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THE EARLIEST INSECT ENDOPHYTIC OVIPOSITION (EARLY PENNSYLVANIAN, EASTERN UKRAINE)

(Представлено членом редакційної колегії д-ром геол. наук, проф. В.В. Огарем)

The world's oldest insect endophytic oviposition from the deposits of the Mospinka Formation (Upper Bashkirian, Lower Pennsylvanian) of the Donets Basin is described in the paper. There is little information on Carboniferous endophytic oviposition of insects. The earliest insect endophytic oviposition specimens are specimens from the Upper Moscovian and the uppermost part of the Gzhelian of Germany, as well as the uppermost Gzhelian of France and the USA. The endophytic oviposition described in this article is almost 10 million years older than specimens from the Upper Moscovian of Germany.

The studied material was collected on five localities and four stratigraphic levels. The study area is the upper reaches of the Velyka Kamyanka River (southern part of the Luhansk Region, Ukraine). The rocks with the studied oviposition were formed in shallow marine, lagoonal and lacustrine environments. Insect damages were noted on leaves of arborescent lycopsids and cordaitaleans, and pteridosperm rachises. The above mentioned oviposition belongs to the following damage types sensu Labandeira et al., 2007: DT76, DT100, DT101 and DT175. The studied oviposition occurs mainly in sediments formed in the environments of a highly watered coastal alluvial-deltaic lowland with associations of the semi-aquatic sphenopsids (shores of lakes, rivers, and freshened lagoons), predominantly arborescent lycopsids (swampy areas), as well as pteridosperms on the elevated areas of accumulation plain. The most likely producers of endophytic oviposition are representatives of Odonatoptera, Palaeodictyopteroidea, and Orthoptera. The new findings substantially supplement the fossil record of insect endophytic oviposition.

Keywords: Ukraine, Donets Basin, Bashkirian Stage, endophytic oviposition, insects.

Introduction. Author has made detailed taphonomic and paleoecological observations on the deposits of the Mospinka Formation (Late Bashkirian) in the central part of Donets Basin (*Dernov, 2016; 2019; Dernov and Udovychenko, 2019b*) for several years. The territory of study is a small area of about 75 km^2 located in the upper reaches of the Velyka Kamyanka River (southern part of the Luhansk Region, Ukraine). Marine, transitional, and continental sediments of the Mospinka Fm. along strike are replaced by marine sediments of the Dyakivka Group at this area (*Dernov, 2016*). Concentrating efforts on a limited territory has led to unique results. One of them is a collection of the world earliest insect endophytic oviposition. The results of its study are presented in this article.

Oviposition is the process by which female insects, using a special organ (the ovipositor) place eggs on the surface of dead or living plants (exophytic oviposition) or in their tissues (endophytic oviposition) (*Gnaedinger et al., 2014; Xu et al., 2018*). The representatives of Odonatoptera, Orthoptera, Hemiptera, Coleoptera, Lepidoptera, and Hymenoptera lay eggs in the plant tissues (*Vassilenko and Rasnitsyn, 2007; Laaß and Hoff, 2014*). Eggs placed in the plant tissues are protected from predators, as well as temperature and humidity fluctuations (*Laaß and Hoff, 2014*).

Research history. There is little information on Carboniferous insect endophytic oviposition. The monograph by David White (*1899, plate III*) depicts cordaitalean leaf with endophytic oviposition. The fossil is found in the Carboniferous sediments of Missouri (USA). In the article (*Bethoux et al., 2004*) endophytic oviposition on the axis of the sphenopsid *Calamites cistii* Brongniart from the Upper Gzhelian of France is described. The potential producers of this oviposition are representatives of Palaeodictyopteroidea or Odonatoptera (*Bethoux et al., 2004*).

The article (*Vassilenko and Scherbakov, 2013*) gives an image of Late Carboniferous cordaitalean leaves with oviposition (Khakassia, Russia). This oviposition can be attributed to the DT100 (Damage Type100) of typology proposed in (*Labandeira et al., 2007*). In the work (*Laaß and Hoff, 2014*) oviposition from the upper part of Stephanian C (the upper part of the Gzhelian) of Germany was described. The work (*Laaß, 2017*) briefly described two morphotypes of endophytic oviposition from Westphalian D of Germany. Westphalian D roughly corresponds to the Myachkovian Horizon of the Moscovian Stage of the East European Platform (*Fisunenko, 2000; Popov, 1979*). The article (*Xu et al., 2018*) described 46 types of plant damages (11 are oviposition) from the uppermost part of Pennsylvanian (the Upper Gzhelian) of Texas. The monograph (*Lucas et al., 2021*) presented an image and a brief description of oviposition DT101 from the Gzhelian of New Mexico (USA).

Thus, the earliest insect endophytic oviposition specimens are specimens from the Upper Moscovian (*Laaß, 2017*) and the uppermost part of the Gzhelian of Germany (*Laaß and Hoff, 2014*), as well as the uppermost Gzhelian of France (*Bethoux et al ., 2004*) and the USA (*Xu et al., 2018; Lucas et al., 2021*). Material from the Upper Carboniferous of Russia (*Vassilenko and Scherbakov, 2013*) is dated too widely. A review of information on the finds of insect remains in the Carboniferous of the Don-Dnipro downramp is presented in works (*Dernov, 2019; Dernov and Udovychenko, 2019a*).

Geological setting. The study area is the bassins of the Luhanchyk and Velyka Kamyanka Rivers (figs. 1B and 1C). This area belongs to the zone of large linear folding (Northern anticline) and the northern zone of small folding of the Donets folded structure. All studied oviposition comes from deposits of the Mospinka Fm. (Fig. 1A).

Mospinka Fm. is represented by a cyclic sequence of mudstones, siltstones, sandstones with subordinate limestones (up to 8 layers) and coals (10-12 seams) (*Nemyrovska and Yefimenko, 2013*). The age of this stratigraphic unit is the Late Bashkirian (Early Pennsylvanian). The absolute age of the base and top of the formation is about 318.5 and 317 Ma, respectively (*Davydov et al., 2010*). The thickness of the formation is 315-730 m (*Nemyrovska and Yefimenko, 2013*). Fossils in the sediments of the Mospinka Fm. are very numerous and varied. From this formation foraminifers, chaetetids, corals, brachiopods, bryozoans, scaphopods, pelecypods, gastropods, cephalopods, crinoids, echinoids, arthropods (ostracods, cyclides, trilobites, horseshoe crabs, and insects), fishes, conodonts, algae, palynoflora, macroflora and trace fossils are known.

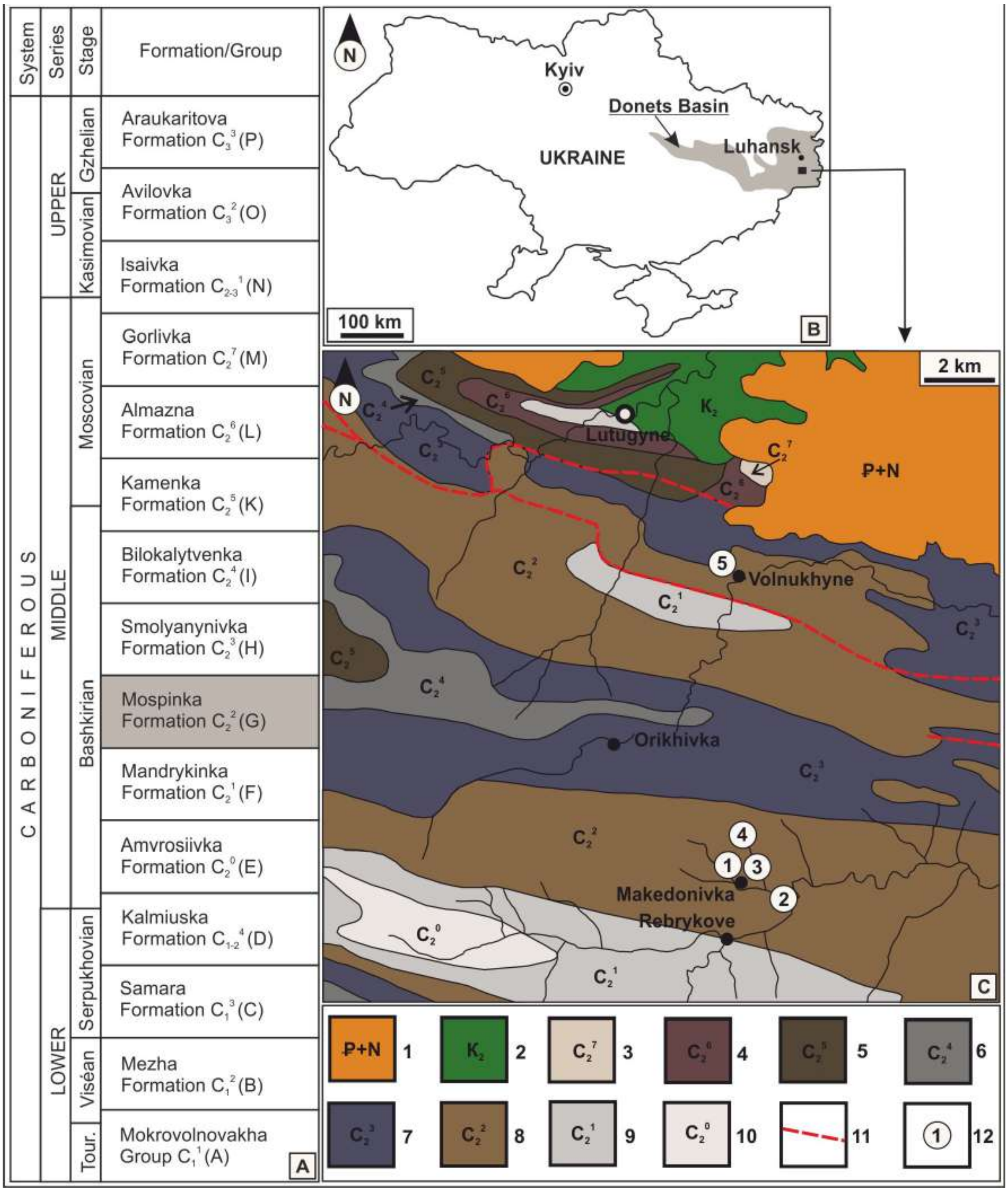

Fig. 1. Stratigraphic position of Mospinka Formation (fig. A) and geographic location of studied outcrops (figs. B and C).
Legend: 1 – Paleogene and Neogene, 2 – Upper Cretaceous, 3 – Gorlivka Fm., 4 – Almazna Fm., 5 – Kamyanka Fm., 6 – Bilokalytvenka Fm., 7 – Smolyanynivka Fm., 8 – Mospinka Fm., 9 – Mandrykinka Fm., 10 – Amvrosiivka Fm., 11 – faults, 12 – localities of oviposition. The stratigraphic scheme after (*Nemyrovska and Yefimenko, 2013*)

The Mospinka Fm. corresponds to the lower half of the Zuevkian Horizon of the Don-Dnipro downwarp, which corresponds to the Cheremshanian Horizon of the East European platform (*Nemyrovska and Yefimenko, 2013*).

The sediments of the Mospinka Fm. are assigned to the Neuralethopteris spp.-Lyginopteris hoeninghausii Zone of the Oleg P. Fisunenko macrofloristic scheme or the Alethopteris decurrens Subzone of the Lyginopteris hoeninghausii Zone of the Nataliya I. Boyarina scheme (*2016*). According to Oleg P. Fisunenko (*1991*), Neuralethopteris spp.-Lyginopteris hoeninghausii Zone corresponds to the base of Westphalian A of Western Europe. According to Nataliya I. Boyarina (*2016*), the Alethopteris decurrens Subzone is an age analogue of the Langsettian of the Western European chronostratigraphic scale.

Andrian V. Popov (*1979*) correlated the Mospinka Fm. with the base of Westphalian A of Western Europe and the Bloyd Fm. of North America. Conodonts (*Nemyrovska, 1999*) make it possible to correlate the Mospinka Fm. with the base of Westphalian A of Western Europe and the upper part of the Morrowan of North America.

The Mospinka Fm. is composed of rocks of various origins: paleosoils (sandstones, siltstones, coals), lacustrine and lagoonal siltstones and mudstones, prodeltaic siltstones, deltaic sandstones and siltstones, shallow marine limestones, and also deepwater mudstones. In addition, sometimes there are thin lenses of extremely shallow marine conglomerates.

In the Bashkirian Age the territory of the modern Donets Basin was located on the western coast of Laurassia at approximately 5° north paleolatitude (*Scotese, 2014*). The climate at the time of accumulation of the Mospinka Fm. in the Donets Basin was humid subtropical or tropical with periodically occurring dry periods (*Dernov, 2019*).

Material and methods. The material was collected on several outcrops of the Mospinka Fm. located in the Lutugyne District of the Luhansk Region (Ukraine). The localities are listed and briefly characterized below (Figs. 1B and 1C).

1. Ukraine, Luhansk Region, Lutugyne District, a ravine near the north-western outskirts of the Makedonivka Village (Fig. 2I; coordinates: 48°14'19.2"N 39°17'35.6"E); siltstone 10-15 m below G_1^2 limestone layer. A single oviposition (specimen IGSU-3/1652) was found in siderite nodule from marine light gray siltstone with remains of pelecypods, gastropods, and other fauna, as well as a single imprint of the lycopsid axis *Lepidodendron aculeatum* Sternberg.

2. Ukraine, Luhansk Region, Lutugyne District, the shore of the Kamyanka reservoir 0.8 km southeast of the outskirts of the Makedonivka Village (figs. 2E, 2H; coordinates: 48°13'44.0"N 39°19'11.3"E); limonite nodules from lacustrine roof shale of the g_1^2 coal bed. The nodules are contains macroflora *Calamites cistii* Brongniart, *Palaeostachya* sp., *Neuralethopteris* sp., *Artisia approximata* (Lindley and Hutton) Corda, *Cordaites principalis* (Germar) Geinitz. Materials: specimens IGSU-3/6345, IGSU-3/7502a, IGSU-3/7643a, IGSU-3/7644, IGSU-3/7649.

3. Ukraine, Luhansk Region, Lutugyne District, dumps of the old mine near the northwestern outskirts of the Makedonivka Village (Fig. 2G; coordinates: 48°14'35.3"N 39°17'54.8"E); roof shale of the g_1^2 coal bed. Material: specimen IGSU-3/7019.

A description of the section and its paleogeographic interpretation are given in (*Dernov, 2019*). A diverse macroflora was identified from this locality (*Dernov and Udovychenko, 2019 b*), as well as the remains of non-marine animals (freshwater pelecypods, horseshoe crabs, fishes, problematics and trace fossils) (*Dernov, 2019*). Sediments were formed in lagoonal and lacustrine environments (*Dernov and Udovychenko, 2019 b*).

4. Ukraine, Luhansk Region, Lutugyne District, quarry 2 km north of the Makedonivka Village (Fig. 2D and 2F; coordinates: 48°14'59.1"N 39°17'50.1"E); siltstones below the g_2 coal bed.

The same sediments, as well as the roof shale of the g_2 coal bed, were studied on dumps of old small mines 300 m east of the quarry. Materials: specimens IGSU-3/1053, IGSU-3/1058, IGSU-3/1067, IGSU-3/4760, IGSU-3/7054.

Some information regarding this locality is given in (*Dernov, 2016*). Macroflora from siltstones below the g_2 coal layer is represented by the following forms: autochthonous appendixes of *Stigmaria*, *Cyperites bicarinatus* Lindley et Hutton, *Annularia radiata* Brongniart, *Calamites carinatus* Sternberg, *Calamites cistii* Brongniart, *Calamites suckowii* Brongniart, *Pinnularia capillacea* Lindley et Hutton, *Pariptteris gigantea* Sternberg (Gothan), and *Cordaites principalis* (Germar) Geinitz. Here are also found rare remains of not yet studied arthropods (horseshoe crabs, cyclides and insects). Siltstones formed in lacustrine environment.

5. Ukraine, Luhansk Region, Lutugyne District, quarry in the Volnukhyne Village (figs. 2B and 2C; coordinates: 48°21'27.9"N 39°16'49.4"E); roof shale of g_3 coal bed. Material: specimen IGSU-3/7044.

The results of studying the remains of macroflora from this locality are given in the article (*Dernov and Udovychenko, 2019b*). The microconchids and trace fossils were also found here (*Dernov and Udovychenko, 2019b*). Siltstones with plant remains have lacustrine origin.

The methodology of the oviposion description was taken from works of Dmitry Vassilenko (*2011; 2013*) with some changes. Abbreviations: L_{OV} – length of oviposition (clutch), L_S – length of single oviposition marks, W_{OV} – maximum width of oviposition (clutch), W_S – maximum width of single oviposition marks, K – L_S/W_S ratio, AM – arithmetic mean.

The studied collection (IGSU-3; author's collection 2010-2013) is housed in the Department of Stratigraphy and Paleontology of Paleozoic Deposits of the Institute of Geological Sciences of the National Academy of Sciences of Ukraine (Kyiv).

Results. Endophytic ovipositions of insects are briefly described below. The work (*Labandeira et al., 2007*) was mainly used to determine the parasystematic affiliation of ovipositions.

Oviposition DT76 (figs. 3H, 3N-P, 4A, 4C, 4E)

Material. Four samples with oviposition from two localities (specimens IGSU-3/6345, IGSU-3/7019, IGSU-3/7044, IGSU-3/7644).

Description. Oviposition consists of a large number of ellipsoidal and rounded relatively small and large lesion located in a line parallel to the axes and veins of pteridosperm rachises (specimens IGSU-3/6345, IGSU-3/7019, IGSU-3/7044) and *Cordaites* leaf venation (specimen IGSU-3/7644) to which they are attached. The oviposition marks of some specimens (for example, Fig. 4A) are concentrated in a row parallel to the axis of the plant shoot. The others (Fig. 4C) are concentrated in zigzag rows.

Dimensions (in mm) and ratios:

Specimen IGSU-3/6345 (Fig. 4A): L_{OV} – 12.0 mm, W_{OV} – 1.0 mm, L_S ranges from 1.2 to 3.0 mm; W_S ranges from 0.7 to 1.0 mm (K=1.0-3.0, K_{AM}=2.22). The distance between the scars is approximately 1.0-2.5 mm.

Specimen IGSU-3/7019 (fig. 3H): L_{OV} (incomplete) – 16.0 mm, W_{OV} – 3.0 mm, L_S – from 0.5 to 1.0 mm, W_S – 0.25-0.50 mm (K=2.0).

Specimen IGSU-3/7044 (figs. 3N-P): L_{OV} – 14.0 mm, W_{OV} – 1.0 mm, L_S – 0.50 mm, W_S – 0.35 mm (K=1.43).

Specimen IGSU-3/7644 (figs. 4C-4E): L_{OV} – about 26.0 mm, W_{OV} (incomplete) – about 7.0 mm, L_S – 0.8-1.0 mm, W_S – 0.3-0.4 mm (K=2.50-2.66).

Potential producers. In the work (*Lin et al., 2019*) the morphological closeness of the oviposition DT76 and egg clutches of the *Ceutorrhynchus quadridens* Panz. (Coleoptera: Curculionidae) was noted. Coleoptera can be excluded from the list of potential producers of the oviposition DT76 from Pennsylvanian of the Donets Basin, since this group of insects are not known in the Carboniferous. Apparently, the producers of DT76 from the Carboniferous of the Donets Basin are Orthoptera, Odonatoptera or Palaeodictyopteroidea. One specimen (figs. 4C and 4E) is slightly different from the other ovipostions DT76. The ovipositional damage is concentrated in zigzag rows. This arrangement of eggs is typical for egg clutches of modern dragonflies (the so-called "Coenagrionid Type" oviposition pattern) (*Laaß and Hoff, 2014*).

Localities. The studied ovipositions were found on the localities 2, 3, and 5.

Oviposition DT100 (figs. 4B, 4D)

Material. One well-preserved oviposition (specimen IGSU-3/7502a).

Description. The oviposition consists of several dozen small, highly elongated lesions on the leaf of the cordaitalean. The egg scars are oriented with their long axis along the leaf veins, but at the same time form rows transverse to the venation.

Dimensions (in mm) and ratios:

Specimen IGSU-3/7502a (figs. 4B, 4D): L_{OV} (incomplete) – 25.0 mm, W_{OV} – 7.0 mm, L_S – 0.4-0.5 mm, W_S – 0.15-0.20 mm (K=2.50-2.66, K_{AM}=2.58).

Potential producers. Oviposition DT100 according to (*Lin et al., 2019*) has significant morphological similarity with egg clutch of modern grasshopper *Cornops frenatum* Marschall (Orthoptera: Acrididae). At the same time, oviposition DT100 is similar to those of modern dragonflies ("Coenagrionid Type" oviposition pattern) (*Laaß and Hoff, 2014*).

Locality. The material comes from locality 2.

Oviposition DT101 (figs. 3A-G, 3I-K)

Material. 10 samples with oviposition from three localities (specimens IGSU-3/1053, IGSU-3/1058, IGSU-3/1067, IGSU-3/1652, IGSU-3/4760, IGSU-3/7054, IGSU-3/7287, IGSU-3/7649, IGSU-3/8000, IGSU-3/8003).

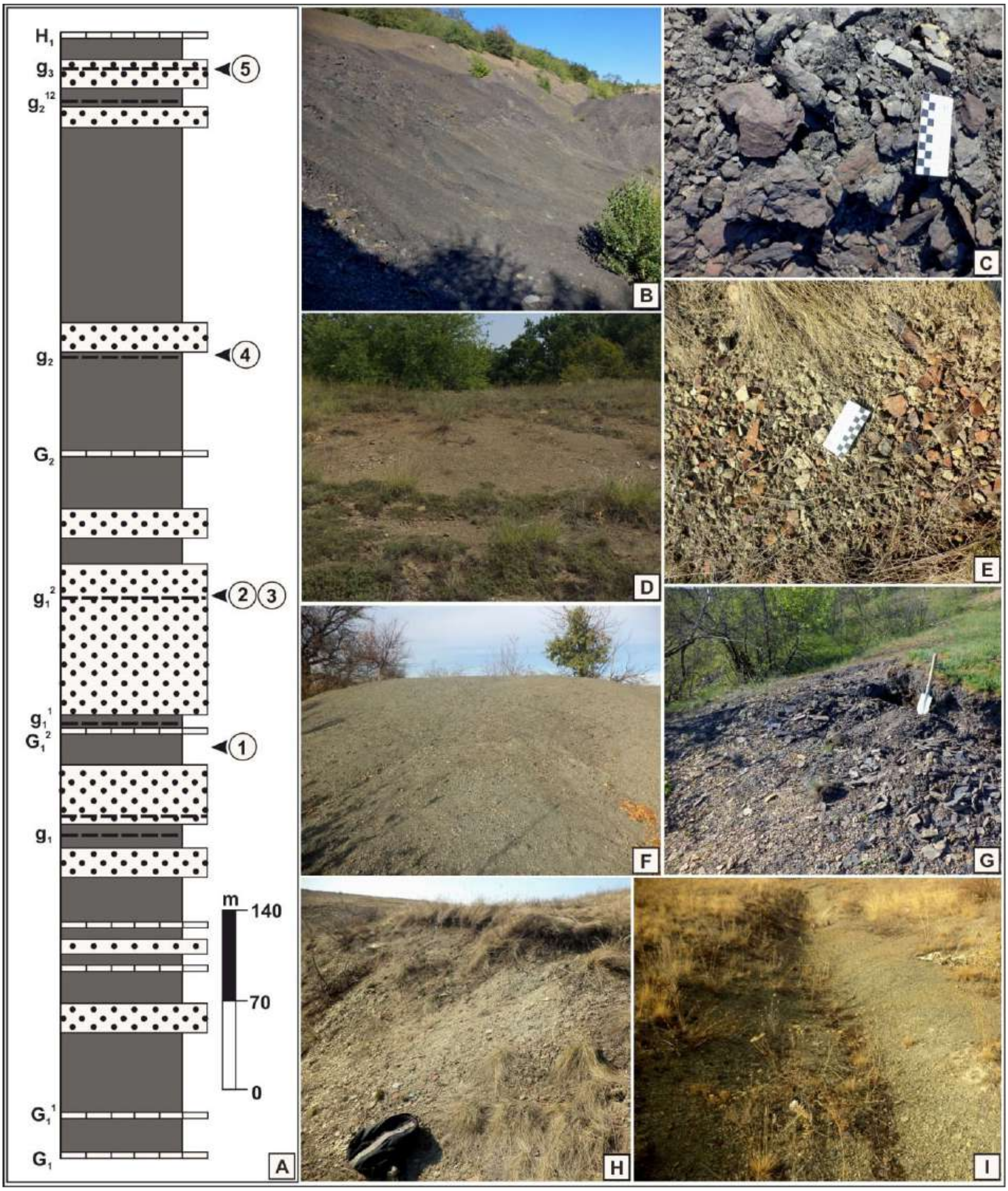

Fig. 2. Stratigraphic position of insect oviposition localities in the section of the Mospinka Fm. (Fig. A) and studied outcrops (B–I):
B – locality 5, C – limonite nodules from siltstones of locality 5, D, F – locality 4,
E – limonite nodules in eluvium of roof shale of the g_1^2 coal seam (locality 2), G – locality 3, H – locality 2, I – locality 1.
Legend: 1 – sandstone, 2 – mudstone and siltstone, 3 – coal, 4 – limestone, 5 – index of coal layer, 6 – index of limestone layer

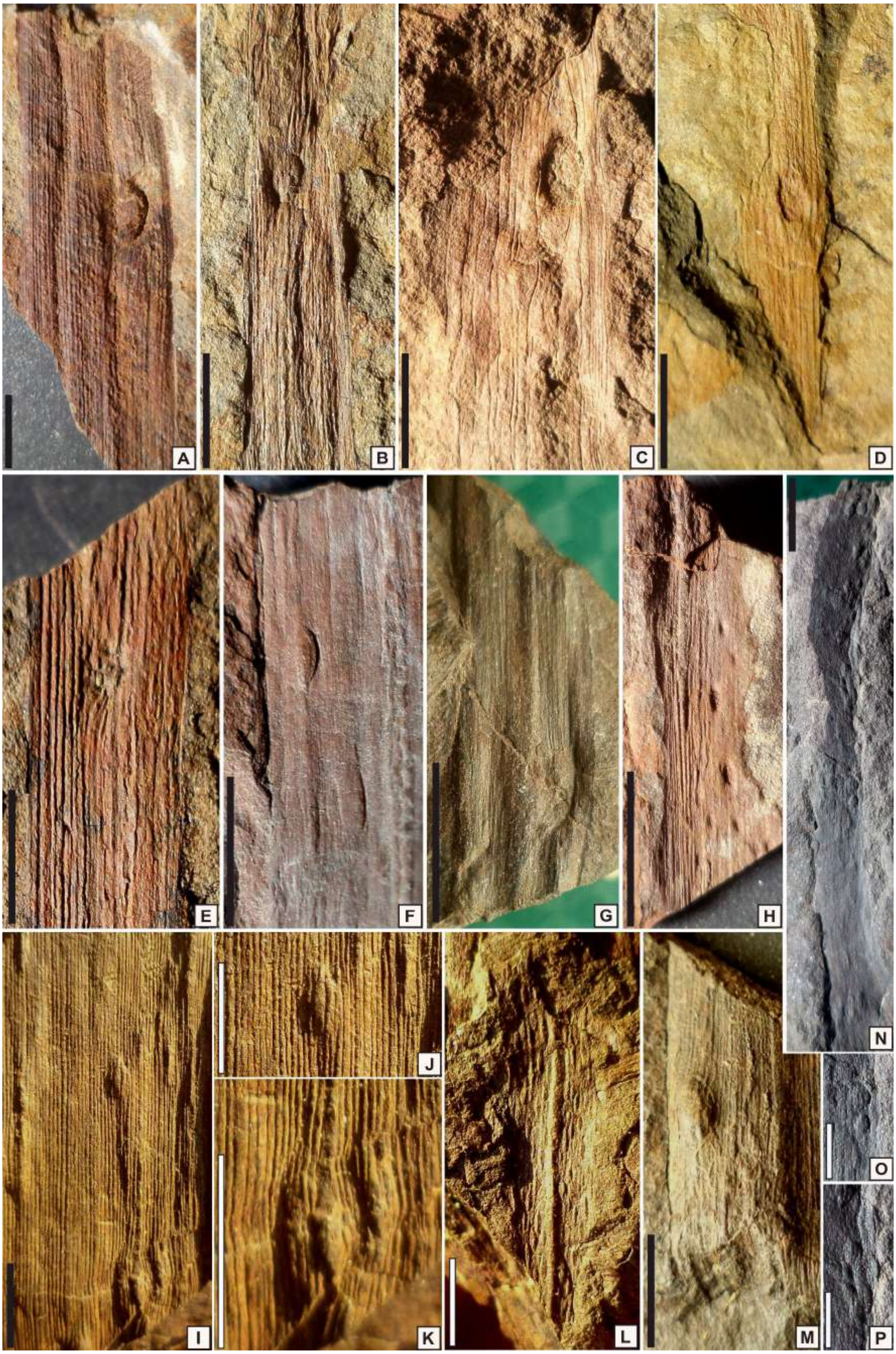

Fig. 3. Insect endophytic oviposition (DT76, DT101, and DT175) from the Pennsylvanian of the Donets Basin:
A-G – oviposition DT101 (locality 4: A – specimen IGSU-3/1053, B – IGSU-3/1058, C – IGSU-3/4760, E – IGSU-3/1067, F – IGSU-3/7054; locality 1: D – IGSU-3/1652; locality 2: G – IGSU-3/7649). H – oviposition DT76 (locality 3: IGSU-3/7019). I-K – oviposition DT101 (locality 2: IGSU-3/8003): I – general view, J and K – enlarged. L – oviposition DT175 (locality 2: IGSU-3/7643a). M – oviposition DT101 (locality 4: field photo). N-P – oviposition DT76 (locality 5: IGSU-3/7044). Scale bars: 5 mm (figs. A–N) and 2 mm (figs. O and P)

Description. Large (length 2.0-4.0 mm, width – 0.8-2.0 mm; K=1.50-2.50, K_{AM}=1.90) elliptical oviposition lesion on the rachises of pteridosperms and cordaitalean leaves. The oviposition marks are oriented parallel to the venation of rachises and leaves. The oviposition consists of single mark, around which a reaction scar is often observed.

Dimensions (in mm) and ratios:

Dimension	Specimens								AM
	IGSU-3/1053	IGSU-3/1058	IGSU-3/1067	IGSU-3/1652	IGSU-3/4760	IGSU-3/7054	IGSU-3/7649	IGSU-3/8000	
L_S	4.0	2.20	3.0	2.20	3.0	2.0	3.0	2.50	2.74
W_S	2.40	1.20	2.0	1.20	1.80	0.80	1.50	1.50	1.55
K	1.67	1.83	1.50	1.83	1.67	2.50	2.0	2.10	1.90

Remarks. Most of ovipositions are found in the lacustrine siltstones; one specimen (IGSU-1652; fig. 3D) was found in siderite nodule from gray siltstones with remains of marine pelecypods *Solenomorpha*, *Sanguinolites*, *Phestia*, gastropods *Euphemites*, cephalopods *Liroceras* and *Peripetoceras* (*Dernov, 2018*).

Potential producers. Oviposition DT101 is similar to egg clutch of the modern beetle *Dytiscus marginalis* L. (Coleoptera: Dytiscidae) (*Lin et al., 2019*). Nevertheless, apparently, the producers of the oviposition DT101 from the Carboniferous of Donets Basin are Palaeodictyopteroidea.

Localities. The studied oviposition was found on localities 1, 2, and 4.

Oviposition DT175 (fig. 3L)

Material. One sample with oviposition (specimen IGSU-3/7643a).

Description. Oviposition consisting of a large number of lenticular small lesion located in a line parallel to the axes of lycopsid leaf *Cyperites bicarinatus* Lindley et Hutton to which it was attached.

Dimensions (in mm) and ratios:

Specimen IGSU-3/7643a (fig. 3L): L_{OV} (incomplete) – 13.0 mm, W_{OV} – 3.0 mm, L_S – 0.4-0.5 mm, W_S – 0.15-0.20 mm (K=2.50-2.66, K_{AM}=2. 58).

Potential producers. Ovipositions DT175 are very close to the egg clutch of *Neodiprion sertifer* (Geoffroy ex Fourcroy) (Hymenoptera: Tenthredinidae) (*Lin et al., 2019*). However, Hymenoptera are not known from the Carboniferous.

Locality. The material comes from locality 2.

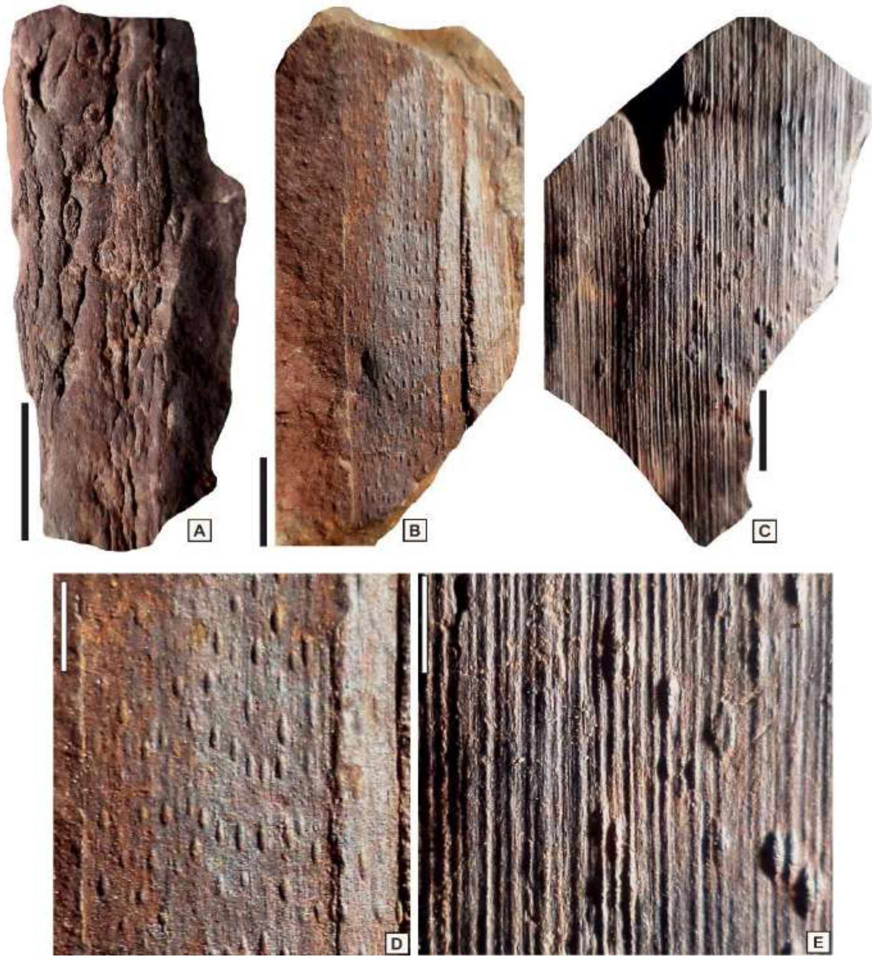

Fig. 4. Insect endophytic oviposition (DT76 and DT100) from the Pennsylvanian of the Donets Basin:
A – oviposition DT76 (locality 2: specimen IGSU-3/6345); B, D – oviposition DT100 (locality 2: IGSU-3/7502a): B – general view, D – enlarged; C, E – oviposition DT76 (locality 2: IGSU-3/7644). Scale bars: 5 mm (figs. A-C) and 2 mm (figs. D and E)

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Taphonomy and paleoecology. The studied oviposition occurs mainly in sediments formed in the environments of a highly watered coastal alluvial-deltaic lowland with associations of semi-aquatic sphenopsids (shores of lakes, rivers, and freshened lagoons), predominantly arborescent lycopsids (swampy areas), and pteridosperms on the elevated areas of accumulation plain (*Fisunenko, 1975; 1978*).

Insects ("dragonflies") in the Middle Carboniferous (Lower and Middle Pennsylvanian) of the Donets Basin were characteristic of the slightly elevated coastal plain with lycopsid-fern-pteridosperm phytocoenosis and the most elevated areas of the sedimentation area mainly with pteridosperm phytocoenosis (Fisunenko, 1987). The following groups of insects are known from the Pennsylvanian of the Donets Basin: Palaeodictyopteroidea (*Sharov and Sinichenkova, 1977; Dernov, 2019*), Odonatoptera (*Dernov, 2016*), Dictyoptera (*Dernov and Udovychenko, 2019a*) and presumably Orthoptera (unpublished data; definition by Joerg W. Schneider, Freiberg).

The predominant amount of material comes from the sediments of freshwater lakes, which have arisen as a result of siltation of peat swamp. It should be noted that ovipositions were observed on various plant organs: leaves of lycopsids and cordaitaleans, as well as rachises of pteridosperms.

The number of the plant damages is sometimes quite large. For example, on the surface of limonite nodule (specimen IGSU-3/7643), with an area of approximately 21 cm^2, among the plant detritus two plants fragments with traces of arthropod influence were found: oviposition DT100 (lycopsid leaf) and piercing and sucking DT138 (pteridosperm rachis). As already noted, insect endophytic ovipositions are also known in the marine sediments of the Mospinka Fm.

The most likely producers of endophytic ovipositions are representatives of Odonatoptera, Palaeodictyopteroidea, Dictyoptera, Archaeorthoptera, Hemipteroidea, and Orthoptera (*Schachat et al., 2014*). To date, it is almost impossible to correlate the above-described oviposition with a specific group of insects due to limited information regarding the reproductive strategy of insects in the Late Paleozoic. Applying the principle of actualism and comparing Carboniferous and modern insect oviposition is fraught with gross mistakes. Nevertheless, at least some of the oviposition described in this article may belong to Odonatoptera (DT100) and Palaeodictyopteroidea (DT76, DT101).

The earliest endophytic oviposition of insects, as already noted, are specimens from the Upper Moscovian (*Laaß, 2017*) and the uppermost part of the Gzhelian of Germany (*Laaß and Hoff, 2014*), France (*Bethoux et al., 2004*), and the United States (*Xu et al., 2018; Lucas et al., 2021*). The endophytic ovipositions described in this article are almost 10 million years older than specimens from the Upper Moscovian of Germany.

Conclusion. The main results of the study are as follows.

(1) The world's earliest endophytic ovipositions of insects (DTs 76, 100, 101, 175) described are from the deposits of the lower part of the Bashkirian stage of the Donets Basin.

(2) New findings substantially supplement the fossil record of insect endophytic oviposition. The producers of the described ovipositions are presumably Palaeodictyopteroidea, Odonatoptera and/or Orthoptera.

(3) The research results show significant prospects for the study of Carboniferous terrestrial ecosystems on the example of the Donets Basin.

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НАЙДАВНІШІ ЕНДОФІТНІ ЯЙЦЕКЛАДКИ КОМАХ (РАННІЙ ПЕНСИЛЬВАНІЙ, СХІДНА УКРАЇНА)

З відкладів моспинської світи (верхній башкир, нижній пенсильваній) Центрального Донбасу описано найдавніші у світі ендофітні яйцекладки комах. Відомостей щодо ендофітних яйцекладок комах із кам'яновугільних відкладів небагато. Найдавнішими з них, описаними в літературі на сьогодні, є екземпляри з верхів московського і найвищої частини гжельського ярусу Німеччини, а також верхів гжельського ярусу Франції і США. Описані у статті ендофітні яйцекладки комах є майже на 10 млн років давнішими за екземпляри, що відомі з верхів московського ярусу Німеччини.

Вивчений матеріал походить з п'яти місцезнаходжень і чотирьох стратиграфічних рівнів. Територією досліджень є верхня течія ріки Велика Кам'янка (південна частини Луганської області, Україна). Породи зі слідами життєдіяльності комах утворилися в мілководно-морських, лагунних та озерних умовах. Яйцекладки комах відзначені на листових пластинках деревовидних лікопсид і кордаїтантових, а також

рахісах птеридоспермів. Вивчені іхнофоссилії належать до таких типів пошкоджень sensu (Labandeira et al., 2007): яйцекладки DT76, DT100, DT101, DT175. Переважна більшість вивчених яйцекладок походить з відкладів, що накопичились в умовах сильно зволоженої приморської алювіально-дельтової низовини, вкритої заростями напівводних членистостеблових (узбережжя озер, річок і розпріснених лагун), переважно деревовидних лікопсид (заболочені ділянки), а також птеридоспермів (припідняті ділянки області седиментації). Найімовірнішими продюсерами ендофітних яйцекладок є представники Odonatoptera, Palaeodictyopteroidea, Dictyoptera, Archaeorthoptera, Hemipteroidea і Orthoptera. Нові знахідки суттєво доповнюють викопний літопис ендофітних яйцекладок комах.

Ключові слова: Україна, Донбас, башкирський ярус, ендофітні яйцекладки, комахи.

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ДРЕВНЕЙШИЕ ЭНДОФИТНЫЕ ЯЙЦЕКЛАДКИ НАСЕКОМЫХ (РАННИЙ ПЕНСИЛЬВАНИЙ, ВОСТОЧНАЯ УКРАИНА)

Из отложений моспинской свиты (верхний башкир, нижний пенсильваний) Центрального Донбасса описаны древнейшие в мире эндофитные яйцекладки насекомых. Сведений о каменноугольных эндофитных яйцекладках насекомых немного. Древнейшими из них, описанными в литературе на сегодняшний день, являются экземпляры из верхов московского и высшей части гжельского яруса Германии, а также верхов гжельского яруса Франции и США. Описанные в статье эндофитные яйцекладки насекомых почти на 10 млн лет древнее известных экземпляров из верхней части московского яруса Германии.

Изученный материал происходит из пяти местонахождений и четырех стратиграфических уровней. Территорией исследований является верхнее течение реки Большая Каменка (южная часть Луганской области, Украина). Породы со следами жизнедеятельности насекомых образовались в мелководно-морских, лагунных и озерных условиях. Яйцекладки насекомых отмечены на различных органах растений: листовых пластинках древовидных ликопсид и кордаитантовых, а также рахисах птеридоспермов. Ихнофоссилии относятся к следующим типам повреждений sensu (Labandeira et al., 2007): яйцекладки DT76, DT100, DT101, DT175. Изученные яйцекладки происходят преимущественно из отложений сильно увлажненной приморской аллювиально-дельтовой низменности, покрытой зарослями полуводных членистостебельных (побережья озер, рек и опресненных лагун), древовидных ликопсид (заболоченные участки), а также птеридоспермов (приподнятые участки области седиментации). Наиболее вероятными продюсерами эндофитных яйцекладок являются представители Odonatoptera, Palaeodictyopteroidea, Dictyoptera, Archaeorthoptera, Hemipteroidea и Orthoptera. Новые находки существенно дополняют ископаемую летопись эндофитных яйцекладок насекомых.

Ключевые слова: Украина, Донбасс, башкирский ярус, эндофитные яйцекладки, насекомые.