Annales de la Société géologique de Belgique, T. 115 - fasc. 2 - 1992, pp. 519-529 Juin 1993

PALYNOLOGICAL CHARACTERISTICS OF THE LOWER PART OF THE CARBONIFEROUS OF THE CENTRAL REGION OF THE RUSSIAN PLATFORM.

by

Tamara V. BYVSHEVA[1] & Nina I. UMNOVA[2]

(4 figures and 1 plate)

ABSTRACT. - The palynology of boreholes through the lower part of the Carboniferous and the latest Devonian in the central part of the Russian Platform has been studied. The late Devonian Khovansky Series contains spores of the *Retispora lepidophyta - tenera* (Ltn) Subzone of the *Retispora lepidophyta* (L) Zone. The Coupavninsky suite, which is locally developed and rests disconformably on the Khovansky Series, contains spores of the *Vallatisporites pusillites - Bascaudaspora mischkinensis* (PMi) Subzone of the *Vallatisporites pusillites* (P) Zone. *Retispora lepidophyta* is not found at this horizon. The overlying Malevsky suite contains spores of the *Tumulispora malevkensis* (M) Zone. The succeeding Upinsky suite contains spores of the *Grandispora upensis* (U) Zone. There is no representation in the central region of the Russian Platform of the PM and PLE Subzones of the P Zone which occur elsewhere below the M Zone. They are cut out at the boundary between the Khovansky Series and the Coupavninsky suite. The PMi Subzone and the M Zone are correlated with the VI Zone of Western Europe. A new species, *Stenozonotriletes auriculatus* Umnova sp. nov., is described. (Editors)

INTRODUCTION

According to the unified stratigraphical scheme for the Carboniferous formations of the Russian Platform agreed in 1988, the Humerovsky horizon is the lowest stratigraphical division of the Carboniferous. Together with the Malevsky and Upinsky horizons, it forms the Khaninsky supra-Horizon. The data presented below have been obtained from borehole sections on the southern rim of the Moscow Syneclise: in the Moscow, Kaluga, Tula, Bryansk and Smolensk areas (Fig. 1). In this region the Khaninsky series, consisting of the Coupavninsky (analogous to the Upper Humerovsky horizon), Malevsky and Upinsky suites, lie disconformably on the late Devonian Khovansky suite. The Coupavninsky and Malevsky suites consist of calcareous mudrock with intercalations of argillaceous limestone. The lower part of these formations, known only in a few sections, consists of limestone "with *Bisphaera*", with thinly bedded, black mudrock at its base (the so called *Bisphaera* beds). This unit of limestone and black mudrock was formerly referred to as the lower Malevsky subsuite (Makhlina *et al.*, 1986); but has since been named the Coupavninsky suite (Makhlina *et al.*, 1988). Its thickness ranges from 0.1 to 0.4 m. Blue green mudrock with intercalations of limestone, formerly referred to the Upper Malevsky subdivision, now comprises the Malevsky suite. The thickness of the latter ranges from 10 to 12m. The Coupavninsky and Malevsky suites are characterised by both macro- and microfossils and by plant spores (Makhlina *et al.*, 1988).

In the unified stratigraphical scheme for the Carboniferous formations of the Russian Platform, agreed in 1951, the lowest subdivision of the Carboniferous - the Malevsky Horizon - was reported to be characterised by spore assemblages with large numbers of *Tumulispora malevkensis* (according to S.N. Naumova - 23rd spore complex from the Malevsky Horizon in the Tula region). The boundary

1 *VNIGNI, Moscow.*
2 *PGO "Geological Centre" Moscow.*

Fig. 1.- Location of boreholes discussed in the text.

between the Devonian and the Carboniferous in the 1951 scheme corresponded exactly to the boundary recognised at the Heerlen Congress (1935) at the base of the *Gattendorfia* Genozone. In the 1962 version of the unified stratigraphical scheme for the Carboniferous formations of the Russian Platform, strata within the lower part of the Malevsky Horizon were shown as containing abundant *Vallatisporites pusillites*. However, despite the opinions of palynologists, the boundary between the Devonian and Carboniferous System in the 1962 Scheme was designated at the level of the base of the Zavolzhsky horizon, which corresponds to the base of the *Wocklumeria* Genozone. Thus, in the 1962 scheme, in the central regions of the Russian Platform, the lower part of the Malevsky Horizon is characterised by spore assemblages with *Vallatisporites pusillites* and its upper part, by assemblages with *Tumulispora malevkensis*. Strata with *Vallatisporites pusillites,* judging from numerous borehole sections studied, are sporadically developed (Umnova, 1971). According to N.I. Umnova, V.T. Umnova, and L.G. Raskatova, a large number of the sections comprehensively studied in this region contain only assemblages with *Tumulispora malevkensis.* Spores of the *Vallatisporites pusillites* complex do not occur in the Volga region around Volgograd (Nazarenko, 1986).

In subsequent years, the palynological characterisation of strata on either side of the Devonian/Carboniferous boundary has been essentially completed and their division on the basis of spores has been made in some detail; thus Zones and Subzones have been established (Fig. 2). At the palynological colloquium held in Minsk in December 1984, the *Vallatisporites pusillites* (P) Zone was divided into three Subzones, distinguished by their content of the species *Retispora lepidophyta* and *Tumulispora malevkensis* compared with the abundant concentration of *Vallatisporites pusillites.* The lower *Vallatisporites pusillites - Retispora lepidophyta - Hymenozonotriletes explanatus* Subzone (PLE), with abundant *Retispora lepidophyta,* was established in the Udmurtsky beds in the eastern region of the Russian Platform and the Lower Kalinovsky beds (Kl_1) in the Pripyat Basin. The middle *Vallatisporites pusillites - Tumulispora malevkensis - Retispora lepidophyta* Subzone (PML) includes rare *Retispora lepidophyta* in the Upper Kalinovsky beds (Kl_2) in the Pripyat Basin. The upper *Vallatisporites pusillites -Tumulispora malevkensis* Subzone (PM), which does not contain *Retispora lepidophyta,* was recognised in the central regions of the Russian Platform (Bogoslovsky *et al.*, 1985, p.72).

In this paper, the P Zone is divided into two (Fig. 2). The middle PML Subzone and the upper PM Subzone are united into a single PM Subzone (Avchimovitch, 1986, Byvsheva, 1986, Byvsheva *et al.*, 1986, 1988). It should be appreciated, however, that as a result of this amalgamation of Subzones, the precision of the divisions of the P Zone is lost, and the labelling of the new Subzones does not draw attention to the occurrence of the species *Retispora lepidophyta* (in its variety *minor*), which is normally characteristic of sections in the P Zone in the Pripyat Basin. With such a division of the P Zone, it should be noted that some strata in the upper PM Subzone do not contain *Retispora lepidophyta* (in the central regions) or contain very small proportions of this species (in the Pripyat Basin). Despite these differences, the PM Subzone in the Pripyat Basin is characterised by a noticeable increase in the proportion of *Tumulispora malevkensis* in parallel with the continuation of the great abundance of *Vallatisporites pusillites*, a feature which is not seen in the central region.

The naming of the miospore Zones around the Devonian/Carboniferous boundary in the palynological scheme for western Europe has accorded the species *Retispora lepidophyta* considerable significance. In relation to this, a three fold division of the P Zone was proposed at the palynological symposium held in Moscow (January 1987) at which foreign specialists attended. As a result of this work, the PM Subzone of the Pripyat Basin (Upper Kalinovsky - Velizhsky beds) was equated with the upper part of the LN Zone. The PM Subzone of the central regions (Coupavninsky suite) received as an index *Vallatisporites pusillites - Bascaudaspora mischkinensis* (PMi). This Subzone and the M Zone have been compared with the VI Zone of western Europe (Byvsheva 1984, 1986, Byvsheva *et al.*, 1984, Bogoslovsky *et al.*, 1985, Avchimovitch *et al.*, 1988).

RUSSIAN PLATFORM									WESTERN EUROPE
SYSTEM	HORIZON	MIOSPORE ZONE	BYVSHEVA in BOGOLOSVSKY et al. 1985		BYVSHEVA et al. 1986,1988		AVCHIMOVITCH et al., 1988		BYVSHEVA et al. 1984 AVCHIMOVITCH et al. 1988
CARBONIFEROUS	MALEVSKY	M	M		M		M		VI
	HUMEROVSKY	P	P	PM	P	PM	P	PM	
				PML				PML	LN
				PLE		PLE		PLE	

Fig.2.- Lowermost Carboniferous spore zones of the Russian Platform and their correlation with Western Europe

PALYNOSTRATIGRAPHY

The characteristics of the complexes of zonal spores of both the PMi Subzone (of the P Zone) and of the M Zone are described below from a few sections. These include stratotypes from various regions of the Russian Platform and extend into younger formations. In previous publications of data from this region, only the spore complex of the M Zone has been examined: the publications were based on examination of the Michaïlovsk (71) borehole (Aristov, 1981); the Vorobievsk borehole (Rodionova & Umnova, 1984); the Glubokovsk 1-K (124957) borehole (Byvsheva, 1984, Makhlina *et al.*, 1988); and the Moninsk borehole (Makhlina *et al.*, 1988).

The Coupavninsky and Malevsky suites in the sections studied (Fig.3) are well differentiated lithologically - they are argillaceous rocks. At their base they rest on thick limestones or marls of Khovansky age; at their top, they are succeeded by limestones of the Upinsky horizon. In numerous sections, the limestone "with *Bisphaera* " has not been encountered; its presence in the M Zone or PMi Subzone has always been debated, because of inadequate study. The occurrence of the limestone "with *Bisphaera* " in the Glubokovsk borehole, where it contains spores assigned to the M Zone (Byvsheva, 1984), has been re-established by M. Kh. Makhlina. In the Moninsk borehole, in the interval 373 - 381.3 m spanning the Coupavninsk and Malevsky suites, *Bisphaera malevkensis* Birina, *Earlandia minima* (Birina), *Earlandia elegans* (Rauser & Reitlinger), *Vicinisphaera* sp., and *Parathurammina* sp. have been identified.

In the Glubokovsk 1-K borehole, the Malevsky suite contains, in addition to foraminiferans, *Patrognathus crassus* (Kononova & Migdisova), *Bispathodus aculeatus plumulus* (Rhodes, Austin & Druce) as well as *Carbonita malekvensis* Posner, *Shivaella microphylla* (Eichwald), etc. (Makhlina *et al.*, 1988). A remarkable transition between the spore complexes of the PMi Subzone and those of the M Zone has been observed in a homogenous bed of dark grey mudstone, dense, plastic and sandy at its base, in the Novoskakovsk 11 borehole. The interval sampled is 0.4m thick. A similar transition has been recognised in the Moninsk borehole, where the unit of

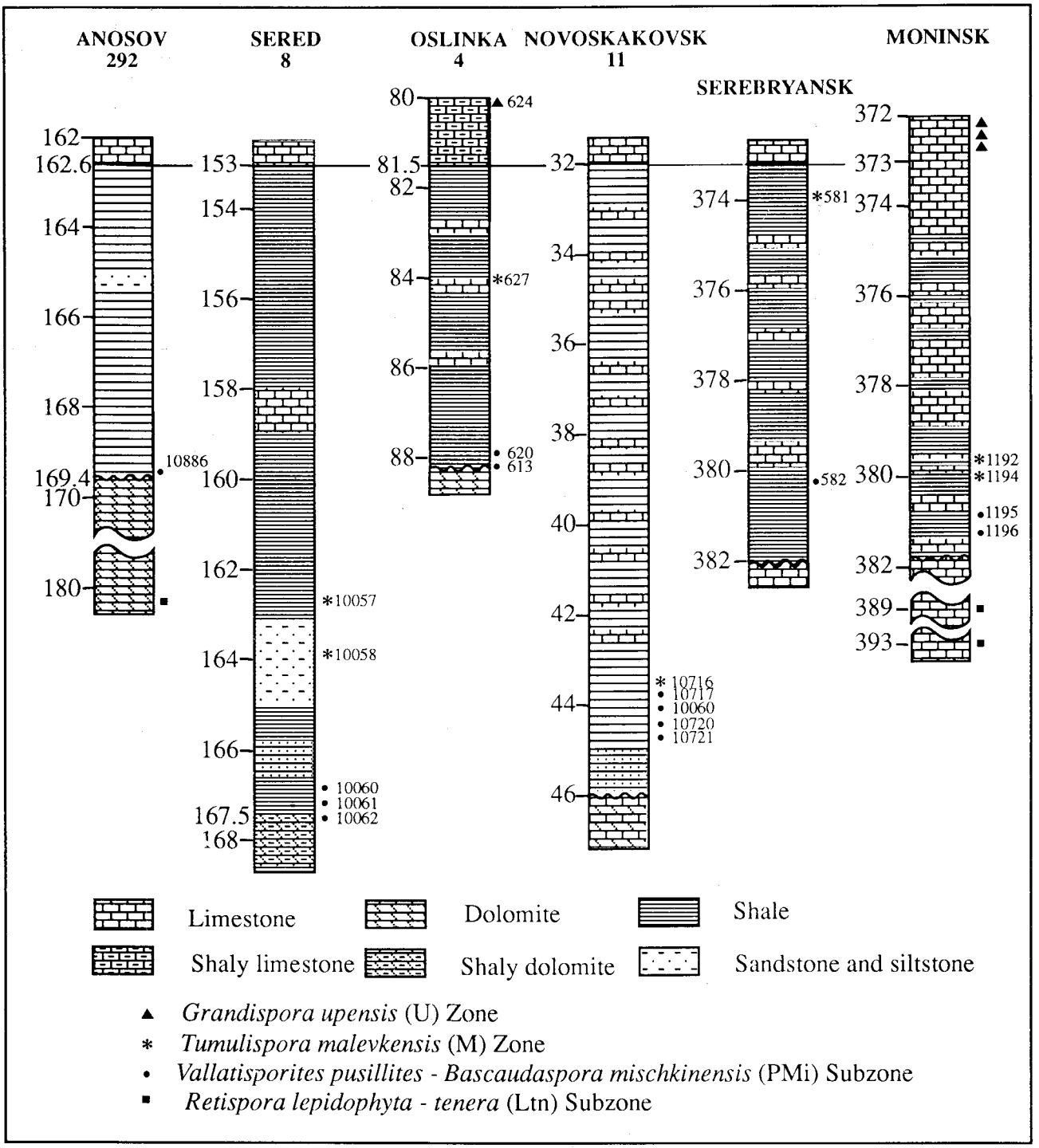


Fig. 3.- Comparison of the sections of the Coupavninsk and Malevsky suites of the central parts of the Russian Platform. See fig. 1 for locations.

dark grey mudstone, interbedded on a fine scale with lenses of limestone breccia, changes towards the top into limestone and blue green mudstone (the interval sampled is 0.7m thick). This section is the stratotype section of the Coupavninsk suite (the interval from 380 to 381.7 m). In the other boreholes, the samples with spore complexes of the PMi Subzone and of the M Zone were collected at much wider intervals than those in the Novoskakovsk and Moninsk boreholes (Fig. 3).

As can be seen in the diagram illustrating the percentages of spore taxa present (Fig. 4), the spore complexes of the PMi Subzone and the M Zone are closely comparable in their composition of species. The distinction between the zones is based on the change in dominance of the species *Vallatisporites pusillites* (interpreted in a broad sense, which would include *Vallatisporites hystricosus* Winslow) and *Tumulispora malevkensis*. In the spore complex of the PMi Subzone, the proportion of the first species, *V. pusillites*, varies from 6 to 58% (rarely it can be between 1 and 2%); in the M Zone, in contrast, its content is reduced to the point of total disappearance. The percentages of the second species, *Tumulispora malevkensis*, are insignificant in the spore complexes of the PMi Subzone (0-6%), but increase significantly in the complexes of the M Zone, attaining 12-30%. In the M Zone of the Sered 8 borehole (samples 10058 and 10057), the zonal species has not been found. The proportion of the species *Vallatisporites pusillites* in the PMi Subzone in this borehole (samples 10062, 10060) varies from 2 to 42%, and in the Novockakovsk 11 borehole (samples 10721 - 10717) from 1 to 13-32%.

In several sections in the PMi Subzone, the proportion of *Bascaudaspora mischkinensis* (Byvsheva) Byvsheva increases sporadically (the Anosov 232 borehole, sample 10886 - 28%; the Oslinka 4 borehole, sample 620 - 30%). This species is found as well in formations above those assigned to the M Zone. Except for the species mentioned above, the spore complexes of the PMi Subzone and of the M Zone of the central regions of the Russian Platform are characterised by the following taxa which are common to both: *Stenozonotriletes*, *Punctatisporites*, *Auroraspora*, *Cyclogranisporites* (*Trachytriletes*), *Lophozonotriletes*. The following occur sporadically and in smaller numbers: *Dictyotriletes trivialis* Kedo, *Convolutispora major* (Kedo) Turnau, *Reticulatisporites glumaceus* (Byvsheva) Byvsheva, *Cyrtospora cristifera* (Luber) Van der Zwan, *Pulvinispora scolecophora* Neves & Ioannides.

The species *Cymbosporites minutus* (Kedo) Avchimovitch & Streel and *Rugospora radiata* (Kedo) Byvsheva have also been found. They are commonly characteristic of older beds around the Devonian/ Carboniferous boundary that are absent in the central region. The species *Stenozontriletes auriculatus* Umnova sp. nov. (Plate 1, fig. 8) is found essentially in the basal part of the section in the PMi Subzone. However it is rare and its use in making a qualitative division of the assemblage of the PMi Subzone is very problematical. This species has a rounded triangular outline, a narrow cingulum, a smooth exine, and long sutures that reach the inner edge of the cingulum. The diameter of the spore ranges from 34 to 52μm; the width of the cingulum ranges from 3 to 6μm. Spores of this species, as a rule, are preserved not in polar compression; as a consequence, two of the sutures enclose a more or less straight interradial margin; the two other interradial margins are convex to rounded. This species is distinguished from other species of the genus *Stenozonotriletes* by the way that the ends of the two sutures overlie the cingulum, giving rise to the so called "auricles". The content of spores of this species in the samples is not very great - up to 3% (8% in the Moninsk Borehole sample 1196) - and in some samples no specimens have been found. The palynological characteristics of the Coupavninsky and Balievsky suite described above are repeated in many sections in the central region of the Russian Platform even though the lowest part, the PMi Subzone, as shown above, is present only locally in comparison with the upper part, the M Zone. Neither the species *Retispora lepidophyta*, nor any of its varieties, has been found in the PMi Subzone in any of the sections studied.

The lower formations, of the Khovansky Series, are characterised by the spore complex of the *Retispora lepidophyta-tenera* (Ltn) Subzone of the *Retispora lepidophyta* (L) Zone. In the Anosov 292 borehole, at a depth of 182.5m in pale grey dolomite, the following taxa occur : *Retispora lepidophyta* (Kedo) Playford (2.5%), *Retispora lepidophyta* var. *tenera* (Kedo) (11%), *Retispora lepidophyta* var. *minor* (Kedo) (5.5%), *Knoxisporites dedalus* (Naumova) Moreau-Benoit (5%), *Diaphanospora rugosa* (Naumova) Byvsheva (10%), *Tumulispora malevkensis* (Kedo) Turnau (0.5%), *Punctatisporites* spp. (2.5%), *Stenozonotriletes* spp. (2.5%), *Cyclogranisporites* spp. (18.5%), and *Auroraspora* spp. (8%). A similar assemblage of spores has been found in the Moninsk borehole at a depth of 136.4m, in the lower part of the Khovansky Series (Makhlina *et al.* 1988).

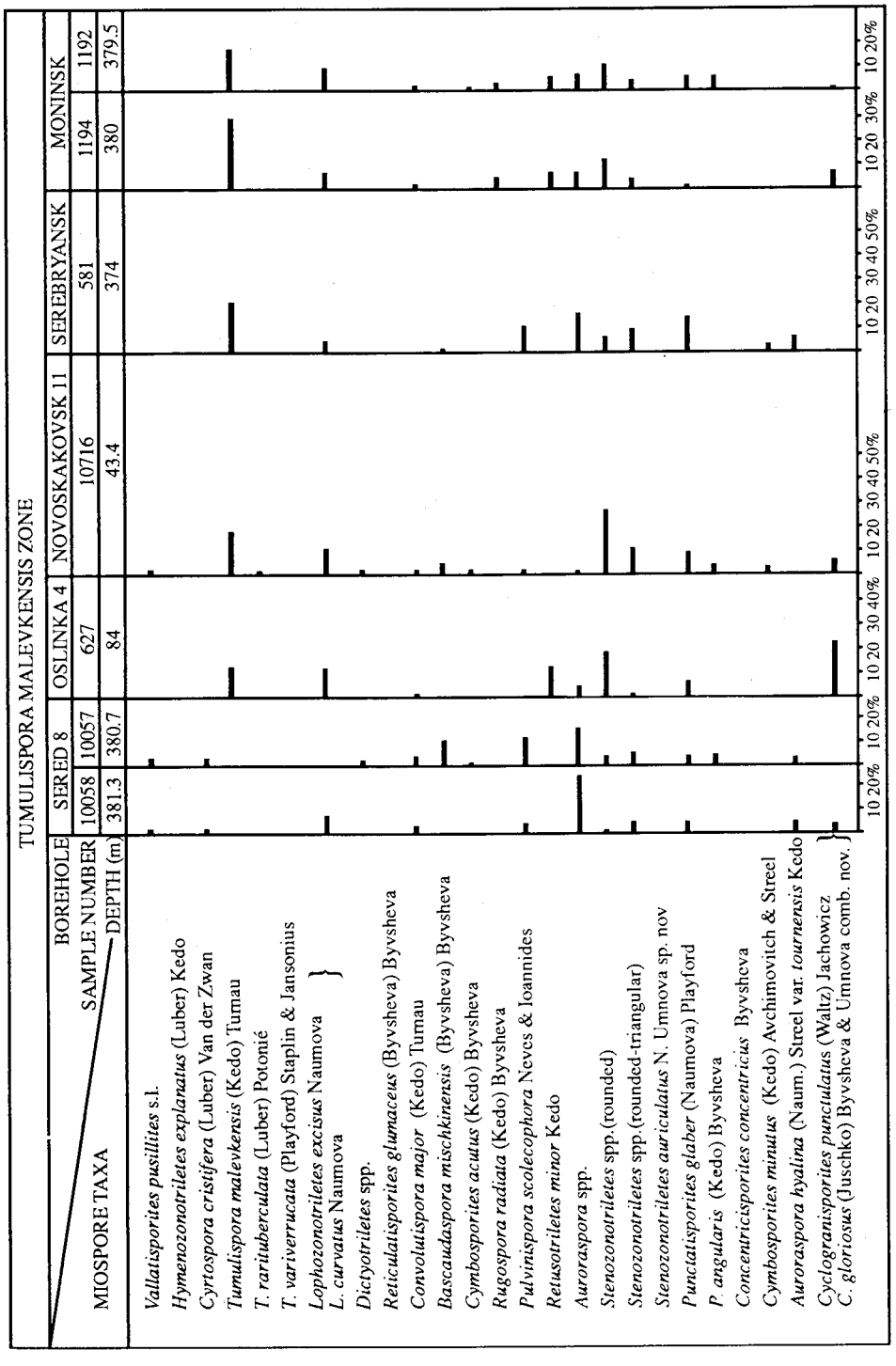


Fig. 4a

Fig. 4.- Content of spores (in percent) in the PMi Subzone and the M Zone of the central part of the Russian Platform.

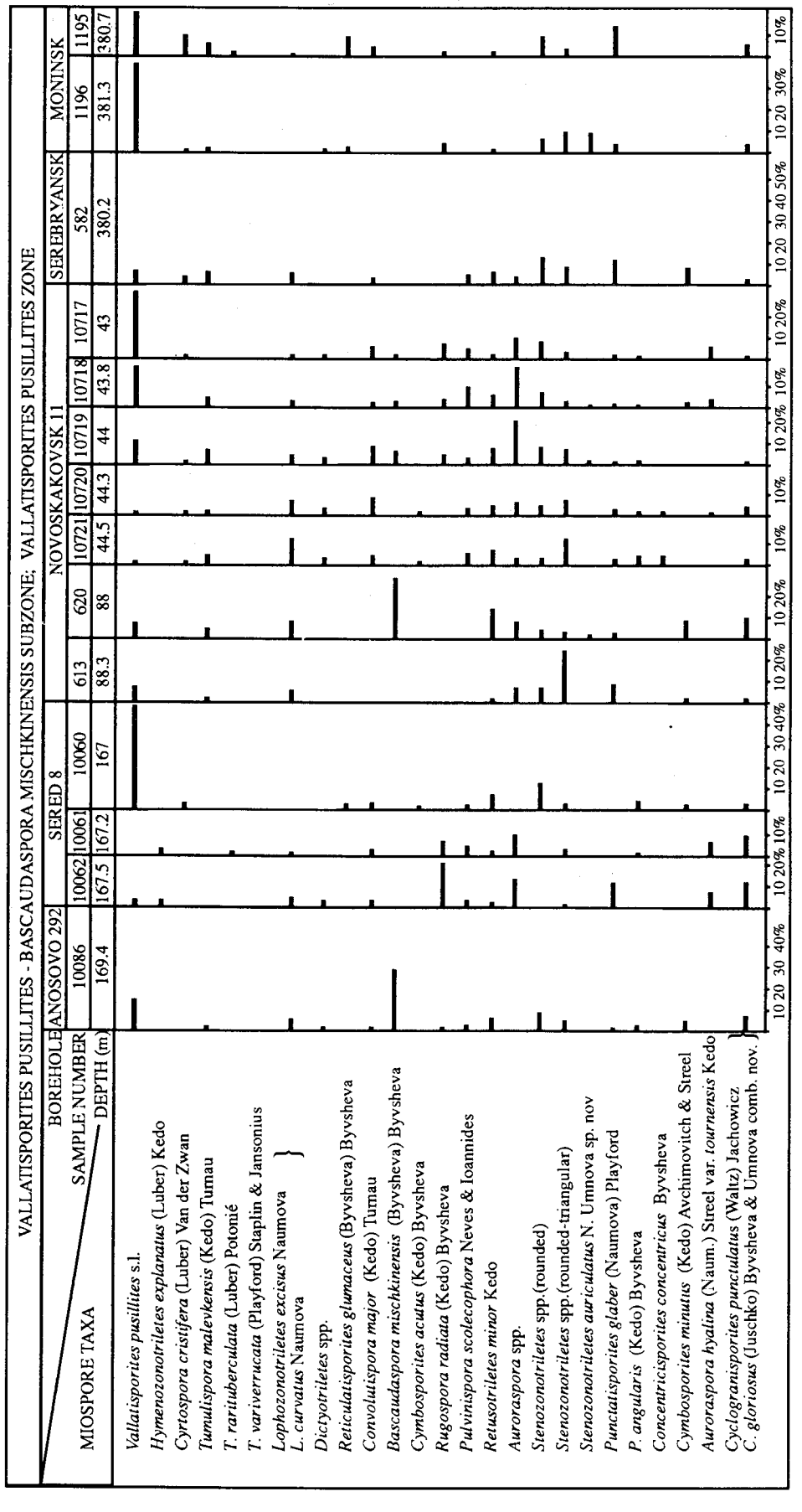

VALLATISPORITES PUSILLITES - BASCAUDASPORA MISCHKINENSIS SUBZONE; VALLATISPORITES PUSILLITES ZONE
BOREHOLE
SAMPLE NUMBER
DEPTH (m)
MIOSPORE TAXA
ANOSOVO 292
10086
169.4
SERED 8
10062
167.5
10061
167.2
10060
167
613
88.3
620
88
NOVOSKAKOVSK 11
10721
44.5
10720
44.3
10719
44
10718
43.8
10717
43
SEREBRYANSK
582
380.2
MONINSK
1196
381.3
1195
380.7
Vallatisporites pusillites s.l.
Hymenozonotrileles explanatus (Luber) Kedo
Cyrtospora cristifera (Luber) Van der Zwan
Tumulispora malevkensis (Kedo) Tumau
T. rarituberculata (Luber) Potonié
T. variverrucata (Playford) Staplin & Jansonius
Lophozonotrileles excisus Naumova
L. curvatus Naumova
Dictyotrileles spp.
Reticulatisporites glumaceus (Byvsheva) Byvsheva
Convolutispora major (Kedo) Tumau
Bascaudaspora mischkinensis (Byvsheva) Byvsheva
Cymbosporites acutus (Kedo) Byvsheva
Rugospora radiata (Kedo) Byvsheva
Pulvinispora scolecophora Neves & Ioannides
Retusotrileles minor Kedo
Auroraspora spp.
Stenozonotrileles spp.(rounded)
Stenozonotrileles spp.(rounded-triangular)
Stenozonotrileles auriculatus N. Umnova sp. nov
Punctatisporites glaber (Naumova) Playford
P. angularis (Kedo) Byvsheva
Concentricisporites concentricus Byvsheva
Cymbosporites minutus (Kedo) Avchimovitch & Streel
Auroraspora hyalina (Naum.) Streel var. tournensis Kedo
Cyclogranisporites punctulatus (Waltz) Jachowicz
C. gloriosus (Juschko) Byvsheva & Umnova comb. nov.
10 20 30 40%
10 20% 10%
10 20 30 40%
10 20% 10%
10 20%
10%
10 20%
10%
10 20%
10%
10 20 30 40 50%
10 20 30%
10%

Fig. 4b

The spore complex of the overlying formations (the Upinsky horizon - *Grandispora upensis* (U) Zone) has been recognised in the Oslinka 4 and Moninsk boreholes. In the lowest intercalation of shale in the former at a depth of 80m, the assemblage includes a large proportion of *Auroraspora* spp. (*A. subgranulata* (Kedo) Byvsheva, etc.) - 20%; and forms with a coarse, scabrate ornament, *Cyclogranosporites punctulatus* (Waltz) Jachowicz and *C.* (formerly *Trachytriletes*) *gloriosus* (Juschko) Byvsheva & Umnova *comb. nov.* - 17%. The following spores occur in relatively small numbers : *Vallatisporites pusillites* (Kedo) Dolby & Neves *emend.* Byvsheva (3.5%); *Hymenozonotriletes explanatus* (Luber) Kedo (1.5%); *Tumulispora malevkensis* (Kedo) Turnau (3.0%); *Lophozonotriletes. excisus* Naumova (2%); *L. proscurrus* Kedo (3%), *Auroraspora flexuosa* (Juschko) Byvsheva (1.5%); *Stenozonotriletes* spp. (round forms 8%; triangular forms 4.5%); and *Punctatisporites glaber* (Naumova) Playford (2%). In addition to these, *Grandispora upensis* (Kedo) Byvsheva (2%) and *Grandispora echinata* Hacquebard (3%) have been found. In the Moninsk borehole, similar spore assemblages have been recognised within the Upinsky horizon in the interval 363.6-373 m.

These, then, are the palynological characteristics of the lower horizons of the Carboniferous of the central regions of the Russian Platform. The dark grey mudrocks at the base of the Carboniferous - the Coupavninsky suite - contain a much younger spore complex of the P Zone than in the Pripyat Depression. It is characterised by the presence of *Vallatisporites pusillites* s.l., *Bascaudaspora mischkinensis*, *Stenozonotriletes auriculatus*, and by the absence of *Retispora lepidophyta* and its varieties. The strata containing this spore complex are distinguished as the PMi Subzone of the P Zone. The blue, grey-green bed clays in the region containing the stratotype of the Malevsky horizon are characterised by a complex of spores of the M Zone. At the boundary between the Coupavninsk and Khovansky suites, the PM and PLE Subzones of the P Zone are cut out.

The specific composition of the spore complexes of the PMi Subzone and of the closely similar M Zone suggests their correlation with the VI Zone of Western Europe.

BIBLIOGRAPHY

ARISTOV, B. A., 1981.- The conodonts of the Devonian-Carboniferous boundary of the Russian Platform. *In*: Biostratigraphic research of the Devonian-Carboniferous boundary deposits: *Preprint SVK NII DVNTs USSR Academy of Sciences, Magadan*: 8pp. (in Russian).

AVCHIMOVITCH, V.I., 1986. - Palynological basis of the Devonian-Carboniferous boundary in the Pripyat Depression. The Devonian-Carboniferous boundary in the territory of the USSR. *Bel NIGRI. All Union conference materials, Minsk*:9-13. (in Russian).

AVCHIMOVITCH, V .I., BYVSHEVA, T. V., HIGGS, K., STREEL, M. & UMNOVA, V. T., 1988.- Miospore systematics and stratigraphic correlation of Devonian-Carboniferous boundary deposits in the European part of the USSR and Western Europe. *Cour. Forsch.-Inst. Senckenberg*, 100: 169-191.

BARSKOV, I .S., KONONOVA, L. I., MIGDISOVA, A .V., 1984. Conodonts of the Lower Tournaisian of the Moscow Basin. *In*: Paleontological characteristics and biostratigraphy of the reference sections of the Carboniferous deposits of the Moscow syneclise. Moscow: 3-27. (in Russian).

BOGOLOVSKY, B. I., BYVSHEVA, T. V., REITLINGER, E. A., *et al.*, 1985. - Problems of the division and correlation of the boundary formations and of the definition of the Devonian and the Carboniferous in the territory of the USSR: problems of the limit between the Devonian and Carboniferous in Eurasia. *SVK NII DVNTs USSR Academy Sciences, Magadan*: 56 -75.

BYVSHEVA, T. V.,1984. - The Malevsky horizon in the Russian Platform and its analogue in Western Europe. *In*: Biostratigraphic research of the Devonian-Carboniferous boundary deposits Russian Platform. *Preprint, SVK NII DVNTs USSR Academy Sciences Magadan*: 18-27. (in Russian).

BYVSHEVA, T. V., 1986. - Division and correlation of the boundary formations of the Devonian and Carboniferous of Eastern and Western Europe on the basis of spores. *In*: Key sections and correlation of the Devonian/Carboniferous boundary in Eurasia (with the participation of foreign authors). *SVK NII DVNTs USSR Academy Sciences, Magadan*: 147-155. (in Russian).

BYVSHEVA, T. V., AVCHIMOVITCH, V. I. & UMNOVA, H. I., 1986. The *Vallatisporites pusillites* Zone of the Lower Carboniferous and its analogues in Western Europe. The Devonian-Carboniferous boundary in the territory of the USSR. *Bel NIGRI. All Union conference materials, Minsk*: 30-32. (in Russian).

BYVSHEVA, T. V., HIGGS, K., & STREEL, M., 1984. - Spore correlation between the Rhenish Slate Mountains and the Russian Platform near the Devonian-Carboniferous boundary. *Cour.Forsch.-Inst. Senckenberg*, 67: 37-45.

BYVSHEVA, T.V., TCHIBRIKOVA, E.V., & AVCHIMOVITCH, V.I.,1988.- Steps in the development of the flora (from spores) at the boundary of the Devonian and Carboniferous. *In*: Golubtsov, V.K. *et al.* (eds). The Devonian-Carboniferous boundary in the territory of the USSR. *Minsk, "Nauka i Technika"* : 40-53. (in Russian).

MAKHLINA, M.H., JULITOVA, V.E., & GRIGORIEVA, A.D.,1986.- On the Malevsky and Upinsky horizons in their type regions. The Devonian-Carboniferous boundary in the territory of the USSR. *Bel NIGRI. All Union conference materials, Minsk*: 70-72. (in Russian).

MAKHLINA, M.H., RODIONOVA, G.D., UMNOVA, V.T., UMNOVA, N.I., BYVSHEVA, T. V., GRIGORIEVA, A.D., *et al.*, 1988.- The Devonian-Carboniferous boundary deposits of the central regions of the Russian Platform. *In*: Golubtsov, V.K. *et al.* (eds). The Devonian-Carboniferous boundary in the territory of the USSR. *Minsk, "Nauka i Technika"* : 78-87. (in Russian)

NAZARENKO, A. M., 1986. - The significance of the palynological researches of G.I. Kedo for the definition of the limit between the Devonian and Carboniferous in the regions around the Volga at Volgograd. The Devonian-Carboniferous boundary in the territory of the USSR. *Bel NIGRI. All Union conference materials, Minsk*: 152-155. (in Russian).

RODIONOVA, G. D. & UMNOVA, V. T., 1988.- Biostratigraphy of the formations around the Devonian/Carboniferous boundary in the syneclise south-west of Moscow. *In*: Biostratigraphic research of the Devonian-Carboniferous boundary deposits Russian Platform. *Preprint, SVK NII DVNTs USSR Academy Sciences, Magadan*: 7-13. (in Russian).

UMNOVA, V. T., 1971.- On the Devonian-Carboniferous boundary in the central regions of the Russian Platform from playnological data. *Izv. AN SSSR. Series Geol.*, 4: 109-122. (in Russian)

PLATE 1

1. *Punctatisporites glaber* (Naumova) Playford
   Glubokovsk 1-k borehole, sample 131, 125.9-126.2m; yellow-grey limestone (? with *Bisphaera*); M Zone

2. *Punctatisporites angularis* (Kedo) Byvsheva
   Glubokovsk 1-k borehole, sample 27934, 126.5m; grey claystone (below limestone? with *Bisphaera*); PMi Subzone

3. *Cyclogranisporites soidus* (Naumova) Byvsheva
   Glubokovsk 1-k borehole, sample 131; M Zone

4,5. *Retusotriletes minor* Kedo
   Glubokovsk 1-k borehole, sample 131; M Zone

6. *Apiculiretusispora spinosa* (Byvsheva) Byvsheva
   Glubokovsk 1-k borehole, sample 184, 119.6-120.2m; blue-grey mudrock; M Zone

7. *Stenozonotriletes conformis* Naumova
   Glubokovsk 1-k borehole, sample 131; M Zone

8. *Stenozonotriletes auriculatus* N. Umnova sp. nov
   Holotype. Glubokovsk 1-k borehole, sample 27934; PMi Subzone

9. *Cymbosporites minutus* (Kedo) Avchimovitch & Streel
   Glubokovsk 1-k borehole, sample 27934,; PMi Subzone

10. *Cymbosporites acutus* (Kedo) Byvsheva
    Glubokovsk 1-k borehole, sample 132, 123.1-125.9m; pale grey mudrock; M Zone

11. *Tumulispora malevkensis* (Kedo) Turnau
    Glubokovsk 1-k borehole, sample 131; M Zone

12. *Tumulispora variverrucata* (Playford) Staplin & Jansonius
    Glubokovsk 1-k borehole, sample 131; M Zone

13,17. *Vallatisporites hystricosus* (Winslow) Byvsheva
    Glubokovsk 1-k borehole, sample 27934,; PMi Subzone

14. *Tholisporites esenensis* Byvsheva
    Glubokovsk 1-k borehole, sample 132; M Zone

15. *Lophozonotriletes proscurrus* Kedo
    Glubokovsk 1-k borehole, sample 131; M Zone

16. *Lophozonotriletes excisus* Naumova
    Glubokovsk 1-k borehole, sample 131; M Zone

18. *Knoxisporites literatus* (Waltz) Playford
    Glubokovsk 1-k borehole, sample 131; M Zone

19. *Tumulispora varia* (Kedo) Byvsheva
    Glubokovsk 1-k borehole, sample 178, 120.2-120.4m; pale grey mudrock; M Zone

20. *Raistrickia corynoges* Sullivan
    Glubokovsk 1-k borehole, sample 187, 119.2-119.4m; blue grey mudrock; M Zone

21. *Grandispora senticosa* (Ischenko) Byvsheva
    Glubokovsk 1-k borehole, sample 131; M Zone

22. *Convolutispora malor* (Kedo) Turnau
    Glubokovsk 1-k borehole, sample 184; M Zone

23. *Concentricosporites concentricus* Byvsheva
    Glubokovsk 1-k borehole, sample 132; M Zone

24. *Endosporites granulatus* (Naumova) Byvsheva
    Glubokovsk 1-k borehole, sample 131; M Zone

25. *Bascaudaspora mischkinensis* (Byvsheva) Byvsheva
    Glubokovsk 1-k borehole, sample 27934; PMi Subzone

26. *Cyrtospora cristifera* (Luber) Van der Zwan
    Glubokovsk 1-k borehole, sample 132; M Zone


1


2


3


4

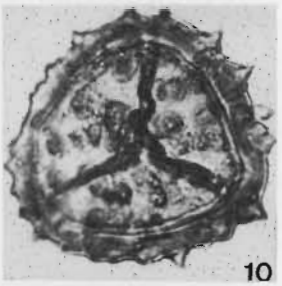

5


6


7

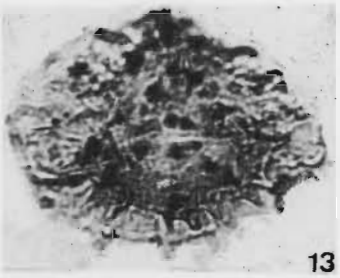

8


9


10

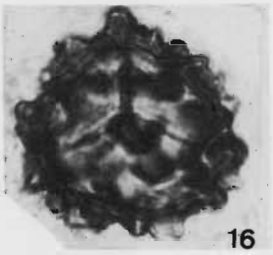

11


12


13


14

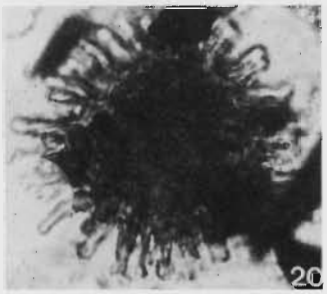

15

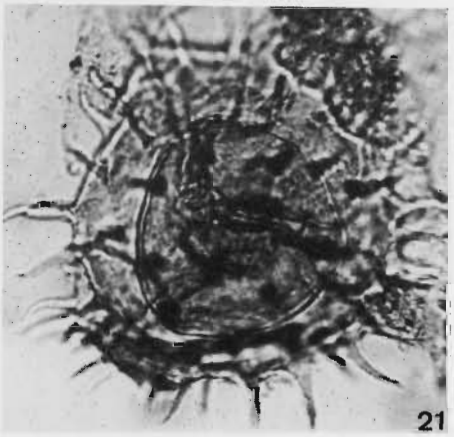

16

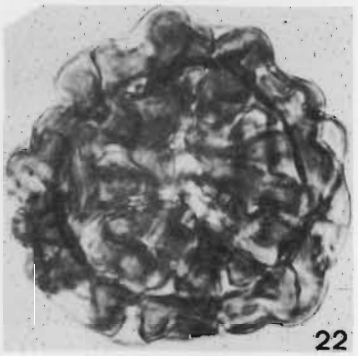

17


18

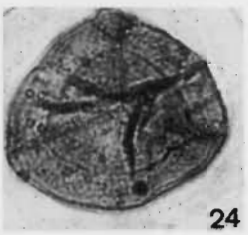

19

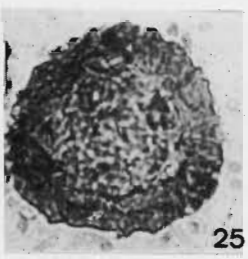

20


21


22


23


24


25


26