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Famenian palynostratigraphy of the Volyn–Podillya margin of the East–European platform

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Abstract. Famenian carbonate-terrigenous deposits with thickness in 300-580 m are widely distributed within the Volyn-Podillia margin of the East-European platform. It is the facies-varying complex of rocks, the stratification of which is very difficult because there are no faunal remains in the sediments (with the exception of the lower part). Therefore, during the study of this stratum, the palynological method and the palynostratigraphic division are very important. The main purposes of this study are

to identify palynozones, distinguish their generalized description and to create a local scale of the palynological zonation - the vertical succession of biozones. The material for research consists of more than 450 samples, selected from 31 boreholes. The main method is the facies-palynological analysis, or the method of palynoorictocenosis. This is the first study to perform the standardized description of the biostratigraphic units determined by the palynological data for the Famenian of the Volyn-Podillia margin of the East-European platform. In general, five palynozones are allocated in the Famenian. All palynozones are comprehensively documented thanks to numerous palynological data, characterized by a zonal spore assemblage, in the structure of which there are following categories of taxa: based on the vertical range characteristics - key, characteristic, transit ones; on the content - subdominant, accessory. According to spreading peculiarities of key and characteristic species the following types of bio-units are identified: the Range-Zone (two units) and the Concurrent-Range Zone (three ones). General the Famenian deposits of the Volyn-Podillia margin of the East-European platform were palynologically subdivided into **lebedianensis–magnificus** (the oldest zone), **varicornata**, **cassis–lupinovitshi**, **versabilis–hamulus**, **lepidophyta** (the youngest unit) miopore zones. Palynozones with a thickness from 17 to 231 m are laterally widespread, recorded from a number of boreholes within Volyn-Podillia. They have a set of palynological features that allow easy recognition of deposits. Palynozones detail the sequence bedding, complement the paleontological characteristic and form the local palynological zonal scheme of the Famenian of the Volyn-Podillia margin of the East-European platform.

Keywords: palynology, miopores, palynozones, Famenian, the Volyn-Podillia margin of the East-European platform.

Паліностратиграфія фаменських відкладів Волино–Подільської окраїни Східноєвропейської платформи

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Анотація. Фаменські карбонатно-теригенні відклади потужністю 300 - 580 м, повсюдно поширені в межах Волино-Подільської окраїни Східно-Європейської платформи, складають фаціально мінливий комплекс порід, стратифікація якого викликає значні труднощі через те, що у відкладах (за винятком меншої нижньої частини) немає фауністичних решток. Тому для вивчення цієї товщі велике значення має палінологічний метод та виконання паліностратиграфічних побудов, головна мета яких - виділення всебічно схарактеризованих палінозон і створення місцевої шкали палінологічної зонації – вертикальної послідовності паліностратонів. Матеріалом для досліджень стали понад 450 зразків, відібраних із 31 свердловини. Головним методом обрано фаціально-палінологічний аналіз, або метод паліноориктоценозів. Уперше для фаменських відкладів Волино-Подільської окраїни Східно-Європейської платформи наведено стандартизовану характеристику біостратиграфічних підрозділів, визначених за палінологічними даними у відкладах фамену ВПО СЕП, їх кореляцію з біопідрозділами суміжних регіонів. Загалом у розрізі фамену виділено п'ять палінозон. Вони комплексно обґрунтовані, схарактеризовані зональним споровим комплексом, у структурі якого є такі категорії таксонів: виділені за особливостями поширення в розрізі – керівні, характерні, або типові, транзитні; визначені за вмістом: субдомінанти, рідкісні. За сполученням керівних і характерних видів у фаменських відкладах визначено такі типи біопідрозділів: дві біозони і три конкурентно-рангові зони. Загалом у фаменських відкладах Волино-Подільського краю Східно-Європейської платформи визначено такі зони (від давнішої до наймолодшої): **lebedianensis–magnificus**, **varicornata**, **cassis–lupinovitshi**, **versabilis–hamulus**, **lepidophyta**. Палінозони латерально витримані, простежені в розрізах свердловин у межах Волино-Поділля, мають товщину від 17 до 231 м, деталізують стратиграфічне розчленування розрізів, доповнюють палеонтологічну характеристику відкладів і формують місцеву біостратиграфічну шкалу, визначену за палінологічними даними.

Ключові слова: палінологія, спори, палінозони, фаменський ярус, Волино-Подільська окраїна Східноєвропейської платформи

Introduction. One of the prioritized direction in today's geology are the updated, modernized and substantiated reinterpretation of existing stratigraphic schemes - one of the main normative geological documents, and improvement of the biostratigraphic support of regional geological works. Spores and pollen are a group of organic microfossils with a significant lateral spreading that has quickly evolved and is a component of sedimentary rocks. Palynological data are a basis for a polyfacial sediments correlation, a stratification with varying degrees of detail, the biostratigraphic justification of lithostratigraphic units, and it is an additional search criterion for oil and gas, etc. This is one of the most important floristic groups, which must necessarily be used for the stratigraphic division, correlation of sedimentary rocks and an improvement of straton characteristics.

Famenian carbonate-terrigenous deposits with a thickness of 300 to 580 m are widely spread within the Volyn-Podillia margin of the East-European platform (VPM EEP). This is a polyfacial complex of rocks with varied lithology, including limestone, dolomites, clastics. Their stratification is very difficult because strata are poor in fossils (with the exception of the smaller lower part). Therefore, during the study of this stratum, **palynological method** and palynostratigraphic division are of great importance. The main aim of these investigations is to determine and fully characterize the palynozones, define their types, age and create a local scale of a palynological zonation - the vertical **succession** of bio-units. Palynological research of the Upper Devonian deposits of Volyn-Podillya was started in the 60's of the twentieth century by G. I. Kedo, I. I. Partyka (only handwritten conclusions on individual samples). The first attempts to generalize the palynological materials with the allocation of complexes were made by I. I. Partyka and A. V. Ivanina in the 90's of the XX century (Ivanina, Partyka, 1990).

Today, during the rapid development of information technology, one of the main tasks of stratigraphy, in addition to the certification of geological bodies, is the formation of an interactive standardized system - a catalog of personified stratum. The systematization and unification of stratigraphic materials is needed because of the low quality of main stratigraphic normative documents - stratigraphic schemes - due to the dominance of the subjective approach to the definition of the stratigraphic hierarchy, too generalized stratum characteristics without specifying clear criteria for their selection, violations of stratigraphic nomenclature rules, etc. Creation of the standardized system of stratigraphic units' characteristics unifies and specifies of stratum diagno-

ses, facilitates of stratigraphic information perception, and it is a convenient form of storage and a reliable tool for the analysis of valid scientific data and various operations.

Currently, due to new data and the improvement of methodological principles of the palynological analysis, revision of the miospores' definitions according to the updated taxonomy of M. V. Oshurkova (Oshurkova, 2003) has been performed, taxa spreading ranges have been specified, biostratigraphic divisions by the palynological data have been determined, zonal characteristics are unified and specified, standardized characteristics of palynozones and the palynological zonation scheme of the Famenian of the VPM EEP are worked out.

Materials and methods. The materials for studying consists of more than 450 samples from 31 boreholes. The main method is the facial-palynological analysis, or the method of palynoorictocenosis, based on the complex studying palynomorphs and the lithological-facial composition of country rocks (Ivanina, 1998, 2014). It's characteristics and the methodology of the zones' and zonal scales determining by palynological data are described in (Ivanina, 1997, 2014; Ivanina, Shulga, 2005). Palynozones are biostratigraphic units with the unique, characteristic only for zonal sediments miospores' assemblage. In it's structure there are the following categories of taxa: according to the peculiarities of vertical distribution - key (with significant lateral spreading and narrow stratigraphic range; limited to one - three palynozones); characteristic (with a spread from a part of stage to a part of system, but with higher content within some intervals); transit with a wide stratigraphic range (common in the deposits of systems or their large parts, they are suitable only for general characteristics of stratigraphic units); on the content - subdominant (their content in spectra is between 5% to 20%), accessory (less than 5%). The main criteria to palynozones' definition are based on the appearance or disappearance of characteristic and key species and less quantitative changes in the assemblages composition. By these criteria in Famenian of the VPM EEP the two types of bio-units are identified: the Concurrent-Range Zone (zones of common distribution of two index species) and the Rank zone (or spread zone of key taxon).

Results and their analysis. Below for the first time, for the Famenian sediments of the VPM EEP, the standardized description of biostratigraphic units determined by palynological data, their correlation with the bio-units of the adjacent regions are given. Palynozones with a thickness of 17 to 231 m are

widespread. They have been recorded from a number of boreholes within Volyn-Podillya. They are distributed within the structural-facial region or part of the geological region. Zones are based on the vertical range characteristics of the recorded taxa. A stratigraphic range of selected miospores is given in table 1. **General the Famenian deposits of the VPM EEP** were palynologically subdivided into such zones: **lebedianensis–magnificus (LM)** (the oldest zone), **varicornata (V)**, **cassis–lupinovitchi (CL)**, **versabilis–hamulus (VH)**, **lepidophyta (L)** (the youngest unit) miospores zones.

Miospores zones detail the stratigraphic division of the Famenian, supplement the paleontological characteristics of deposits and form a local biostratigraphic scale, determined according to the palynological data. The local miospore zonation scheme of Famenian of the VPM EEP have been correlated with standart schemes of the palynological zonation from the type regions – the Central regions of the East-European platform and the Franko-Belgian Ardenne Massif (Streel M. et al., 1987; Avkhimovitch et al, 1993).

Table 1. A stratigraphic range of Famenian key and characteristic miospores of the Volyn-Podillia margin of the Eastern European platform

Miospore taxa	Palynozones				
	LM	V	CL	VH	L
<i>Monilospora latomarginatus</i>	+				
<i>Retusotriletes radiusus</i>	+				
<i>Cymbosporites magnificus</i>	+				
<i>Corystisporites multispinosus</i>	+				
<i>Tuberculiretusispora subgibberosa</i>	+				
<i>Chelinospora timanica</i>	+				
<i>Lophozonotriletes crassatus</i>	+	+			
<i>Knoxisporites perlotus</i>	+	+			
<i>Lophozonotriletes lebedianensis</i>	+	+			
<i>Retusotriletes simplex</i>	+	+			
<i>Ancyrospora honesta</i>	+	+			
<i>Geminospora notata</i>	+	+			
<i>Sinuosisporis intertextus</i>	+	+	+		
<i>Ancyrospora gibbosa</i>	+	+	+	+	
<i>Reticulatisporites perlotus</i>	+	+	+	+	
<i>Archaeotriletes hamulus</i>	+	+	+	+	
<i>Auroraspora varia</i>	+	+	+	+	+
<i>Lophozonotriletes grumosus</i>	+	+	+	+	+
<i>Retusotriletes communis</i>	+	+	+	+	+
<i>Knoxisporites literatus</i>	+	+	+	+	+
<i>Hymenozonotriletes poljessicus</i>	+	+	+	+	+
<i>Diaphanospora rugosa</i>	+	+	+	+	+
<i>Lophozonotriletes curvatus</i>	+	+	+	+	+
<i>Lophozonotriletes scurrus</i>	+	+	+	+	+
<i>Grandispora famenensis</i>		+	+	+	+
<i>Geminospora compacta</i>		+	+	+	+
<i>Hymenozonotriletes mucronatus</i>		+	+	+	+
<i>Cyrtospora cristifera</i>		+	+	+	+
<i>Auroraspora hyalina</i>		+	+	+	+
<i>Hymenozonotriletes commutatus</i>		+	+	+	+
<i>Cornispora varicornata</i>		+			
<i>Diaphanospora lebedianensis</i>		+			
<i>Crystatisporites lupinovitchi</i>		+	+		
<i>Tuberculispora regularis</i>		+	+	+	
<i>Geminospora golubinica</i>			+	+	
<i>Hymenozonotriletes cassis</i>			+	+	+
<i>Kedomonoletes glaber</i>			+	+	+
<i>Grandispora distincta</i>				+	+
<i>Convolutispora usitata</i>				+	+
<i>Grandispora facilis</i>				+	+
<i>Hymenozonotriletes versabilis</i>				+	+
<i>Retispora lepidophyta</i>					+

Lophozonotriletes lebedianensis – Cymbosporites magnificus (LM) Zone

1. Author: A. V. Ivanina.
2. Date of publication - described at first.
3. Type of Zone – the Concurrent-Range Zone.
4. Lateral distribution - widespread, traced in 26 wells.
5. Typical section: Volyn region, borehole Lito-vezch 1, 1 041–1 257 m.
6. Thickness – 117–231 m.
7. The most important signs: 46 taxa are recorded - 31 transit and 24 key and typical species, 11 of which appear at the base of the Zone; and five species (*Chelinospora timanica* (Naum.)

Loboziak et Streel, *Cymbosporites magnificus* (McGregor) McGregor et Camf., *Retusotriletes radiosus* Rask., *Tuberculiretusispora subgibberosa* (Naum.) Oshurk., *Corystisporites multispinosus* Richard., *Monilospora latemarginatus* (Kedo) Ivanina) disappear in the top of the Zone; two index species *Lophozonotriletes lebedianensis* Naum. and *Cymbosporites magnificus* (McGregor) McGregor et Camf. are with mutually blocked spreading – they happen together only in this zone.

8. Summary palynological characteristic – in table 2.

Table 2. Miospores' composition of the **Lophozonotriletes lebedianensis – Cymbosporites magnificus (LM) Zone**

Taxa	Subdominant	Accessory
Key	<i>Knoxisporites perlotus</i>	<i>Corystisporites multispinosus</i> , <i>Retusotriletes radiosus</i> , <i>Chelinospora timanica</i> , <i>Monilospora latemarginatus</i> , <i>Cymbosporites magnificus</i> , <i>Lophozonotriletes lebedianensis</i> , <i>L. crassatus</i> , <i>Sinuosisporis intertextus</i> , <i>Tuberculiretusispora subgibberosa</i>
Characteristic	<i>Archaeotriletes hamulus</i> , <i>Ancyrospora gibbosa</i> , <i>A. honesta</i> , <i>Lophozonotriletes curvatus</i>	<i>Knoxisporites literatus</i> , <i>Lophozonotriletes grumosus</i> , <i>L. scurrus</i> , <i>Retusotriletes communis</i> , <i>R. simplex</i> , <i>Reticulatisporites perlotus</i> , <i>Hymenozonotriletes poljessicus</i> , <i>Auroraspora varia</i> , <i>Geminospora notata</i> , <i>Diaphanospora rugosa</i>
Transit	<i>Punctatisporites</i> , <i>Calamospora</i> , <i>Stenozonotriletes conformis</i> , <i>Ambitisporites pumilis</i>	<i>Granulatisporites</i> , <i>Leiotriletes simplex</i> , <i>Retusotriletes minor</i> , <i>R. triangulatus</i> , <i>Stenozonotriletes laevigatus</i> , <i>Ambitisporites simplex</i> , <i>Verrucosisporites</i> , <i>Foveolatisporites</i> , <i>Acanthotriletes</i> , <i>Geminospora rugosa</i> , <i>Microreticulatisporites</i> , <i>Trachytriletes</i> , <i>Lophotriletes</i> , <i>Converrucosisporites</i> , <i>Reticulatisporites</i> , <i>Camptotriletes</i> , <i>Periplecotriletes</i> , <i>Spinizonotriletes</i> , <i>Apiculiretusispora</i> , <i>Anapiculatisporites</i>

9. The nature of the contacts: the base of the Zone is defined by the first appearance of *Knoxisporites perlotus* (Naum.) Ivanina, *K. literatus* (Waltz) Playf., *Sinuosisporis intertextus* (Nekr. et Serg.) Ivanina, *Lophozonotriletes lebedianensis* Naum., *L. crassatus* Naum., *L. grumosus* Naum., *Ancyrospora gibbosa* (Naum.) Richard., *Retusotriletes communis* Naum., *Archaeotriletes hamulus* Naum., *Reticulatisporites perlotus* (Naum.) Obukh., *Hymenozonotriletes poljessicus* Kedo); concordantly overlapped by the V Zone.
10. Age determination and palynological correlation with units of general European palinostratigraphic scales: corresponds to the **CZ (cristifer–zadonica)** Zone and the **Im (immensus)** Zone, which established in the Zadon-Eletsk Horizon of all regions of the East-European platform (Naumova, 1953; Raskatova, 1973; Nazarenko, 1975; Avkhimovitch et al, 1993), Pripyat (Некрята, 1974) and Dnieper-Donetsk (Kononenko, 1984) depressions; and in general it is comparable to the whole V Zone and the lower part of the **GH (gracilis–hirtus)** Zone, that has been identified in the lower part of the Nehden Stage (Famenian) of Germany (Streel M. et al, 1987; Avkhimovitch et al, 1993).

Cornispora varicornata (V) Zone

1. Author: A. V. Ivanina.
2. Date of publication - described at first.
3. Type of Zone – the Range-Zone.
4. Lateral distribution - traced only in 6 wells of the Central and Northern parts of VPM EEP.
5. Typical section: Lviv region, borehole Volitsa 1, 1 075–1 092 m.
6. Thickness – 17–26 m.
7. The most important signs: appearance and maximum development of index species *Cornispora varicornata* Stapl. et Jans. with content 5-20%; presence only in this zone key species *Diaphanospora lebedianensis* (Naum.) Balme et Hassell; the first appearance of 8 characteristic taxa; disappearance at the top *Ancyrospora honesta* (Naum.) Oshurk., *Geminospora notata* (Naum.) Obukh., *Ambitisporites simplex* (Naum.) Oshurk., *Retusotriletes simplex* Naum.; generally 35 transit and 29 characteristic and key taxa are defined.
8. Summary palynological characteristic - in table 3.
9. The nature of the contacts: consonant contacts with underlying (of the LM Zone) and overlapping (of the CL Zone) rocks; the base of the Zone is defined by the first appearance of *Cornispora varicornata* Stapl. et Jans., *Crystatisporites lupinovitchi* (Avch.) Avch., *Tuberculispora regularis* Ivanina, *Grandispora famenensis* (Naum.) Streel,

Hymenozonotriletes mucronatus Kedo, *H. commutatus* Naum., *Geminospora compacta* (Nekr.) Ivanina, *Cyrtospora cristifera* (Lub.) Van der Zwan, *Auroraspora hyalina* (Naum.) Streel.

10. Age determination and correlation with units of general European palynostratigraphic scales: equivalent to that established in the lower part of the **CVa (varicornata)** Zone of the Lebediansk Horizon of

the East-European platform (Nazarenko, 1975; Avkhimovitch et al, 1993), Pripyat (Avkhimovitch, 1986) and Dnieper-Donetsk (Kononenko, 1984) depressions. It also correlated with uppermost the **GH (gracilis–hirtus)** Zone and lowermost the **GF (gracilis–famenensis)** Zone, which defined in the upper part of the the Nehden Stage and in the lower part Hemberg Stage of Germany (Streel M. et al., 1987; Avkhimovitch et al, 1993).

Table 3. Miospores' composition of the **Cornispora varicornata (V)** Zone.

Taxa	Subdominant	Accessory
Key	<i>Cornispora varicornata</i> var. <i>monocornata</i>	<i>Cornispora varicornata</i> var. <i>bicornata</i> , <i>C. varicornata</i> var. <i>tricornata</i> , <i>Crystatisporites lupinovitchi</i> , <i>Sinuosisporis intertextus</i> , <i>Lophozonotriletes lebedianensis</i> , <i>L. crassatus</i> , <i>Tuberculispora regularis</i> , <i>Knoxisporites perlotus</i> , <i>Diaphanospora lebedianensis</i>
Characteristic	<i>Ambitisporites simplex</i> , <i>Lophozonotriletes curvatus</i> , <i>Knoxisporites literatus</i> , <i>Auroraspora varia</i> , <i>Ancyrospora gibbosa</i>	<i>Ancyrospora honesta</i> , <i>Geminospora notata</i> , <i>Retusotriletes simplex</i> , <i>Grandispora famenensis</i> , <i>Cyrtospora cristifera</i> , <i>Hymenozonotriletes mucronatus</i> , <i>H. commutatus</i> , <i>Geminospora compacta</i> , <i>Auroraspora hyalina</i> , <i>Diaphanospora rugosa</i> , <i>Lophozonotriletes scurrus</i> , <i>L. grumosus</i> , <i>Archaeotriletes hamulus</i> , <i>Retusotriletes communis</i> , <i>Hymenozonotriletes poljessicus</i> , <i>Reticulatisporites perlotus</i>
Transit	<i>Calamospora</i> , <i>Punctatisporites</i> , <i>Stenozonotriletes conformis</i> , <i>Ambitisporites pumilis</i>	<i>Leiotriletes simplex</i> , <i>L. nigratus</i> , <i>Granulatisporites</i> , <i>Retusotriletes minor</i> , <i>R. triangulatus</i> , <i>Stenozonotriletes laevigatus</i> , <i>Verrucosisporites grumosus</i> , <i>V. communis</i> , <i>Acanthotriletes</i> , <i>Trachytriletes</i> , <i>Geminospora rugosa</i> , <i>Foveolatisporites</i> , <i>Microreticulatisporites</i> , <i>Lophotriletes</i> , <i>Converrucosisporites</i> , <i>Reticulatisporites</i> , <i>Campotriletes</i> , <i>Periplecotriletes</i> , <i>Spinozonotriletes</i> , <i>Apiculiretusispora</i> , <i>Anapiculatisporites</i>

Hymenozonotriletes cassis – Crystatisporites lupinovitchi (CL) Zone

1. Author: A. V. Ivanina.
2. Date of publication - described at first.
3. Type of Zone – the Concurrent-Range Zone.
4. Lateral distribution - widespread, traced in 18 wells.
5. Typical section: Volyn region, borehole Litovezh 7, 980–1 050 m.
6. Thickness – 56–93 m.
7. The most important signs: the Zone is marked by 41 transit and 23 key and characteristic taxa; the compatible presence of index species *Hymenozonotriletes cassis* Kedo and *Crystatisporites lupinovitchi* (Avch.) Avch.; the increase in number

Hymenozonotriletes poljessicus Kedo, *H. commutatus* Naum., *Diaphanospora rugosa* (Naum.) Balme et Hassell, *Geminospora compacta* (Nekr.) Ivanina, *Reticulatisporites perlotus* (Naum.) Obukh., *Auroraspora varia* (Naum.) Ahmed.

8. Summary palynological characteristic - in table 4.
9. The nature of the contacts: consonant contacts with underlying rocks and overlapping of the **VH** Zone sediments; the base of the Zone is defined by the first appearance of *Kedomonoletes glaber* (Kedo) Oshurk., *Geminospora golubinica* (Nazar.) Ivanina, *Hymenozonotriletes cassis* Kedo.

Table 4. Miospores' composition of the **Hymenozonotriletes cassis – Crystatisporites lupinovitchi (CL)** Zone.

Taxa	Subdominant	Accessory
Key	–	<i>Sinuosisporis intertextus</i> , <i>Hymenozonotriletes cassis</i> , <i>Geminospora golubinica</i> , <i>Kedomonoletes glaber</i> , <i>Crystatisporites lupinovitchi</i> , <i>Tuberculispora regularis</i>
Characteristic	<i>Hymenozonotriletes poljessicus</i> , <i>H. commutatus</i> , <i>Diaphanospora rugosa</i> , <i>Geminospora compacta</i> , <i>Reticulatisporites perlotus</i> , <i>Auroraspora varia</i>	<i>Ancyrospora gibbosa</i> , <i>Cyrtospora cristifera</i> , <i>Auroraspora hyalina</i> , <i>Grandispora famenensis</i> , <i>Retusotriletes communis</i> , <i>Lophozonotriletes curvatus</i> , <i>L. scurrus</i> , <i>L. grumosus</i> , <i>Knoxisporites literatus</i> , <i>Archaeotriletes hamulus</i> , <i>Hymenozonotriletes mucronatus</i>
Transit	<i>Calamospora</i>	<i>Punctatisporites</i> , <i>Granulatisporites</i> , <i>Leiotriletes simplex</i> , <i>Retusotriletes simplex</i> , <i>R. minor</i> , <i>R. triangulatus</i> , <i>Stenozonotriletes conformis</i> , <i>S. laevigatus</i> , <i>Ambitisporites pumilis</i> , <i>Foveolatisporites</i> , <i>Acanthotriletes</i> , <i>Trachytriletes</i> , <i>Geminospora rugosa</i> , <i>Microreticulatisporites</i> , <i>Lophotriletes</i> , <i>Verrucosisporites</i> , <i>Converrucosisporites</i> , <i>Campotriletes</i> , <i>Periplecotriletes</i> , <i>Brochotriletes</i> , <i>Spinozonotriletes</i> , <i>Apiculiretusispora</i> , <i>Anapiculatisporites</i>

10. Age determination and correlation with units of general European palynostratigraphic scales: equivalent to the upper part of the **CVa (Cornispora vari-cornata)** Zone, that is found in the Optukhov Horizon of the East-European platform (Avkhimovitch et al, 1993, Nazarenko, 1975), Pripjat (Avkhimovitch, 1993) and Dnieper-Donetsk (Kononenko, 1984) depressions; similar to the uppermost **GF (gracilis-famenensis)** Zone from the upper part of Hemberg Stage (Famenian) of Germany (Streel M. et al., 1987; Avkhimovitch et al, 1993).

Hymenozonotriletes versabilis – Archaeotriletes hamulus (VH) Zone

1. Author: A. V. Ivanina.

2. Date of publication - described at first.
3. Type of Zone – the Concurrent-Range Zone.
4. Lateral distribution - widespread, traced in 19 wells.
5. Typical section: Volyn region, borehole Litovezh 7, 878–980 m.
6. Thickness – 47–103 m.
7. The most important signs: the presence of 26 characteristic and 38 transit taxa; abundant of zonate cavate miospores; the regular occurrence of two characteristic species of *Hymenozonotriletes versabilis* Kedo and *Archaeotriletes hamulus* Naum., whose spreading ranges are mutually suppressed.
8. Summary palynological characteristic - in table 5.

Table 5. Miospores' composition of the **Hymenozonotriletes versabilis – Archaeotriletes hamulus (VH) Zone**

Taxa	Subdominant	Accessory
Key	<i>Convolutispora usitata</i> , <i>Hymenozonotriletes versabilis</i>	<i>Grandispora distincta</i> , <i>G. facilis</i> , <i>Kedomonoletes glaber</i> , <i>Hymenozonotriletes cassis</i> , <i>Tuberculispora regularis</i> , <i>Geminospora golubinica</i>
Characteristic	<i>Lophozonotriletes scurrus</i> , <i>L. curvatus</i> , <i>Knoxisporites literatus</i> , <i>Grandispora famenensis</i> , <i>Auroraspora varia</i> , <i>Hymenozonotriletes poljessicus</i> , <i>H. commutatus</i> , <i>Diaphanospora rugosa</i>	<i>Reticulatisporites perlatus</i> , <i>Ancyrospora gibbosa</i> , <i>Hymenozonotriletes mucronatus</i> , <i>Cyrtospora cristifera</i> , <i>Geminospora compacta</i> , <i>Auroraspora hyalina</i> , <i>Archaeotriletes hamulus</i> , <i>Retusotriletes communis</i> , <i>Lophozonotriletes grumosus</i>
Transit	<i>Calamospora</i>	<i>Punctatisporites</i> , <i>Leiotriletes simplex</i> , <i>Retusotriletes minor</i> , <i>R. triangulatus</i> , <i>Stenozonotriletes conformis</i> , <i>S. laevigatus</i> , <i>Ambitisporites pumilis</i> , <i>Verrucosisporites</i> , <i>Acanthotriletes</i> , <i>Trachytriletes</i> , <i>Reticulatisporites</i> , <i>Foveolatisporites</i> , <i>Microreticulatisporites</i> , <i>Lophotriletes</i> , <i>Converrucosisporites</i> , <i>Camptotriletes</i> , <i>Periplecotriletes</i> , <i>Brochotriletes</i> , <i>Spinozonotriletes</i> , <i>Apiculiretusispora</i> , <i>Anapiculatisporites</i>

9. The nature of the contacts: concordance bedding at the **CL** Zone; in the Central part of the VPM EEP consonant overlapped of the **L** Zone (Upper Famenian) or in the south and north it is overlaid with disconformity by Lower Carboniferous; the base of the Zone is defined by the first appearance of *Convolutispora usitata* Playf., *Grandispora distincta* (Naum.) Avch., *G. facilis* (Kedo) Avch., *Hymenozonotriletes versabilis* Kedo.

10. Age determination and correlation with units of general European palynostratigraphic scales: corresponds to the **VF (versabilis-famenensis)** Zone, which established in the Plavsk Horizon of the Central regions of the East-European platform (Umnova, 1971, Avkhimovitch et al, 1993;), the Streshin Horizon in the Pripjat Depression (Avkhimovitch, Demidenko, 1985), in Upper Famenian of the Volga region (Nazarenko, 1975); and in general it is comparable to the **VCo (versabilis-cornuta)** Zone, that has been identified in Dasberg

Stage (Famenian) of the Germany (Streel M. et al., 1987; Avkhimovitch et al, 1993).

Retispora lepidophyta (L) Zone

1. Author: A. V. Ivanina.
2. Date of publication - described at first.
3. Type of Zone – the Range-Zone.
4. Lateral distribution - traced only in 12 wells of the Central and Northern parts of VPM EEP.
5. Typical section: Volyn region, borehole Zapust 5 437, 240–398 m.
6. Thickness – 78–125 m.
7. The most important signs: the high content and diversity of zonate cavate miospores, the appearance and the presence only in this zone of zonal species *Retispora lepidophyta* (Kedo) Playf.; generally 31 transit and 22 characteristic and key taxa are defined.
8. Summary palynological characteristic - in table 6.

Table 6. Miospores' composition of the **Retispora lepidophyta (L)** Zone

Taxa	Subdominant	Accessory
Key	<i>Hymenozonotriletes versabilis</i>	<i>Retispora lepidophyta</i> , <i>Hymenozonotriletes cassis</i> , <i>Grandispora distincta</i> , <i>G. facialis</i> , <i>Convolutispora usitata</i>
Characteristic	<i>Lophozonotriletes scurrus</i> , <i>Hymenozonotriletes poljessicus</i> , <i>H. commutatus</i> , <i>Auroraspora varia</i>	<i>Hymenozonotriletes mucronatus</i> , <i>Lophozonotriletes curvatus</i> , <i>L. grumosus</i> , <i>Geminispora compacta</i> , <i>Grandispora famenensis</i> , <i>Diaphanospora rugosa</i> , <i>Kedomonoletes glaber</i> , <i>Cyrtospora cristifera</i> , <i>Auroraspora hyalina</i> , <i>Retusotriletes communis</i> , <i>Knoxisporites literatus</i>
Transit	<i>Calamospora</i>	<i>Punctatisporites</i> , <i>Leiotriletes simplex</i> , <i>Retusotriletes minor</i> , <i>R. triangulatus</i> , <i>Stenozonotriletes conformis</i> , <i>S. laevigatus</i> , <i>Ambitisporites pumilis</i> , <i>Verrucosisporites</i> , <i>Foveolatisporites</i> , <i>Trachytriletes</i> , <i>Acanthotriletes</i> , <i>Microreticulatisporites</i> , <i>Reticulatisporites</i> , <i>Lophotriletes</i> , <i>Converrucosisporites</i> , <i>Camptotriletes</i> , <i>Periplecotriletes</i> , <i>Brochotriletes</i> , <i>Spinozonotriletes</i> , <i>Apiculiretusispora</i> , <i>Anapiculatisporites</i>

9. The nature of the contacts: concordance bedding at the **HV** Zone and overlapped with disconformity by Carboniferous.

10. Age determination and correlation with units of general European palynostratigraphic scales: correlate with the **LE (lepidophyta–explanatus)** Zone from Ozersk and Chovansk Horizons of the Pripyat Depression (Avkhimovitch et al, 1993; Kedo, Avkhimovitch, 1981; Avkhimovitch, Demidenko, 1985) and the upper part of the **VCo (versabilis–cornuta)** Zone, which defined in the Wocklum Stage (Famenian) of the Germany (Streel M. et al., 1987; Avkhimovitch et al, 1993).

Conclusion. Due to facial-palynological research in the Famenian of the Volyn-Podillia margin of the East-European platform, five palynozones have been distinguished, characterized and their sequence has been determined. By the appearance or disappearance of characteristic and key species the following categories of biostratigraphic units are distinguished: two Range-Zones, three - Concurrent-Range Zones. The Famenian palynological zonal scheme proposed in this paper consists of five biostratigraphic units: the oldest - **lebedianensis–magnificus (LM)**, then **varicornata (V)**, **cassis –lupinovitchi (CL)**, **versabilis –hamulus (VH)** and the youngest zone - **lepidophyta (L)**. Palynozones are allocated laterally, traced in a number of boreholes within Volyn-Podillya. They are local specialized biostratigraphic units with a set of palynological signs (a unique set of key, characteristic and transit taxa) that allow easy recognition of the different stratigraphic levels of the Famenian. The method of presentation of biostratigraphic data has been updated. The standardized (unified and concretized) characteristics of the palynozones have been developed, which greatly regulate and facilitate the perception of stratigraphic information.

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