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Miospores of the Givetian-Frasnian boundary deposits in Belarus

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ABSTRACT. The global miospore zone *Contagisporites optivus-Cristatisporites triangulatus* spanning the Givetian-Frasnian boundary deposits may be also distinguished in Eastern Europe. In Belarus, this zone is divided into three local zones – (i) *Cristatisporites triangulatus-Corystisporites serratus serratus* Zone, (ii) *Ancyrospora incisa-Geminospora micromanifesta* Zone, and (iii) *Acanthotriletes bucerus-Archaeozonotriletes variabilis insignis* Zone. The basis for defining these zones is the first appearance of (i) *Cristatisporites triangulatus*, (ii) *Ancyrospora incisa*, and (iii) *Acanthotriletes bucerus*, and also the occurrence of characteristic assemblages.

Palynological correlation with the central regions of Russia, and with the Timan – Pechora region indicate that the lower zone corresponds to the conodont Middle or Upper *varcus* Subzone, and the upper zone corresponds to the *falsiovalistransitans* zones. The middle zone is not dated with conodonts. A prominent palaeofloristic event takes place at the lower boundary od this zone. This level may possibly correspond to the base of the *hermanni-cristatus* Zone.

KEY WORDS: palynostratigraphy, Devonian, Givetian, Frasnian, Belarus

INTRODUCTION

Distinguishing the Givetian-Frasnian boundary in Belarus and other regions of Eastern Europe is difficult because of the absence of conodonts in the boundary deposits. For this reason, miospore research on these deposits is very important. Unfortunately, so far, there are no distinct palynological criterions for distinguishing this boundary, and it is being placed within the *Contagisporites optivus-Cristatisporites triangulatus* Zone which spans a long stratigraphic interval – from the Upper *Polygnathus varcus* to Lower *Polygnathus asymmetricus* conodont zones (Richardson & McGregor 1986).

PALYNOSTRATIGRAPHY

In eastern and southern Belarus, the Givetian-Frasnian boundary deposits corresponding to the global miospore zone *Contagisporites optivus – Cristatisporites triangulatus* (Richardson & McGregor 1986) are dissected by numerous boreholes. This is a predominantly terrigenous sequence without marine fauna. Its biostratigraphic division is based on miospores. The succession can be divided into three parts or three local miospore zones. The lower and the upper zones can be related to the standard conodont zonation on indirect correlation.

The lower, *Cristatisporites triangulatus-Corystisporites serratus* Zone (corresponding to the topmost subzone of the *Geminospora extensa* Zone of Kedo & Obuhhovskaya 1981) is distinguished in the upper Stolin, and Moroch beds of the Polotsk Horizon (Fig. 1). The deposits consist of sandstones, clays, and thin layers of dolomite. The first appearance of *Cristatisporites triangulatus* (Allen) McGregor et Camfield, and single specimens of *Contagisporites optivus* (Chibrikova) Owens var. *optivus* Owens is noted here while *Chelinospora concinna* Allen appears somewhat below the base of the zone (Fig. 2). The association (see Fig. 3) includes abundant representatives of

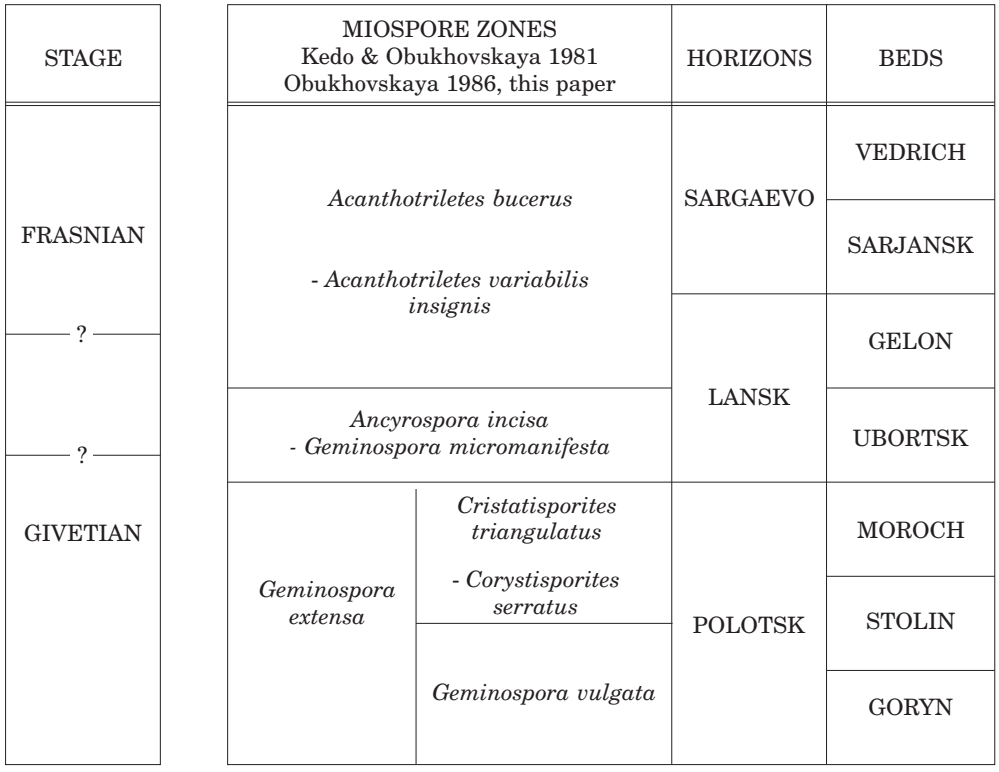

Fig. 1. Stratigraphic chart of Givetian and lower Frasnian of Belarus

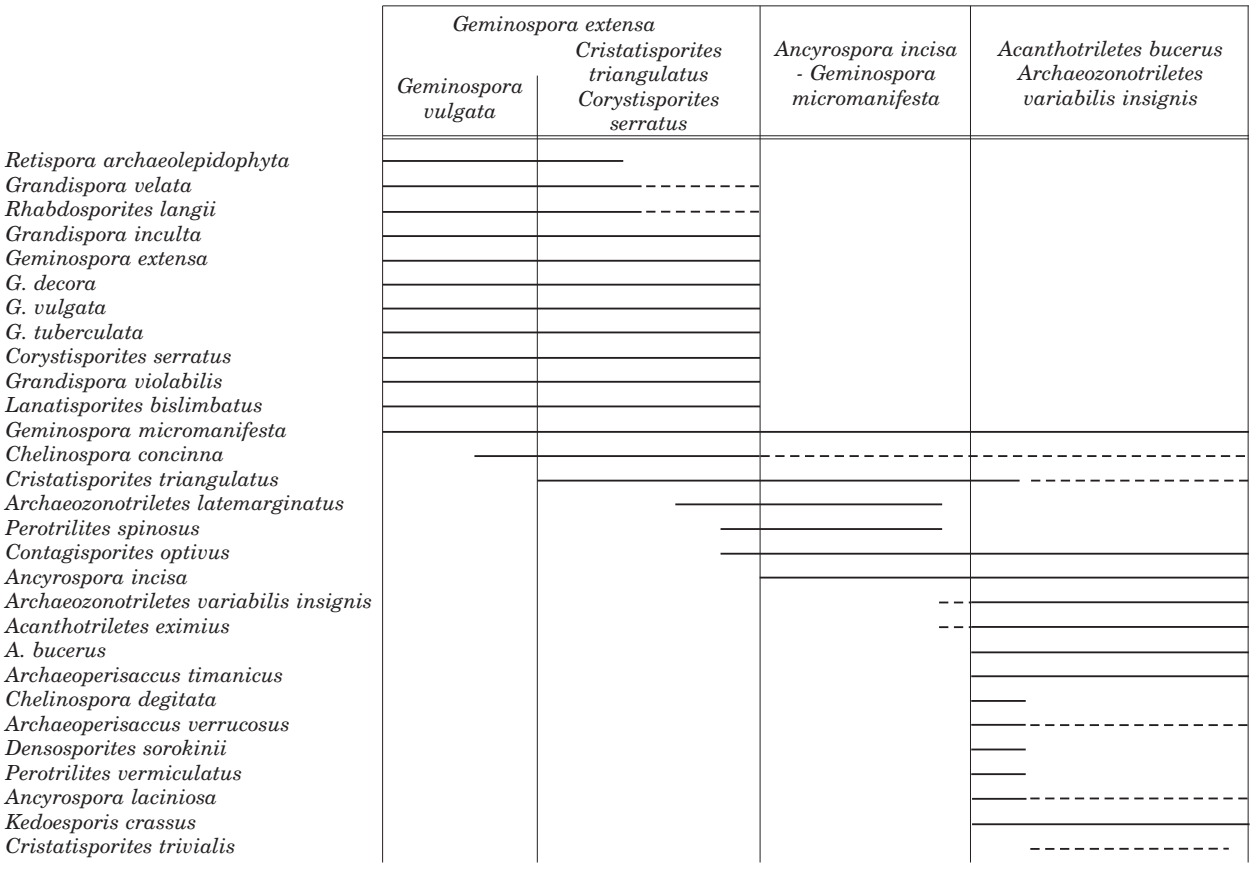

Fig. 2. Stratigraphic ranges of selected miospore species in Givetian-Frasnian boundary deposits of Belarus

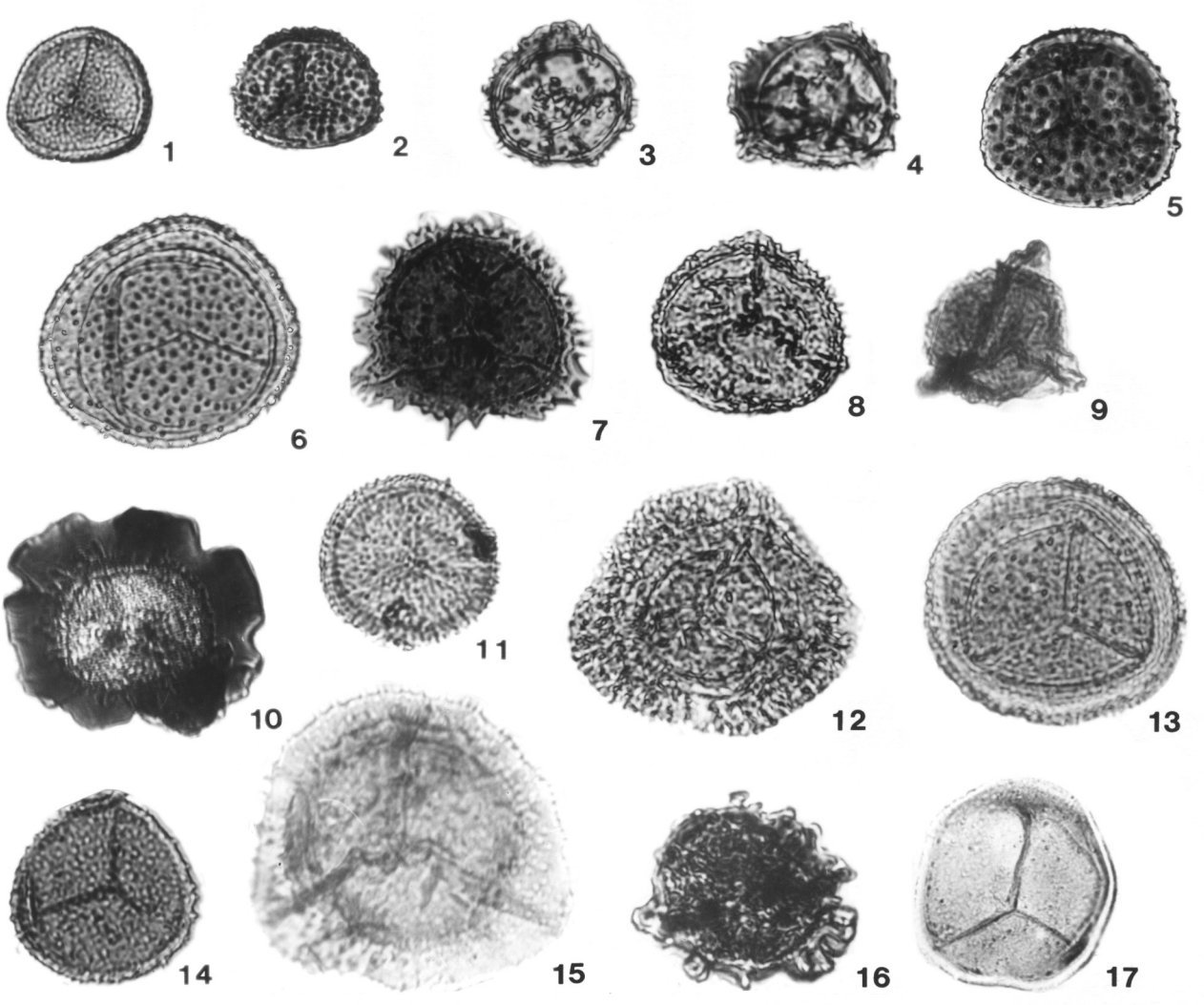

Fig. 3. Spores of the *Cristatisporites triangulatus-Corystisporites serratus* Zone; × 500. **1** – *Geminospora extensa* (Naumova) Gao, borehole 3260, 128 m; **2** – *G. pustulata* (Naumova) var. *minor* Kedo, borehole Mstislavskaya-1, 253 m; **3–4** – *Chelinospora concinna* Alen, borehole Mstislavskaya 1, 261 m; **5** – *Geminospora decora* (Naumova) Arkhangelskaya, borehole 3259, 91.3 m; **6** – *G. tuberculata* (Kedo) Allen, borehole Wjasma 1, 654 m; **7–8** – *Corystisporites serratus* (Kedo) McGregor et Camfield; 7 – borehole PNPZ, 106 m; 8 – borehole Mstislavskaya 1, 263 m; **9** – *Cristatisporites triangulatus* (Allen) McGregor et Camfield, borehole Mstislavskaya-1, 263 m; **10** – *Archaeozonotriletes latemarginatus* (Kedo) Obukhovskaya, borehole Mstislavskaya-1, 263 m; **11** – *Geminospora tenuispinosa* (Naumova) Obukhovskaya, borehole 3259, 91.3 m; **12** – *Lanatisporites bislimbatus* (Tschibrikova) Arkhangelskaya, borehole PNPZ, 106 m; **13** – *Geminospora punctata* Owens, borehole 3259, 91.3 m; **14** – *Geminospora vulgata* (Naumova) Arkhangelskaya, borehole Mstislavskaya-1, 265 m; **15** – *Grandispora violabilis* (Tschibrikova) Obukhovskaya, borehole Mstislavskaya-1, 265 m; **16** – *Verrucosisporites premnus* Richardson, borehole 3259, 109.5 m; **17** – *Aneurospora greggsii* (McGregor) Streel, borehole 3259, 91.3 m

Geminospora extensa (Naumova) Gao, *G. tuberculata* (Kedo) Allen, *G. decora* (Naumova) Arkhangelskaya, *G. vulgata* (Naumova) Arkhangelskaya, *Corystisporites serratus* (Kedo) McGregor et Camfield, and *Lanatisporites bislimbatus* (Tchibrikova) Arkhangelskaya. These are typical Givetian species which do not range into the succeeding zone. Other species last appearing in the zone are *Grandispora violabilis* (Tchibrikova) Obukhovskaya, *Grandispora velata* (Eisenack) McGregor et Camfield, *Densosporites devonicus* Richardson, *Rhabdosporites langii* (Eisenack) Richardson, and *Verrucosisporites premnus* Richardson.

The middle zone *Ancyrospora incisa-Geminospora micromanifesta* corresponds to the Ubortsk beds of the Lansk horizon (Kedo & Obukhovskaya 1981, Avkhimovitch et al. 1993). The deposits are sandstones and claystones, they are the basal part of a large transgressive rhythm. The lower boundary of the *incisa-micromanifesta* Zone represents a prominent palaeofloristic event marked by extinction of many Givetian species (Fig. 2). The miospore

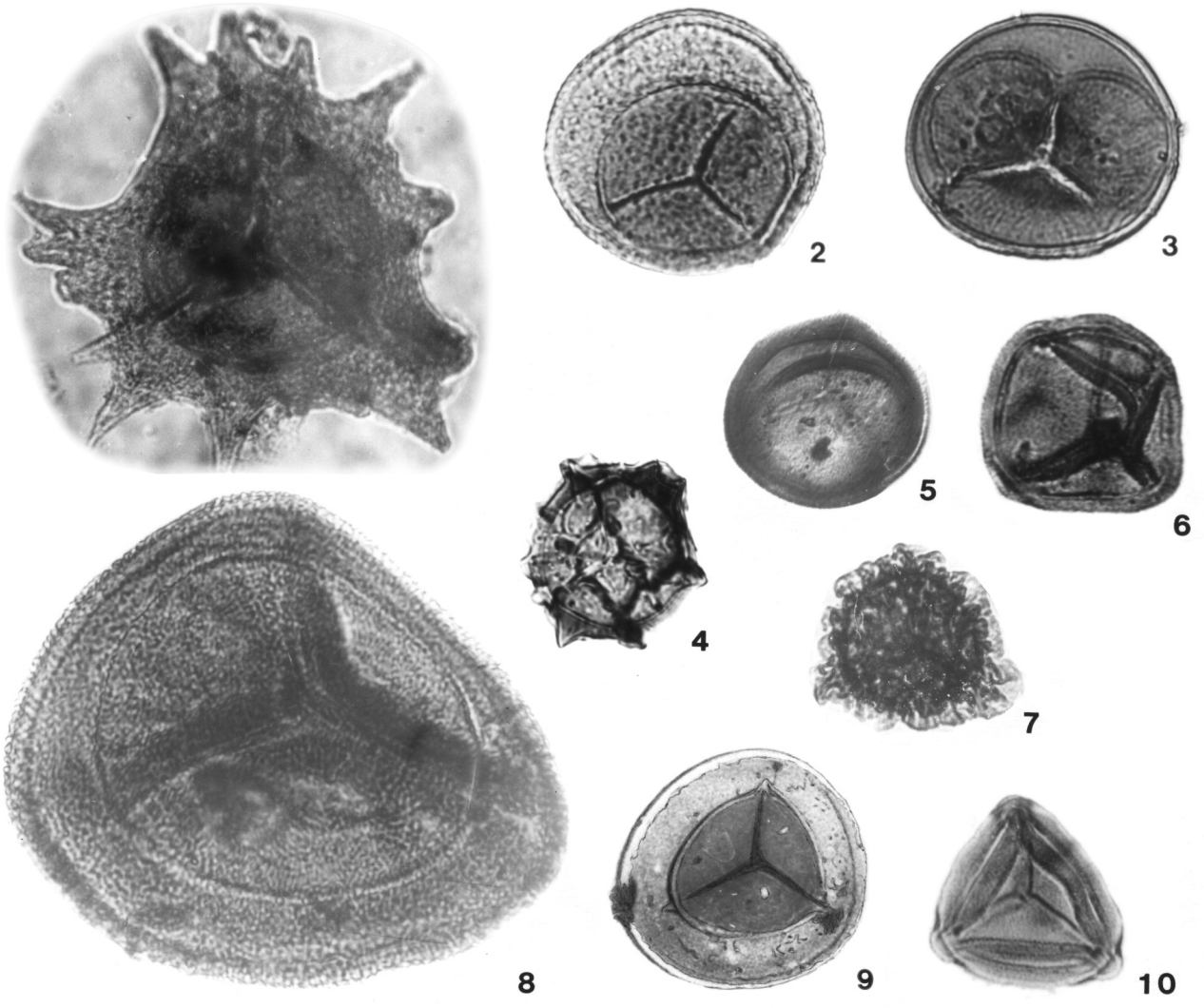

Fig. 4. Spores of *Ancyrospora incisa-Geminospora micromanifesta* Zone; × 500. **1** – *Ancyrospora incisa* (Naumova) M. Raskatova et Obukhovskaya, borehole 3260, 67 m; **2** – *Geminospora micromanifesta* (Naumova) Arkhangelskaya, borehole Mstislavskaya-1, 238 m; **3** – *Retusotriletes rugulatus* Riegel, borehole 3285, 71 m; **4** – *Reticulatisporites retiformis* (Naumova) Obukhovskaya, borehole Mstislavskaya-1, 225–230 m; **5** – *Geminospora rugosa* (Naumova) Obukhovskaya, borehole 3285, 71 m; **6** – *Geminospora notata* (Naumova) Obukhovskaya, borehole Mstislavskaya-1, 225–230 m; **7** – *Cristatisporites triangulatus* (Allen) McGregor et Camfield, borehole Chotimsk-1, 244 m; **8** – *Contagisporites optivus* (Tschibrikova) Owens, borehole Chotimsk-1, 244 m; **9** – *Archaeozonotriletes confusus* Naumova, borehole 3260, 67 m; **10** – *Geminospora plicata* Owens, borehole Mstislavskaya-1, 225–230 m

assemblages (Fig. 4) are dominated by species ex gr. *Geminospora lemurata*: *G. micromanifesta* (Naumova) Arkhangelskaya, *G. rugosa* (Naumova) Obukhovskaya, *G. notata* (Naumova) Obukhovskaya, which first appear in the preceding *G. extensa* Zone. *Cristatisporites triangulatus, Chelinospora concinna, Contagisporites optivus, Retusotriletes rugulatus* Riegel continue to exist. The appearance of new species is limited to *Ancyrospora incisa* (Naumova) M. Raskatova et Obukhovskaya, *A. melvillensis* Owens, and *Archaeozonotriletes retiformis* Naumova.

The upper miospore zone *Acanthotriletes bucerus-Archaeozonotriletes variabilis insignis* corresponds to the Gelon beds of the Lansk Horizon and to the Saryansk and Vedrich beds of the Sargaevo horizon (Obukhovskaya 1986, Avkhimovitch et al. 1993). Gelon beds consist of clays, marls and dolomites formed during a marine transgression. The Saryansk and Vedrich beds consist mainly of dolomites and limestones whith intercalations of marls and claystones in the Saryansk beds. The deposits were formed within the inner shelf of marine basin and they contain brachiopods, gastropods, and crinoids (Golubtsov & Makhnach 1961). This zone is characterized by the first appearance of the nominal species and of *Acanthotriletes dentatus* Naumova, *Archaeo-*

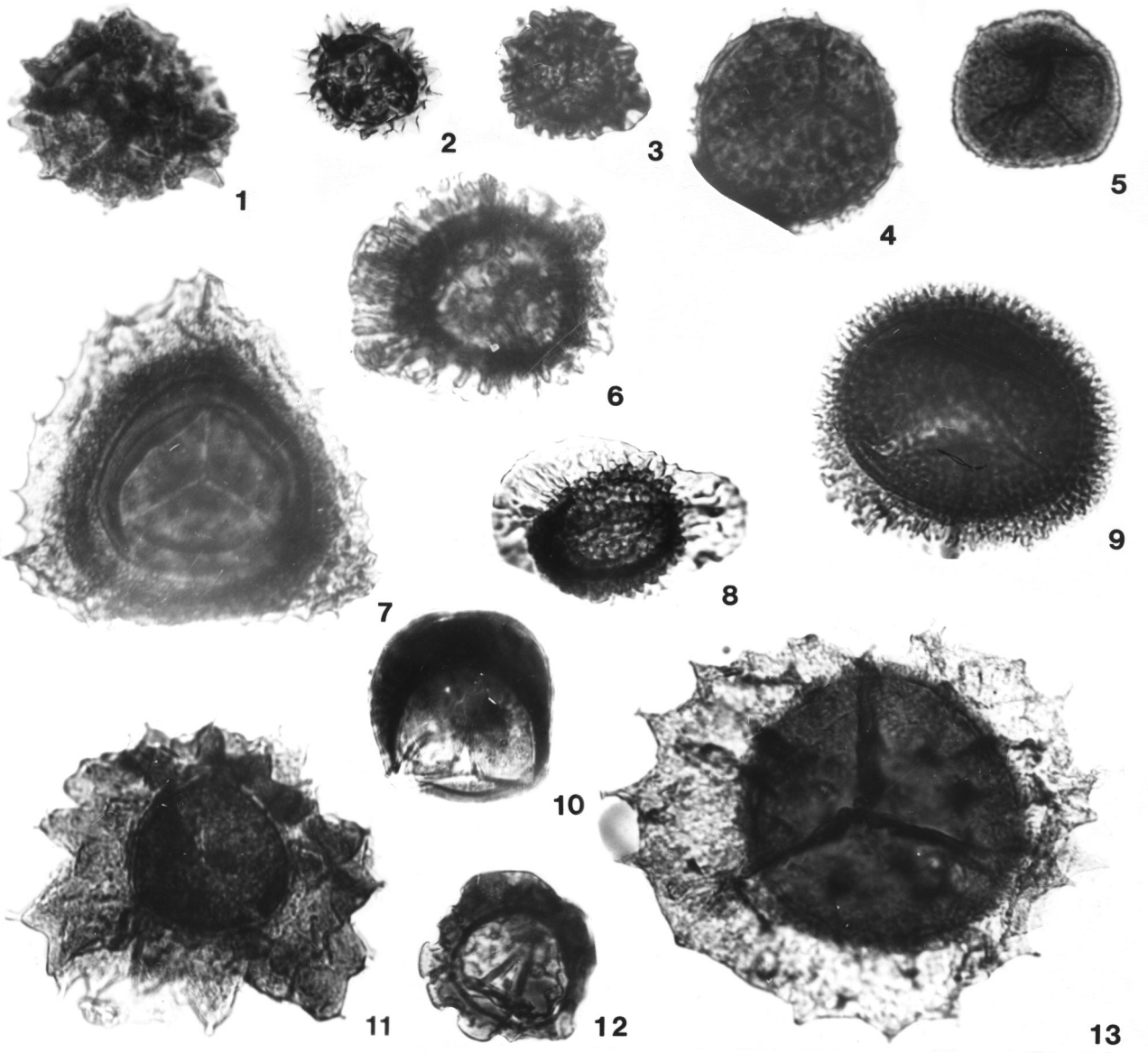

Fig. 5. Spores of *Acanthotriletes bucerus-Archaeozonotriletes variabilis insignis* Zone; × 500. 1–2 – *Acanthotriletes bucerus* Tschibrikova; **1** – borehole Globinskaya-561, 219 m; **2** – Stolinskaya-12, 304.5 m; **3** – *A. dentatus* Naumova, borehole Globinskaya-561, 219 m; **4** – *Acanthotriletes eximius* Naumova, borehole Globinskaya-561, 219 m; **5** – *Kedoesporis crassus* Panschina, borehole Globinskaya-561, 221.5 m; **6** – *Chelinospora degitata* Araslanova, borehole Chotimsk-1, 134 m; **7** – *Densosporites sorokinii* Obukhovskaya, borehole Globinskaya-609, 261 m; **8** – *Archaeoperisaccus verrucosus* Pashkevitch, borehole Globinskaya-561, 219 m; **9** – *Perotrilites* (?) *vermiculatus* Medyanik in litt., borehole Globinskaya-561, 219 m; **10** – *Archaeozonotriletes variabilis* Naumova, borehole Mstislavskaya-1, 158–164 m; **11** – *A. laciniosa* (Naumova) Mantsurova, borehole Globinskaya-561, 219 m; **12** – *Archaeozonotriletes timanicus* Naumova, borehole Globinskaya-561, 221.5 m; **13** – *Ancyrospora ampulla* Owens, borehole Globinskaya-561, 219 m

perisaccus verrucosus Pashkevitch, *A. timanicus* Pashkevitch, *Perotrilites (?) vermiculatus* Medyanik, *Convolutispora* sp., and some species of the genus *Ancyrospora* (see Fig. 5). *Cristatisporites triangulatus*, and *Hymenozonotriletes krestovnikovii* Naumova are very rare. The first appearance of acritarchs (*Leiosphaeridia*, *Micrhystridium*, *Veryhachium*) is noted here. In the upper part of the zone, in the Sargaevo Horizon, the dominant species is *Archaeozonotriletes variabilis* Naumova and representatives of *Geminospora*. The first appearance of *Verrucosisporites* cf. *bullatus* Taugourdeau-Lantz is noted here. The palynomorph assemblages of the Sargaevo Horizon contain numerous acritarchs. The lower boundary of this horizon is not well marked by changes in miospore assemblages, but is readily distinguished on the basis of palynofacies.

CORRELATION AND AGE OF MIOSPORE ZONES

In Belarus, the deposits under discussion lack conodonts, but they can be correlated on miospores with other regions, where palynological data are confirmed by conodonts. The author has studied miospore assemblages from the Givetian and Frasnian deposits of the Timan – Pechora region where conodonts are also found.

Miospore assemblages of the upper part of the *Geminospora extensa* Zone (*triangulatus-serratus* Subzone) are equivalent of those from the upper part of the Ardatov Horizon and from Mullin Horizon of the central regions of Russia (Raskatova 1969, Arkhangelskaya 1985, Rodionova et al. 1995). Givetian age of this deposits was confirmed on conodonts of the Middle-Upper *varcus* Subzone (Aristov 1988, Rodionova et al. 1995). These deposits may be compared on the miospore data to the lower part of the *Samarisporites triangulatus-Chelinospora concinna* (TC) Zone distinguished in the Ardenne – Rhine regions (Streel et al. 1987). This part corresponds to the Fla + Flb of the Fromelennes Formation (Boulonnais, France) (Loboziak & Streel 1980, Streel et al. 1987, Streel & Loboziak 1994). The miospore assemblage present in this interval includes *Aneurospora goensis* Streel (= *Geminospora extensa* (Naumova) Gao), *Chelinospora concinna* Allen, *Grandispora inculta* Allen, *G. velata* (Eisenack), *Auroraspora micromanifesta* Hacquebard, *Densosporites devonicus* Richardson.

The miospore assemblages of the *incisa-micromanifesta* Zone were described also from the Pashyi Horizon of Russia (Raskatova 1969, Rodionova et al. 1995). The terrigenous deposits included in this Zone in Eastern Europe do not contain conodonts. Similarly as in Belarus, the lower boundary of this zone is marked by a very distinct change of palynoflora which allows to establish this boundary unquestionably over a large territory. A similar reconstruction of miospore associations takes place in the Ardenne – Rhine regions near the base of the conodont *hermanni-cristatus* Zone (Brice et al. 1979, Loboziak & Streel 1980). The miospore assemblages of the discussed zone may be compared to these from the upper part of the Fromelennes Formation and from lower "Frasnes" based on trends of compositional development of miospore assotiations. In both regions, the number of first appearances is limited but there is quite a number of extinctions.

The miospore assemblage of the lower part of the *bucerus-variabilis insignis* local zone from Gelon beds of Belarus may be compared to compositionally identical assemblages from the Timan Horizon of the Timan – Pechora (borehole B-1, outcrops 18, 13, 13a, 14 in vicinity of Ukhta) and also from the Middle Timan (boreholes 655, 55, and outcrops along the B. Valsa River). Conodont associations characteristic of the shallow water facies of the *rotundiloba-rotundiloba* zone were determined in outcrops 13 and 14 from the Upper Timan Horizon (Kuzmin 1995, 1996). This part of the Timan Horizon is included in the beds with *Polygnathus pennatus* corresponding to the late *falsiovalis* Zone (Kuzmin 1996, Qiang Ji & Ziegler 1993). So far, conodonts have not been found in the lower part of this horizon but as its spore assemblages do not differ from these from the Upper Timan Horizon, it is logical to include it also to the Frasnian.

Miospore associations with *Archaeoperisaccus timanicus* and *A. ablongus* (= *A. verrucosus*) were defined in the Givetian-Frasnian boundary deposits of Canada (McGregor 1979, McGregor et al. 1985).

The impoverished (facies controlled) miospore associations of the upper part of the *bucerus-variabilis insignis* Zone were found in the deposits of the Sargaevo Horizon of the Voronezh Anteclise of central regions of Russia (Raskatova 1969, Rodionova et al. 1995), and miospores from this horizon of the Timan-Pechora (outcrops 14, 16 and 17b by Ukhta) were studied by the present author. The miospore associations are also impoverished, and the prevalence of acritarches indicates high stand of the transgression, maximum of which was timed for Sargaevo. Conodonts were also found in these deposits (outcrops 14, 16 and 17b). They indicate the presence of *rotundiloba-rotundiloba – transitans* Zones (Kuzmin 1995, 1996).

It follows that the miospore zone *bucerus-variabilis insignis* corresponds to the late *falsiovalis – rotundiloba – transitans* conodontes zones and it is of Frasnian age. The position of the Givetian/Frasnian boundary can not be recognized on spore data. This boundary runs probably within the *incisa-micromanifesta* Zone in which conodonts are absent.

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