UDC 56.016.4:551.781(477.63) DOI: https://doi.org/10.30836/igs.2522-9753.2023.295187

ICHTYOCOPRUS AFFECTATUS MAKARENKO, 1993 IS A BIVALVE BORING ROCK CAST, NOT A COPROLITE

ICHTYOCOPRUS AFFECTATUS MAKARENKO, 1993 — ЯДРО НІРКИ БІВАЛЬВІЇ, А НЕ КОПРОЛІТ

Vitaly S. Dernov
В. С. Дернов

Institute of Geological Sciences, NAS of Ukraine, 55-b Oles Honchar Str., Kyiv, Ukraine, 01601
(vitallydernov@gmail.com)

The type material of *Ichtyocoprus affectatus* Makarenko, 1993, originating from the Eocene deposits of the Vizyrka quarry near the former town of Ingulets' (now part of the city of Kryvyi Rih), was studied. This ichnotaxon was originally classified as a fish coprolite. The results of the study of the specimen figured and described by Dmytro Ye. Makarenko demonstrated that this fossil is actually a rock cast of a bivalve boring belonging to the ichnogenus *Gastrochaenolites* Leymerie, 1842. However, it was not possible to determine its ichnospecies affiliation due to the insufficient preservation of the material. The unusual surface pattern of the only specimen of *Ichtyocoprus affectatus* described by Makarenko is an imprint of a coral substrate, rather than a structure that can occur in the gut of a coprolite producer.
Keywords: coprolite, bivalve boring, *Gastrochaenolites, Ichtyocoprus,* Eocene, Ukraine.

Вивчено типовий матеріал *Ichtyocoprus affectatus* Makarenko, 1993, що походить з еоценових відкладів кар'єру Візирка біля колишнього міста Інгулець (нині входить до складу м. Кривий Ріг). В оригінальному описі цей іхнотаксон було інтерпретовано як копроліт риби. Вивчення екземпляру, зображеного та описаного Дмитром Макаренко, показало, що насправді ця іхнофосилія є породним зліпком нірки бівальвії, що відноситься до іхнороду *Gastrochaenolites* Leymerie, 1842. Однак, визначити її іхновидову належність через недостатню збереженість матеріалу не вдалося. Незвичний візерунок на поверхні єдиного описаного Д. Макаренко екземпляра *Ichtyocoprus affectatus* є відбитком поверхні коралового субстрату, а не структурою, яка може виникнути в кишечнику продуцента копроліту.
Ключові слова: копроліт, перфорації бівальвій, *Gastrochaenolites, Ichtyocoprus,* еоцен, Україна.

INTRODUCTION

In 1993, Dmytro Yelyseyovych Makarenko (Fig. 1), a prominent Ukrainian palaeontologist, described a very unusual trace fossil *Ichtyocoprus affectatus* Makarenko, 1993, which he classified as a fish coprolite. The single specimen described by Makarenko (1993) was collected from the middle Eocene deposits exposed in the Vizyrka quarry near the town of Inhulets', which is now a part of the city of Kryvyi Rih, Dnipropetrovsk Region, Ukraine. *Ichtyocoprus affectatus* has not been cited in the literature, except for Dernov and Udovychenko (2014). A possible reason for this is doubts about the belonging of this ichnotaxon to coprolites, since the very unusual ornamentation of the outer surface could not have arisen in the gut of its potential producer. Additionally, the transverse section of *Ichtyocoprus affectatus* lacks the spiral pattern that is characteristic of fish coprolites, especially cartilaginous fishes (Milàn, 2011; Dentzien-Dias et al., 2021).

In November 2023, thanks to the courtesy of Dr Tamara Ryabokon (Institute of Geological Sciences of the National Academy of Sciences of Ukraine — IGS NASU, Kyiv), the author was able to examine a part of the collection of late Dmytro Ye. Makarenko, stored in the Department of Stratigraphy and Palaeontology of Cenozoic Sediments of the IGS NASU, and found the only figured specimen of *Ichtyocoprus affectatus*, as well as two other specimens marked by Makarenko in specimen's labels as "coprolites". Examination

Цитування: Дернов В. С. *Ichtyocoprus affectatus* Makarenko, 1993 — ядро нірки бівальвії, а не копроліт. Збірник наукових праць Інституту геологічних наук НАН України. 2023. Т. 16, вип. 1. С. 70–80. https://doi.10.30836/igs.2522-9753.2022.295187.

Citation: Dernov V. S. 2023. *Ichtyocoprus affectatus* Makarenko, 1993 is a bivalve boring rock cast, not a coprolite. Collection of scientific works of the Institute of Geological Sciences of NAS of Ukraine, Vol. 16, iss. 1. Pp. 70–80. https://doi.10.30836/igs.2522-9753.2022.295187.

of this material revealed that *Ichtyocoprus affectatus* is actually a rock cast of a bivalve boring *Gastrochaenolites* Leymerie, 1842. This trace fossil is briefly described below.

GEOLOGICAL SETTING, MATERIAL AND METHODS

One specimen of *Gastrochaenolites* isp. collected by Dmytro Ye. Makarenko from the middle Eocene deposits exposed in the Vizyrka quarry, located about 2.5 km west of the former town of Inhulets' (Fig. 2A, B) is investigated in this study. The quarry is flooded currently (Fig. 2C) and is part of the landscape reserve "Vizyrka", so it is impossible to collect fossils here.

Makarenko and Bilokrys (1985) and Bogdanovich et al. (2006) reported that the Vizyrka quarry exposed a Cenozoic sedimentary sequence consisting of carbonates and clays of the Sarmatian regional stage (late Miocene), early Oligocene carbonate manganese ores, and the middle and possibly late Eocene clays, sands and carbonates. The middle Eocene rocks, especially in its lower part, are rich in fossils, such as algae, radiolarians, foraminifers, infusorians, sponges, corals, bryozoans, brachiopods, gastropods, bivalves, scaphopods, echinoids, ostracods, crabs, and fishes (Makarenko and Bilokrys, 1985; Bogdanovich et al., 2006). According to Bogdanovich et al. (2006), the rocks described by Makarenko and Bilokrys (1985) belong to the late Lutetian–early Bartonian zones NP15 and NP16.

Currently, the sedimentary succession described by Makarenko and Bilokrys (1985) and Bogdanovich et al. (2006) refers to three rock formations: Rakhmanivka, Malynivka, and Staryi Inhulets', which are the analogues of the Buchak and Kyiv formations (Lutetian–Bartonian) of northern Ukraine (for details see Berezovsky (2009a, 2009b, 2017, 2022); Berezovsky and Kolesnik, (2015); Berezovsky and Pacaud (2019)).

In addition to Makarenko (1993), trace fossils from the Eocene deposits of the Inhulets' area were studied by Ablets and Berezovsky (1992) and Ablets (1993, 1994a, 1994b). Ablets and Berezovsky (1992) identified sponge borings, that probably belong to the ichnogenus *Entobia* Bronn, 1837 (author's interpretation), bryozoan and barnacle borings (probably *Rogerella* Saint-Seine, 1951), as well as 9 types of bivalve borings. Ablets (1993, 1994a) described the borings *Simonizapfes elongata* Codez, 1957 and *Zapfella* isp. produced by acrothoracic cirripedians, as well as phoronid borings *Talpina* isp. from the Vizyrka quarry and the quarry of the Inhulets' mining and processing plant.

Fig. 1. Dmytro Yelyseyovych Makarenko (1925–2008) (photo from the archive of the Department of Stratigraphy and Palaeontology of Mesozoic Sediments, IGS NASU).

The Eocene deposits in the area of the former town of Inhulets' are significant for identifying bivalve boring producers, as they often contain mollusk shells preserved *in situ* (Bilokrys et al., 1991; Bilokrys, 1992; Berezovsky, 1994). For example, Berezovsky (1994) noted that shells, belonging to the genus *Coralliophaga* Blainville, 1824 from the Lutetian deposits of the area of the town of Inhulets' occur in borings of various morphologies, which may have a calcareous lining of the inner surface.

The ichnofossil described below is rather poorly preserved and represented by rock cast of the boring. This material is housed in the Department of Palaeontology and Stratigraphy of Cenozoic Sediments of the IGS NASU (collection IGS-DYM01). Makarenko (1993) referred to *Ichtyocoprus affectatus* only the specimen IGS-DYM01/01, but two other specimens (IGS-DYM01/02 and IGS-DYM01/03), which are not described in Makarenko's work, were also considered coprolites by him, as evidenced by the inscriptions on the boxes in which they are stored. The article uses the morphological terminology of *Gastrochaenolites* proposed by Kelly & Bromley (1984: Fig. 1).

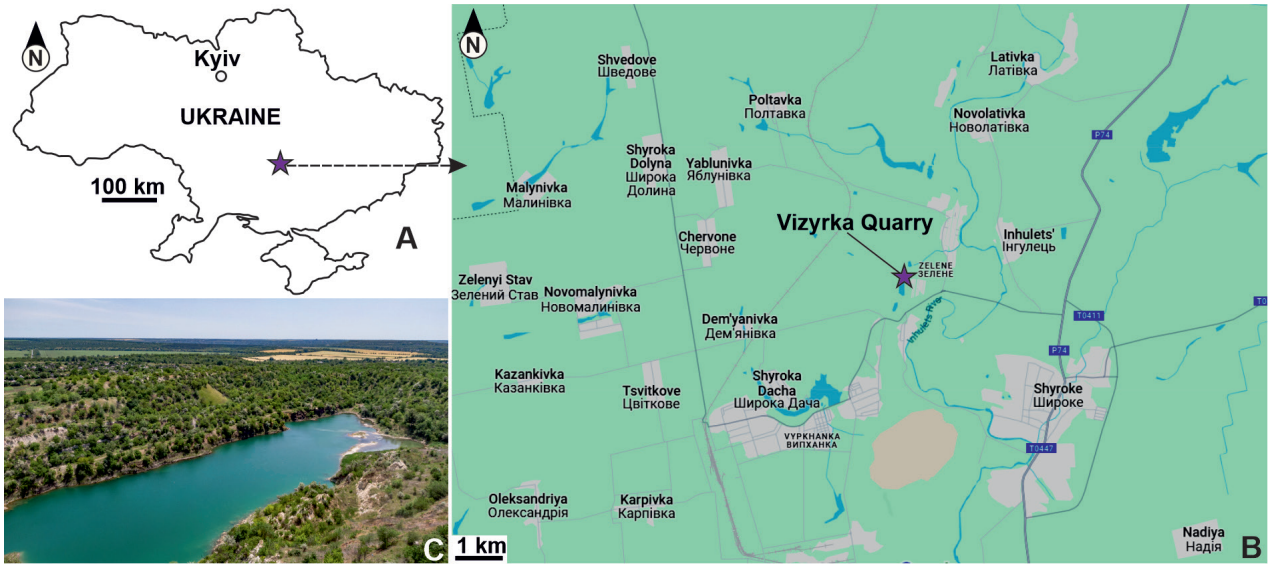

Fig. 2. Geographical location of the Vizyrka quarry (A, B) and its current state (C). Photo in Fig. 2C taken from #Findway (https://find-way.com.ua/oblast/dnipropetrovska/kryvyi-rih/vizyrka-kryvyi-rih).

SYSTEMATIC PALAEONTOLOGY

Ichnogenus *Gastrochaenolites* Leymerie, 1842

Type ichnospecies: *Gastrochaenolites lapidicus* Kelly & Bromley, 1984; by subsequent designation.

Diagnosis. Clavate borings in lithic substrates. The apertural region of the boring is narrower than the main chamber and may be circular, oval, or dumb-bell shaped. The aperture may be separated from the main chamber by a neck region which in some cases may be widely flared. The main chamber may vary from subspherical to elongate, having a parabolic to rounded truncated base and a circular to oval cross section, modified in some forms by a longitudinal ridge or grooves to produce an almond-or heart-shaped section (after Kelly and Bromley, 1984: p. 797).

Other included ichnospecies. *G. ampullatus* Kelly & Bromley, 1984; *G. anauchen* Wilson & Palmer, 1998; *G. cluniformis* Kelly & Bromley, 1984; *G. cor* Bromley & D'Alessandro, 1987; *G. dijugus* Kelly & Bromley, 1984; *G. hospitium* Kleemann, 2009; *G. japonicus* (Hatai et al., 1974); *G. oelandicus* Ekdale & Bromley, 2001; *G. orbicularis* Kelly & Bromley, 1984; *G. ornatus* Kelly & Bromley, 1984; *G. pickerilli* Donovan, 2003; *G. raigadensis* (Badve & Ghare, 1984); *G. torpedo* Kelly & Bromley, 1984; *G. turbinatus* Kelly & Bromley, 1984 and *G. vivus* Edinger & Risk, 1994 (Donovan and Jagt, 2013; Wisshak et al., 2019).

Remarks. *Gastrochaenolites* is one of the most common bioerosion trace fossil in Jurassic–Holocene carbonate substrates (Mikuláš and Dronov, 2006). The earliest *Gastrochaenolites* date back to the Pennsylvanian (Wilson and Palmer, 1998) or even the Ordovician (Ekdale and Bromley, 2001; Ekdale et al., 2002). The producers of *Gastrochaenolites* are mainly boring bivalves, but also gastropods of the family Coralliophillidae and some sipunculids (Bromley, 2004; Donovan, 2011).

Occurrence. ?Ordovician, Pennsylvanian to present; worldwide distribution.

Gastrochaenolites isp.

Fig. 3D, E

1993 *Ichtyocoprus affectatus*: Makarenko, p. 88, unnumbered text-fig.

Material. One poorly preserved fragment of the natural cast of the bivalve boring (specimen IGS-DYM01/01) which was found in a colonial coral (Makarenko, 1993: p. 87). The fragment is composed of the greyish-yellow calcareous clay.

Description. Specimen IGS-DYM01/01 is represented by the boring preserved as a fragment of the rock cast with a rounded in cross-section, cone-like outline main chamber (11 mm in diameter, 16 mm in length), which has a subhemispherical base. The structure of the cast is homogeneous with rare voids from dissolved mollusc shell fragments (Fig. 3D). The cast's outer surface is covered with a complex pattern (Fig. 3E), which is probably the imprints of the coral surface where the specimen IGS-DYM01/01 was found. Boring is not lined.

Remarks. Ichnospecies of the ichnogenus *Gastrochaenolites* listed above differs from each other in the shape of the main chamber, the degree

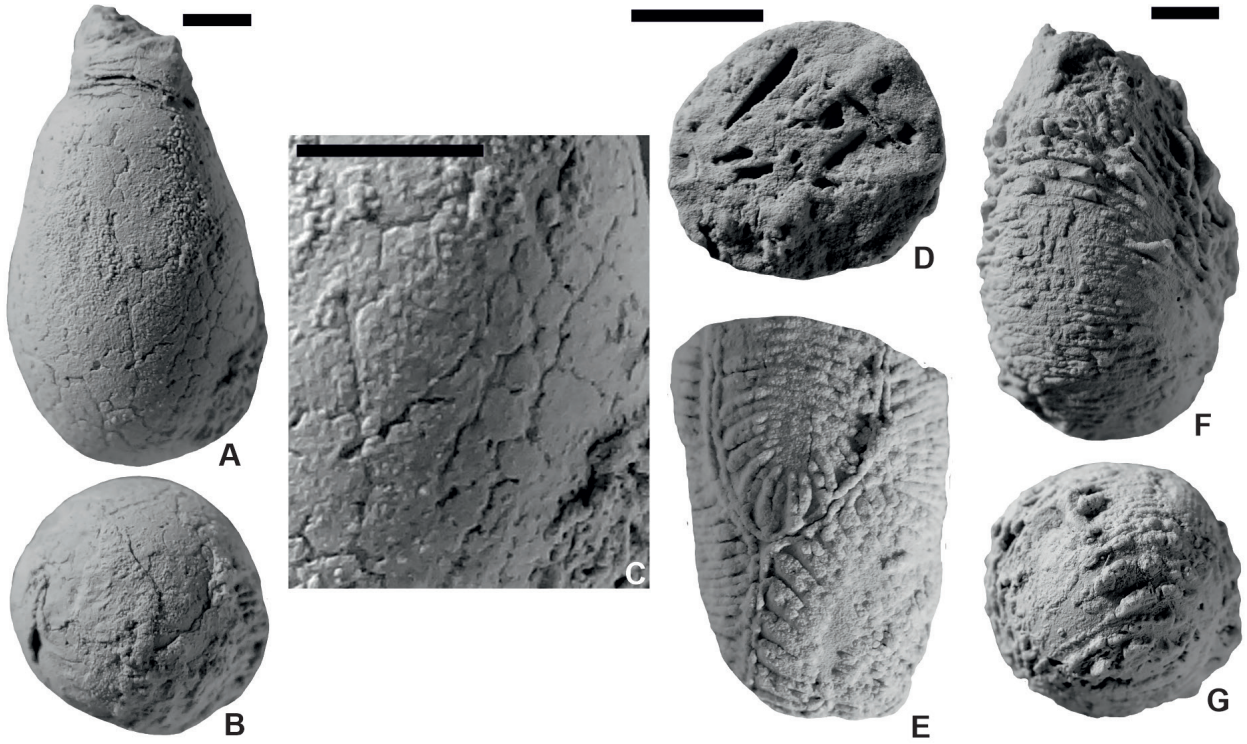

Fig. 3. Bivalves (A–C, F, G) and the bivalve boring (D, E) from the middle Eocene of the Vizyrka quarry. **A–C** — cast of *Clavagella* (*C.*) *polylophophora* Bilokrys, 1991 (IGS-DYM01/03): A — lateral view, B — anterior view, C — enlarged part of the lateral surface bearing burrows *Arachnostega* isp. **D, E** — *Gastrochaenolites* isp. (IGS-DYM01/01): D — natural fracture with a rounded cross section of the cast, E — lateral view. **F, G** — cast of *Clavagella* (*C.*) *polylophophora* Bilokrys, 1991 (IGS-DYM01/02): F — lateral view, G — anterior view. Scale bars = 5 mm.

of the neck expression and, to a lesser extent, the surface ornamentation. Unfortunately, the available material only allows for comparison with some ichnospecies of *Gastrochaenolites*. The described specimen is similar to *G. torpedo* from the Miocene and Pliocene deposits of the Antilles (Donovan and Hensley, 2006: fig. 3) in the shape of the main chamber. In addition, like the specimen IGS-DYM01/01, the Antilles specimens also bear impressions of the coral substrate on the surface of the boring casts. However, doe to the insufficient preservation of the specimen IGS-DYM01/01, it is not possible to make a precise comparison with another ichnospecies of the ichnogenus *Gastrochaenolites*.

Locality. Ukraine, Dnipropetrovsk Region, Vizyrka quarry near the city of Kryvyi Rih; middle Eocene.

DISCUSSION

The described specimen IGS-DYM01/01 cannot be classified as the coprolite due to the absence of characteristic coprolite morphological features such as phosphate or sulphide composition, undigested food fragments (e.g., fish scales, bone or shell debris), spiral structure and spiral surface pattern as seen in cartilaginous fish coprolites. Furthermore, the fact that *Ichtyocoprus affectatus* was found inside a colonial coral (Makarenko, 1993) provides additional evidence that it is not a coprolite. Instead, the described trace fossil can be confidently attributed to the ichnogenus *Gastrochaenolites*, as it is not contradicting its diagnosis provided above. In addition, the described here trace fossil are morphologically significantly different from the Palaeogene fish coprolites from Ukraine (Dernov and Udovychenko, 2014, 2023) and other countries (e.g., Dentzien-Dias et al., 2021; Jacquet et al., 2023).

In addition to the single fragment of the rock cast of *Gastrochaenolites*, two fragments of moulds of bivalves *Clavagella* (*C.*) *polylophophora* Bilokrys, 1991, designated by Makarenko as coprolites, were found in his collection (Fig. 3A–C, F, G). *Clavagella* (*C.*) *polylophophora* was described by Bilokrys

(1991) from the middle Eocene deposits of the quarry of the Inhulets' mining and processing plant.

The traces belonging to the ichnogenus *Arachnostega* Bertling, 1992 are present on the specimen IGS-DYM01/03 (see Fig. 3C). *Arachnostega* is usually interpreted as a domichnia or feeding structure in a consolidated soft- to firmground substrate, produced by detritus- or deposit-feeding polychaetes (Bertling, 1992; Fatka et al., 2011; Zatoń, 2020). The formation of *Arachnostega* likely occurred after the mollusk shell was filled with sediment, but before the sediment was lithified.

In Ukraine, *Gastrochaenolites* have been recorded on the surface of the Berriasian and Albian (Early Cretaceous) rockgrounds, pebbles, shells and corals in Crimea (Tseisler, 1958; Hekker and Uspenskaya, 1966; Yanin, 1978; Yanin and Vishnevsky, 1989; Baraboshkin and Baraboshkin, 2014), as well as on the Albian firmground of the area surrounding the city of Kaniv (Makarenko and Sokolov, 1987; Makarenko, 1990; Ogienko et al., 2017), in the mollusk shells and colonial corals from the Danian–Selandian (Palaeocene) deposits of the Luzanivka fossil site in Cherkassy Region (Ablets, 1994b), in the ?Ypresian and Lutetian (Eocene) hardgrounds of Luhansk Region (Dernov and Udovychenko, 2023), Lutetian of Kryvyi Rih (Ablets and Berezovsky, 1992; Ablets, 1994b) and the Priabonian (Eocene) of the Rybalskyi quarry in the city of Dnipro (Ablets, 1994b and author's unpublished data), the Miocene (Neogene) firmground of Podillia (Vyalov and Goretsky, 1965) and the Quaternary sediments of the Black Sea (Ablets, 1994b).

Gastrochaenolites described by Makarenko and Sokolov (1987) contain the bivalve shells *Myopholas semicostatus* (Agassiz, 1842) preserved *in situ*. However, it is important to note that this mollusk is of Albian or Cenomanian (Cretaceous) age (Ogienko et al., 2017), not Callovian (Jurassic) as previously believed by Makarenko and Sokolov (1987), Makarenko (1990) and Dykan' and Makarenko (1990). This is confirmed by the fact that the Callovian clays and siltstones are overlain by Albian or Cenomanian sands from the contact surface of which mollusc burrows intrude into the Callovian rocks. This is due to the fact that the firmground with *Gastrochaenolites* was formed in the Albian or Cenomanian.

Gastrochaenolites is typical of the Trypanites ichnofacies (Mikuláš and Dronov, 2006), which is characterised by the development of bioerosion trace fossils belonging to the ichnogenera *Trypanites, Gastrochaenolites, Entobia, Rogerella, Uniglobites, Maeandropolydora, Circolites, Conchotrema* and *Caulostrepsis* (Furlong et al., 2015). Biological erosion is the destruction of hard substrates, such as rocks, shells, bones, or wood, by a variety of organisms through scraping, perforation by chemical and mechanical means, etc. (Bromley, 1992; Demircan, 2012). Endolithic bioeroder communities develop on substrates that lack sedimentation (Bromley and Asgaard, 1993). Relatively simple, shallow traces that occur during short-term episodes of bioerosion are usually produced by pioneer bioeroder communities (Bromley and Asgaard, 1993), which disappear when erosion is replaced by sedimentation.

The surface of the specimen IGS-DYM01/01 bears a pattern that is an impression of the upper surface of a colonial coral substrate, which should probably be called Fremdskulpturen *sensu* Voigt (1971), i.e., "…imprints of diagenetically dissolved aragonitic skeletal structure on the walls of tunnels burrowed by worms in corals" (after Žítt and Mikuláš, 2006: p. 196). Corals have not been studied from the Eocene deposits of the Vizyrka quarry (some were figured by Bilokrys et al. (1991)), but there are several works (e.g., Berezovsky and Berezovsky, 2016; Berezovsky and Satanovska, 2018, 2020) devoted to the study of the middle Eocene corals from the quarry of the Inhulets' mining and processing plant, which is located about 2 km south the abandoned Vizyrka quarry.

According to Berezovsky and Girik (2016), the coral assemblage from the quarry of the Inhulets' mining and processing plant includes about 50 species belonging to 30 genera, of which species of the genera *Acropora*, *Cyathoseris*, *Lithophyllon*, *Trochocyathus*, and *Turbinolia* have been formally described (Berezovsky and Berezovsky, 2016; Berezovsky et al., 2017; Berezovsky and Satanovska, 2018, 2020). The pattern on the surface of the specimen IGS-DYM01/01 is most similar to the surface of the coral identified by Bilokrys et al. (1991: pl. 1, fig. 5) as the species of the genus *Diploria* Milne Edwards & Haime, 1848. However, there are also similarities with *Colpophyllia slavutytschensis* Kuzmicheva, 1987 from the Mandrykivka Beds (Priabonian, late Eocene) exposed in the Rybalskyi quarry in the city of Dnipro.

Bilokrys et al. (1991) reported that the middle Eocene corals from the Vizyrka quarry and the quarry of the Inhulets' mining and processing plant are represented usually by small (several centimetres in diameter) corallites, which sometimes contain borings produced by *Lithophaga* Röding, 1798. Bilokrys et al. (1991) figured borings and their fills in corals from quarry of the Inhulets' mining and processing plant with shells *Lithophaga* preserved *in situ*. They also note that the outer surface of the boring casts sometimes bears the impression of the surface of the coral substrate. This is also observed in some of the specimens described above.

The potential producers of the above-described boring *Gastrochaenolites* isp. may be bivalves *Aspidopholas armata* Bilokrys, 1992, which occurs mainly in borings in the coral substrate among the Eocene deposits exposed by the Vizyrka quarry and the quarry of the Inhulets' mining and processing plant. Borings produced by *Aspidopholas armata* (Bilokrys, 1992: pl. 2, fig. 1) in the coral substrate morphologically closely resemble *Gastrochaenolites* isp. described above.

CONCLUSIONS

The study of the original material shows that the ichnospecies *Ichtyocoprus affectatus* Makarenko, 1993 from the middle Eocene deposits of the Vizyrka quarry is not the fish coprolite taxon, but rather the natural casts of the bivalve boring belonging to the ichnogenus *Gastrochaenolites*. The unusual pattern on the surface of the only specimen of *Ichtyocoprus affectatus* described by Makarenko is an imprint of the surface of a coral substrate, rather than a structure that can occur in the gut of a coprolite producer. Unfortunately, the described boring cannot be attributed to a specific ichnospecies of the ichnogenus *Gastrochaenolites* due to its poor preservation. However, it is very similar to *G. torpedo*. The producer of the studied boring is most likely bivalve, which are widely represented in the middle Eocene deposits of the area of the former town of Inhulets'; some of them were found *in situ* in *Gastrochaenolites* by previous researchers.

ACKNOWLEDGEMENTS

I would like to thank Dr Tamara Ryabokon (Institute of Geological Sciences, NAS of Ukraine, Kyiv) for the opportunity to study the collection of Dmytro Ye. Makarenko. The author is sincerely grateful to the anonymous reviewers whose comments and suggestions improved the quality of the final version of the manuscript.

The research was carried out within the framework of the scientific theme "Late Precambrian and Phanerozoic biota of Ukraine: biodiversity, revision of systematic composition and phylogeny of leading groups" (No. 0122U001609).

REFERENCES

Ablets V. V., 1993. Trace fossils of acrothoracic cirripeds from the Eocene of the Kryvyi Rih Basin. *Paleontological Journal*. No. 2. Pp. 56–61. (In Russian).

Аблец В. В. Следы жизнедеятельности акроторацидных усоногих раков из эоцена Кривого Рога. *Палеонтологический журнал*. 1993. № 2. С. 56–61.

Ablets V. V., 1994a. Phoronid borings from the Eocene of Ukraine. *Paleontological Journal*. No. 1. Pp. 122–125. (In Russian).

Аблец В. В. Сверления форонид из эоцена Украины. *Палеонтологический журнал*. 1994а. № 1. С. 122–125.

Ablets V. V., 1994b. Trace fossils in Cenozoic hard substrates of Ukraine. PhD Thesis abstract. Kyiv. 18 p. (In Russian).

Аблец В. В. Следы жизнедеятельности в твердых субстратах кайнозоя Украины. Тезисы диссертации на соискание ученой степени кандидата геол.-мин. Наук. Киев, 1994б. 18 с.

Ablets V. V., Berezovsky A. A., 1992. Some trace fossils from the Eocene deposits of the area of the city of Inhulets'. In: Teslenko Yu.V. (Ed.), Geological history of environments in Ukraine. Kyiv: Naukova Dumka. Pp. 104–106. (In Russian).

Аблец В. В., Березовский А. А. Некоторые следы жизнедеятельности из эоценовых отложений района г. Ингулец. Тесленко Ю. В. (Ред.) *Геологическая история экологических обстановок на территории Украины*. Киев: Наукова думка, 1992. С. 104–106.

Agassiz L., 1842. Études critiques sur les mollusques fossiles. 2. Monographie des Myes. Neuchâtel: Imprimerie de Petitpiere. 141 p. https://doi.org/10.5962/bhl.title.1126

Agassiz L. Études critiques sur les mollusques fossiles. 2. Monographie des Myes. Neuchâtel: Imprimerie de Petitpiere, 1842. 141 pp.

Baraboshkin E. Yu., Baraboshkin E. E., 2014. The structure and origin of the Albian rockground in the Chernorech'e village

Baraboshkin E. Yu., Baraboshkin E. E. The structure and origin of the Albian rockground in the Chernorech'e village area of

area of southwestern Crimea. *Moscow University Geology Bulletin*. Vol. 69. No. 6. Pp. 424–432. https://doi.org/10.3103/s0145875214060027.

Berezovsky A. A., 1994. New species of the genus *Coralliophaga* (Bivalvia) from the Eocene of Ukraine. *Palaeontological Journal*. No. 1. Pp. 11–15. (In Russian).

Berezovsky A. A., 2009a. Staryi Inhulets' Formation (middle Eocene, Kryvyi Rih Basin): subdivision, age and correlation. *Geology and Mineralogy Bulletin of Kryvyi Rih National University*. Vol. 21–22. Pp. 35–66. (In Russian).

Berezovsky A. A., 2009b. On the faunistic characteristics of the Malynivka Formation (middle Eocene) of the Kryvyi Rih Basin. *Transactions of the National Mining University (Dnipro)*. Vol. 33. No. 1. Pp. 33–42. (In Russian).

Berezovsky A. A., 2017. Rakhmanivka Formation (middle Eocene, southern slope of the Ukrainian Shield): age, distribution and correlation. *Proceedings of the All-Ukrainian Scientific and Practical Conference "Development of industry and society". Section 5. Geology and applied mineralogy (24–26 May, 2017; Kryvyi Rih)*. Kryvyi Rih: Kryvyi Rih National University Publishing Center. Pp. 11–16. (In Russian).

Berezovsky A. A., 2022. Revision of *Bathytormus* (Crassatellidae, Bivalvia) of the middle Eocene of Krivoi Rog (Ukraine). *Paleontological Journal*. Vol. 56. No. 1. Pp. 24–36. https://doi.org/10.1134/s0031030122010038.

Berezovsky A. A., Berezovsky D. A., 2016. A first record of the coral genus *Turbinolia* (Scleractinia) in the middle Eocene of Kryvyi Rih. *Proceedings of the All-Ukrainian Scientific and Practical Conference "Development of industry and society". Section 5. Geology, applied mineralogy and ecology (25–27 May, 2016; Kryvyi Rih)*. Kryvyi Rih: Kryvyi Rih National University Publishing Center. Pp. 43–46. (In Russian).

Berezovsky A. A., Berezovsky D. A., Matviyko V. D., 2017. Morphological features of the species of the genus *Trochocyathus* from the middle Eocene of the Kryvyi Rih Basin. *Proceedings of the All-Ukrainian Scientific and Practical Conference "Development of industry and society". Section 5. Geology and applied mineralogy (24–26 May, 2017; Kryvyi Rih).* Kryvyi Rih: Kryvyi Rih National University Publishing Center. Pp. 39–44. (In Russian).

Berezovsky A. A., Girik G. N., 2016. A first record of the gastropods *Faunus* in the Eocene of Ukraine. *Proceedings of the 12th All-Ukrainian Scientific and Practical Conference "Modern geological science and practice in the research of students and young professionals" (24–26 March, 2016; Kryvyi Rih).* Kryvyi Rih: Kryvyi Rih National University Publishing Center. Pp. 69–71. (In Russian).

Berezovsky A. A., Kolesnik V. I., 2015. Stratigraphy of Paleogene deposits exposed by the quarry of the Inhulets' mining and processing plant. *Proceedings of the 11th All-Ukrainian Scientific and Practical Conference "Modern geological science and practice in the research of students and young professionals" (26–28 March, 2015; Kryvyi Rih).* Kryvyi Rih: Kryvyi Rih National University Publishing Center. Pp. 66–69. (In Russian).

Berezovsky A. A., Pacaud J.-M., 2019. New species of the genus *Chelotia* (Pleurotomariidae, Gastropoda) from the middle

southwestern Crimea. *Moscow University Geology Bulletin*. 2014. Vol. 69. No. 6. Pp. 424–432.

Березовский А. А. Новые виды *Coralliophaga* (Bivalvia) из эоцена Украины. *Палеонтологический журнал*. 1994. № 1. С. 11–15.

Березовский А. А. Староингулецкая свита (средний эоцен, Кривбасс): расчленение, возраст и корреляция. *Геолого-мінералогічний вісник Криворізького національного університету*. 2009а. № 21–22. С. 35–66.

Березовский А. А. К фаунистической характеристике малиновской свиты (средний эоцен) Криворожского бассейна. *Збірник наукових праць Національного гірничого університету.* 2009б. № 1. С. 33–42.

Березовский А. А. Рахмановская свита (средний эоцен, южный склон Украинского щита): возраст, распространение и корреляция. *Розвиток промисловості та суспільства. Секція 5. Геологія і прикладна мінералогія (Кривий Ріг, 24–26 травня 2017 р.).* Кривий Ріг: Видавничий центр Криворізького національного університету, 2017. С. 11–16.

Berezovsky A. A. Revision of *Bathytormus* (Crassatellidae, Bivalvia) of the middle Eocene of Krivoi Rog (Ukraine). *Paleontological Journal*. 2022. Vol. 56. No. 1. Pp. 24–36.

Березовский А. А., Березовский Д. А. Первая находка кораллов рода *Turbinolia* (Scleractinia) в осадках среднего эоцена Кривого Рога. *Розвиток промисловості та суспільства. Секція 5. Геологія і прикладна мінералогія. Екологія. Матеріали науково-технічної конференції (Кривий Ріг, 24–26 травня 2017 р.).* Кривий Ріг: Видавничий центр Криворізького національного університету, 2016. С. 43–46.

Березовский А. А., Березовский Д. А., Матвийко В. Д. Морфологические особенности одного вида кораллов рода *Trochocyathus* из среднего эоцена Кривбасса. *Сучасна геологічна наука і практика в дослідженнях студентів і молодих фахівців. Матеріали XII Всеукраїнської науково-практичної конференції (Кривий Ріг, 24–26 травня 2017 р.).* Кривий Ріг: Видавничий центр Криворізького національного університету, 2017. С. 39–44.

Березовский А. А., Гирик Г. Н. Первая находка представителей рода *Faunus* (Gastropoda) в среднеэоценовых отложениях Украины. *Сучасна геологічна наука і практика в дослідженнях студентів і молодих фахівців. Матеріали XII Всеукраїнської науково-практичної конференції (Криворізький національний університет, 24–26 березня 2016 р.).* Кривий Ріг: Видавничий центр Криворізького національного університету, 2016. С. 69–71.

Березовский А. А., Колесник В. И. Стратиграфия палеогеновых отложений карьера Ингулецкого ГОКа (Кривбасс). *Сучасна геологічна наука і практика в дослідженнях студентів і молодих фахівців. Матеріали XI Всеукраїнської науково-практичної конференції (Криворізький національний університет, 26–28 березня 2015 р.)*. Кривий Ріг: Видавничий центр Криворізького національного університету, 2015. С. 66–69.

Berezovsky A. A., Pacaud J.-M. New species of the genus *Chelotia* (Pleurotomariidae, Gastropoda) from the middle

Eocene of Ukraine. *Paleontological Journal*. Vol. 53. No. 6. Pp. 593–597. https://doi.org/10.1134/s0031030119060029.

Eocene of Ukraine. *Paleontological Journal*. 2019. Vol. 53. No. 6. P. 593–597.

Berezovsky A. A., Satanovskaya T. J. 2018. The genus *Acropora* (Scleractinia) in the middle Eocene of the Kryvyi Rih Basin. *Proceedings of the 13th All-Ukrainian Scientific and Practical Conference "Modern geological science and practice in the research of students and young professionals" (29–31 March, 2018; Kryvyi Rih).* Kryvyi Rih: Kryvyi Rih National University Publishing Center. Pp. 18–20. (In Russian).

Березовский А. А., Сатановская Т. Ю. Род *Acropora* (Scleractinia) в среднем эоцене Кривбасса. *Сучасна геологічна наука і практика в дослідженнях студентів і молодих фахівців. Матеріали XIV Всеукраїнської науково-практичної конференції Криворізький національний університет (29–31 березня 2018 р.)*. Кривий Ріг: Видавничий центр Криворізького національного університету, 2018. С. 18–20.

Berezovsky A. A., Satanovskaya T. J. 2020. Genus *Lithophyllon* (Scleractinia) in the middle Eocene of Kryvyi Rih. *Geology and Mineralogy Bulletin of Kryvyi Rih National University*. Vol. 43–44. Pp. 105–113. (In Russian).

Березовский А. А., Сатановская Т. Ю. Род *Lithophyllon* (Scleractinia) в среднем эоцене Кривого Рога. *Геолого-мінералогічний вісник Криворізького національного університету*. 2020. № 43–44. С. 105–113.

Bertling M., 1992. *Arachnostega* n. ichnog. — burrowing traces in internal moulds of boring bivalves (late Jurassic, Northern Germany). *Paläontologische Zeitschrift*. Vol. 66. Pp. 177–185.

Bertling M. *Arachnostega* n. ichnog. — burrowing traces in internal moulds of boring bivalves (late Jurassic, Northern Germany). *Paläontologische Zeitschrift*. 1992. Vol. 66. P. 177–185.

Bilokrys L. S., 1991. Tube-dwelling bivalves from the Eocene of Ukraine. *Paleontological Journal*. No. 4. Pp. 32–41. (In Russian).

Белокрыс Л. С. Бивальвии-трубкожилы из эоцена Украины. *Палеонтологический журнал*. 1991. № 4. С. 32–41.

Bilokrys L. S., 1992. Pholadid species (Bivalvia) from the Eocene of Ukraine. *Paleontological Journal*. No. 4. Pp. 11–16. (In Russian).

Белокрыс Л. С. Виды фоладид (Bivalvia) из эоцена Украины. *Палеонтологический журнал*. 1992. № . 4. С. 11–16.

Bilokrys L. S., Ablets V. V., Berezovsky A. A., 1991. Eocene commensal mytilids (Bivalvia) from Ukraine. *Palaeontological Review*. Vol. 28. Pp. 21–26. (In Russian).

Белокрыс Л. С., Аблец В. В., Березовский А. А. Эоценовые митилиды-комменсалы (Bivalvia) из Украины. *Палеонтологический сборник*. 1991. Т. 28. С. 21–26.

Blainville H. M. D. de, 1824. Mollusques, Mollusca (Malacoz.). In: Cuvier F. (Ed.), Dictionnaire des Sciences Naturelles. Vol. 32. Strasbourg et Paris: Levrault & Le Normant. 392 p.

Blainville H. M. D. de. Mollusques, Mollusca (Malacoz.). Cuvier F. (Ed.) *Dictionnaire des Sciences Naturelles*. Vol. 32. Strasbourg et Paris: Levrault & Le Normant, 1824. 392 pp.

Bogdanovich E. M., Konenkova I. D., Ivanova T. A., Bondar O. V., Manyuk V. V., 2006. On the stratigraphic position and palaeontological features of the Eocene deposits of Dnipropetrovsk Region (Vizyrka Quarry). In: Gozhyk P. F. (Ed.), Palaeontological and stratigraphic problems of the Proterozoic and Phanerozoic of Ukraine. Scientific works of the Institute of Geological sciences of the NAS of Ukraine. Kyiv. Pp. 188–192. (In Russian).

Богданович Е. М., Коненкова И. Д., Иванова Т. А., Бондарь О. В., Манюк В. В. О стратиграфическом положении и палеонтологических особенностях эоценовых отложений Днепропетровской области (карьер Визирка). Гожик П. Ф. (ред.) Проблеми палеонтології та біостратиграфії фанерозою України. Збірник наукових праць Інституту геологічниз наук НАН України. Київ, 2006. С. 188–192.

Bromley R. G., 1992. Bioerosion: eating rocks for fun and profit. In: Maples C. G., West R. R. (Eds.), *Trace Fossils. Short Course in Paleontology*. Vol. 5. Cambridge: Cambridge University Press. Pp. 121–129. https://doi.org/10.1017/s2475263000002312

Bromley R. G. Bioerosion: eating rocks for fun and profit. Maples C. G., West R. R. (Eds.) *Trace Fossils. Short Course in Paleontology*. *Vol. 5*. Cambridge: Cambridge University Press, 1992. P. 121–129.

Bromley R. G. 2004. A stratigraphy of marine bioerosion. In: McIlroy D. (Ed.), The application of ichnology to palaeoenvironmental and stratigraphic analysis. *Geological Society special publication*. Vol. 228. Pp. 455–479. https://doi.org/10.1144/gsl.sp.2004.228.01.20.

Bromley R. G. A stratigraphy of marine bioerosion. McIlroy D. (Ed.) *The application of ichnology to palaeoenvironmental and stratigraphic analysis*. *Geological Society special publication*. 2004. Vol. 228. P. 455–479.

Bromley R. G., Asgaard U., 1993. Two bioerosion ichnofacies produced by early and late burial associated with sea-level change. *Geologische Rundschau*. Vol. 82. Pp. 276–280. https://doi.org/10.1007/BF00191833.

Bromley R. G., Asgaard U. Two bioerosion ichnofacies produced by early and late burial associated with sea-level change. *Geologische Rundschau*. 1993. Vol. 82. P. 276–280.

Bromley R. G., d'Alessandro A., 1987. Bioerosion of the Plio-Pleistocene transgression of southern Italy. *Rivista Italiana di Paleontologia e Stratigrafia*. Vol. 93. Pp. 379–422. https://doi.org/10.54103/2039-4942/13191.

Bromley R. G., d'Alessandro A. Bioerosion of the Plio-Pleistocene transgression of southern Italy. *Rivista Italiana di Paleontologia e Stratigrafia*. 1987. Vol. 93. P. 379–422.

Bronn H. G. 1835–1838. Lethaea Geognostica, oder Abbildungen und Beschreibungen der für die GebirgsFormationen bezeichnendsten Versteinerungen.

Bronn H. G. Lethaea Geognostica, oder Abbildungen und Beschreibungen der für die GebirgsFormationen

Stuttgart: Schweizerbart's Verlagshandlung. 1346 s. https://doi.org/10.5962/bhl.title.59080.

Demircan H., 2012. Determination of a Late Miocene rocky palaeoshore by bioerosion trace fossils from the Bozcaada Island, Çanakkale, Turkey. *Comptes Rendus Palevol*. Vol. 11. No. 5. Pp. 331–344. https://doi.org/10.1016/j.crpv.2011.11.002.

Dentzien-Dias P., Hunt A. P., Lucas S. G., Francischini H., Gulotta M., 2021. Coprolites from shallow marine deposits of the Nanjemoy Formation, Lower Eocene of Virginia, USA. *Lethaia*. Vol. 54. No. 1. Pp. 26–39. https://doi.org/10.1111/let.12380.

Dernov V. S., Udovychenko M. I., 2014. Coprolites of cartilaginous fishes from the Paleogene deposits of Crimea. *Transactions of the Dnipropetrovsk University. Geology and Geography*. Vol. 15. Pp. 2–8. (In Ukrainian).

Dernov V., Udovychenko M., 2023. Trace fossils from the Buchak Formation (Lutetian, Eocene) of Luhansk Oblast, Ukraine, and their palaeogeographic significance. *GEO&BIO*. Vol. 24. Pp. 106–140. (In Ukrainian). https://doi.org/10.53452/gb2408.

Donovan S., 2003. A new ichnospecies of *Gastrochaenolites* Leymerie from the Pleistocene Port Morant Formation of Southeast Jamaica and the taphonomy of calcareous linings in clavate borings. *Ichnos*. Vol. 9. No. 1–2. Pp. 61–66. https://doi.org/10.1080/10420940190034085.

Donovan S., 2011. The recent boring *Gastrochaenolites ornatus* Kelly & Bromley, 1984, in a Chalk cobble from Cromer, England. *Bulletin of the Mizunami Fossil Museum*. Vol. 37. Pp. 185–188.

Donovan S. K., Hensley C., 2006. *Gastrochaenolites* Leymerie in the Cenozoic of the Antillean Region. *Ichnos*. Vol. 13. No. 1. Pp. 11–19. https://doi.org/10.1080/10420940500511629.

Donovan S. K., Jagt J. W.M. 2013. Aspects of clavate borings in the type Maastrichtian (Upper Cretaceous) of the Netherlands and Belgium. *Netherlands Journal of Geosciences*. Vol. 92. Pp.133–143. https://doi.org/10.1017/S0016774600000068.

Dykan' K. V., Makarenko, D. Ye., 1990. Upper Jurassic bivalves and gastropods of the Dnipro-Donets Depression. Kyiv, Naukova Dumka, 140 p. (In Russian).

Edinger E. N., Risk M. J., 1994. Oligocene–Miocene extinction and geographic restriction of Caribbean corals: roles of turbidity, temperature, and nutrients. *Palaios*. Vol. 9. No. 6. Pp. 576–598. https://doi.org/10.2307/3515129.

Ekdale A. A., Benner J. S., Bromley R. G., Gibert J. M. de, 2002. Bioerosion of Lower Ordovician hardgrounds in southern Scandinavia and western North America. *Acta Geologica Hispanica*. Vol. 37. No. 1. Pp. 9–13.

Ekdale A. A., Bromley R. G., 2001. Bioerosional innovation for living in carbonate hardgrounds in the early Ordovician of Sweden. *Lethaia*. Vol. 34. No. 1. Pp. 1–12. https://doi.org/10.1080/002411601300068152.

Fatka O., Mikuláš R.; Szabad M., Micka V., Valent M., 2011. *Arachnostega* Bertling, 1992 in the Drumian (Cambrian) sediments of the Teplá-Barrandian region (Czech Republic). *Acta Geologica Polonica*. Vol. 61. No. 4. Pp. 367–381.

Furlong C. M., Gingras M. K., Zonneveld J.-P., 2015. *Trypanites*-type ichnofacies at the Bay of Fundy, Nova Scotia, Canada.

bezeichnendsten Versteinerungen. Stuttgart: Schweizerbart's Verlagshandlung, 1835–1838. 1346 s.

Demircan H. Determination of a Late Miocene rocky palaeoshore by bioerosion trace fossils from the Bozcaada Island, Çanakkale, Turkey. *Comptes Rendus Palevol*. 2012. Vol. 11. No. 5. P. 331–344.

Dentzien-Dias P., Hunt A. P., Lucas S. G., Francischini H., Gulotta M. Coprolites from shallow marine deposits of the Nanjemoy Formation, Lower Eocene of Virginia, USA. *Lethaia*. 2021. Vol. 54. No. 1. P. 26–39.

Дернов В. С., Удовиченко М. І. Копроліти хрящових риб із палеогенових відкладів Криму. *Вісник Дніпропетровського університету. Серія «Геологія. Географія»*. 2014. Вип. 15. С. 2–8.

Дернов В., Удовиченко М. Іхнофосилії з відкладів бучацької світи (лютецький ярус, еоцен) Луганщини та їхнє палеогеографічне значення. *GEO&BIO*. 2023. Т. 24. С. 106–140.

Donovan S. A new ichnospecies of *Gastrochaenolites* Leymerie from the Pleistocene Port Morant Formation of Southeast Jamaica and the taphonomy of calcareous linings in clavate borings. *Ichnos*. 2003. Vol. 9. No. 1–2. P. 61–66.

Donovan S. The recent boring *Gastrochaenolites ornatus* Kelly & Bromley, 1984, in a Chalk cobble from Cromer, England. *Bulletin of the Mizunami Fossil Museum*. 2011. Vol. 37. P. 185–188.

Donovan S. K., Hensley C. *Gastrochaenolites* Leymerie in the Cenozoic of the Antillean Region. *Ichnos*. 2006. Vol. 13. No. 1. P. 11–19.

Donovan S. K., Jagt J. W.M. Aspects of clavate borings in the type Maastrichtian (Upper Cretaceous) of the Netherlands and Belgium. *Netherlands Journal of Geosciences*. 2013. Vol. 92. P. 133–143.

Дыкань К. В., Макаренко Д. Е. Двустворчатые и брюхоногие моллюски верхней юры Днепровско-Донецкой впадины. Киев: Наукова думка, 1990. 140 с.

Edinger E. N., Risk M. J. Oligocene–Miocene extinction and geographic restriction of Caribbean corals: roles of turbidity, temperature, and nutrients. *Palaios*. 1994. Vol. 9. No. 6. P. 576–598.

Ekdale A. A., Benner J. S., Bromley R. G., Gibert J. M. de. Bioerosion of Lower Ordovician hardgrounds in southern Scandinavia and western North America. *Acta Geologica Hispanica*. 2002. Vol. 37. No. 1. P. 9–13.

Ekdale A. A., Bromley R. G. Bioerosional innovation for living in carbonate hardgrounds in the early Ordovician of Sweden. *Lethaia*. 2001. Vol. 34. No. 1. P. 1–12.

Fatka O., Mikuláš R.; Szabad M., Micka V., Valent M. *Arachnostega* Bertling, 1992 in the Drumian (Cambrian) sediments of the Teplá-Barrandian region (Czech Republic). *Acta Geologica Polonica*. 2011. Vol. 61. No. 4. P. 367–381.

Furlong C. M., Gingras M. K., Zonneveld J.-P. *Trypanites*-type ichnofacies at the Bay of Fundy, Nova Scotia, Canada. *Palaios*. 2015. Vol. 30. No. 4. P. 258–271.

Palaios. Vol. 30. No. 4. Pp. 258–271. https://doi.org/10.2110/palo.2014.056.

Goretsky V. A., 1957. Tortonian infauna of some fossil sine in Volyn and Podillia. *Transactions of the Lviv Geological Society*. Vol. 4. Pp. 267–276. (In Russian).

Горецкий В. А. Инфауна тортона некоторых местонахождений Волыно-Подолии. *Геологический сборник Львовского геологического общества*. 1957. Вып. 4. С. 267–276.

Hekker R. F., Uspenskaya E. A., 1966. On the significance of the smooth surfaces of limestones, eroded by rock-boring organisms. In: Hekker R. F. (Ed.), Organism and environment in the geological past. Moscow: Nauka. Pp. 246–254. (In Russian).

Геккер Р. Ф., Успенская Е. А. Об индикаторном значении сглаженных поверхностей известняков, иссверленных камнеточцами. Геккер Р. Ф. (Ред.) *Организм и среда в геологическом прошлом*. Москва: Наука, 1966. С. 246–254.

Jacquet S. M., Webb J.-L., Huntley J. W., Selly T., Schiffbauer J. D., 2023. X-ray tomographic microscopy of Eocene coprolites from Pipestone Springs Main Pocket, southwest Montana. *Frontiers in Earth Science*. Vol. 11. Article 1130107. https://doi.org/10.3389/feart.2023.1130107.

Jacquet S. M., Webb J.-L., Huntley J. W., Selly T., Schiffbauer J. D. X-ray tomographic microscopy of Eocene coprolites from Pipestone Springs Main Pocket, southwest Montana. *Frontiers in Earth Science*. 2023. Vol. 11. Article 1130107.

Kelly S. R. A., Bromley R. G., 1984. Ichnological nomenclature of clavate borings. *Palaeontology*. Vol. 27. Pt. 4. Pp. 793–807.

Kelly S. R. A., Bromley R. G. Ichnological nomenclature of clavate borings. *Palaeontology*. 1984. Vol. 27. Pt. 4. P. 793–807.

Kleemann K., 2009. *Gastrochaenolites hospitium* isp. nov., trace fossil by a coralassociated boring bivalve from the Eocene and Miocene of Austria. *Geologica Carpathica*. Vol. 60. No. 4. Pp. 339–342. https://doi.org/10.2478/v10096–009–0025–0.

Kleemann K. *Gastrochaenolites hospitium* isp. nov., trace fossil by a coralassociated boring bivalve from the Eocene and Miocene of Austria. *Geologica Carpathica*. 2009. Vol. 60. No. 4. P. 339–342.

Kuzmicheva E. I., 1987. Upper Cretaceous and Paleogene corals of the USSR. Moscow: Nauka, 187 p. (In Russian).

Кузьмичева Е. И. Верхнемеловые и палеогеновые кораллы СССР. Москва: Наука, 1987. 187 с.

Makarenko D. Ye., 1990. Jurassic bivalves of the Kaniv Dislocations. In: Vyalov O. S. (Ed.), Palaeontological and biostratigraphic research during geological mapping in Ukraine. Kyiv: Naukova Dumka. Pp. 61–65. (In Russian).

Макаренко Д. Е. Юрские двустворки из района Каневских дислокаций. Вялов О. С. (Ред.) *Палеонтологические и биостратиграфические исследования при геологической съемке на Украине*. Киев: Наукова думка, 1990. С. 61–65.

Makarenko D. Ye., 1993. On the coprolite from the Eocene of Ukraine. In: Vyalov O. S., Fedonkin M. A. (Eds), Traces of ancient organisms. Moscow: Nauka. Pp. 86–89. (In Russian).

Макаренко Д. Е. О копролите из эоцена Украины. Вялов О. С., Федонкин М. А. (Ред.) *Следы жизнедеятельности древних организмов*. Москва: Наука, 1993. С. 86–89.

Makarenko D. Ye., Bilokrys L. S., 1985. Middle Eocene deposits in the middle reaches of the Inhulets' River. *Palaeontological Review*. Vol. 22. Pp. 78–85. (In Russian).

Макаренко Д. Е., Белокрыс Л. С. Среднеэоценовые отложения среднего течения реки Ингульца. *Палеонтологический сборник*. 1985. Вып. 22. С. 78–85.

Makarenko D. Ye., Sokolov I. P., 1987. Boring mollusk *Myopholas* as an environmental indicator of the Late Jurassic palaeobasin. In: Vyalov O. S. (Ed.), Biostratigraphy and palaeontology of the sediment cover of Ukraine. Kyiv: Naukova Dumka. Pp. 70–73. (In Russian).

Макаренко Д. Е., Соколов И. П. Всверливающийся моллюск *Myopholas* как индикатор среды позднеюрского бассейна. Вялов О. С. (Ред.) Биостратиграфия, палеонтология осадочного чехла Украины. Киев: Наукова думка, 1987. С. 70–73.

Mikuláš R., Dronov A., 2006. Paleoichnology — introduction to the study of trace fossil. Prague. 122 p. (In Russian).

Микулаш Р., Дронов А. Палеонтология (введение в изучение ископаемых следов жизнедеятельности). Прага, 2006. 122 с.

Milàn J., 2011. Coprolites from the Danian limestone (Lower Paleocene) of Faxe Quarry, Denmark. In: Milàn J., Lucas S. G., Lockley M. G., Spielmann J. A. (Eds), Crocodyle tracks and traces. *New Mexico Museum of Natural History and Science Bulletin*. Vol. 51. Pp. 215–218.

Milàn J. Coprolites from the Danian limestone (Lower Paleocene) of Faxe Quarry, Denmark. Milàn J., Lucas S. G., Lockley M. G., Spielmann J. A. (Eds) *Crocodyle tracks and traces*. *New Mexico Museum of Natural History and Science Bulletin*. 2011. Vol. 51. P. 215–218.

Milne Edwards H., Haime J., 1848. Recherches sur les polypiers. Deuxieme mémoire: Monographie des Turbinolides. *Annales des Sciences Naturelles, Zoologie, Series*. Vol. 3. No. 9. Pp. 211–344.

Milne Edwards H., Haime J. Recherches sur les polypiers. Deuxieme mémoire: Monographie des Turbinolides. *Annales des Sciences Naturelles, Zoologie, Series*. 1848. Vol. 3. No. 9. P. 211–344.

Ogienko O. S., Kyselevych L. S., Tymchenko Yu. A., 2017. Steinkerns of *Myopholas* from the Lower Cretaceous deposits of the Kaniv Dislocations. In: Gozhyk P. F. (Ed.), *40 years of the Palaeontological Society of Ukraine. Proceedings of 38th session of the Paleontological society of the NAS of Ukraine (23–26 May, 2017; Kaniv).* Kyiv. Pp. 93–94. (In Ukrainian).

Огієнко О. С., Киселевич Л. С., Тимченко Ю. А. Ядра Myopholas нижньокрейдових відкладів району Канівських дислокацій. Гожик П. Ф. (Ред.) *40 років Палеонтологічному товариству України. Матеріали XXXVIII сесії Палеонтологічного товариства НАН України (Канів, 23–26 травня 2017 р.)*. Київ, 2017. С. 93–94.

Röding P. F., 1798. Museum Boltenianum sive catalogus cimeliorum e tribus regnis naturæ quæ olim collegerat Joa. Fried Bolten, M. D. p.d. per XL. annos proto physicus Hamburgensis. Pars secunda continens conchylia sive testacea univalvia, bivalvia & multivalvia. Hamburg. 199 p.

Saint-Seine R., 1951. Un Cirripède acrothoracique du Crétacé, *Rogerella lecontrei* n.g., n. sp. *Comptes Rendus — Académie des sciences*. Vol. 233. Pp. 1051–1053.

Tseisler V. M., 1958. Rock-boring mollusks from the Albian deposits of the Crimea. *Bulletin of the Moscow Society of Naturalists, Geology*. Vol. 33. No. 3. Pp. 132–133. (In Russian).

Voigt E., 1971. Fremdskulpturen an Steinkernen von Polychaeten-Bohrgängen aus der Maastrichter Tuffkreide. *Paläontologische Zeitschrift*. Bd. 45. S. 144–153. https://doi.org/10.1007/bf02989572

Vyalov O. S., Goretsky V. A., 1965. Trace fossils from the contact of the Upper Cretaceous and Miocene deposits in the Podilia. *Palaeontological Review*. Vol. 2. Pp. 38–46. (In Russian).

Wilson M. A., Palmer T. J., 1998. The earliest *Gastrochaenolites* (early Pennsylvanian, Arkansas, USA): an Upper Paleozoic bivalve boring? *Journal of Paleontology*. Vol. 72. No. 4. Pp. 769–772. https://doi.org/10.1017/s0022336000040464.

Wisshak M., Knaust D., Bertling M. 2019. Bioerosion ichnotaxa: review and annotated list. *Facies*. Vol. 65. No. 2. Article 24. 39 p. https://doi.org/10.1007/s10347–019–0561–8.

Yanin B. T. 1978. Trace fossils from the Cretaceous and Paleogene deposits of Crimea. In: Kulikov M. V., Khozatsky L. I. Djalilov M. R. (Eds), Questions of the taphonomy and palaeobilogy. Dushanbe: Donish. Pp. 173–185. (In Russian).

Yanin B. T., Vishnevsky L. E. 1989. Cretaceous System. Lower Series. In: Mazarovich O. A., Mileeva A. S. (Ed.), Geology of the Kacha Uplift of the Mountain Crimea. Mesozoic Stratigraphy. Moscow: Publishing of the Moscow University. Pp. 81–123. (In Russian).

Zatoń M., 2020. No evidence for fungal infection of Upper Jurassic horseshoe crabs: A comment on Błażejowski et al. (2019). *Palaeogeography, Palaeoclimatology, Palaeoecology*. Vol. 554. Article 109142. https://doi.org/10.1016/j.palaeo.2019.03.043.

Röding P. F. Museum Boltenianum sive catalogus cimeliorum e tribus regnis naturæ quæ olim collegerat Joa. Fried Bolten, M. D. p.d. per XL. annos proto physicus Hamburgensis. Pars secunda continens conchylia sive testacea univalvia, bivalvia & multivalvia. Hamburg, 1798. 199 p.

Saint-Seine R. Un Cirripède acrothoracique du Crétacé, *Rogerella lecontrei* n.g., n. sp. *Comptes Rendus — Académie des sciences*. 1951. Vol. 233. P. 1051–1053.

Цейслер В. М. Сверлящие моллюски из альбских отложений Крыма. *Бюллетень Московского общества испытателей природы. Отдел геологический*. 1958. Т. 33, № 3. С. 132–133.

Voigt E. Fremdskulpturen an Steinkernen von Polychaeten-Bohrgängen aus der Maastrichter Tuffkreide. *Paläontologische Zeitschrift*. 1971. Bd. 45. S. 144–153.

Вялов О. С., Горецкий В. А. Следы жизнедеятельности на поверхности контакта мела и миоцена Подолии. *Палеонтологический сборник*. 1965. Вып. 2. С. 38–46.

Wilson M. A., Palmer T. J. The earliest *Gastrochaenolites* (early Pennsylvanian, Arkansas, USA): an Upper Paleozoic bivalve boring? *Journal of Paleontology*. 1998. Vol. 72. No. 4. P. 769–772.

Wisshak M., Knaust D., Bertling M. Bioerosion ichnotaxa: review and annotated list. *Facies*. 2019. Vol. 65. No. 2. Article 24. 39 p.

Янин Б. Т. Ископаемые следы жизнедеятельности организмов в меловых и палеогеновых отложениях Крыма. Джалилов М. Р. (Ред.) *Вопросы тафономии и палеобиологии*. Душанбе: Дониш, 1978. С. 173–185.

Янин Б. Т., Вишневский Л. Е. Меловая система. Нижний отдел. Мазарович О. А. (Ред.) *Геологическое строение Качинского поднятия Горного Крыма. Стратиграфия мезозоя*. Москва: Издательство Московского университета, 1989. С. 81–123.

Zatoń M. No evidence for fungal infection of Upper Jurassic horseshoe crabs: A comment on Błażejowski et al. (2019). *Palaeogeography, Palaeoclimatology, Palaeoecology*. 2020. Vol. 554. Article 109142.

Manuscript received February 10, 2023;
revision accepted May 4, 2023.

Інститут геологічних наук НАН України,
Київ, Україна