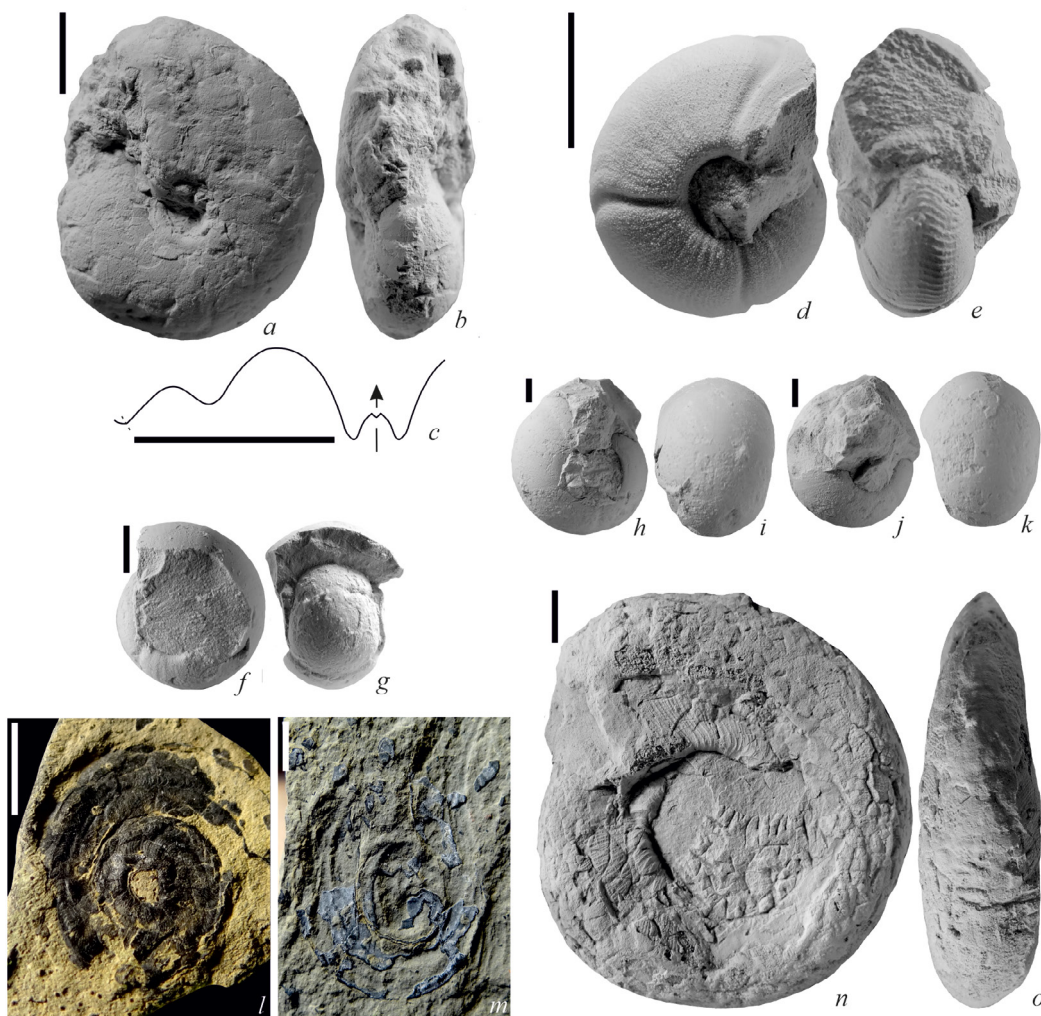
**Description.** Specimen NMNHU-G 8637/65 is a well-preserved mould with a diameter of 10.7 mm (Fig. 4, d, e). It is thinly pachyconic ( $ww/dm = 0.62$ ) with weakly depressed ( $ww/wh = 1.32$ ) and weakly embracing whorls ( $IZR = 0.14$ ). The venter is convex, the flanks are slightly convex, converging to the broadly rounded ventrolateral shoulder; the umbilical margin is narrowly rounded, and the umbilicus is narrow ( $uw/dm = 0.24$ ).

Table 1. Dimensions (in mm) of *Homoceratoides stenus* Popov, 1979

Таблиця 1. Розміри (мм) *Homoceratoides stenus* Попов, 1979

| Specimen        | dm   | ww  | wh  | uw  | ah | ww/dm | ww/wh | uw/dm | WER | IZR  |
|-----------------|------|-----|-----|-----|----|-------|-------|-------|-----|------|
| NMNHU-G 8637/01 | 12.0 | 7.2 | 5.7 | 3.0 | –  | 0.60  | 1.26  | 0.25  | –   | –    |
| NMNHU-G 8637/62 | 10.8 | 6.6 | 5.6 | 2.9 | –  | 0.61  | 1.18  | 0.27  | –   | –    |
| NMNHU-G 8637/65 | 10.7 | 6.6 | 5.0 | 2.6 | –  | 0.62  | 1.32  | 0.24  | –   | 0.14 |
| NMNHU-G 8637/66 | 8.0  | 5.1 | –   | 2.4 | –  | 0.64  | –     | 0.30  | –   | –    |

Ornamentation consists of coarse growth lines, extending with a broad, shallow lateral sinus, a low, relatively narrow ventrolateral projection, and a deep, narrow ventral sinus. The growth lines are coarse near the umbilical margin and branch out in the middle of the flank. The width of the lines near the umbilical margin is approximately 0.15 mm, decreasing to around 0.05 mm after branching. There are three constrictions in the whorl; they have a wide lateral sinus, a small and narrow ventrolateral projection and a shallow wide ventral sinus.



**Fig. 4.** Late Serpukhovian and early Bashkirian ammonoids of the Donetsk Basin. *a-c* — *Anthracoceras* sp. (*a* — lateral view, *b* — apertural view, *c* — suture line), specimen NMNHU-G 8637/83. *d, e* — *Homoceratoides stenus* Popov, 1979 (*d* — lateral view, *e* — apertural view), specimen NMNHU-G 8637/65. *f-k* — *Richardsonites baccans* Popov, 1979 (*f, h, j* — lateral views, *g* — apertural view, *i, k* — ventral views; *f, g* — NMNHU-G 8637/52, *h, i* — NMNHU-G 8637/51, *j, k* — NMNHU-G 8637/49). *l, m* — *Bilinguites* sp. (*l* — NMNHU-G 8637/23a, crushed conch in lateral view, *m* — NMNHU-G 8637/28, crushed conch in lateral view). *n, o* — *Cancelloceras tenerum* Popov, 1979 (*n* — lateral view, *o* — ventral view), specimen NMNHU-G 8637/12. Scale bars = 5 mm.

**Рис. 4.** Пізньосерпуховські та ранньобашкирські амонідеї Донецького басейну. *a-c* — *Anthracoceras* sp. (*a* — латерально, *b* — зі сторони апертури, *c* — лопатева лінія), екземпляр NMNHU-G 8637/83. *d, e* — *Homoceratoides stenus* Попов, 1979 (*d* — латерально, *e* — зі сторони апертури), екземпляр NMNHU-G 8637/65. *f-k* — *Richardsonites baccans* Попов, 1979 (*f, h, j* — латерально, *g* — зі сторони апертури, *i, k* — вентрально; *f, g* — NMNHU-G 8637/52, *h, i* — NMNHU-G 8637/51, *j, k* — NMNHU-G 8637/49). *l, m* — *Bilinguites* sp. (*l* — NMNHU-G 8637/23a, роздавлена черепашка, латеральний вид, *m* — NMNHU-G 8637/28, роздавлена черепашка, латеральний вид). *n, o* — *Cancelloceras tenerum* Попов, 1979 (*n* — латерально, *o* — вентрально), екземпляр NMNHU-G 8637/12. Масштабні штрихи завдовжки 5 мм.

**Remarks.** *Homoceratoides stenus* differs from *H. librovitchi* Ruzhencev & Bogoslovskaya, 1978 by a narrower conch ( $ww/dm = 0.57$  at 7.7 mm conch diameter in *H. stenus* and  $ww/dm = 0.71$  at 7.5 mm conch diameter in *H. librovitchi*) and a less compressed whorl profile ( $ww/wh = 1.22$  at 7.7 mm conch diameter in *Homoceratoides stenus* and  $ww/wh = 1.60$  at 7.5 mm conch diameter in *H. librovitchi*). In *H. stenus* lack umbilical nodes, but they are characteristic for young conchs of *H. librovitchi*. It is not possible to compare mature conchs of *H. stenus* and *H. librovitchi*, as the first species is represented by small, juvenile conchs.

*Homoceratoides stenus* and *H. ferganensis* Ruzhencev & Bogoslovskaya, 1978 differ by a much narrower umbilicus in the latter species ( $uw/dm = 0.10$  at 11.0 mm conch diameter in *H. ferganensis* and  $uw/dm = 0.27$  at 10.8 mm conch diameter in *H. stenus*). *Homoceratoides stenus* has constrictions on the conch surface, which is absent in *H. ferganensis*, and in general, the transverse surface ornamentation of *H. stenus* is coarser. *H. stenus* differs from *H. kalmiusi* Popov, 1979, another endemic Donets Basin species, in the absence of umbilical nodes and an umbilical rim, coarser growth lines and constrictions with a ventral sinus. The conch ornamentation of *H. tabidus* Popov, 1979 is less coarse than that of *H. stenus*. *Homoceratoides stenus* further differs from *H. svetlanae* Korn, 1997 by more pronounced constrictions in the former, although other morphological features of these species are quite similar.

**Occurrence.** Lower Bashkirian (*Reticuloceras-Bashkortoceras* zone), Donets Basin.

## Family Reticuloceratidae Librovitch, 1957

### Genus *Bilinguites* Librovitch, 1946

Type species: *Reticuloceras superbilingue* Bisat, 1924; by original designation.

### *Bilinguites* sp.

Fig. 4, *l, m*

**Material.** Ten crushed conchs between 14 and 25 mm in diameter (specimens NMNHU-G 8637/23a, 24, 25, 27–33) from the Blahodatne village locality.

**Description.** Specimen NMNHU-G 8637/23a (Fig. 4, *l*) is one of the best-preserved specimens. It consists of a crushed conch measuring 14 mm in diameter. The form of the conch is impossible to describe. The umbilicus is very narrow ( $uw = 1.9$  mm,  $uw/dm = 0.14$ ). The conch surface bears thin biconvex growth lines forming a narrow ventral sinus, a narrow high ventrolateral projection, and a shallow wide lateral sinus. There are two longitudinal grooves on the ventrolateral shoulder. Specimen NMNHU-G 8637/28 (Fig. 4, *m*) is a crushed conch, *c.* 28 mm in diameter. The umbilicus is narrow ( $uw = 5.0$  mm,  $uw/dm = 0.18$ ). The conch surface bears a longitudinal groove on the ventrolateral shoulder.

**Remarks.** The described ammonoids are extremely poorly preserved, thus precluding any meaningful comparison of morphology with that of other members of the genus *Bilinguites*.

## Superfamily Somoholitoidea Ruzhencev, 1938

### Family Glaphyritidae Ruzhencev & Bogoslovskaya, 1971

#### Genus *Richardsonites* Elias, 1956

Type species: *Gastrioceras richardsonianum* Girty, 1909; by original designation.

### *Richardsonites baccans* Popov, 1979

Fig. 4, *f–k*; Table 2

1979 *Richardsonites baccans* sp. nov.; Popov, p. 61, text-figs 6г, 6д, 7в, pl. 4, figs 4–7.

1983 *Richardsonites baccans* A. Popov, 1979; Astakhova, p. 119, pl. 68, figs 1–4.

**Holotype.** Specimen VSEGEI-3051/01, A. P. Karpinsky All-Russian Research Geological Institute, St. Petersburg. Illustrated in Popov (1979: pl. 4, figs 4, 5).

**Type locality.** Ukraine, Donetsk Oblast, Zapal-Tyube Hill near the town of Starobesheve.

**Type stratigraphic level.** Serpukhovian portion of the Kalmius Formation, shale above the D<sub>5</sub><sup>7</sup> limestone.

**Diagnosis.** Species of *Richardsonites* with a pachyconic ( $ww/dm = 0.70–0.76$ ), moderately and strongly depressed conch ( $ww/wh = 1.80–2.86$ ); a venter is forming with flanks a single hemispheric surface; an umbilical margin is angular and an umbilicus is moderate. The coiling rate is low ( $WER = c. 1.55$ ). The ornament consists of lamellar growth lines, forming a broad, very low ventral projection

and linear constrictions. The suture line with a broad ventral lobe divided into two lanceolate branches by a median saddle; a ventrolateral saddle is moderately rounded; an adventive lobe is Y-shaped, pointed at the base; a dorsolateral saddle is asymmetrically rounded.

**Material.** Ten limestone moulds from the Zhelvakova Valley (NMNHU-G 8637/49 to 57, 86).

**Description.** Specimen NMNHU-G 8637/52 is a moderately preserved mould with a diameter of 7.6 mm (Fig. 4, *f, g*). It is pachyconic ( $ww/dm = 0.70$ ) with moderately depressed ( $ww/wh = 1.80$ ) and very strongly embracing whorls ( $IZR = 0.48$ ). The venter is forming with flanks a single hemispheric surface; the umbilical margin is angular and the umbilicus is moderate ( $uw/dm = 0.41$ ). The coiling rate is low ( $WER = 1.56$ ). The umbilical wall is wide and flattened. The ornament consists of lamellar growth lines, forming a broad, very low ventral projection. The width of the lines on the venter is *c.* 0.15 mm. Constrictions (two per whorl) are linear. Specimen NMNHU-G 8637/51 is a moderately well-preserved mould with a diameter of 14.0 mm (Fig. 4, *h, i*). It is pachyconic ( $ww/dm = 0.71$ ) with very strongly depressed ( $ww/wh = 2.86$ ) whorls. The venter is forming with flanks a single hemispheric surface; the umbilical margin is angular and the umbilicus is moderate ( $uw/dm = 0.40$ ). The ornament consists of lamellar growth lines, forming a broad, very low ventral projection. The width of the lines on the venter is measuring approximately 0.20 mm. The constrictions (one per whorl) are linear.

Table 2. Dimensions (in mm) of *Richardsonites baccans* Popov, 1979  
Таблиця 2. Розміри (мм) *Richardsonites baccans* Popov, 1979

| Specimen        | dm   | ww   | wh  | uw  | ah  | ww/dm | ww/wh | uw/dm | WER  | IZR  |
|-----------------|------|------|-----|-----|-----|-------|-------|-------|------|------|
| NMNHU-G 8637/52 | 7.6  | 5.3  | 2.9 | 3.1 | 1.5 | 0.70  | 1.80  | 0.41  | 1.56 | 0.48 |
| NMNHU-G 8637/49 | 12.4 | 9.4  | 3.4 | –   | –   | 0.76  | 2.76  | –     | –    | –    |
| NMNHU-G 8637/51 | 14.0 | 10.0 | 3.5 | 5.6 | –   | 0.71  | 2.86  | 0.40  | –    | –    |

**Remarks.** *Richardsonites baccans* differs from *R. gairensis* (Currie, 1954) by the absence of a raised rim around the umbilicus, and by a much wider umbilicus ( $uw/dm = 0.40–0.41$  in *R. baccans* and  $uw/dm = 0.22$  in *R. gairensis*). *Richardsonites baccans* and *R. mapei* (Saunders, 1973) differ by a slightly wider conch in the latter species ( $ww/dm = 0.80$  at 8.6 mm conch diameter in *R. mapei* and  $0.70–0.76$  at 7.6–14.0 mm conch diameter in *R. baccans*), as well as a much wider umbilicus in *R. baccans* ( $uw/dm = 0.40$  at 14.0 mm conch diameter in *R. baccans* and  $0.28$  at 14.0 mm conch diameter in *R. mapei*).

**Occurrence.** Upper Serpukhovian (*Fayettevillea-Delepinoceras* genus zone), Donetsk Basin.

## Superfamily Gastrioceratoidea Hyatt, 1884

### Family Gastrioceratidae Hyatt, 1884

#### Genus *Cancelloceras* Ruzhencev & Bogoslovskaya, 1969

Type species: *Gastrioceras cancellatum* Bisat, 1923; by original designation.

#### *Cancelloceras tenerum* Popov, 1979

Fig. 4, *n, o*

1979 *Cancelloceras tenerum* sp. nov.; Popov, p. 81, pl. 10, figs 4–8.

**Holotype.** Specimen VSEGEI-13, which is stored in the A. P. Karpinsky All-Russian Research Geological Institute, St. Petersburg; Ukraine, Donetsk Oblast, Kysla Valley near the village of Dmytrivka; E<sub>8</sub> or E<sub>9</sub> limestone bed of the early Bashkirian Amvrosiyivka Formation. Illustrated by Popov (1979: pl. 10, fig. 7).

**Material.** One significantly laterally compressed sideritized conch (specimen NMNHU-G 8637/12) from the Kysla Valley fossil site.

**Description.** Specimen NMNHU-G 8637/12 is a relatively large conch ( $dm = 59.7$  mm,  $wh = 16.8$  mm) with a broadly convex venter, rounded ventrolateral shoulders, slightly convex flanks, which converging to the ventrolateral shoulders, a moderate umbilicus ( $uw = 16.8$  mm,  $uw/dm = 0.33$ ) and an angular umbilical margin. The conch ornament consists of thin growth lines (0.10–0.15 mm thick)

forming a lateral shallow narrow sinus, a low ventrolateral projection and a shallow narrow ventral sinus. The growth lines are intersected by thin lirae, about 0.1 mm thick, forming a reticulate ornament. At the umbilical margin, the growth lines join into narrow, sharp, short ribs, 0.20 mm thick, which continue to the umbilical wall.

**Remarks.** *Cancelloceras tenerum* differs from *C. pachygyrum* (Yang, 1987) in the absence of lateral ribs, but the latter species has a tendency to reduce these ribs in ontogeny, so it is possible that large conch do not have them. The same applies to *Cancelloceras solitarii* Nikolaeva & Kullmann, 1995, *C. elegans* Ruzhencev & Bogoslovskaya, 1978, *C. extenuatum* Ruzhencev & Bogoslovskaya, 1978, and *C. rurae* (Schmidt, 1925), although no weakening of the ribs during ontogeny was observed in these species. In contrast to *Cancelloceras oliveirai* Nikolaeva & Kullmann, 1995, *C. tenerum* has no constrictions on the conch surface, but specimen NMNHU-G 8637/12 has almost twice the conch diameter of *Cancelloceras oliveirai*.

**Occurrence.** Lower Bashkirian (*Bilinguites*–*Cancelloceras* genus zone), Donets Basin.

## Discussion and concluding remarks

Several ammonoid species described from the upper Serpukhovian and lower Bashkirian strata of the Donets Basin, namely *Anthracoceras* sp., *Homoceratoides stenus* Popov, 1979, *Richardsonites baccans* Popov, 1979, *Nuculoceras donbassicum* Popov, 1979, *Cancelloceras tenerum* Popov, 1979, and *Bilinguites* sp.

In the Carboniferous succession of the Donets Basin, the upper Serpukhovian–lower Bashkirian interval is best characterised by ammonoids. Currently, 17 genera are recognised from the Kalmius and Amvrosiyivka formations, including *Stenopronorites*, *Anthracoceras*, *Proshumardites*, *Cravenoceras*, *Cravenoceratoides*, *Glaphyrites*, *Richardsonites*, *Euroceras*, *Nuculoceras*, *Homoceratoides*, *Surenites*, *Reticuloceras*, *Bilinguites*, *Cancelloceras*, *Isohomoceras*, *Homoceras*, and *Phillipsoceras* (Popov, 1979; Astakhova, 1983).

The original descriptions of some endemic ammonoid species (e.g., *Homoceratoides stenus*, *H. tabidus*, and *Reticuloceras berestovense*) are based on a sparse and poorly preserved moulds without suture lines. Unfortunately, this preservation is typical of the Carboniferous ammonoids from the Donets Basin (Popov, 1979; Dernov, 2022b; Dernov & Poletaev, 2024).

Previously, *Anthracoceras discus* was described by Astakhova (1983) from the D<sub>1</sub> limestone in the Kalmius Formation. The single specimen of *Anthracoceras* sp. described above extends the stratigraphic distribution of this species in the sections of the Donets Basin to the shale above the D<sub>5</sub><sup>7</sup> limestone of the Kalmius Formation. The original description of *Homoceratoides stenus* in Popov (1979: p. 67) is based on a single mould of a very small conch (dm = 8.0 mm). This species has not been re-described in subsequent works, so the available material allows us to clarify the details of the morphology of this species. *Cancelloceras tenerum* was also described by Popov (1979: p. 81) on poor material (three moulds of small conchs). The relatively large conch (dm = 59.7 mm), which originates from the locality from which Popov (1979) previously reported poorly preserved conchs of *Bilinguites superbilinguis* is described above. The specimens of *Bilinguites* figured here (Fig. 4, *l*, *m*) and those described by Popov (1979: pl. 8, figs 3a, 3r) are very poorly preserved and cannot be identified more precisely than *Bilinguites* sp. In Popov's work (1979: pl. 8, figs 3b and 3v) figured ammonoids that do not belong to the genus *Bilinguites*; these are likely to be representatives of the genus *Cancelloceras*.

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## References

- Astakhova, T. V. (1983). Goniatites. In: Didkovs'kyi V. Ya. (Ed.), *Upper Serpukhovian of the Donets Basin*, 115–123. Kyiv. [Russian]
- Bisat, W. S. (1923). *Gastrioceras cancellatum* (sp. nov.) at Meanwood, Leeds. *Transactions of the Leeds Geological Association*, 19, 47–50.
- Bisat, W. S. (1924). The Carboniferous goniatites of the North of England and their zones. *Proceedings of the Yorkshire Geological Society*, 20, 40–124. <https://doi.org/10.1144/pygs.20.1.40>
- Bonelli, J. R. Jr., & Patzkowsky, M. E. (2011). Taxonomic and ecologic persistence across the onset of the Late Paleozoic Ice Age: evidence from the Upper Mississippian (Chesterian Series), Illinois Basin, United States. *PALAIOS*, 26(1), 5–17. <https://doi.org/10.2110/palo.2010.p10-013r>
- Currie, E. D. (1954). Scottish Carboniferous goniatites. *Transactions of the Royal Society*, 62, 527–602. <https://doi.org/10.1017/s0080456800009376>
- Dernov, V. (2022a). Ammonoid biostratigraphy of the Bashkirian (Pennsylvanian) in the Donets Basin. *Collection of scientific works of the Institute of Geological Sciences of the NAS of Ukraine*, 15, 123–137. <https://doi.org/10.30836/igs.2522-9753.2022.267080>
- Dernov, V. (2022b). Late Bashkirian ammonoids from the Mospyne Formation of the Donets Basin, Ukraine. *Fossil Imprint*, 78(2), 489–512. <https://doi.org/10.37520/fi.2022.021>
- Dernov, V. S., & Poletaev, V. I. (2024). New geological and palaeontological data of the Dyakove Group (Carboniferous) and age-related rock formations of the central Donets Basin, Ukraine. *Geologičnij žurnal*, 386, 3–21. <https://doi.org/10.30836/igs.1025-6814.2024.1.285644>
- Elias, M. (1956). Upper Mississippian and Lower Pennsylvanian formations of south-central Oklahoma. *Petroleum geology of southern Oklahoma. Vol. 1. American Association of Petroleum Geologists Special Volume*, 16, 56–134. <https://doi.org/10.1306/sv16348c3>
- Ellison, S., & Graves R. W. Jr. (1941). Lower Pennsylvanian (Dimple Limestone) conodonts of the Marathon Region, Texas. *Bulletin of the Missouri University, School of Mines and Metallurgy*, 14, 1–21.
- Frech, F. (1899). *Lethaea geognostica oder Beschreibung und Abbildung der für die Gebirgs-Formationen bezeichnendsten Versteinerungen. Teil 1: Lethaea palaeozica, Band 2, Lieferung. Die Steinkohlenformation.* Stuttgart, 1–452.
- Furnish, W. M., & Knapp W. D. (1966). Lower Pennsylvanian fauna from Eastern Kentucky. Part 1. Ammonoids. *Journal of Paleontology*, 40(2), 296–308.
- Girty, G. H. (1909). Fauna of the Caney Shale of Oklahoma. *United States Geological Survey Bulletin*, 377, 1–106. <https://doi.org/10.3133/b377>
- Griffis, N., Mundil, R., Montañez, I., Le Heron, D., Dietrich, P., Iannuzzi, R. (2023). A Carboniferous apex for the late Paleozoic Icehouse. *Geological Society, London, Special Publications*, 535, 117–129. <https://doi.org/10.1144/SP535-2022-256>
- Hyatt, A. (1883). Genera of fossil cephalopods. *Proceedings of Boston Society of Natural History*, 22, 273–338.
- Hyatt, A. (1900). Tetrabranchiate Cephalopoda. In: von Zittel, K. A., & Eastman, C. R. *Text-book of palaeontology.* Vol. 1. First English edition, part I & II, 502–604. London–New York.
- Klug, C., Korn, D., Landman N. H., Tanabe, K., De Baets, K., & Naglik, C. (2015). Describing ammonoid conchs. In: Klug, C., Korn, D., De Baets, K., Kruta, I., & Mapes, R. H. (Eds), *Ammonoid paleobiology: from macroevolution to paleogeography. Topics in Geobiology*, 44, 3–24. [https://doi.org/10.1007/978-94-017-9630-9\\_1](https://doi.org/10.1007/978-94-017-9630-9_1)
- Korn, D. (1997). The Palaeozoic ammonoids of the South Portuguese Zone. *Memórias do Instituto geológico e Mineiro*, 33, 1–131.
- Korn, D. (2010). A key for the description of Palaeozoic ammonoids. *Fossil Record*, 13(1), 5–12. <https://doi.org/10.1002/mmng.200900008>
- Librovitch, L. S. (1946). A new scheme of subdivision and correlation of the Carboniferous deposits of the Donets Basin (based on the distribution of cephalopod faunas). *Proceedings of the All-Union Scientific Research Geological Institute. General Series*, 7, 77–90. [Russian]
- Librovitch, L. S. (1957). On some groups of ammonoids from the Carboniferous of the USSR. *Yearbook of the All-Union Palaeontological Society*, 16, 246–273. [Russian]

- Nemirovskaya, T. I., Poletaev, V. I. & Vdovenko, M. V. (1990). The Kal'mius Section, Donbass, Ukraine, U.S.S.R., a Soviet proposal for the Mid-Carboniferous boundary stratotype. *Courier Forschungsinstitut Senckenberg*, **130**: 247–272.
- Nemirovskaya, T. I., Poletaev, V. I., & Vdovenko, M. V. (1992). The Kalmius Section of the Carboniferous of the Donets Basin, a candidate for the stratotype of the mid-Carboniferous boundary. *Tectonics and Stratigraphy*, **32**: 62–72.
- Nemyrovskaya, T. I. (2017). Late Mississippian–Middle Pennsylvanian conodont zonation of Ukraine. *Stratigraphy*, **14**(1–4), 299–317. <https://doi.org/10.29041/strat.14.1-4.299-318>
- Nemyrovskaya, T. I., Yefimenko, V. I. (2013). Middle Carboniferous (Lower Pennsylvanian). In: Gozhik P. F. (Ed.), *Stratigraphy of the Upper Proterozoic and Phanerozoic of Ukraine. Vol. 1. Stratigraphy of the Upper Proterozoic, Palaeozoic, and Mesozoic*, 283–303. Kyiv. [Ukrainian]
- Nikolaeva, S. V., & Kullmann, J. (1995). The Late Namurian genus *Cancelloceras* (Carboniferous Ammonoidea) and its distribution. *Paläontologische Zeitschrift*, **69**, 353–376. <https://doi.org/10.1007/bf02987800>
- Plummer, F. B., & Scott, G. (1937). Upper Paleozoic ammonites in Texas. *The University of Texas Bulletin*, **3**, 13–516.
- Poletaev, V. I., & Vdovenko, M. V. (2013). Lower Carboniferous (Mississippian). In: Gozhik, P. F. (Ed.), *Stratigraphy of the Upper Proterozoic and Phanerozoic of Ukraine. Vol. 1. Stratigraphy of the Upper Proterozoic, Palaeozoic, and Mesozoic*, 250–283. Kyiv. [Ukrainian]
- Poletaev, V. I., Vdovenko, M. V., Shchokholev, O. K., Boyarina, N. I., & Makarov, I. A. (2011). *Stratotypes of the Carboniferous and Lower Permian regional stratigraphic units of the Don-Dnipro Downwarp*, 1–236. Kyiv. [Ukrainian]
- Popov, A. V. (1979). Carboniferous ammonoids of the Donets Basin and their stratigraphic significance. *Trudy VSEGEI, novaya seriya*, **220**, 1–119. [Russian]
- Raymond, A., Kelley, P. H., & Blanton Lutken, C. (1990). Dead by degrees: articulate brachiopods, paleoclimate and the mid-Carboniferous extinction. *PALAIOS*, **5**(2), 111–123. <https://doi.org/10.2307/3514808>
- Ruzhencev, V. Ye. (1938). Ammonoids of the Sakmarian Stage and their stratigraphic significance. *Problemy Paleontologii*, **4**, 187–285. [Russian]
- Ruzhencev, V. Ye., & Bogoslovskaya, M. F. (1969). Revision of the family Dimorphoceratidae. *Palaeontological Journal*, **1**, 51–66. [Russian]
- Ruzhencev, V. Ye., & Bogoslovskaya M. F. (1971). Namurian stage in the evolution of ammonoids. Early Namurian ammonoids. *Proceedings of the Palaeontological Institute, Academy of Sciences of the USSR*, **133**, 1–382.
- Ruzhencev, V. Ye., & Bogoslovskaya, M. F. (1978). Namurian stage in the evolution of ammonoids. Late Namurian ammonoids. *Proceedings of the Palaeontological Institute, Academy of Sciences of the USSR*, **167**, 1–338.
- Saunders, W. B. (1973). Upper Mississippian ammonoids from Arkansas and Oklahoma. *Special Papers of the Geological Society of America*, **145**, 1–110. <https://doi.org/10.1130/SPE145-p1>
- Schmidt, H. (1925). Die carbonischen Goniatiten Deutschlands. *Jahrbuch der Preussischen Geologischen Landesanstalt*, **45**, 489–609.
- Yang, F. (1987). Early late Carboniferous ammonoids from Zhongwei, Ningxia Autonomous Region, China. *Geoscience*, **1**(2), 157–172. [Chinese]