

MIOSPORES IN MIDDLE—UPPER FRASNIAN TO FAMENNIAN SEDIMENTS PARTLY DATED BY CONODONTS (BOULONNAIS, FRANCE)

STANISLAS LOBOZIAK and MAURICE STREEL

*Paléobotanique, Université des Sciences et Techniques de Lille, Villeneuve d'Ascq
(France) (associé au C.N.R.S.)*

Paléobotanique et Paléopalynologie, Université de Liège, Liège (Belgium)

(Accepted for publication March 18, 1981)

ABSTRACT

Loboziak, S. and Streel, M., 1981. Miospores in Middle—Upper Frasnian to Famennian sediments partly dated by conodonts (Boulonnais, France). *Rev. Palaeobot. Palynol.*, 34: 49–66.

The middle—upper part of the Formation de Beaulieu exposed in the new railroad trench at Caffiers—Ferques and the Formation de Ferques exposed in the Tartinskale quarries contain well-preserved miospore assemblages. They are here restudied in comparison with new conodont data ranging from the middle *asymmetricus* to the *Ancyrognathus triangularis* Zone. The conodonts allow precise correlations with the type Frasnian area as well as with the Russian Platform and Timan—Pechora provinces. The miospore assemblages of the Formation d'Hydrequent are also considered and their age discussed in terms of the Frasnian/Famennian boundary.

In the systematic part, two new combinations are proposed: *Ancyrospora lysii* (Taugourdeau-Lantz, 1960) nov. comb., and *Pustulatisporites rugulatus* (Taugourdeau-Lantz, 1967) nov. comb.

INTRODUCTION

An Upper Devonian rock sequence outcrops in the Boulonnais, between Calais and Boulogne in the northernmost area of France. This area belongs to a western extension of the Namur syncline which is mainly developed in Belgium.

Taugourdeau-Lantz (1960, 1967a, b and 1971) has described miospores from the succession of the Schistes de Beaulieu, Calcaire de Ferques and Schistes d'Hydrequent in the Boulonnais. Most of the investigated "Lower Frasnian" Schistes de Beaulieu were core-drill samples with no mention about their exact stratigraphical position regarding the base of these beds. The "Middle Frasnian" Calcaire de Ferques was studied by Taugourdeau-Lantz in the La Parisienne and Bois de Beaulieu (Beaulieu Nord) quarries, the "Upper Frasnian" in the Briqueterie de Beaulieu quarry. Her samples were noted in relation to an (unpublished) general section used by Magne (1964).

Recent works by D. Brice and collaborators, which have culminated in a formal definition of the lithological units of the Devonian of Ferques (Brice et al., 1979a), have also allowed better correlations within the Tartinskale quarries. Therefore most of these quarries as well as the upper part of the Ferques railroad section have been resampled for conodont and spore analysis. The lower part of the Formation de Beaulieu and the underlying Formation de Blacourt which has been well dated by conodonts (Bultynck in Brice et al., 1976, 1979b), was palynologically studied by us in this railroad section (Loboziak and Streel, 1980).

Productive spore samples are located on Fig. 1. Letters *Q* to *S* refer to lithological units in Brice et al. (1976), while letters *VW*, *WY* and *Z* refer to lithological units or intervals in Brice et al. (1977). The conodont results have been published by Coen (in Brice et al., 1981). They are shown on Fig. 1 with additional data from Magne (1964) and Bultynck (in Brice et al., 1979b). A few ostracod data of the Formation d'Hydrequent are taken from Lethiers (in Bonte et al., 1974).

SYSTEMATIC NOTES

Ancyrospora lysii (Taugourdeau-Lantz 1960) nov. comb. (Plate IV, 5).

Basionym: *Densosporites lysii* Taugourdeau-Lantz 1960, Rev. Micropaléontol. 3: 146, pl. 2, figs. 29–30, pl. 3, figs. 40–42.

Synonym: *D. lysii* Taugourdeau-Lantz 1960 in Taugourdeau-Lantz 1971, pl. IV, figs. 5, 7–9, 12–14.

There is a complete gradation from specimens with true bifurcated spines to nearly smooth specimens. The exine structures are otherwise similar to other *Ancyrospora*. Corroded specimens are comparable to forms assigned to *Pseudowilsonia naoumovae* by Taugourdeau-Lantz 1960 and later compared (Taugourdeau-Lantz, 1971) with the megaspore *Wybostisporites variabilis* Mortimer et Chaloner 1967.

Auroraspora sp. A. (Plate III, 6)

Synonym: *A. sp. cf. Diaphanospora perplexa* Balme et Hassell 1962 in Becker et al. 1974, pl. 21, figs. 12–14.

Cymbosporites sp. A (Plate I, 13–14)

Diameter: 45–55 μm .

Ornamentation of biform elements (1–2 μm high) consisting of rounded verrucae (1–2 μm wide) with a narrow tip (less than 1 μm high). The distribution of the ornaments entirely distal is typically irregular (2–8 μm apart).

Cymbosporites sp. B (Plate I, 15–16)

Diameter: 40–50 μm .

Ornamentation of coarse coni (2 μm wide and high) on the distal surface. The ornaments are evenly distributed (3–4 μm apart), denser at the equator.

Grandispora sp. A (Plate II, 16)

Diameter: 65–80 μm .

Intexine, thin, excentrically detached from the thick (3–4 μm) exoexine. Distal surface and equatorial region ornamented with prominent spinae, 6–12 μm high, tapering sharply. Ornaments evenly distributed with 30–40 elements prominent at equator. Suturæ accompanied by typical largely flexuous ray folds at the apex.

Pustulatisporites rugulatus (Taugourdeau-Lantz 1967) nov. comb. (Plate I, 3–4)

Basionym: *Polymorphisporites rugulatus* Taugourdeau-Lantz 1967, Rev. Micropaléontol, 10: 50, pl. 1, figs.1–2.

Synonyms: *Polymorphisporites rugulatus* Taugourdeau-Lantz 1967 in Taugourdeau-Lantz 1971, pl. V, figs.3, 5.

Reticulatisporites sp. in Taugourdeau-Lantz 1960, pl. 1, fig.11.

We consider the equatorial darkening to be the result of the general exine thickness and not to correspond to a true cingulum.

Rugospora cf. *flexuosa* (Juschko) Strel in Becker et al. 1974 (Plate I, 11)

The typical convoluted ornaments of the species are not quite discernible on this material.

Samarisporites triangulatus Allen 1965 (Plate II, 1–5)

Synonyms: *Samarisporites euglypheus* Taugourdeau-Lantz 1967, pl. 2, figs.7–8.

Samarisporites euglypheus Taugourdeau-Lantz 1967 in Taugourdeau-Lantz 1971, pl. VIII, figs.4–5.

Samarisporites triangulatus Allen in Loboziak et Strel 1980, pl. II, figs. 11–12.

Samarisporites cf. *inusitatus* Allen in Taugourdeau-Lantz 1971, pl. VIII, fig.7.

Samarisporites sp. aff. *S. inusitatus* Allen in Becker et al. 1974, enclosure II.

Compared to the material studied and illustrated in the Formation de Blacourt, there is a trend in the distal ornaments to fuse in a more or less reticulate pattern. A few specimens of the latter are encountered in the Formation de Beaulieu but they are dominant in the Formation of Ferques.

Samarisporites cf. *triangulatus* Allen 1965 (Plate II, 6)

A nearly smooth specimen, otherwise similar to the species.

Samarisporites sp. A (Plate II, 7–8)

Synonyms: "Gen. nov." in Strel 1965, pl. 1, figs.4–6.

Samarisporites sp. cf. *Hymenozonotriletes acanthyrugosus* Chibrikova, in Becker et al. 1974, pl. 18, fig.8.

This form is structurally similar to *Samarisporites triangulatus* from which it could be derived. It has a thick, often dark, spherical central body and a thin

narrow equatorial wing, slightly expanding in front of the ends of the trilete rays. Ornaments are mainly composed, on the distal and equatorial surfaces, of narrow spines, 2–3 μm high.

FAUNAL AND MIOSPORE EVIDENCES

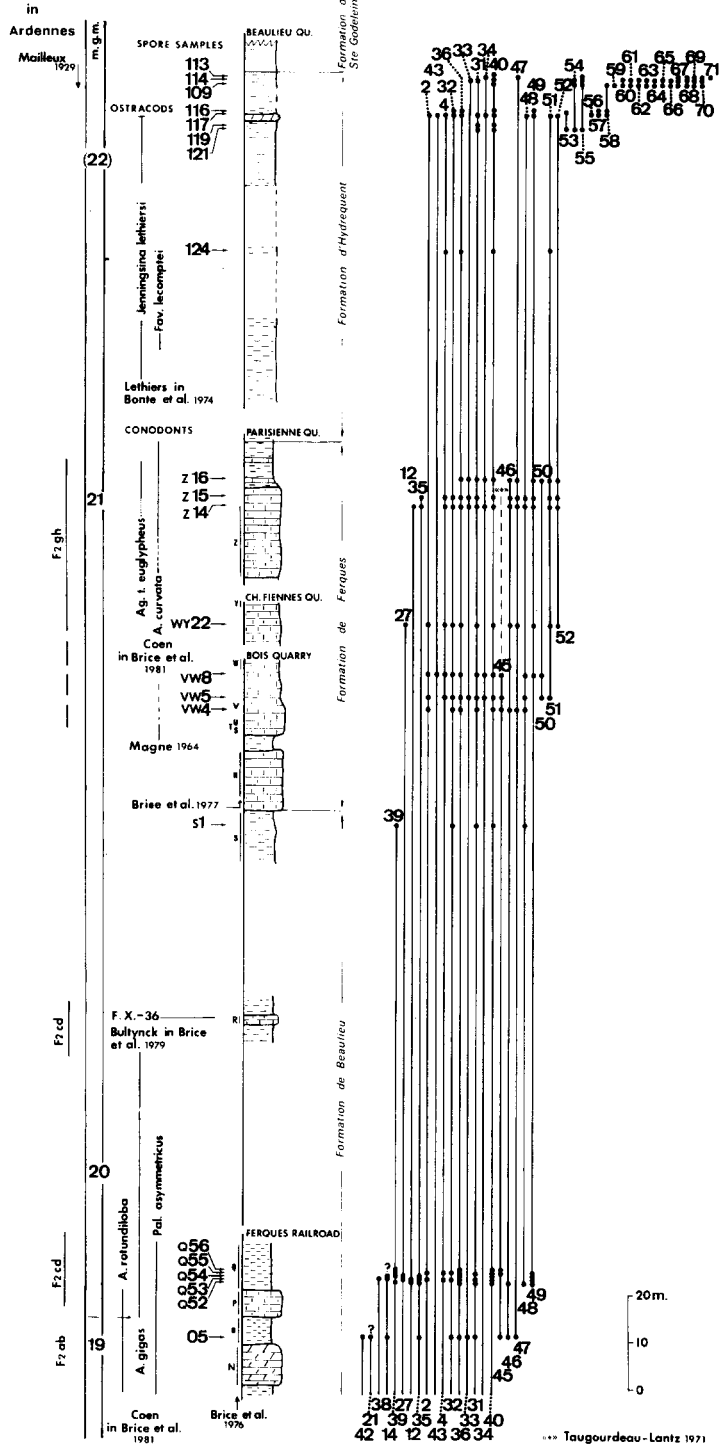
The stratigraphical distribution of the most significant miospores is given in Fig.1. In the following discussion the identification numbers applied in this distribution chart are given between brackets. It should be noted that, where adequate, the same numbers have been used as on the distribution chart of Loboziak and Strel (1980, fig.1).

Before considering the distribution of the miospores, we must remember (Loboziak and Strel, 1980) the occurrence of a spore assemblage characterised by *Chelinospora concinna* (38), *Cirratriradites jekhovskyi* (39) and *Geminospira lemurata* (40) in the upper part of the Formation de Blacourt (with a *P. varcus* conodont fauna) and in the lower part of the Formation de Beaulieu

Fig.1 = Stratigraphical distribution of the most significant miospores. Lithological column composed from Brice et al. (1976, 1977); m.g.m. = micropaleontological guiding mark (Bouckaert and Strel, 1974).

Legend: 2 = *Archaeozonotriletes variabilis* (Naumova) Allen 1965 (Plate I, 17); 4 = *Convolutispora disparilis* Allen 1965 (Plate I, 7); 12 = *Contagisporites optivus* (Chibrikova) Owens 1971 (Plate III, 13); 14 = *Ancyrospora ancyrea* var. *brevispinosa* Richardson 1962; 21 = *Grandispora inculta* Allen 1965; 27 = *Verrucosisorites* cf. *uncatus* (Naumova) Richardson 1965; 31 = *Ancyrospora langii* (Taugourdeau-Lantz) Allen 1965 (Plate IV, 2); 32 = *Grandispora tomentosa* Taugourdeau-Lantz 1967b (Plate II, 15); 33 = *Hystricosporites* spp.; 34 = *Perotriletes ergatus* Allen 1965; 35 = *Rhabdosporites parvulus* Richardson 1965 (Plate III, 1); 36 = *Samarisporites triangulatus* Allen 1965 (Plate II, 1–5); 38 = *Chelinospora concinna* Allen 1965 (Plate I, 18); 39 = *Cirratriradites jekhovskyi* Taugourdeau-Lantz 1967b (Plate II, 12); 40 = *Geminospira lemurata* Balme 1962 (Plate III, 2); 42 = *Corystisporites multispinosus* Richardson 1965 (Plate IV, 1); 43 = *Convolutispora* cf. *subtilis* Owens 1971; 45 = *Verrucosisorites bullatus* Taugourdeau-Lantz 1967b (Plate I, 9, 10); 46 = *Ancyrospora simplex* Guennel 1963 (Plate IV, 6); 47 = *Hystricosporites multifurcatus* (Winslow) Mortimer et Chaloner 1967 (Plate IV, 4); 48 = *Convolutispora tegula* Allen 1965 (Plate I, 8); 49 = *Planisporites scaber* Taugourdeau-Lantz 1971 (Plate I, 12); 50 = *Lophozonotriletes media* Taugourdeau-Lantz 1967b (Plate III, 10); 51 = *Pustulatisporites rugulatus* (Taugourdeau-Lantz) nov. comb. (Plate I, 3, 4); 52 = *Ancyrospora lysii* (Taugourdeau-Lantz) nov. comb. (Plate IV, 5); 53 = *Grandispora* cf. *tenuispina* (Hacquebard) Playford 1971; 54 = *Samarisporites* sp. A (Plate II, 7, 8); 55 = *Diducites poljessicus* (Kedo) Van Veen 1981 (Plate III, 7); 56 = *Grandispora* sp. A (Plate II, 16); 57 = *Cymbosporites* sp. B (Plate I, 15, 16); 58 = *Rugospora* cf. *flexuosa* (Juschko) Strel in Becker et al. 1974 (Plate I, 11); 59 = *Knoxisporites dedaleus* (Naumova) Strel 1977 (Plate III, 11); 60 = *Knoxisporites* cf. *hederatus* (Ishenko) Playford 1963 (Plate III, 12); 61 = *Corbulispora* sp. (Plate I, 5); 62 = *Auroraspora hyalina* (Naumova) Strel in Becker et al. 1974 (Plate III, 5); 63 = *Auroraspora macra* Sullivan 1968 (Plate III, 4); 64 = *Diducites plicabilis* Van Veen 1981 (Plate III, 8); 65 = *Diducites versabilis* (Kedo) Van Veen 1981 (Plate III, 9); 66 = *Auroraspora* sp. A (Plate III, 6); 67 = *Retusotriletes planus* Dolby et Neves 1970 (Plate I, 1, 2); 68 = *Cymbosporites* sp. A (Plate I, 13, 14); 69 = *Grandispora gracilis* (Kedo) Strel in Becker et al. 1974 (Plate II, 13); 70 = *Auroraspora solisorta* Hoffmeister, Staplin et Malloy 1955 (Plate III, 3); 71 = *Densosporites* spp. (see Plate II, 10, 11).

LITHO - BIOSTRATIGRAPHY



(with a lower *asymmetricus* conodont fauna including *Ancyrodella rotundiloba*).

An almost similar spore assemblage is present in the samples taken below and above the first limestone with "Pentamères" (Unit P) in the Ferques railroad section. This limestone has a middle *asymmetricus* conodont fauna, with *Ancyrodella gigas*. Among the seventeen miospore species belonging to this assemblage are *Corystisporites multispinosus* (42), *Grandispora inculta* (21), *Chelinospora concinna* (38), *Ancyrospora ancyrea* var. *brevispinosa* (14), *Verrucosiporites* cf. *uncatus* (27) and *Archaeozonotriletes variabilis* (2), six species which were given a too short stratigraphical range by Loboziak and Streel (1980). This assemblage may however be distinguished by marking the first occurrence of *Verrucosiporites bullatus* (45), *Ancyrospora simplex* (46), *Hystricosporites multifurcatus* (47), *Convolutispora tegula* (48) and *Planisporites scaber* (49).

Other miospores occur in the lower part of the Formation de Ferques which has an upper *asymmetricus* conodont fauna with *Ancyrodella curvata* (Magne, 1964). The joint first incoming of *Lophozonotriletes media* (50), *Pustulatisporites rugulatus* (51) and *Ancyrospora lysii* (52) was also noted by Taugourdeau-Lantz (1971, tableau 1) in the same Bois quarry as well as the disappearance of *Cirratriradites jekhovskiyi* (39), a typical zonate form, at the top of the Formation de Beaulieu in the La Parisienne quarry. *Verrucosiporites bullatus* was found in the upper part of the Formation de Ferques by Taugourdeau-Lantz (1971) in the La Parisienne quarry, the same locality where Coen (in Brice et al., 1981) has identified *Ancyrognathus triangularis euglypheus* specimens. These last conodont specimens definitely belong to the *Ancyrognathus triangularis* zone sensu Ziegler. (See the related note in Brice et al., 1981.) They are present in the conodont assemblage characterising the upper part ("F2gh") of the "assise de Frasnes" in Belgium.

Productive samples of the Formation d'Hydrequent were obtained only from immediately below and above the dolomitic bed and also from the uppermost part of the Formation.

Near the dolomitic bed (121 and 119 within 2 m below; 117 and 116 within 20 cm above) occur a few typical species most of which are mentioned here in open nomenclature. They are *Grandispora* cf. *tenuispinosa* (53), *Samarisporites* sp. A (54), *Diducites poljessicus* (55), *Grandispora* sp. A (56), *Cymbosporites* sp. B (57) and *Rugospora* cf. *flexuosa* (58). Many species disappear above that level, particularly *Samarisporites triangulatus* (36), *Grandispora tomentosa* (32), *Convolutispora disparalis* (4), *Pustulatisporites rugulatus* (51) and *Ancyrospora lysii* (52).

More significant is the change of microflora observed in the uppermost part of the Formation d'Hydrequent (109, 114 and 113 within 3 m below the top). Thirteen taxa occur in these samples: *Knoxisporites dedaleus* (59), *K.* cf. *hederatus* (60), *Corbulispora* sp. (81), *Auroraspora hyalina* (62), *A. macra* (63), *Diducites plicabilis* (64), *D. versabilis* (65), *Auroraspora* sp. A (66), *Retusotriletes planus* (67), *Cymbosporites* sp. A (68), *Grandispora gracilis* (69), *Auroraspora solisorta* (70) and *Densosporites* spp. (71).

There are no conodont data available from the Formation d'Hydrequent and we have to rely on brachiopods and ostracods.

Most of the Formation including the dolomitic bed should still belong to the Frasnian as this bed contains the last *Ripidiorhynchus ferquensis* (Gosselet), a very typical brachiopod of the underlying Formation de Ferques (Brice and Meats, 1972), and also several Frasnian ostracods (Lethiers in Bonte et al., 1974). Indeed the change in the spore content near the dolomitic bed is not very important compared with the Formation de Ferques assemblage. The ostracod *Favulella lecomptei* is present only in the lower part of the Formation d'Hydrequent. But, in the Ardennes (Casier, 1977) the *Favulella lecomptei* zone ends near the contact of the Formation de Frasnes and the Formation de Neuville where the upper *Ancyrognathus triangularis* subzone sensu Coen (1973) occurs. Therefore we assume that our samples near the dolomitic beds should correspond more or less to that conodont subzone.

On the other hand, the last spore assemblage from the uppermost part of the Formation d'Hydrequent is very different and this suggests a sediment gap or condensation between the dolomitic bed and these samples. To date this uppermost part of the Formation d'Hydrequent which is devoid of any other fossils, it is necessary to rely on the evidence of the spores themselves.

THE BOULONNAIS SPORE ASSEMBLAGES AND THEIR CORRELATION WITH OTHER REGIONS

(1) Loboziak and Streel (1980) recognised the Formation de Blacourt and basal Formation de Beaulieu to contain a *Triangulatus* spore assemblage, firstly described in Spitsbergen by Allen (1965, 1967, 1973) and retained by Richardson (1974) as a major assemblage zone of Givetian—Frasnian age. The joint appearance of *Verrucosiporites bullatus* (45) and *Hystricosporites multifurcatus* (47) within the Formation de Beaulieu introduces another major assemblage zone, the *optivus—bullatus* assemblage (Richardson, 1974) of Frasnian age. We consider the latter to extend at least to the top of the Formation de Ferques. These major spore assemblages may now be more accurately dated in terms of the conodont zones: the *triangulatus* assemblage ranging at least from the *obliquimarginatus* Zone to the lower *asymmetricus* Zone¹, the *optivus—bullatus* assemblage corresponding to the middle and upper *asymmetricus* Zone and, at least, the lower part of the *Ancyrognathus triangularis* Zone (see Fig. 2).

Both of these assemblages may however be easily subdivided into several regional phases sensu Van der Zwan and Van Veen (1978). From the base to the top of the rock sequences the following may be recognised:

¹Not to be confused with the lowermost *asymmetricus* Zone.

The TLa¹ phase (Samarisporites triangulatus—Rhabdosporites langii phase). This phase is reflected by the composition of sample G-02 at the base of the Formation de Blacourt (Griset quarry). It has many species in common with the Givetian Orcadian sequence (see Loboziak and Streel, 1980, p.296).

The TCo² phase (Samarisporites triangulatus—Chelinospora concinna phase). Synonym: sequence number I in Brice et al. (1981). This phase is reflected by the composition of sample 26 in unit H in the upper part of the Formation de Blacourt (Ferques railroad trench). It is characterized by the joint occurrence of *Chelinospora concinna* (38), *Cirratriradites jekhovskiy* (39), *Geminospora lemurata* (40), and several so-called "Givetian" species like *Aneurospora goensis* (11), *Ancyrospora ancyrea* var. *ancyrea* (13), *Aurora spora macromanifesta* (16), *Cymbosporites* cf. *cyathus* (20), *Grandispora velata* (22) and *Samarisporites inaequus* (23).

The BJ phase (Verrucosisporites bullatus—Cirratriradites jekhovskiy phase). Synonym: sequence number II in Brice et al. (1981). This phase is typified by the composition of sample sequence Q52 to Q56 in the Formation de Beaulieu (Ferques railroad trench). It may be characterised by the joint occurrence of *Verrucosisporites bullatus* (45), *Hystricosporites multifurcatus* (47) and *Cirratriradites jekhovskiy* (39).

The BM phase (Verrucosisporites bullatus—Lophozonotriletes media phase). Synonym: sequence number III in Brice et al. (1981). The phase is typified by the composition of samples VW5 and 8 in the Formation de Ferques (Bois quarry). It has a joint occurrence of *Verrucosisporites bullatus* (45), *Lophozonotriletes media* (50) and *Pustulatisporites rugulatus* (51). *Ancyrospora lysii* (52) is sometimes a very typical element of this phase.

Which of the above-mentioned species have to be selected to establish true concurrent range zones will be discussed in a later paper. Then we hope to be able to use this scheme for accurate correlation with other regions.

At this stage, however, it is important to emphasize that the *triangulatus* assemblage of Allen in Spitsbergen might cover a slightly different time span than the *triangulatus* assemblage of Richardson. The former one has *Chelinospora concinna* as a characteristic species of its lower part and therefore could well be mainly Frasnian. The *langii—triangulatus* assemblage of Streel in Becker et al. (1974) has a long stratigraphic range extending from the TCo phase of the *triangulatus* assemblage into at least the *optivus—bullatus* assemblage. Its subdivision in two subzones (LTi and LTs; Streel in Becker et al., 1974) based on a continental sequence in the Campine Basin (Belgium) has to be revised in the light of the present new data.

¹TLa: not TL, to avoid a confusion with the former LT Zone of Streel in Becker et al. (1974).

²TCo: not TC, to avoid a confusion with the Viséan TC Zone in Clayton et al. (1977).

(2) The spore assemblage occurring near the dolomitic bed of the Formation d'Hydrequent is too poorly known to be given an accurate definition (see sequence number IV in Brice et al., 1981). This assemblage might be characterised by the joint occurrence of *Samarisporites triangulatus* and *S. sp. A*, the latter being possibly a species derived from the former.

Long-distance correlation on spore evidence are difficult in Frasnian time. This is clearly substantiated by parallelising (see Fig. 2) the spore succession of the Boulonnais with the time equivalent (on conodont evidence) but otherwise very different spore succession of southern Timan (Kushnareva et al., 1978) and their lateral equivalent on the Russian Platform (Sennova, 1974). They most probably belonged to separate phytogeographical areas (Streel, 1981).

(3) The spore assemblage occurring at the uppermost part of the Formation d'Hydrequent (sequence number V in Brice et al., 1981) has several characteristics of the Lower Famennian in the type area of Senzeilles in Belgium (sequence number 7; Streel in Becker et al., 1974) where *Diducites plicabilis* (64) and *D. versabilis* (65) occur in sediments with conodonts of the *crepida* Zone. In the same area the ostracod *Jenningsina lethiersi* Becker ends earlier (at Senzeilles in the underlying *P. triangularis* conodont zone), a situation which is more or less reflected in the Formation d'Hydrequent.

Knoxisporites (*Archaeozonotriletes*) *dedaleus* and small saccate spores like *Hymenozonotriletes hyalinus*, *H. pallidus*, *H. varius*, *H. immensus*, *H. zadonicus*, etc., are common spores of the Zadonsk—Elets "horizons" in various regions of the U.S.S.R. (see Naumova, 1953; Sennova, 1972; Rastakova, 1974; Chibrikova and Naumova, 1974). The Zadonsk—Elets "horizons" were almost always considered to be basal Famennian by Russian authors until new conodont material in the Volga—Ural province (Ovnatanova, 1979; and in Chijova et al., 1979) gave a *P. crepida* Zone as the oldest conodont zone for these "horizons". Compared with the Belgian type sequence, the Zadonsk—Elets "horizons" are better correlated with the "Fa1b" rather than with the "Fa1a" at Senzeilles (see Fig. 2).

Providing that the dolomitic bed of the Formation d'Hydrequent corresponds at least to the upper *A. triangularis* conodont subzone sensu Coen (1973) (which has still to be observed), and the uppermost part of the same Formation to the *P. crepida* Zone (which is probable on spore evidence), there would be in the Boulonnais a large gap in the spore record between our assemblages IV and V where we have no sample. This interval would correspond, on the Russian Platform, to the spore assemblage sequences XIV—XVIII of Rastakova (1974) or more simply to the "super-assemblage" 7 of Chibrikova and Naumova (1974).

It is hoped that further study on the Formation d'Hydrequent will be done in the future.

PLATE I (Description on p. 63)

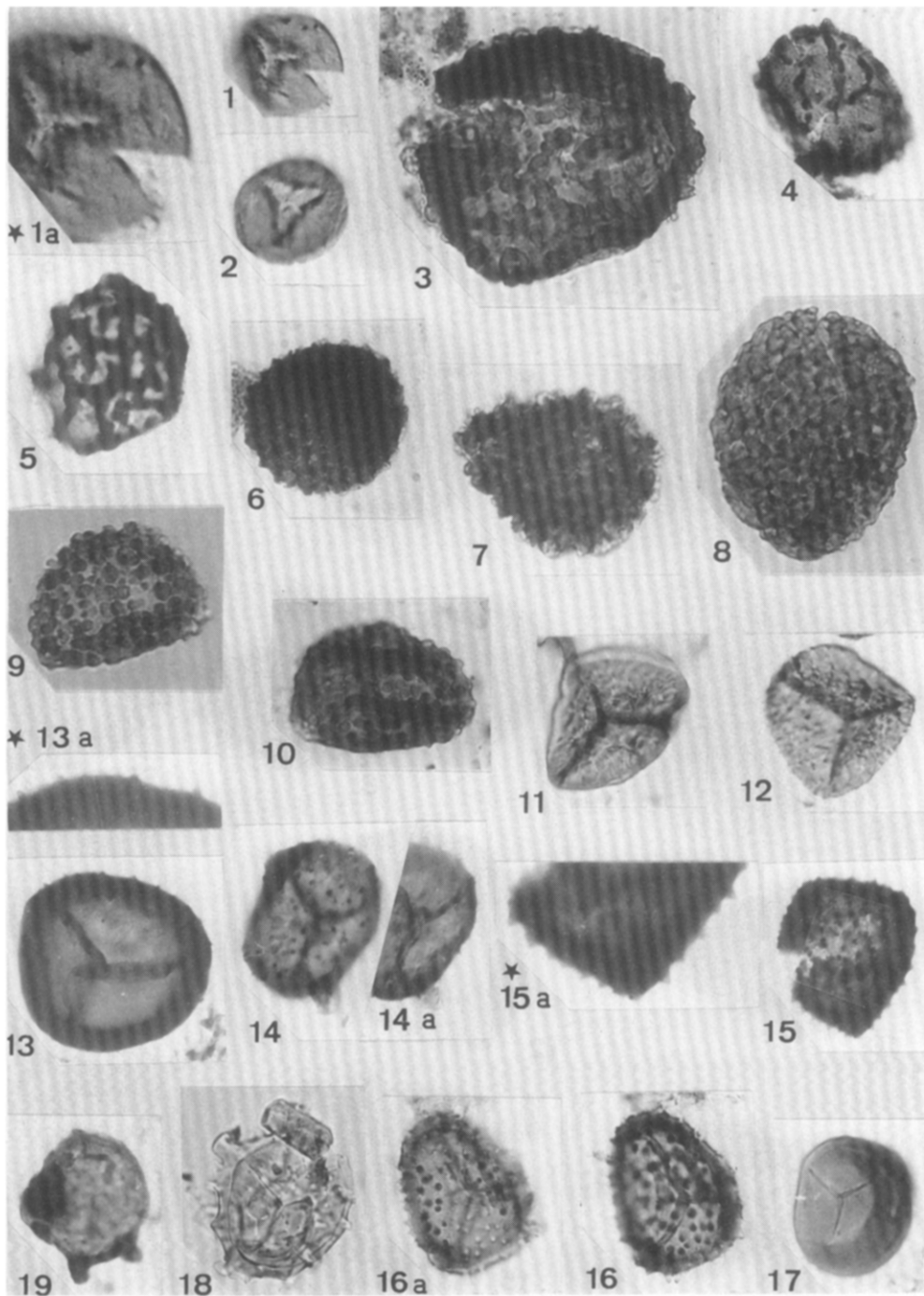


PLATE II (Description on p. 63)

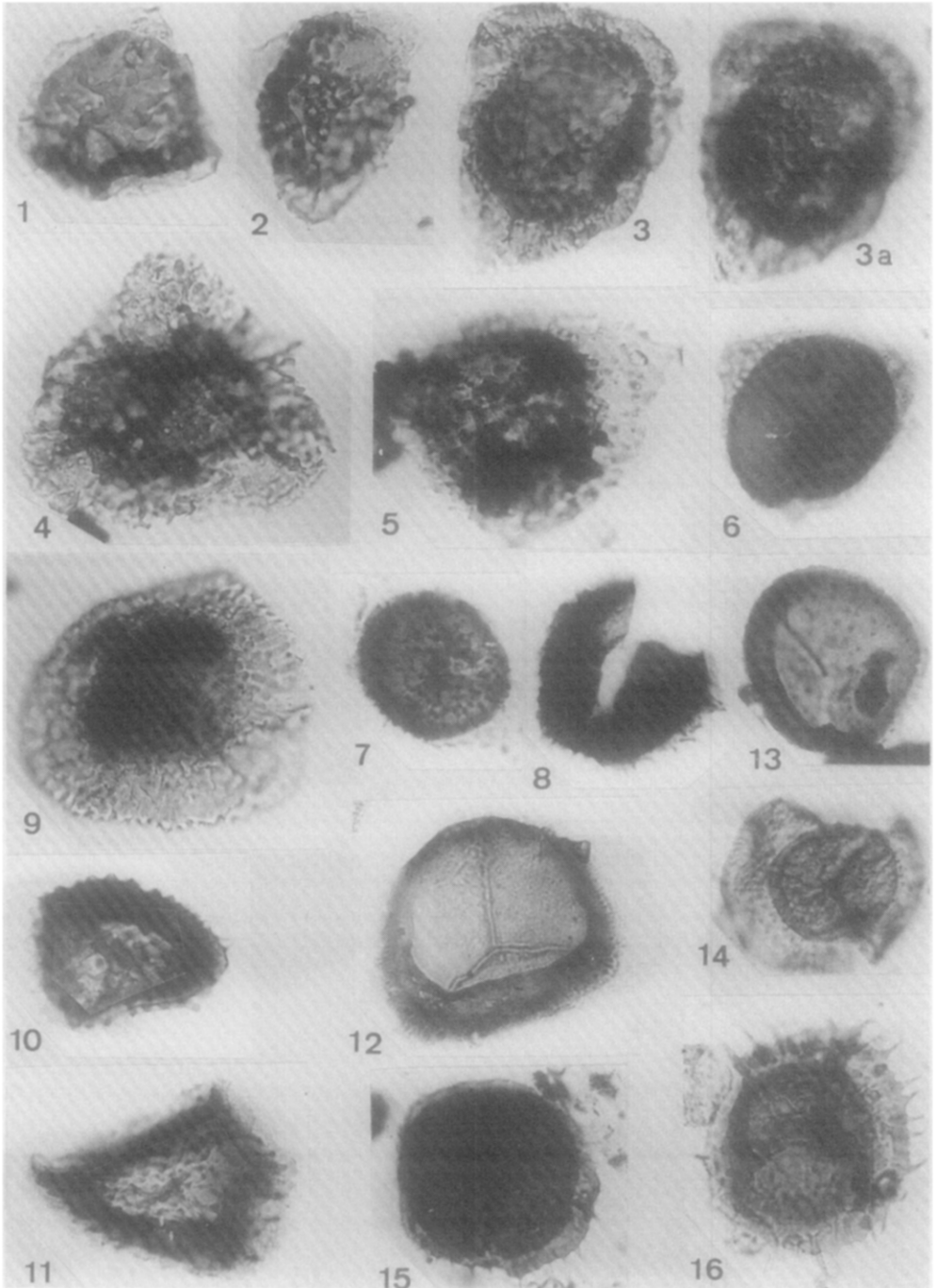


PLATE III (Description on p. 63—64)

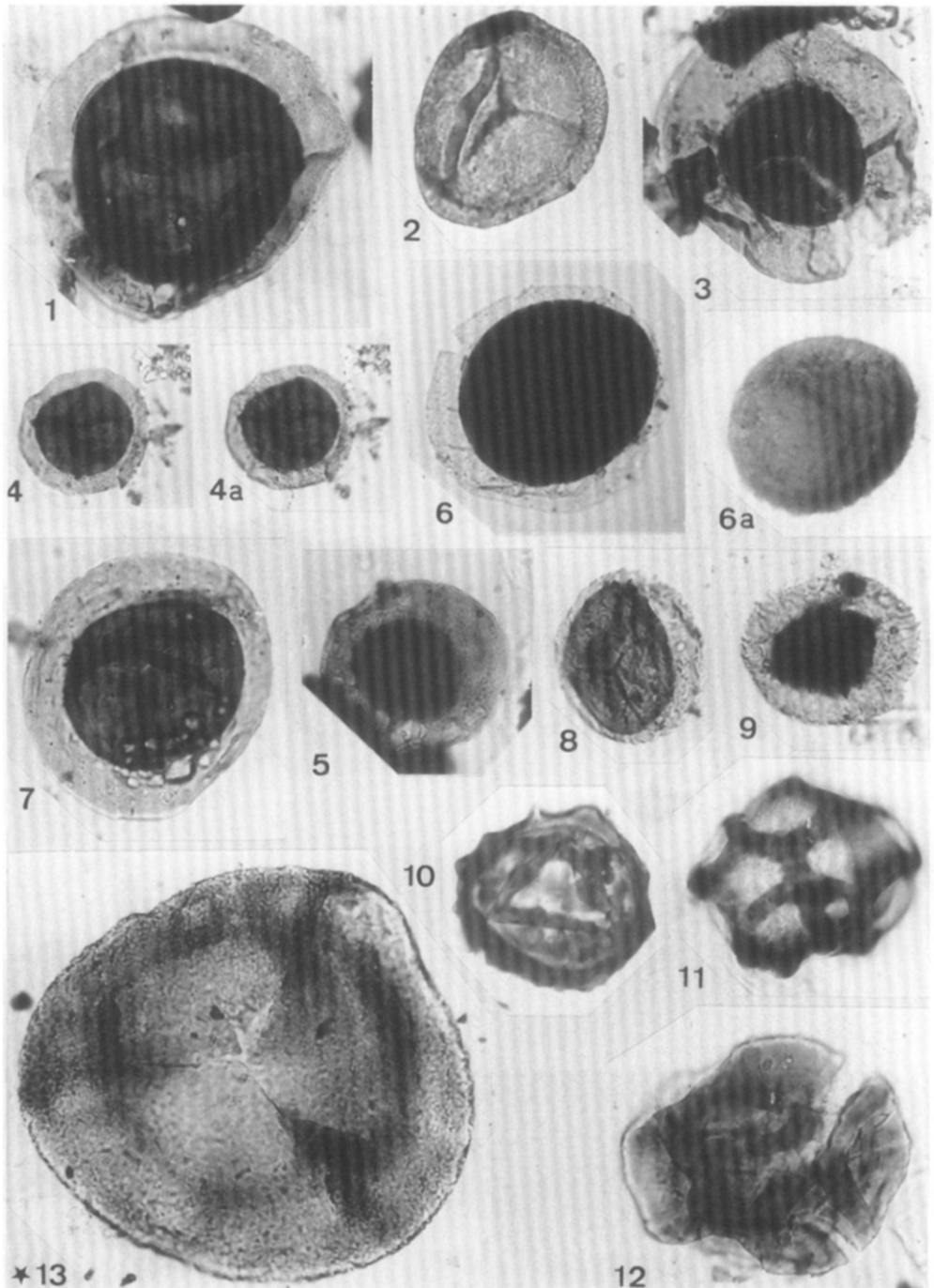


PLATE IV (Description on p. 64)

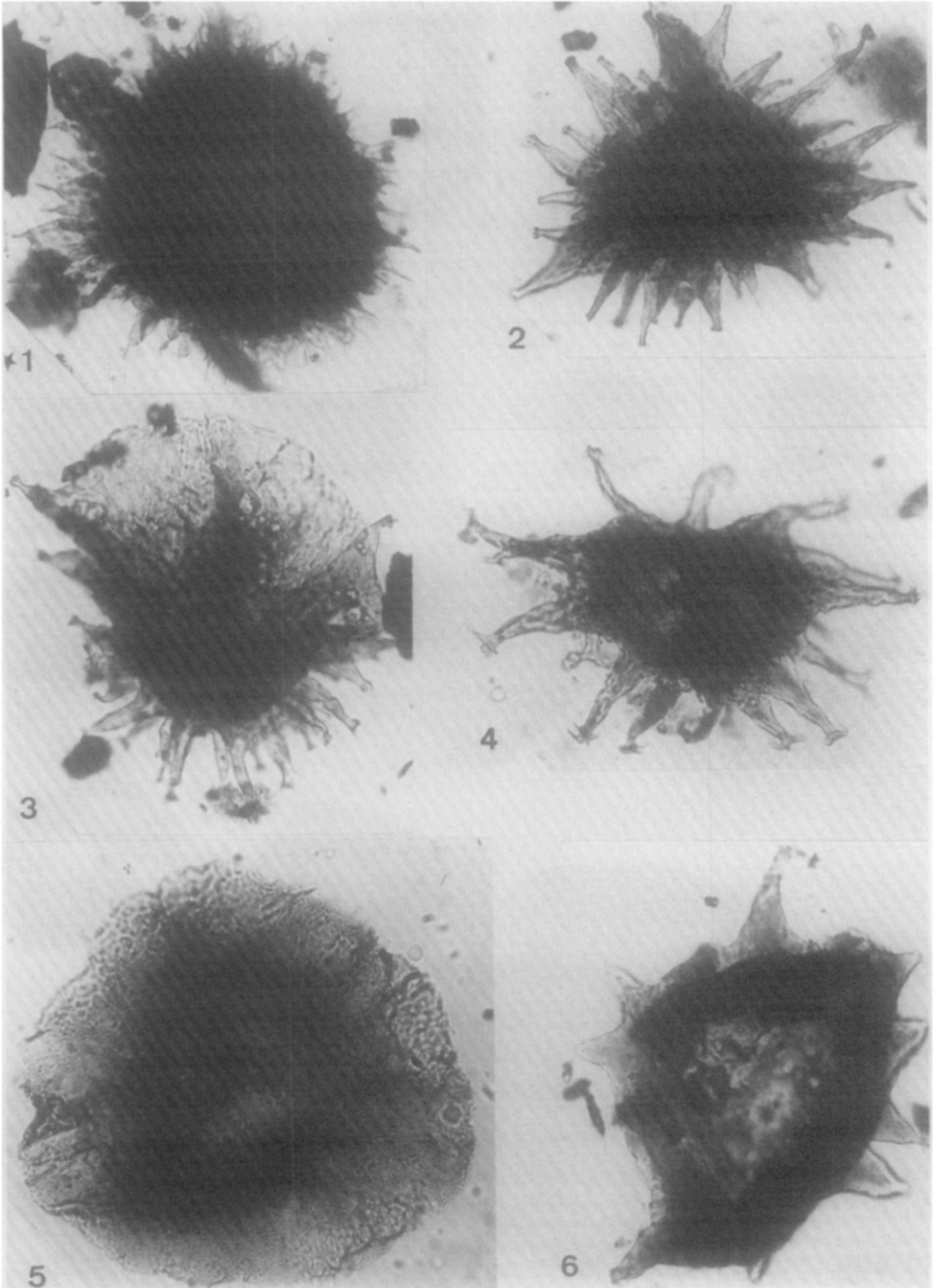


PLATE I (p. 59)

All photographs $\times 500$, except where otherwise stated*. Identification numbers (Fig.1) are given between brackets; IC = interference contrast.

- 1, 2. (67) *Retusotriletes planus* Dolby et Neves. 1. IC, Slide 114(7), 26/58; 1a, IC, detail of 1, $\times 1000$. 2. IC, Slide 109(6), 23/12.
- 3, 4. (51) *Pustulatissporites rugulatus* (Taugourdeau-Lantz) nov. comb. 3. Slide VW 8(2), 18/75. 4. Slide 114(3), 23/81.
5. *Corbulispora* sp. Slide 114(2), 19/09.
6. *Convolutispora* sp. Slide S 1(2), 05/58.
7. (4) *Convolutispora disparilis* Allen. Slide VW 8(1), 09/55.
8. (48) *Convolutispora tegula* Allen. Slide VW 5(2), 19/34.
- 9, 10. (45) *Verrucosissporites bullatus* Taugourdeau-Lantz. 9. Slide VW 5, 28/19. 10. Slide 05(1), 18/10.
11. (58) *Rugospora* cf. *flexuosa* (Juskho) Strel in Becker et al. IC Slide 117(1), 08/85.
12. (49) *Planisporites scaber* Taugourdeau-Lantz. Slide 117(1), 09/84.
- 13, 14. (68) *Cymbosporites* sp. A. 13. Slide 109(5), 11/73; 13a, detail of 13, $\times 1000$. 14. Slide 114(6), 10/12; 14a, IC, proximal focus.
- 15, 16. (57) *Cymbosporites* sp. B. 15. Slide 116(3), 30/04; 15a, detail of 15, $\times 1000$. 16. Slide 117(1), 08/11; 16a, IC, distal focus.
17. (2) *Archaeozonotriletes variabilis* (Naumova) Allen. Slide VW 5(1), 14/26.
18. (38) *Chelinospora concinna* Allen. Slide 53(3), 17/08.
19. ?Cf. *Cyrtospora cristifer* (Luber) Van der Zwan. Slide 114(1), 13/11.

PLATE II (p. 60)

All photographs $\times 500$.

Identification numbers (Fig.1) are given between brackets; IC = interference contrast.

- 1-5. (36) *Samarisporites triangulatus* Allen. 1. Slide VW 8(3), 25/68. 2. Slide Z 14(3), 18/77. 3. IC, Slide VW 8(2), 16/57; 3a, IC, distal focus. 4. Slide Z 15(2), 10/78. 5. Slide Z 16(2), 22/19.
6. *Samarisporites* cf. *triangulatus* Allen. Slide 116(2), 21/19.
- 7, 8. (54) *Samarisporites* sp. A. 7. Slide 114(5), 18/44. 8. Slide 109(2), 01/38.
9. *Samarisporites* sp. Slide Q52(1), 21/02.
10. *Densosporites* sp. Slide 117(2), 22/53.
11. *Densosporites* sp. Slide 117(3), 11/42.
12. (39) *Cirratiradites jekhovskiyi* Taugourdeau-Lantz. Slide S1(1), 21/99.
13. (69) *Grandispora gracilis* (Kedo) Strel in Becker et al. Slide 09(1), 24/10.
14. (21) *Grandispora inculta* Allen. IC, Slide 117(1), 14/44.
15. (32) *Grandispora tomentosa* Taugourdeau-Lantz. Slide 05(1), 26/40.
16. (56) *Grandispora* sp. A. Slide 117(1), 12/53.

PLATE III (p. 61)

All photographs $\times 500$, except where otherwise stated*. Identification numbers (Fig.1) are given between brackets; IC = interference contrast.

1. (35) *Rhabdosporites parvulus* Richardson. Slide 05(1) 19/02.
2. (40) *Geminospora lemurata* Balme. Slide VW 8(1), 26/27.
3. (70) *Auroraspora solisorta* Hoffmeister, Staplin et Malloy. Slide 114(1), 21/98.
4. (63) *Auroraspora macra* Sullivan, Slide 114(1), 14/86. 4a, IC.
5. (62) *Auroraspora hyalina* (Naumova) Strel in Becker et al. Slide 109(1), 10/32.
6. (66) *Auroraspora* sp. A. Slide 114(2), 17/19. 6a, central body.
7. (55) *Diducites poljessicus* (Kedo) Van Veen. Slide 114(3), 23/82.
8. (64) *Diducites plicabilis* Van Veen. IC, Slide 114(2), 16/50.

9. (65) *Diducites versabilis* (Kedo) Van Veen. IC, Slide 114(5), 14/59.
10. (50) *Lophozonotriletes media* Taugourdeau-Lantz. Slide VW 8(1), 16/79.
11. (59) *Knoxisporites dedaleus* (Naumova) Streel. Slide 109(3), 14/91.
12. (60) *Knoxisporites cf. hederatus* (Ishchenko) Playford. Slide 114(2), 16/03.
13. (12) *Contagisporites optivus* (Chibrikova) Owens. Slide VW 5(1), 09/78, × 300.

PLATE IV (p. 62)

All photographs × 300, except where otherwise stated*. Identification numbers (Fig.1) are given between brackets.

1. (42) *Corystisporites multispinosus* Richardson. Slide 05(1), 21/50, × 500.
2. (31) *Ancyrospora langii* (Taugourdeau-Lantz) Allen. Slide Z 14(1), 20/30.
- 3, 4. (47) *Hystricisporites multifurcatus* (Winslow) Mortimer et Chaloner. 3. Slide Z 14(2), 22/71. 4. Slide VW 8(1), 17/43.
5. (52) *Ancyrospora lysii* (Taugourdeau-Lantz) nov. comb. Slide VW 22(1), 10/22.
6. (46) *Ancyrospora simplex* Guennel. Slide Z 14(2), 14/69.

REFERENCES

- Allen, K.C., 1965. Lower and Middle Devonian spores of North and Central Vestspitsbergen. *Palaeontology*, 8(4): 687–748.
- Allen, K.C., 1967. Spore assemblage and their stratigraphical application in the Lower and Middle Devonian of North and Central Vestspitsbergen. *Palaeontology*, 10(2): 280–297.
- Allen, K.C., 1973. Further information on the Lower and Middle Devonian spores from Dicksonland, Spitsbergen. *Nor. Polarinst. Årb.*, 1971, Oslo, pp.43–54.
- Balme, B.E., 1962. Upper Devonian (Frasnian) spores from the Carnarvon Basin, Western Australia. *Palaeobotanist*, 9: 1–10.
- Balme, B.E. and Hassell, C.W., 1962. Upper Devonian spores from the Canning Basin. *Western Australia. Micropaleontology*, 8: 1–28.
- Becker, G., Bless, M.J.M., Streel, M. and Thorez, J., 1974. Palynology and ostracode distribution in the upper Devonian and basal Dinantian of Belgium and their dependence on sedimentary facies. *Meded. Rijks Geol. Dienst, N.S.*, 25(2): 9–99.
- Bonte, A., Colbeaux, J.P., Hoyez, B. and Lethiers, F., 1974. Les "Schistes d'Hydrequent" (Dévonien supérieur du Bas Boulonnais): nouvelles observations. *Ann. Soc. Géol. Nord*, XCIV(3): 117–121.
- Bouckaert, J. and Streel, M. (Editors), 1974. Guidebook, International Symposium on Belgian Micropaleontological Limits from Emsian to Viséan, Namur (1974). Geological Survey of Belgium, Brussels.
- Brice, D. and Meats, P., 1972. Le genre *Ripidiorhynchus* (Rhynchonellida — Brachiopodes) dans le Dévonien de Ferques (Boulonnais). *Ann. Soc. Géol. Nord*, XCI(4): 215–228.
- Brice, D., Bultynck, P., Colbeaux, J.P., Lethiers, F., Mistiaen, B., Rohart, J.C. and Bigey, F., 1976. Une nouvelle coupe dans le Dévonien de Ferques. *Ann. Soc. Géol. Nord*, XCVI(2): 135–155.
- Brice, D., Bigey, F., Mistiaen, B., Poncet, J. and Rohart, J.C., 1977. Les organismes constructeurs (Algues, Stromatopores, Rugueux, Tabulés, Bryozoaires) dans le Dévonien de Ferques (Boulonnais — France). *Associations — Répartition stratigraphique. Mém. B.R.G.M.*, 89: 136–151.
- Brice, D., Colbeaux, J.P., Mistiaen, B. et Rohart, J.C., 1979a. Les formations dévoniennes de Ferques (Bas-Boulonnais, France). *Ann. Soc. Géol. Nord*, XCVIII: 307–324.
- Brice, D., Bultynck, P., Deunff, J., Loboziak, S. and Streel, M., 1979b. Données biostratigraphiques nouvelles sur le Givetien et le Frasnien de Ferques (Boulonnais — France). *Ann. Soc. Géol. Nord*, XCVIII: 325–344.
- Brice, D., Coen, M., Loboziak, S. and Streel, M., 1981. Précisions biostratigraphiques

- relatives au Dévonien supérieur de Ferques (Boulonnais, France). *Ann. Soc. Géol. Nord*, sous presse.
- Casier, J.G., 1977. Contribution à la connaissance des ostracodes du Frasnien de la Belgique. *Serv. Géol. Belg., Prof. Pap.* 1977/10 No. 147: 1–22.
- Coen, M., 1973. Faciès, Conodontes et Stratigraphie du Frasnien de l'Est de la Belgique, pour servir à une révision de l'étage. *Ann. Soc. Géol. Belg.*, 95, 1972, II: 239–254.
- Chibrikova, E.V. and Naumova, S.N., 1974. Zonal complexes of Devonian spores and pollen in the European part of the U.S.S.R. and their analogues abroad. In: *Palynology of Proterophyte and Palaeophyte*, Proc. 3rd Int. Palynol. Conf., Novosibirsk. Nauka, Moscow, pp.39–46 (in Russian).
- Chijova, V.A., Bouckaert, J., Alekseev, A.S., Aristov, V.A., Barskov, I.S., Gagiry, M.Ch., Dreesen, R., Kononova, L.I., Lipnagov, O.M., Ovnatanova, N.S., Simakov, K.V. and Chalimbadja, V.G., 1979. The correlation of Famennian and Tournaisian deposits of the U.S.S.R. and French–Belgian basins on conodonts. *Serv. Géol. Belg., Prof. Pap.* 1979/5, No. 161: 1–40 (in Russian and English).
- Clayton, G., Coquel, R., Doubinger, J., Gueinn, K.J., Loboziak, S., Owens, B. and Streel, M., 1977. Carboniferous miospores of western Europe: illustration and zonation. *Meded. Rijks. Geol.Dienst*, 29: 1–71.
- Dolby, G. and Neves, R., 1970. Palynological evidence concerning the Devonian–Carboniferous boundary in the Mendips, England. *C.R. Congr. Int. Stratigr. Geol. Carbonifère 6th*, Sheffield, 1967, 2: 631–646.
- Errera, M., Mamet, B. and Sartenaer, P., 1972. Le Calcaire de Givet et le Givetien à Givet. *Bull. Inst. R. Sci. Nat. Belg.*, 48, Sciences de la Terre, 1: 1–59.
- Guennel, G.K., 1963. Devonian spores in a Middle Silurian reef. *Grana Palynol.*, 4(2): 245–261.
- Hoffmeister, W.S., Staplin, F.L. and Malloy, R.E., 1955. Geologic range of Paleozoic plant spores in North America. *Micropaleontology*, 1: 9–27.
- Kushnareva, T.I., Khalymbadzha, V.G. and Busygina, Yu.N., 1978. Biostratigraphic zoning of the Domanik Suite in the stratotype section. *Sov. Geol.*, 1978: 60–71 (in Russian).
- Loboziak, S. and Streel, M., 1980. Miospores in Givetian to lower Frasnian sediments dated by conodonts from the Boulonnais, France. *Rev. Palaeobot. Palynol.*, 29: 285–299.
- Magne, F., 1964. Données micropaléontologiques et stratigraphiques dans le Dévonien du Boulonnais (France) et du bassin de Namur (Belgique). Thesis, University of Paris, Paris, 172 pp. (unpublished).
- Mailleux, E. and Demanet, F., 1929. L'échelle stratigraphique des terrains primaires de la Belgique. *Bull. Soc. Belg. Géol., Paléontol., Hydrol.*, XXXVIII, 1928: 124–131.
- Mortimer, M.G. and Chaloner, W.G., 1967. Devonian megaspores from the Wyboston borehole, Bedfordshire, England. *Palaeontology*, 10(2): 189–213.
- Naumova, S.N., 1953. Sporo-pollen complexes from the Upper Devonian of the Russian Platform and their stratigraphic value. *Akad. Nauk S.S.S.R., Inst. Geol. Nauk. Tr., Geol. Ser.*, 143(60): 1–204 (in Russian).
- Ovnatanova, N.S., 1979. Frasnian–Famennian conodonts of the Volga–Ural region. *Serv. Géol. Belg. Prof. Pap.* 1979/5, 161: 59–70 (in Russian and English).
- Owens, B., 1971. Miospores from the Middle and early Upper Devonian rocks of the Western Queen Elisabeth Islands, arctic Archipelago. *Geol. Surv. Can.*, 70(38): 1–157.
- Playford, G., 1963. Lower Carboniferous microfloras of Spitsbergen. Part II. *Palaeontology*, 5(3): 550–618.
- Playford, G., 1971. Lower Carboniferous spores from the Bonaparte Gulf Basin, Western Australia and Northern Territory. *Aust. Bur. Min. Resour., Bull.*, 115: 1–104.
- Raskatova, L.G., 1974. Detailed stratigraphic subdivision of the Devonian of the Central Devonian Field in the light of palynological evidence. In: *Palynology of Proterophyte and Palaeophyte*, Proc. 3rd Int. Palynol. Conf. Novosibirsk, 1971. Nauka, Moscow, pp.67–71 (in Russian).

- Richardson, J.B., 1962. Spores with bifurcate processes from the Middle Old Red Sandstone of Scotland. *Palaeontology*, 5(2): 171–194.
- Richardson, J.B., 1965. Middle Old Red Sandstone spore assemblage from the Orcadian basin northeast Scotland. *Palaeontology*, 7(4): 559–605.
- Richardson, J.B., 1974. The stratigraphic utilization of some Silurian and Devonian microspore species in the Northern Hemisphere: an attempt at a synthesis. *Int. Symp. Namur*, 1974, 9: 1–13.
- Sennova, V.F., 1972. Spore–pollen assemblages of the Upper Devonian of Timan–Pechora Province. In: *Geology and Oil- and Gas-Bearing Beds of the Northeast European Part of the U.S.S.R.*, II. Min. Geol. RSFSR, Syktyvkar, pp.99–107 (in Russian).
- Sennova, V.F., 1974. Assemblages of the spores and other microfossils from deposits in the Timan–Pechora province. In: *Palynology of Proterophyte and Palaeophyte*, Proc. 3rd Int. Palynol. Conf., Novosibirsk. Nauka, Moscow, pp.72–75 (in Russian).
- Streel, M., 1965. Etude palynologique du Dévonien du sondage de Booischot (Belgique). *Bull. Soc. Belg. Géol., Paleontol., Hydrol.*, LXXIII, 2(1964): 172–185.
- Streel, M., 1977. Corrélations palynologiques dans le Tournaisien du Synclinorium de Namur. *Bull. Soc. Belg. Géol.* (1973), 82(2): 397–415.
- Streel, M., 1981. Evidences palynologiques sur les relations entre le climat et la distribution géographique des flores dévoniennes et dinantiennes. *Mém. Mus. Nat. Hist. Nat., Paris, B, Bot.*, XXVII: 261–267.
- Sullivan, H.J., 1968. A Tournaisian spore flora from the Cementstone Group of Ayreshire, Scotland. *Palaeontology*, 11(1): 116–131.
- Taugourdeau-Lantz, J., 1960. Sur la microflore du Frasnien inférieur de Beaulieu (Boulonnais). *Rev. Micropaléontol.*, 3(3): 144–154.
- Taugourdeau-Lantz, J., 1967a. Les spores du Frasnien du Bas-Boulonnais (France). *Rev. Palaeobot. Palynol.*, 1(1–4): 131–139.
- Taugourdeau-Lantz, J., 1967b. Spores nouvelles du Frasnien du Bas-Boulonnais (France). *Rev. Micropaléontol.*, 10(1): 48–60.
- Taugourdeau-Lantz, J., 1971. Les spores du Frasnien d'une région privilégiée, le Boulonnais. *Mém. Soc. Géol. Fr., N.S.*, L(114): 1–86.
- Tsien, H.H., 1975. Introduction to the Devonian reef development in Belgium. In: 2nd Int. Symp. on Fossil Corals and Reefs, Paris, 1975, Guidebook, Excurs. C. Belgian Geological Survey, Brussels, pp.3–43.
- Van der Zwan, C.J. and Van Veen, P.M., 1978. The Devonian–Carboniferous transition sequences in southern Ireland: integration of palaeogeography and palynology. *Palinología*, 1: 469–479.
- Van Veen, P.M., 1981. Aspects of Late Devonian and Early Carboniferous palynology of southern Ireland. IV. Morphological variation within *Diducites*, a new formgenus to accommodate camerate spores with a two-layered outer wall. *Rev. Palaeobot. Palynol.*, 31: 261–287.