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LOWER VISEAN RUGOSE CORALS *DORLODOTIA* SALÉE, 1920 FROM THE DONETS BASIN

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Two species of colonial rugose corals *Dorlodotia* Salée, 1920 are described. *Dorlodotia briarti* Salée is widely spread species in the Lower Viséan of Western Europe and Asia Minor. A clear identification of this species in the Donets Basin gives additional information for interregional stratigraphic correlation and for paleogeographical reconstructions. The second species is characterized by complicated axial structure and developed minor septa. It is similar to *Thysanophyllum vermiculare* Degtjarev, 1973 described in the Urals. It's belonging to the genus *Dorlodotia* should be confirmed by additional research. Some discussion points of phylogeny and systematic position of *Dorlodotia* are considered.

Key words: Carboniferous, Mississippian, Rugose corals, *Dorlodotia,* Ukraine.

The southern part of the Donets Basin is a unique area where the uppermost part of the Devonian and Lower Carboniferous rocks extends. The numerous flux quarries expose the Upper Devonian and Tournaisian-Viséan predominantly carbonate strata in addition to natural sections. Rich coral fauna was collected from different Lower Carboniferous stratigraphic levels during field study of the Central quarry located on the western outskirts of Dokuchaevsk town (Donetsk region) (Fig. 1). New and previously unknown in the Donets Basin taxa among the corals were found.

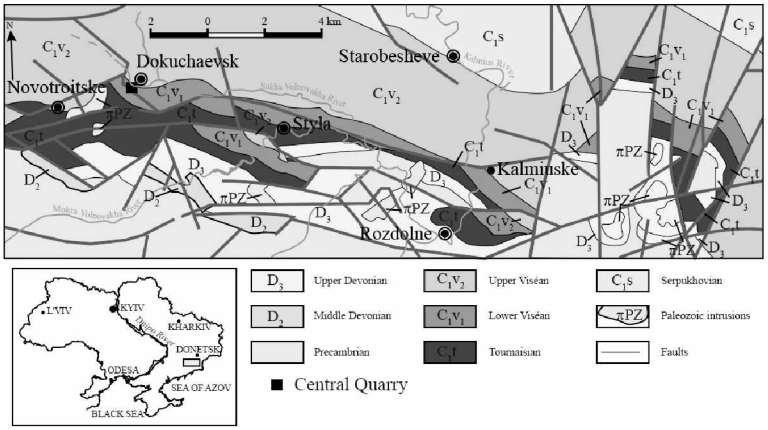

Fig. 1. Simplified geological map of the South Donbas (modified after Aizenverg et al. [4]) with location of the Central quarry

The genus *Dorlodotia* Salée, 1920 is common in the Lower Carboniferous of Eurasia, particularly in Great Britain, France, Belgium, Germany, Poland, Tyrkey, as well as China and Japan [7]. *Dorlodotia* includes features of different families; therefore systematic position of the genus is controversial and not fully defined despite of continued research. Probably some species of this genus were reported by N.P. Vasilyuk [1, p. 10–11] according to the preliminary study by I.I. Gorsky. There are *Thysanophyllum pseudovermiculare* McCoy, *Thysanophyllum pseudovermiculare* McCoy 1849 var. nov. (Tournaisian, T b–c) and *Thysanophyllum* sp. (Visean, V d). *Thysanophyllum pseudovermiculare* are referred nowdeys to the genus *Dorlodotia* Salée, 1920 [17, 24]. Since the collection previously studied by I.I. Gorsky was lost, so there is no way to check his definitions. Another species of *Dorlodotia fomitschevi* Zhizhina, 1978 [2] was founded in the Vb Zone, in the outcrop along the Sukha Volnovakha River. Separateness of this species is questionable because only the fragment of one colony with two corallites (holotype) is described. The species *Pseudolonsdaleia subkakimii* Vassiljuk, 1978 from the Upper Viséan (Vf) was found on the left bank outcrop of the Kalmius River near Komsomolske town (from 2016 Kalmiuske town). *Pseudolonsdaleia* Minato, 1955 is considered as the junior synonym of *Dorlodotia* Salée, 1920 [10, 17] or as subgenus of this genus [24]. In 2010 [15], the author presented the image of the colony fragment collected from the Lower Viséan (Vb-c) and predefined it as *Dorlodotia pseudovermiculare* (McCoy, 1849). As it was indicated later [7, 10], this specimen belongs to the species *Dorlodotia briarti* Salée. The presence of this species in the Lower Viséan of the Donets Basin was confirmed by new findings. Its allowed the author made confidently identification and detailed description of *Dorlodotia briarti* in this paper.

Besides, the fasciculate colony with complicated axial structure and well-developed minor septa was first discovered. It is very similar to the species described by D. D. Degtyarev from the upper levels of the Lower Viséan on the Central Urals western flank as *Thysanophyllum vermiculare* [3].

Abundant distribution of the genus *Dorlodotia* makes it especially valuable for interregional stratigraphic correlations and paleogeographical reconstructions, therefore morphology and phylogeny of this genus had been studied by many researchers [7, 10, 13, 14, 16–19, 24]. Several dozen species have been described all over the world, but many of them are often referred to as other genera and should be revised.

The Central quarry exposed the most complete Lower Carboniferous carbonate sequence (the Mokrovolnovakha Series) in the stratigraphic interval from the middle part of the Tournaisian (Tb) to the lower part of the Viséan (Ve), Fig. 2.

The Lower Viséan part of this series called as the Skelevatka Suite and it composed of rather homogeneous carbonate rock. Possibly unconformably, it overlays Tournasian succession (the Karpivka Suite). The Styla Suite (Upper Viséan) contains cherty marl, shale and limestone. It is unconformably overlay the Skelevatka Suite. The unconformity is marked by a karstified level. The Styla Suite is correlated with the lower part of the Tula horizon of the Moscow Basin [5].

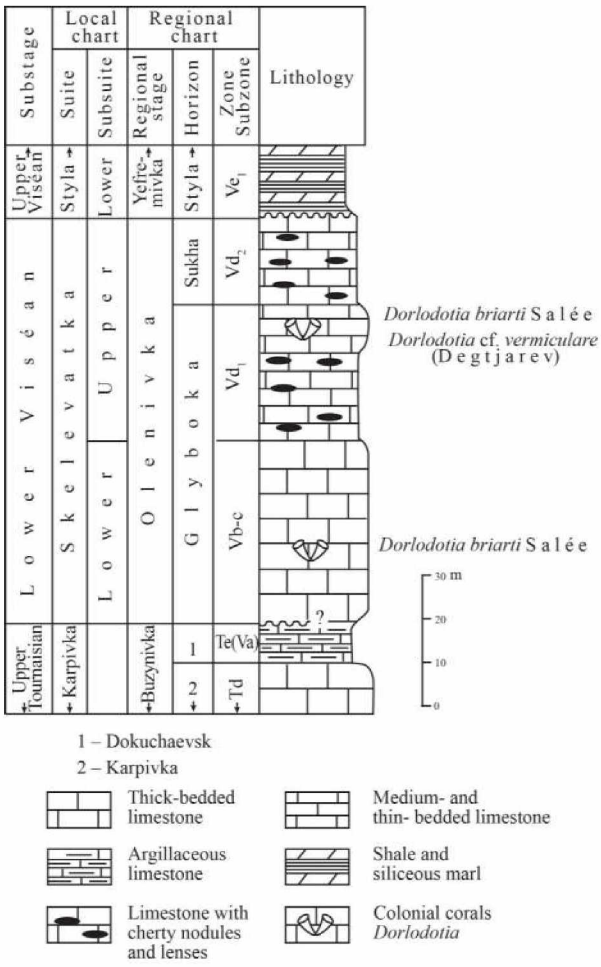

Fig. 2. General stratigraphic chart of the Lower Viséan strata exposed in the Central quarry with position of the *Dorlodotia* sampling levels

The Skelevatka Suite has been divided into two subsuites. The Lower Skelevatka Subsuite composed of relatively monotonous, grey, thick-bedded and massive, foraminiferal and foraminiferal-algae packstone-grainstone. *Siphonodendron, Sychnoelasma, Syringopora* were collected from this part of the section as well as described here *Dorlodotia*. Large gastropods and brachiopods *Palaeochoristites grabovi* are ordinary for this interval. The thickness of the lower subuite is 40–45 m. The Upper Skelevatka Subsuite established by the occurrence of nodules and lenses of black cherts. It is composed of gray and dark-gray, medium and thin-bedded limestone. Peloidal algae-foraminiferal grainstone and packstone are predominated among these rocks. The fragments of syringporids are ordinary here. The thickness of subsuite is 41–50 m.

In the middle part of the Upper Skelevatka subsuite is allocated a 6-10 meter sequence without cherts. It is uppermost part of Glyboka horizon (the upper part of the Vd_1 Subzone).

Solitary species ('*Dibunophyllum*', '*Palaeosmilia*') and colonial rugose corals (*Siphonodendron*, *Ceriodotia* and described here *Dorlodotia*) are found. The tabulate corals *Syringopora* is ordinary here. This part overlay by dark gray limestones with black cherts and colonial rugose corals *Siphonodendron, Diphyphyllum, Ceriodotia* with large brachiopods *Delepinea*. This part corresponds to the Sukha regional horizon (Vd_2).The Glyboka ($Vb\text{-}d_1$) and Sukha (Vd_2) regional horizons based on faunal assemblage included into the Olenivka regional stage [5].

To study corals (thin sections and polished surfaces) traditional methods were applied. Studied material is housed in Museum of Paleontology of Taras Shevchenko National University of Kyiv (Acronyms TSNUK-2P264-A and 2P267-A).

Subclass Rugosa
Order Stauriida
Family Uncertain
Genus ***Dorlodotia*** Salée, 1920

Diagnosis. Fasciculate colonies with lateral increase. Major septa usually withdrawn from the axis, minor septa poorly or not developed. Columella present in some species, in some cases discontinuous, composed of a single axial plate, commonly thickened. Dissepimentarium typically composed of large lonsdaleoid dissepiments and two rows of simple interseptal dissepiments. The lonsdaleoid dissepiments are usually absent or poorly developed in small-sized corallites. The inner row of simple dissepiments is commonly thickened and forms an inner wall. Tabulae complete, conical where the columella is present, flat or domed where it is absent. The outer wall is thick and festooned [8].

Type genus. *Dorlodotia briarti* Salée, 1920 [17, p. 190, figs 5–6]. Belgium, Landelies, river Sambre valley, Lower Viséan, Neffe Formation, Cf4δ Foraminifera Subzone and RC5 Coral Zone [18].

Remarks. This genus is widespread in the Eurasian Carboniferous but its genetic characteristics are unambiguous entirely. The main differences are the lack of developed minor septa and the shape of the axial structure. So, in the diagnosis by E. Poty the presence of a single axial plate commonly thickened was indicated. However, in some species there are axial lamellae. Systematic position of *Dorlodotia* and its evolution are discussing now. Initially E. Poty [17] attributed it to the Lonsdaleidae family, later [18] he suggested that *Dorlodotia* evolved from a solitary caninoid coral and placed *Dorlodotia* in the Lonsdaleidae with a question mark. D. Weyer also included this genus in the family Lithostrotionidae, subfamily Thysanophyllinae. Based on the study of typical materials and rich collection from north-western Turkey J. Denayer [7] excluded *Dorlodotia* from both the Lonsdaleidae and Lithostrotionidae because the diagnosis of the genus is not compatible with that of either family. Also interesting is the idea of attributing *Dorlodotia* to the family Axophyllidae based on the presence of complex axial structure in some species [10].

Dorlodotia briarti Salée, 1820
Pl., fig. *1–4*

Lectotype. Specimen 1/78, Collection A. Salée (housed in the University of Liège), Lower Viséan ('Cf4d' = MFZ11 and RC5a), path from Forкt to Magne, Eastern Belgium.

Diagnosis. Phaceloid colony with corallites 13–16 mm in diameter and 26–28 septa, commonly thickened. Minor septa poorly developed or absent. Columella strongly thickened, commonly connected to the counter septum, but absent in some cases. Dissepimentarium made of simple and lonsdaleoid dissepiments. The inner edge of the dissepimentarium is thickened. Cardinal fossula inconspicuous. Tabulae complete and upturned towards the columella. Wall thick, undulate or festooned [8].

Material. Two fragments of colonies from the Central Quarry (2P274-A/16; 2P267-A/Vd-11). Two transverse, one longitudinal thin sections and one polished surface were sudied.

1917 Endophyllum cf pseudovermiculare (McCoy, 1849): Vaughan, p. 39, pl. 5, fig. 3 [23]
1920 Dorlodotia briarti, sp. nov.: Salée, p. 150, figs. 5–6 [20]
1929 Dorlodotia briarti Salée 1920: Dutertre, p. 110, pl. 7, figs 1, 4 [9]
1933 Dorlodotia delepinei Charles: Charles, p. 126, pl. 5, figs 22–25 [6]
1964 Dorlodotia briarti Salée 1920: Monty, pl. 2, figs 5–6 [12]
1975 Dorlodotia briarti Salée 1920: Poty, p. 93, pl. 2, figs 1–2, 5, 7 [16]
1975 Dorlodotia briarti Salée 1920 *forma α*: Poty, p. 100, pl. 1, fig. 4, pl. 3, figs 1–3 [16]
1975 Dorlodotia briarti Salée 1920 *forma β*: Poty, p. 100, pl. 3, fig. 4 [16]
?*1978 Dorlodotia fomitschevi* Zhizhina:Vassiljuk & Zhizhina, p. 27, pl. 1, fig. 1[2]
1981 Dorlodotia briarti briarti Salée 1920: Poty, p. 68, pl. 32, fig. 6, pl. 33, figs 1–2 [17]
1981 Dorlodotia briarti densa Poty: Poty. p. 68, pl. 33, figs. 3 [17]
1981 Dorlodotia briarti Salée 1920: Nudds, p. 333, pl. 18, figs. 1–6 [13]
1984 Dorlodotia briarti Salée 1920: Somerville and Strank, p. 92, fig. 4 [21]
1989 Dorlodotia briarti Salée Salĭe 1920: Somerville et al., p. 58, fig. 5 [22]
1993 Dorlodotia briarti Salée 1920: Nudds, p. 128, fig. 11.1 [14]
1994 Dorlodotia briarti Salée 1920: Javaux, p. 135, figs 8–9 [11]
1994 Dorlodotia (Dorlodotia) briarti Salée 1920: Weyer, p.161, fig.6, 7(1–3) [24]
1994 Dorlodotia briarti Salée 1920: Poty and Hannay, p. 67, pl. 6, fig. 3 [19]
2010 Dorlodotia pseudovermiculare (McCoy, 1849): Ogar, p. 91, fig. 6P [15]
2011. Dorlodotia briarti Salée, 1920: Denayer, p. 1438–1440, text-fig., 5, 6A–J [7]

Description. Fragments of dendroid colonies consist of 2–6 subcylindrical corallites. The maximum diameter of the corallites is 15 mm and the maximum diameter of the tabularium is 12 mm. The ratio of the corallite and tabularium diameters and septa numbers is given in Table 1.

Table 1

Specimen	Corallite diameter (mm)	Tabularium diameter (mm)	Number of septa
2P274-A/16	12.5	8,5	25
Idem	10.5–11.5	8.0	24
2P267-A/Vd-11	4.5	4.0	18
Idem	5.5	4.2	20
Idem	6.2–6.8 7	5.8	21
Idem	12.6	9,2	30
Idem	15.0	12.0	28

The major septa are short, their length exceed about half of the corallites radius. At the young growth stages they are connected with the wall of coral, but in the adult stages they are separated from the outer wall of dissepiments, occasionally penetrating into the dissepimentarium or presented in the form of short spines located on the dissepiments. Septa thickened; their thickness increases near the inner edge of the dissepimentarium. In young and adult grow stages the septa are thinned. The median line is visible in the septa structure. Minor septa are not developed. Sometimes near the elongated counter septum appear two contiguous minor septa [15, p. 291, fig. P, upper corallite]. The cardinal and counter septa in young stages are elongated and connected occasionally. The longest is the cardinal septum. The columella is thin in the histero-neanic stages. It is a simple axial plate linked to the cardinal septum. In mature stages it is thickened, lenticular, with dark median line (Pl, fig. 3). Its width is 0.7–1.0 mm and length is 3.0–3.1 mm. In ephebic stage the columella thinned and disappeared. The dissepimentarium is divided into two zones. The inner zone is variable. It consists of one row of interseptal dissepiments intersected by septa. The peripheral zone is formed of one-two rows of lonsdaleoid dissepiments. The first dissepiments occur at the corallite diameter of 4.5 mm as separate dissepiments and do not form a continuous dissepimentarium. The continuous zone of londsdaleoid dissepiments appears at a corallite diameter of 8 mm. The corallite wall is thin (0.15–0.25 mm) and consists of two layers. The outer darker layer is thin (0.05 mm) and the inner lighter layer is thicker (0.2 mm). The wall is undulated or places festooned. In the longitudinal section the tabulae are complete, tent-shaped or bell-shaped, sub-horizontal and upturned to the columella. In adult stages tabulae are concave (Pl., fig. 4). The distance between tabulae is 0.5–0.9 mm. The dissepiments are hollow inclining. The length of the dissepiments in the adult stages is 5–6 mm and the width is 2 mm.

Discussion. The described specimens are almost identical to the typical material of Belgium as well as known from other areas. There are some differences in a slightly longer septa within typical material.

Distribution. In Western Europe *D. briarti* is known from Moliniacian, RC4β2-RC5α (MFZ9-11) of the Southern Belgium, Boulonnais area in France and Aachen region in Germany [8] and from the equivalent level (Arundian) of northern Germany (Loissin borehole by Greifswald, Mecklenburg-Vorprommen) [24]. In northern England and in northeast Wales this species was discovered in Arundian [14, 21, 22]. In north-western Turkey *D. briarti* was found in the stratigraphic interval compared with the top of Moliniation ($RC4\beta_2$) and lower part of the Livian (RC5- RC6) of Belgium [7]. In the Donets Basin this species is found exclusively in the Lower Viséan–Skelevatka Suite, Glyboka ($C_1^v b\text{-}d_1$) and Sukha ($C_1^v d_2$) horizons. The specimen 2P264-A/16 initially was attributed by the author [15] to the species *Dorlodotia pseudovermiculare* (McCoy, 1849) and actually belongs to *Dorlodotia briarti* Salée, 1920. Unfortunately in the fig. 5 caption mistakenly mentioned Volnovakha Suite ($C_1^t c$), Tournaisian. The correct stratigraphic level (Skelevatka Suite, Zones $C_1^v b\text{-}d$) where this specimen was found is indicated in the text of that paper (p. 287).

Dorlodotia cf. ***vermiculare*** (Degtjarev, 1973).
Pl. fig. *5–8*

Material. One fragment of colonie from the Central Quarry (2P267-A/Vd-4). One transverse and two longitudinal thin sections were sudied.

Description. The fragment of the dendroid colony consists of four cylindroconical coralites with diameter from 7.5 to 20 mm. The diameter of the tabularium varies from 5 to 8.5 mm. There are 19-25 major septa. The ratio of the corallite and tabularium diameters and septa numbers of the studied specimen is given in Table 2.

Table 2

Corallite diameter (mm)	Tabularium diameter (mm)	Number of septa
7.5	5	19Ч2
14.0	8	22Ч2
17.0	8.5	25Ч2
20.0	8.0	23Ч2

Major septa are long and variable in length. Their length varies from half to s of the tabularium. Minor septa are developed. Their length extend from half to s of the major septa lengths. They are sharpen near the axial zone and thickened near the inner edge of the dissepimentarium. Major and minor septa somewhere penetrate into the dissepimentarium where discontinue of the lonsdaleoid dissepiments. The axial structure is complicated and variable. It consists of columella and various amounts of short radial lamellae (Pl., fig. 6). The irregular bent lenticular columella is linked to one of the septum (counter?). In the young growth stages there is only a lens-like columella. In adult stages columella is thinned and irregularly bent. There are 6–8 short radial lamellae. Some of them are attached to the columella, but others do not reach it. Similarly some radial lamellae are connected to major septa and others are separated from them. There are 1–2 traces of axial tabulae intersections in transverse sections of corallites. The dissepimentarium consists of two zones and separated from the tabularium by a thickened inner wall. The inner zone is narrow (0.5–0.7 mm) and developed only in some coralites. The septa penetrate into this zone and it is composed by concentric dissepiments. The outer zone is thick. Their thickness in adult stages is 2.5–4.5 mm. This zone is composed of lonsdaleoid dissepiments. The outer wall is festooned. It consists of two layers. The outer layer is dark and thin (0.05 mm) and the inner layer is light and thicker (0.2 mm). Total thickness of the wall is 0.15–0.25 mm. The tabularium is biform. The tabulae are incomplete, tent-shaped and upturned towards the columella. There are both the tabulae normally elevated adaxial and the tabulae with depressed marginal part. There are 14–20 tabulae on 10 mm of corallite length in longitudinal sections. There is one row of the dissepiments. Their length is 3–5 mm and height is 0.5–2.0 mm. Dissepiments inclined towards the tabularium at an angle of 45–60 degrees. There are 9–10 dissepiments on 10 mm of a corallite high in the longitudinal sections.

Discussion. The described specimen is similar to the typical species of *Dorlodotia briarti* Salée but clearly differs in the development of minor septa, particularly in the presence of a biform tabularium and the complicated axial structure. The presence of minor septa a bit contradicts the diagnosis of the genus *Dorlodotia*. Along with that, the minor septa are not a stable feature of this genus. Especially short minor septa are clearly seen on the transverse section of the lectotype *Dorlodotia briarti* Salée [17, pl XXXII, fig. 6a].

The most similar development of minor septa in the Ural species described as *Thysanophyllum vermiculare* Degtjarev, 1973 [3, p. 195–196, p. l. II, fig. 1, 2] = *Th. vermiformes* (p. 200). But it differs in the absence of columella and the development of trapezoidal tabulae. Nevertheless, in the cross-sectional image (Pl. II, 2a) it is clearly seen that 4–6 septa reach the

axis of the coralite. Axial ends or these septa connected, irregularly bent and thicken. The cardinal and counter septa are presented among the longest septa. Unfortunately, the longitudinal section illustrates only the periphery of two corallites. The axial part of the corallite is not illustrated. In general, this species should be re-studied, since it was described only in one fragment of the colony (holotype).

Dorlodotia euxinensis Denayer, 2011 [7, p. text-figure 8A–I, p. 1440–1444] from the lower part of the Livian (Middle Viséan) of North-eastern Turkey has very similar structure to described specimen axial structure. It composed of a short, but thick plates with some radial lamellae, which commonly enclosed to the stereoplasm surrounding the columella. However, this species has a larger diameter of corallites and more septa (20 mm, number of septa 30). There are no developed minor septa, consequently the biform tabularium are not developed as well.

Distribution. Donets Basin, Lower Viséan, Skelevatka Suite, Sukha horizon, Vd_1 Subzone. *Dorlodotia vermiculare* was found in the Western flank of the Central Urals (the Druzhinino section) from the Zapadny Ural horizon. M. Hecker [10] correlated this stratigraphic interval with the upper part of the Pester'ki horizon of the the Western flank of the Central Urals, and the Bobriki horizon of the Moscow Basin and the Moliniation (?) – Lower Livian of the West Europe.

Conclusion. Findings of *Dorlodotia* in the Donets Basin confirm the abundant distribution of this genus in Eurasia and points out the paleogeographic relationships between the seas of Western Europe, north-western part of Asia Minor and probably Urals during the Early Visйan time.

The systematic position of the genus is not finally established. This is due to the fact that it morphologically combines features of different families and suborders. The solution to this systematic question lies in the reconstruction of the phylogeny of *Dorlodotia* species. It will be achieved by studying of morphology and identification of the stratigraphic and paleogeographical distribution of similar taxa. Today the lineage *Corphalia* (solitary corals) - *Dorlodotia* (fasciculate colonies)- *Ceriodotia* (cerioid colonies) is generally confirmed on the Donets material.

So, previously described from the Lower Visйan *Dorlodotia fomitschevi* Zhizhina, 1978 (the Donets Basin) and *Thysanophyllum vermiculare* Degtjarev, 1973 presented only by holotypes (fragments of colonies) and need to be re-studied for confirmation of these corals as separate species.

Significant distribution of *Dorlodotia briarti* Salée allows us to correlate the Lower Viséan of the Donets Basin (Vb-d Zones) with Moliniacian and Arundian (RC4β2–RC5α coral Subzones) of Western Europe [8]. The species *Dorlodotia* cf. *vermiculare* is first described in the Donets Basin and very similar to the Central Urals *Thisanophyllum vermiculare* Degtjarev, 1973 from the upper part of Pester'ki horizon of the Western flank of the Central Urals.

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EXPLANATION OF PLATE

Fig. 1–4. Dorlodotia briarti Salée, 1920: Specimen 2P267-A/Vd-4: *1*, *2* – transverse sections of the colony fragment; *3* – detail of the transverse section showing structure of the columella; *4* – tangential section of the corallite (ephebic stadies of grow). Central quarry, Lower Viséan, Skelevatka Suite (lower subsuite), Glyboka horizon, Vd_1 Subzone.

Fig. *5–8.* – Dorlodotia cf. vermiculare (Degtjarev, 1973): 2P267-A/Vd-4: *5* – transverse section of the colony fragment; *6* – detail of transverse section showing structure of the corallite axial area; *7, 8* – longitudinal sections of the corallite. Central quarry, Lower Viséan, Skelevatka Suite (lower subsuite), Glyboka horizon, Vd_1 Subzone.

Scale bar: 10 mm for all, except of specially indicated fig. 3 and 6.

НИЖНЬОВІЗЕЙСЬКІ РУГОЗИ *DORLODOTIA* SALÉE, 1920 З ДОНЕЦЬКОГО БАСЕЙНУ

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Описано два види колоніальних ругоз роду *Dorlodotia* Salée, *1920. Dorlodotia briarti* Salée має значне поширення у нижньому візе Західної Європи і Малої Азії. Впевнена ідентифікація цього виду в Донецькому басейні дає додаткову інформацію для міжрегіональної стратиграфічної кореляції та палеогеографічних реконструкцій. Другий описаний вид характеризується ускладненою осьовою структурою і розвитком малих септ та схожий на описаний на Уралі як *Thysanophyllum vermiculare* Degtjarev, 1973. Включення уральського виду до роду *Dorlodotia* має бути підтверджено додатковими дослідженнями. Розглянуто деякі питання філогенії та систематики роду *Dorlodotia*.

Ключові слова: кам'яновугільні відклади, міссісіпій, ругози, *Dorlodotia,* Україна.

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