ПАЛЕОНТОЛОГІЧНИЙ ЗБІРНИК
2018. № 50. С. 60–72

PALEONTOLOGICAL REVIEW
2018. N 50. P. 60–72

УДК [561:581.33]:551.762/.763 (477)

# SPORE-POLLEN BIOSTRATIGRAPHY JURASSIC AND CRETACEOUS OF UKRAINE

**O. Shevchuk**[·]

*Institute of Geological Sciences, National Academy of Sciences of Ukraine, Kyiv, Ukraine; 55b Olesia Gonchara St. 01054 Kyiv, Ukraine*

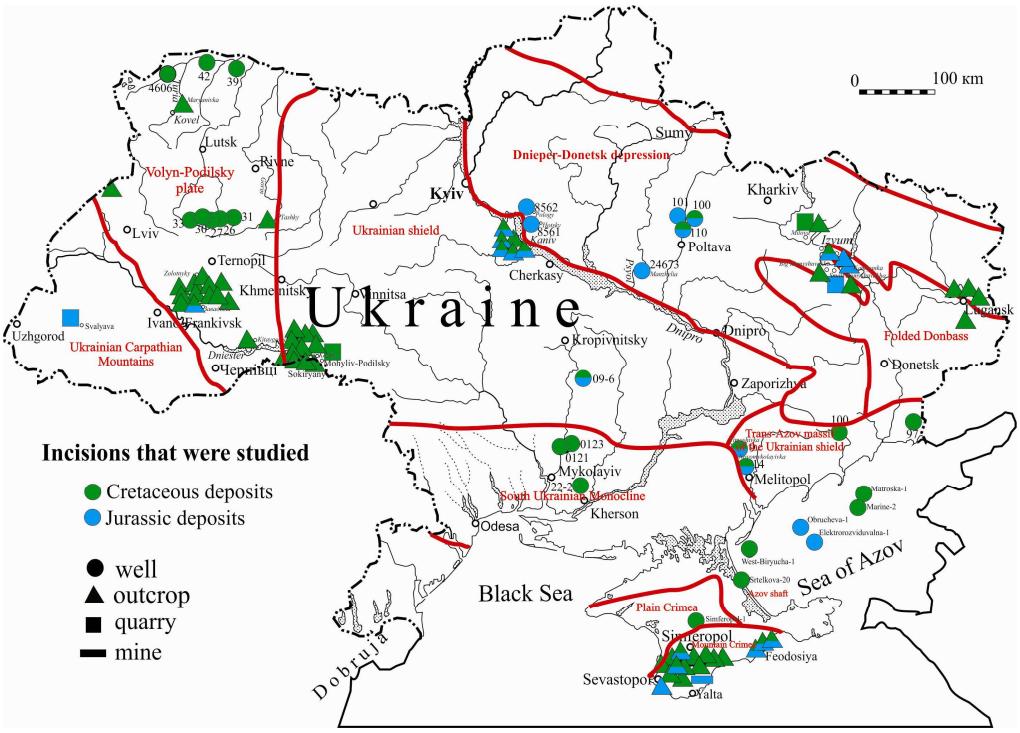
The scheme of biostratigraphic division for the spore-pollen assemblages at the level of stages for the deposits of the Middle-Upper Jurassic and Cretaceous of Ukraine (from Aalenian to Maastrichtian inclusive) has been developed based on the data of M.A. Voronova, G.G. Yanovskaya, M.E. Ogorodnik, G.V. Shramkova also used own material and others. The analysis of more than 1000 own samples, collected from 93 localities, was carried out, representing almost all the middle, Upper Jurassic and Cretaceous zones of the ammonites of Ukraine. Characteristic features are established for 19 spore-pollen assemblages of all stratigraphic subdivisions corresponding to the sub-stage division of the middle-upper Jurassic and Cretaceous.

*Keywords:* spore-pollen assemblages, biostratigraphy, Jurassic and Cretaceous, Ukraine.

For the deposits of the Middle, Upper Jurassic and Cretaceous of the territory of Ukraine, a scheme of biostratigraphic division according to the data of spore-pollen assemblages has been developed.

Palynological studies of Jurassic and Cretaceous deposits in Ukraine allow to define a characteristic features of spore-pollen assemblages for each period separately. Materials from marine sections provide their calibration against ammonite scale and definition of reference spore-pollen assemblages at some levels in Middle-Upper Jurassic and the Lower and Upper Cretaceous [2, 5]. Defined succession of spore-pollen assemblages reflects the evolutionary stages of Jurassic and Cretaceous palynofloras. Considerable lateral variations of spore-pollen assemblages related to facial and palaeogeographical features preclude accurate interregional correlations based on spore-pollen data, but some general tendencies in the evolutionary development of spore-pollen assemblages for some stratigraphic levels can be defined.

This is the first comprehensive spores and pollen study carried out on both continental and marine sediments of the Jurassic and Cretaceous of Ukraine. Rock samples were collected from 93 location and analysed from the Middle, Upper Jurassic and Cretaceous deposits of the Peninska zone of the Carpathians, the Volyn-Podilska plate, the western and eastern slopes of the Ukrainian shield, the Priazovsky massif of the Ukrainian shield, the Dnipro-Donets depression, the Donbas, the South Ukrainian monoclines (the Black Sea Basin), the Mountain and Plain Crimea, the North Azov deflection and the Central Azov shaft. Present study is based on about 1000 samples from the Aalenian to the Maastrichtian (Ris. 1).




Ris. 1. Location map of the studied areas.

According to the results of the palynological research, the Middle, Upper Jurassic and Cretaceous deposits of Ukraine are characterized on the stage level. The spore-pollen assemblages for each stage (Aalenian  Maastrichtian) are established. These assemblageare traced in different regions of Ukraine and have stable characteristics. As a result, a scheme of biostratigraphic division in the spore-pollen assemblages of deposits in the Aalenian-Maastrichtian range was developed, taking into account the data of M.A. Voronova [1], G.G. Yanovskaya [15], M.E. Ogorodnik [3, 4], G.V. Shramkova [14] my own material [7-13, 16-17] and others (Ris. 2-4). According to the Stratigraphic Code of Ukraine [6], in this scheme layers with spore-pollen assemblages are singled out.

Layer with **aalenian** spores-pollen assemblage.

Spores: 1. Make up to 65% and predominate over the pollen of gymnosperms.

2. *Marratisporites scabratus, Klukisporites variegatus* are typical.

3. *Coniopteris* spp., *Cyathidites* spp., *Tripartina variabilis*, *Camptotriletes anagrammensis*, *Callialasporites* spp. dominate.

Pollen: 4. *Eucommiidites troedssoni* and *Cerebropollenites mesozoicus* are first appear.

5. Ginkgocycadophytus dominate among the gymnosperms.

6. Ancestors of conifers *Pseudopiceae magnifica*, *Pseudopiceae variabiliformis*, *Pseudopinus* spp. and *Classopollis* spp. are rare amount of pollen.

These assemblages are established in the middle sub-suite of the Beshuiska suite of the Mountain Crimea (the mine in the reserve of Beshuiski mines, Chuun-Ilga coal deposit).

Layer with **bajocian** spores-pollen assemblage.

Spores: 1. *Leiotriletes lineatus* and *Neoraistrickia rotundiformis* are first appear.

2. Osmundaceae, Cyatheaeceae and *Biretisporites* sp., *Callialasporites* spp. dominate.

3. *Duplexisporites anagrammensis, Converrucosisporites disparituberculatus* are typical.

Pollen: 4. *Pseudopiceae* sp., *Pseudopinus* sp., *Protopinus* sp., *Caytonia oncodes* dominate among the gymnosperms.

5. *Quadraeculina* sp., *Podozamites* sp. are present and rare specimens *Classopollis* spp.

These assemblages are established in the lower part of the Zhubrakivska suite of the Carpathians (Priborgavsky quarry); thicker limestones, in the upper sub-suite of the Sokalska suite of Volyn-Podilska plate (Zavadivkyi quarry); Pidluzhna and Orelska suite of the Dnipro-Donets depression (wells 8561, 8562, 24673); the lower part of the Cherkaska suite of the Priazovsky massif of the Ukrainian shield (well 14); in the upper sub-suite of the Beshuiska suite of the Mountain Crimea (the mine in the reserve of Beshuiski mines, Chuun-Ilga coal deposits).

Layer with **bathonian** spores-pollen assemblage.

Spores: 1. *Coniopteris* sp., *Cyathidites australis, Cyathidites* spp., somewhat less *Biretisporites* sp., *Callialasporites* spp. dominate.

2. *Clathropteris obovata* var. *magna, Salvinia perpulchra, Converrucosisporites disparituberculatus, Carnisporites granulatus* are typical.

3. *Neoraistrickia rotundiformis* – to 8%.

Pollen: 4. *Pseudopiceae* sp., *Pseudopinus* sp., *Protopinus* sp., *Caytonia oncodes* dominate among the gymnosperms; *Pinuspollenites* sp., *Piceapollenites* sp., *Cedripites* sp. are rare.

5. *Classopollis* sp. (to 2%) are typical.

6. Alete pollen *Quadraeculina* sp. and *Perinopollenites elatoides* are rare.

These assemblages are established in the upper part of the Zhubrakivska suite of the Carpathians (the Priborgavsky quarry); Nizhynsky suite of the Dnipro-Donets depression (wells 8561, 8562, 24673); Kamyanska suite of the the northwestern outskirts of the Donbas (Shevchenky village, near the village Kamyanka, the right bank of the river Siversky Donets).

Layer with **callovian** spores-pollen assemblage.

Spores: 1. *Dictyophyllidites* sp., *Coniopteris* sp., *Callialasporites* sp., *Marattisporites* sp. dominate.

Pollen: 2. The family of Pinaceae is equal to the participation of the pollen of ancestral forms and a pollen close to modern coniferous: *Pseudopiceae* sp., *Pseudopinus* sp., *Protopinus* sp. and *Pinuspollenites* sp., *Piceapollenites* sp., *Cedripites* sp.

3. *Classopollis* sp. (to 40%) dominates.

4. *Chasmatosporites* sp., *Quadraeculina* sp., *Caytonia oncodes* are typical.

These assemblages are established in the Ivanitska suite of the north-eastern part the Ukrainian Shield (Kaniv and Trahtemyriv hill); Ichnyanska and Ivanitska suites of the Dnipro-Donets depression (wells 8561, 8562).

Layer with **oxfordian** spores-pollen assemblage.

Spores: 1. *Cyathidites minor* dominates.

2. Rare *Gleicheniidites, Lophotriletes torosus, Tripartina variabilis, Marattisporites* spp., *Densoisporites velatus* are typical.

Pollen: 3. *Classopollis* spp. dominates.

4. Alete pollen: *Inaperturopollenites magnus*, *Chasmatosporites* sp., *Quadraeculina* sp., Ginkgocycadaceae, Araucariaceae, Cupressaceae are typical.

These assemblages are established in the lower part of the Colorful layer of the limestone of the Carpathians (Priborgavsky quarry); the Izumska suite of the northwestern outskirts of Donbas (Kamyanyi quarry, near the village Mala Komishuhaha and the northern outskirts of Kamyanka, Kharkiv region); deposits of Oxfordian of the Central Azov valley (well Electric exploration-1) and others.

Layer with **kimmeridgian** spores-pollen assemblage.

Spores: 1. *Trilobosporites* is first appear with a smooth and rough sculpture.

2. *Taurocusporites segmentatus, Staplinisporites caminus* are rare but typical.

Pollen: 3. *Classopollis* spp. to 90% dominate.

4. Rare alete pollen Ginkgocycadaceae, Araucariaceae, Cupressaceae are typical.

These assemblages are established at the top of the strata-colored layer of the Carpathian limestones (Priborgavsky quarry); the Donetska suite of the northwestern outskirts of the Donbas (the northern outskirts of Kamianka of the Kharkiv region).

Layer with **tithonian** spores-pollen assemblage.

Spores: 1. *Marattisporites* spp., *M. scabratus* (10%) dominate and less *Callialasporites* sp.

2. Dipteridaceae, Osmundaceae, Ophioglossaceae, Hymenophyllaceae, Cyatheaeceae, Matoniaceae, rare Gleicheniaceae (small forms) are typical.

Pollen: 3. *Classopollis* spp. (70%) dominate.

4. Rare *Pseudopiceae* sp., *Pseudopinus* sp., *Protopinus* sp. (ancestors of conifers pollen) are typical.

5. Pinaceae, Podocarpaceae (like pollen of modern plants) are present constantly.

These assemblages are established in the Svalyavska suite of the Carpathians (Priborgavsky quarry); Nyznivska suite Volyn-Podillya (Zavadivskiy quarry); Donetska suite of the north-western outskirts of Donbas (the northern outskirts of Kamyanets town and Kremenets mountain, near Izyum town of the Kharkiv region), the lower sub-suite of the Dvoyakirna suite of the Mountain Crimea (Krasnoselivka town, Tonas river, the Dvoyakirna bay).

Layer with **berriasian** spores-pollen assemblage.

Spores: 1. Schizeaceae with ribbed sculpture *Cicatricosisporites* spp. and *Appendicisporites* sp. are first appear.

2. Rare *Plicifera, Gleicheniidites, Matonisporites, Cyathidites* are typical.

Pollen: 3. *Classopollis* spp. (35-40%) dominate among the gymnosperms.

These assemblages are established in the upper sub-suite of Dvoyakirna suite (Krasnoselivka town, Kuchuk-Uzen river; Krasnoselivka town, Tonas river; the outskirts of Feodosia city, the Cape Ilya (lighthouse), the central part of the Dvoyakirna bay), Belbekska strata (Kuybyshev town); Bechku suite (in the valley of the Belbek river, the town of Kuybyshev); Kuchkinska suite (town Kuybyshevo), Albatska strata (Kuybyshev town) of the Crimean Mountains.

Layer with **valanginian** spores-pollen assemblage.

1. Pollen of gymnosperms and spores of ferns, lycopods are equally represented.

Spores: 2. The typical variety of Schizeaceae with ribbed sculptures.

3. *Cyathidites, Concavisporites* and smooth and shallow spores Gleicheniaceae are constantly present.

Pollen: 4. *Classopollis* to 50% are typical.

5. *Ginkgocycadophytus*, Pinaceae, Podocarpaceae are present.

These assemblages are established in the lower parts of Karatlichska suite (Kuybyshevo town) and the Ryazanska suite (Verkhorichtsya village) of the Crimean Mountains.

Layer with **hauterivian** spores-pollen assemblage.

Spores: 1. *Trilobosporites bernisartensis, Appendicisporites tricostatus* are first appear.

2. Schizaeaceae (*Cicatricosisporites, Appendicisporites, Trilobosporites*) dominate.

3. *Leiotriletes* and *Gleicheniidites, Plicifera* are typical.

Pollen: 4. *Gnetaceaepollenites rotundus, Ginkgocycadophytus* dominate among the gymnosperms.

5. Participation *Classopollis* gradually decreases (35%).

These assemblages are established in the upper part of the Verhorichtska strata (Verhorichtsya village) and Holubinska strata (Golubinka village); the upper part of the Karatlichtska suite (Mountain Karatlih, Kuibyshev village) of the Crimean Mountains.

Layer with **barremian** spores-pollen assemblage.

Spores: 1. Gleicheniaceae, Dicksoniaceae, Osmundaceae dominate.

2. *Pilosisporites* spp. and *Cicatricosisporites mediostriatus* are typical.

Pollen: 3. Angiosperms *Clavatipollenites hughesii* is first appear.

4. Pinaceae, Podocarpaceae, Ginkgocycadophytus are typical among the gymnosperms.

These assemblages are established in the Gromokliivska suite (wells 0121, 0123 of the Black Sea Basin) and the lower part of the Pokrovo-Kireevska suite (well 9) Ukrainian shield; Shyrokinska strata (Shiroke village, Balaklava district); the lower part of the Biasalinska suite (Verhhorichtsya village of Bakhchisaray district) of the Crimean Mountains.

Layer with **aptian** spores-pollen assemblage.

Spores: 1. *Murosporoides floridus* is first appear.

2. Gleicheniaceae (to 75%) dominate and its are characterized by a large variety of species.

Pollen: 3. *Cedripites* spp. dominate among gymnosperms (bisaccate).

4. Participation of angiosperms – 1-3%.

These assemblages are established in the middle part of the Pokrovo-Kireevska suite (wells 97, 100), Tymoshivska strata (well 9) and Orlovska strata (wells 9, 14) of the Priazovsky massif of the Ukrainian shield; in a pack of coal clay in the Black Sea basin (wells 0121, 0123); the upper part of the Biasalinska suite and the upper part of the Marianska strata of the Mountain Crimea (Verkhorichtsia village, Bakhchisaray district), etc.

Layer with **albian** spores-pollen assemblage.

Spores: 1. Appearing beans like spores Polypodiaceae.

2. *Corniculatisporites* sp. is typical.

3. *Gleicheniidites* sp., *Cyathidites* sp., *Ophioglossum* sp., *Osmundacidites* sp. are constant, but rare.

Pollen: 4. *Pinuspollenites* spp., Cupressaceae-Taxodiaceae dominate.

5. Angiosperms – 3-5%.

These assemblages are established in the lower sub-suite Kozlivska suite (a series of outcrops between the villages of Kozlov and Nagoriany, near the dam number 2 of the Dniester hydroelectric power station), Nezvyska suite (a series of outcrops near Bernashivka village, Vinnytsia region, Mohyliv-Podilsky district, the left bank of the Dniester river, the outcrop on the outskirts of the town of Novodnistrovsk, Chernivtsi region, the wall of the Dniester hydroelectric power station, dam number 1), Volodymyretska suite (wells 42, 4606,

39); the lower part of the Pilipchanska suite (near Kitajhorod village; Tashky village of Slavutsky district Ternava river), the Volyn-Podilska plate and the western slope of the Ukrainian shield; in the layers of the Virzhikivsky and the Gezo-pack spongolite (4 outcrops near Kaniv town), Melitopolska strata (well 14), Tokmakska strata (well 9), Staromayorivska and the Veselivska strata (wells 97, 100) of the eastern part of the Ukrainian shield; the lower part of the Burimska suite of the Dnipro-Donets depression (wells 8561, 8562); West-Mykolayiv strata (well 0121) of the Black Sea depression; Albian deposits of the North Azov deflection (well Western Birucha-1); Plain Crimea (well Simferopol-1); Konstantinovska strata (Konstantinovka village, Simferopol district), thicker sand and Chorgunska strata (Chernorechchia village) of the Crimean Mountains, etc.

Layer with **cenomanian** spores-pollen assemblage.

Spores: 1. *Taurocusporites reduncus, Ophioglossum cenomanicum* are first appear.

2. *Kuylisporites lunaris* are typical.

3. Small Gleicheniaceae, *Cicatricosisporites* spp., beans like spores Polypodiaceae are constant.

Pollen: 4. Alete of pollen (non-bisaccate) Cupressaceae-Taxodiaceae and *Inaperturo-pollenites dubius, Araucariacites australis* dominate.

5. *Pinuspollenites* spp. and small *Podocarpidites* sp. are typical among the bisaccate gymnosperms.

6. *Pollenites, Extratripollenites* are typical among the angiosperms.

These assemblages are established in the upper sub-suite of the Kozlovska suite (Kozlov village), Nezvyska suite (Bernashevka village, Mohyliv-Podilsky town), Volodymyretska suite (wells 31, 42, 4606), the upper part of the Pilipchanska suite (Kitajhorod village, Tashky village of Slavutsky district) and Rusavska suite (Bernashevka village, Mohyliv-Podilsky town), layers of limestone with prisms of inocerams (wells 26, 27, 30, 31, 33, 39; Bernashivka village, Mohyliv-Podilsky town; Zolotniki village; Zavadiv quarry) of the Volyn-Podilska plate and the western part of the Ukrainian shield; Genicheska suite (wells 9, 14, 97), Slovianohirska suite (Segmenivsky, Priizimsky strata – Kremenets mountain, near town Izyum, Kharkiv region), the sand Conglomerate pack (Glafirivka village of Lugansk region), the upper part of the Burimska suite (wells 8561, 8562) of the eastern part of the Ukrainian shield, the Dnipro-Donets depression, Donbas; Belogorska suite of Mountain Crimea (Trudolivka village of Bakhchisaray district); Cenomanian of the Plain Crimea; The North Azov deflection and the Central Azov valley, and others.

Layer with **turonian** spores-pollen assemblage.

Spores: 1. Make up 7%. *Leiotriletes* sp., *Matoniasporites* sp. and beans like spores Polypodiaceae are present.

2. *Stenozonotriletes* sp. are typical.

Pollen: 3. *Classopollis* disappear.

4. Cupressaceae-Taxodiaceae and Pinaceae dominate among the gymnosperms.

5. *Proteacidites magnus, Trudopollis nonperfectus* and *Pompeckjoidaepollenites* sp. are first appear.

6. *Tricolpites reticulatus, Tricolporopollenites* sp., *Triatriopollenites* sp. dominate among the angiosperms.

These assemblages are established in the Ozarinetska suite (Novodnistrovsk town, Sokyryansky district, Mohyliv-Podilsky town, Bernashevka village, etc.), lower parts of sub-suites of the Zdolbunivska suite (wells 4606, 26, 27, 30, 31, 33, 39, 42 and others) and

Dubovetska suite (12 outcrops of the Ternopil region) of the Volyn-Podilska plate and the Ukrainian shield; the lower part of the Shyrokivska suite of the north-western outskirts of the Donbas (Zokotnenska and Hirska sub-suite – Izyum town, Kremenets mountain, Milova quarry of the Kharkiv region); the Menderska suite (village Trudolyubivka, Bakhchisaray district), a pack of marls with spherical concretions of the flint (the village of Chernorechy of the Sevastopol district) and the lower part of the Khmelnytska suite (Chernorichya village of the Sevastopol district) of the Crimean Mountains.

Layer with **coniacian** spores-pollen assemblage.

Spores: 1. Beans like spores Polypodiaceae are typical.

Pollen: 2. Gymnosperms *Pinuspollenites* sp., *Podozamites* sp. and *Ginkgocycadophytus* are typical.

3. Angiosperms Normapolles and Postnormapolles are to 55%.

4. Present pollen grains of flowering plants that are close to modern ones Betulaceae, Juglandaceae, Platanaceae, Fagaceae, Araliaceae, Caprifoliaceae.

These assemblages are established in the upper parts of sub-suites of the Dubivetska suite (12 outcrops of the Ternopil region), the Zdolbunivska suite (wells 4606, 26, 27, 30, 31, 33, 42, etc.) of the Volyn-Podilska plate; the upper part of the Khmelnitska suite (village Chernorichchya of the Sevastopol district) Mountain Crimea.

Layer with **santonian** spores-pollen assemblage.

Spores: 1. *Leiotriletes* sp., *Camptotriletes* sp., Selaginellaceae are rare.

Pollen: 2. Alete pollen Araucariaceae, Ginkgoaceae and *Podozamites* are dominate among the gymnosperms.

3. Small *Pinuspollenites* spp. are typical.

4. First appear among the angiosperms *Oculopollis* sp. and *Trudopollis* (small form).

These assemblages are established in the Turiyska suite of the Volyn-Podilska Plate (wells 4606, 26, 27, 30, 33, Marianka village, Kovel district); Elanchicska suite of the northern of the Donbas (Uspenska sub-suite - village Mala Kamyshutaha of the Kharkiv region); Chernorichenska suite (Chernorichya village of the Sevastopol district) Mountain Crimea.

Layer with **campanian** spores-pollen assemblage.

Spores: 1. The spores of the ferns are rare and presented *Densoisporite*s, *Lygodiumsporites.*

Pollen: 2. Pinaceae are typical among the gymnosperms.

3. Angiosperms Normapolles dominate.

4. *Extratriporopollenites* spp. are first appear.

5. *Oculopollis* spp., *Trudopollis* spp., *Nudopollis* spp., *Tricolporopollenites radiatostriatus, T. mutabilis* are characteristic among pollen angiosperms.

These assemblages are established in the Berezynska suite (well 30) of the Volyn-Podilska plate; Sidorivska suite (Tarasivska sub-suite - outcrop near Zbirnya village, the Krutenka bridges, Luhansk region; Georgiyivska sub-suite - outcrops near the town of Georgiyivka, the Konoplyanka beam of the Luhansk region) Donbas; Staromlynivska suite (well 100), Velikotokmakska suite (well 9) and the Kumachivska strata (well 97) of the Priazovsky array Ukrainian shield; in the sediments of the Campanian of the North Azov deflection and the Central Azov valley (wells Matrosskaya-1; Western-Biryuch-1; Strelkova-20); Plain Crimea (well Simferopol-1).

Layer with **maastrichtian** spores-pollen assemblage.

Spores: 1. *Lygodiumsporites* sp., *Camptotriletes ambigens, Leptolepidites tenuis, Polypodiumsporite*s sp., *Cyathidites* sp., *Polypodiaceoisporites verruspeciosus* are rare.

Pollen: 2. *Pinuspollenites* sp. are rare and characteristic among the gymnosperms.

3. Angiosperms *Oculopollis solidus* and *Papillopollis* sp. are first appear.

4. *Trudopollis* spp., *Nudopollis* spp. dominate among the angiosperms.

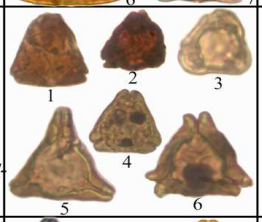
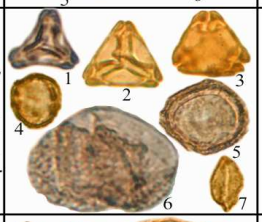
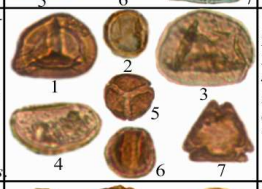
These assemblages are established in the Kamyanobrodska suite (Jar Stone edge of the outskirts of Lugansk); the upper part of the Novo-Mykolaiivska strata (wells 97, 9, 14) of the Priazovsky massif of the Ukrainian shield; Potelychska suite of the Lviv-Lublin deflection (Potelich village of Zhovkiv district of Lviv region); the Maastrichtian deposits of the North Azov deflection and the Central Azov valley.

The characteristic features of coeval spore-pollen assemblage, which have a resolution at the stages level, allow to specify the volume and boundaries of individual strattons in various facional sections of the middle, upper Jurassic and lower Cretaceous within Ukraine and can be used for interregional correlations.

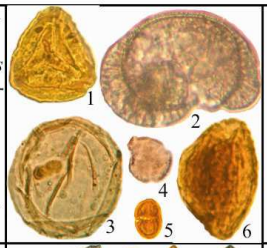
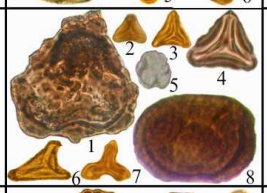
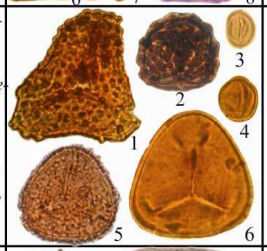
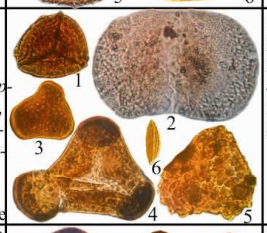
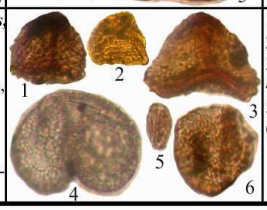
As a result, the scheme of biostratigraphic division of the Aalenian-Maastrichtian deposits of Ukraine for spore-pollen assemblage has been developed.

*Eucommiidites troedssoni* and *Cerebropollenites mesozoicus* occur first in the Aalenian are first appear. *Leiotriletes lineatus, Neoraistrickia rotundiformis, Duplexisporites anagrammensis, Converrucosisporites disparituberculatus, Laevigatosporites ovatus, Leptolepidites major, Densoisporites velatus, Callialasporites dampieri, Araucariacites australis* and *Vitreisporites (Caytoniapollenites) pallidus* appear in the Middle Jurassic at the base of the Bajocian. The appearance of more genera *Foveosporites, Klukisporites, Lycopodiacidites*, and *Uvaesporites* distinguishes the Bathonian stage and shows an increase in diversity of fern spores in this stage. No new spore-pollen appearance was noted in the Callovian. Spore-pollen assemblages of the Oxfordian - Kimmeridgian are biogenically degraded. Bisaccate pollen and *Classopollis classoides* (70-90%) form the major part of the assemblage in the Upper Jurassic. The appearance of family members Schizeaceae with ribbed sculpture *Cicatricosisporites mohrioides, C. venustus, Cicatricosisporites exiliodes, C. perforatus, C. remissus, Appendicisporites pseudomacrorhyzus, A. macrorhyzus, A. crimensis* and *Ruffordiaspora australiensis* in the according to ammonite zone Berriasella jacobi and zone dinocysts Gochteodinia villosa of the Crimean Mountains marks the Jurassic/Cretaceous boundary. Pollen of gymnosperms and spores of ferns, lycopods are equal participation in the Valanginian. *Trilobosporites bernisartensis, Appendicisporites tricostatus* are first appear in the Hauterivian. Pollen of angiosperms *Clavatipollenites hughesii* is first occurrence in the Barremian. Spores of family Gleicheniaceae are noted abundantly in the Aptian. Only poorly preserved spore-pollen were recovered in the Albian except the appearance of beans like spores Polypodiaceae from the ammonite zone Mortoniceras inflatum of the the Volyn-Podilska plate, the western slope of the Ukrainian shield, the Dnipro-Donets depression, the Black Sea depression in the Albian. Most of the Cenomanian - Santonian samples, particularly those from the Volyn-Podilska plate, are dominantly rich in dinocysts and bisaccate pollen. *T aurocusporites reduncus, Ophioglossum cenomanicum* are first appear in the Cenomanian and the proportion of pollen of conifers was rather significant but the extinction of Cheirolepidiaceae gymnosperms took place at the Cenomanian - Turonian boundary from the ammonite zone Praeactinocamax plenus - Inoceramus pictus of the platform of Ukraine. *Proteacidites magnus, Trudopollis nonperfectus* and *Pompeckjoidaepollenites* sp. are first appear in the Turonian. Pollen Normapolles and Postnormapolles are to 55% in the Coniacian indicating a progressive increase in angiosperms spe-

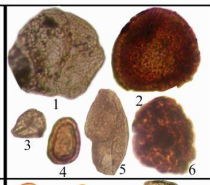
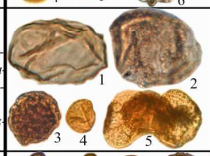
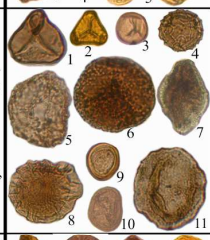
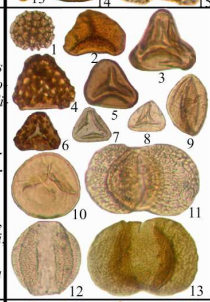
cies. Pollen of angiosperms *Oculopollis* sp. are first appear in the Santonian. *Extratriporopollenites* spp. are first appear in the Campanian. Pollen of angiosperms *Papillopollis* sp. are first appear in the Maastrichtian.

| Period | Epoch | Stage | Spore-pollen assemblages | | |
|---|---|---|---|---|---|
| Cretaceous | Late | Maastrichtian | Spores (5%): **Polypodiaceae,** Cyatheaceae, Matoniaceae, Gleicheniaceae, Lycopodiaceae.<br>Gymnosperms pollen (23%): Pinaceae - small, Taxodiaceae, Cupressaceae.<br>Angiosperm pollen (**72%**): Normapollis, Postnormapollis - *Trudopollis* sp., *Triprojectacites,* ***Oculopollis solidus,*** ***Papillopollis* sp.,** *Subtriporopollenites* spp., *Triatriopollenites* spp., Ulmaceae, Fagaceae, Betulaceae, Proteaceae, Loranthaceae, Rutaceae. |  | 1.*Triorites minor*<br>2.*Pompeckjoidaepollenites* sp<br>3.*Trudopollis conrectiformis*<br>4.*Proteacidites amolosexinus*<br>5.*Papillopollis* sp.<br>6.*Nudopollis hastaclarus*<br>7.*Nudopollis* sp.? |
| | | Campanian | Spores (9%) *Sphagnumsporites* sp., **Polypodiaceae,** *Lycopodiumsporites* sp., *Todisporites* sp., *Lygodiumsporites* sp., *Cyathidites* spp., *Alsophillidites* sp., *Gleicheniidites laetus, Plicifera delicata, Ornamentifera echinata.*<br>Gymnosperms pollen (21%) - *Pinuspollenites* spp., *Cedripites* sp., *Platysaccus* sp.<br>Angiosperm pollen (to 70%) *Pollenites* sp., *Oculopollis* sp., *Gothanipollis* sp., ***Nudopollis* spp., *Extratriporo-pollenites clarus*, *Extratriporo-pollenites perforates*, *Tricolporopollenites radiatostriatus, T. mutabilis*, *Trudopollis* spp.,** *Quercus* sp., *Myrica* sp., *Ulmus* sp., ***Corylus* sp.** |  | 1.*Oculopollis* sp.<br>2.*Oculopollis preadicatus*<br>3.*Triatriopollenites* sp.<br>4.*Trudopollis nonperfectus*<br>5.*Extratriporopollenites* aff. *vestifex*<br>6.*Nudopollis* sp. |
| | | Santonian | Spores (8%) *Cicatricosisporites* sp., ***Polypodiumsporites* sp.,** *Psilatriletes* spp., *Verrucatotriletes* spp., Selaginellaceae.<br>Gymnosperms pollen (33%): Araucariaceae, *Ephedripites* sp., *Cedripites* sp., *Pinuspollenites* spp.<br>Angiosperm pollen (59%): *Monocolpopollenites spheroidites, Psilamonocolpites* sp., *Proxapertites maracaiboensis, Racemonocolpites* sp., *Retimonocolpites* sp., *Spinizonocolpites sutae,* ***Vacuopollis* sp., *Trudopollis* sp., *Oculopollis* sp.,** Betulaceae, Juglandaceae, Platanaceae, Fagaceae, Araliaceae, Caprifoliaceae. |  | 1.*Gothanipollis* sp.<br>2.*Sporopollis singularis*<br>3.*Oculopollis* sp.<br>4.*Tricolporites* sp.<br>5.*Ulriculites visus*<br>6.*Pinus subconcinua*<br>7.Ginkgoaceae |
| | | Coniacian | Spores (7%): **Polypodiaceae**, Gleicheniaceae, *Lygodiumsporites subsimplex*, Matoniaceae, *Sphagnumsporites* sp., *Leiotriletes* sp., *Staplinisporites* sp., *Taurocusporites reduncus*.<br>Gymnosperms pollen (to 50%): Pinaceae, Cupressaceae, Ginkgocycadophytus, Araucariaceae.<br>Angiosperm pollen (to 45%): *Tricolpites reticulatus, Monocolpites* sp., *Tricolpopolenites* sp., *Tricolporopollenites sp., Triatriopollenites* sp., ***Proteacidites magnus,*** *Liliacidites variegates*, *Quercus* sp., *Platanus* sp., *Betula* sp. |  | 1.*Stereisporites (Sphagnumsporites) regium*<br>2.*Platanus* sp.<br>3.*Pinus insignis*<br>4.*Triatriopollenites* sp.<br>5.*Leiotriletes* sp.<br>6.*Anacolosidites* sp.<br>7.*Proteacidites* sp. |
| | | Turonian | Spores (10%): **Polypodiaceae**, *Plicifera* sp.,*Gleicheniidites* sp., *Lygodiumsporites subsimplex*, *Matoniasporites* sp., *Coniopteris* sp., *Leiotriletes* sp., ***Staplinisporites* sp.** *Taurocusporites reduncus*.<br>Gymnosperms pollen (to 55%): Pinaceae, *Podocarpidites* sp., *Cedrus libaniformis*, Cupressaceae, *Inaperturopollenites magnus*, Ginkgocycadophytus, Araucariaceae.<br>Angiosperm pollen (35%): *Tricolpites* spp., ***Pompeckjoidaepollenites* sp., *Basopollis* sp.**,*Trudopollis nonperfectus.* |  | 1.*Staplinisporites caminus*<br>2.*Tricolporoidites* sp.<br>3.*Taxodiumpollenites?* sp.<br>4.*Polypodiumsporites* sp.<br>5.*Pompeckjoidaepollenites* sp<br>6.*Tricolpoporopollenites* sp.<br>7.*Trudopollis nonperfectus* |
| | | Cenomanian | Spores (25%): *Polipodiumsporites* sp., *Selaginelliidites* sp., *Gleicheniidites* sp., *Cyathidites* sp., ***Ophioglossum cenomanicus, Taurocusporites reduncus, Kyulisporites*** sp.<br>Gymnosperms pollen (до 50%): *Pinuspollenites* spp., *Cedrus libaniformis, C. deodaraeformis,* Podocarpaceae, Cupressaceae-Taxodiaceae, *Inaperturopollenites dubius, Araucariacites australis.*<br>Angiosperm pollen (25-30%): *Quercus* sp., *Betula* sp., *Liliacidites* sp., ***Gothanipollis* sp.**, *Tricolpopolenites* sp., *Clavatipollenites* sp., ***Pollenites* sp., *Extratripollenites* sp.** |  | 1.*Triatriopollenites roboratus*<br>2.Betulaceae<br>3.*Gothanipollis* sp.<br>4.*Kyulisporites lunaris*<br>5.*Inaperturopollenites* sp.<br>6. *Pinus vulgaris* |

Ris. 2. Characteristic assemblages of spores and pollen from the Upper Cretaceous deposits of Ukraine.

| Period | Epoch | Stage | Spore-pollen assemblages | | |
|---|---|---|---|---|---|
| Cretaceous | Early | Albian | Spores (22%): ***Polypodiumsporites* sp.,** *Gleicheniidites* spp., *G. senonicus, Trilobosporites asper,* ***Corniculatisporites*** sp., *Leiotriletes* sp., *Sphagnumsporites* sp., ***Murosporoides chlonovae***, Osmundaceae, Lycopodiaceae, Selaginellaceae. Gymnosperms pollen (65%): *Cedrus libaniformis, Pinus trivialis, P. vulgaris, P. nigraeformis,* Cupressaceae, Araucariaceae, Ginkgocycadophytus. Angiosperm pollen (3%): *Clavatipollenites* sp., *Striatopollenites* sp., ***Liliacidites* sp., *Protoquercus* sp.** |  | 1.*Murosporoides* sp.<br>2.*Parvisacceites radiatus*<br>3.*Araucariacites* sp.<br>4.*Tricolpites minutus*<br>5.*Tricolporopollenites* sp.<br>6.*Striatopollis paraneus* |
| | | Aptian | Spores (to 77%): **Gleicheniaceae to 75%** - *Gleicheniidites laetus*, ***Ornamentifera echinata*,** *Clavifera triplex*; ***Murosporoides* spp., *M. floridus*.** Gymnosperms pollen (to 22%): Pinaceae - ***Cedripites* spp.**, *Pinuspollenites* sp., *Dacrydiumites* sp., *Parvisaccites radiatus.* Angiosperm pollen (**1%**): *Clavatipollenites* sp., *Tricolpites* sp. |  | 1.*Murosporoides* sp.<br>2.*Plicifera delicata*<br>3.*Gleicheniidites laetus*<br>4.*Gleicheniidites latifolius*<br>5.*Tricolpites* sp.<br>6.*Ornamentifera* sp.<br>7.*Gleicheniidites toriconcavus*<br>8.*Parvisacceites radiatus* |
| | | Barremian | Spores (80%): *Lygodiumsporites subsimplex*, *L. multiberculatum, Trilobosporites sp., T. asper, T. cavernosus*, *T. bernissartensis, Cicatricosisporites cooksonii, C. exilioides*, ***Pilosisporites* sp.,** *Klukisporites visibilis, Plisifera delicata*, *Gleicheniidites circinidites, Concavisporites junctum*, *C. juriensis, Uvaesporites* sp., *Sphagnumporites* sp. Gymnosperms pollen (20%): *Pseudopinus* sp., *Pseudopicea magnifica, Protopinus sutschanensis, Pinuspollenites sp., Cedripites sp., Podocarpus major*, *Caytonia oncodes, Classopollis* sp., *Eucomiidites troedssonii.* Angiosperm pollen (0,1%): ***Clavatipollenites hughesii*** |  | 1.*Trilobosporites verrucosus*<br>2.*Uvaesporites* sp.<br>3.*Clavatipollenites hughesii*<br>4.*Eucomiidites troedssonii*<br>5.*Pilosisporites notensis*<br>6.*Trilobosporites asper* |
| | | Hauterivian | Spores (30-40%): *Cicatricosisporites* sp., *C. perforatus,* ***Appendicisporites tricornitatus*,** *Trilobosporites* spp., *T. grandis,* ***T. bernisartensis***, *Pelletieria* sp., *P. tersa, Gleicheniidites senonicus, G. laetus*, *Matoniasporites phlebopteroides*, *Coniopteris* sp., *Cyathidites* sp., *Leiotriletes* sp., *Trachytriletes* sp., *Staplinisporites caminus*, *Densoisporites velatus, Lycopodiumsporites* spp., *Klukisporites variegates,* ***Aequitriradites*** sp., *Foveosporites* sp. Gymnosperms pollen (до 70%): *Classopollis* sp., Pinaceae, Podocarpaceae, Ginkgocycadophytus, Caytoniaceae |  | 1.*Staplinisporites caminus*<br>2.*Piceapollenites* sp.<br>3.*Foveosporites* sp.<br>4.*Trilobosporites bernissartensis*<br>5.*Trilobosporites grandis*<br>6.Ginkgoales |
| | | Valanginian | Spores **(50%)**: *Trilobosporites asper, T. bernisartensis, T. grossetuberculatum, T. verrucosus, Cicatricosisporites cooksonii, C. dorogensis, Appendicisporites crimensis; Matonisporites phlebopteroides, Concavisporites junctum, Densoisporites velatus, Lycopodiumsporites* sp., *Ophioglossum* sp., *Taurocusporites* sp., *Cyathidites* sp. Gymnosperms pollen **(50%)**:*Caytoniapollenites* sp., *Pinuspollenites* spp., *Protopinus* sp., Podocarpaceae, Araucariaceae, Cupressaceae, Ginkgocycadaceae, *Classopollis* |  | 1.*Cicatricosisporites perforatus*<br>2.*Cicatricosisporites verbitskaja*<br>3.*Cicatricosisporites hugnesi*<br>4.*Cicatricosisporites (Ruffordiaspora) australiensis*<br>5.*Matonisporites phlebopteroides*<br>6.*Classopollis torosus* |
| | | Berriasian | Spores (22%):***Cicatricosisporites exiliodes, C. perforatus, C. remissus, Appendicisporites pseudomacrorhyzus, A. macrorhyzus, A. crimensis, Trilobosporites* spp.**, *Trilobosporites gibberulus, Klukisporites* spp., Gleicheniaceae, *Trachytriletes* sp., *Concavisporites* sp., *Leiotriletes* sp., *Callialasporites* sp., *Maratisporites scabratus*. П-к голонасінних: (78%): *Classopollis classoides, Eucorollina* sp., Ginkgocycadophytus, Pinaceae, Podocarpaceae, *Eucomiidites* sp. |  | 1.*Klukisporites* sp.<br>2.*Cicatricosisporites* sp.<br>3.*Trilobosporites* sp.,<br>4.*Abietineaepollenites* sp.,<br>5.*Eucommiidites troedssonii*<br>6.*Piceites flavidus* |

Ris. 3. Characteristic assemblages of spores and pollen from the Lower Cretaceous deposits of Ukraine.

| Period | Epoch | Stage | Spore-pollen assemblages | | |
|---|---|---|---|---|---|
| Jurassic | Late | Tithonian | Spores (25%): *Trilobosporites gibberulus*, *Lygodiumsporites* sp., *Klukisporites* spp., *Klukisporites variegatus*, *Plicifera delicata*, *Gleicheniidites laetus*, *Osmundacidites* sp., *Sphagnumsporites* sp., *Foveosporites* sp., *Ophioglossum* sp., *Leptolepidites* sp., *Densoisporites velatus*, *Lycopodium* sp., *Leiotriletes* sp., *Camptotriletes* sp., *C. cerebriformis*, *C. anagramensis*, *Marattisporites* spp., ***M. scabratus* (10%), *Callialasporites*** sp. Gymnosperms pollen (75%): ***Classopollis* (до 70%),** Protoconiferus, Podocarpaceae, Caytoniaceae, Benettitaceae, Araucariaceae, Cupressaceae, Ginkgocyadaceae, ***Eucommiidites* sp.** |  | 1.*Paleoconiferus asaccatus*<br>2.*Osmundacidites* sp.<br>3.*Alsophila* sp.?<br>4.*Circulina (Classopollis) meyeriana*<br>5.*Bennetitaceae*<br>6.*Klukisporites* sp. |
| | | Kimmeridgian | Spores (9%): *Sphagnumsporites* sp.,***Callialasporites* sp.** Gymnosperms pollen (91%): ***Classopollis* sp. (до 90%),** ***Quadraeculina* sp.,** Caytoniaceae, *Pinuspollenites* sp. |  | 1.*Sphagnumsporites antiquasporites*<br>2.*Classopollis* sp.<br>3.*Protopicea minutereticulata*<br>4.*Classopollis classoides*<br>5.*Classopollis* sp.<br>6.*Caytonipollenites pallidus* |
| | | Oxfordian | Spores (29%): *Cyathidites australis, Marattisporites* spp., *Densoisporites velatus, Leiotriletes* spp. Gymnosperms pollen (71%): ***Classopollis* spp. (до 68%),** *Classopollis chateaunovi, Classopollis classoides, Araucariacites australis*, Cupressaceae,Ginkgocycadales, *Eucomiidites* spp., *Eucomiidites troedssonii,* ***Inaperturopollenites* spp.,** *Piceapollenites* spp., *Piceapollenites variabiliformis, Piceaepollenites exilioides, Pinuspollenites* spp., *Pinuspollenites divulgatus, Podocarpidites* sp. |  | 1.*Inaperturopollenites magnus*<br>2.*Piceapollenites* sp.<br>3.*Klukisporites* sp.<br>4.*Classopollis* sp.<br>5.*Podocarpidites* sp. |
| | Middle | Callovian | Spores (60%): ***Dictyophyllidites* sp.,** *Coniopteris* sp., *Calliialasporites* sp., *Maratisporites scabratus, Lycopodiumsporites cerniidites, Lycopodiumsporites marginatus, Selaginellidites* sp., *Leptolepidites* sp., *Cyathidites* sp., *Cyathidites australis, Gleicheniidites* sp., *Klukisporites* sp., *Matoniasporites* sp., *Foveosporites* sp., *Concavisporites* sp., *Dicksonia* sp., *Osmundasporites* sp., *Sphagnumsporites* sp. Gymnosperms pollen (40%): *Classopollis classoides* (to 50%), *Eucorollina* sp., ***Quadraeculina* sp.,** *Cerebropollenites* sp., Araucariaceae, Cupressaceae, Ginkgocycadaceae, Bennetittaceae, *Chasmatosporites* sp.,***Pseudopicea* sp., *Protopinus* sp., *Pseudopinus pergrandis, Pseudopinus contigua,*** *Alisporites typicus, Eucomiidites.* |  | 1.*Dictyophyllidites* sp.<br>2.*Concavisporites junctum*<br>3.*Leiotriletes* sp.<br>4.*Retitriletes semimuris*<br>5.*Cerebropollenites* sp.<br>6.*Omundacidites* sp.<br>7.*Pseudopinus* sp.<br>8.*Callialasporites dampieri*<br>9.*Classopollis* sp.<br>10.*Classopollis* sp.<br>11.*Chasmatosporites* sp. |
| | | Bathonian | Spores (60%): *Coniopteris divaricata,* ***Cyathidites* spp.,** *Concavisporites pectinaeformis, Dictyophyllum* sp., ***Neoraistrickia rotundiformis,*** *Gleichenia angulata, Gleicheniidites laetus, Plicifera delicata, P. stellata; Matoniasporites* sp., *Osmundacidites* sp., *Densoisporites* sp., *Sellaginella sanguinolentiformis, Foveosporites* sp., *Callialasporites* sp., *Calamospora mesozoica, Laevizonosporites* sp., *Toroisporites* sp., ***Converrucosisporites*** sp. Gymnosperms pollen (40%): Pinaceae: *Pinuspollenites* sp., *Piceapollenites* sp., ***Protoconiferus*** sp., ***Protopinus* sp., *Protopinus sublutes,*** *Pseudopinus oblatinoides, P. pergrandis, Pseudopicea* sp., Podocarpaceae: *Podocarpus nexilis, P. multesima, Caytonia oncodes,* ***Costatipollenites ucrainicus,*** *Quadraeculina* sp., *Cerebropollenites mesozoicus* - 3 %, ***Classopollis* sp. - 1%.** |  | 1.*Converrucosisporites disparituberculatus*<br>2.*Camptotriletetes cerebriformis*<br>3.*Striatella seebergensis*<br>4.*Carnisporites granulatus*<br>5.*Cyathidites australis*<br>6.*Neoraistrickia rotundiformis*<br>7.*Klukisporites variegatus*<br>8. *Concavisporites junctum*<br>9.*Classopollis simplex*<br>10.*Quadraeculina limbata*<br>11.*Osmundacidites fissus*<br>12.*Densoisporites psilatus*<br>13.Ginkgoales<br>14.*Ophioglossum* sp.<br>15.*Costatipollenites ucrainicus* |
| | | Bajocian | Spores (70 %): *Lycopodiumsporites perplicatum, Lycopodiumsporites subrotundus, Selaginellidites* spp., *Leptolepidites* spp., *Klukisporites* sp., ***Dictyophyllidites* sp. (13 %),** *Cyathidites* spp., *Marattisporites* sp., *Gleicheniidites* sp., *Gleicheniidites angulatus Matoniasporites* sp., *Concavisporites* sp., *Dicksonia* sp.,*Ophioglossum* sp., *Leptolepidites* sp., *Densoisporites velatus*, *Osmundacidites jurassicus*,***Neoraistrickia rotundiformis* (2%), *Leiotriletes lineatus***, *Dictyophyllum rugosum*, ***Polipodisporites jurassicus, Biretisporites* sp.**, *Callialasporites* spp., ***Duplexisporites anagrammensis (Striatella), Lygodiosporites perverrucatus, Converrucosisporites disparituberculatus***. Gymnosperms pollen (26 %): *Protopinus* sp., *Pseudopicea* sp., *Pseudopinus pergrandis, P.sublutes, P.contigua, Pinus divulgata, Alisporites bisaccus, Podocarpus proxima, Podocarpidites rousei Caytoniapollenites* sp., *Bennettites* sp., *Ephedripites granulatus*, Ginkgocycadaceae, Araucariaceae, Cupressaceae, *Quadraeculina* sp., *Inaperturopollenites magnus*, ***Classopollis*** (1%). |  | 1.*Lycopodiumsporites marginatum*<br>2.*Biretisporites* sp.<br>3.*Matoniasporites* sp.<br>4.*Klukisporites foveolatus*<br>5.*Biretisporites spectabilis*<br>6.*Converrucosisporites disparituberculatus*<br>7.*Dictyophyllidites sp.*<br>8.*Cyathidites minor*<br>9.*Bennettites sp.*<br>*10.Todisporites major*<br>11.*Podocarpidites* sp.<br>12.Coniferales.<br>13.*Pseudopiceae magnifica* |
| | | Aalenian | Spores (65%): ***Marratisporites scabratus, Klukisporites variegatus***, *Coniopteris* spp., *Cyathidites* spp., *Tripartina variabilis, Camptotriletes anagrammensis, Callialasporites* spp., *Hymenophyllum densisgranulatum, Dictyophillidites* spp., *Matoniasporites* spp., *Phlebopteris* sp., *Osmundacidites* spp., *Lycopodiumsporites* spp. Gymnosperms pollen (35%): Ginkgocycadophytus, *Eucommiidites troedssoni,Cerebropollenites mesozoicus, Classopollis* spp., ***Pseudopiceae magnifica, Pseudopiceae variabiliformis, Pseudopinus* spp.**, *Alisporites* sp. |  | 1.*Marratisporites scabratus*<br>2.*Stereisporites bujargiensis*<br>3.*Dictyophyllidites harrisii*<br>4.*Dictyophyllidites harrisii*<br>5.*Camptotriletes anagrammensis*<br>6.*Klukisporites variegatus*<br>7.*Klukisporites variegatus*<br>8.*Alisporites thomasii*<br>9.*Matoniasporites* (*Punctatisporites*) sp. |

Ris. 4. Characteristic assemblages of spores and pollen from the Middle and Upper Jurassic deposits of Ukraine.

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# БІОСТРАТИГРАФІЯ ЮРИ І КРЕЙДИ УКРАЇНИ ЗА СПОРОВО-ПИЛКОВИМИ КОМПЛЕКСАМИ

**О. Шевчук**

*Інститут геологічних наук НАН України,*
*вул. Гончара, 55б, 01054 м. Київ, Україна*

Розроблено схему біостратиграфічного розчленування за спорово-пилковими комплексами на ярусному рівні для відкладів середньої-верхньої юри та крейди України (від аалену до маастрихту включно) з урахуванням даних М.А. Воронової, Г.Г. Яновської, М.Є. Огороднік, Г.В. Шрамкової, використано власний матеріал та ін. Проведено аналіз більш ніж 1000 власних зразків, зібраних з 93 місцевостей, що представляють майже всі середньо-, верхньоюрські та крейдові зони амонітів України. Встановлено характерні ознаки для 19 спорово-пилкових комплексів всіх стратиграфічних підрозділів, що відповідають ярусному поділу середньої-верхньої юри та крейди.

*Ключові слова*: споро-пилкові комплекси, біостратиграфія, юрський та крейдовий період, Україна.

Стаття надійшла до редколегії 14.03.2018
Прийнята до друку 18.04.2018