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MICROFOSSILS DISTRIBUTION IN THE CALLOVIAN SEDIMENTS OF THE NORTH-WESTERN PART OF DNIEPER-DONETS DEPRESSION

Ю. В. Клименко, Ю. Б. Доротяк. РАСПРЕДЕЛЕНИЕ МИКРОФОССИЛИЙ КЕЛЛОВЕЙСКИХ ОТЛОЖЕНИЙ СЕВЕРО-ЗАПАДНОЙ ЧАСТИ ДНЕПРОВСКО-ДОНЕЦКОЙ ВПАДИНЫ. *Приведены результаты микропалеонтологического исследования, полученные по спикулам губок, фораминиферам из келловейских отложений северо-западной части Днепровско-Донецкой впадины. Установлены и описаны комплексы спикул губок и фораминифер из нижне-, средне- и верхнекелловейских отложений. Анализ фораминиферовых комплексов позволил выделить фораминиферовые зоны и отметить их особенности. Впервые на исследуемой территории установлены новые морфовиды спикул губок. Прослежено постепенное изменение комплексов спикул губок и фораминифер от нижнего до верхнего келловея. Дополнено палеонтологическую характеристику келловейских отложений исследуемого района новыми даными, полученными по результатам спикульного и фораминиферового анализов. В комплексе выявлены остракоды и мелкорослые двустворчатые моллюски, что позволило дополнить биостратиграфическую характеристику района исследования. Литологические особенности и закономерности распределения микрофоссилий дали возможность реконструировать условия существования спикул губок, фораминифер, остракод, мелкорослых двустворчатых моллюсок в келловейском палеобассейне.*

***Ключевые слова**: спикулы губок, фораминиферы, остракоды, мелкорослые двустворчатые моллюски, келловейские отложения, Днепровско-Донецкая впадина.*

Ю. В. Клименко, Ю. Б. Доротяк. РОЗПОДІЛ МІКРОФОСИЛІЙ КЕЛОВЕЙСЬКИХ ВІДКЛАДІВ ПІВНІЧНО-ЗАХІДНОЇ ЧАСТИНИ ДНІПРОВСЬКО-ДОНЕЦЬКОЇ ЗАПАДИНИ. *Наведено результати мікропалеонтологічного дослідження отримані за спікулами губок та форамініферами з келовейських відкладів північно-західної частини Дніпровсько-Донецької западини. Встановлені та описані комплекси спікул губок і форамініфер з нижньо-, середньо- і верхньокеловейських відкладів. Аналіз форамініферових комплексів дозволив виділити форамініферові зони і відмітити їх особливості. Вперше на досліджуваній території встановлені нові морфовиди спікул губок. Досліджено зміну комплексів спікул губок і форамініфер від нижнього до верхнього келовею. Доповнено палеонтологічну характеристику келовейських відкладів досліджуваного району новими даними, одержаними за результатами спікульного і форамініферового аналізів. В комплексі виявлені остракоди і мілкорослі двустулкові молюски, що дозволило доповнити біостратиграфічну характеристику району дослідження. Літологічні особливості і закономірності поширення мікрофосилій дали можливість реконструювати умови існування спікул губок, форамініфер, остракод, мілкорослих двустулкових молюсків у келовейскому палеобасейні.*

***Ключові слова**: спікули губок, форамініфери, остракоди, мілкорослі двустулкові молюски, келовейські відклади, Дніпровсько-Донецька западина.*

Introduction. Callovian deposits of the Dnieper-Donets Depression were studied by many researchers: N. Borisyak (1867), P.N. Savenok (1936), L.F. Lungersgauzen (1942-1943), K.O. Tsitovich, L.E. Nalivaiko, L.G. Dayn (1939) [17], I.M. Yamnichenko (1951, 1987) [15; 17], B.P. Sterling (1953-1959), E.Yu. Migachova (1957) [17], O.K. Kaptarenko-Chernousova (1961) [3, 4], F.A. Stanislavskiy (1957) [14], M.A. Voronova (1966) [17], I.I. Nikitin (1983), M.Y. Blank [9; 17], V.V. Permyakov (1983), M.N. Permyakova (1983) [9], D.M. Pyatkova (1974, 2007-2012) [11; 16], E.A. Shevchuk (2007, 2012) [Шевчук, 18, 19, 20], etc.

The aim of the work is to complement the stratigraphic scheme of the north-western part of Dnieper-Donets depression by new paleontological data, age specification and to reconstruct paleoecological conditions in Callovian basin.

Analysis of previous publications. Callovian deposits occur throughout the territory of the Dnieper-Donets depression, and are represented by three substages. They are well-grounded paleontologically, that makes it possible to allocate ammonite and foraminifera zones and layers.

The Lower Callovian deposits extend in the north-western part of the Dnieper-Donets depression, where they are represented by marine facies, and in the north-eastern part – by continental deposits. There are two ammonite zones [16]: the lower - Macrocephalites macrocephalus, and the upper - Sigaloceras calloviensis. There are the two foraminifera zones and layers with foraminifers. In the bottom of Macrocephalites macrocephalus zone, and perhaps slightly lower in foraminifera there are Ammodiscus graniferus layers. Accordingly, in the Macrocephalites macrocephalus zone the Guttulina tatariensis foraminiferal zone is outlined (Fig. 1). The Haplophragmoides infracalloviensis zone is marked above, that corresponds to the Sigaloceras calloviensis zone. Complex of ostracods was found by M.M. Permyakova for the Lower Callovian: *Galliaecytheridea alveolata* (Terq.), *G. reticulata* (Lub.), *Fuhrbargiella* (*F.*) *milanovskyi* (Lub.), *F.* (*F.*) *nikitini* (Lub.), *Pleurocythere explicata* Lub., *P. sudorocostata* (Lub.) [16].

In the Middle Callovian deposits two ammonite zones were identified: the lower – *Kosmoceras jason*, and the upper – *Erymnoceras coronatum*. The Middle Callovian foraminifera complex is clearly different in species composition from the Early Callovian one. During the Middle Callovian the systematic composition of foraminifera changed little,

and therefore the foraminifera zon *Lenticulina cultratiformis* - *Lenticulina pseudocrassa* was found, which belongs to the Middle Callovian and is traced in the DDD and in the north-western part of the Donets region. The ostracods are represented by: *Cytherella collapsa* Grekoffi, *Paracypris bellula* Lub., *Schuleridea translucida* Lub., *Lochocythere kazpinakyi* Lub. [16].

In the Upper Callovian deposits there are Peltoceras athleta and Quenstedtoceras lamberti ammonite zones. Upper Callovian foraminifera are not always clearly marked because some Middle Callovian species existed in the Late Callovian. A characteristic feature of the foraminifera complex is the emergence of new agglutinated species and the presence of numerous spirilinids. By foraminifera the Lenticulina tumida - Epistomina elschankaensis zone is allocated (Fig. 1). Ostracods of the Upper Callovian are represented by *Fastigatocythere interrupta* Trieb., *Fuhrbergiella archangelskyi* (Mand.), *Infracythere dulcis* (Lub.) [16].

In the Callovian sediments the following suites are identified: (Fig. 1) Ichnyanskaya for the Lower Callovian; 2) Ivanitskaya (lower subsuite) for the Middle and Upper Callovian deposits [16].

Materials and methods of research. The materials for our research were the Callovian rock samples taken from cores from wells near the village of Chornobay, Poltava region. In our studies we paid particular attention to the description of the complexes of sponge spicules and foraminifera as well as to clarification of host rocks age. This allowed us to trace the gradual change in complexes of sponges and foraminifers spicules from the Lower to the Upper Callovian, and to complete the paleontological characteristics of the studied area with the new data.

Material processing was made by microfauna analysis (spicules of sponges and foraminifera). Sponge spicules and foraminifera were extracted with 150 g of rock by standard methods and examined using a light microscope MBS-1. Morphological species and types were determined on the basis of parataxonomic classification developed by M.M. Ivanik, which is based on morphological characters of sponge spicules [2].

Results of the study. The test section of the Callovian deposits is located in the north-western part of the Dnieper-Donets depression near the village of Chornobay, Poltava region.

As a result of the study we found the spicules of sponges, foraminifera, ostracods and taxonomic bivalves in all the samples. In addition, in the cross-section of 130,5-131,4 m depth the burrows in glauconite aleurite were found. Also, there are lithified and pyritized wood residues, small fragments of mollusc shells. In the interval of 132,5-134,0 m in dark gray slightly silty limestone clay,

ISS				INTERNATIONAL BIOZONAL STANDARD SCALES					SUITE	LOCAL STRATIGRAFIC UNIT		
SYSTEM	SERIE	STAGE	SUBSTAGE	AMMONITES (Ogg et al., 2008)		BENTHIC FORAMINIFERS (Ogg et al., 2008)		Dinocysts (Ogg et al., 2008)			AMMONITES (zones, strata) I.M. Yamnichenko (1993) [8]	FORAMINIFERS (zones, strata) D.M. Pyatkova (1982) [8]
				BOREAL PROVINCE	THETIC	Smoll	Big	North- Atl. Province		Dnieper-Donets Depression / North-West part / J2		
JURASSIC	MIDDLE	CALLOVIAN	UPPER	Quenstedtoceras lamberti	Quenstedtoceras lamberti	Frondicularia molleri	Kumubia palastiniensis	DSJ19	IVANITSKA	**Lower subsuite** **Lime sandstones and sands, siliceous siltstones, limestones and clays.** 35-60 m	**Quenstedtoceras lamberti** *Quenstedtoceras lamberti, Q. carinatum, Euaspidoceras panderosum.*	**Lenticulina tumida- Epistomina elschankaensis** *Haplophragmoides follis, Textularia depravata, Lenticulina tumida, L. polonica, L. uhligi, Epistomina elschakaensis, E. poltavica, Spirillina kuebleri.*
				Peltoceras athleta	Peltoceras athleta						**Peltoceras athleta**. *Peltoceras athleta, P. arduennensis, Kosmoceras ornatum, K. spinosum.*	
				Erymnoceras coronatum	Erymnoceras coronatum	Citharina macilenta, Triplasia bartensteini, Flabellammina althoffi, Frondicularia franconica	Ataxella occitanica+Satorina apuliensis				**Eremnoctras coronatum**.*Erymnoceras coronatum, Kosmoceras castor, Perisphinctes laferulis.*	**Lenticulina cultratiformis - L. pseudocrassa** *Lenticulina cultratiformis, L. catascopium, L. pseudocrassa, Citharinella nikitini, Pseudolamarckina rjasnensis Epistomina poltavica, E. ukrainica, E. dnepricа.*
				Kosmoceras jason	Reineckeia anceps						**Kosmoceras jason** *Kosmoceras jason, K. gulielmii* та ін.	
			LOWER	Sigaloceras calloviense	Macrocephalites gracilis			DSJ18	ICHNYANSKA	Dark-gray sandy clays, siltstones, sands, sandstones. 10-35 m	**Sigaloceras calloviense.** *Kepple rites gowerianus, Sigaloceras calloviense, Quenstedtoceras tsitovici.*	**Haplophragmoides infracallovienses**. *Lenticulina okrajanzi, L. prarussiensis, Astacolus arguta, Guttulina tatariensis* та ін.
				Proplanulites koenigi							**Macrocephalites macrocephalus.** *Macrocephalites macrocephalus, Cadoceras elatmae, Perispinctes oblique plicatus* and other.	**Guttulina tatariensis.** *Haplophragmoides infracalloviensis, Recurvoides ventosus, Geinitzinita crassata, Pseudonodosaria terquemi, Lenticulina tatariensis, Astacolus harpaformis, A. calloviensis* та ін.
				Macrocephalites herveyi	Bullatimorphites bullatus			DSJ17			Not found	**lays with Ammodiscus graniferu** *Ammodiscus graniferus, Haplophragmoides* sp.
BOTTOMSET BEDS												

Fig. 1. Stratigraphic scheme of Callovian deposits in North-Westerly part of Dnieper-Donets Depression

Zones, strata and characteristic complexes of organic remains

DINOCYSTS (zones,strata)) O.A. Shevchyk (2013) [8]	SPORE-POLLEN COMPLEXES O.A. Shevchyk (2013) [8]	OSTRACOD COMPLEXES M. M. Permyakova (1982) [8]	SPICULES OF SPONGES Y. V. Klimenko (2015)	FORAMINIFERS Y.B. Dorotyak (2015)
Layers Cleistosphaeridium sp., Ctenidodinium ornatum	*Osmundasidites wellmanii, Coniopteris* sp., *Callialasporites sp.,Marattisporites* sp., *Lycopodiumsporites* sp., *Leptolepidites* sp., *Klukisporites* sp., *Matoniasporites* sp., *Foveosporites* sp., *Concavisporites* sp., *Osmundasporites* sp., *Pinaceae, Podozamites* sp., *Tsugaepollenites* sp., *Araucariaceae,Ginkgoaceae, Bennetittes* sp., *Classopollis sp.* - 27%	*Fastigatocythere interrupta, Fuhrbergiella archangelskyi, Infracythere dulcis.*	*Oxyhexactina* cf. *ordinaria, Pentactina* cf. *denticulata, Pentactina* sp.indet, *Hexactina* sp. indet, *Oxyaster* sp. indet, *Oxysphaeraster primitivus, Oxysphaeraster* ex gr. *minutus, Sphaeraster minimus, Sphaeraster* ex. gr. *torosus, Plagiodichoriaena* ex gr.*transiriva,Orthotriaena* ex gr.*intermedia, Monocrepides* sp.*indet.*	**Lenticulina tumida-Epistomina elschankaensis**. *Lenticulina tumida, L. hoplites, L. simplex, L. uhligi, L. ukrainica, L. limataeformis, L.* cf. *sculpta, Epistomina elschnkaensis, Frondicularia spatulata, F. nitida, Citharinella nikitini, Ammobaculites aequalis, A. quadrifidus.*
Ctenidodinium ornatum-Ctenidodinium continuum		*Cytherella collapsa, Paracypris bellula, Schuleridea translucida, Lochocythere kazpinakyi.*		**Lenticulina cultratiformis-L. pseudocrassa.** *Lenticulina cultratiformis, L. tracta, L. munsteri, L.* aff. *inflata, L. tricostata, Astacolus* cf. *praesibirensis, Frondicularia nitida, Ammobaculites quadrifidus, Haplophragmoides follis.*
	Dictyophyllidites sp., *Calliala sporites* sp., *Camptotriletes* sp., *Lycopodiumsporites cerniidites, Selaginella* sp., *Omundacidites wellmanii, Trilobosporites* sp., *Klukisporites* sp., *Tsugaepollenites* sp., *Protopinus* sp., *Pinus* sp., *Classopollis* - 25%	*Galliaecytheridea alveolata, G. reticulata, Fuhrbargiella (F.) milanovskyi, F. (F.) nikitini, Pleurocythere explicata, P. (S.) sudorocostata.*	*Oxea* cf. *minuta, Strongyl* ex gr. *intermedius, Caltrop corrugutus, Plagiotriaena paculiaris, Anatriaena fungiformis, Anatriaena* cf. *abreviata, Monocrepides arcuatus, Monocrepides rectus, Pinulihexactina* aff. *paniculiformis, Pentactina* ex. gr. *ordinaria, Stauractina* ex. gr. *ordinaria, Lamina disciformis, Metaster* cf. *notus, Oxea curvata*	**Haplophragmoides infracallovsensis**. *Lenticulina okrojanzi, L. sphaerica, L. praerussiensis, L. hoplites, L. tricostata.*
				Not found
				Not found

with silty layers with lenses and layers of fine-grained quartz sand, the plicate bivalves, vultures, belemnites are present. In the interval of 134,0-135,1m in gray silty clay, lime, slightly micaceous aleurite the pyritized remains of algae, large prints of ribbed mussel shells are present.

In the Lower Callovian sediments a reprsentative complex of sponge spicules has been found dominated by small and medium oxea: *Oxea* ex gr. *mutica* Ivanik, *Oxea* ex gr. *gradato-acutata* Iv., *Oxea* ex gr. *acuminulata* Iv., *Oxea* ex gr. *intermedia* Iv. The *Oxea* cf. *minuta* Iv. and *Strongyl* ex gr. *intermedius* Iv., of the Monaxonida morphological type are rare. Up the section the number of curved rhabdus decreases that may belong to the genus Axinella. For the first time a few *Monocrepides arcuatus* Iv. et Kl. and *Monocrepides rectus* Iv. et Kl have been found, of the Desmatinae morphological type, and *Microxea nodozariformis* Iv. et Kl., of Sigmatoida. It is also found singular *Caltrop* cf. *regularis* Iv., *Caltrop corrugutus* Iv. et Kl., *Plagiotriaena paculiaris* Iv. et Kl., *Anatriaena fungiformis* Iv. et Kl., *Anatriaena* ex gr. *abbreviata* Iv. et Kl., which belong to morphological type of Tetraxonida. There are small quantities of *Lamina discoformis* Iv. et Kl., typical for Discoididae; and various *Triaena* sp. and *Dichotriaena* sp. common in Tetraxonida morphological type. Single *Pinuli-hexactina* aff. *paniculiformis* Iv., *Pentactina* ex gr. *ordinaria* Iv., *Stauractina* ex gr. *ordinaria* Iv., of Triaxonida were revealed. The *Sterraster* ex gr. *fabeformis* Iv., *Metaste*r cf. *notus* Iv., of the Astroida are also found. (Table 1).

In the deposits of the Middle and Upper Callovian the depleted complex of sponge spicules was found. The complex is dominated by representatives of Euastroidae: *Oxysphaeraster primitivus* Iv. et Kl., *Oxysphaeraster* ex gr. *minutus* Iv.; *Sterraster* ex gr. *fabeformis* Iv., *Sphaeraster minimus* Iv. et Kl., *Sphaeraster* ex gr. *torosus* Iv. are frequent. There are a few small and medium uniaxial spicules: *Oxea* ex gr. *gradato-acutata* Iv. and *Oxea* ex gr. *mutica* Iv., *Oxea* ex gr. *acuminulata* Iv., *Oxea* ex gr. *intermedia* Iv., as well as single curved rhabdus. *Microxea nodozariformis* Iv. et Kl has been identified for the first time. More rare are small *Caltrop* cf. *regularis* Iv., *Orthotriaena* ex gr. *intermedia* Iv., *Orthodichotriaena* ex gr. *transitiva* Iv., of Tetraxonida morphological type. There is a small amount of *Monocrepides* sp. of Desmatinae morphological type. Some *Oxyhexactina* cf. *ordinaria* Ivanik, and *Pentactina* cf. *denticulata* Ivanik, *Hexactina* sp. indet

and *Pentactina* sp. indet of Triaxonida morphological type are found (Table 1).

According to the foraminiferal analysis three foraminiferal complexes (Lower, Middle and Upper Callovian) were identified in the Callovian sediments. Complexes are presented by benthic forms. Minorities in foraminifera complexes were found throughout the section. Foraminifera with secretion shell prevail. Agglutinated ones are represented by single instances. The complexes consist of both specific and transit types. The representatives of the genus Lenticulina are dominating.

In the Lower Callovian sediments we found the foraminifera complex, which is represented by secretion forms – *Lenticulina okrojanzi* (Mjatl.), *L. sphaerica* (Küb. et Zw.), *L. praerussiensis* (Mjatl.), *L. hoplites* (Wisn.), *L.* aff. *inflata* (Wisn.), *L. tricostata* (Mitjan.), *Astacolus compressaformis* (Paalzow), *Planularia tricarinella* (Reuss), *Lagena* aff. *striata* (Orb.), *Dentalina* sp. indet., *Nodosaria mutabilis* Terq. (Table 2).

Table 1

Spicules complexes of the Cellovian sediments of the north-west part Dnieper-Donets depression

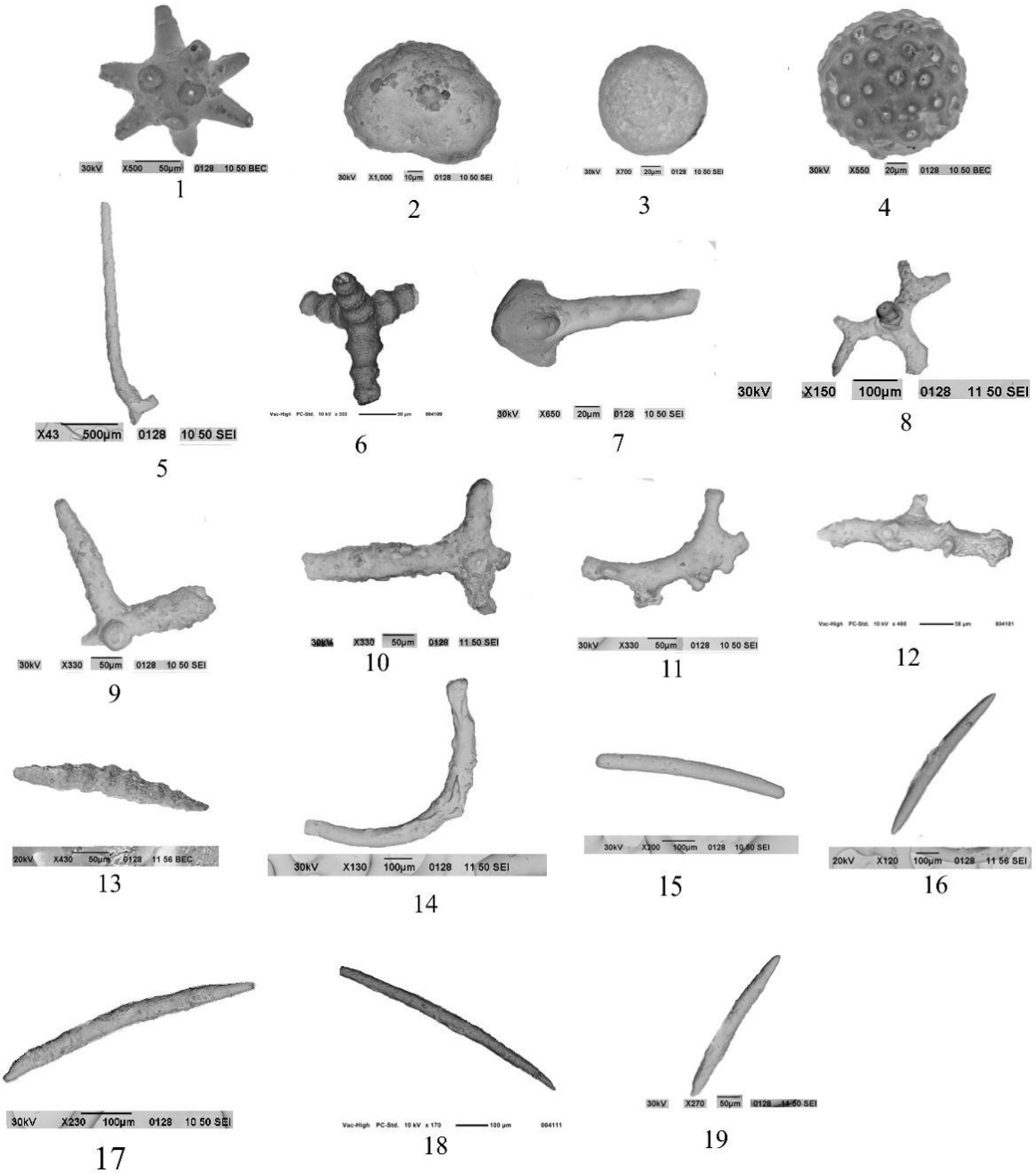
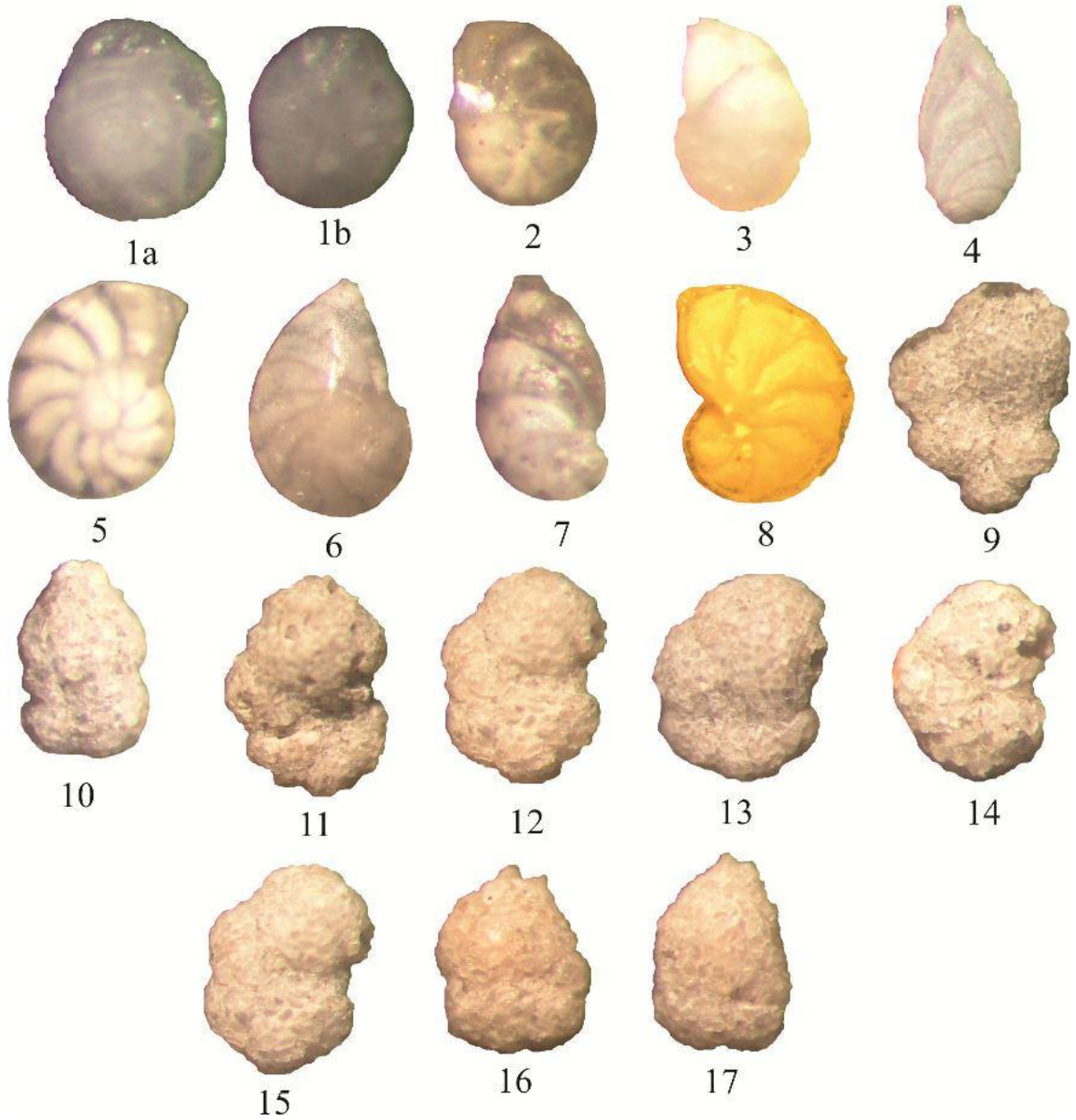


Fig. 1. *Oxysphaeraster primitivus* Iv. et Kl. Fig. 2. *Sterraster* ex gr. *faberformis* Iv. Fig. 3. *Sphaeraster minimus* Iv. et Kl. Fig. 4. *Sphaeraster* ex gr. *torosus* Iv. Fig. 5. *Plagiotriaena paculiaris* Iv. et Kl. Fig. 6. *Caltrop corrugutus* Iv. et Kl. Fig. 7. *Anatriaena* ex gr. *abreviata* Iv. Fig. 8. *Orthodichotriaena* ex gr. *transitiva* Iv. Fig. 9. *Pentactina* sp. indet. Fig. 10. *Hexactina* sp. indet. Fig. 11. *Monocrepides arcuatus* Iv. Fig. 12. *Monocrepides rectus* Iv. Fig. 13. *Microxea nodozariformis* Iv. et Kl. Fig. 14. *Rhabdes curvata*. Fig. 15. *Strongyl* ex gr. *intermedius* Iv. Fig. 16. *Oxea* ex gr. *acuminulata* Iv. Fig. 17. *Oxea* ex gr. *mutica* Iv. Fig. 18. *Oxea* ex gr. *gradato-acutata* Iv. Fig. 19. *Oxea* ex gr. *mutica* Iv.

Table 2

Foraminifers complexes of the Cellovian sediments of the north-west part Dnieper-Donets depression



1a, b – *Epistomina elschankaensis* (Mjatl.). 2 – *Lenticulina sphaerica* (Küb. et Zw.). 3 – *Lenticulina* aff. *inflata* (Wisn.). 4 – *Palmula primordialis* (Terquem). 5 – *Lenticulina tumida* (Mjatl.). 6 – *Lenticulina cultratiformis* (Mjatl.). 7 – *Lenticulina limataeformis* (Mitjan.). 8 – *Lenticulina sculpta* (Mitjan.). 9 – *Haplophragmoides follies* Kapt. 10 – *Ammobaculites aequalis* Mitjan. 11 – *Ammobaculites latus* Mitjan. 12-17 - *Ammobaculites quadrifidus* Mitjan

In this complex the specific types *Lenticulina okrojanzi* (Mjatl.), *L. praerussiensis* (Mjatl.) are allocated. *Lagena* aff. *striata* (Orb.), *Dentalina* sp. indet. are the transit types in the complex. The index species *Haplophragmoides infracalloviensis* Dain is absent.

For the Lower Callovian D.M. Pyatkova allocated foraminifera layers with Ammodiscus graniferus and two zones: the lower – Guttulina tatariensis and the upper – Haplophragmoides infracalloviensis (Fig. 1). Based on the systematic structure of the complex and characteristic species of *Lenticulina okrojanzi* (Mjatl.), L. *praerussiensis* (Mjatl.) it is possible to say that the identified complex corresponds to the upper foraminiferal zone of Haplophragmoides infracalloviensis.

In the Middle Callovian sediments the foraminifera complex ia represented by secretion *Lenticulina cultratiformis* (Mjatl.), *L. tracta* (Mitjan.), *L. münsteri* (Roemer), *L.* aff. *inflata* (Wisn.), *L. tricostata* (Mitjan.), *Astacolus* cf. *praesibirensis* (Kosyreva), *Frondicularia nitida* Terq., *F. spatulata* Terq., *Tristix temirica* (Dain), *Saracenaria cornucopiae* (Schwager), *Nodosaria* aff. *claviformis* Terq., *N. prima* Orb., *Lagena* aff. *striata* (Orb.), *Dentalina* sp. indet. and single agglutinated forms *Ammobaculites quadrifidus* Mitjan., *Haplophragmoides follies* Kapt. (Table 2).

The complex consists of species that are often found in samples of *L. tricostata* (Mitjan.), *L. tracta* (Mitjan.), *L.* aff. *inflata* (Wisn.) and transit - *Lagena* aff. *striata* (Orb.), *Dentalina* sp. indet. We also found the index species *Lenticulina cultratiformis* (Mjatl.) in the complex.

Based on the systematic structure of the complex and index species *Lenticulina cultrati-formis* (Mjatl.) it can be stated that the complex belongs to Lenticulina cultratiformis - Lenticulina pseudocrassa zone.

The foraminifera complex of the Upper Callovian sediments is represented by *Epistomina elschankaensis* Mjatl., *Lenticulina tumida* (Mjatl.), *L. hoplites* (Wisn.), *L. simplex* (Küb. et Zw.), *L. uhligi* (Wisn.), *L. ukrainica* (Kapt.), *L. limataeformis* (Mitjan.), *L.* cf. *sculpta* (Mitjan.), *Citharinella nikitini* (Uhlig.), *Frondicularia spatulata* Terq., *F. nitida* Terq., *Nodosaria* aff. *claviformis* Terq., *Palmula primordialis* (Terq.), *Dentalina pseudocommunis* Franke, *Ammobaculites aequalis* (Roemer), *A. quadrifidus* Mitjan. (Table 2).

In this complex a characteristic types *Lenticulina tumida* (Mjatl.), *L. uhligi* (Wisn.) are present, as well as index species *Epistomina elschankaensis* Mjatl. and *Lenticulina tumida* (Mjatl.), which allows us to date these sediments as the Upper Callovian.

The analysis of the identified foraminiferal complexes allowed to highlight foraminiferal zones, as well as to point out some of their features. In the Lower Callovian deposits the agglutinated forms are absent, and the complex contains only the species of the Nodosaridae family. The genus Lenticulina in these sediments is dominant. In the Middle Callovian sediments we defined *Haplophragmoides follies* Kapt, that is characteristic of the Upper Callovian, and in the Upper Callovian we found *Citharinella nikitini* (Uhlig.), typical for the Middle Callovian sediments. This indicates a change in complexes when some species start to exist in the Middle Callovian (*Haplophragmoides follies* Kapt), while others continue (*Citharinella nikitini* (Uhlig.)) [16].

Together with the foraminifera and sponge spicules in the complexes we have identified individual ostracods and small bivalves.

M.M. Permyakova identified the characteristic ostracod complexes for the Callovian deposits of the Dnieper-Donets depression [16].

In the Lower Callovian deposits *Galliaecytheridea alveolata* (Terquem), *Praeschuleridea* cf. *wartae* Blaszyk, *Crucicythere* cf. *flexicosta* (Triebel) are found, which confirm the age of the host rocks.

In the Middle Callovian sediments *Lophocythere karpinsky* (Mandel. In Lub.), *Crucicythere* cf. *flexicosta* (Triebel), *Parariscus* cf. *octoporalis* Blaszyk, *Schuleridea translucida* (Lub.) have been revealed. The taxonomic composition and species *Lophocythere karpinsky* (Mandel. In Lub.), *Schuleridea translucida* (Lub.) are characteristic of this age.

In the Upper Callovian deposits the ostracods are represented by *Parariscus* cf. *octoporalis* Blaszyk, *Schuleridea* cf. *translucida* (Lub.), *Crucicythere* cf. *intermedia* (Lutze), *Infracythere dulcis* (Lub.). The taxonomic composition and identified characteristic form *Infracythere dulcis* (Lub.) confirm the age of the deposits.

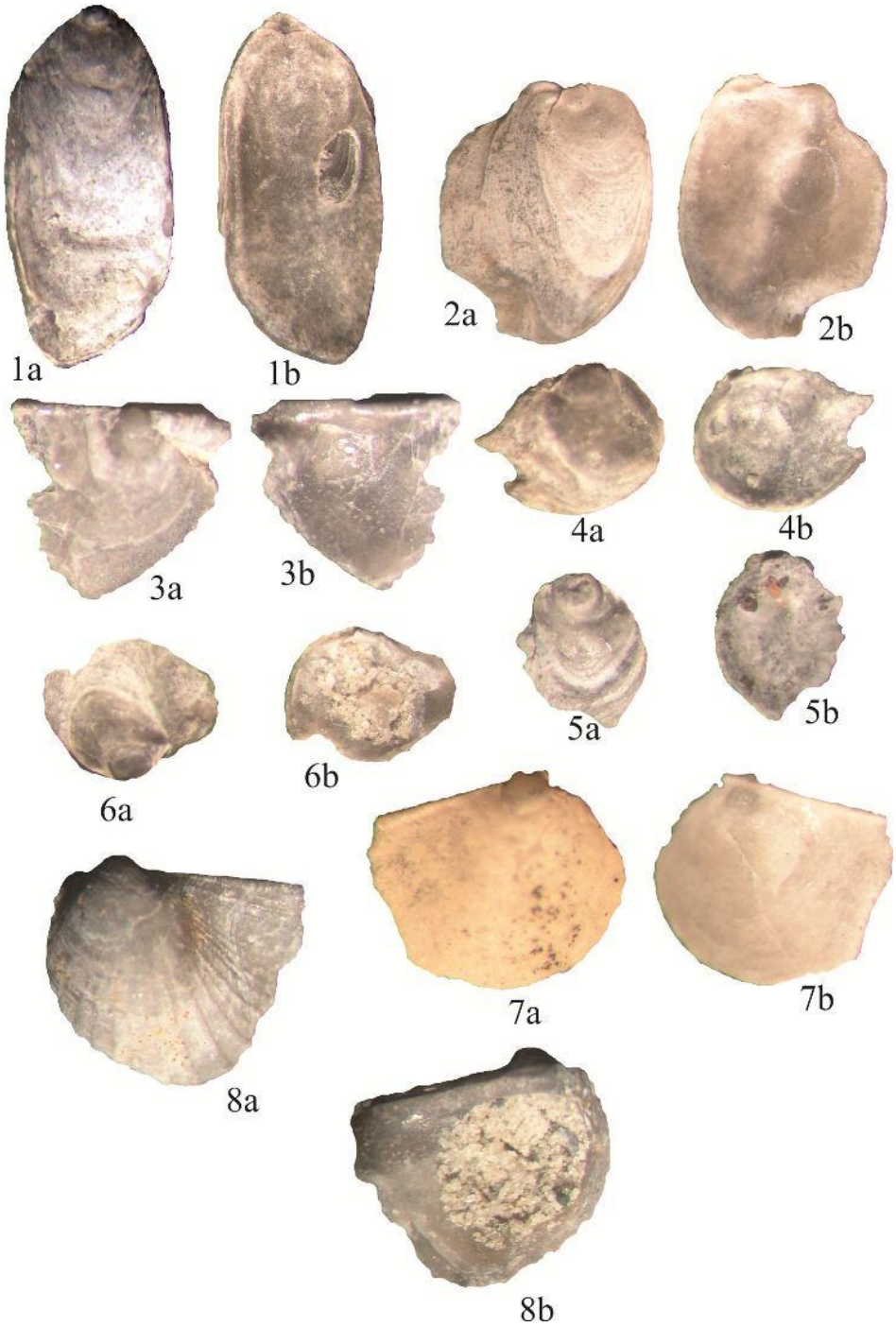
Also, we found two species of small bivalves *Liostrea* cf. *acuminata* (Sowerby) (Table 3) - a thin-walled shell, fragile; *Oxytoma* (*Oxytoma*) cf. *arzisiensis* Grebenschicova et Romanov (Table 3) - a thin-walled shell, thick. According to L.F. Romanov *Liostrea acuminata* (Sowerby) is found from the Upper Bajocian to the Middle Callovian of Dniester and Prut interfluve, and in top layers it is not found [12]. N.V. Grebenschikova found *Oxytoma* (*Oxytoma*) *arzisiensis* Grebenschicova et Romanov in the Upper Bajocian between the rivers Dniester and Prut [1].

Discussion. Analysis of the sponge spicules composition found in Callovian sediments of Dnieper-Donets Depression has shown that they belong to the sponges of two types Hyalospongea and Demospongea. Tetraxonida and Cornacu-spongida are allocated in Demospongea. Among sponge spicules of the Tetraxonida unit there are those that relate to the sponges with a disconnected skeleton - subtype Astrophora and sponges with associated lithistide skeleton consisting of different Desma - subtype Desmophora. Among Astrophora and Desmophora a number of families can be identified by characteristic spicules with the types of sponges that existed in Callovian basin.

Thus, the presence in the Lower, Middle and Upper Callovian complexes (Ichnyanskaya and Ivanitskaya suite) of oxea, strongyles, triene and small bean-shaped sterrasters, oxyasters, spherasters, indicates the presence of sponges of Geodiidae family in the complex. They are characteristic of the genera Geodia, Geodinella of this family. The sponges of the Pachatrellidae family in the Middle and Upper Callovian complexes (Ivanitskaya suite) are indicated by the presence of microscleres - oxyasters, and spherasters, macroscleres - oxea, caltrop, triaene. It does not rule out the presence of Tethyidae family in these sediments also characterized by the presence of spherasters, oxyasters and styles. In the Lower Callovian (Ichnyanskaya suite) metasters and oxyasters are found, characteristic for Thenea genera from the same family. The presence of oxea, dicotrienes, plagiotrienes or protrienes and anatrienea in the complex is the confirmation of the available sponges of this family [7].

Table 3

Bivalves small of the Cellovian sediments of the north-west part Dnieper-Donets depression



1-6 – *Liostrea* cf. *acuminata* (Sowerby). 7-8 – *Oxytoma* (*Oxytoma*) cf. *arzisiensis* Grebenschicova et Romanov

Desma and silicon plates characteristic of the genus Plinthosella of the Plinthosellidae family and Desmophora subtype are also found in the Lower Callovian complex.

The predominance of sponge spicules in the complex of Ichnyanskaya suite of small, straight or slightly curved short-edged oxea, strongyles, curved rhabdus indicate the presence of sponges of Cornacuspongida type, Haliclonidae family, Hellius, Haliclona genera [5].

Quite often in the Ichnyanskaya suite the curved rhabdus are found, that are characteristic of the Axinellidae family, especially the Axinella genus [5].

The presence of sponges from the Farreidae family of the Hexactinosa subtype, Amphiscophora type in the Ivanitskaya and Ichnyanskaya suite indicates isolated spicules like hexactines, pentacti-nes, stauractines, pinular hexactines. They belong to Hyalospongiae class [6].

Thus, with a certain degree of probability we can assume that in the Middle and Upper Callovian basin there were sponges of Geodidae, Pachastrellidae, Tethyidae families of Tetraxonida type, and the Haliclonidae family of Cornacuspongida type. The presence of sponges of the Farreidae family, Hexactinosa subtype, Amphiscophora type is also possible.

In the Lower Callovian basin probably existed sponges of such families as Geodidae, Theneidae, Plinthosellidae, Haliclonidae, Axinellidae, of Hyalospongiae type and possible representatives of Amphiscophora type of Hyalonematidae family, as well as the Farreidae family of the Hexactinosa subtype.

According to the foraminiferal analysis in the Callovian deposits we have identified three foraminiferal complexes (Lower, Middle and Upper Callovian). Analysis of foraminiferal complexes allowed us to conduct a detailed dissection of the well section:

– in the Lower Callovian, on a complex of characteristic species there was set a foraminifera complex, which corresponds to the zone Haplophragmoides infracalloviensis;

– in the Middle Callovian, on a complex of characteristic species and the index species *Lenticulina cultratiformis* (Mjatl.) we highlighted the foraminifera complex that belongs to the Lenticulina cultratiformis zone – Lenticulina pseudocrassa;

– in the Upper Callovian, on the complex characteristic species and the index species *Lenticulina tumida* (Mjatl.) and *Epistomina elschankaensis* Mjatl. we highlighted the foraminifera complex that belongs to the Lenticulina tumida zone - Epistomina elschankaensis.

In addition, we identified ostracods from the Lower, Middle and Upper Callovian deposits. In our work we have compared and supplemented the characteristics of ostracod complexes identified by M.M. Permyakova. The paleogeographic reconstruction of living conditions in the Callovian basin was made.

In the Early Callovian the transgression of the sea occured, gradually seized the territory of the Dnieper-Donets depression. The south-eastern part of the Dnieper-Donets depression is the lowland covered with lakes, swamps and river valleys, where sandy and clay rocks with plant residues deposited. The northwestern part of the Dnieper-Donets depression was covered by the sea, in the north it was connected with an open Srednerusskoye Jurassic sea.

In the Middle and Upper Callovian the lowering of large areas of Ukraine continued, and connected with this transgression of the sea, which began in the Early Callovian. In the Dnieper-Donets depression the sea spread in the south-eastern part and flooded north-western outskirts of Donbass. At this time the connection of the sea with Crimea-Caucasus basin renewed [17].

Ecological features (depth, temperature, salinity, currents, substrate etc.) and community composition of foraminifera, sponge spicules, ostracods and small bivalves served as the basis for the reconstruction of the Callovian paleobasin. We used the published data obtained in the study of modern marine organisms [1, 5, 6, 7, 10, 12, 13].

The zone of maximum abundance of species of sponges is within the depth of 500-1000 m. Hexactinellida are not found at a depth of less than 100 m. Tetraxonida are extended from the surface to 4000 m and deeper. They reach maximum development at a depth of 100-400 m. The subtype Desmophora is known in areas of small and great depths, but they are more abundant at depths of 150-300 m. Cornacuspongida are most numerous at depths of 200-350 m, but can also be found at large depths. Geodidae family, representatives of which were present in Callovian complex, is found at the depth of 90-170 m. Haliclonidae family prefers a depth between 50 and 300 m. The family Theneidae, which supposedly existed in the Lower Callovian basin prefers a depth of 8-820 m, and the family Axinellidae – 90-370 m.

The family Pachatrellidae, which probably existed in the Upper and Middle Callovian basin, is found at depths ranging from 30 to 1,550 m, and the Tethyidae family prefers the depth 5-440 m.

As in the Lower, Middle and Upper Callovian sediments were met the individual representatives of Triaxonida, a few representatives of Tetraxonida, and representatives of Oxea, which relate to Cornacuspongida are the most numerous, it can be assumed that the sea at that time was shallow 100 m.

Water temperature is an important factor that determines the development of the sponges. Most Tetraxonida relate to heat-loving animals, only few have adapted to life at constantly low temperatures. The types of Geodiidae family, which existed in the Callovian basin prefer temperatures from 0.4 to 8.5º, and the family Haliclonidae is more psychrophilic as they are found at temperatures of up to -1.64 and 2.9º. In the Lower Callovian basin the representatives of Axinellidae family, which prefer a temperature of 2-5º were present. In the Middle and Upper Callovian basin except for the Haliclonidae and Geodiidae the species of the Pachatrellidae family existed, which like a family Tethya prefer above-zero temperature. Likely the indicators of water masses in the Callovian basin were about 5-10º.

Sponges live in slightly diluted water and water with normal salinity. Tetraxonida are quite sensitive to changes in salinity. However, under other favorable conditions, they can adapt to a certain decrease in salinity. Families Axinellidae and Haliclonidae

spicules of which were found in the Lower Callovian sediments prefer water with a salinity of 34-35 ‰.

As the sponges are filter feeders, they usually settle in the area where groundwater flow is not very intense.

Sponges are mainly distributed in the solid ground, on stones and rocks in the surf zone and the upper horizons of the subtidal zone. They formed on the substrate, but with the depth the solid substrate is getting smaller, as silts dominate in the depths. So it can be concluded that the sea in the Callovian time was not deep.

Foraminiferal communities that inhabited the investigated part of the Callovian paleobasin are exclusively benthic organisms (Lagenida type (Nodosaridae family), Rotaliida (Epistomina family) and Ammodiscida (Lituolidae family)). There are psychrophilous, thermophilic, deep and shallow foraminifera. Basically, these forms are free existed (Nodosaridae family, Ammobaculites and Haplophragmoides genera), but capable ones which exist in the transition mode are met (Epistomina genus).

We can not say with certainty that among foraminifera there are only psychrophilous or thermophilic forms, or deep and shallow. For each type, family, genus, etc. there are favorable conditions of existence in which they are capable to produce a wide variety of species and specimens.

Secretion forms may exist before the boundary where they are capable of removing calcium carbonate from water, i.e. water masses should be sufficiently saturated with dissolved calcium carbonate, which is absorbed by the foraminifera to form shells. Below this boundary the dominant position is occupied by exclusively agglutinated forms. They exist at various depths and at different temperatures of the water masses. However, favorable living conditions for them are temperatures of the water masses from 2º to 10º [13].

The foraminiferal communities are dominated by Lagenida type (Nodosaridae family), which are relatively shallow and thermophilic forms, but compared to miliolids they are deep and psychrophilous. The temperatures of the water masses from 5.5 to 10º, the depth of the basin from 400 to 1000 m and salinity 34,5-37,7 ‰ are favorable conditions [13].

Representatives of the Rotaliida type are more thermophilic forms compared with a group of Lagenida. Favourable conditions are the depth of 300 to 1000 m, the water temperature of more than 15-25º and salinity 34,6-35 ‰ [13].

Representatives of the Ammodiscida type (Ammobaculites, Haplophragmoides genera) occur at various depths. The most favorable temperatures of water masses are below 3º, at which they are presented in large number of species at depths of 750 to 6000 m and in large number at depths of 1,000 to 2,500 m. At the water temperature above 10º generally there are few species of this group, and single specimens are found [13].

Analysing foraminiferal communities we can assume what was the temperature of paleobasin, its depth, salinity, etc. Foraminiferal communities largely composed of small numbers of nodozarias that are relatively shallow forms. Their small number, perhaps was affected by the higher temperatures of the water masses and small depth of the paleobasin. The high temperatures and shallowness of the Callovian paleobasin confirm individual ammobaculites and haplofrogmoides. But for epistominids which were found in single forms, probably water temperatures were low. The shallow basin is confirmed by the complete absence of planktonic foraminifera [13]. Therefore, we can assume that the investigated part of the Callovian paleobasin was shallow and reached about 100m depth, water temperature ranged from 10 to 15º.

Ostracoda communities consist of Podocopida representatives found in the various basins. The main habitats of ostracods are demersal coastal areas, at least one third of known species settle on algae. The rest are located in different parts of the bottom, mainly at depths up to 200 m. The frequency of ostracods occurrence and morphology of their shells depends largely on the substrate. This is due to the fact that most of ostracods are crawling, sometimes burrowing, and only few are preferably floating forms [10].

Small bivalves like their modern representatives are benthic animals. They live at different depths, but most of them at shallow depth near the banks. They have crawling, burrowing, attached or partly attached mode of life [1].

Mesozoic oxitomas, like their modern representatives, lifelong attached to the substrate. Perhaps the representatives of this species found good conditions for life on the shallow bottom areas periodically exposed to the strong influence of the waves. Habitat conditions of small fauna are little depth of the basin of more than 200 m at a normal salinity (35 ‰) [1].

Given the characteristics of all living organisms, we can guess in which conditions they lived in the Callovian paleobasin. In the Middle Jurassic the territory of Ukraine was within the tropical climate zone. However, at the end of the era (Callovian time) there were the processes of climate aridization. Mesophilic thermophilic plant associations dominated on land. In shallow seas the bioherm structures were created, carbonate sediments accumulated, there was a tropical biota, which reached its maximum development in the Callovian. After the Early Aalenian a decrease in average annual Mezotetis

water temperatures up to 10º - the climate minimum is observed, but then quickly enough the average temperatures reached 22-27º and more [8].

The paucity of microfossils we have identified, show that the water temperature and depth of the paleobasin for these organisms were not favorable, and their small number, perhaps was influenced by the lack of food.

The results of our research allow us to assume that in the Callovian time the depth of the studied paleobasin reached not more than 100 m. The temperatures of water masses ranged from 10 to 15º, and the salinity was 34-35 ‰. A comprehensive study of the various microfossil groups allows us to conclude that the taxonomic composition of microfossils, lithological features of sediments indicate the coastal and shallow nature of Callovian paleobasin.

Conclusions. We have installed and described complexes of sponges spicules and foraminifers of the Lower, Middle and Upper Callovian sediments in the Dnieper-Donets depression on the results of microfossils study. Analysis of foraminiferal complexes allowed to allocate foraminiferal zones and note their characteristics. We have traced the gradual change in the complexes of sponges spicules and foraminifers from the Lower to the Upper Callovian. The paleontological characteristics of the Callovian sediments have been completed by the new data of spicule and foraminifera analysis. The regularities of microfossils distribution allowed us to reconstruct the existing conditions in Callovian paleobasin.

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