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COMPLEX PALYNOLOGICAL CHARACTERISTIC OF VESTISPORA COSTATA–KNOXISPORITES POLYGONALIS ZONE FROM BASHKIRIAN (LOWER PENNSYLVANIAN) OF VOLYN-PODILLIA MARGIN OF THE EAST-EUROPIAN PLATFORM

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Spores and pollen - one of the most important floristic groups, which is used for dismemberment and correlation of sedimentary deposits. Palynological material is mass, with numerous taxa and the significant lateral distribution. During biostratigraphic studying, it is offered to use quantitative and qualitative indicators of palynospectra. The source material is data on the spreading spores and pollen in sequence and laterally. The main tool for the bedding of sediments by the palynological data is the palynozone. This is the specialized biostratigraphic unit - sediments containing a unique set of different categories of taxa (according to the peculiarities of vertical distribution - key, characteristic, transit ones; on the content - dominant, subdominant, accessory), combined in the zonal complex. For Bashkirian (Lower Pennsylvanian) of the Volyn-Podilsky margin of the East-European platform on the example of the palynozone **Vestispora costata–Knoxisporites polygonalis** the newest way of presenting biostratigraphic material in the form of a standardized and unified system of description of palynostratigraphic subdivisions was used. Stratons characteristic uncludes such main signs: zone's category, it's laterial spreading, thickness, quantitative and qualitative miospores' contain, age, correlation with other stratigraphycal units and so on. Such form of stratigraphical information is very easy to the perception and the conservation, and it is reliable tools for analysis of valid scientific data.

Keywords: spores, pollen, complex palynological characteristics, palynozone, Bashkirian, Lower Pennsylvanian, Volyn-Podillia margin of the East-Europian platform.

Bashkirian mainly terrigenous deposits with a thickness of 240 m are spread at the West of the Volyn-Podillia margin of the East-European platform (VPM EEP). This is a polyfacial complex of rocks with varied lithology, including limestone and different clastics. Their stratification is very difficult because strata are poor in fossils. Therefore, during the study of this stratums, palynology 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 succesion of bio-units. In the Volyn-Podilsky outskirts of the Eastern European platform, palynological studies of Carboniferous were initiated almost simultaneously with the discovery of its industrial coal content, but by the 1990s. they were only fragmentary. The first attempts to generalize palynological materials with the selection of complexes and palynozones were made by I. I. Partyka and O. G. Schwartzman in the 90s of the last century and continued by A. V. Ivanina [1-6]. Palynological research of the Bashkirian deposits of Volyn-Podillya was started in the '60s of the twentieth century by I. I. Partyka. The first attempts to generalize the

palynological materials with the allocation of complexes were made by O. G. Scharzman and A. V. Ivanina in the 90s of the XX century [3, 4]. 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 [8] 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 are worked out.

The materials for studying consists of more than 250 samples from 16 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 1, 2, 6]. It's characteristics and the methodology of the zones' and zonal scales determining by palynological data are described in [1-6]. Palynozones are biostratigraphic units with the unique, characteristic only for zonal sediments miospores' assemblage. In it's a 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 the stage to a part of the 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 on quantitative changes in the composition of the assemblage. By these criteria in lower part of Bashkirian of the VPM EEP the Concurrent-Range Zone (zones of common distribution of two index species) are identified.

Nowadays, according to the author, the functions of stratigraphy are somewhat broader than those specified in the Stratigraphic Code of Ukraine [9]. Determining the temporal-spatial relationships of stratons is impossible, first, without their certification - the specification of stratons and the creation of their personalized characteristics on a set of unified parameters; secondly, without the formation of an interactive standardized system - a catalogue of personalized stratons.

The need for systematization and unification of palynological material is also caused by the specifics of the spore-pollen method. Spores and pollen perform the most important function - they are responsible for the existence of the species on Earth. Plants, protecting the process of pollination and resettlement from possible accidents, first, produce pollen and spores in huge quantities (for example, one stem of lycopodium produces up to 30 million spores per year; Swedish coniferous forests annually produce 75 thousand tons of pollen, etc.); secondly, nature invests in reproductive cells all the margin of safety (protoplast is protected by a triple or double shell, one of which is composed of cutin-like organic matter, resistant to chemical and mechanical influences, capable of excellent storage in the fossil state); thirdly, reproductive grains are adapted for significant lateral distribution in nature and have for this purpose various morphological adaptations (air sacs, outgrowths, thorns), small size, insignificant specific weight, etc. They behave in the external environment as ordinary sedimentary particles of pellet size, are transported over long distances (up to 600-800 km), are buried according to the laws of gravitational sedimentation in different types of sedimentation environments. That is, fossil spores and pollen act in two roles - they are microscopic remains of macroplants, the composition of which reflects the patterns and features of the evolutionary development of

plant communities; in the external environment they behave as the smallest particles and their distribution is controlled by sedimentation laws. The mass and polytaxony of miospores, on the one hand, increase the informativeness and objectivity of the spore-pollen method, and on the other hand, complicate the work of a palynologist because it is not clear which criteria - quantitative or qualitative - to prefer when performing biostratigraphic studies. This contradiction is eliminated by the standardized characteristic of palynozone.The first step in creating an interactive standardized system of carbon palinostratons should be to determine their personalized characteristics according to the criteria covered in numerous scientific publications and regulations. The main feature by which palinozones are distinguished is the systematic composition of miospores, which is reflected in quantitative (dominant, subdominant, rare - as a percentage of the spectra) and qualitative (guiding, characteristic, background [7] - by vertical distribution) parameters. The standardized characteristics of the palyzone should also include the following items: name, category, lateral distribution, straton power, the geographical and tectonic position of the reference section, where the zone sediments are represented in full, relative age, nature of contacts with bedrock and overlying rocks, ratios with other straton categories and interregional correlation with palynological subdivisions of adjacent regions. In addition to the above, to prevent violations of the rules of priority, it is necessary to indicate the author and the year of the first description (indicating the exact bibliographic reference).

Due to facial and palynological studies within the Volyn-Podilsky outskirts of the Eastern European platform, 15 miospore zones have been identified on the basis of a combination of key and characteristic forms of certain stratigraphic intervals. The **Vestispora costata**–**Knoxisporites polygonalis** (**SP**) palyzone is defined at the bottom of the Bashkir section. Below, for the first time, a standardized characteristic of this zone is given.

Vestispora costata–Knoxisporites polygonalis (**SP**) Zone

1. Author: A. V. Ivanina.
2. Date of publication – fully described at first.
3. Type of Zone – the Concurrent-Range Zone.
4. Lateral distribution – widespread in VPM EEP, traced in 16 boreholes.
5. Typical section: Volyn region, borehole Paromiv 5 500 – 505–542 m.
6. Thickness – 22–66 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) disappeare 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.

7. Complex palynological characteristics (table, fig. 1, 2).

7.1. Qualitative composition of taxa.

7.1.1. Key - no.

7.1.2. Characteristic: appear - *Knoxisporites polygonalis* (Ibr.) Pot. et Kr., *Florinites mediapundens* (Loose) Pot. et Kr., disappear - *Vestispora costata* (Balme) Bharadwaj, *Tripartites vetustus* Schemel.

7.1.3. Transit: *Raistrikia fulva* Artruz, *Cirratriradites saturni* (Ibr.) Schopf, Wilson et Bentall, *Florinites similis* Kozanke, *Alatisporites pustulatus* Ibrahim, *Radiizonates aligerens* (Knox) Staplin et Jansonius, *Lycospora pusilla* (Ibr.) Somers, *Dictyotriletes* (Naumova) Pot. et Kr., *Vallatisporites variabilis* (Naumova) Oshurkova, *Convolutispora* Hoffmeister, Staplin et Melloy, *Vestispora lucida* (Butterworth et Williams) Wilson et Venkatachala, *Punctatisporites* (Ibr.) Pot. et Kr., *Potonieisporites novicus* Bhardwaj, *Monilospora carnosa* (Knox) Jachowicz, *Knoxisporites densoarcuatus* (Teteryuk) Ivanina, *K. hageni* Pot. et Kr., *Granulatisporites* (Ibr.) Pot. et Kr., *Calamospora* Schopf, Wilson et Bentall, *Acanthotriletes* (Naumova) Pot. et Kr., *Lophotriletes* Naumova, *Cyclogranisporites* Pot. et Kr., *Secarisporites lobatus* Neves, *Murospora irregularis* (Alpern) Ivanina, *M. primitiva* (Teteryuk) Ivanina, *Microreticulatisporites* (Knox) Bharadwaj, *Schulzospora* Kozanke, *Bellispores nitidus* (Horst) Sullivan, *Crassispora kosankei* (Pot. et Kr.) Bharadwaj, *Cingulizonates bialatus* (Waltz) Smith et Butterworth, *Ahrensisporites guerickei* (Horst) Pot. et Kr., *Callisporites nux* Butterworth et Williams, *Densosporites* Butterworth, *Laevigatosporites* Ibrahim, *Florinites visendus* (Ibrahim) Schopf, Wilson et Bentall, *Cristatisporites connexus* Pot. et Kr., *Triquitrites tribullatus* (Ibrahim) Pot. et Kr.

7.2. Quantitative composition of taxa.

7.2.1. Dominants (over 20%): Lycospora pusilla (Ibr.) Somers, Densosporites (Berry) Butterworth, Vallatisporites variabilis (Naumova) Oshurkova.

7.2.2. Subdominants (5–20%): *Murospora irregularis* (Alpern) Ivanina, *Cingulizonates bialatus* (Waltz) Smith et Butterworth, *Callisporites nux* Butterworth et Williams, *Cyclogranisporites* Pot. et Kr., *Bellispores nitidus* (Horst) Sullivan, *Microreticulatisporites* (Knox) Bharadwaj, *Knoxisporites densoarcuatus* (Teteryuk) Ivanina.

7.2.3. Accessory (до 5%): *Monilospora carnosa* (Knox) Jachowicz, *Knoxisporites polygonalis* (Ibr.) Pot. et Kr., *K. hageni* Pot. et Kr., *Florinites mediapundens* (Loose) Pot. et Kr., *F. similis* Kozanke, *F. visendus* (Ibr.) Schopf, Wilson et (Berry) Butterworth, *Mooreisporites* Neves, *Verrucosisporites* (Ibr.) Smith et Bentall, *Schulzospora* Kozanke, *Raistrikia fulva* Artruz, *Cirratriradites saturni* (Ibr.) Schopf, Wilson et Bentall, *Alatisporites pustulatus* Ibrahim, *Radiizonates aligerens* (Knox) Staplin et Jansonius, *Potonieisporites novicus* Bhardwaj, *Lophotriletes* Naumova, *Punctatisporites* (Ibr.) Pot. et Kr., *Granulatisporites* (Ibr.) Pot. et Kr., *Convolutispora* Hoffmeister, Staplin et Melloy, *Calamospora* Schopf, Wilson et Bentall, *Acanthotriletes* (Naumova) Pot. et Kr., *Dictyotriletes* (Naumova) Pot. et Kr., *Secarisporites lobatus* Neves, *Ahrensisporites guerickei* (Horst) Pot. et Kr., *Triquitrites tribullatus* (Ibr.) Pot. et Kr., *Crassispora kosankei* (Pot. et Kr.) Bharadwaj, *Mooreisporites* Neves, *Tripartites vetustus* Schemel, *Verrucosisporites* (Ibr.) Smith et Butterworth, *Murospora primitiva* (Teteryuk) Ivanina, *Laevigatosporites* Ibrahim, *Vestispora costata* (Balme) Bharadwaj, *V. lucida* (Butterworth et Williams) Wilson et Venkatachala, *Cristatisporites connexus* Pot. et Kr.

Table

Miospores' composition of the **Vestispora costata-Knoxisporites polygonalis** (**CP**) Zone

TTaxa	Dominant, subdominant	Accessory
Key	–	*Knoxisporites polygonalis, Florinites mediapundens*
Characteristic	*Murospora irregularis, Callisporites nux, Bellispores nitidus, Knoxisporites densoarcuatus*	*Vestispora costata, Tripartites vetustus, Raistrikia fulva, Cirratriradites saturni, Alatisporites pustulatus, Radiizonates aligerens, Vestispora lucida, Potonieisporites novicus, Secarisporites lobatus, Monilospora carnosa, Knoxisporites hageni, Schulzospora, Murospora primitiva, Crassispora kosankei, Ahrensisporites guerickei, Mooreisporites, Laevigatosporites, Florinites visendus, F. similis, Cristatisporites connexus, Triquitrites tribullatus*
Transit	*Lycospora pusilla, Densosporites, Vallatisporites variabilis, Cingulizonates bialatus, Cyclogranisporites, Microreticulatisporites*	*Dictyotriletes, Convolutispora, Punctatisporites, Granulatisporites, Calamospora, Acanthotriletes, Lophotriletes, Verrucosisporites, Leiotriletes, Converrucosisporites, Ambitisporites, Reticulatisporites, Camptotriletes, Periplecotriletes, Brochotriletes, Reinschospora, Endosporites, Anapiculatisporites, Foveolatisporites*

9. The nature of the contacts: consonant contacts with underlying rocks of **SF** zone and overlapping of the **VL** Zone sediments; the base of the Zone is defined by the first appearance of *Knoxisporites polygonalis* (Ibr.) Pot. et Kr.; near the top of the Zone disappear *Vestispora costata* (Balme) Bharadwaj, *Tripartites vetustus* Schemel.

10. Correlation with other stratigraphic units: isolated in the lower part of the Morozovitsky suite, between limestones B_1–B_3.

11. Palynological correlation with units of general Europian palinostratigraphic scales: corresponds to the lower parts of Zones: **KV (Crassispora kosankei–Grumosisporites varioreticulatus**) of Northern England, Scotland [11]; P (**Lycospora pellucid)** of North America [13], **Rc** (**Reticulatisporites carnosus)** of Lublin coal basin, **Dv** (**Densosporites variabilis**) Upper Silesian coal basins of Poland [12]; upper part of **LM (Vestispora lucida–Microreticulatisporites microreticulatus)** Zone of Donetsk basin of Ukraine [10].

12. Age determination: Bashkirian, Lower Pennsylvanian.

Thus, for the Carboniferous Volyn-Podilsky outskirts of the Eastern European platform for the first time on the example of palyzone **Vestispora costata**–**Knoxisporites polygonalis** a standardized system of characteristics of biosubjects was introduced, which unified the description of palynoses, specified such mandatory parameters as indicators), thickness, stratigraphic position, lateral distribution, correlation with other stratigraphic units, etc.

This is the first time that such a standardized and unified system of characteristics of palynozones, which organizes features, unifies and concretizes their diagnoses, was introduced

for the Carboniferous Volyn-Podillia margin of the Eastern European platform. It greatly facilitates the perception of stratigraphic information, is a convenient form for its storage and a reliable tool for the analysis of valid scientific data and various operations.

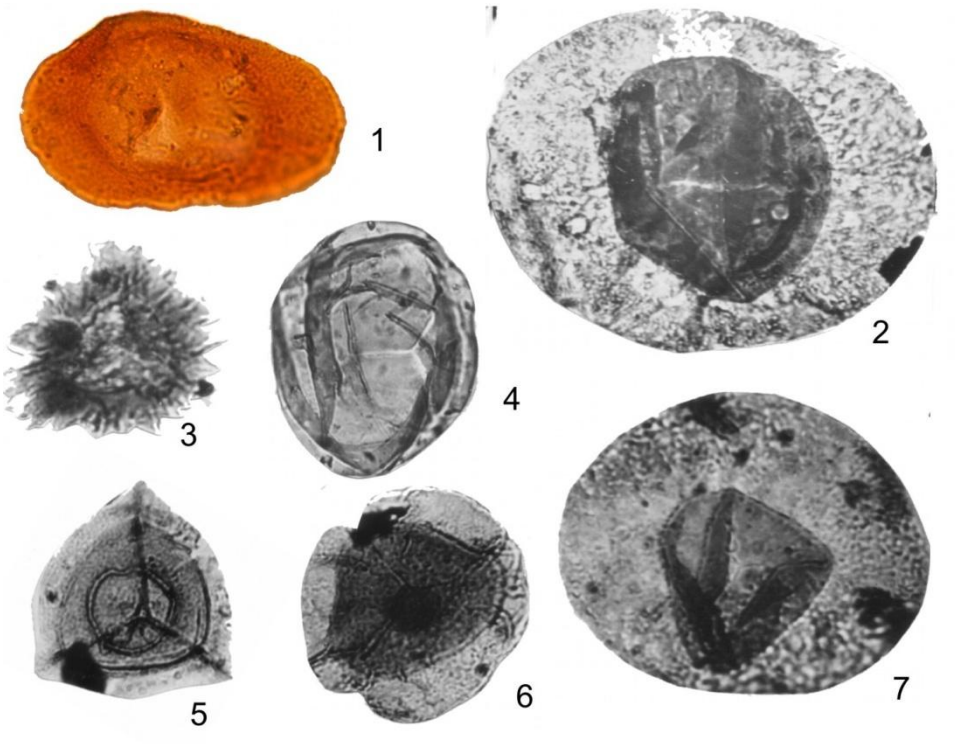

Fig. 1. Some characteristic miospores of **CP** Zone of Bashkirian of the Volyn-Podillia margin of the East-European platform:

1 - *Schulzospora campyloptera* (Waltz) Hoffmeister, Staplin et Melloy; *2* - *Potonieisporites novicus* Bharad.; *3* - *Cristatisporites connexus* Pot. et Kr.; *4* - *Vestispora lucida* (Butter. et Willams) Wilson et Venkatachala; *5* - *Cirratriradites saturni* ((Ibr.) Schopf, Wilson et Bentall; *6* - *Alatisporites pustulatus* Ibr.; *7* - *Florinites similis* Koz.

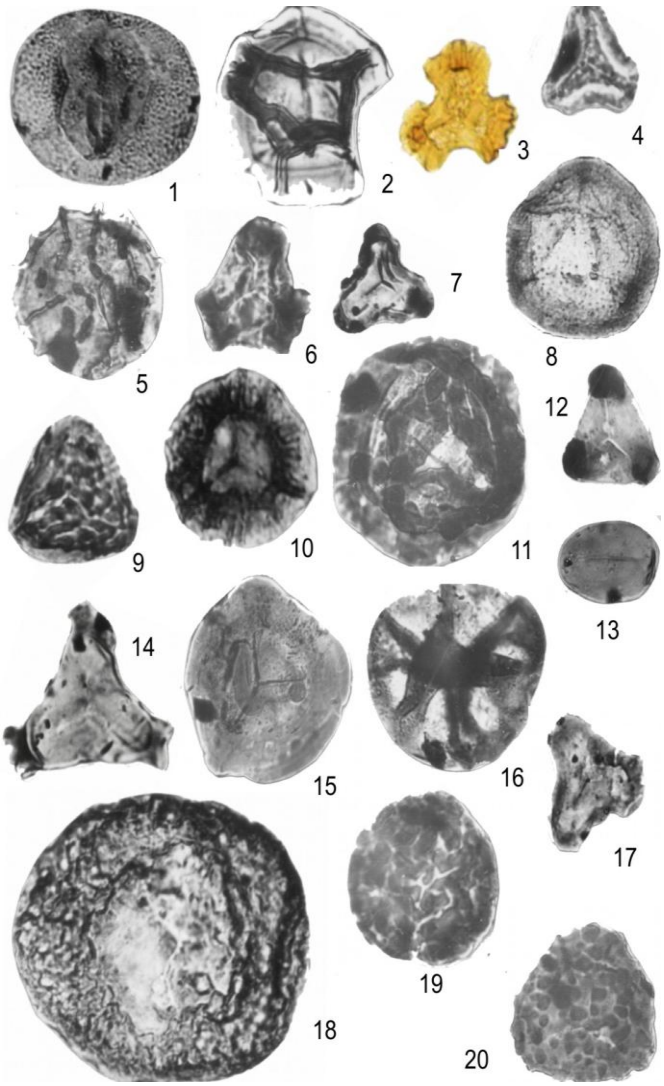

Fig. 2. Some characteristic miospores of **CP** Zone of Bashkirian of the Volyn-Podillia margin of the East-European platform:

1 - *Florinites mediapundens* (Loose) Pot. et Kr.; *2* - *Knoxisporites polygonalis* (Ibr.) Pot. et Kr.; *3* - *Tripartites vetustus* Schemel; *4* - *Bellispores nitidus* (Horst) Sull.; *5* - *Vestispora costata* (Balme) Bharad.; *6* - *Ahrensisporites guerickei* (Horst) Pot. et Kr.; *7* - *Murospora irregularis* (Alpern) Ivanina; *8* - *Crassispora kosankei* (Pot. et Kr.) Bharad.; *9* - *Callisporites nux* Butter. et Willams; *10* - *Radiizonates aligerens* (Knox) Staplin et Jans.; *11* - *Knoxisporites densoarcuatus* (Tet.) Ivanina; *12* - *Triquitrites tribullatus* (Ibr.) Pot. et Kr.; *13*. - *Laevigatosporites vulgaris* (Ibr.); *14* - *Mooreisporites fustis* Neves; *15* - *Monilospora carnosa* (Knox) Jach.; *16* - *Knoxisporites hageni* Pot. et Kr.; *17* - *Murospora primitiva* (Tet.) Ivanina; *18* - *Florinites visendus* (Ibr.) Schopf, Wilson et Bentall; *19* - *Secarisporites lobatus* Neves; *20* - *Raistrikia fulva* Artuz.

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КОМПЛЕКСНА ПАЛІНОЛОГІЧНА ХАРАКТЕРИСТИКА ЗОНИ VESTISPORA COSTATA–KNOXISPORITES POLYGONALIS З БАШКИРСЬКИХ ВІДКЛАДІВ (НИЖНІЙ ПЕНСИЛЬВАНІЙ) ВОЛИНО-ПОДІЛЬСЬКОЇ ОКРАЇНИ СХІДНОЄВРОПЕЙСЬКОЇ ПЛАТФОРМИ

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Спори і пилок – одна з найважливіших флористичних груп, яку застосовують для розчленування і кореляції осадових розрізів. Палінологічний матеріал є масовим, політаксонним, поліфаціальним, зі значним латеральним поширенням. Під час біострати-графічних досліджень запропоновано використовувати кількісні і якісні показники паліноспектрів. Вихідним матеріалом є

дані про розподіл спор і пилку у розрізі і по латералі. Головним інструментом для розчленування і кореляції відкладів за палінологічними даними є палінозона. Це спеціалізований біостратиграфічний підрозділ, сукупність відкладів, що містить неповторний, властивий лише їм, набір різних категорій таксонів (за кількісною участю: домінанти, субдомінанти рідкісні; за особливостями стратиграфічного поширення: фонові, або транзитні, типові, або характерні, керівні), об'єднаних у зональний комплекс. Для пенсильванію Волино-Подільської окраїни Східноєвропейської платформи на прикладі палінозони **Vestispora costata–Knoxisporites polygonalis** використано новітній спосіб подання біостратиграфічного матеріалу у вигляді стандартизованої та уніфікованої системи опису паліностратиграфічних підрозділів. Характеристику стратону виконували за такими головними ознаками: категорія зони, її літоральне поширення, потужність, кількісний та якісний склад міоспор, страти-графічне положення, співвідношення з іншими стратиграфічними підрозділами, міжрегіональна кореляція тощо. Така форма подання стратиграфічної інформації значно впорядковує і полегшує її сприйняття, зручна для збереження та є надійним інструментом аналізу валідних наукових даних.

Ключові слова: спори, пилок, комплексна палінологічна характеристика, палінозона, башкирський ярус, пенсильваній, Волино-Подільська окраїна Східноєвропейської платформи.

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