SCIENTIFIC PAPERS UNIVERSITY OF LATVIA 2012, Vol. 783,
EARTH AND ENVIRONMENTAL SCIENCES pp. 24–36

Frasnian Miospore Assemblages and Zones of Southern Latvia and North-Western Russia (Pskov Region)

Marina Raskatova*, Aleftina Jurina**
* Geological Department, Voronezh State University
Voronezh, University Square 1, Russia
E-mail: *kig207@geol.vsu.ru*

** Department of Palaeontology, Faculty of Geology, Moscow State University
Moscow, 119991 Vorobjevy Gory, GSP 1, Russia
E-mail: *jurina@geol.msu.ru*

The present work is a result of studies of Frasnian miospores found in various stratigraphic units of Latvia and NW Russia. These units are characterized by zonal miospore assemblages which comprise a stratigraphical interval from the Pļaviņas to the Stipinai regional stages. The taxonomic composition of spore assemblages of the Main Devonian Field has been compared with the miospore assemblages of the Central Devonian Field. Some units were characterized with miospore zones.

Keywords: Biostrarigraphy • Main Devonian Field • miospore zonation • systematics • Upper Devonian

Manuscript submitted 7 November 2011; accepted 15 December 2011.

Introduction

The purpose of the article is to re-describe and illustrate the Frasnian miospores from Latvia and Western Russia on the basis of some previously published and unpublished materials; to give detailed elaboration of existing biostratigraphic scheme of the Frasnian Stage for the studied area; to allocate zones and subzones based on the changes of miospore assemblages; to review some previous definitions of miospores and transfer taxa from the old system into the new one.

Regular studies of miospore assemblages from the Upper Devonian deposits of Latvia were started by V.R. Ozoliņa (1963). She published a monographic report on the studies of miospores from the three outcrops located in the basins of the rivers Gauja and Daugava and from 12 boreholes in the vicinities of Rembate, Pļaviņas, Branti close to Tirza, Ālande, etc. Ozoliņa (1963) described and illustrated in detail five miospore assemblages for the Frasnian deposits from Latvia: assemblage I, common for the Amula and Bauska formations, assemblage II typical for the Ogre Formation (Fm), assemblage III from the Daugava Fm, assemblage IV, common for

the Salaspils and Pļaviņas fms, and assemblage V, common for the Amata and Gauja fms. The work of Ozoliņa has the great importance as it showed for the first time the possibility of stratigraphic subdivision of the Frasnian deposits in Latvia, using miospores. Besides, miospore assemblages allocated by Ozoliņa are important for the comparative analysis.

Later, palynological data obtained by S.N. Starikova, G.I. Kedo and L.G. Raskatova for the Snezha, Ogre and Amula regional stages (RS) of Latvia were used within the biostratigraphic research. These miospore assemblages were compared with their counterparts from the coeval deposits of Belarus and the Central regions of Russia (Central Devonian Field, or CDF) (Sorokin 1981). Thus, by the time of the beginning of our studies many of the Frasnian stratigraphic units have been briefly characterized by miospores.

The position of the Givetian-Frasnian boundary in the Baltic area is debatable, but the authors agree with the opinion that the boundary is traceable below the Plaviņas Fm (e.g., Stinkulis and Zelčs 2011). According to this point of view, the Frasnian Stage in the studied area corresponds to the Pļaviņas RS, Dubnik RS (Salaspils Fm in Latvia), Daugava RS (Daugava Fm in Latvia; Porkhov, Svinord, Il'men', Buregi, Altovo beds in Russia), Stipinai RS and Amula RS in Latvia (for the detailed correlation of stratigraphic units of Latvia and NW Russia see, e.g. Rzhonsnitskaya and Kulikova 1999; Lukševičs 2001). According to the position of the Middle/Upper Devonian boundary accepted here, the assemblage V described by Ozoliņa corresponds to the Givetian Stage.

In the beginning of 1980-ies the authors began the studies of taxonomic composition of spore assemblages from various stratigraphic units of Latvia and NW Russia and compare these assemblages with the miospore assemblages of the Central Devonian Field (CDF). The first attempt to allocate miospore zones and subzones was made and the obtained material was partially published (Raskatova M. 1977, 1999; Raskatova L. *et al*. 1988). These studies analysing the available palynological material for detailed biostratigraphy of the Frasnian deposits of Latvia and NW Russia were continued during 2010-2011.

Material and methods

The study is based on the materials collected during the fieldwork of 1975 to 1976 in the south, south-eastern Latvia and the Pskov region of Russia. All samples were selected from the boreholes located near the following towns: Bauska (boreholes no. 5, 13), Daugavpils (borehole no. 1-T), Ilūkste (borehole no. 6) in Latvia; Velikie Luki (borehole no. 9) and Ostrov district of the Pskov Region (borehole no. 38) of Russia (Fig. 1). The samples were technically processed using alkali-free maceration of rocks (Teterjuk and Philippov 1989). More than 100 preparations, including 35 constant ones, were prepared: 21 from Latvian sections and 14 from NW Russia (Pskov region sections).

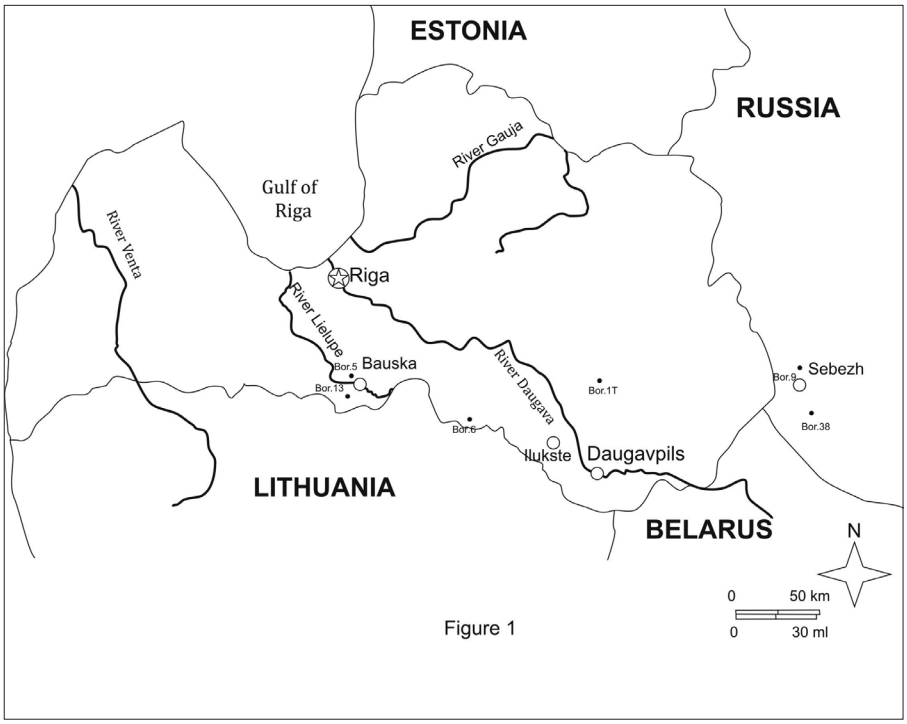

Figure 1. **Map of Latvia and NW Russia showing the location of studied boreholes.**

Results and interpretation

Miospore assemblage of the **Pļaviņas RS** is characterized on the basis of 36 samples selected from three boreholes no. 5, 9, and 38. The largest part (80%) of samples was empty, and 20% contained miospores and acritarchs. Miospores from the Pļaviņas deposits of Latvia have the subordinated value and are characterized by the following composition: *Leiotriletes perpusillus* Naum., *Calamospora minutissima* (Naum.) Lub., *Calamospora atava* (Naum.) McGregor, *P. solidus* (Naum.) Byvsch., *Lophotriletes minutissimus* Naum., *Apiculatisporis eximius* (Naum.) Oshurk., *A. dentatus* (Naum.) Obukh., *Geminospora rugosa (Naum.)* Obukh., *G. notata* (Naum.) Obukh., *Archaeozonotriletes variabilis* Naum. var. *insignis* Sen., *Stenozonotriletes definitus* Naum., *Densosporites* sp. (Fig.2, A-F).

Miospore assemblage from the sections of two boreholes in the Pskov region is more representative than in Latvia, which results in a greater species diversity within the genus *Geminospora*, occurrence of large miospores with long processes within the genus *Ancyrospora* and presence of a large miospore *Biharisporites*. Ozoliņa allocated the united miospore assemblage IV from the Pļaviņas and the Salaspils fms of Latvia, indicating, in her opinion, the absence of distinctions in flora from these formations. Probably, it was also associated with little palynological material. Assemblage IV was characterized by the presence of large miospores with processes

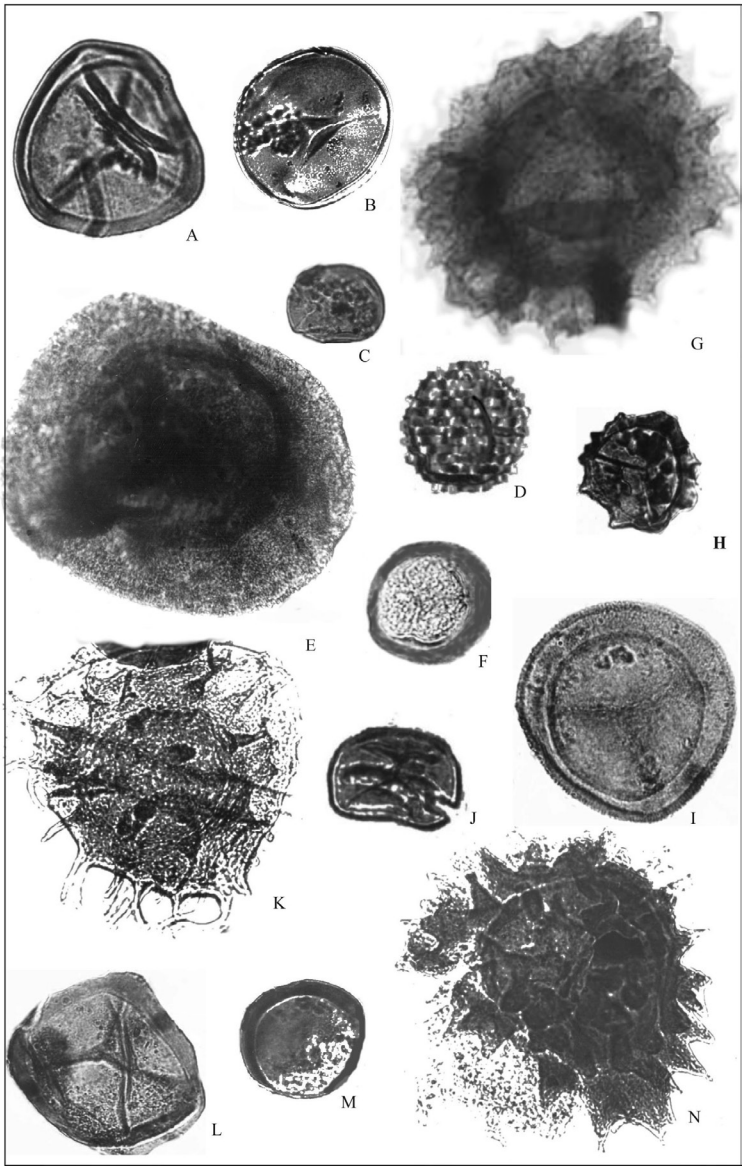

Figure 2. **Frasnian miospore assemblages from Latvia. A-F, miospores from the Pļaviņas RS: A, *Geminospora notata* (Naum.) Obukh.; B, *Punctatisporites atavus* (Naum.) Andr.; C, *Calamospora minutissima* (Naum.) Lub.; D, *Apiculatisporis eximius* (Naum.) Oshurk.; E, *Biharisporites* sp.; F, *Archaeozonotriletes variabilis* (Naum.) var. *insignis* Sen. VSU, no L2011/24-25. G-N, miospores from the Dubnik RS: G, *Densosporites* cf. *sorokinii* Obukh.; H, *Converrucosisporites curvatus* (Naum.) Turnau; I, *Geminospora micromanifesta* (Naum.) Arch.; J, *Retusotriletes simplex* Naum.; K, *Ancyrospora melvillensis* Owens; L, *Geminospora rugosa* (Naum.) Obukh.; M, *Archaeozonotriletes variabilis* Naum.; N, *Ancyrospora pulchra* Owens. VSU, no L2911/27. Magnification x 500.**

and by the first occurrence of the genus *Archaeoperisaccus* (Ozoliņa 1963). However, no species of the genus *Archaeoperisaccus* have been found in the sections of the Pļaviņas RS during our studies.

The Pļaviņas RS yields rather poor miospore assemblage, aging as the Frasnian because the index species of the subzone IB *Archaeozonotriletes variabilis insignis* and species of the genera *Apiculatisporis* and *Densosporites* appear in its composition. These genera are typical for this subzone, which corresponds to the Sargaevo RS of the CDF (Avkhimovitch *et al*. 1993), and are absent in the miospore assemblage from the Gauja RS (Jurina and Raskatova 2011).

Miospores from the **Dubnik RS** were studied from the section of borehole no. 5 in Latvia, and from two boreholes, no. 9, and 38, in Russia (Pskov region), where 14 samples were selected. 25% of the studied samples contained from 180 to 200 miospores. The most complete palynological characteristic of the Dubnik deposits was obtained from the borehole no. 5. The diversity of the Dubnik miospores is wider than in the Pļaviņas assemblage. The Dubnik assemblage which was established during this study contains *Leiotriletes laevis* Naum., *Calamospora minutissima* (Naum.) Lub., *C. simplicissima* (Naum.) Oshurk., *Cyclogranisporites rugosus* (Naum.) Oshurk. var. *minor* Naum., *Geminospora rugosa* (Naum.) Obukh., *G. micromanifesta* (Naum.) Arkh., *G. semilucensa* (Naum.) Obukh. et M. Rask., and *Reticulatisporites retiformis* (Naum.) Obukh. Some species were found in a small number of spores: *Retusotriletes simplex* Naum., *R. communis* Naum., *Stenozonotriletes definitus* Naum., *S. pumilus* (Waltz) Naum., *S. recognitus* Naum., *Kedoesporis angulosus* (Naum.) Obukh., *Ancyrospora pulchra* Owens *A. melvillensis* Owens, *Densosporites* cf. *sorokinii* Obukh., *Verrucosisporites grumosus* (Naum.) Obukh., *Converrucosisporites curvatus* (Naum.) Turnau (Fig.2, G-N). In general the miospore assemblage from the Dubnik RS has common features with the Pļaviņas assemblage. Some differences between these two assemblages consist in the almost total absence of miospores with conate sculpture of the exine (1%), in the presence of miospores with verrucate ornamentation and considerable diversity of species within the genera *Stenozonotriletes* and *Ancyrospora* typical to the Dubnik RS.

The general structure of the Dubnik miospore assemblage from Latvia and NW Russia indicates the Frasnian age of deposits and shows some similarity with the XI miospore assemblage from the Rudkino RS of the CDF (Raskatova L. 1969). The miospore assemblage from the Rudkino RS is characterized by wider diversity of species within the genera *Geminospora*, *Acanthotriletes*, *Apiculatisporis*, *Stenozonotriletes*, by presence of patinate miospores *Archaeozonotriletes (A. variabilis* Naum.) up to 20%, constituting 3% in the Dubnik assemblage. A common feature for the two assemblages is the presence of large numbers of acritarchs (up to 45% in the borehole no. 5, depth 116.5 m). The structure of the Dubnik miospore assemblage enables to allocate the analogue of the zone Acanthotriletes bucerus – Archaeozonotriletes variabilis insignis (BI) (Frasnian) (Avkhimovitch *et al*. 1993) for the deposits studied by the authors in Latvia and the Pskov area.

First results of studies of the miospore assemblage from the **Daugava RS** were gained from the Il'men' Fm in the Pskov area (borehole no. 9), where a rich miospore assemblage has been found (Raskatova M. 1977). Later miospores from

the Daugava deposits in boreholes no. 9 and no. 5 were studied and compared with miospore assemblage from the Semiluki RS of the CDF (Raskatova L. *et al*. 1988). Later two miospore assemblages were established for the Daugava RS: the first one is similar in the composition to that of the SD (Geminospora semilucensa – Perotriletes donensis) miospore zone and the second one resembles in composition that of the SB (Spelaeotriletes bellus) miospore subzone, entering into the OG (Archaeoperisaccus ovalis - Verrucosisporites grumosus) zone characteristic for the Buregi and Altovo fms (Raskatova M. 1999).

In this paper the results of studies of the miospore assemblage from the **Daugava deposits** in Latvia (boreholes no. 5 and 1-T; 15 samples from two sections) and in Pskov region (borehole no. 9; 4 samples) are presented. 35% of samples from the sections of the Daugava deposits in Latvia contained a significant amount of miospores (180-200). In the section of borehole no. 9 the content of miospores is higher than in other boreholes (up to 250). Distinctive features of the assemblage are the first appearance of the genus *Archaeoperisaccus* (*A. ovalis* Naum.) (Fig. 3 C) in the lower part of the section, increased diversity of species in the upper part of the RS (*A. concinnus* Naum., *A. mirus* Naum.) (Fig. 3 E, M), and domination of genera *Geminospora* and *Stenozonotriletes*. However, there are some differences between the dominant miospore genera in the assemblages from the sections of boreholes no. 5 and 1-T as they include *Geminospora rugosa* (Naum.) Obukh., *G. semilucensa* (Naum.) Obukh. et M. Rask., *Stenozonotriletes laevigatus* Naum., *S. definitus* Naum., *Converrucosisporites curvatus* (Naum.) Turnau. The diversity in the genera *Geminospora* (13%) and *Stenozonotriletes* (10%) is much less than in the assemblage from the borehole no. 9 (45.5%). Miospores belonging to the genus *Converrucosisporites* make 13% of all spores, but consist mainly of the remains of one species, namely *C. curvatus* (Naum.) Turnau. The miospore assemblage from the borehole no. 1-T is characterized by abundant large miospores with bifurcate processes *Archaeotriletes conspicuous* Naum. and *Ancyrospora fidus* (Naum.) Obukh. (Fig. 3 G,N). The assemblage from the borehole no. 9 contains the following species: *Geminospora rugosa* (Naum.) Obukh., *G. compacta* (Naum.) Obukh., *G. plicata* Owens, *G. opipara* Owens, *G. semilucensa* (Naum.) Obukh. et M.Rask., *G. micromanifesta* (Naum.) Arkh., *G. nalivkinii* (Naum.) Obukh. (Fig. 3 K, L), *Apiculiretusispora verrucosa* (Caro-Moniez) Streel (Fig. 3 F), *Archaeozonotriletes variabilis* Naum (Fig. 3 B), *Hymenozonotrilete argutus Naum.* (Fig. 3 O), *Calyptosporites krestovnikovii* (Naum.) Oshurk. (Fig. 3 J), *Ancyrospora laciniosa* (Naum.) Mants. (Fig. 3 H), *Convolutispora subtilis* Owens (Fig. 3 I), *Kedoesporis livnensis* (Naum.) Obukh. (3.1%), *K. angulosus* (Naum.) Obukh., *Stenozonotriletes conformis* Naum., *S. simplex* Naum., *S. definitus* Naum., *S. conspersus* Naum., *S. extensus* Naum. var. *major* Naum., *S. pumilus* (Waltz) Naum., *S. simplicissimus* Naum., *S. calamites* Naum., and *S. formosus* Naum. The species of the genus *Kedoesporis* dominates this assemblages reaching up to 6% in some samples. Small and medium-sized miospores with simple sculpture are also present including *Leiotriletes microrugosus* (Ibr.) Naum., *Calamospora minutissima* (Naum.) Lub. and *Punctatisporites solidus* (Naum.) Byvsch. Miospores with the contact area *Retusotriletes communis* Naum., *R. simplex* Naum., *R. pychovii* Naum., and

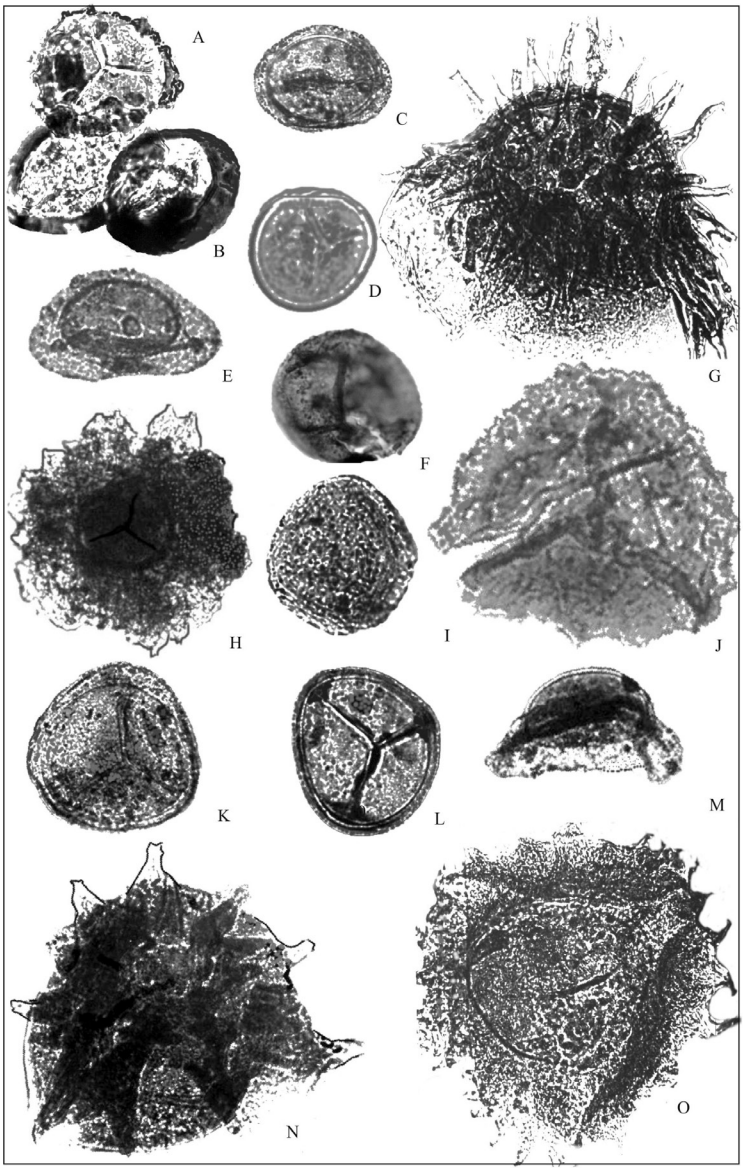

Figure 3. **Frasnian miospore assemblages from Latvia. A-O, miospores from the Daugava RS: A, *Verrucosisporites scurrus* (Naum.) McGreg. et Camf.; B, *Archaeozonotriletes variabilis* Naum.; C, *Archaeoperisaccus ovalis* Naum.; D, *Stenozonotriletes formosus* Naum.; E, *Archaeoperisaccus concinnus* Naum.; F, *Apiculiretusispora verrucosa* (Caro-Moniez) Streel; G, *Archaeotriletes comspicuus* Naum.; H, *Ancyrospora laciniosa* (Naum.) Mants.; I, *Convolutispora subtilis* Owens; J, *Calyptosporites krestovnikovii* (Naum.) Oshurk.; K, *Geminospora micromanifesta* (Naum.) Arkh.; L, *G. nalivkinii* (Naum.) Obukh.; M, *Archaeoperisaccus mirus* Naum.; N, *Ancyrospora fidus* (Naum.) Obukh.; O, *Hymenozonotriletes argutus* Naum. VSU, no. L2011/29-31.**

Verruciretusispora semilucensa (Naum.) Oshurk. are more abundant in the deposits from the Pskov region than in the samples from Latvia.

Ozoliņa (1963) described the miospore assemblage III from the deposits of the Daugava Fm, which was characterized by the reduced regular structure with prevalence of such genera as *Stenozonotriletes*, *Verrucosisporites* and *Lophozonotriletes*. This assemblage differs from the miospore assemblage established by the authors of this work. The comparison of the Daugava miospore assemblage with that from the Semiluki RS of the CDF (Raskatova L. 1969) demonstrates that most of the species are common and *Geminospora* and *Stenozonotriletes* dominate the miospore assemblages of both units. However, there are less miospores belonging to *Stenozonotriletes* and zonal index *Perotrilites donensis* (10.4%) dominates in the Semiluki miospore assemblage, whereas this zonal index is absent in the Daugava assemblage. Miospores with contact area are widely represented in both units by such species as *Retusotriletes communis* Naum., *R. pychovii* Naum. and *Verruciretusispora semilucensa* (Naum.) Oshurk. Miospores with verrucate ornamentation are more diverse on a species level in the Semiluki RS than in the Daugava RS, but the dominant species for both units is *Converrucosisporites curvatus* (Naum.) Turnau (1.9%). Thus the miospore assemblage from the Daugava RS shows the change in species composition in time, corresponding to the two Frasnian zones: Geminospora semilucensa – Perotriletes donensis (SD) and lower portion of the Archaeoperisaccus ovalis – Verrucosisporites grumosus (OG) zone (Avkhimovitch *et al*. 1993).

The detailed palynological study of deposits of the **Katleši RS** from two boreholes no. 5 and 6 in Latvia and borehole no. 9 in Russia shows total absence of miospores in all samples. Some samples contained fragments of the changed dark matter.

The Pamūšis RS (Ogre Fm) is characterized by miospores showing considerable variety and good preservation. Miospores of the Pamūšis RS were studied from two boreholes no. 5 and 13 in Latvia. The miospore assemblage from the Pamūšis RS is characterized by abundant species of the genus *Geminospora*: *G. rugosa* (Naum.) Obukh. (12%), *G. compacta* (Naum.) Obukh. (4%), *G. semilucensa* (Naum.) Obukh. et M.Rask. (4%), *G. notata* (Naum.) Obukh. (4%), as well as by a significant presence of the genus *Archaeoperisaccus*: *A. mirus* Naum. (6%), *A. echynatus* Rask. (3%), *A. ovalis* Naum. (2%), *A. menneri* Naum. (2%), and *A. mirandus* Naum. (1%). Spores of *Cyclogranisporites rugosus* (Naum.) Oshurk. (6%), *Tuberculispora perspicua* (Naum.) Oshurk. (5%), *Retusotriletes communis* Naum. (4%), *Stenozonotriletes definitus* Naum. (4%), *S. simplicissimus* Naum. (3%), *S. pumilus* (Waltz.) Naum. (3%), *S. conformis* Naum. (2%), *Hymenozonotriletes argutus* Naum. (1%), *Kedoesporis evlanensis* (Naum.) Obukh. (2%), *Lophozonotriletes torosus* Naum. (3%), *Verrucosisporites grumosus* (Naum.) Obukh. (2%) (Fig.4 A-G, L) are also present. Simple miospores without sculpture and ornamentation of exine are also present in significant amounts: *Calamospora microrugosa* (Ibr.) Schopf, Wilson et Bentall (6%), *Calamospora atava* (Naum.) McGregor (2%), *Leiotriletes laevis* Naum. (5%), *L. simplex* Naum. (4%). At the same time there are a lot of acritarchs (36%) in the samples from this interval. Their maximum corresponds to the depth of 38.5 m in borehole no. 5, where the forms of small size with a smooth, scabrate, or spiny exine sculpture belonging to the genera *Leiosphaeridia, Lophosphaeridium,*

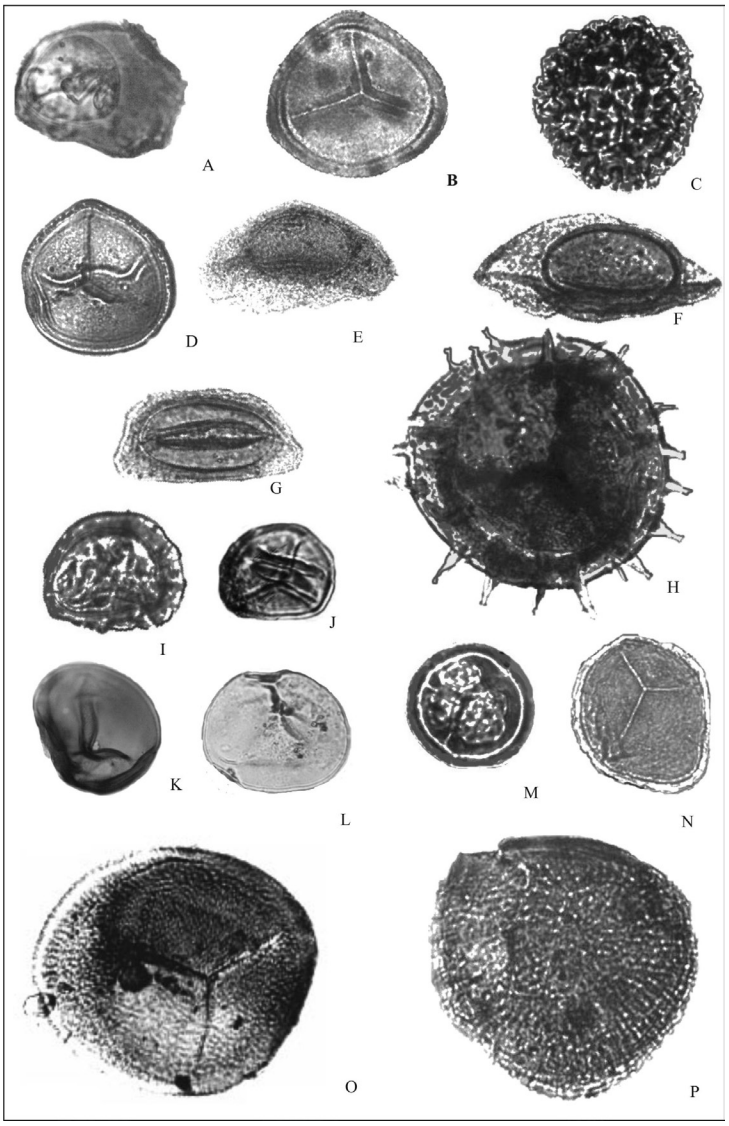

Figure 4. **Frasnian miospore assemblages from Latvia. A-G, K-L, O, miospores from the Pamūšis RS: A, *Cyrtospora expleta* Arkh.; B, *Geminospora semilucensa* (Naum.) Obukh. et M.Rask.; C, *Convolutispora crassitunicata* (Obukh.) Obukh.; D, *Geminospora notata* (Naum.) Obukh.; E, *Archaeoperisaccus mirandus* Naum.; F, *A. menneri* Naum.; G, *A. concinna* Naum.; L, *Calamospora* cf. *atava* (Naum.) McGregor; O, *Geminospora macromanifesta* (Naum.) Owens. VSU, no L2011/32-33. K, microspore from uncoordinated sporangium: *Stenozonotriletes laevigatus* Naum. VSU, L2011/32mc. H-J, M-N, P, miospores from the Stipinai RS: H, *Hystricosporites* cf. *grandiusculus* (Kedo); I, *Tholisporites densus* McGreg.; J, *Kedoesporis evlanensis* (Naum.) Obukh.; M, *Retusotriletes pychovii* Naum.; N, *Diaphanospora rugosa* (Naum.) Byvsch.; P, *Membrabaculisporis radiatus* (Naum.) Arkh. VSU, no L2011/35.**

Micrhystridium predominate. The remains of uncoordinated sporangium were found in the borehole no. 13. This sporangium contains acavate zonate microspores (Fig. 4 K) of small size (35-40 μm), without sculpture. These microspores are similar to the dispersed taxon *Stenozonotriletes laevigatus* Naum.

The comparison of the Pamūšis miospore assemblage from Latvia and miospore assemblage XV from the Lower Voronezh RS of CDF (Raskatova L. 1975) shows that the content of the species in the dominant genus *Geminospora* in both assemblages is nearly the same: *G. rugosa* (12%), *G. compacta* (4%) and *G. semilucensa* (1.5-2%). In general proportions of species belonging to the genus *Archaeoperisaccus* are similar: *A. mirus* Naum. (6% and 2.1% respectively), *A. ovalis* Naum. (2 % and 2.1%), *A. menneri* Naum. (2% and 1.4%). A typical feature of these two assemblages is the presence of the index species of the genus *Archaeoperisaccus* representing the OG zone of the Middle Frasnian. The miospore assemblage from the Pamūšis RS corresponds to the middle portion of the Archaeoperisaccus ovalis – Verrucosisporites grumosus (OG) zone.

S.N. Starikova (Sorokin 1978) has allocated the miospore assemblage for the lower part of the Pamūšis RS (Lielvārde Member; Mb) near Lielvārde, Latvia. This assemblage is characterized by the abundant species of the genus *Archaeoperisaccus*, that allowed compare this member with the Petino Fm of the CDF. During this study this assemblage was not found in the sections of boreholes no. 5 and no. 13. Basing on the lithology and miospore assemblage documented in the two boreholes (8 samples were taken in the interval from 83.7 to 37.1 m, borehole no. 5; 7 samples were taken in the interval from 91.2 to 56.3 m, borehole no. 13), it can be assumed that the Lielvārde Mb is absent in the studied sections.

Ozoliņa (1963) provided a uniform miospore assemblage for the whole Ogre Fm which is characterized by the great diversity of species in the genera *Calamospora*, *Retusotriletes*, *Geminospora*, *Stenozonotriletes*, *Archaeoperisaccus*, and *Verrucosisporites*. This assemblage corresponds to the Pamūšis miospore assemblage established by the authors of this paper, which demonstrate a considerable diversity in the genera *Geminospora*, *Stenozonotriletes* and *Archaeoperisaccus*.

The miospore assemblage of the Pamūšis RS is compared with the miospore assemblages XIV of Belarus (Golubtsov *et al*. 1975) and miospore assemblages XIV – XV of the CDF (Smirnova 1974; Raskatova L. 1975). It is necessary to note that the miospore assemblage from the Pamūšis RS can be attributed to the Archaeoperisaccus mirus – Diducites radiatus (MR) regional zone which has been established for the Voronezh RS in Belarus (Obukhovskaja *et al*. 2005).

Miospores of the **Stipinai RS** were studied from borehole no. 5 in Latvia. This miospore assemblage is characterized by the dominance of species of the genus *Geminospora*: *G. rugosa* (Naum.) Obukh. (7%), *G. compacta* (Naum.) Obukh. (6%), *G. micromanifesta* (Naum.) Arkh. (4%), and *G. semilucensa* (Naum.) Obukh. et M. Rask. (2%). Other genera are represented by approximately the same percentage of the species: *Membrabaculisporis radiatus* (Naum.) Arkh. (2%), *Diaphanospora rugosa* (Naum.) Byvsch. (3%), *Stenozonotriletes conformis* Nuam. (4%), *S. definitus* Naum. (3%), *Tholisporites densus* McGreg (2%), *Verrucosisporites grumosus* (Naum.) Obuch. (2%), *Converrucosisporites curvatus* (Naum.) Turnau (3%),

L. grumosus (Naum.) Sull. (2%), *Retusotriletes communis* Naum. (4%), *R. pychovii* Naum. (4%), *Cyclogranisporites rugosus* (Naum.) Oshurk. (5%), *C. rotundus* (Naum.) Oshurk. (2%), *Kedoesporis evlanensis* (Naum.) Obukh. (7%), and *Hystricosporites* cf. *grandiusculus* (Kedo) (3%) (Fig.4 H-J, M-N, P,). Simple miospores without sculpture and ornamentation of exine are also present in the miospore assemblage: *Calamospora minutissima* (Naum.) Lub. (7%), *C. atava* (Naum.) McGregor (3%) and *Punctatisporites solidus* (Naum.) Byvsch. (3%). Small acritarchs (30%) with a smooth exine belonging to the genera *Leiosphaeridia*, *Trachysphaeridium*, *Baltisphaeridium*, and *Yranomarginata* have been found within the assemblage from the depth 34.7 m. *Archaeoperisaccus* is not presented in the material of this study from the Stipinai RS, what can be explained by a small number of the studied samples, although the corresponding stratigraphic level in other regions is characterized by a steady enough presence of the species of this genus.

The first (I) miospore assemblage allocated for the Bauska Beds and the Amula RS in western Latvia by Ozoliņa (1963) contains small quantity of miospores thus differing from the miospore assemblages from the Upper Frasnian deposits of the CDF.

The Stipinai miospore assemblage has been compared with the miospore assemblage XVI of the CDF (Raskatova 1975), which was established for the Upper Voronezh RS of the Upper Frasnian of the East European Platform. The miospore assemblage from the Stipinai RS is characterized by the appearance of *Membrabaculisporis radiates* (index species of the MR subzone) and species such as *Diaphanospora rugosa* (Naum.) Byvsch., *Kedoesporis livnensis* (Naum.) Obukh., and *Verrucosisporites grumosus* (Naum.) Obuch., which are typical for the Auroraspora speciosa (AS) subzone. This subzone characterizes the Evlanovo RS. As it was already noted for the Pamūšis RS the miospore assemblage from the Stipinai RS can be referred to the MR regional zone which was allocated in Belarus (Obukhovskaja *et al*. 2005).

Conclusions

Miospore assemblages, zones and subzones are of a great importance in modern international and regional scales. There is not enough material to trace all miospores zones and subzones in the Upper Devonian deposits of Latvia, but the first steps have been already made. In this study five miospore assemblages characteristic for the Pļaviņas, Dubnik, Daugava, Pamūšis and Stipinai RS, Frasnian deposits of Latvia has been allocated, and the attempt to identify miospore zones and subzones for the deposits of the Pļaviņas, Dubnik, Daugava, Pamūšis and Stipinai RS has been made.

Previous researchers have described only miospore assemblages, based on the studies carried out in the middle and second half of the 20th century when the zonal miospore biostratigraphy of the Devonian has only started to develop. Compared with the studies of Ozoliņa (1963), in this study each regional stage for the first time is characterized by a separate miospore assemblage.

One subzone BI (Acanthotriletes bucerus – Archaeozonotriletes variabilis insignis) and two miospore zones, SD (Geminospora semilucensis – Perotriletes

donensis) and OG (Archaeoperisaccus ovalis – Verrucosisporites grumosus), have been identified according to the miospore zonation of the Frasnian Stage of the East European Platform. Regional zone MR (Archaeoperisaccus mirus – Diducites radiatus), first described from the Voronezh RS of Belarus (Obukhovskaja *et al*. 2005), has been traced within the Pamūšis and Stipinai regional stages. The miospore assemblage of the Pamūšis RS is compared to the miospore assemblage XIV of Belarus (Golubtsov *et al*. 1975) and miospore assemblages XIV–XV of the CDF (Smirnova 1974; Raskatova L. 1975).

Acknowledgements

We thank Ervins Lukševičs for advices and attention to our research.

The research was supported by Russian Foundation for Basic Research, project N11-04-01604a.

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