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Devonian Miospore Palynology in Western Gondwana:

An application to oil exploration

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Volume III: Taxonomy

"The road to excess leads to the palace of wisdom"
(William Blake)

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Chapter 1 – Some considerations on Devonian miospore taxonomy

1.1. Introduction

Human beings need to have name tags for things and classify them in different boxes, in order to deal with them. Therefore, miospore taxa are named by using Linnaean-style Latinized binomial nomenclature, formally governed by the International Code of Botanical Nomenclature (ICBN). The purpose of formal nomenclature is to provide a precise, simple and stable system of unique names used by scientists all over the world. This system must allow for expansion and refinement to accommodate increasing knowledge (see Traverse, 1996). However, Palaeozoic miospore taxonomy has currently become somewhat problematic. The number of described species has been so huge that it is difficult to cope with all this information. Firstly, each author works preferably with his own discriminatory criteria, so one possesses a personal conception of the miospore classification. Authors do not necessarily use the same discriminatory features when they erect new taxa. Consequently comparisons between assemblages described by different authors are getting really confusing. Secondly, lots of species were not always accurately described, either because they have a rather rough diagnosis, or because they were defined from very few specimens resulting in the ignorance of their intraspecific morphological variability. Furthermore, diagnoses on the base of badly preserved specimens are not always precise and can be uneasily usable by other authors. Finally, species which are defined in not very widespread journals are unknown by many miospore searchers and sometimes can be described in other languages than English. These species are mainly used by the local authors and have been completely unusable and/or forgotten by most of the palynologists. All these reasons have caused a taxonomical chaos resulting in the overlapping diagnoses of some taxa. This work does not intend to resolve the problems related to miospore taxonomy but rather to highlight some of them by using some examples from the studied Devonian assemblages from northwestern Gondwana.

1.2. Discussion

The fact that miospores are generally retrieved from sediments after their dispersal often imply, at least for the Palaeozoic, ignorance of their parent plants and consequently of their natural affinities, most of the time. Thus Palaeozoic miospore taxonomy is generally arbitrary and artificial. As essential material of palaeopalynology is dispersed spores, morphology obviously provides the principal and unique basis for taxonomic discrimination. Therefore, miospores, as acritarchs, are classified into different groups by a simple morphological comparison. Miospore workers use indeed form-genera and form-species (i.e. parataxa). At the suprageneric level, the completely informal subgroups of Potonié (1956) are commonly used. His turmal system, which has been revised several times in his Synopsis volumes (Potonié 1956-1970) is a scheme for classifying fossil miospores according to the morphological characters. As one can choose any version of Potonié's system or make up his own, and as the individual units in the system are not subject to rules of priority (see Traverse, 1988), this kind of classification seems to be very confusing. Miospore genera are defined according to the general structural features of miospores, such as equatorial outline, wall stratification, wall sculpturing, and any structural modifications of the spore wall (e.g. cingulum, zona or patina). Miospore species are described on the basis of ornament characters, such as their size, shape, and distribution. At the infraspecific level, the rank variety is rarely used. Other methods of classifying miospores have been used (see Traverse, 1996). Hughes' biorecord (1975-1991) scheme is another parataxonomy; as conventional taxa tend to be expanded by reference to them of newly discovered slightly variant forms until the taxa are 'balloon taxa' of little stratigraphic use, this system treats every newly described form as completely unchangeable and independent of others, preventing 'ballooning'. In summary, palynological parataxonomy produces groupings with common morphological features whereas a true taxonomy describes the hierarchy of groupings of plants indicative of presumed natural relationships (see Traverse, 1996).

Some authors urge the stratigraphic utility of subdividing miospore groupings as much as possible; but others note that gradations between taxa may be so slight that intermediates can often be found between species or even genera, frequently regarded as separate. Many cases of such intergrading taxa are common in the fossil record (e.g. Playford, 1983; Steemans & Gerrienne, 1984; Richardson et al., 1993; Breuer et al., 2005). The palynomorphs often transgress taxonomical boundaries they have originally been defined on. That is why concepts of palynodeme (Visscher; 1971) and morphon (Van der Zwan, 1979) have been introduced. A palynodeme defines a group of palynomorph species that intergrade and probably represent the palynological reflection of a known or hypothetical plant species (Visscher, 1971). As originally used, this concept was phylogenetic and referred to characters changing in time. Whereas a morphon delimits a group of palynological species (form-species) simply united by continuous variation of morphological characteristics (Van der Zwan, 1979). However in practice the two concepts are considered by many as synonymous (Traverse, 1988). The main idea of these concepts can be resumed as follows: the apparent morphological continua may represent spore variation in a particular known or hypothetical natural plant species or group of related species. However, evolutionary convergence may cause morphological similarities between miospores that do not necessarily reflect links between their parent plants. During Palaeozoic times, different plant groups often produced miospores of similar morphology (Gensel, 1980; Fanning et al., 1992). In contrast, a same sporangium can give two different genera of trilete spore (Habgood et al., 2002). The palynodeme and morphon concepts are complementary to the typological approach of traditional taxonomy in palynology. They emphasize the continuity of the morphological characters more than the discontinuity. They integrate morphological trends which are space/or time-dependent but also sensitive to various environmental conditions. They may facilitate the interpretation of the morphological variations in terms of natural variation. Unfortunately, such studies treating the environmental influences on miospore variability are rare or nonexistent. For Devonian miospores, McGregor & Playford (1992) have defined several morphons as much variation has been observed in certain morphological characters. Those morphons are useful for comparison of assemblages on a second level (McGregor & Playford, 1992).

Authors have rarely mentioned phylogenetic miospore evolution in Palaeozoic sediments (e.g. Van der Zwan, 1979; Marshall, 1996; Maziane et al., 2002; Breuer et al., 2005). Some authors have demonstrated continuous morphological intergradation among some dispersed spores that have previously been attributed to different form-species and even -genera. However, the morphological signal presented by miospores may not only reflect biological evolution. Indeed, it may be influenced locally by other parameters such as state of preservation, sedimentary sorting (Jäger, 2004) and/or reworking of simpler and older morphotypes in assemblage containing more complex and younger ones (Breuer et al., 2005).

1.3. Examples of morphological variation

In this part, three examples of continuous morphological intergradation are presented and one about a possible taphonomic problem. These specimens come from Devonian core samples from Libya and Saudi Arabia studied here.

1.3.1. Continuous morphological intergradation within a unique form-species

Grandispora libyensis Moreau-Benoit, 1980b (Pl. 76, figs 6, 7, Pl. 77, figs, 1-6, Pl. 120, figs 14-25, Pl. 121, figs 1-9) occurs notably in Middle Devonian sediments in Libya (see e.g. Massa & Moreau-Benoit, 1976; Loboziak & Streel, 1989). This species of *Grandispora* Hoffmeister et al. emend. Neves & Owens, 1966 is mainly defined by its equatorially thickened sexine (3-7 µm thick) and its distal surface sculptured with spines or biform elements with 3-7 µm wide bulbous base, commonly 3-10 µm high (rarely up to 13 µm), the rounded apices supporting a small spine. The ornament is usually densely spaced. In this work, it appear that the specimens show a continuous morphological variation in ornamentation, intergrading from a morphotype with rather slender spines to one characterized by bulbous biform elements. Although two end-members exist, all the intermediate forms are present. The morphotype characterized by the most massive ornaments seems to appear later than the morphotype with more slender ornaments, but in the youngest samples, the two-end members co-occur.

1.3.2. Continuous morphological intergradation within a unique form-genus

The genus *Verrucosiporites* Ibrahim emend. Smith, 1971 occurs notably in Middle Devonian samples. In Libyan samples, this very confusing group includes probably the following described species: *Verrucosisporites premnus* Richardson, 1965 (Pl. 107, figs 11-16, Pl. 108, figs 1-3), *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 (Pl. 108, figs 4-14), *Dibolisporites farraginis* McGregor & Camfield, 1982 (Pl. 51, figs 1-11) and *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982 (Pl. 55, figs 3-7). Although the two latter species were described in the genus *Dibolisporites* Richardson, 1965, many authors consider them to belong to *Verrucosisporites*. All these described species co-occur in most of the levels of Libya they are typical in, and are discriminated with difficulty. Indeed, this group of form-species have very close diagnoses. These species can be differentiated as follows. *Dibolisporites farraginis* is distinguished from *Dibolisporites uncatus* by its smaller sculptural elements. *Dibolisporites uncatus* has predominantly somewhat smaller and less crowded conate spinose and biform sculpture; than that of *Verrucosisporites scurrus*. *Verrucosisporites premnus* has larger, predominantly flat-topped or bulbous verrucae and bacula. However reality is more complex than theory and problematic specimens still remain to determine. Specimens herein assigned to these species seem to form a more or less intergrading series from those with predominantly conate and small verrucose sculpture (*Dibolisporites farraginis*) to those with large verrucate sculptural elements, and thus conform rather closely to the diagnosis of *Verrucosisporites scurrus* and *Verrucosisporites premnus*. Besides, McGregor & Playford (1992) have designated the *Dibolisporites farraginis* and *Verrucosisporites scurrus* Morphon; they have noted morphological intermediates between them. The *Dibolisporites farraginis* Morphon is considered here as included in the *Verrucosisporites scurrus* Morphon (Tab. 1, p. 185).

1.3.3. Continuous morphological intergradation between two form-genera

A continuous morphological intergradation between two genera has been highlighted in Early Devonian miospore assemblages from Saudi Arabia. Ornamentation and their organization on the spore distal surface vary between the two end-members which correspond to two distinct genera: *Cymbosporites* Allen, 1965 and *Dictyotriletes* Naumova, 1939 ex Ishchenko, 1952. All the intermediary forms between them co-occur in the assemblages. This 'lineage' includes morphotypes undescribed in the literature except *Dictyotriletes biornatus* Breuer et al., 2007c (Pl. 58, figs 1-15). In the simplest spore form ornaments (in the shape of small cones) are evenly distributed on the distal surface (*Cymbosporites* sp. 1; Pl. 42, figs 1-14). In the intermediary forms (*Cymbosporites* sp. 2; Pl. 43, figs 1-14; and *Cymbosporites* sp. 3; Pl. 44, figs 1-14) they progressively organize and combine until they form a pseudo-reticulum, the walls of which are constituted by the discrete ornaments (*Dictyotriletes biornatus*). In the most complex spore form ornaments become merged and form elongated ornaments which represent a perfectly closed reticulum (*Dictyotriletes* sp. 1; Pl. 60, figs 14-20). Thus a progressive organization of the ornamentation appears from the simplest spores to the most evolved ones. This example illustrates that the miospore taxonomy is artificial because the two end-members of this lineage belong to two distinct genera. All morphotypes are grouped into the *Dictyotriletes biornatus* Morphon (Tab. 1, p. 185).

Thanks to statistical texture image analysis, a study of the spatial distribution of the ornaments has been realised on this continuous morphological intergradation (Breuer et al., 2007b). This analysis provides a gauging tool to quantify the morphological evolution and seems to allow assisted automatic classification. Indeed, spore classification by image analysis gives strict accuracy of 61% but gives 98% of accuracy if we accept spore misclassing in a neighbour taxon.

1.3.4. Taxonomical confusion as a result of preservation?

Finally, palynologists have to be careful because morphological differences may depend on the state of preservation or the transport undergone by the miospores, not necessarily on original features. In the present study, two form-species described below co-occur in the same layers or are found separately. *Diaphanospora* sp. 1 (Pl. 48, figs 1-14) is two-layered and rounded. The nexine possesses a dark triangular thickening of the proximal pole and the sexine is very thin and strongly folded. *Retusotriletes* sp. 2 (Pl. 95, figs 5-13) does not have a thin outer layer but has the same spore body as *Diaphanospora* sp. 1. Although they can be clearly separated morphologically, either they may represent two varieties of a close parent plant species, or *Retusotriletes* sp. 2 may result from the corrosion of *Diaphanospora* sp. 1. Indeed, a slight detachment of the sexine can be observed locally on some specimens of *Diaphanospora* sp. 1 (Pl. 48, figs 6, 10), thus the thin sexine may have been torn by sedimentary or taphonomic processes because it seems very delicate. In badly preserved material, *Retusotriletes* sp. 2 will be observed probably in predominance over *Diaphanospora* sp. 1. The contrary is also true; *Diaphanospora* sp. 1 is observed alone in very well-preserved material. Therefore, the *Diaphanospora* sp. 1 Morphon is defined (Tab. 1, p. 185). Burgess (1991) has noted the same problem with *Segestrespora membranifera* (Johnson) Burgess, 1991, a Silurian cryptospore species which is a dyad enclosed within a membrane. When specimens of this taxon, have lost their membrane they are attributed to another genus and species (*Pseudodyadaspora laevigata* Johnson, 1985). This situation can be confusing when comparing different assemblages.

1.4. Conclusions

The different examples of continuous intergrading morphological variation showed above illustrate one of the major problems in miospore taxonomy: the morphological variability of each taxon, combined with the description of individual forms, which are rarely studied within large populations. The rather rough description of new taxa in older papers does not correspond any more to the requirements of the present palynology. Furthermore, often too few specimens were illustrated for new taxa. Many miospore species were described from only few specimens and their variability is not well-known. It is important to illustrate correctly the variability of each new taxon. The morphological variability can be observed at the intraspecific, but also at the intrageneric level. Most authors preferred to place their new taxa in well-defined boxes than in a palynodeme or morphon, which are concepts introduced for miospore species linked by continuous variation of morphological characters. Indeed, it may be difficult or even impossible to attribute some transitional forms between other well-defined taxa. Ideally larger populations and the relationships between the taxa should be studied to better understand the nature of a miospore taxon. It appears obvious that today the description of a new miospore species should be associated with studies on variability and biometrics. But in reality, the studied material does rarely allow to stick to this theory. The material can be badly preserved or scarce regularly as in most Devonian sediments. But this should not prevent the improvement of the knowledge of palynological assemblages. Indeed when several specimens of a new form-species are observed in a badly preserved material and appeared easily distinct from what has been already described in the literature, palynologists can describe them either in open nomenclature or even formally. Then, the new taxa can be emended later by others when more specimens are discovered as the ICBN recommend.

Another important point in miospore taxonomy is the search of useful characters in the separation of taxa. We have to ask ourselves which discriminatory criteria should be used at the generic, specific and intraspecific level. These characters should be common to all authors in order to stop the ongoing current taxonomical chaos.

Finally, the purpose of this introduction neither is to solve problems related to the somewhat chaotic miospore taxonomy nor to call the numerous stratigraphic correlations based on it into question, but rather to highlight some of them and to encourage a common approach to taxonomy.

Chapter 2 – Miospore taxonomy

The miospore populations of the species encountered in this work have been described and measured in details. Their morphological variability has been illustrated in plates by several specimens for each. Synonymy is listed for each species. The comparison of each species with possible resembling forms is discussed. In addition, the stratigraphic and palaeogeographic distribution of species are enumerated from a part of the literature. Nevertheless, the age of the miospore assemblages, where the species described here occur, are cited as in the original papers and are not reappraised. A glossary of palynological terms and a list of morphons used are situated at the end of this volume.

2.1. Cryptospores

Genus *Artemopyra* Burgess & Richardson, 1991

Type species: *Artemopyra brevicosta* Burgess & Richardson, 1991.

Description: Proximally hilate cryptospore monads. Amb originally circular to subcircular in equatorial view. Proximal hilum sculptured with predominantly radial muri. Distal exine laevigate or sculptured with grana, coni, biform elements or spinae.

***Artemopyra inconspicua* Breuer et al., 2007c**

Pl. 1, figs 1-8

2007c *Artemopyra inconspicua* Breuer et al., p. 42, Pl. 1, figs 1-5.

Description: Amb circular to subcircular. A diffuse to clear curvatura delimits a more or less circular hilum. Proximal surface is characterized by scars which often looks like a trilete mark. The hilum radius commonly equal to 3/4 to 4/5 of the amb radius. Hilum sculptured with closely spaced, radially disposed muri which are straight, up 0.5-1 µm wide and 0.5-1 µm apart at the equator, becoming thinner towards the proximal pole. Typically the muri are weakly defined and extend from the curvatura to, from half to all of the way to the proximal pole. There are numerous muri, usually between 60 and 90. Distal surface laevigate.

Dimensions: 36 (48) 57 µm, 20 specimens measured.

Comparisons: *Artemopyra brevicosta* Burgess & Richardson, 1991 has more robust, radial muri which always are confined to the equatorial region of the contact area. *Artemopyra recticosta* Breuer et al., 2007c possesses thicker muri which are less numerous (18-46). *Artemopyra inconspicua* Breuer et al., 2007c sometimes can be mistaken for *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia* Breuer et al., 2007c because of the inconspicuous nature of the muri.

Stratigraphic and palaeogeographic occurrence:

- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6; earliest Givetian.
- Saudi Arabia: Boreholes BAQA-1, JNDL-1, 3, 4; Jauf and Jubah Formations; A2-A4; ?late Pragian-Eifelian.

• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; Assemblage 6; late Eifelian.

Artemopyra recticosta Breuer et al., 2007c

Pl. 1, figs 9-17

2006 *Artemopyra*? spp.; Wellman, Pl. 20, fig. i.
2007c *Artemopyra recticosta* Breuer et al., p. 43, Pl. 1, figs 6-12.

Description: Amb circular to subcircular. A diffuse to clear curvatura 0.5-2 µm wide delimits a more or less circular hilum. Proximal surface is characterized by different types of scar which sometimes show a shape similar to a trilete mark. The hilum radius equals, or is approximately 4/5 of the amb radius. Hilum sculptured by radially disposed muri which are straight and up 0.7-2.6 µm wide at the equator, becoming thinner towards the proximal pole. They extend from the curvatura to, from half to all of the way to the proximal pole. There are usually 18-46 muri. Distal surface laevigate.

Dimensions: 34 (51) 70 µm, 36 specimens measured.

Comparisons: *Artemopyra laevigata* Wellman & Richardson, 1996 is generally smaller (33-48 µm) and possesses proximal radial muri which are highly variable in appearance and sometimes bifurcate. *Artemopyra brevicosta* Burgess & Richardson, 1991 is smaller (22-49 µm) and shows proximal radial muri which can be slightly sinuous and are short, less than 1/2 of the hilum radius. *Emphanisporites orbicularis* Turnau, 1986 is described as a trilete spore but is very similar. There might be confusion about the nature of this alleged trilete mark. ?*Artemopyra* spp. in Wellman (2006) represents the same species described here.

Remarks: The trilete spore *Emphanisporites rotatus* McGregor emend. McGregor, 1973 has the same kind of muri as *Artemopyra recticosta* Breuer et al., 2007c. Some specimens of *Artemopyra recticosta* Breuer et al., 2007c in the studied material possess a darkened area which is located at or near the proximal pole.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Libya: Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A7; Emsian-Givetian.
• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, JNDL-1, 3, 4, S-462 and wells FWRH-1, HWYH-956, KHRM-2, UTMN-1830, YBRN-1; Jauf and Jubah Formations; A2-A7; ?late Pragian-Givetian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A8; ?late Emsian-Givetian.
• United Kingdom: Scotland, Rhynie outlier; Lower Shales Unit; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Genus *Cymbohilates* (Richardson) Breuer et al., 2007c

Type species: *Cymbohilates horridus* Richardson, 1996.

Description: Proximally hilate cryptospore monads. Exine sculptured subequatorially and distally with grana, coni, spinae, bacula, verrucae or biform elements, sometimes fused in groups. Contact area (hilum) sculptured or smooth, with random or concentric folds, and/or radial muri. Hilum, more or less circular, curvatural ridge distinct or barely perceptible.

Comparisons: *Hispanaediscus* Cramer emend. Burgess & Richardson, 1991 is similar except for a distal sculpture of verrucae and/or muri. G*neudnaspora* Balme, 1988 emend. Breuer et al., 2007c is laevigate.

Remarks: These monad cryptospores are supposed to be derived from 'loose' dyads, but some specimens may still be associated in dyads. *Cymbohilates cymosus* Richardson, 1996 is generally preserved as tetrads.

Cymbohilates baqaensis **Breuer et al., 2007c**

Pl. 2, figs 1-8

? 1995 *Cymbohilates dammmensis* Steemans (pars), p. 101.
2007c *Cymbohilates baqaensis* Breuer et al., p. 43, Pl. 1, figs 13-19.

Description: Amb circular to subcircular. An undulating and irregular curvatura delimits a more or less circular, smooth hilum. The smooth proximal surface shows different types of scars such as multiple radial branches, cross tears, pseudo-trilete mark, or simple slit. Exine is sculptured subequatorially and distally with evenly distributed bacula 0.75-2 µm high, 0.75-1.5 µm wide at base and 1.5-3 µm apart. The tops of elements are flat or slightly concave, with a generally bifurcate shape.

Dimensions: 30 (36) 40 µm, 16 specimens measured.

Comparisons: According to Turnau (pers. comm., 2006) *Cymbosporites baculatus* Turnau et al., 2005 which also possesses bacula but without bifurcate shape is a different taxon. *Cymbosporites dammamensis* Steemans, 1995 appears very similar but is a trilete miospore, although some specimens do not show a perceptible trilete mark. Some specimens could probably have been misinterpreted in Steemans (1995) and need to be revised.

Remark: Some specimens can be preserved as dyads.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4 and wells HWYH-956, KHRM-2, SDGM-462, UTMN-1830; Jauf Formation and Jubah Formation; A1-A4; late Pragian-Eifelian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.

Cymbohilates comptulus **Breuer et al., 2007c**

Pl. 2, figs 9-17

? 1988 *Gneudnaspora* sp. (Tchibrikova) Balme, p. 17, Pl. 3, fig. 15.
? 1996 *Cymbohilates amplus* Wellman & Richardson, p. 55, Pl. 10, figs 1-3.
2007c *Cymbohilates comptulus* Breuer et al., p. 43, Pl. 2, figs 1-7.

Description: Amb circular to subcircular. The hilum is well defined by a curvatura and its slightly granulate character is barely perceptible. Narrow, radial, irregular scars commonly characterize the proximal surface. The hilum radius equals about 3/4 of the amb radius. Exine is sculptured subequatorially and distally with evenly distributed and spaced elements 0.5-1.5 µm high, less than 1 µm wide at base and 1-3 µm apart. The ornamentation varies from bacula to spinae and coni. Exine 1-3 µm thick.

Dimensions: 48 (58) 70 µm, 28 specimens measured.

Comparisons: *Gneudnaspora* sp. in Balme (1988) also appears very similar to *Cymbohilates comptulus* Breuer et al., 2007c, however it is only represented by a single specimen that is ornamented with evenly disposed cones about 1 µm high and 1 µm in basal diameter. *Cymbohilates amplus* Wellman & Richardson, 1996 possesses a very similar distal ornamentation but it is significantly larger (73-104 µm) than *Cymbohilates comptulus* Breuer et al., 2007c. In addition, it does not possess narrow radial tears in the exine on the proximal surface, although this feature may be caused by taphonomy.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2 and JNDL-4; Jauf Formation; A1-A3a; late Pragian-Emsian.

Cymbohilates cymosus Richardson, 1996

Pl. 3, fig. 1

1996 *Cymbohilates cymosus* Richardson, p. 34, Pl. 6, figs 3-6, Pl. 7, figs 1-4.

Description: Tetrad sculptured with short spines, 1-2 µm high and in star-shaped clusters, 2-4 µm apart. Exine about 1 µm thick.

Remark: The clusters of short spines are diagnostic. According to Richardson (1996), spore units occur mainly in tetrads but sometimes as hilate monads, possibly indicating derivation from dyads.

Dimensions: 62 µm, 1 specimen measured.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Borehole BAQA-2; Jauf Formation; A1; late Pragian.

Cymbohilates heteroverrucosus Breuer et al., 2007c

Pl. 3, figs 2-10

2007c *Cymbohilates heteroverrucosus* Breuer et al., p. 47, Pl. 2, figs 9-12, Pl. 3, figs 1, 2.

Description: Amb circular to subcircular. Hilum is often barely perceptible and commonly shows narrow scars that may resemble a pseudo-trilete mark. Distal and proximal surfaces bear a varied sculpture of verrucae and bacula, 0.5-7 µm wide at base and up to 4 µm high. The elements can have a flared base or more parallel sides. The ornament size and type can be very variable on the same specimen. The small and largest elements are distributed unevenly, however the contact area normally possesses the smallest verrucae.

Dimensions: 45 (53) 62 µm, 34 specimens measured.

Comparisons: *Hispanaediscus*? *irregularis* Wellman & Richardson, 1996 has less variation in the size of the verrucae and is only sculptured outside the contact surface. It does not show scars on proximal face.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes JNDL-1, 3, 4 and well UTMN-1830; Jauf and Jubah Formations; A3a-A4; Emsian-Eifelian.

Cymbohilates sp. 1

Pl. 3, figs 11-13

Description: Amb subcircular. A curvatura 0.5-1 µm wide delimits a more or less circular or subcircular, smooth hilum. The hilum radius equals or is more or less 7/10 of the amb radius. Exine is sculptured subequatorially and distally with loosely and irregularly distributed spines 1-3.5 µm high, 0.75-2.5 µm wide at base. In some specimens, ornaments can be very few in number.

Dimensions: 37 (39) 42 µm, 5 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.

Genus *Dyadaspora* Strother & Traverse, 1979

Type species: *Dyadaspora murusattenuata* Strother & Traverse, 1979.

Description: Cryptospore dyads, permanently fused. Individual spores spherical to subspherical to hemispherical in outline. Exine laevigate.

Dyadaspora murusattenuata Strother & Traverse, 1979

Pl. 3, fig. 14

1979 *Dyadaspora murusattenuata* Strother & Traverse, p. 15, Pl. 3, figs 9, 10.

Description: Thin walled dyad. Exine folded, reflecting the contact margin of the two spores. Individual spore bodies spherical to subspherical in shape.

Dimensions: 52 µm, 1 specimen measured.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Well HWYH-956; Jauf Formation; A2; ?late Pragian-Emsian.

Genus *Gneudnaspora* Balme, 1988 emend. Breuer et al., 2007c

Type species: *Gneudnaspora kernickii* Balme, 1988.
Description: Proximally hilate cryptospore monads. Amb circular to oval. Exine alveolate or laevigate, proximally attenuated. Contact face bordered by a weakly to strongly developed circular to oval curvatural ridge. Different types of scars can be present on the contact face, from an irregular, simple, pseudo-trilete or pseudo-tetralete scar to an irregular substellate opening.

Remarks: The Saudi material is very similar to that figured and described by Balme (1988) and it is considered that the proximal structure of *Gneudnaspora* has been misinterpreted by Balme. It corresponds to scars, sometimes looking like a trilete or monolete mark, but commonly having no particular shape. In addition, some specimens do not show these scars and are therefore similar to the genus *Laevolancis* Burgess & Richardson, 1991 described from the Silurian. Finally, Breuer et al. (2007c) considered that the latter form was a junior synonym of the genus *Gneudnaspora* Balme, 1988.

Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia

Pl. 4, figs 1-9

non 1991 *Laevolancis divellomedia* (Tchibrikova) Burgess & Richardson, p. 607, Pl. 2, figs 4, 6.
1988 *Gneudnaspora divellomedium* (Tchibrikova) Balme, p. 125, Pl. 3, figs 1-7.
2007c *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia*; Breuer et al., p. 48, Pl. 3, figs 3-9.

Description: Amb circular to subcircular. A diffuse to clear curvatura delimits a more or less circular hilum. The hilum radius equals 3/4 to 6/7 amb radius. Contact face shows different types of scars, from an irregular, simple, pseudo-trilete or pseudo-tetralete, to an irregular substellate shape. Proximal and distal surfaces are entirely laevigate.

Dimensions: 32 (54) 82 µm, 17 specimens measured.

Remark and comparisons: Specimens assigned to *Laevolancis divellomedia* (Tchibrikova) Burgess & Richardson, 1991 are not considered to be conspecific with *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia*. *Laevolancis divellomedia* (Tchibrikova) Burgess & Richardson, 1991, which is transferred in *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *minor* Breuer et al., 2007c, is generally smaller than *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia*. Furthermore, the former species very often shows an intact contact face whilst the latter usually possesses different types of scars.

Stratigraphic and palaeogeographic occurrence:
- Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988). Adavale Basin; Eastwood and Log Creek Formations; *annulatus-sextantii* and *devonicus-naumovii* Assemblage Zones; Emsian-Eifelian (Hashemi & Playford, 2005).
- Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Libya: Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A7; Emsian-Givetian.

• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4, S-462 and wells FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830, YBRN-1; Jauf and Jubah Formations; Assemblage 2 to 9; ?late Pragian-Givetian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A8; ?late Emsian-Givetian.

Gneudnaspora divellomedia (Tchibrikova) Balme, 1988 var. _minor_ Breuer et al., 2007c

Pl. 4, figs 10-18

1959 *Archaeozonotriletes divellomedium* Tchibrikova, p. 65, Pl. 9, fig. 4.
1966c *Hispanaediscus bernesgae* Cramer, p. 82, Pl. 1, figs 2, 11, text-fig. 2.
1968 Spore n° 2651; Magloire, Pl. 1, fig. 6.
1969 ?*Archaeozonotriletes* cf. *divellomedium* Tchibrikova; Richardson & Lister, p. 238, Pl. 43, fig. 12.
1974 *Archaeozonotriletes* (?) *divellomedium* (Tchibrikova) Arkhangelskaya, Pl. 1, fig. 51.
1974 *Zonaletes* (?)*divellomedium* (Tchibrikova) Arkhangelskaya, Pl. 6, figs 3, 4.
1974 ?*Archaeozonotriletes divellomedium* Tchibrikova; McGregor, Pl. 1, figs 35, 40.
1978 *Hispanaediscus* sp.; McGregor & Narbonne, p. 1296, Pl. 1, figs 20-22.
1980 *Zonaletes* (?) *divellomedium* (Tchibrikova) Arkhangelskaya, Pl. 5, fig. 34.
1984 ?*Stenozonotriletes irregularis* (Schultz) McGregor, p. 37, Pl. 1, fig. 26.
1986 *Archaeozonotriletes* cf. *divellomedium* Tchibrikova; Buret & Moreau-Benoit, Pl. 1, fig. 1.
1986 *Tholisporites divellomedium* (Tchibrikova) Turnau, p. 349, Pl. 2, fig. 12, Pl. 4, fig. 14.
1991 *Laevolancis divellomedia* (Tchibrikova) Burgess & Richardson, p. 607, Pl. 2, figs 4, 6.
1993 *Archaeozonotriletes* cf. *divellomedium* Tchibrikova; Moreau-Benoit et al., Pl. 1, fig. 2.
2007c *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *minor* Breuer et al., p. 48, Pl. 3, figs 10-16.

Description: Amb circular to subcircular. A diffuse to clear curvatura delimits a more or less circular hilum. Hilum radius is commonly 3/4 to 4/5 spore radius. Contact face sometimes shows a small simple scar. Proximal and distal surfaces are entirely laevigate.

Dimensions: 28 (31) 34 µm, 21 specimens measured.

Remark: As the genus *Laevolancis* Burgess & Richardson, 1991 is considered to be a junior synonym of genus *Gneudnaspora* Balme, 1988, *Laevolancis divellomedia* (Tchibrikova) Burgess & Richardson, 1991 requires reassignment (Breuer et al., 2007c). Since it is suggested above that *Laevolancis divellomedia* differs from *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia*, the reassignment necessitates introduction of a new variety, *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *minor* Breuer et al., 2007c.

Comparison: *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia* has a similar structure but is larger (32-82 µm) in this material. The smaller variety shows a little size variability. Furthermore, the larger variety always possesses different types of scars, unlike *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *minor* Breuer et al., 2007c, which often possesses an intact contact face. *Gneudnaspora plicata* (Burgess & Richardson) Breuer et al., 2007c appears very similar and is thus difficult to distinguish, however it is only known from Wenlock strata. Steemans et al. (1996) define a morphon which includes the two taxa and record intermediate forms with a range of thin to thick wall thicknesses.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Oued Karkaï Formation; Pridoli-Lochkovian (Moreau-Benoit et al., 1992).
• Australia: Adavale Basin; Eastwood and Log Creek Formations; *annulatus-sextantii* and *devonicus-naumovii* Assemblage Zones; Emsian-Eifelian (Hashemi & Playford, 2005).
• Bolivia: Cordillera Oriental, Laurani section; Santa Rosa and Icla Formations; Dowtonian-Emsian or Eifelian (McGregor, 1984).
• Brazil: Parnaíba Basin; Tianguá Formation; *Laevolancis divellomedia* Subzone; Llandovery (Grahn et al., 2005). Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
• Canada: Arctic Archipelago, Cornwallis Island; Read Bay Formation; late Silurian (McGregor & Narbonne, 1978). Western Newfoundland; Clam Bank Formation; *Apiculiretusispora* sp. E Zone; Lochkovian (Burden et al., 2002).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone I; Lochkovian (Ghavidel-Syooki, 2003).
• Libya: Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *Apiculiretusispora* Subbiozone? to *Apiculiretusispora* sp. E Biozone?; Ludlow-middle Pridoli (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
• Morocco: Doukkala and Essaouira Basins; Palynozone DI1-DI2; late Pragian-Emsian (Rahmani-Antari & Lachkar, 2001).
• Poland: Pomerania-Kujawy region; Polskie Laki IG-1 and Jamno IG-1 boreholes; Jamno Formation; reworked in early-middle Eifelian (Turnau & Matyja, 2001). Random-Lublin area; Borehole Terebin IG 5; Czarnolas and Zwoleń Formations; MN-PoW Oppel Zones; Lochkovian-?basal Emsian. Borehole Giezcezw PIG 5; Terrigenous Suite; FD?-FD Oppel Zones; upper Emsian (Turnau et al., 2005).
• Saudi Arabia: Well UDYN-1; Tawil Formation; Ashgill or Early Silurian-Lochkovian (Steemans, 1995). Boreholes BAQA-1, 2, JNDL-1, 3, 4, and wells HWYH-956, NFLA-1, SDGM-462, UTMN-1830; Jauf and Jubah Formations; A1-A4; late Pragian-Eifelian.
• Spain: Cantabrian Mountains; San Pedro Formation; Wenlockian-early Siegenian (Rodriguez, 1978b).
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.
• United Kingdom: Welsh Borderland and South Wales; Wenlock Shales to Middle Ditton Group; Wenlockian-Dittonian (Richardson & Lister, 1969). Scotland, Rhynie outlier; White Sandstones, Shales and Muddy Sandstones, Lower Shales, Rhynie Chert, Upper Shales, and Windyfield Sandstones and Shales and Chert Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Genus *Tetrahedraletes* Strother & Traverse emend. Wellman & Richardson, 1993

Type species: *Tetrahedraletes medinensis* Strother & Traverse emend. Wellman & Richardson, 1993.

Description: Tetrahedral cryptospore tetrads, permanently fused. Tetrads subcircular to circular in outline and composed of four laevigate, crassitate, subtriangular spores. Crassitudes of individual spores more or less equatorial, fused or discrete. Distal spore exine tend to invaginate, but can remain inflated.

***Tetrahedraletes medinensis* Strother & Traverse emend. Wellman & Richardson, 1993**

Pl. 4, fig. 19

1971 Spore tetrads in tetrahedral configuration; Gray & Boucot, fig. 1h.
1971 Tetrad of rather thick walled spore-like alete palynomorphs; Cramer, Pl. 4, fig. 1.
1972 Non-miospore tetradic palynomorph; Cramer & Díez, p. 116, Pl. 36, figs 79, 84.
1979 *Nodospora burnhamensis* Strother & Traverse, p. 10, Pl. 1, fig. 11, Pl. 2, fig. 1.
1979 *Tetrahedraletes medinensis* Strother & Traverse, p. 8, Pl. 1, figs 5, 14-17.
1982 Tetrahedral tetrads; Gray et al., figs 2a-b, 3, 4, 8, 9, 10a-b.
1982 *Nodospora burnhamensis* Strother & Traverse; Miller & Eames, p. 248, Pl. 5, fig. 5, Pl. 6, fig. 3.
1985 *Tetrahedraletes* cf. *T. medinensis* Strother & Traverse; Gray et al., fig. 5f-h.
1985 *Nodospora burnhamensis* Strother & Traverse; Johnson, p. 344, Pl. 11, fig. 4.
1985 cf. *Tetrahedraletes medinensis* Strother & Traverse; Hill et al., Pl. 15, fig. 1.
1985 Permanent tetrad; Hill et al., Pl. 15, fig. 3.
1985 *Nodospora burnhamensis* Strother & Traverse (pars); Duffield, figs 1-6.
1991 *Tetrahedraletes medinensis* Strother & Traverse var. *parvus* Burgess, p. 579, Pl. 1, figs 1-4.
1993 *Tetrahedraletes medinensis* Strother & Traverse emend. Wellman & Richardson, p. 165, Pl. 2, figs 8, 10-12.

Description: Tetrads of inaperturate, subtriangular spores or spore-like palynomorphs arranged in thightly adhering tetradhedral configuration. Exine collapsed towards tetrad centre. Contact margins between the individual spores thickened, forming a dark ring around the margin of each spore. Exine laevigate.

Dimensions: 41 (51) 58 µm, 9 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
• Canada: Western Newfoundland; Clam Bank Formation; *Apiculiretusispora* sp. E Zone; Lochkovian (Burden et al., 2002).
• Libya: Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' and Tadrart Formations; *Apiculiretusispora* Subbiozone? to MN Oppel Zone?; Ludlow-early Lochkovian (Rubinstein & Steemans, 2002).
• Poland: Pomerania-Kujawy region; Polskie Laki IG-1 and Chojnice 5 boreholes; Silno, and Tuchola Formations; reworked in early-middle Eifelian (Turnau & Matyja, 2001).
• Saudi Arabia: Well UDYN-1; Tawil Formation; Ashgill or Early Silurian (Steemans, 1995). Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes JNDL-3, 4 and wells FWRH-1, HWYH-956, KHRM-2, UTMN-1830; Jauf Formation; A2-A3a; ?late Pragian-Emsian.

2.2. Monolete spores

Genus *Archaeoperisaccus* Naumova emend. McGregor, 1969.

Type species: *Archaeoperisaccus menneri* Naumova, 1953.

Description: Camerate monolete spores. Nexine rigid, oval, elliptical or subcircular, surrounded by a sac-like sexine which is inflated in the equatorial region. The sac may extend to form a fold over the proximal pole along the longitudinal axis of the spore. Equatorially the sexine extends beyond the margin of the central body in the regions opposite the ends of monolete mark, but may be less widely separated from the nexine, or even be appressed to it, equatorially near the shorter axis of the spore. The sexine is closely appressed to the nexine proximally except in the area of the proximal fold, and is closely appressed (?attached) to the nexine in the distal polar region. Laesura straight, simple or labrate, may be obscured by the proximal fold of the sexine. Sexine laevigate or sculptured. Nexine laevigate.

Archaeoperisaccus cf. _A. rhacodes_ Hashemi & Playford, 2005

Pl. 5, figs 1, 2

cf. 2005 *Archaeoperisaccus rhacodes* Hashemi & Playford, p. 388, Pl. 13, figs 10, 11; Pl. 14, figs 4, 7, 8.

Description: Camerate monolete spores with amb generally oval to irregular. Miospore width typically about 3/4 length. Laesura marked by fold-like labra about 2-4 µm thick. Central body radius equals about 3/5 to 3/4 amb radius. Ornaments closely and regularly distributed, consisting of coni and spines of variable form, up to 3 µm high and 2 µm in basal diameter.

Dimensions: 74 (94) 115 µm, 2 specimens measured.

Remark: *Archaeoperisaccus rhacodes* Hashemi & Playford, 2005 is is slightly different; it is larger and show conate elements which can be loosely distributed. The recognition of a more numerous population of the specimens described here in North Africa allow to know better their correct affinity.

Comparisons: *Archaeoperisaccus verrucosus* Pashkevich, 1964 is verrucate and therefore sculpturally distinct form *Archaeoperisaccus* cf. *A. rhacodes* Hashemi & Playford, 2005. *Archaeoperisaccus opiparus* Owens, 1971 has a greater overall length, a strongly elevated fold-like labra, thicker nexine and biform sculptural elements. *Archaeoperisaccus oblongus* Owens, 1971 has a more elongate amb and a coarser sculpture. *Archaeoperisaccus indistinctus* Lu Lichang, 1980 is scabrate.

Stratigraphic and palaeogeographic occurrence:
- Tunisia: Borehole MG-1; Awaynat Wanin II Formation; A6-A8; Givetian.

Genus *Devonomonoletes* Arkhangelskaya, 1985

Type species: *Devonomonoletes microtuberculatus* (Tchibrikova) Arkhangelskaya, 1985.

Description: Bilateral azonate monolete spores. Amb oval or subcircular. Exine thin, almost or entirely laevigate at the contact area. Outside the contact area, which is partially or completely delineated by thin scars of the curvaturae, the surface is ornamented with grana, tubercules, cones or spines.

***Devonomonoletes* sp. 1**

Pl. 5, figs 4-6

Description: Amb subcircular. Contact faces laevigate. The monolete mark length corresponds to 1/2 to 3/4 of the amb radius. Sutura distinct, straight to slightly curved, terminating in well defined curvaturae. Sculptured outside of the contact area with evenly distributed spines 0.5-1.5 µm high and 0.5-1 µm apart.

Dimensions: 48 (51) 57µm, 3 specimens measured.

Comparison: *Devonomonoletes microtuberculatus* (Tchibrikova) Arkhangelskaya, 1985 is clearly oval-shaped and is sculptured with small tubercules. Furthermore, indistinctly outlined darkened muri are present where the distal and proximal sides meet.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2; A1-A2; late Pragian-?Emsian.

Genus *Latosporites* Potonié & Kremp, 1954

Type species: *Latosporites latus* Potonié & Kremp, 1954.

Description: Bilateral azonate monolete spores. Amb broadly oval to approximately circular; distal side relatively strongly inflated, more strongly curved (swollen) in the distal polar area. Polar axis typically 1/2-1/1 of the longest axis in the equatorial plane. Exine laevigate to infra-reticulate.

Comparison: *Laevigatosporites* has a proportionally much shorter polar axis and lacks the distal distension.

***Latosporites ovalis* Breuer et al., 2007c**

Pl. 6, figs 7-15, Pl. 7, figs 1-8

? 2006 ?monolete spore, Wellman, Pl. 19, fig. h.
2007c *Latosporites ovalis* Breuer et al., p. 52, Pl. 12, figs 8-12.

Description: Amb elliptical to oval. The length of the short axis generally equal to 7/10 of the long axis. Suture distinct, straight to slightly curved and accompanied by distinctive labra 2-5 µm in overall width. Suture extending almost to equator and terminating in well defined curvaturae. Exine entirely laevigate, 1.5-3 µm thick.

Dimensions: 32 (48) 62 µm, 22 specimens measured.

Comparisons: *Latosporite*s sp. A and *Latosporites* sp. B in Owens (1971) are larger and have a thicker exine. *Latosporites* sp. B has a finely granulate exine and lacks prominent labra. *Latosporites* sp. in McGregor (1960) possesses a short, poorly defined Y-like bifurcation. *Limbomonoletes lenis* Arkhangelskaya, 1985 has a thinner exine and is cingulate. *Devonomonoletes* Arkhangelskaya, 1985 is ornamented outside the contact surface. *Laevigatosporites antiqus* Moreau-Benoît, 1966 is too poorly described to be compared with *Latosporites ovalis* Breuer et al., 2007c. *Laevigatosporites* sp. in McGregor & Camfield (1982) is more elongate. Its suture is simple and extends about 1/2 to 5/6 of the longest diameter of spore. *Laevigatosporites* sp. in de Jersey (1966) is smaller and its laesura extends about half length of spore and the exine can be very faintly scabrate. *Laevigatosporites* sp. A in Hashemi & Playford (2005) shows laesura equal to 2/5 to 1/2 of spore length. Wellman (2006) has probably found a monolete spore similar to *Latosporites ovalis* Breuer et al., 2007c in the Rhynie Outlier in Scotland.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Libya: Borehole A1-69; Awaynat Wanin I Formation; specimen probably reworked in Eifelian strata.
• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4 and wells ABSF-29, FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830; Jauf and Jubah Formations; A2-A3a; ?late Pragian-Emsian, specimens from the Jubah Formation are probably reworked.
• Tunisia: Borehole MG-1; Awaynat Wanin II Formation; specimen probably reworked in Givetian strata.

Latosporites sp. 1

Pl. 7, figs 9-11

Description: Amb oval. The length of the short axis equal to 8/10 to 9/10 of the long axis. Suture distinct, simple and straight. Suture generally equal to more or less 8/10 of the long axis and terminating in well defined curvaturae. Exine entirely laevigate, 0.5-1.5 µm thick.

Dimensions: 38 (43) 49 µm, 3 specimens measured.

Comparisons: *Latosporites ovalis* Breuer et al., 2007c is labrate, more elliptical and thicker, resulting in a sturdy appearance.

Stratigraphic and palaeogeographic occurrence:
• Tunisia: Borehole MG-1; Ouan-Kasa Formation, Awaynat Wanin I and Awaynat Wanin II Formations; A4-A7; Eifelian-Givetian.

Genus *Reticuloidosporites* Pflug in Thomson & Pflug, 1953

Type species: *Reticuloidosporites dentatus* Pflug in Thomson & Pflug, 1953.

Description: Monolete spores with reniform amb. Sculptural or structural elements arranged into a reticulum.

Reticuloidosporites antarcticus Kemp, 1972

Pl. 7, figs 13-16

1972 *Reticuloidosporites antarcticus* Kemp, p. 117, Pl. 56, figs 1-13.

Description: Monolete spores with elliptical to oval amb. Outline plano-convex in lateral compression. The length of the short axis equal to about 7/10 of the long axis. Laesurae straight, extending almost full length of spore and terminating in elevated curvaturae, 2-4.5 µm high, and simple or bordered with distinctive labra individually up to 2 µm thick. The distal and equatorial surface is sculptured with an imperfect reticulum consisting of muri 1-4 µm high and 1 µm wide, enclosing irregularly polygonal lumina, 2-8 µm in diameter. Exine 1.5-2.5 µm thick.

Dimensions: 37 (47) 60 µm, 13 specimens measured.

Comparisons: The species is distinguished from previously described species of *Reticuloidosporites* by the possession of smooth, clearly demarked contact areas, and by the general form of the distal reticulum with its high narrow muri.

Stratigraphic and palaeogeographic occurrence:
- Antarctica: Ohio Range; Horlick Formation; early Emsian (Kemp, 1972).
- Saudi Arabia: Borehole BAQA-1; Jauf Formation; A2; ?late Pragian-early Emsian.

2.3. Trilete spores

Genus *Acinosporites* Richardson, 1965

Type species: *Acinosporites acanthomammillatus* Richardson, 1965.

Description: Trilete spores with subcircular to subtriangular amb. Ornament consists of a series of convoluted and anastomosing ridges which bear verrucae with spines, spinose projections, or coni.

Comparison: *Convolutispora* Hoffmeister et al., 1955 has an ornament consisting solely of convolute and anastomosing ridges without superimposed various spinose ornaments.

Remark: Some species of *Acinosporites* can be two- or three-layered.

***Acinosporites acanthomammillatus* Richardson, 1965**

Pl. 8, figs 1-4

1925 Type I; Lang, Pl. 1, fig. 21.
1965 *Acinosporites acanthomammillatus* Richardson, p. 577, Pl. 91, figs 1, 2, text-fig. 6.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae bordered by lips up to 6 µm in total thickness, reaching the equatorial margin. Thick exine bears contorted anastomosing ridges 4 to 6 µm wide. Verrucae 3 to 5 µm high, rounded or polygonal in plan view, superimposed on the ridges, and surmounted by slender cones or spines with pointed or occasionally blunt and expanded apices, 1.5 to 4 µm long and 1 to 2 µm wide at their base. Ornament confined to the distal surface and equatorial margin. Proximal surface laevigate, infrapunctate or infragranular.

Dimensions: 63 (71) 80 µm, 8 specimens measured.

Comparisons: This species differs from *Acinosporites macrospinosus* Richardson, 1965 and *Acinosporites* sp. A in Richardson (1965) by short rounded verrucae whose height is more or less equal to their width. *Archaeozonotriletes arduus* Archangelskaya, 1963 is similar but smaller.

Stratigraphic and palaeogeographic occurrence:
• Australia: Adavale Basin; Lissoy Sandstone; *devonicus-naumovii* Assemblage Zone; early Eifelian-early Givetian (Hashemi & Playford, 2005).
• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; AP-?BM Oppel Zones; late Eifelian-Frasnian (Perez-Leyton, 1990).
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Oppel Zone; Eifelian-Givetian (Loboziak et al., 1988). Central Parnaíba Basin; Itaim Formation; AD-pre Lem Interval Zone; Eifelian-earliest Givetian (Loboziak et al., 1992b).
• Canada: Arctic Archipelago, Queen Elisabeth and Melville Islands; Weatherall and Hecla Bay Formations; Eifelian-early Givetian (Owens, 1971; McGregor & Uyeno, 1972; McGregor & Camfield, 1982). Ontario, Moose River Basin; Williams Island Formation; *devonicus-orcadensis* Provisional Assemblage Zone; Givetian (McGregor & Camfield, 1976).
• China: Guizhou and Yunnan; Assemblage Zone V; Eifelian (Gao Lianda, 1981).
• Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Nohn Formation; early Eifelian (Riegel, 1973). Prüm Syncline, Eifel; Berle, Wiltz, Heisdorf, Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages A-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; Eifelian-Givetian (Loboziak et al., 1990).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone IV; Eifelian-early Givetian (Ghavidel-Syooki, 2003).
• Libya: Cyrenaica; AD Oppel Zone; late Eifelian-early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 4-7; late Emsian/earliest Eifelian-middle Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formation; A4-A6; Eifelian-Givetian.
• Poland: Western Pomerania; Studnica, Jamno and Miastko Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996).
• Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.
• Tunisia: Borehole MG-1; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A6; Eifelian-Givetian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Wick Flagstone Group and Achanarras fish Beds; Eifelian-Givetian (Richardson, 1965). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

Acinosporites apiculatus (Streel) Streel, 1967

Pl. 8, figs 5, 6

1964 *Verrucosisporites apiculatus* Streel, Pl. 1, fig. 13.
1967 *Acinosporites* cf. *apiculatus* (Streel) Streel, p. 36, Pl. 3, figs 38, 39.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae are often undulating and bordered by lips 2-4 µm wide in total thickness. Thin exine, 1-2 µm thick, laevigate on the proximal face, ornamented elsewhere with more or less combined verrucae 1-1.5 µm high, thus forming convoluted and anastomosing ridges, 0.5-1 µm wide, supporting small irregular often blunt coni. Furrows between the ridges about 1 µm wide.

Dimensions: 57 (85) 125 µm, 7 specimens measured.

Stratigraphic and palaeogeographic occurrence:

• Belgium: Verviers Synclinorium; Goé; Pepinster Formation; early Givetian (Streel, 1964). The age was reviewed at the time of the cartography of the region and now is considered as late Eifelian (Laloux et al., 1996). Dinant Synclinorium; late Emsian-early Couvinian (Streel, 1967).

• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Oppel Zone; Eifelian-early Givetian (Loboziak et al., 1988). Amazon Basin; Maecuru and Ererê Formations; GS-LLi Interval Zones; late Emsian-early Givetian (Melo & Loboziak, 2003).

• Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Heisdorf, Lauch and Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Prüm Syncline, Eifel; Berle, Wiltz, Lauch, Nohn, Ahrdorf, Junkerberg, Freiling, Ahbach, Loogh and Cürten Formations; Assemblages A, B, E-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen, Ahbach and Loogh Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).

• Libya: Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A5; ?late Emsian-Givetian.

• Luxembourg: Oesling region; AP Oppel Zone; late Emsian (Steemans et al., 2000).

• Morocco: Doukkala and Essaouira Basins; Palynozones DI2-DM2; Emsian-Eifelian (Rahmani-Antari & Lachkar, 2001).

• Saudi Arabia: Borehole JNDL-1 and wells ABSF-29, HWYH-956, SDGM-462; Jauf and Jubah formation; A3b-A6; ?late Emsian-Givetian.

• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3b-A5; ?late Emsian-Eifelian.

Acinosporites eumammillatus Loboziak et al., 1988

Pl. 9, figs 1-4

1966 *Acinosporites* sp.; McGregor & Owens, Pl. 3, figs 9, 10.
1968 *Acinosporites* sp. B; Riegel, p. 89, Pl. 19, figs 8-10.
1987 *Acinosporites* sp.; Burjack et al., Pl. 1, fig. 6.
1988 *Acinosporites eumammillatus* Loboziak et al., p. 354, Pl. 1, figs 4-11.

Description: Trilete spores with subtriangular to subcircular amb. Trilete mark often barely visible and reaching the equatorial margin. Exine rather thick equatorially and distally (2-4 µm), ornamented with elements in the shape of mammae, closely distributed to fused, 2-4 µm high and wide, formed by a large verruca surmounted by a small cone or spine, 0.5-1.5 µm high and 0.5-1 µm wide at base. Furrows between the ridges or mammae commonly about 1-2 µm wide.

Dimensions: 36 (41) 44 µm, 7 specimens measured.

Comparisons: *Acinosporites acanthomammillatus* Richardson, 1965 is clearly more massive. Its elements are higher and wider (2-8 µm) and surmounted by spines, 1-3 µm high and 1 µm wide at base. They are very closely distributed to anastomosed. Other species of *Acinosporites* Richardson, 1965 have commonly biform ornamentation but they do not show, in general, this typical feature of mammae.

Stratigraphic and palaeogeographic occurrence:
- Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; Zone IV; late Frasnian (Loboziak et al., 1988).
- Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor & Owens, 1966).
- Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968).
- Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.

Acinosporites hirsutus (Brideaux & Radforth) McGregor & Camfield, 1982

Pl. 9, fig. 5

1965 *Acinosporites* sp. A; Richardson, p. 579, Pl. 91, fig. 9.
1970 *Corytisporites hirsutus* Brideaux & Radforth (pars), p. 36, fig. 19.
? 1974 *Acinosporites* sp., aff. *A. macrospinosus* Richardson; Bär & Riegel, Pl. 1, fig. 6.
1982 *Acinosporites hirsutus* (Brideaux & Radforth) McGregor & Camfield, p. 11, Pl. 1, figs 7, 8, 12, 13, text-fig. 9.

Description: Trilete spores with subcircular or subtriangular amb. Thin inner body. Trilete mark 2-4 µm thick. Exine thick equatorially and of considerable thickness distally. Exine laevigate, scabrate or minutely granulate proximally. Distal and equatorial regions densely set with ornaments that are joined in ridges and vary greatly in form and size. Ornaments are biform with a bulbous more or less parallel-sided base supporting a small spine. Sculptural elements 5-11 µm in total length and 3.5-5 µm wide at base. Most are longer than their basal width. The largest elements commonly occur at or near the equator.

Dimensions: 59µm, 1 specimen measured.

Comparisons: *Acinosporites hirsutus* (Brideaux & Radforth) McGregor & Camfield, 1982 is intermediate in structure between *Acinosporites acanthomammillatus* Richardson, 1965 and *Acinosporites macrospinosus*. It appears to lack the concertina-like folds evident at the equator of these species. It is further distinguished from *Acinosporites acanthomammillatus* Richardson, 1965 by its more elongate spines, and from *Acinosporites macrospinosus* Richardson, 1965 by its shorter, less uniformly tapered spines and its more prominently developed equatorial and distal ridges.

Stratigraphic and palaeogeographic occurrence:
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; BJ Oppel Zone; early Frasnian (Perez-Leyton, 1990).
- Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; late Eifelian-early Givetian (McGregor & Camfield, 1982).
- Libya: Ghadames Basin; Palynozone 5; early Eifelian (Moreau-Benoit, 1989).
- Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.
- United Kingdom: Northeast Scotland, Orcadian Basin; Hillhead Beds; Givetian (Richardson, 1965).

Acinosporites lindlarensis Riegel, 1968

Pl. 9, figs 6-10, Pl. 10, figs 1, 2

1966 Unidentified spore; McGregor & Owens, Pl. 5, fig. 17.
1968 *Acinosporites lindlarensis* Riegel, p. 89, Pl. 19, figs 11-16.
? 1969 Indeterminate; Cramer, Pl. 2, fig. 27.
1972 *Aneurospora* cf. *heterodonta* (Naumova) Streel; p. 206, Pl. 2, figs 1-7.
1973 *Geminospora treverica* Riegel, p. 97, Pl. 16, figs 4-7.
? 1975 *Cymbosporites cyathus* Allen; Tiwari & Schaarschmidt, Pl. 15, fig. 4.
1976 *Acinosporites lindlarensis* Riegel var. *lindlarensis*; McGregor & Camfield, p. 6, Pl. 5, figs 2-3.
1976 *Acinosporites lindlarensis* Riegel var. *minor* McGregor & Camfield, p. 8, Pl. 5, figs 4, 5.
? 1991 *Dibolisporites* sp. cf. *echinaceus* (Eisenack) Richardson; Grey, Pl. 1, fig. 9.

Description: Trilete spores with subcircular to subtriangular amb. Some specimens show a variably separated sexine. Laesurae straight, 7/10 to 9/10 the radius long, simple or bordered by lips up to 6 µm in total thickness. Nexine 1-3.5 µm thick, laevigate, sexine 1.5-3 µm thick, densely sculptured proximo-equatorially and distally with cones, spines, and biform processes (flask-shaped or mammate, commonly with delicate apical spine). Sculptural elements on the distal hemisphere round to polygonal in plan view, 1.5-5 µm wide at their base, 1-6 µm high, closely spaced, discrete or joined to form ridges of varied length. The longest elements, occur subequatorially at the outer limit of the contact areas, where they tend to be fused and delimit curvaturae. Proximal surface laevigate or with scattered grana 0.5-2 µm wide.

Dimensions: 63 (75) 91 µm, 20 specimens measured.

Remarks: A separated inner body (probably only attached proximally) is regarded by some authors of doubtful significance at the generic level. This feature is not mentioned as a criterion circumscribing *Acinosporites* by Richardson (1965). Indeed, some *Acinosporites acanthomammillatus* described by Richardson (1965) occasionally have a discernible central body. Therefore, the presence of this feature in *Acinosporites lindlarensis* Riegel, 1968 is not sufficient to exclude it from the genus.
Acinosporites lindlarensis Riegel, 1968 shows continuous morphological variation of the distribution, size and shape of ornaments. Morphotypes with loosely distibuted sculpture intergrade with others characterized by more crowded distal sculpture. Richardson et al. (1993) have illustrated it by defining the *Acinosporites lindlarensis* Morphon. It contains different types and subtypes which are difficult to apply to the present material.

Comparisons: McGregor & Camfield (1976) have shown that *Geminospora treverica* Riegel, 1973, characterized by a completely separated inner body, cannot be distinguished from *Acinosporites lindlarensis* Riegel, 1968. *Acinosporites acanthomammillatus* Richardson, 1965 has close affinity (Richardson et al., 1993), but it is distinguished from *Acinosporites lindlarensis* Riegel, 1968 by a more massive appearance due to commonly coarser ridges.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Orsine Formation; Emsian-early Eifelian (Moreau-Benoit et al., 1992).
- Argentina: San Juan Precodillera, Cerro del Fuerte Section; Talacasto Formation; Emsian (Le Hérissé et al., 1996).
- Belgium: Dinant Synclinorium; late Emsian (Lessuise et al., 1979). Dinant, Verviers Synclinoriums and Theux Window; Siβ-Su Interval Zones; late Lochkovian-late Pragian (Steemans, 1989). Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).

• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; AD-BJ Oppel Zones; late Eifelian-early Frasnian (Perez-Leyton, 1990).
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem-BJ Oppel Zones; Eifelian-Frasnian (Loboziak et al., 1988). Amazon Basin; Maecuru, Ererê and Barreirinha Formations; GS-BPi Interval Zones; late Emsian-early Frasnian (Melo & Loboziak, 2003).
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Arctic Archipelago, Baturst Island; Eids, Blue Fiord, Bird Fiord, Cape De Bray, Weatherall and Hecla Bay Formations; Eifelian-early Givetian (McGregor & Uyeno, 1972; McGregor & Camfield, 1982). Ontario, Moose River Basin; Stooping River, Sextant, Kwataboahegan and Williams Island Formations; *annulatus-lindlarensis* to *devonicus-orcadensis* Provisional Assemblage Zone; Emsian-Givetian (McGregor & Camfield, 1976).
• Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Heisdorf and Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Siegerland; Siβ -Paβ Interval Zones; late Lochkovian-late Pragian (Steemans, 1989). Eifel, Hillesheim Syncline; Freilingen and Ahbach Formations; AD-Ref Interval Zone; Eifelian (Loboziak et al., 1990).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zones III-IV; late Emsian-early Givetian (Ghavidel-Syooki, 2003).
• Libya: Cyrenaica; AP Oppel Zone; early Eifelian (Streel et al., 1988). Ghadames Basin; Palynozones 3-5; Emsian-early Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A6; ?late Emsian-Givetian.
• Poland: Western Pomerania; Studnica and Jamno Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; FD-AP Oppel Zones; uppermost Emsian-?basal Eifelian (Turnau et al., 2005).
• Romania: Moesian Platform, Chilia well; G Interval Zone; late Lochkovian (Steemans, 1989).
• Saudi Arabia: Boreholes JNDL-1, 3, 4, S-462 and wells ABSF-29, HWYH-956, KHRM-2, SDGM-462, UTMN-1830, YBRN-1; Jauf and Jubah Formations; A3a-A7; Emsian-Givetian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A8; ?late Emsian-Givetian.
• United Kingdom: Shetland, Fair Isle; Observatory Group; late Givetian (Marshall & Allen, 1982). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).
• U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

Acinosporites sp. 1

Pl. 10, figs 3-6

Description: Trilete camerate spores with subcircular to subtriangular amb. Commonly three layers visible. Laesurae straight, simple or bordered by lips up to 4 µm in total thickness and extending generally to the outer margin of the second layer. Endonexine (about 1 µm) not always discernible, ectonexine 1-2.5 µm thick, laevigate, sexine 1.5-3.5 µm thick, sculptured proximo-equatorially and distally with biform processes (bulbous base with apical spine). Sculptural elements on the distal hemisphere round in plan view, 3-7 µm wide at their base, 2-8 µm high, joined to form ridges of varied length. The longest elements, occur subequatorially at the outer limit of the contact areas. Proximal surface granular.

Dimensions: 59 (71) 85, 9 specimens measured.

Comparisons: *Acinosporites acanthomammillatus* Richardson, 1965 is single-layered and has a more closely distributed ornamentation. When the third layer is visible, it distinguishes *Acinosporites* sp. 1 from all the other species of *Acinosporites* Richardson, 1965.

Stratigraphic and palaeogeographic occurrence:
• Canada: Arctic Archipelago, Baturst Island; Eids, Blue Fiord and Bird Fiord formations; Eifelian-Givetian (McGregor & Uyeno, 1972).
• Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.

Genus *Alatisporites* Ibrahim, 1933

Type species: *Alatisporites pustulatus* Ibrahim, 1933.

Description: Trilete spores with three sacci.

***Alatisporites* sp. 1**

Pl. 11, figs 1-3

Description: Saccate trilete spores with circular to subcircular amb. Laesurae distinct, straight, simple and equal 1/2 to 2/3 amb radius. Curvaturae sometimes visible. Central body radius equals commonly 3/5 to 4/5 total amb radius. Exine of the central body 1.5-3 µm thick equatorially. Zona is divided entirely or partially into three individual proximo-equatorial sacci, the maximum width (commonly 14-25 µm) of which is opposite the trilete rays. Sacci are often folded radially and can be folded back. Thin generally sinuous attachment lines of the sacci on the central body can be distinguished on the proximal face. Proximal and distal surfaces entirely laevigate.

Dimensions: 80 (94) 103 µm, 4 specimens measured.

Comparison: *Zonotriletes* sp. 4 has a more subtriangular amb is only zonate and thus possess a unique flange, which can appear tri-lobed, surrounding the central body.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes JNDL-3, 4; Jauf Formation; A3a; late Emsian.
• Tunisia: Borehole MG-1; Ouan Kasa and Awaynat Wanin I Formations; A3b-A5; ?late Emsian-Eifelian.

Genus *Ambitisporites* Hoffmeister, 1959

Type species: *Ambitisporites avitus* Hoffmeister, 1959.

Description: Trilete spores with subcircular to roundly triangular amb. Ornamentation laevigate to variously sculptured. Laesurae distinct, simple. Labra absent to slightly elevated. Thickened exinous equatorial band (crassitude or cingulum), of uniform width or slightly wider opposite the trilete rays. Width of crassitude 1/10 to 1/5 of spore radius. Crassitude and remainder of spore wall may have some or different ornamentation patterns.

Comparison: The structure of *Camarozonotriletes* Naumova, 1939 ex Naumova, 1953 is similar but its equatorial cingulum is always thicker interradially than opposite the laesurae. It shows a larger variety of ornamentation.

Ambitisporites asturicus (Rodriguez) comb. nov.

Pl. 11, figs 4-9

1978b *Retusotriletes rotundus* (Streel) Lele & Streel; Rodriguez, p. 420, Pl. 4, fig. 2.
1978b *Retusotriletes triangulatus* (Streel) Streel; Rodriguez, p. 421, Pl. 3, fig. 1.
1983 *Archaicusporites asturicus* Rodriguez, p. 32, Pl. 6, fig. 5, Pl. 7, fig. 3, and fig. 3-54.

Description: Trilete cingulate spores with subcircular to subtriangular amb. Laesurae simple, straight and extending to elevated curvaturae. Exine 1.5-3 µm thick equatorially. The contact areas show a subcircular to subtriangular darkening at about 1/3 radius from the proximal pole, thereby forming a subcircular to subtriangular delineation within which the spore wall is much thinner. Concentic folds common.

Dimensions: 30 (39) 47 µm, 10 specimens measured.

Remark: The genus *Archaicusporites* Rodriguez, 1983 is considered here as a junior synonym of *Ambitisporites* Hoffmeister, 1959. Indeed the diagnosis of the first one describes cingulate spores characterized by folds that are disposed parallel and concentrically with respect to the lines of curvaturae. As folds is probably due to polar compression, this genus can be perfectly included in the general definition of *Ambitisporites* Hoffmeister, 1959.

Comparison: *Retusotriletes tenerimedium* Tchibrikova, 1959 has a more pronounced wider darker subtriangular apical zone and does not have elevated curvaturae.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Well HWYH-956; Jauf Formation; A2; ?late Pragian-Emsian.
- Spain: Cantabrian Mountains; San Pedro Formation; Downtonian-early Siegenian (Rodriguez, 1978b).
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.

Ambitisporites avitus Hoffmeister, 1959

Pl. 11, figs 10-18

1959 *Ambitisporites avitus* Hoffmeister, p. 332, Pl. 1, figs 1-8.

Description: Trilete cingulate spores with subcircular to subtriangular amb. Contact area subtriangular. Equatorial cingulum 2 to 4 µm wide along interradial margin and up to 2 µm wide opposite the trilete rays. Laesurae simple, straight and extending to the inner edge of the thickened equatorial band (cingulum). Exine mostly laevigate, but sometimes faintly granular.

Dimensions: 31 (38) 67 µm, 13 specimens measured.

Comparison: *Camarozonotriletes parvus* Owens, 1971 is sculptured with grana or coni and its cingulum is wider interradially than that of *Ambitisporites avitus* Hoffmeister, 1959.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Oued Karkaï Formation; Pridoli-Lochkovian (Moreau-Benoit et al., 1992).
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Canada: Western Newfoundland; Clam Bank Formation; *Apiculiretusispora* sp. E Zone; Lochkovian (Burden et al., 2002).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone I; Lochkovian (Ghavidel-Syooki, 2003).
• Libya: Ghadames Basin, boreholes B2-34 and C1-34; Tanezzuft and Acacus Formations; Wenlockian-Downtonian (Richardson & Ioannides, 1973). Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *Apiculiretusispora* Subbiozone? to *Apiculiretusispora* sp. E Biozone?; Ludlow-middle Pridoli (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
• Saudi Arabia: Well UDYN-1; Tawil Formation; Ashgill or Early Silurian (Steemans, 1995). Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone; Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4 and wells HWYH-956, UTMN-1830; Jauf and Jubah Formations; A1-A4; late Pragian-Eifelian.
• Spain: Cantabrian Montains; San Pedro and Furada Formations; Wenlockian-early Siegenian ian (Cramer, 1966a; Rodriguez, 1978b).
• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3a-A5; Emsian-Eifelian.

***Ambitisporites eslae* (Cramer & Díez) Richardson et al., 2001**

Pl. 12, figs 1, 2

? 1968 Spore n° 2513; Magloire, Pl. 1, fig. 13.
1973 *Ambitisporites* sp. B (pars); Richardson & Ioannides, p. 277, Pl. 6, fig. 8.
1975 *Retusotriletes eslae* Cramer & Díez (pars), p. 343, Pl. 1, fig. 11.
? 1976 *Ambitisporites tripapillatus* Moreau-Benoit, p. 37, Pl. 7, fig. 2-4.
? 1995 *Ambitisporites tripapillatus* Moreau-Benoit; Burgess & Richardson, p. 16, Pl. 6, fig. 16.
2001 *Ambitisporites eslae* (Cramer & Díez) Richardson et al., p. 142, Pl. 5, fig. 1.

Description: Trilete cingulate spores with subcircular to subtriangular amb. Equatorial cingulum 1 to 5 µm wide. Laesurae straight and reaching the faintly developed imperfect curvaturae at the equator. The laesurae are bordered by faint, imperfect ridges which radially grade into the curvaturae. Subcircular papillae, 5-9 µm wide, are developed at approximately the center of each interradial regions. Exine laevigate to infragranular.

Dimensions: 32 (39) 47 µm, 4 specimens measured.

Comparisons: *Ambitisporites tripapillatus* Moreau-Benoit, 1976 has a darkened area along the Y-rays at the spore apex with straight to concave sides. *Scylaspora elegans* Richardson et al., 2001 has a large darkened apical area and proximal rugulate sculpture. *Retusotriletes maculatus* McGregor & Camfield, 1976 and, in part, *Ambitisporites* sp. B in McGregor & Camfield (1976), appear to have an equatorially thinner exine, but are otherwise similar to

Ambitisporites eslae (Cramer & Díez) Richardson et al., 2001. *Synorisporites papillensis* McGregor, 1973 has smaller proximal papillae. Moreover, its distal face is commonly verrucate and cingulum is irregular.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-1, 2 and well FWRH-1; A2; ?late Pragian-Emsian.
• Spain: Cantabrian Mountains; San Pedro Formation; Dittonian-early Siegenian (Cramer & Díez, 1975; Rodriguez, 1978b). Cantabrian Mountains; San Pedro Formation; *elegans-cantabrica* to *micrornatus-newportensis* Assemblage Zones; early Lochkovian (Richardson et al., 2001).

Genus *Amicosporites* Cramer, 1966a

Type species: *Amicosporites splendidus* Cramer, 1966a.

Description: Trilete spores with circular to subcircular amb. Laesurae, straight, with narrow simple lips, extending to margin. On distal side a circular ridge (annulus) is present.

Comparison: *Coronospora* Rodriguez, 1978a exhibits a proximal annulus.

***Amicosporites jonkeri* (Riegel) Steemans, 1989**

Pl. 12, figs 3-11

1968 Spore n° 333; Magloire, Pl. 1, fig. 16.
1973 *Anulatisporites jonkeri* Riegel, p. 92, Pl. 14, figs 1-4.
1983 *Coronaspora* sp. (pars); Le Hérissé, p. 41, Pl. 8, fig. 3.
1984 *Anulatisporites jonkeri* Riegel; Volkmer p. 42, Pl. 10, figs 4-7.
1986 *Anulatisporites jonkeri* Riegel; Turnau, p. 323, Pl. 5, fig. 1.
1989 *Amicosporites jonkeri* (Riegel) Steemans, p. 91, Pl. 19, figs 9-11.

Description: Trilete cingulate spores with circular to subcircular amb. Equator is thickened into a cingulum, generally 2-4 µm wide. Laesurae simple, straight and extending to the inner margin of the equatorial cingulum. Distal face bears a dark regular annulus, 4-8 µm wide, approximatelly situated halfway between the equator and the distal pole. Its margins are not always sharp. Proximal surface laevigate and sometimes torn.

Dimensions: 32 (41) 46 µm, 9 specimens measured.

Comparisons: *Amicosporites streelii* Steemans, 1989 has an annulus formed by verrucae resulting in an irregular appearance. Moreover, other verrucae are present in the center of the annulus. *Concentricosporites borbullatus* (Rodriguez) Rodriguez, 1983 has a similar appearance except that the author places the annulus proximally. The smooth specimens of *Coronaspora* sp. in Le Hérissé (1983) are synonymous with *Amicosporites jonkeri* (Riegel) Steemans, 1989 whereas those sculptured with verrucae are synonymous with *Amicosporites streelii* Steemans, 1989.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant, Verviers Synclinoriums and Theux Window; Siα Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).

• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).
• Germany: Rheinland, Eifel; Nohn Formation; early Eifelian (Riegel, 1973). Siegerland; Z-Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
• Libya: Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
• Poland: Random-Lublin area; Borehole Terebin IG 5; Zwoleń Formation; PoW Oppel Zone; Pragian-?basal Emsian (Turnau et al., 2005).
• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A2-A3a; ?late Pragian-Emsian but some specimens are probably reworked in younger strata.

***Amicosporites streelii* Steemans, 1989**

Pl. 12, figs 12-25

1967 *Cirratriradites* sp. F (pars); Streel, Pl. 5, fig. 59.
1981 *Coronaspora mariae* Rodriguez; Streel et al., p. 184, Pl. 3, figs 1-4.
1983 *Coronaspora* sp. (pars); Le Hérissé, p. 41-42, Pl. 7, fig. 16, 17, Pl. 8, figs 1, 2.
1989 *Amicosporites streelii* Steemans, p. 92, Pl. 19, figs 15-17, Pl. 20, figs 1, 2.
2006 *Amicosporites* spp.; Wellman, Pl. 19, fig. m.

Description: Trilete cingulate spores with circular to subcircular amb. Equator is thickened into a cingulum, 2-6 µm wide. Laesurae simple, straight, extending to the inner margin of the equatorial cingulum and invaginated at the end. Distal face is ornamented with subcircular verrucae, 4-9 µm in diameter, joined to each other to form an annulus with sinuous edges, which is more or less centred on the distal pole. The annulus and the equatorial cingulum are not always well-defined in poorly preserved specimens, giving in this case a spore with a very broad cingulum up to 12 µm wide. A single subcircular verruca, 5-9 µm wide, is almost always present in the center of the annulus. Sometimes it is accompanied with smaller verrucae, irregularly distributed and occupying almost the whole inner area of the annulus. These last verrucae are subcircular to elongate, 3-5 µm wide. Proximal surface laevigate and often torn.

Dimensions: 30 (38) 45 µm, 18 specimens measured.

Comparisons: Some specimens of Le Hérissé (1983) are possibly synonymous with *Amicosporites streelii* Steemans, 1989. On the other hand the author has noticed some of his specimens have no ornamentation other than the annulus, they are consequently placed in synonymy with *Amicosporites jonkeri* (Riegel) Steemans, 1989.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Bolland borehole; ?Emsian (Streel, 1967). Dinant, Neufchâteau-Eifel, Verviers Synclinoriums and Theux Window; G-Paα Interval Zones; late Lochkovian-Pragian (Steemans, 1989).
• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).
• Saudi Arabia: Well DMMM-45; Tawil Formation; E Interval Zone; Lochkovian-Pragian (Steemans, 1995). Boreholes BAQA-1, 2, JNDL-1, 4, and wells FWRH-1, HWYH-956, KHRM-2, UTMN-1830; Jauf Formation; A1-A3b; late Pragian-early Eifelian?.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.

• United Kingdom: Scotland, Rhynie outlier; Rhynie Chert Unit; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Genus *Ancyrospora* Richardson emend. Richardson, 1962

Type species: *Ancyrospora grandispinosa* Richardson emend. Richardson, 1962.

Description: Trilete monosaccate spores. Amb circular, subcircular, subtriangular to triangular. Inner body subcircular to subtriangular. Exine bears spinose processes which are bifurcate at their tips.

Comparison: *Hystricosporites* McGregor, 1960 has no inner body.

***Ancyrospora langii* (Taugourdeau-Lantz) Allen, 1965**

Pl. 13, figs 1-8

? 1953 *Hymenozonotriletes incisus* Naumova, p. 68, Pl. 9, fig. 11.
1960 *Archaeotriletes langii* Taugourdeau-Lantz, p. 145, Pl. 3, fig. 33, 34, 39.
1965 *Ancyrospora langii* (Taugourdeau-Lantz) Allen, p. 743, Pl. 106, figs 5-7.
1966 *Ancyrospora* sp.; de Jersey, p. 21, Pl. 9, figs 5, 7.
1968 *Ancyrospora amadei* Hodgson, p. 74, Pl. 8, fig. 8.
1968 *Ancyrospora* cf. *A. simplex* Guennel; Hodgson, p. 75, Pl. 8, figs 9-11, text-fig. 1.
1975 *Ancyrospora* sp. A; Grey, fig. 61b.

Description: Trilete zonate spores with subcircular to subtriangular amb. Laesurae, flexuous and elevated, up to 13 µm high at the pole (gula), and extends, decreasing in height, to, or almost to, the equator. The inner body radius, not always well-defined, commonly equals 2/3 to 4/5 amb radius. Nexine laevigate or punctate. Sexine equatorially and distally ornamented with spines, 16-40 µm long, 9-22 µm wide at base. Spines are conical and striate and taper to a width of less than 2 µm, then flare in bifurcate tips which are curved downwards. These tips are often broken. Spines are joined at the bases, so the amb has a crenulated appearance. Equator presents a maximum of about ten spines. Contact areas laevigate.

Dimensions: 83 (103) 128 µm, 10 specimens measured.

Comparison: *Ancyrospora langii* (Taugourdeau-Lantz) Allen, 1965 is distinguished from other *Ancyrospora* species by the shape of the spines, typically slender and bifurcate, and the density of ornamentation. *Hymenozonotriletes incisus* Naumova, 1953 is similar, and should this species prove to have grapnel-tipped spines, then it would be conspecific.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Gazelle Supérieure Formation; Famennian (Boumendjel et al., 1988). Illizi Basin; Tin Meras Formation; Frasnian (Moreau-Benoit et al., 1992).
• Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988). Canning Basin; Gogo Formation; *lemurata-magnificus* Zone; middle Givetian (Grey, 1991). Adavale Basin; Etonvale Formation; *optivus-triangulatus* and *ovalis-bulliferus* Assemblage Zones; late Givetian-early Frasnian (Hashemi & Playford, 2005).

• Belgium: Dinant Synclinorium; Famennian (Becker et al., 1974). Campine Basin, Booischot borehole; ?TA Oppel Zone to Zone IV; ?Givetien-Frasnien (Streel & Loboziak, 1987).
• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; TA-VCo Oppel Zones; late Givetian-Famennian (Perez-Leyton, 1990).
• China: Guangxi; Assemblage Zone VI; Givetian (Gao Lianda, 1981).
• France: Boulonnais; Blacourt, Beaulieu, Ferques and Hydrequent Formations; late Givetian-late Frasnian; TLa Oppel Zone to Zone IV (Brice et al., 1979; Loboziak & Streel, 1980, 1988).
• Germany: Eifel, Hillesheim Syncline; Ahbach, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; latest Eifelian-Givetian (Loboziak et al., 1990).
• Libya: Cyrenaica; Frasnian-?early Famennian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 7-9/10; middle Givetian-late Frasnian/early Famennian (Coquel & Moreau-Benoit, 1986; Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A8; late Givetian-?early Frasnian.
• Saudi Arabia: Borehole S-462; Jubah Formation; A8; late Givetian-?early Frasnian but some specimens may be caved in older strata.
• Norway: Spitsbergen; Upper Mimer Valley Series; Givetian (Allen, 1965).
• Tunisia: Borehole MG-1; Awaynat Wanin III Formation; A8; late Givetian-?early Frasnian.
• United Kingdom: Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996).

***Ancyrospora nettersheimensis* Riegel, 1973**

Pl. 14, figs 1-6

1973 *Ancyrospora nettersheimensis* Riegel, p. 100, Pl. 17, figs 6-8.

Description: Trilete zonate spores with subcircular to subtriangular amb. Laesurae flexuous and elevated, up to 7 µm high at the pole (gula), and extends, decreasing in height, to or almost to the equator. The inner body radius equals commonly 2/5 to 3/5 amb radius. Zona somewhat wider at the ends of the rays. Sexine equatorially and distally ornamented with more or less parallel-sided or moderately tapered spines, 4-11 µm long, 2-8 µm wide at base. Spines commonly are strongly tapered up to a minute bifurcate tip. These are often broken. Spines generally 5-10 µm apart, their broad basal portions imparting a slightly crenulated appearance to the amb. Proximal surface laevigate or scabrate.

Dimensions: 128 (140) 155 µm, 9 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Gazelle Inférieure Formation; reworked in early Givetian (Boumendjel et al., 1988). Illizi Basin; Orsine Formation; late Emsian-early Eifelian (Moreau-Benoit et al., 1992).
• Germany: Rheinland, Eifel; Heisdorf, Lauch and ?Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Eifel, Hillesheim Syncline; Freilingen Formation; AD-Ref Interval Zone; Eifelian (Loboziak et al., 1990).
• Libya: Cyrenaica; AP Oppel Zone; early Eifelian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 4-6; late Emsian/earliest Eifelian-early Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A5; Eifelian.

• Poland: Random-Lublin area; Borehole Giezczezw PIG 5, Terrigenous Suite, AP Oppel Zone, uppermost Emsian-?basal Eifelian (Turnau et al., 2005).

Genus *Aneurospora* Streel emend. Richardson et al., 1982

Type species: *Aneurospora goensis* Streel, 1964.

Description: Trilete spores with a subequatorial proximal region which is especially rigid and probably thickened so as to appear like a dark band (equatorial crassitude). The inner limits of the equatorial crassitude are often ill-defined and its width is also more or less variable even in the same specimen. Proximal region laevigate, bearing interradial papiliae or variously sculptured. Distal region sculptured with grana, coni, spinae, and biform elements.

Comparisons: *Synorisporites* Richardson & Lister, 1969 has distal sculpture of verrucae and/or muri. *Ambitisporites* Hoffmeister, 1959 is distally laevigate.

***Aneurospora* cf. *A. bollandensis* Steemans, 1989**

Pl. 15, figs 1-7

1983 *Cymbosporites echinatus* Richardson & Lister; Le Hérissé, p. 50, Pl. 7, fig. 10.
cf. 1989 *Aneurospora bollandensis* Steemans, p. 96, Pl. 20, figs 14-19, 46.

Description: Trilete spore with subcircular to subtriangular amb. Laesurae straight, accompanied by labra, 1-3 µm wide individually, length around 3/4 the spore radius. Equatorial crassitude 2-5 µm wide. Proximal region laevigate. Distal and equatorial regions sculptured with evenly distributed conical bacula, 1-2.5 µm wide and high, 0.5-3 µm apart. The tops of elements are flat or slightly rounded and can be slightly flared.

Dimensions: 30 (36) 49 µm, 7 specimens measured.

Comparisons: *Aneurospora bollandensis* Steemans, 1989 is only distinguished by the presence of proximal inspissations or papillae. *Cymbosporites echinatus* Richardson & Lister, 1969 in Le Hérissé (1983) is similar with *Aneurospora bollandensis* Steemans, 1989 except for the absence of proximal inspissations or papillae synonymous. The unique figured specimen is thus considered as synonymous with the specimens described here. *Cymbosporites echinatus* Richardson & Lister, 1969 is patinate and bears larger, not always parallel-sided, sculptural elemnents. *Cymbosporites dammamensis* Steemans, 1995 is also patinate, with simple laesurae and the tops of elements are generally bifurcate-shaped.

Stratigraphic and palaeogeographic occurrence:
• France: Armorican Massif, Laval Syncline; Saint-Cénéré Formation; Assemblage 1; Pragian (Le Hérissé, 1983).
• Saudi Arabia: Borehole BAQA-1 and well UTMN-1830; Jauf Formation; A2; ?late Pragian-Emsian.

Genus *Apiculiretusispora* (Streel) Streel, 1967

Type species: *Apiculiretusispora brandtii* Streel, 1964.

Description: Trilete spores with circular to subtriangular amb. The distal extremities of laesurae are connected by clearly perceptible curvaturae, delineating contact areas that are smooth or have reduced ornamentation. Outside the contact areas the exine shows a variable sculpture of small grani, coni, or spinae.

Comparisons: Differs from *Cyclogranisporites* Potinié & Kremp, 1954 and *Planisporites* Knox emend. Potonié & Kremp, 1954 in the distinct curvaturae and reduced sculpture in the contact area. *Retusotriletes* emend. Streel, 1964 is completely laevigate.

***Apiculiretusispora brandtii* Streel, 1964**

Pl. 15, figs 8-15, Pl. 16, figs 1, 2

1963 *Cyclogranisporites* sp.; Chaloner, fig. 8.
1964 *Apiculiretusispora brandtii* Streel, p. 8, Pl. 1, figs 6-10.
1966 *Cyclogranisporites* sp.; McGregor & Owens, Pl. 2, fig. 7, 17-19.
1966 ?*Perotrilites* sp.; McGregor & Owens, Pl. 5, fig. 13.
1967 *Cyclogranisporites* sp.; McGregor, Pl. 1, fig. 1.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae simple and straight, formed with a thin triradiate ridge, about 1 µm wide. Fine curvaturae visible. A triangular darkened apical area may be present. Distal and equatorial regions are densely ornamented with small grani, coni and spinae, up to 1.5 µm high, up to 1 µm wide and 0.5-1.5 µm apart. Distal face sometimes folded. Ornamentation is less dense or absent on the proximal face. Exine 1-2 µm thick. On some specimens, the sexine is irregularly detached from nexine.

Dimensions: 50 (69) 95 µm, 15 specimens measured.

Remarks: The specimens of *Apiculiretusispora brandtii* Streel, 1964 which show local detachment of sexine could be transition forms towards *Rhabdosporites minutus* Tiwari & Schaarschmidt, 1975 which presents a completely detached sexine. Indeed, the two species have exactly the same fine ornamentation. In addition, these two species seem to intergrade with *Cymbosporites asymmetricus* Breuer et al., 2007c which has also the same ornamentation but is patinate. Therefore, the *Apiculiretusispora brandtii* Morphon is defined here (Tab. 1, p. 185).

Comparisons: *Cyclogranisporites* sp. in Chaloner (1963) is identical to *Apiculiretusispora brandtii* Streel, 1964. Several other species of *Cyclogranisporites* Potonié & Kremp, 1954 have an ornamented exine quite close in morphology but the curvaturae are not clearly defined, e.g. *Cyclogranisporites amplus* McGregor, 1960 and *Cyclogranisporites lasius* (Waltz) Playford, 1962. *Retusotriletes parvimammatus* Naumova var. *parvimammatus* Naumova, 1953, from the Russian Plateform, has well-defined curvaturae but the drawing does not allow recognition of the exact nature of the ornamented exine. *Cymbosporites asymmetricus* Breuer et al., 2007c is patinate. *Apiculiretusispora plicata* (Allen) Streel, 1967 is clearly smaller and does not show partial detachments of a layer.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Orsine Formation; Emsian-early Eifelian (Moreau-Benoit et al., 1992).
- Belgium: Verviers Synclinorium; Goé; Pepinster Formation; early Givetian (Streel, 1964; Lele & Streel, 1969). The age was reviewed at the time of the cartography of the region and

now is considered as late Eifelian (Laloux et al., 1996). Dinant Synclinorium; late Emsian-Eifelian (Lessuise et al., 1979).

- Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Quebec, Gaspé Peninsula; York River, Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973).
- France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).
- Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Prüm Syncline, Eifel; Berle, Wiltz, Heisdorf, Lauch, Nohn, Ahrdorf, Junkerberg, Freiling, Ahbach, Loogh and Cürten Formations; Assemblages A-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975).
- Libya: Cyrenaica; early or middle Emsian-early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 4-6; late Emsian/earliest Eifelian-early Givetian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa Formation; A3b; ?late Emsian-early Eifelian.
- Luxembourg: Oesling region; AP Oppel Zone; late Emsian (Steemans et al., 2000).
- Morocco: Doukkala and Essaouira Basins; Palynozones DI1-DI2; late Pragian-Emsian (Rahmani-Antari & Lachkar, 2001).
- Poland: Pomerania-Kujawy region; Polskie Laki IG-1 borehole; early-middle Eifelian (Turnau & Matyja, 2001). Random-Lublin area; Borehole Terebin IG 5; Zwoleń Formation; PoW Oppel Zone; Pragian-?basal Emsian. Borehole Giezcezw PIG 5; Terrigenous Suite; FD?-AP Oppel Zones; upper Emsian-?basal Eifelian (Turnau et al., 2005).
- Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, JNDL-1, 3, 4 and wells ABSF-29, HWYH-956, KHRM-2, SDGM-462, UTMN-1830; Jauf and Jubah Formations; A2-A6; ?late Pragian-Givetian.
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3b; ?late Emsian-early Eifelian.
- United Kingdom: Scotland, Rhynie outlier; White Sandstones, Shales and Muddy Sandstones, Lower Shales, Rhynie Chert, Upper Shales, Windyfield Sandstones and Shales and Chert Units, and Longcroft Tuffs Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).
- U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

***Apiculiretusispora densa* Al-Ghazi, 2007**

Pl. 16, figs 3-5

? 1986 Unidentified; Turnau, Pl. 8, fig. 4.
2007 *Apiculiretusispora densa* Al-Ghazi, p. 68, Pl. 1, figs 1-6, text-fig. 5.

Description: Trilete spores with circular to subcircular amb. Laesurae straight, simple or accompanied by thin labra, up to 1.5 µm in overall width, length about 7/8 spore radius. Exine 1-2 µm thick. Contact areas laevigate with circular to subcircular, dark (thickened) areas occupying 1/2 to 7/8 of each interradial area. Proximo-equatorial and distal regions sculptured with closely spaced and relatively evenly distributed spinae, up to 1.5 high, less than 1 µm wide at base, 0.5-1 µm apart.

Dimensions: 38 (54) 70, 10 specimens measured.

Comparisons: *Apiculiretusispora densa* Al-Ghazi, 2007 differs from all published species of the genus *Apiculiretusispora* (Streel) Streel, 1967 by its three characteristic dark coloured, rounded interradial thickenings of the proximal face. *Apiculiretusispora brandtii* Streel, 1964 possesses a more densely distributed conate sculpture. Turnau (1986) illustrates an unnamed specimen resembling *Apiculiretusispora densa* Al-Ghazi, 2007 but no description is given.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, JNDL-1, JNDL-4 and well KHRM-2; Jauf and Jubah Formations; A2-A4; ?late Pragian-Eifelian.

***Apiculiretusispora plicata* (Allen) Streel, 1967**

Pl. 16, figs 6-14, Pl. 17, figs 1-4

1965 *Cyclogranisporites plicatus* Allen, p. 695, Pl. 94, figs 6-9.
1966 ?*Perotrilites* sp.; McGregor & Owens, Pl. 5, fig. 13.
1967 *Apiculiretusispora plicata* (Allen) Streel, p. 33, Pl. 2, figs 31, 34.
1968 *Cyclogranisporites plicatus* Allen; Lanninger, p. 120, Pl. 22, fig. 3.
1972 *Granulatisporites* sp.; Kemp, p. 110, Pl. 52, figs 4, 5, 7.
1974 ?*Apiculiretusispora plicata* (Allen) Streel; McGregor, Pl. 1, fig. 39.

Description: Trilete spores with subcircular to more rarely subtriangular amb. Laesurae simple, straight, formed with a thin triradiate ridge, about 1 µm wide and equals 3/5 or almost the spore radius. Curvaturae visible. Distal and equatorial regions are ornamented with small coni or spinae, up to 1 µm high, rarely up to 1 µm wide and 0.5-1 µm apart. Proximal surface laevigate. Exine 0.5-2 µm thick.

Dimensions: 41 (49) 73 µm, 39 specimens measured.

Comparisons: *Apiculiretusispora plicata* (Allen) Streel, 1967 is distinguished from *Apiculiretusispora brandtii* Streel, 1964 by its smaller size and its single-layered exine. In addition, ornamentation of the former is more regular and slightly less packed. *Apiculiretusispora microconus* (Richardson) Streel, 1967 has an ornamentation similar to *Apiculiretusispora plicata* (Allen) Streel, 1967 but is much larger.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Orsine Formation; Emsian-early Eifelian (Moreau-Benoit et al., 1992).
• Antarctica: Ohio Range; Horlick Formation; early Emsian (Kemp, 1972).
• Argentina: Precordillera of Mendoza; Villavicencio Formation; Ems Interval Zone; late Pragian-early Emsian (Rubinstein & Steemans, 2007).
• Belgium: Dinant Synclinorium and Bolland Borehole; early Siegenian-late Emsian (Streel, 1967). Dinant Synclinorium; Famennian (Becker et al., 1974). Dinant, Neufchâteau-Eifel, Verviers Synclinoriums and Theux Window; Siα Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
• Bolivia: Cordillera Oriental, Laurani section; Santa Rosa, Icla and Huamampampa Formations; Downtonian-Eifelian (McGregor, 1984).
• Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor, 1973). Ontario, Moose River Basin; Kenogami River, Stooping River, Sextant and Kwataboahegan Formations; *mircrornatus-proteus* to *velata-langii* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).

• China: Eastern Yunnan, Qujing District, Cuifengshan; Xujiachong Formation; Emsian (Lu Lichang & Ouyang Shu, 1976). Yunnan; Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983). Armorican Massif, la Haye-du-Puits Syncline, Saint-Germain-sur-Ay Outcrop; Nβ-R Interval Zones; early Lochkovian (Steemans, 1989).
• Germany: Soutwestern Eifel; Klerfer Formation; Emsian (Lanninger, 1968). Prüm Syncline, Eifel; Wiltz, Heisdorf, Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages B, D-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Siegerland; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
• Libya: Cyrenaica; AD-Lem Interval Zone; early Givetian (Streel et al., 1988). Ghadames Basin; Palynozones 0-6; early Lochkovian-early Givetian (Moreau-Benoit, 1989).
• Luxembourg: Oesling region; Pow-AP Oppel Zones; middle Pragian-late Emsian (Steemans et al., 2000).
• Morocco: Doukkala and Essaouira Basins; Palynozones DI1-DM2; late Pragian-Givetian (Rahmani-Antari & Lachkar, 2001).
• Norway: Spitsbergen; Reuterskiøldfjellet Sandstone and Lower Mimer Valley Series; Gedinnian-Givetian (Allen, 1965).
• Poland: Pomerania-Kujawy region; Polskie Laki IG-1 and Jamno IG-1 boreholes; Jamno Formation; early-middle Eifelian (Turnau & Matyja, 2001). Random-Lublin area; Borehole Terebin IG 5, Czarnolas and Zwoleń Formations, MN-PoW Oppel Zones; Lochkovian-?basal Emsian. Borehole Giezcezw PIG 5, Terrigenous Suite, FD?-AP Oppel Zones; upper Emsian-?basal Eifelian (Turnau et al., 2005).
• Romania: Moesian Platform, Chilia well; G Interval Zone; late Lochkovian (Steemans, 1989).
• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4 and well HWYH-956; Jauf Formation; A1-A3b; late Pragian-?early Eifelian.
• Spain: Asturias; *Gosselatia* Sandstone Formation; Eifelian-Givetian (Cramer, 1969).
• United Kingdom: Scotland, Rhynie outlier; White Sandstones, Shales and Muddy Sandstones, Lower Shales, Rhynie Chert, and Upper Shales Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Genus *Archaeozonotriletes* Naumova emend. Allen, 1965

Type species: *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965.

Description: Trilete spores with circular to subtriangular amb. Laesurae usually long, simple or with lips. Exine one- or two-layered, acavate, laevigate or punctuate, distally patinate. Patina may be uniform in thickness or thickest in the distal polar region.

Comparisons: *Cymbosporites* Allen, 1965 has a variably sculptured patina. *Cyrtospora* Winslow, 1962 has a distal surface laevigate with a large irregular intumescent or glebous mass and tubercules.

Archaeozonotriletes chulus (Cramer) Richardson & Lister, 1969

Pl. 17, figs 5-15

1966b *Retusotriletes chulus* Cramer, p. 74, Pl. 2, fig. 14.
1969 *Archaezonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, p. 234, Pl. 43, figs 1-6, text-fig. 4.
1969 *Archaezonotriletes chulus* (Cramer) var. *nanus* Richardson & Lister, p. 238, Pl. 43, figs 10-11, text-fig. 4.
1973 *Tholisporites chulus* var. *chulus* (Cramer) McGregor, p. 56, Pl. 7, figs 13-15.

Description: Trilete patinate spores with subcircular to triangular amb with rounded corners. Exine thin in the contact areas, 1.5-4 µm thick (rarely up to 5.5 µm) equatorially and distally also thickened. Exine thickness at the equator often exceeds that at the distal pole. Laesurae simple, straight and extending to the inner margin of the equatorial thickening. Exine entirely laevigate. Proximally thin contact areas frequently collapsed and the spores usually have a narrow concentric fold, simulating curvaturae, just inside the equatorial border.

Dimensions: 27 (31) 37 µm, 14 specimens measured.

Remarks: In polar compression, some *Archaeozonotriletes* Naumova emend. Allen, 1965 resemble spores of the genus *Amibitisporites* Hoffmeister, 1959 except that the former have very thin contact areas. However, some tetrads and obliquely compressed specimens show clearly that the exine is much thicker at the equator and over the distal surface (Richardson & Lister, 1969).

Comparisons: *Ambitisporites avitus* and *Punctatisporites*? *dilutus* Hoffmeister, 1959 appear to have a more or less similar equatorial thickening. However, they can be distinguished from *Archaeozonotriletes chulus* (Cramer) Richardson & Lister, 1969 since these species show an equatorial thickening clearly narrower opposite the trilete rays. Moreover, they lack the thin proximal face and thick distal wall. *Retusotriletes semizonalis* McGregor, 1964 does not have the pronounced differential thickening between the proximal and distal surfaces of the spores described above and has minute sculpture.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Méderba Formation; Silurian (Boumendjel et al., 1988).
• Bolivia: Cordillera Oriental, Laurani section; Santa Rosa and Icla Formations; Gedinnian-Emsian (McGregor, 1984).
• Brazil: Amazon Basin; Manacapuru and Maecuru Formations; NsZ-GS Oppel Zones; Lochkovian-early Eifelian (Melo & Loboziak, 2003). Parnaíba Basin; Tianguá and Jaicós Formations; *Laevolancis divellomedia* Subzone and Su Interval Zone; Llandovery and latest Pragian-earliest Emsian (Grahn et al., 2005). Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
• Canada: Quebec, Gaspé Peninsula; York River and Battery Point Formations; Emsian (McGregor, 1973). Ontario, Moose River Basin; Kenogami River, Stooping River, Sextant and Kwataboahegan Formations; *chulus-vermiculata* to *velata-langii* Provisional Assemblage Zone; Siegenian-Eifelian (McGregor & Camfield, 1976). Western Newfoundland; Clam Bank Formation; *Apiculiretusispora* sp. E Zone; Lochkovian (Burden et al., 2002).

• China: Eastern Yunnan, Qujing District, Cuifengshan; Xujiachong Formation; Emsian (Lu Lichang & Ouyang Shu, 1976). Guangxi and Yunnan; Assemblage Zones I-III; Gedinnian-early Siegenian (Gao Lianda, 1981).
• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).
• Libya: Ghadames Basin, boreholes B2-34 and C1-34; Tanezzuft and Acacus Formations; Wenlockian-Downtonian (Richardson & Ioannides, 1973). Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' and Tadrart Formations; *tripapillatus-spicula* Biozone? to MN Oppel Zone?; Ludlow or Pridoli-early Lochkovian (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A6; Emsian-Givetian.
• Morocco: Doukkala and Essaouira Basins; Palynozones S-DM2; Pridoli-Emsian (Rahmani-Antari & Lachkar, 2001).
• Poland: Pomerania-Kujawy region; Polskie Laki IG-1 and Jamno IG-1 boreholes; Jamno Formation; reworked in early-middle Eifelian (Turnau & Matyja, 2001). Random-Lublin area; Borehole Terebin IG 5; Czarnolas and Zwoleń Formations; MN-PoW Oppel Zones, Lochkovian-?basal Emsian. Borehole Giezcezw PIG 5; Terrigenous Suite; FD?-FD Oppel Zones; upper Emsian (Turnau et al., 2005).
• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes JNDL-1, 3, 4, S-462 and wells ABSF-29, FWRH-1, HWYH-956, KHRM-2, SDGM-462; Jauf and Jubah Formations; A2-A6; ?late Pragian-Givetian.
• Spain: Cantabrian Mountains; San Pedro Formation; Wenlockian-late Gedinnian (Rodriguez, 1978b).
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A6; Emsian-Givetian.
• United Kingdom: Welsh Borderland and South Wales; Wenlock Shales to Middle Ditton Group; Wenlockian-Dittonian (Richardson & Lister, 1969).
• U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

Archaeozonotriletes variabilis **Naumova emend. Allen, 1965**

Pl. 17, figs 16-21

1953 *Archaeozonotriletes variabilis* Naumova, p. 30, 83, Pl. 2, figs 12, 13, Pl. 12, figs 8-11; Pl. 13, figs 7-9.
1965 *Archaeozonotriletes variabilis* Naumova emend. Allen, p. 721, Pl. 100, figs 3-6.

Description: Trilete patinate spores with circular to subcircular amb. Laesurae simple, straight, equals 3/4 to full central area radius. Exine homogeneous, laevigate to finely punctate, distally strongly patinate, up to 23 µm thick and proximally markedly thinner.

Dimensions: 46 (58) 71 µm, 12 specimens measured.

Remarks: As *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965 has a very thick distal patina, it is therefore frequently preserved in oblique compression, thus giving the impression of an irregular cingulum. The thickness of the patina is sometimes as much as 30% of the total diameter.

Comparisons: *Tholisporites tenuis* McGregor, 1960 has a proximal membranous veil and a thinner patina. *Tholisporites scoticus* Butterworth & Williams, 1958 is smaller and the patina is equatorially thicker. *Trematozonotriletes irregularis* (Andrejeva in Luber & Waltz) Ishchenko, 1958 appears very similar, but the punctae are confined to the inner margin of the patina. *Stenozonotriletes fixus* Ishchenko, 1952 with its punctate exine, appears to be similar but is cingulate rather than patinate. Some extreme variants of *Lophozonotriletes media* Taugourdeau-Lantz, 1967, which show a similar exine and a very reduced ornamentation, could intergrade with *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965. Consequently, the *Archaeozonotriletes variabilis* Morphon is defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:

• Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).

• Australia: Canning Basin; middle Givetian (Grey, 1991). Adavale Basin; Etonvale Formation; *optivus-triangulatus* and *ovalis-bulliferus* Assemblage Zones; late Givetian-early Frasnian (Hashemi & Playford, 2005).

• Belgium: Campine Basin, Booischot borehole; ?BJ Oppel Zone to Zone IV; Frasnien (Streel & Loboziak, 1987).

• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; TA-?BM Oppel Zones; late Givetian-Frasnian (Perez-Leyton, 1990).

• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira Formation; AD-Lem Interval Zone to Zone IV; early Givetian-earliest Famennian (Loboziak et al., 1992b). Amazon Basin; Ererê Formation; LLi Interval Zone; early Givetian (Melo & Loboziak, 2003).

• Canada: Arctic Archipelago, Queen Elisabeth, Melville and Bathurst Islands; Weatherall, Hecla Bay and Griper Bay Formations; Eifelian-early Famennian (McGregor & Owens, 1966; Owens, 1971; McGregor & Uyeno, 1972; McGregor & Camfield, 1982).

• China: Guangxi, Hunan and Yunnan; Assemblage Zones V-VI; Eifelian-Givetian (Gao Lianda, 1981).

• France: Boulonnais; Blacourt, Beaulieu, Ferques and Hydrequent Formations; late Givetian-late Frasnian; TLa Oppel Zone to Zone IV (Loboziak & Streel, 1980, 1988; Loboziak et al., 1983).

• Germany: Eifel, Prüm Syncline; Lauch and Nohn Formations; Assemblages E-H; early Eifelian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh and Cürten Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).

• Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).

• Libya: Cyrenaica; BM Oppel Zone to Zone IV; Frasnian-?early Famennian (Streel et al., 1988). Ghadames Basin; Palynozones 7-11; middle Givetian-'Strunian' (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6-A8; Givetian-?early Frasnian.

• Morocco: Doukkala and Essaouira Basins; Palynozones DM2-DS3; Givetian-Famennian (Rahmani-Antari & Lachkar, 2001).

• Norway: Spitsbergen; Upper Mimer Valley Series; Givetian (Allen, 1965).

• Poland: Western Pomerania; Studnica Formation; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).

• Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A6-A8; Givetian.

• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.

• United Kingdom: Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996).

Genus *Auroraspora* Hoffmeister et al., 1955

Type species: *Auroraspora solisortus* Hoffmeister et al., 1955.

Description: Trilete pseudosaccate spores with subcircular amb. Inner body subcircular to subtriangular in proximal view. Sexine delicate, laevigate, infrapunctate, or occasionally infragranular, width subequal, commonly folded because of extreme thinness. Nexine laevigate. Labra bordered laesurae and raised into a narrow ridge extending to, or almost to, the margin of the inner body.

Comparison: *Endosporites* Wilson & Coe, 1940 has an equatorial limbus.

Auroraspora macromanifesta (Hacquebard) Richardson, 1960

Pl. 18, figs 1, 2

1925 Type A; Lang, p. 255, Pl. 1, figs 1, 2.
1944 *Triletes velatus* Eisenack (pars), p. 108.
1957 *Endosporites macromanifestus* Hacquebard, p. 317, Pl. 3, figs 14, 15.
1960 *Auroraspora macromanifestus* (Hacquebard) Richardson, p. 50, Pl. 14, figs 1-2, text-fig. 6a.

Description: Trilete pseudosaccate spores with subcircular amb. Laesurae, sometimes obscured by the triradiate folds, approximately half of the radius of the spore body. Nexine laevigate. The inner body radius equals about 1/2 of the whole amb radius. Sexine laevigate and often folded and has pronounced folds along laesurae, these folds usually reach the equatorial margin.

Dimensions: 122 (123) 124 µm, 2 specimens measured.

Comparisons: These spores were originally described as type A by Lang (1925). According to Richardson (1960), similar spores were included in *Triletes velatus* by Eisenack (1944).

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Tin Meras Formation; middle Givetian-Frasnian (Moreau-Benoit et al., 1992).
• Canada: Nova Scotia, Blue Beach; Horton Group; Mississippian (Hacquebard, 1957).Arctic Archipelago, Queen Elisabeth, Melville and Bathurst Islands; Bird Fiord and Weatherall Formations; Givetian (McGregor & Owens, 1966; Owens, 1971; McGregor & Uyeno, 1972).
• Germany: Eifel, Prüm Syncline; Heisdorf, Lauch, Junkerberg, Freilingen, Ahbach and Loogh Formations; Assemblages C, E, F, L-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975).
• France: Boulonnais, railroad trench Caffiers-Ferques; Blacourt Formation; late Givetian-early Frasnian (Brice et al., 1979; Loboziak & Streel, 1980).
• Poland: Western Pomerania; Studnica Formation; RL Zone; late Eifelian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999).

• Tunisia: Borehole MG-1; Awaynat Wanin II Formation; A6-A7; Givetian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Wick Flagstone Group, Achanarras fish Beds, Thurso Flagstone and Eday groups; Eifelian-Givetian (Richardson, 1965). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

Auroraspora minuta Richardson, 1965

Pl. 18, figs 3-10

1965 *Auroraspora minuta* Richardson, p. 586, Pl. 93, fig. 2.

Description: Trilete pseudosaccate spores with subcircular, subtriangular or irregular amb. Laesurae straight and equals to inner body radius, lips thickened. Nexine, only slightly smaller than the sexine. The inner body radius equals 75 to 90 % of the whole amb radius. Nexine laevigate. Sexine thin, often strongly folded, externally laevigate or infrapunctate, occasionally infragranular.

Dimensions: 59 (72) 92 µm, 14 specimens measured.

Comparisons: *Auroraspora minuta* Richardson, 1965 differs from other species of *Auroraspora* by the large size of the inner body in relation to the sexine. Further the sexine is loose as indicated by the frequent asymmetrical position of the central body (Richardson, 1965). *Auroraspora macromanifesta* (Hacquebard) Richardson, 1960 is larger and the ratio of inner body to sexine radius is smaller. *Hymenozonotriletes variabilis* Naumova, 1953 resembles *Auroraspora minuta* Richardson, 1965 but has laesurae which reaches the equatorial outline.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-?early Eifelian (McGregor & Owens, 1966).
• France: Armorican Massif, Anjou, Fléchay Outcrop; Emsian (Moreau-Benoit, 1966).
• Libya: Ghadames Basin; Palynozone 5; early Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A5-A6; Eifelian-Givetian.
• Saudi Arabia: Boreholes JNDL-1, S-462 and well YBRN-1; Jubah Formation; A4-A7; Eifelian-Givetian.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Eday Group; Givetian (Richardson, 1965).

Genus *Biornatispora* Lele & Streel, 1969

Type species: *Biornatispora dentata* Lete & Streel, 1969.

Description: Trilete spores, roundly triangular to circular, characterized by two kinds of sculpture, i.e. low ridges (muri) of variable height that show a strong tendency to anastomose, forming a more or less reticuloid pattern, with apiculate ornaments (coni, verrucae, pila or baculae) of variable shape and size superimposed over and occasionally intermixed with the muri sculpture mostly well-developed on distal side, may encroach on proximo-equatorial region.

Comparison: *Acinosporites* Richardson, 1965 has convoluted pattern of muri that bear characteristically biform ornaments. *Dictyotriletes* Naumova, 1939 ex Ishchenko, 1952 is ornamented with a perfectly closed reticulum. *Camptotriletes* Naumova 1939 ex Potonié & Kremp, 1954 differs in having sparsely spaced cristate ridges which are more or less concentrically distributed and do not form a reticuloid pattern through anastomosis.

Biornatispora dubia (McGregor) Steemans, 1989

Pl. 19, figs 1-24

1973 *Camptotriletes dubius* McGregor, p. 42, Pl. 5, figs 9-11, 13, 14.
1989 *Biornatispora dubia* (McGregor) Steemans, p. 104, Pl. 22, figs 21-25.

Description: Trilete spores with subcircular to broadly triangular amb. Laesurae simple or with low labra individually up to 1 µm wide, length 2/3 to 9/10 spore radius. Contact areas laevigate. Distal and equatorial regions ornamented with coni, truncate coni, bacula or biform tubercules generally 1-2 µm wide at base, 1-2.5 µm long, 1-4 µm apart, commonly interconnected by ridges 0.5-2.5 wide and high that form an incomplete reticulum. Muri thickens where the ornaments are rooted. Lumina of the reticulum 2-8 µm in greatest diameter. Exine thickens up to 2 µm at equator.

Dimensions: 29 (37) 51 µm, 30 specimens measured.

Remarks: *Biornatispora dubia* (McGregor) Steemans, 1989 is a morphologically very variable species. All gradations are observed between specimens characterized by small muri and ornament to ones showing thicker ornamentation. The appearance of the reticulum is very varied between an almost complete to a very incomplete reticulum.

Comparisons: This species is distinguished from *Brochotriletes* sp. B in McGregor (1973) by its smaller size and low-ridged or incomplete foveo-reticulate sculpture. It is smaller than *Biornatispora dentata* (Streel) Lele & Streel, 1969 and has a more variable, less regularly disposed sculpture.

Stratigraphic and palaeogeographic occurrence:

- Belgium: Dinant, Neufchâteau-Eifel and Verviers Synclinoriums; Z Interval Zone-AB Oppel Zone; late Lochkovian-Pragian (Steemans, 1989).
- Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor, 1973).
- Germany: Siegerland; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
- Libya: Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4, MG-1 and wells ABSF-29, FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-late Emsian.

• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3b; late Emsian-?early Eifelian.

Biornatispora sp. 1

Pl. 20, figs 1-4

Description: Trilete spores with subcircular amb. Laesurae, straight, simple or widens up to 2 µm wide, length commonly 3/5 to 4/5 spore radius. Curvaturae visible and sometimes bounded by a single continuous thin and translucent murus, up to 2.5 µm high. Contact areas granular. Distal and equatorial regions ornamented with pila (elements with a swollen tip), or more rarely bacula and parallel-sided spinae. Elements 0.5-1 µm wide at base, 1-3 µm long, 1-3 µm apart, commonly interconnected by low ridges, generally about 0.5 µm wide and high that form an incomplete reticulum. Irregular lumina of the reticulum 3-8 µm in greatest diameter. Exine 1-1.5 µm thick at equator.

Dimensions: 41 (51) 60 µm, 5 specimens measured.

Comparison: This species is easily recognizable because it is the only form of *Biornatispora* Lele & Streel, 1969 that is ornamented with pila.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Borehole BAQA-2; Jauf Formation; A2; late Pragian-?earliest Emsian.

Genus *Brochotriletes* Naumova, 1939 ex Ishchenko, 1952

Type species: *Brochotriletes magnus* Ishchenko, 1952.

Description: Trilete spore azonate and foveolate.

Brochotriletes bellatulus Steemans, 1989

Pl. 20, figs 5, 6

1973 *Brochotriletes* sp. B; McGregor, p. 41, Pl. 4, figs 4, 5.
1989 *Brochotriletes bellatulus* Steemans (pars), p. 108, Pl. 24, figs 8-12.

Description: Trilete spores with subcircular to oval amb. Laesurae fine, simple, straight and extending to the equator. Proximal face thin and infragranular. Distal and equatorial regions foveolate. Foveae are subcircular and their greatest diameter varies from 1 to 7 µm on a same specimen. Exine ornamented, between the foveae, with pointed-tipped spinae or flat- or rounded-tipped bacula. Elements 1-2.5 µm high, 1-3 µm wide at base, 1-4 µm apart and irregularly distributed.

Dimensions: 66 (67) 68, 2 specimens measured.

Comparisons: *Brochotriletes robustus* (Scott & Rouse) McGregor, 1973 have thinner ornaments and fovea are more loosely distributed.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant Synclinorium; AB Oppel Zone; Emsian (Steemans, 1989).

• Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor, 1973).
• Germany: Siegerland; AB Oppel Zone; Emsian (Steemans, 1989).
• Luxembourg: Oesling region; AB Oppel Zone; early Emsian (Steemans et al., 2000).
• Saudi Arabia: Wells FWRH-1, KHRM-2, YBRN-1; Jauf and Jubah Formations; A2; ?late Pragian-Emsian, the specimen from the Jubah Formation is probably reworked.

Brochotriletes foveolatus Naumova, 1953

Pl. 20, figs 7-11, Pl. 21, figs 1-6

1953 *Brochotriletes foveolatus* var. *major* Naumova, p. 58, Pl. 7, fig. 23.
1953 *Brochotriletes foveolatus* var. *major* Naumova, p. 59, Pl. 7, fig. 24.
1961 *Perforosporites robustus* Scott & Rouse (pars), p. 978.
? 1963 *Brochotriletes perforatus* (Luber) Naumova; Shepeleva, fig. 9.
1966 *Brochotriletes* spp. (pars); McGregor & Owens, Pl. 4, fig. 8.
1967 *Perforosporites* sp. 1; Beju, Pl. 1, figs 25, 26.
1967 *Brochotriletes* sp.; McGregor, Pl. 1, fig. 3.
1968 *Perforosporites* sp. 1; Jardiné & Yapaudjian, Pl. 1, fig. 28.
1968 *Perforosporites* sp. 2; Jardiné & Yapaudjian, Pl. 1, figs 26, 27.
1973 *Brochotriletes ?foveolatus* Naumova; McGregor, p. 39, Pl. 4, figs 20,23, 24.
1973 *Brochotriletes* sp. A; McGregor, p. 40, Pl. 5, figs 2, 3.
1976 *Brochotriletes ?foveolatus* Naumova, McGregor & Camfield, p. 12, Pl. 5, fig. 10.
1976 *Brochotriletes* sp.; Massa & Moreau-Benoit, Pl. 1, fig. 23.
1976 *Brochotriletes* sp.; Moreau-Benoit, p. 34, Pl. 6, fig. 3.
1979 *Brochotriletes libyensis* Moreau-Benoit, p. 52, Pl. 8, fig. 2.
1979 *Brochotriletes mac gregori* Moreau-Benoit, p. 53, Pl. 8, fig. 1.
1981 *Brochotriletes* sp. B; Steemans, p. 52.
1981 *Brochotriletes* sp. E; Steemans, p. 52.
1983 *Brochotriletes* cf. *Brochotriletes* sp. A McGregor; Le Hérissé, p. 33, Pl. 6, figs 1, 2.
1984 *Brochotriletes* sp.; Steemans & Gerrienne, Pl. 2, fig. 8.
1988 *Brochotriletes* sp. cf. *Perforosporites* sp. 2 in Jardiné & Yapaudjian; Boumendjel et al., Pl. 1, fig. 1.
1989 *Brochotriletes ?foveolatus* Naumova; Steemans, p. 108, Pl. 24, figs 14-16, Pl. 25, figs 1, 2.

Description: Trilete spores with subcircular to rounded triangular amb. Laesurae not always perceptible, simple, straight, and extending to equator. Exine 1.5-3 µm thick equatorially and distally, thinner on contact areas of proximal face. Contact areas laevigate to infragranular. Distal and proximo-equatorial regions foveolate. Foveae circular, subcircular, roughly polygonal or elongate in plan, U-shaped in profile, 2.5-10 µm in diameter (rarely wider), 1.5-4 µm deep, and 1.5-5 µm apart. Exine between foveae laevigate.

Dimensions: 47 (63) 77 µm, 17 specimens measured.

Comparisons: The absence of sculpture between foveae distinguishes this species from *Brochotriletes bellatulus* Steemans, 1989 and *Brochotriletes robustus* (Scott & Rouse) McGregor, 1973. *Perforosporites* sp. in Allen (1965) is much larger and has a thicker exine. The illustrated specimens of *Perforosporites* sp. 1 and *Perforosporites robustus* in Beju (1967) appear similar to *Brochotriletes foveolatus* Naumova, 1953, but since no description was given, the degree of similarity must remain open to question. *Brochotriletes* sp. in de Jersey (1966) has smaller, more closely spaced pits. *Brochotriletes hudsonii* McGregor & Camfield, 1976 is ornamented with more foveae which are moreover smaller. *Chelinospora cantabrica* Richardson et al., 2001 is distinghished by the presence of constriction of muri between lumina.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin, borehole TRN 3; Hassi-Tabankort Formation; Pragian (Boumendjel et al., 1988).
- Brazil: Amazon Basin; Maecuru Formation; Ems Interval Zones; late Lochkovian-?early Emsian (Melo & Loboziak, 2003). Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Belgium: Dinant, Verviers Synclinoriums and Theux Window; Siα-Su Interval Zones; late Lochkovian-late Pragian (Steemans, 1989).
- Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River, Sextant and Kwataboahegan Formations; *annulatus-lindlarensis* Provisional Assemblage; Zone Emsian (McGregor & Camfield, 1976).
- France: Armorican Massif, Laval Syncline; Montguyon and Saint-Céneré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983). Armorican Massif, Laval Syncline, Saint-Céneré Outcrop; Siβ Interval Zone; late Lochkovian (Steemans, 1989).
- Germany: Siegerland; Su Interval Zone; late Pragian (Steemans, 1989).
- Libya: Ghadames Basin; Palynozones 2-5; Pragian-early Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa and Awaynat Wanin II Formations; A3a-A6; Emsian-Givetian.
- Poland: Random-Lublin area; Borehole Terebin IG 5; Zwoleń Formation; PoW Oppel Zone; Pragian-?basal Emsian (Turnau et al., 2005).
- Romania: Moesian Platform, Chilia well; G Interval Zone; late Lochkovian (Steemans, 1989).
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-4, S-462 and wells ABSF-29, FWRH-1, HWYH-956, KHRM-2, SDGM-462, UTMN-1830; Jauf and Jubah Formation; A1-A7; late Pragian-Givetian.
- Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin II and Awaynat Wanin III Formations; A3a-A8; Emsian-?early Frasnian.

Brochotriletes hudsonii **McGregor & Camfield, 1976**

Pl. 21, figs 7, 8

1966 *Brochotriletes* sp.; McGregor & Owens, Pl. 1, figs 8, 9.
? 1968 Spore n° 380; Magloire, Pl. 1, fig. 9, Pl. 2, fig. 2.
1970 *Brochotriletes* sp.; McGregor et al., Pl. 1, figs 14, 15.
1975 *Brochotriletes* sp. in McGregor; Sanford & Norris, Pl. 1, figs 14, 15.
1976 *Brochotriletes hudsonii* McGregor & Camfield, p. 12, Pl. 3, figs 1, 2.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae barely perceptible, simple, straight, length 2/3 to 4/5 the spore radius. Exine 2.5-6 µm thick equatorially and distally, thinner on contact areas of proximal face. Contact areas infragranular to granular. Distal and proximo-equatorial regions foveolate. Foveae round to oval, occasionally irregular in plan, U-shaped in profile, 1.5-5 µ in diameter, 2-4 µ deep and 1-4 µ apart. Number of foveae on the equator varies with size of spore, commonly about 30. Exine between foveae laevigate.

Dimensions: 52 (66) 79 µm, 4 specimens measured.

Comparisons: The highly carbonized spores referred to as 'spore n° 380' in Magloire (1968) may be similar to *Brochotriletes hudsonii* McGregor & Camfield, 1976. *Brochotriletes foveolatus* Naumova, 1953 has a thinner equatorial and distal exine. Its foveae are relatively larger and in consequence are less numerous.
Stratigraphic and palaeogeographic occurrence:
• Canada: Quebec, Gaspé Peninsula; Cape Bon Ami Formation; upper Gedinnian (McGregor & Owens, 1966). Ontario, Moose River Basin; Kenogami River and Stooping River Formations; *caperatus-emsiensis* Provisional Assemblage Zone; Siegenian (McGregor & Camfield, 1976).
• Germany: Siegerland; Su Interval Zone; late Pragian (Steemans, 1989).
• Libya: Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
• Poland: Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; FD Oppel Zone; uppermost Emsian (Turnau et al., 2005).
• Saudi Arabia: Borehole BAQA-1; Jauf Formation; A2; ?late Pragian-Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3a; Emsian.

Brochotriletes robustus (Scott & Rouse) McGregor, 1973

Pl. 21, figs 9, 10

1961 *Perforosporites robustus* Scott & Rouse (pars), p. 978, Pl. 113, figs 1, 2.
1966 *Brochotriletes* spp. (pars); McGregor & Owens, Pl. 4, fig. 5.
1967 *Perforosporites robustus* Scott & Rouse; Beju, Pl. 1, figs 23, 24.
1973 *Brochotriletes robustus* (Scott & Rouse) McGregor, p. 40, Pl. 5, figs 1, 6.
? 1983 *Brochotriletes* cf. *robustus* (Scott & Rouse) McGregor; Le Hérissé, p. 34, Pl. 5, fig. 11.
1989 *Brochotriletes bellatulus* Steemans (pars), p. 108, Pl. 24, fig. 13.

Description: Trilete spores with rounded subtriangular to subcircular amb. Laesurae not observed because of the tear of the contact surface and estimated from 2/3 to as long as the radius of the spore. Exine about 2-3 µm thick equatorially and distally, thinner on proximal face. Distal and proximo-equatorial regions foveolate. Foveae round or irregular in plan view, 1-4 µm in diameter and about 1-3 µm apart. On some specimens the open ends of the pits are narrowed by overhanging flaps of exine. Distal and proximo-equatorial regions between foveae ornamented with discrete elements, up to 1 µm high and 1 µm wide and 1-3 µm apart. Ornaments seems interconnected by barely perceptible very fine muri. They delimit a polygonal pattern, around foveae, bearing ornaments at the angles.

Dimensions: 35 (37) 40 µm, 3 specimens measured.

Comparisons: This species is distinguished from *Brochotriletes bellatulus* Steemans, 1989 by its smaller size and spinose sculpture. It is very close to it, and may represent an extreme member of the *Brochotriletes bellatulus* population. Unfortunately, few specimens have been found. Other spores included in *Perforosporites robustus* by Scott & Rouse, 1961 apparently do not bear ornaments. They would appear to belong in *Brochotriletes foveolatus* Naumova, 1953. One figured specimens of *Brochotriletes bellatulus* in Steemans (1989) is exactly similar to our small specimens of *Brochotriletes robustus*.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant and Verviers Synclinoriums; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).

• Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River, Sextant and Kwataboahegan Formations; *caperatus-emsiensis* to *annulatus-lindlarensis* Provisional Assemblage Zone; Emsian (McGregor & Camfield, 1976).
• Germany: Siegerland; Z-E Interval Zones; late Lochkovian-early Pragian (Steemans, 1989).
• Saudi Arabia: Wells HWYH-956 and YBRN-1; Jauf and Jubah Formation; A2; ?late Pragian-Emsian, specimens from the Jubah Formations are probably reworked.

Brochotriletes sp. 1

Pl. 21, figs 11, 12; Pl. 22, figs 1, 2

Description: Trilete patinate spores with subcircular amb. Laesurae, simple, straight, length 3/4 to 9/10 spore radius. Exine 2-6.5 µm thick equatorially and distally, thinner on contact areas of proximal face. Contact areas laevigate to infragranular. Subcircular papillae, 4-9 µm wide, are developed on each interradial region rather than towards the apical pole. Distal face foveolate. Foveae circular to elongate or roughly polygonal in plan, 4-9 µm in diameter and 1.5-5 µm apart. Exine between foveae laevigate.

Dimensions: 45 (55) 61 µm, 3 specimens measured.

Comparisons: Although the specimen figured as *Brochotriletes* sp. cf. *B. foveolatus* Naumova, 1953 in McGregor & Playford (1992) seems to have proximal sculptures (Pl. 4, fig. 11), the taxon described above is the only form of *Brochotriletes* Naumova, 1939 ex Ishchenko, 1952 known in the literature so far that shows proximal papillae.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Borehole A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.

Brochotriletes sp. 2

Pl. 22, figs 3-9

Description: Trilete spores with subcircular to subtriangular amb. Laesurae often open, straight, simple, extending to or almost to the equator. Exine 1.5-3.5 µm thick. Proximal and distal regions foveolate. Foveae round to oval in plan, 3-6 µm in diameter, up to 2µm deep and 2-4 µm apart. Number of foveae on the equat around 15. Exine between foveae laevigate.

Dimensions: 33 (36) 40 µm, 8 specimens measured.

Comparisons: *Coronospora reticulata* Richardson et al., 2001 has kyrtome on the contact areas and is not reticulate proximally. *Brochotriletes* sp. B in Tekbali & Wood (1991) may correspond to specimens described above but there are only illustrations in the paper.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Ouan-Kasa and Awaynat Wanin I Formations; A3a-A4; Emsian-Eifelian.
• Saudi Arabia: Boreholes JNDL-1 and JNDL-3, Jauf and Jubah Formations, A3a-A4; Emsian-Eifelian.

Genus *Camarozonotriletes* Naumova, 1939 ex Naumova, 1953

Type species: *Camarozonotriletes devonicus* Naumova, 1953.

Description: Cingulate trilete spore. Amb subcircular to triangular with the margins convex, straight, or slightly concave. The equatorial cingulum is thicker interradially than opposite the trilete rays.

Camarozonotriletes filatoffii Breuer et al., 2007c

Pl. 22, figs 10-20

2007c *Camarozonotriletes filatoffii* Breuer et al., p. 49, Pl. 4, figs 14-23, Pl. 5, fig. 1.

Description: Amb subcircular to subtriangular. Contact area subtriangular to triangular with rounded corners and laevigate. Laesurae simple or accompanied by narrow labra, straight, 3/5 to 4/5 of the radius in length. Exine darker adjacent to rays, forming a more or less triangular darkened and presumably thickened zone around the proximal pole and extending to the end of the rays. Cingulum 1-2 µm thick equatorially opposite the trilete rays and up to 6 µm interradially. Distal and equatorial sculpture composed of spines generally 1-2 µm high, 0.5-1.5 µm wide at their base, and 1.5-2.5 apart. Elements are commonly situated on indistinctly defined muri, about 1-2.5 µm wide, that form a perfectly closed reticulum. Lumina are generally 3-7 µm in their longest diameter. Cingulum slightly darker than central area.

Dimensions: 24 (29) 35 µm, 35 specimens measured.

Comparisons: ?*Reticulatisporites* sp. in Kemp (1972) which is synonymous with *Rotaspora retiformis* Hashemi & Playford, 2005 are distally reticulate but are not ornamented with spines. In contrast, *Rotaspora rara* (Raskatova) Hashemi & Playford, 2005 is also very close in morphology with the same kind of spines but is not distally reticulate. *Camarozonotriletes sextantii* McGregor & Camfield, 1976 is larger (37-60 µm), in addition its distal and equatorial sculpture does not possess a reticulum and the ornaments are evenly distributed.

Stratigraphic and palaeogeographic occurrence:

- Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4 and wells FWRH-1, HWYH-956, KHRM-2, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-Emsian.

Camarozonotriletes parvus Owens, 1971

Pl. 22, figs 21-28

1966 *Camarozonotriletes* sp. cf. *C. breviculus* Ishchenko; McGregor & Owens, Pl. 9, fig. 5.
1971 *Camarozonotriletes parvus* Owens, p. 40, Pl. 11, figs 1-4.
1972 *Camarozonotriletes* n. sp.; McGregor & Uyeno, Pl. 2, fig. 2.
non 1989 *Camarozonotriletes parvus* Owens; Steemans, p. 112, Pl. 26, figs 4-8, 56.
non 2007 *Camarozonotriletes parvus* Owens; Mendlowicz Mauller et al., Pl. 5, fig. 7.

Description: Trilete cingulate spores with amb subcircular to subtriangular. Contact area subtriangular to triangular with rounded corners and laevigate. Laesurae simple, straight, commonly 3/5 to 4/5 of the radius in length. Curvaturae sometimes visible. Cingulum 1-3 µm thick equatorially opposite the trilete rays and 2.5-6 µm thick interradially. Exine laevigate proximally. Distal and equatorial sculpture composed of grana, coni or rarely spines, closely spaced, generally less than 0.5 µm high and wide (rarely as much as 1 µm high) and thus often barely perceptible. Cingulum slightly darker than central area.

Dimensions: 28 (36) 43 µm, 15 specimens measured.

Comparisons: The specimens described as *Camarozonotriletes parvus* Owens, 1971 in Steemans (1989) are misidentified because they show higher sculptural elements in the shape of pila and bacula. *Camarozonotriletes minutus* Naumova ex Tchibrikova, 1959 and *Camarozonotriletes antiquus* Kedo, 1955 are described as shagreenate. In all other respects, they appear identical to *Camarozonotriletes parvus* Owens, 1971. *Camarozonotriletes laevigatus* McGregor & Camfield, 1982 resembles strongtly to the latter but is unsculptured.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
- Canada: Arctic Archipelago, Queen Elisabeth and Melville Islands; Weatherall, Hecla Bay and Griper Bay Formations; late Eifelian-Frasnian (McGregor & Owens, 1966; Owens, 1971; McGregor & Uyeno, 1972; McGregor & Camfield, 1982).
- Libya: Ghadames Basin; Palynozones 5-8; early Eifelian-late Frasnian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6; early Givetian.
- Morocco: Doukkala Basin; Palynozones DM2; Givetian (Rahmani-Antari & Lachkar, 2001).
- Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A6; early Givetian but some specimens from borehole S-462 may be caved in older strata.
- Tunisia: Borehole MG-1; Awaynat Wanin III Formation; A8; late Givetian-?early Frasnian.

Camarozonotriletes rugulosus Breuer et al., 2007c

Pl. 23, figs 1-11

2007c *Camarozonotriletes rugulosus* Breuer et al., p. 49, Pl. 5, figs 2-9.

Description: Amb triangular. The corners are slightly rounded, while the margins are slightly convex, straight, or sometimes slightly concave. Exine thin. Laesurae distinct, simple and straight. The trilete mark radius is at least longer than 4/5 of the amb radius. Curvaturae are not easily distinguishable. Cingulum generally 1-2 µm thick equatorially opposite the trilete rays and 3-5 µm interradially. Contact faces laevigate. Distal face sculptured with very thin rugulae 0.5 µm in maximum width.

Dimensions: 37 (46) 59 µm, 30 specimens measured.

Comparison: *Leiotriletes horridulus* Ishchenko, 1958, an Upper Mississippian species from Russia, resembles *Camarozonotriletes rugulosus* Breuer et al., 2007c according to the original description, but is smaller (30-35 µm). Furthermore, this taxon is not interradially thickened.

Remark: As the rugulae are very thin, they may be barely visible or undistinguishable because of poor preservation. Its thin exine appears delicate.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A7; Givetian.
- Saudi Arabia: JNDL-1. Jubah Formation; A4; Eifelian.

Camarozonotriletes sextantii McGregor & Camfield, 1976

Pl. 23, figs 10-25

1954 Unnamed spore; Radforth & McGregor, fig. 63.
1968 *Apiculatisporites* sp. 1; Jardiné & Yapaudjian, Pl. 1, figs 15, 18.
? 1968 *Procoronaspora ambigua* Butterworth & Williams; Lanninger, p. 129, Pl. 22, fig. 21.
1970 *Procoronaspora* sp., McGregor et al., Pl. 2, figs 1, 2.
1974 Microspores of *Chaleuria cirrosa* Andrews et al., p. 396, 398, Pl. 55, fig. 3, Pl. 56, figs 5, 6, Pl. 57, figs 1-3, 5.
1976 *Camarozonotriletes sextantii* McGregor & Camfield, p. 12, Pl. 4, figs 13, 14, 16-18.
? 1982 *Craspedispora arctica* McGregor & Camfield, p. 28, Pl. 5, figs 5-9, text-fig. 38.

Description: Trilete cingulate spores with subcircular to subtriangular amb. Contact area in polar view subtriangular to triangular with rounded corners, interradial margins convex to more commonly concave. Laesurae simple, straight, 3/5 to 4/5 the radius long. Exine along laesurae dark, presumably a thickened zone, dark region widest near the proximal pole, tapering towards the equator. Cingulum 1-2.5 µm thick equatorially opposite the trilete rays and up to 5 µm interradially where the smooth nexine and the ornamented sexine may be separated. Contact areas laevigate or infragranular, curvaturae visible. Distal and equatorial sculpture composed of grana, pointed or blunt coni, spines and biform ornaments, 0.5-3.5 µm high, 0.5-2 µm wide at their base, and 0.5-3 µm apart. The largest ornaments occur in the equatorial region interradially. Sculpture may be present, reduced in size or less commonly absent equatorially at apices.

Dimensions: 31 (39) 59 µm, 21 specimens measured.

Remarks: Two populations of specimens can be discriminated: one from North Africa with small specimens (31-36 µm) and the other from Saudi Arabia characterized by a larger size (37-59 µm).

Comparisons: Examination of Lanninger's figured specimen by McGregor & Camfield (1976) suggests that specimens referred to *Procoronaspora ambigua* Butterworth & Williams in Lanninger (1968) are probably similar to *Camarozonotriletes sextantii*. *Procoronaspora luteola* Turnau, 1974 is smaller, has relatively widely spaced small cones, and may be folded but apparently not thickened interradially at the equator. McGregor in McGregor & Camfield (1976) has examined specimens of *Apiculatisporites* sp. 1 in Jardiné & Yapaudjian, 1968 from the Sahara, and has confirmed that they are assignable to *Camorozonotriletes sextantii*. *Diatomozonotriletes oligodontus* Tchibrikova, 1962 is at least superficially like *Camarozonotriletes sextantii*. However, the precise nature and distribution of the sculpture of this species is not clearly stated by Tchibrikova, so close comparison is not possible. The microspores of *Chaleuria cirrosa* Andrews et al., 1974 are identical to dispersed specimens of *Camarozonotriletes sextantii* from the Moose River Basin. *Camarozonotriletes obtusus* Naumova, 1953, *Camarozonotriletes devonicus* Naumova, 1953, and *Camarozonotriletes moslovicus* Naumova in Kedo (1955) lack the darkened subtriangular area in the angles between rays. Other sculptural and structural features are difficult to compare from the data given by the authors of these species. *Craspedispora arctica* McGregor & Camfield, 1982 is herein considered as synonymous of *Camarozonotriletes sextantii* McGregor & Camfield, 1976 because the criteria used to distinguish them are not discriminatory. Indeed, *Craspedispora arctica* McGregor & Camfield, 1982 has notably straight convex interradial margins of the contact area while those of *Camarozonotriletes sextantii* McGregor & Camfield, 1976 are convex to more commonly concave. In addition, *Craspedispora arctica* McGregor & Camfield, 1982 resembles strongly to the North African population from boreholes A1-69 and MG-1.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin; Orsine Formation; Emsian (Moreau-Benoit et al., 1992).
- Belgium: Dinant Synclinorium; AB Oppel Zone; Emsian (Steemans, 1989).
- Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Ontario, Moose River Basin; Stooping River, Sextant and Kwataboahegan Formations; *annulatus-lindlarensis* Provisional Assemblage Zone; Emsian (McGregor & Camfield, 1976).
- Germany: Siegerland; AB Oppel Zone; Emsian (Steemans, 1989).
- Libya: Ghadames Basin; Palynozones 3-4; Emsian-earliest Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa and Awaynat Wanin I Formations; A3; Emsian-?early Eifelian.
- Morocco: Doukkala and Essaouira Basins; Palynozones DI2-DM1; Emsian-Eifelian (Rahmani-Antari & Lachkar, 2001).
- Poland: Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; FD Oppel Zone; uppermost Emsian (Turnau et al., 2005).
- Saudi Arabia: Well DMMM-45; Jauf Formation; AB Oppel Zone; Emsian (Steemans, 1995). Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes JNDL-1, 3, 4, and wells KHRM-2, NFLA-1, SDGM-462, UTMN-1830; Jauf and Jubah Formations; A3a-A4; Emsian-Eifelian.
- Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3b-A5; late Emsian-Eifelian.

***Camarozonotriletes* sp. 1**

Pl. 24, figs 1-8

Description: Trilete cingulate spores with triangular amb. The corners are rounded, while the margins are slightly convex, straight, or sometimes slightly concave. Exine thin. Laesurae distinct, simple, straight and extending to the inner margin of the cinguluum. Trilete rays sometimes open. Curvaturae are not easily distinguishable. Cingulum generally 1-3 µm wide equatorially opposite the trilete rays and commonly 4-10 µm interradially. Contact faces laevigate. Proximal-equatorial and distal regions infra-granular, sculptured with minute closely spaced grana or coni, less than 0.5 µm in diameter and sometimes barely visible. Cingulum slightly darker than central area.

Dimensions: 42 (69) 85 µm, 17 specimens measured.

Comparisons: *Camarozonotriletes minutus* Naumova ex Tchibrikova, 1959 and *Camarozonotriletes antiquus* Kedo, 1955 are smaller and are described as shagreenate. *Camarozonotriletes parvus* Owens, 1971 is smaller and more rounded. *Camarozonotriletes laevigatus* McGregor & Camfield, 1982 is unsculptured and also smaller. *Camarozonotriletes rugulosus* Breuer et al., 2007c is commonly smaller and finely rugulate distally but ornamentation is sometimes barely visible. *Camarozonotriletes*? *concavus* Loboziak & Streel, 1989 is smaller and the width of cingulum is barely reduced opposite the laesurae, what calls its allocation to the genus *Camarozonotriletes* Naumova, 1939 ex Naumova, 1953 into question.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A5-A6; Eifelian-Givetian.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-Givetian.

Camarozonotriletes? _concavus_ Loboziak & Streel, 1989

Pl. 25, figs 1-10

1989 *Camarozonotriletes*? *concavus* Loboziak & Streel, p. 175, Pl. 1, figs 13-15.

Description: Trilete cingulate spores with subtriangular to triangular amb. Rounded corners and generally concave to almost straight, interradial margins. Laesurae simple, straight and extending to the inner margin of cingulum. Cingulum, 2-5 µm wide, slightly reduced at corners, slightly darker than central area of the spore. Exine proximally laevigate, equatorially and distally infragranulate to granulate giving a spongy appearance. Sculptural elements less than 1 µm wide and high, often barely perceptible and closely distributed.

Dimensions: 32 (40) 48 µm, 23 specimens measured.

Remarks: Sometimes, two slightly separated walls can be detected. Reduction of the cingulum width at corners is not often very conspicuous in this species and attribution to *Camarozonotriletes* Naumova, 1939 ex Naumova, 1953 is therefore questionable (Loboziak & Streel, 1989).

Comparisons: Amongst sculptured species, *Camarozonotriletes antiquus* Kedo, 1955 has convex interradial margins. *Camarozonotriletes parvus* Owens, 1971 has the cingulum clearly reduced in front of the laesurae and a more rounded general amb. *Camarozonotriletes pusillus* Naumova ex Tchibrikova, 1959 has ornamentation up to 1.5 µm high.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem-BJ Oppel Zones; Eifelian-Frasnian (Loboziak et al., 1988). Amazon Basin; Ererê Formation; Per-LLi Interval Zones; early Eifelian-early Givetian (Melo & Loboziak, 2003).
• Libya: Borehole A1-69; Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian
• Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; A6-A7; Givetian.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.

Genus *Chelinospora* Allen, 1965

Type species: *Chelinospora concinna* Allen, 1965.

Description: Trilete spores with circular to roundly triangular amb. Laesurae distinct, usually long, simple or accompanied by narrow folds. Exine one or two-layered, acavate, thin proximalIy, equatorialIy and distally patinate, the patina may be of even thickness, or with its maximum thickness either equatorially or distally. Patina reticulate or foveoreticulate, contact areas laevigate or with a reduced sculpture of muri, granules, and cones.

Comparison: *Chelinospora* Allen, 1965 differs from other patinate forms in the reticulate or foveoreticulate sculpture of patina.

Chelinospora cantabrica Richardson et al., 2001

Pl. 25, figs 11-19

2001 *Chelinospora cantabrica* Richardson et al., p. 155, Pl. 4, fig. 7, Pl. 9, fig. 1.

Description: Trilete spores with subtriangular to triangular amb. Laesurae straight and simple, but often not observed because of the thinness of proximal exine, frequently torn. Exine laevigate to infragranulate, 2-7 µm equatorially thick, thinner proximally. Patina sculptured with broad reticulum. Muri 2-7 µm wide and 1-4 µm high. At junctions, muri commonly widen into large rounded or flat-topped verrucae, 4-9 µm wide, up to 8 µm high, sometimes fused together. Lumina, polygonal or irregular in plan view, 2-10 µm in greatest diameter. Muri show constrictions broken by narrow sutures between each pair of junctions.

Dimensions: 37 (56) 69 µm, 13 specimens measured.

Comparisons: The broad muri with distinct constrictions and sutures, and wide more or less polygonal lumina, distinguish this species from other species of *Chelinospora* Allen, 1965. *Coronaspora reticulata* Richardson et al. (2001) has similar reticulate sculpture but has an equatorial crassitude and a proximal kyrtome. However, *Chelinospora cantabrica* Richardson et al., 2001 seems to have somewhat a structure of *Brochotriletes* Naumova, 1939 ex Ishchenko, 1952, *Brochotriletes foveolatus* Naumova, 1953 is distinghished above all from it by the absence of constriction of exine between foveae.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2 and well UTMN-1830; Jauf Formation; A1-A2; late Pragian-?early Emsian.
- Spain: Cantabrian Mountains; San Pedro Formation; *reticulata-sanpetrensis* Assemblage Zone to *hemiesferica* Interval Zone; late Ludfordian-Pridoli (Richardson et al., 2001).

Chelinospora concinna Allen, 1965

Pl. 26, figs 1-11

1964 *Knoxisporites reticulatus* Vigran, p. 22, Pl. 1, figs 10-12, Pl. 2, figs 8, 9.
1965 *Chelinospora concinna* Allen, p. 728, Pl. 101, figs 12-20.

Description: Trilete patinate spores with circular to subcircular amb. Laesurae distinct, simple, straight, length 3/4 to full central area radius. Exine homogeneous to infrapunctate, equatorially 2-11 µm thick. Contact areas laevigate or support a sparse ornament of small verrucae or granules, 2 µm or less in width and height, and less frequently rugulae or muri, 0.5-3 µm wide. Patina coarsely reticulate, muri 0.5-2 µm wide, 1-5 µm high, enclosing large polygonal to irregularly rounded lumina 5-25 µm in longest diameter.

Dimensions: 36 (51) 65 µm, 22 specimens measured.

Remarks: There is considerable variation in width of the patina, thickness of muri and size of lumina.

Comparisons: *Knoxisporites reticulatus* Vigran, 1964 is considered herein as synonymous with *Chelinospora concinna* Allen, 1965. Indeed, contact areas of the described specimens are either laevigate (corresponding to the orginal diagnosis of *Knoxisporites reticulatus* Vigran, 1964) or ornamented (corresponding to the orginal diagnosis of *Chelinospora concinna* Allen, 1965).

Stratigraphic and palaeogeographic occurrence:
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; BJ-?BM Oppel Zones; Frasnian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; TCo Oppel Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988).
- Canada: Arctic Archipelago, Melville Island; Weatherall, Hecla Bay and Griper Bay Formations; late Givetian-Frasnian (McGregor & Uyeno, 1972).
- France: Boulonnais; Blacourt and Beaulieu Formations; late Givetian-early Frasnian; TCo-BJ Oppel Zones (Brice et al., 1979; Loboziak & Streel, 1980, 1988).
- Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A8; late Givetian-?early Frasnian.
- Norway: Spitsbergen; Mimer Valley Series and Upper Svalbardia Sandstone; ?late Eifelian-Frasnian (Vigran, 1964; Allen, 1965).
- Poland: Western Pomerania; Jamno, Miastko and Sianowo Formations; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
- Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).
- Russia: central and eastern parts of European Russia; Staryi Oskol Group; Ex Zone; middle Givetian (Arkhangelskaya & Turnau, 2003).
- Saudi Arabia: Borehole S-462; Jubah Formation; A8; late Givetian-?early Frasnian.
- Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A8; late Givetian-?early Frasnian.
- United Kingdom: Shetland, Fair Isle; Ward Hill, Observatory and Bu Ness Groups; late Givetian (Marshall & Allen, 1982). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996).

***Chelinospora hemiesferica* (Cramer & Díez) Richardson et al., 2001**

Pl. 26, figs 12-15

1975 *Iberoespora hemiesferica* Cramer & Díez, p. 341, Pl. 2, figs 34-36.
2001 *Chelinospora hemiesferica* (Cramer & Díez) Richardson et al., p. 156, Pl. 4, fig. 9, Pl. 9, figs 3, 5.

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae straight, simple or labrate (up to 2 µm wide) and extending to the inner edge of patina. Exine laevigate or infragranulate, 3-7 µm equatorially thick, thinner proximally. Contact areas laevigate, sometimes torn. Patina sculptured with brain-like convoluted muri, 0.5-2 µm wide and up to 1.5 µm apart. Muri become radially oriented over the equatorial and subequatorial regions.

Dimensions: 41 (47) 56, 5 specimens measured.

Remark: The spores may be double-layered and on some specimens some local detachments of outer layer are seen (Pl. 26, fig. 15). *Chelinospora* cf. *hemiesferica* (Cramer & Díez) Richardson et al., 2001 has wider muri. The two species could intergrade within the *Chelinospora hemiesferica* Morphon (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A2; ?late Pragian-Emsian.
- Spain: Cantabrian Mountains; San Pedro Formation; Dittonian-early Siegenian (Cramer & Díez, 1975; Rodriguez, 1978b). Cantabrian Mountains; San Pedro Formation; *hemiesferica* Interval Zone to *micrornatus-newportensis* Assemblage Zone; Pridoli-early Lochkovian (Richardson et al., 2001).

Chelinospora cf. *hemiesferica* (Cramer & Díez) Richardson et al., 2001

Pl. 27, figs 1-11

2001 *Chelinospora* cf. *hemiesferica* (Cramer & Díez) Richardson et al., p. 156, Pl. 4, figs 6, 10, Pl. 9, fig. 4, Pl. 10, fig. 1.
cf. 2001 *Chelinospora hemiesferica* (Cramer & Díez) Richardson et al., p. 156, Pl. 4, fig. 9, Pl. 9, figs 3, 5.

Description: Trilete patinate spores with circular to subtriangular amb. Laesurae straight, simple or accompanied by labra, up to 3 µm in overall width, extending to the inner edge of patina. Exine infragranulate, 2-8 µm thick equatorially, thinner proximally. Contact areas laevigate, sometimes torn. Patina sculptured with brain-like convoluted muri, 1-4 µm wide and 1-3 µm apart. Muri become radially oriented over the equatorial and subequatorial regions.

Dimensions: 43 (55) 71, 17 specimens measured.

Comparison: *Chelinospora hemiesferica* (Cramer & Díez) Richardson et al., 2001 has narrower distal muri which are closely spaced. Nevertheless, the two species could intergrade within the *Chelinospora hemiesferica* Morphon (Tab. 1, p. 185). *Chelinospora* sp. 1 has less muri and *Chelinospora* sp. 2 has the same muri but these are more densely spaced. All these convolutate forms of *Chelinospora* Allen, 1965 are included in the *Chelinospora hemiesferica* Morphon. They were probably derived from a group of closely related plants.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2 and well HWYH-956; Jauf Foramtion; A1-A2; late Pragian-?early Emsian.
- Spain: Cantabrian Mountains; San Pedro Formation; *elegans-cantabrica* to *micrornatus-newportensis* Assemblage Zones; Pridoli-early Lochkovian (Richardson et al., 2001).

Chelinospora sanpetrensis (Rodriguez) Richardson et al., 2001

Pl. 27, figs 12-14

1973 cf. *Brochotriletes* sp. A; Richardson & Ioannides, p. 276, Pl. 4, figs 5, 6, 8-10.
1978b *Brochotriletes sanpetrense* Rodriguez, p. 414, Pl. 1, fig. 13.
1983 *Brochotriletes sanpetrensis* Rodriguez, p. 34., Pl. 1, figs 10, 19.
2001 *Chelinospora sanpetrensis* (Rodriguez) Richardson et al., p. 159, Pl. 4, fig. 8, Pl. 7, fig. 10.

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae simple, straight and rarely perceptible. Proximal face very thin and laevigate. Exine equatorially and distally, 3-6 µm thick, thicker than proximally, foveolate. Lumina oval or of irregular shape, 2-10 µm in longest diameter. Sinuous muri bewteen lumina 2-6 µm wide.

Dimensions: 49 (51) 58 µm, 4 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant and Verviers Synclinoriums; Nα-G Interval Zone; Lochkovian (Steemans, 1989).
• France: Armorican Massif, Laval Syncline; Montguyon Formation; Assemblage 2; late Siegenian (Le Hérissé, 1983).
• Libya: Ghadames Basin, boreholes B2-34 and C1-34; Acacus Formation; Lludlovian-Downtonian (Richardson & Ioannides, 1973).
• Spain: Cantabrian Mountains; San Pedro Formation; Lludolovian-Downtonian (Rodriguez, 1978a, b). Cantabrian Mountains; San Pedro Formation; *elegans-cantabrica* to *micrornatus-newportensis* Assemblage Zones; Pridoli-early Lochkovian (Richardson et al., 2001).
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3; late Emsian-?early Eifelian.

Chelinospora timanica (Naumova) Loboziak & Streel, 1989

Pl. 28, figs 1-14

1953 *Archaeozonotriletes timanicus* Naumova, p. 81, Pl. 12, fig. 14.
? 1962 *Convolutispora fromensis* Balme & Hassell, p. 8, Pl. 1, figs 14-16.
? 1959 *Archaeozonotriletes polymorphus* Naumova var. *takatinicus* Tchibrikova, p. 58, Pl. 7, figs 2, 3.
? 1962 *Archaeozonotriletes timanicus* Naumova var. *radiatus* Tchibrikova, p. 412, Pl. 7, fig. 1.
? 1965 *Convolutispora tegula* Allen, p. 705, Pl. 97, figs 4-8.
1965 *Archaeozonotriletes ignoratus* Naumova; Hemer, Pl. 2.
1965 *Archaeozonotriletes timanicus* Naumova var. n°1; Nazarenko, Pl. 1, figs 49, 50.
? 1965 *Tholisporites ancylus* Allen (pars), p. 724, Pl. 101, fig. 5.
? 1966 *Archaeozonotriletes laticolaris* Mikhailova, p. 209, Pl. 3, fig. 4.
1982 *Archaeozonotriletes timanicus* Naumova; McGregor & Camfield, p. 20, Pl. 3, figs 13-15.
1989 *Chelinospora timanica* (Naumova) Loboziak & Streel, p. 175, Pl. 2., figs 8, 9.
1992 *Archaeozonotriletes timanicus* Naumova; McGregor & Playford, Pl. 4, figs 3, 4.

Description: Trilete patinate spores with circular to subtriangular amb. Laesurae straight, simple, extending to or almost to the inner edge of the patina. Contact areas thin, equatorial and distal regions enclosed by a patina, commonly 3-9 µm thick, about the same thickness equatorially and distally. Patina laevigate or infrapunctate, dissected into irregularly or closely distributed, partly anastomosing rugulo-convolutae, muri and rounded or flat-topped verrucae, commonly 1-8 µm wide at base, up to 4 µm high. Channels or lumina of irregular shape in plan view, 1-6 µm or less in greatest diameter.

Dimensions: 43 (54) 74 µm, 54 specimens measured.

Remarks: Numerous specimens are allocated to this taxon which may include several species defined in the literature and probably belonging to genera other than *Chelinospora* Allen, 1965. Indeed, these forms are very variable and are not easily distinguishable. It is difficult to determine, in such forms, the positive or negative character of sculptural elements because variation between the two characters seems to be continuous. Integradations from *Chelinospora timanica* (Naumova) Lobozial & Streel, 1989 to other species of *Convolutispora* Hoffmeister et al., 1955 genus exist most likely.

Comparisons: *Convolutispora fromensis* Balme & Hassell, 1962 seems very close according to the diagnosis, however the specimens figured are of poor quality. *Chelinospora timanica* (Naumova) Loboziak & Streel, 1989 is difficult to distinguish from *Convolutispora tegula* Allen, 1965. The main difference is that the patina is dissected into elements (negative) in *Chelinospora timanica* (Naumova) Loboziak & Streel, 1989 while exine of *Convolutispora tegula* Allen, 1965 is sculptured with positive elements. However, the two characters are distinguishable with difficulty (see above). *Convolutispora tegula* Allen, 1965 may be thus included in the present taxon. *Convolutispora florida* Hoffmeister et al., 1955 has a more extensively anastomosing muroid pattern, and wider lumina. *Convolutispora uistatas* Playford, 1962 has similar sculpture, but is much larger. *Convolutispora crassata*? (Naumova) McGregor & Camfield, 1982 is not patinate. *Convolutispora subtilis* Owens, 1971 possesses narrower convolutae. *Archaeozonotriletes asymmetricus* Panshina, 1971 appears to be of similar basic construction but its large, flat, irregular tubercules are larger towards the equator where they are commonly fused with one another. Extreme forms of spores with convolute and verrucose sculpture, including notably species of *Convolutispora* Hoffmeister et al., 1955, *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982 and *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982, may intergrade with *Chelinospora timanica* (Naumova) Loboziak & Streel, 1989. Indeed all these species are morphologically very close and occur mostly in the same Givetian strata. A large morphon could be defined.

Stratigraphic and palaeogeographic occurrence:

- Australia: Canning Basin; middle Givetian (Grey, 1991). Adavale Basin; Etonvale Formation; *optivus-triangulatus* and *ovalis-bulliferus* Assemblage Zones; late Givetian-early Frasnian (Hashemi & Playford, 2005).
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; TA-?BM Oppel Zones; late Givetian-Frasnian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira Formation; AD-Lem Interval Zone to Zone IV; early Givetian-earliest Famennian (Loboziak et al., 1992b). Amazon Basin; Ererê and Barreirinha Formations; LLi-TP Interval Zones; early Givetian-?middle Famennian (Melo & Loboziak, 2003).
- Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; Eifelian-early Givetian (McGregor & Camfield, 1982).
- Germany: Eifel, Hillesheim Syncline; Ahbach, Loogh, Cürten and Kerpen Formations -Ref Interval Zone to TA Oppel Zone; late Eifelian-Givetian; AD (Loboziak et al., 1990).
- Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6-A8; Givetian-?early Frasnian.

• Poland: Western Pomerania; Jamno, Miastko and Sianowo Formations; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
• Saudi Arabia: Borehole S-462; Jubah Formation; A6-A8; Givetian-?early Frasnian.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; late Eifelian-?early Frasnian.
• United Kingdom: Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996).

Chelinospora sp. 1

Pl. 29, figs 1-3

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae straight, simple and extending to the inner edge of patina. Exine laevigate to infragranulate, 3-6 µm equatorially thick, thinner proximally. Contact areas laevigate. Patina sculptured with just convoluted muri loosely distributed, 3-5 µm wide and from 1 to more than 10 µm apart. They form an irregular reticulum pattern.

Dimensions: 51 (53) 57, 3 specimens measured.

Remark: When compressed, specimens may have a zonate appearance at the equator (Pl. 26, fig. 2).

Comparisons: *Chelinospora* cf. *hemiesferica* (Cramer & Díez) Richardson et al., 2001 has narrower distal muri which are closely spaced and more numerous. This characteristic apart, the two forms may be similar and could intergrade in the *Chelinospora hemiesferica* Morphon (Tab. 1, p. 185). Although a few specimens have been found we prefer to distinguish them from the population of *Chelinospora* cf. *hemiesferica* (Cramer & Díez) Richardson et al., 2001. *Chelinospora cassicula* Richardson & Lister, 1969 shows the same kind of irregular reticulum pattern but has narrower, high and fold-like muri.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A2; ?late Pragian-early Emsian.

Chelinospora sp. 2

Pl. 29, figs 4-10

Description: Trilete patinate spores with subcircular to triangular amb. Laesurae straight, simple and extending to the inner edge of patina. Exine laevigate to infragranulate, 3-5 µm thick equatorially, thinner proximally. Contact areas laevigate. Patina sculptured with brain-like convoluted muri almost adjoining, 1.5-4 µm wide and commonly less than 1 µm apart (rarely up to 2 µm). Muri become radially oriented over the equatorial and subequatorial regions.

Dimensions: 40 (48) 68, 10 specimens measured.

Comparisons: *Chelinospora hemiesferica* (Cramer & Díez) Richardson et al., 2001 has narrower distal muri. *Chelinospora* cf. *hemiesferica* (Cramer & Díez) Richardson et al., 2001 has the same muri but these are loosely spaced. Moreover, *Chelinospora* sp. 2 is darker than the two latter taxa in the same samples. All these convolutate forms of *Chelinospora* Allen, 1965 represent a spore morphon (Tab. 1, p. 185) and were probably derived from a group of closely related plants.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A2; ?late Pragian-early Emsian.

Chelinospora sp. 3

Pl. 29, figs 11-13

Description: Trilete patinate spores with circular to subcircular amb. Laesurae simple, straight, length 3/4 to full central area radius. Equatorial and distal regions enclosed by a patina, about 3 µm thick and about the same thickness equatorially and distally. Contact areas thinner supporting a sparse ornament of broad rugulae and muri 2-4 µm wide. Patina sculptured with irregularly distributed broad rounded muri, 2-5 µm wide and high, forming an imperfect to perfect reticulum pattern. Lumina, irregular in plan view, commonly 3-10 µm in greatest diameter.

Dimensions: 49 (52) 56, 3 specimens measured.

Comparisons: *Chelinospora concinna* Allen, 1965 has narrower muri, larger lumina and commonly a thicker patina. *Chelinospora timanica* (Naumova) Loboziak & Streel, 1989 has also a thicker patina with a very irregular ornament pattern.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A8; late Givetian-?early Frasnian.

Genus *Cirratriradites* Wilson & Coe, 1940

Type species: *Cirratriradites maculatus* Wilson & Coe, 1940.

Description: Trilete spores with a broad more or less membranous equatorial flange which appears to be supported by rigid rays of the trilete mark that extend to the outline of the flange. Faint striations, rod or fringe-like secondary layers often present on inner edge of the flange. At distal pole one or a few foveae are present.

Cirratriradites diaphanus Steemans, 1989

Pl. 30, figs 3-12

1981 *Cirratriradites* sp. A; Steemans, p. 53.
1981 *Cirratriradites* sp. A in Steemans; Streel et al., Pl. 3, figs 10, 11.
1989 *Cirratriradites diaphanus* Steemans, p. 119, Pl. 30, figs 4-9.
2006 Unidentified zonate spores; Wellman, Pl. 19, fig. d.

Description: Trilete spores with circular to subtriangular amb. Laesurae sinuous to straight, simple or bordered by labra, 2 µm in maximal overall width, length 2/3 to full central area radius. The equatorial margin differentiates into two distinct parts. An inner zona thickened in a broad crassitude, 2-5 µm wide, and a thinner outer zona forming a flange, equals 1/7 to 1/3 the spore radius. This outer flange is often strongly damaged. Proximal and distal surface laevigate. Rounded to oval papillae, 3-7 µm wide, are developed on each interradial area.

Dimensions: 46 (58) 71 µm, 10 specimens measured.

Remark: There is some doubt about the allocation of this species to the genus *Cirratriradites* Wilson & Coe, 1940 because no foveae are observed in the present population.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant, Verviers Synclinoriums and Theux Window; Siβ-Su Interval Zones; late Lochkovian-late Pragian (Steemans, 1989).
• Brazil: Amazon Basin; Manacapuru and Maecuru Formations; NsZ Interval Zone; Lochkovian (Melo & Loboziak, 2003). Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Germany: Siegerland; Siβ-Su Interval Zones; late Lochkovian-late Pragian (Steemans, 1989).
• Luxembourg: Oesling region; Pow-FD Oppel Zones; middle Pragian-middle Emsian (Steemans et al., 2000).
• Romania: Moesian Platform, Chilia well; G Interval Zone; late Lochkovian (Steemans, 1989).
• Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4 and wells FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in Eifelian strata.
• United Kingdom: Scotland, Rhynie outlier; Rhynie Chert Unit; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Genus *Clivosispora* Staplin & Jansonius, 1964

Type species: *Clivosispora variabilis* Staplin & Jansonius, 1964.

Description: Trilete patinate spores with subcircular to irregular amb. Distal region sculptured with several very large verrucae.

Comparison: The extremely thick exine and very large distal verrucae distinguish this genus from *Tumulispora* Staplin & Jansonius, 1964.

Clivosispora verrucata McGregor, 1973 var. *convoluta* McGregor & Camfield, 1976

Pl. 31, figs 1-6

1976 *Clivosispora verrucata* McGregor var. *convoluta* McGregor & Camfield, p. 15, Pl. 2, figs 13-21.

Description: Trilete cingulate spores with circular to subcircular amb. Laesurae not always visible, straight, simple and commonly extending to or almost to the inner margin of cingulum. Contact areas thin, laevigate or scabrate. Cingulum laevigate, 3-8 µm wide. Distal region sculptured with closely set, irregular, convolute ridges 2.5-7 µm wide and about as high, flat to rounded in profile. The largest ridges are adjacent to the cingulum and overlap onto it distally.

Dimensions: 36 (48) 63 µm, 7 specimens measured.

Comparisons: This variety seems to intergrade with *Clivosispora verrucata* McGregor, 1973 var. *verrucata*. The *Clivosispora verrucata* Morphon is thus defined (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
• Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Canada: Ontario, Moose River Basin; Kenogami River and Stooping River Formations; *mircrornatus-proteus* to *annulatus-lindlarensis* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).
• France: Armorican Massif, Laval Syncline; Montguyon Formation; Assemblage 2; Pragian (Le Hérissé, 1983).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen and Faraghan Formations; Zone II; Pragian-Emsian (Ghavidel-Syooki, 2003).
• Libya: Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *tripapillatus-spicula* Biozone; Ludlow or Pridoli (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
• Morocco: Doukkala and Essaouira Basins; Palynozones DI1-DI2; late Pragian-Emsian (Rahmani-Antari & Lachkar, 2001).
• Saudi Arabia: Boreholes BAQA-1, 2, JNDL-4 and wells FWRH-1, KHRM-2, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-Emsian.
• United Kingdom: Scotland, Rhynie outlier; Upper Shales Unit; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Clivosispora verrucata **McGregor, 1973 var.** ***verrucata***

Pl. 31, figs 7-19

1954 Spore type C6; Radforth & McGregor, Pl. 1, fig. 35.
1966 cf. *Clivosispora*; McGregor & Owens, Pl. 3, figs 16, 17.
? 1968 Trilete verruquée sp. 1; Jardiné & Yapaudjian, Pl. 1, fig. 23.
1970 *Clivosispora* sp.; McGregor et al., Pl. 1, figs 28, 29.
1973 *Clivosispora verrucata* McGregor, p. 54, Pl. 7, figs 4, 5, 10.
1976 *Clivosispora verrucata* McGregor var. *verrucata*; McGregor & Camfield, p. 15, Pl. 3, figs 11-14.
non 1981 *Clivosispora verrucata* McGregor var. *verrucata*; Gao Lianda, Pl. 2, fig. 3.

Description: Trilete cingulate spores with circular to subcircular amb. Laesurae straight, simple or accompanied by fold-like labra along the sutures. Arcuate folds simulate curvaturae 1/2 to 2/3 of the way towards the equator. Contact areas thin, laevigate or scabrate. Cingulum laevigate, 3-9 µm wide. Distal region sculptured with coarse verrucae 2-13 µm in basal width, commonly closely set, broadly polygonal or subcircular to elongate in plan view.

Dimensions: 36 (43) 55 µm, 13 specimens measured.

Comparisons: This variety differs from *Clivosispora verrucata* McGregor, 1973 var. *convoluta* McGregor & Camfield, 1976 in that the distal sculpture consists of convolute ridges. The two varieties are otherwise alike, and intergrade in the *Clivosispora verrucata* Morphon defined here (Tab. 1, p. 185). *Synorisporites verrucatus* Richardson & Lister, 1969 has a narrower cingulum and smaller verrucae.

Stratigraphic and palaeogeographic occurrence:

- Canada: Quebec, Gaspé Peninsula; York River and Battery Point Formations; Emsian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Kenogami River and Stooping River Formations; *caperatus-emsiensis* to *annulatus-lindlarensis* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).
- Iran: Zagros Basin, Faraghan Mountain; Zakeen and Faraghan Formations; Zone II; Pragian-Emsian (Ghavidel-Syooki, 2003).
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-1, 4 and wells FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830; Jauf Formation; A2-A3b; ?late Pragian-?early Eifelian.
- United Kingdom: Scotland, Rhynie outlier; Upper Shales Unit; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Genus *Concentricosisporites* Rodriguez, 1983

Type species: *Concentricosisporites sagittarius* (Rodriguez) Rodriguez, 1983.

Description: Trilete spores characterized by an equatorial crassitude and by an ornamentation on the proximal face consisting of papillae, muri or exinal thickenings of the wall that in most cases is not an elevation of the wall surfaces. This ornamentation may form circular surfaces, or rather circumferences, which are concentrically oriented with regard to the proximal pole.

Remarks: From the manner in which the slight folding of the proximal exine, with the thin-labrate or narrowly folded laesurae, seems not to affect the distortion of 'Rodriguez's thickening', it appears probable to Jansonius & Hills (1990) that the latter represent an inner central body.

Comparisons: It differs from *Streelispora* Richardson & Lister emend. Richardson et al., 1982 and *Synorisporites* Richardson & Lister, 1969 in the different position and nature (not raised) of the sculpture.

***Concentricosisporites sagittarius* (Rodriguez) Rodriguez, 1983**

Pl. 32, figs 1-3

1978a *Stenozonotriletes sagittarius* Rodriguez, p. 219, Pl. 1, fig. 7.
1983 *Concentricosisporites sagittarius* (Rodriguez) Rodriguez, p. 36, Pl. 3, fig. 15.

Description: Trilete cingulate spores with subcircular to subtriangular amb. Laesurae straight simple or folded and extending to the inner margin of the cingulum. Cingulum 1.5-3 µm wide. Polar region of proximal face thickened to form a circular to subtriangular darker area. Diameter of proximal thickening about 2/5 spore diameter. Exine laevigate to scabrate.

Dimensions: 28 (36) 47 µm, 4 specimens measured.

Stratigraphic and palaeogeographic occurrence:

- Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
- Libya: Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *Apiculiretusispora* sp. E Biozone?; middle Pridoli (Rubinstein & Steemans, 2002).

- Saudi Arabia: Boreholes BAQA-1, 2 and well UTMN-1830; Jauf Formation; A2; ?late Pragian-Emsian.
- Spain: Cantabrian Mountains; San Pedro Formation; Lludlovian-Downtonian (Rodriguez, 1978a, b). Cantabrian Mountains; San Pedro Formation; *reticulata-sanpetrensis* to *micrornatus-newportensis* Assemblage Zones; late Ludfordian-early Lochkovian (Richardson et al., 2001).
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3a; Emsian.

Genus *Contagisporites* Owens, 1971

Type species: *Contagisporites optivus* (Tchibrikova) Owens, 1971.

Description: Trilete camerate spores with subcircular to subtriangular amb. Exine two-layered, the sexine being attached to the nexine over only part of the proximal surface, being completely separated in the equatorial plane and over the entire distal surface. Laesurae distinct, commonly accompanied by broad, thickened labra, and connected by prominent, broad, elevated, ridge-like curvaturae. Nexine forming the inner body thin, laevigate, commonly folded. Sexine thick, contact areas laevigate, remainder of the proximal surface and the entire distal surface sculptured with a granulate, conate or spinose elements.

Comparisons: The thick sexine and the prominent curvaturae defining the limits of the contact areas render this genus readily distinguishable from all previously described camerate genera. *Spelaeotriletes* Neves & Owens, 1966 possesses large contact areas, the extent of which is defined by a restriction in the distribution of the conate, verrucose or granulate ornamentation rather by distinct curvaturae. Moreover, it may be distinguished by its thinner sexine and an inner body which is normally only visible in over-oxidized specimens.

***Contagisporites optivus* (Tchibrikova) Owens, 1971**

Pl. 32, figs 4, 5, Pl. 118, figs 1-3

1959 *Archaeozonotriletes optivus* Tchibrikova, p. 60, Pl. 7, fig. 9.
1960 *Retusotriletes* sp. Taugourdeau-Lantz, p. 145, Pl. 1, fig. 5.
1962 *Archaeozonotriletes optivus* var. *vorobjevensis* Tchibrikova, p. 430, Pl. 2, fig. 6.
1964 *Biharisporites spitsbergensis* Vigran, p. 12, Pl. 2, figs 1-4.
1965 *Calyptosporites optivus* (Tchibrikova) Allen, p. 736, Pl. 104, figs 1-4.
1966 *Archaeozonotriletes* cf. *A. optivus* var. *vorobjevensis* Tchibrikova; McGregor & Owens, Pl. 16, figs 3, 4.
1966 *Archaeozonotriletes optivus* Tchibrikova; McGregor & Owens, Pl. 17, fig. 6.
1967 *Rhabdosporites cuvillieri* Taugourdeau-Lantz, p. 54, Pl. 3, figs 1-6.
1971 *Contagisporites optivus* (Tchibrikova) var. *optivus* Owens, p. 52, Pl. 16, figs 1-3.
1971 *Contagisporites optivus* var. *vorobjevensis* (Tchibrikova) Owens, p. 53, Pl. 16, figs 4-6.
1987 Megaspore (*Biharisporites*) *of Tanaitis furchihasta* Krassilov et al., p. 173, Pl. 4, figs 1, 2, Pl. 7, figs 1, 2.

Description: Trilete camerate megaspores with subcircular to subtriangular amb. Exine two-layered, the nexine which forms an inner body is attached to the sexine in the region of proximal pole. Laesurae straight, accompanied by labra, normally obscured by folds. These folds are up to about 20 µm wide, generally extending to the equator or terminating between the sexine and nexine margins. The trilete folds are connected by curvatural ridges, up to 12 µm wide/high, and which are coincident with the nexine diameter and obscure it. Nexine 1-2 µm thick. Sexine laevigate on the contact areas. Sexine outside the contact areas commonly sculptured with closely packed coni, grana, 0.5-2.5 µm wide and high. Sculptural elements are normally conical in profile but can be biform by being surmounted by a smaller conus. Top of sculptural elements pointed, rounded or blunt. Sexine shows commonly a limbus, up to 12 µm wide.

Dimensions: 200 (223) 250 µm, 7 specimens measured.

Remark: Although *Contagisporites optivus* var. *vorobjevensis* (Tchibrikova) Owens, 1971 differs mainly from *Contagisporites optivus* (Tchibrikova) var. *optivus* Owens, 1971 by its coarser, low verrucose or blunt pointed conate elements, both are grouped here together because they appear to intergrade and the difference is often difficult to discern under a transmitted light microscope.

Comparison: *Contagisporites optivus* (Tchibrikova) Owens, 1971 differs from *Rhabdosporites langii* (Eisenack) Richardson, 1960 by its well-developed curvaturae and elevated labra.

Stratigraphic and palaeogeographic occurrence:
- Canada: Arctic Archipelago, Queen Elisabeth and Melville Islands; Hecla Bay and Griper Bay Formations; Frasnian (McGregor & Owens, 1966; Owens, 1971; McGregor & Uyeno, 1972).
- China: Yunnan; Assemblage Zone V; Eifelian (Gao Lianda, 1981).
- France: Boulonnais; Blacourt, Beaulieu, Ferques and Hydrequent Formations; late Givetian-late Frasnian; TLa Oppel Zone to Zone IV (Brice et al., 1979; Loboziak & Streel, 1980, 1988; Loboziak et al., 1983).
- Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.
- Norway: Spitsbergen; Upper Mimer Valley Series and Upper Svalbardia Sandstone; Givetian-Frasnian (Vigran, 1964; Allen, 1965).
- Poland: Western Pomerania; Jamno and Sianowo Formations; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
- Russia: central and eastern parts of European Russia; Staryi Oskol Group; Ex Zone; middle Givetian (Arkhangelskaya & Turnau, 2003).
- Saudi Arabia: Borehole S-462; Jubah Formation; ?A6-A7; Givetian, some specimens may be slightly caved.
- Spain: Asturias; *Gosselatia* Sandstone Formation; Givetian (Cramer, 1969).
- United Kingdom: Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000).

Genus *Convolutispora* Hoffmeister et al., 1955

Type species: *Convolutispora florida* Hoffmeister et al., 1955.

Description: Trilete spores with circular to subcircular amb. Ornamentation closely packed overlapping anastomosing vermiculate ridge-like processes, often causing a convoluted or coarsely reticulate-punctate appearance. Laesurae short, usually simple, but may have distinct labra, often obscured by the overlapping ridges. Exine generally thick, lacking conspicuous folding.

Convolutispora subtilis Owens, 1971

Pl. 32, figs 6-12

1971 *Convolutispora subtilis* Owens, p. 35, Pl. 9, figs 3-6.
1987 *Chelinospora* sp.; Burjack et al., Pl. 2, fig. 1.
1988 *Chelinospora paravermiculata* Loboziak et al., p. 355, Pl. 3, figs 7-13.

Description: Trilete spores with circular to subcircular amb. Laesurae straight, simple or accompanied by low labra, up to 1.5 µm wide individually, and extending between 3/5 and 4/5 of the spore radius, length variable even on one specimen. Ends of the laesurae may show minor terminal bifurcation. Exine 2-4 µm thick equatorially, uniformly sculptured with low, narrow, densely packed, convolutae which show considerable fusion, resulting in a fine reticulate appearance. Convolutae which are 0.5-2 µm wide and up to 1.5 µm high, are rounded in profile and are separated by narrow, irregular channels of thinner exine that may superficially resemble a vermiculate sculpture. Ornamentation reduced or absent on the contact areas.

Dimensions: 37 (49) 62 µm, 7 specimens measured.

Comparisons: *Convolutispora fromensis* Balme & Hassell, 1962 possesses slightly coarser convolute ridges (generally 2-4 µm wide). *Convolutispora paraverrucata* McGregor, 1964 possesses a thinner exine but in addition has a fine, densely distributed, sometimes anastomosing verrucose or rugulose ornament in which the elements rarely exceed 7 µm in length and are up to 4 µm high. *Chelinospora paravermiculata* Loboziak et al., 1988 is herein considered as synonymous with *Convolutispora subtilis* Owens, 1971 because their diagnoses are similar. Moreover, *Chelinospora* Allen, 1965 is not the most appropriate genus for the forms described in our material.

Stratigraphic and palaeogeographic occurrence:

- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; TA-BJ Oppel Zones; Givetian-early Frasnian (Loboziak et al., 1988).
- Canada: Arctic Archipelago, Queen Elisabeth and Melville Islands; Weatherall, Hecla Bay and Griper Bay Formations; late Eifelian-Frasnian (Owens, 1971; McGregor & Camfield, 1982).
- Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone VI; Frasnian (Ghavidel-Syooki, 2003).
- Poland: Western Pomerania; Jamno Formation; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999).
- Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.
- United Kingdom: Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996).

Genus *Corystisporites multispinosus* Richardson, 1965

Type species: *Corystisporites multispinosus* Richardson, 1965

Description: Trilete azonate spores, with sculpture consisting of spinose processes with pointed, blunt to slightly expanded apices. Laesurae with lips elevated in the form of an apical prominence or gula.

Comparisons: The prominent triradiate ridges exlude these spores from the genus *Acanthotriletes* Naumova emend. Potonié & Kremp, 1954. The genus *Lagenicula* is closely similar but is a megaspore genus, whereas the spores described in *Corystisporites* Richardson, 1965 are of relatively small size.

Corystisporites collaris Tiwari & Schaarschmidt, 1975

Pl. 33, figs 1-3, Pl. 118, figs 4-6

1975 *Corystisporites collaris* Tiwari & Schaarschmidt, p. 28, Pl. 6, figs 2-5, text-fig. 18.

Description: Trilete spores with subtriangular amb. Laesurae elevated, up to 13 µm high, and reaching the equatorial margin. They are seen as contorted folds in polar compression. Spines crowded, 6-16 µm high and longer on the equator, 3-10 µm wide at the base, narrowing slowly, then swelling again in the form of a collar, to become narrower and pointed in the end. The tips seems to be darker than the rest of the elements.

Dimensions: 72 (74) 77 µm, 3 specimens measured.

Comparisons: *Corystisporites multispinosus* Richardson, 1965 differs in the nature of the spines.

Stratigraphic and palaeogeographic occurrence:
- Germany: Prüm Syncline, Eifel; Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages E-P; early Eifelian-early Givetian (Tiwari & Schaarschmidt, 1975).
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.
- Poland: Western Pomerania; Studnica and Jamno Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999).
- Saudi Arabia: Borehole S-462; Jubah Formation; A8; late Givetian-?early Frasnian.

Corystisporites multispinosus Richardson, 1965

Pl. 33, figs 4, 5, Pl. 34, figs 1, 2, Pl. 118, figs 7-9

1965 *Corystisporites multispinosus* Richardson, p. 570, Pl. 89, fig. 10, text-fig. 4.

Description: Trilete spores with circular to subtriangular amb. Exine, 2-6 µm thick equatorially, often thicker in the interradial areas. Equatorial and distal regions sculptured with spines which often have swollen bases and pointed tips. Spines occasionally fused in groups and occur in more or less concentric rows. Spines length commonly 4-10 µm, 1-5 µm wide at base, number around the equator 40 to 60.

Dimensions: 70 (88) 120 µm, 9 specimens measured.

Remarks: On some specimens, local detachment of sexine is seen.

Comparisons: *Hymenozonotriletes polyacanthus* var. *major* Tchibrikova, 1962 is similar but has a much larger size range (150 to 250 µm) and appears to have no triradiate labra or apical prominence.

Stratigraphic and palaeogeographic occurrence:

- Belgium: Campine Basin, Booischot borehole; ?TA-BM Oppel Zones; ?Givetien-Frasnien (Streel & Loboziak, 1987). Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Oppel Zone; Eifelian-Givetian (Loboziak et al., 1988).
- Canada: Arctic Archipelago, Melville and Bathurst Islands; Blue Fiord, Bird Fiord and Weatherall and Hecla Bay Formations; Eifelian-Givetian (McGregor & Uyeno, 1972; McGregor & Camfield, 1982).
- France: Boulonnais; Blacourt Formation and Beaulieu Formations; late Givetian-early Frasnian; TCo Oppel Zone (Loboziak & Streel, 1980, 1988).
- Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Nohn Formation; early Eifelian (Riegel, 1973). Prüm Syncline, Eifel; Wiltz, Heisdorf, Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages B-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; Eifelian-Givetian (Loboziak et al., 1990).
- Libya: Ghadames Basin; Palynozones 4-8; Emsian/Eifelian-late Frasnian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.
- Morocco: Doukkala Basin; Palynozones DM1-DS1; Eifelian-Frasnian (Rahmani-Antari & Lachkar, 2001).
- United Kingdom: Northeast Scotland, Orcadian Basin; Thurso Flagstone and Eday groups; Givetian (Richardson, 1965).

Corystisporites undulatus **Turnau, 1996**

Pl. 34, figs 3-8, Pl. 35, figs 1-3, Pl. 118, figs 10-15

1989 *Hystricosporites mitratus* Allen; Loboziak & Streel, Pl. 8, figs 3, 4.
1996 *Corystisporites undulatus* Turnau, p. 117, Pl. 1, fig. 1.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, accompanied by prominent labra, up to about 5 µm wide and 8 µm high, length approximately 3/4 to the whole spore radius. Exine 4-11 µm thick, homogenous or spongy. Contact areas laevigate, small, radial diameter approximately half of the spore radius, bounded by smooth, narrow elevated curvaturae. Proximo-equatorial and distal regions sculptured with acuminate spinae, 10-40 µm high, 3-9 µm wide at base with enlarged, often bulbous bases. Sculptural elements loosely or sometimes more densely distributed.

Dimensions: 75 (110) 156 µm, 15 specimens measured.

Remark: The megaspore *Heliotriletes longispinosus* Fuglewicz & Prejbisz, 1981 which resembles strongly to the microspore *Corystisporites undulatus* Turnau, 1996 is present in North Africa in same samples but have not been studied in this work. These two species co-also occur in Poland.

Comparisons: Loboziak & Streel (1989) have misidentified specimens from North Africa because none *Hystricosporites mitratus* Allen, 1965 with its typical grapnel-tipped ornaments have been recognized in the re-studied slides of Loboziak & Streel (1989). The figured specimen in Loboziak & Streel (1989) show the characteristics of *Corystisporites undulatus* Turnau, 1996.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6-A8; Givetian-?early Frasnian.
- Poland: Western Pomerania; Studnica Formation; Ex Zone; late Eifelian (Turnau, 1996).
- Saudi Arabia; Well YBRN-1; Jubah Formation; A6; Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.

Genus *Craspedispora* Allen, 1965

Type species: *Craspedispora craspeda* Allen, 1965

Description: Trilete spores with subcircular to roundly triangular amb. Laesurae usually distinct, simple or with labra. Central area encompassed interradially by a narrow zona. Central area sculptured distally and on periphery of proximal side.

***Craspedispora ghadamesensis* Loboziak & Streel, 1989**

Pl. 35, figs. 4-7, Pl. 118, figs 16-18

1989 *Craspedispora ghadamesensis* Loboziak & Streel, p. 177, Pl. 2, figs 1-4, Pl. 9, fig. 4.

Description: Trilete zonate spores with subcircular to roundly triangular amb. Laesurae slightly sinuous, up to 8 µm high, almost reaching the equator. Exine 1.5-4 µm thick, thicker in the central area and often microfolded on the proximal face. Zona, 2-6 µm wide interradially, distinctly narrower or absent radially, if present radially may be deflected onto the proximal face. Proximal surface laevigate. Distal surface and zona sculptured with tapered spines, up to 4 µm wide at base and in height.

Dimesions: 71 (80) 95 µm, 9 specimens measured.

Comparisons: *Craspedispora craspeda* Allen, 1965 is smaller and has a laevigate or sparsely sculptured zona. *Samarisporites eximius* (Allen) Loboziak & Streel, 1989 has the same type of ornament but has a larger amb and the zona as wide interradially as radially.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Oppel Zone; Eifelian-Givetian (Loboziak et al., 1988). Amazon Basin; Ererê Formation; Per-LLi Interval Zones; early Eifelian-early Givetian (Melo & Loboziak, 2003).
• Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.
• Saudi Arabia: Borehole S-462; Jubah Formation; A7; Givetian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A7; ?late Emsian-Givetian.

Craspedispora sp. in Paris et al. (1985)

Pl. 36, figs 1, 2

? 1966a *Perotriletes gordianus* Cramer, p. 266, Pl. 3, fig. 64.
1985 *Craspedispora* sp.; Paris et al., Pl. 18, fig. 9.

Description: Zonate trilete spores with amb subtriangular to triangular with rounded corners. Laesurae distinct, straight to slightly sinuous, up to 1.5 µm high, extending to the inner margin of the zona. Curvaturae not visible. Central body radius equals more or less 9/10 amb radius. Exine of the central body thin equatorially. The thin proximo-equatorial flange is commonly 2-4.5 µm wide interradially. The flange is generally narrower opposite the trilete rays. Thin transverse attachment lines of the flange on the central body often can be distinguished on the proximal face. Proximal and distal surfaces entirely laevigate.

Dimensions: 32 (35) 39 µm, 3 specimens measured.

Comparison: *Perotriletes gordianus* Cramer, 1966a, the diagnosis of which is rather imprecise may be the same taxon. *Craspedispora* sp. in Paris et al. (1985) represent the same taxon and has been found from equivalent Libyan material.

Stratigraphic and palaeogeographic occurrence:
• Libya: Cyrenaica; early or middle Emsian (Paris et al., 1985).
• Saudi Arabia: Borehole A1-69; Ouan-Kasa and Awaynat Wanin II Formations; A3; late Emsian-?early Eifelian, the specimen from the Awaynat Wanin II Formation may be reworked.

Genus *Cristatisporites* Potonié & Kremp, 1954

Type species: *Cristatisporites indignabundus* (Loose) Potonié & Kremp, 1954.

Description: Trilete spores with subcircular or subtriangular amb. Laesurae often difficult to distinguish. Exine two-layered. Central body or nexine thin and laevigate. Sexine sculptured with coni or spinae which are fused together at their bases into ridges carrying the spinose projections, that may more or less parallel the equator.

Comparison: *Samarisporites* Richardson (1965) is notably considered as a junior synonym of *Cristatisporites* Potonié & Kremp, 1954 by Playford (1971). However, *Samarisporites* Richardson (1965) includes forms with a wide variety of distal sculpture (e.g. coni, cristae, verrucae) which cannot be accommodated within *Cristatisporites* Potonié & Kremp, 1954.

The species described here in *Samarisporites* Richardson (1965) show a more flimsy and better individualised zona than the forms described just below.

***Cristatisporites* sp. 1**

Pl. 36, figs 3-7, Pl. 118, figs 19-21

? 1975 *Calyptosporites reticulatus* Tiwari & Schaarschmidt, p. 45., Pl. 27, figs 2-4, Pl. 28, fig. 1, text-fig. 35.
? 1989 *Acinosporites acanthomammillatus* Richardson; Loboziak & Streel, Pl. 1, fig. 4.

Description: Trilete zonate spores with subcircular or subtriangular amb. Laesura straight or sinuous, extending to equatorial margin and commonly obscured by triradiate fold-like labra about 2-6 µm thick in total width. A thin inner body is often visible and its radius equals 7/10 to 9/10 amb radius. Sexine laevigate or shagreenate, sculpured distally and equatorially with fold-like ridges, 2-6 µm thick and high, bearing spines or biform elements (bulbous coni supporting a simple-tipped apical spine), 1-5 µm wide at their base and 2-10 µm (rarely as much as 14 µm) high. Cristae thus formed are distributed in a sinuous, subreticulate pattern, the meshes of which are 2-10 µm wide.

Dimensions: 57 (85) 113 µm, 10 specimens measured.

Comparisons: *Calyptosporites reticulatus* Tiwari & Schaarschmidt, 1975 resembles *Cristatisporites* sp. 1. *Acinosporites acanthomammillatus* Richardson, 1965 illustrated in Loboziak & Streel (1989) was probably misidentified because it does not bear contorted anastomosing ridges as in the diagnosis of Richardson, 1965 but rather ridges forming a subreticulate pattern. The specimen figured in Loboziak & Streel, 1989 may be similar to *Cristatisporites* sp. 1. *Cristatisporites* sp. 2 which is morphologically very close, is larger and does not possess a discernible inner body. These two taxa seem to intergrade in the *Cristatisporites* sp. 1 Morphon defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:

- Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.
- Saudi Arabia: Borehole S-462 and well YBRN-1; A5-A7; Eifelian-Givetian, some specimens may be caved.
- Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin II Formations; A3b-A6; early Eifelian-Givetian.

***Cristatisporites* sp. 2**

Pl. 36, figs 8, 9, Pl. 37, figs 1, 2, Pl. 118, figs 22-24, Pl. 119, figs 1-3

? 1988 *Acinosporites acanthomammillatus* Richardson; Loboziak et al., Pl. 1, fig. 12.
? 1985 *Samarisporites* sp. B; Paris et al., Pl. 20, fig. 6.

Description: Trilete spores with subtriangular amb. Laesura straight or sinuous, extending to equatorial margin and commonly obscured by triradiate fold-like labra about 4-9 µm thick in total width. A central area can sometimes be delimited by thick folds but a inner body is not clearly present. Sexine laevigate, infra-granular or shagreenate, sculpured distally and equatorially with fold-like ridges, up to 6 µm thick and high, bearing spines or biform elements (bulbous coni supporting a simple-tipped apical spine), commonly 1-5 µm wide at their base and 3-7 µm high. Cristae thus formed, are sometimes closely distributed and constitutes a subconcentric, sinuous or subreticulate pattern. On some specimens, the ridges may be barely visible.

Dimensions: 87 (104) 130 µm, 12 specimens measured.

Comparisons: *Acinosporites acanthomammillatus* Richardson, 1965 illustrated in Loboziak et al. (1988) was probably misidentified because the specimen does not bear contorted anastomosing ridges as in the diagnosis of Richardson, 1965 but rather ridges forming a subconcentric, sinuous or subreticulate pattern. The specimen figured in Loboziak & Streel, 1989 may be similar to *Cristatisporites* sp. 2. *Cristatisporites* sp. 1 is somewhat smaller, shows very often a thin inner body and cristae are instead distributed in a subreticulate pattern. However, extreme variants could intergrade with *Cristatisporites* sp. 1 and form a morphon (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6; Givetian.
- Saudi Arabia: Borehole S-462 and well YBRN-1; A7; Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.

Genus *Cymbosporites* Allen, 1965

Type species: *Cymbosporites cyathus* Allen, 1965.

Description: Trilete spores with circular to rounded triangular amb. Laesurae long, simple or with labra. Exine thin proximally, equatorially and distally patinate. Patina of even thickness, or thickest at distal pole, variably sculptured with grana, coni or spines.

Comparisons: *Archaeozonotriletes* Naumova emend. Allen, 1965 has laevigate or punctate patina. *Tholisporites* Butterworth & Williams emend. Allen, 1965 has only minute sculpture.

***Cymbosporites asymmetricus* Breuer et al., 2007c**

Pl. 37, figs 3-13

2007c *Cymbosporites asymmetricus* Breuer et al., p. 49, Pl. 5, figs 15-19, Pl. 6, figs 1, 2.

Description: Trilete patinate spores with oval to subtriangular amb, with a distinctly elongate axis aligned with one of the laesurae. Contact faces laevigate with the one, that is transected by the long axis, being smaller than its neighbours. The smallest interradial angle, formed by the two shorter trilete mark branches, is commonly between 70° and 100°. Laesurae distinct, straight to slightly sinuous and accompanied by prominent labra commonly 1-2.5 µm in overall width. Radius of contact surface generally equals to 3/4 of the amb radius. Proximo-equatorial and distal regions patinate and sculptured with coni and spinae about 1 µm high, which are densely distributed. Exine 2-4 µm thick.

Dimensions: 43 (53) 69 µm, 29 specimens measured.

Remark: We think that the sexine, which is sometimes slightly locally detached (Pl. 34, fig. 14), may be completely removed, to give forms resembling *Retusotriletes* Naumova emend. Streel, 1964.

Comparison: *Apiculiretusispora brandtii* Streel, 1964 has a similar size and ornamentation, and sometimes also has asymmetrically placed laesurae, but differs in not being patinate. *Rhabdosporites minutus* Tiwari & Schaarschmidt, 1975 also possesses a similar ornamentation but the sexine is totally detached from the nexine at the equator. These three species seems related and are included in a same morphon (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
- Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Libya: Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A4; Emsian-Eifelian, the isolated occurrence of a specimen in the Givetian part of the Awaynat Wanin II Formation is probably due to reworking.
- Saudi Arabia: Boreholes JNDL-1, 3, 4 and wells HWYH-956, NFLA-1, SDGM-462, UTMN-1830; Jauf and Jubah Formations; A2-A4; Emsian-Eifelian.
- Tunisia: Borehole MG-1; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A5; Eifelian, the isolated occurrence of a specimen in the Givetian part of the Awaynat Wanin II Formation is probably due to reworking.

***Cymbosporites catillus* Allen, 1965**

Pl. 5, fig. 3, Pl 38, figs 1-15

? 1953 *Archaeozonotriletes basilaris* Naumova, p. 33, 81, 128, Pl. 3, fig. 3, Pl. 13, fig. 16; Pl. 19, fig. 8.
? 1953 *Archaeozonotriletes truncatus* Naumova, p. 34, Pl. 3, fig. 7.
? 1955 *Retusotriletes verrucosus* Kedo, p. 22, Pl. 1, fig. 17.
? 1959 *Archaeozonotriletes subpusillus* Tchibrikova, p. 61, Pl. 8, fig. 2.
? 1959 *Retusotriletes accuratus* Tchibrikova, p. 51, Pl. 5, fig. 6.
1965 *Cymbosporites catillus* Allen, p. 727, Pl. 100, figs 11, 12.
non 1978b *Cymbosporites catillus* Allen; Rodriguez, p. 416, Pl. 3, figs 17, 21.

Description: Trilete patinate spores with circular, subcircular to subtriangular amb. Laesurae straight, sometimes indistinct, accompanied by slightly elevated labra, up to 4 µm in overall width and extending to or almost to the inner margin of the patina. Exine proximally thin, distally and equatorially patinate, commonly 3-8 µm thick equatorially. Proximal surface laevigate, patina sculptured with densely packed grana, small verrucae or coni, commonly 1.5 µm or less high and wide (rarely up to 2 µm).

Dimensions: 34 (48) 63 µm, 37 specimens measured.

Remarks: One specimen formed as a monolete spore (Pl. 5, fig. 3) has been found. Note that poorly preserved darker specimens may seem to have coarser ornamentation but that may be due to the taphonomy.

Comparisons: Several species included within *Archaeozonotriletes* Naumova emend. Allen, 1965 and *Retusotriletes* Naumova emend. Streel, 1964 have a similar proximo-distal appearance. Their descriptions are not precise about their construction, which may be patinate, cingulate, or thick-walled apiculate. The synonymy includes species with a somewhat similar proximo-distal appearance, size range, and sculptural elements, which may prove to have a patinate construction similar to the specimens described herein (Allen, 1965). *Cymbosporites cyathus* Allen, 1965 has an ornamention of larger coni. *Cymbosporites cyathus* and *Cymbosporites catillus* Allen, 1965 which are generally found together in the same samples from the studied Saudi material intergrade and consequently represent a morphon. The *Cymbosporites catillus* Morphon is defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
• Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; AP-TA Oppel Zones; late Eifelian-late Givetian (Perez-Leyton, 1990).
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; TA Oppel Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira Formation; AD-Lem Interval Zone to Zone IV; early Givetian-earliest Famennian (Loboziak et al., 1992b). Amazon Basin; Ererê and Barreirinha Formations; LLi-TP Interval Zones; early Givetian-?middle Famennian (Melo & Loboziak, 2003).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone V; Givetian (Ghavidel-Syooki, 2003).
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A7-A8; Givetian-?early Frasnian.
• Norway: Spitsbergen; Upper Mimer Valley Series; Givetian (Allen, 1965).
• Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A7-A8; Givetian-?early Frasnian., some specimens may be caved.
• Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A7-A8; Givetian-?early Frasnian.

Cymbosporites cyathus Allen, 1965

Pl. 39, figs 1-14

1965 *Cymbosporites cyathus* Allen, p. 725, Pl. 101, figs 8-11.

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae straight sometimes indistinct, accompanied by labra, up to 5 µm in overall width and extending to or almost to the inner margin of the patina. Exine proximally thin, equatorially and distally patinate, commonly 4-13 µm thick, homogeneous to infragranulate. Proximal surface laevigate to granular, patina sculptured with a variable concentration of coni (more rarely spines), 1.5-5 µm wide at base, 1-4 µm high, often supporting a small apical spine or sometimes blunt. When densely packed, the elements have polygonal bases.

Dimensions: 37 (48) 70 µm, 97 specimens measured.

Remark: Some *in situ* specimens show local detachments of sexine.

Comparisons: *Lycospora magnifica* McGregor, 1960 is larger, and has some fusion of the basal ornament. *Cymbosporites catillus* Allen, 1965 has a less developed ornamention but some specimens intergrade with *Cymbosporites cyathus* Allen, 1965 within the *Cymbosporites catillus* Morphon (Tab. 1, p. 185). *Cymbosporites echinatus* Richardson & Lister, 1969 has a thinner patina and differs in the character of ornamentation.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; BJ-VCo Oppel Zones; early Frasnian-Famennian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; TA Oppel Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Amazon Basin; Ererê and Barreirinha Formations; LLi-TP Interval Zones; early Givetian-?middle Famennian (Melo & Loboziak, 2003).
- China: Yunnan; Assemblage Zone V; Eifelian (Gao Lianda, 1981).
- Germany: Eifel, Prüm Syncline; Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages G-P; early Eifelian-early Givetian (Tiwari & Schaarschmidt, 1975).
- Libya: Ghadames Basin; Palynozones 7-8; middle Givetian-late Frasnian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A7-A8; Givetian-?early Frasnian.
- Norway: Spitsbergen; Upper Mimer Valley Series; Givetian (Allen, 1965).
- Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A7-A8; Givetian-?early Frasnian, some specimens may be caved.
- Tunisia: Borehole MG-1; Awaynat Wanin III Formation; A8; late Givetian-?early Frasnian.

Cymbosporites dammamensis Steemans, 1995

Pl. 40, figs 1-10

? 1973 *Raistrickia* sp.; McGregor, p. 35-36, Pl. 4, figs 9, 10.
1983 *Raistrickia* sp. A; Le Hérissé, p. 24, Pl. 4, figs 2, 8a, 8b.
1983 *Raistrickia* sp. B; Le Hérissé, p. 25, Pl. 4, fig. 3.
1983 *Raistrickia* sp. D; Le Hérissé, p. 25, Pl. 4, figs 6, 7.
1995 *Cymbosporites dammamensis* Steemans (pars), p. 101, Pl. 2, figs 10-12.

Description: Trilete patinate spores with circular to subtriangular amb. Laesurae straight, simple and extending to the inner margin of patina. Exine thicker outside the contact areas, 1-3.5 µm thick equatorially. Proximal face laevigate to granular. Patina sculptured with evenly distributed bacula, 1-2 µm wide, 1-3 µm high and 1-3 µm apart. Elements may have concave sides. The upper part of the elements are one to two times thicker than the thinner part. The tops of elements are flat or slightly concave, with a generally bifurcate shape.

Dimensions: 27 (34) 43, 20 specimens measured.

Comparisons: The different specimens described by Le Hérissé (1983) are very similar to the species described by Steemans (1995). The ornamentation of *Raistrickia* sp. in McGregor (1973) is similar but there is no value for the thickness of the exine. *Cymbosporites echinatus* Richardson & Lister, 1969 is larger and its elements are different and larger. *Cymbohilates baqaensis* Breuer et al., 2007c appears similar but is hilate. Some specimens, where the proximal face has been torn, are difficult to assign. In addition, some specimens of Steemans (1995) have probably to be reassigned in the hilate taxon because they have just slits as laesurae. *Raistrickia* sp. 2 is more triangular and sculptured with loosely distributed and generally larger bacula. *Verrucosisporites* sp. 3 is not patinate and bears verrucae that are generally wider at the base.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• France: Armorican Massif, Laval Syncline; Saint-Cénéré Formation; Assemblage 2; Pragian (Le Hérissé, 1983).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone I; Lochkovian (Ghavidel-Syooki, 2003).
• Saudi Arabia: Well DMMM-45; Tawil Formation; Si-Pa Interval Zones; Lochkovian-Pragian (Steemans, 1995). Boreholes BAQA-1, 2, JNDL-3, 4 and wells FWRH-1, HWYH-956, KHRM-2, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in Eifelian strata.

Cymbosporites dittonensis Richardson & Lister, 1969

Pl. 40, figs 11-16

1969 *Cymbosporites dittonensis* Richardson & Lister, p. 241, Pl. 41, figs 10-13.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple or labrate, up to 2 µm wide, extending to or almost to the equatorial margin. Proximal surface laevigate and thin. Exine thicker outside the contact areas, 1.5-5 µm thick equatorially. Equatorial and distal regions sculptured typically with a mixture of relatively large verrucate or rugulate elements, 1-7 µm wide and 0.5-1 µm high, and small pointed coni, about 0.5-1 wide and high. In plan large elements are rounded, subangular, polygonal, elongate, or irregular.

Dimensions: 30 (35) 41 µm, 7 specimens measured.

Remark: *Cymbosporites dittonensis* Richardson & Lister, 1969 has a relatively thin distal patina and may be transferred in a more appropriate genus.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant, Verviers Synclinoriums and Theux Window; Mβ-Z Interval Zones; Lochkovian (Steemans, 1989).
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
• China: Eastern Yunnan, Qujing District, Cuifengshan; Xujiachong Formation; Emsian (Lu Lichang & Ouyang Shu, 1976). Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
• France: Armorican Massif, la Haye-du-Puits Syncline, Saint-Germain-sur-Ay Outcrop; Nβ-Mα Interval Zones; Lochkovian (Steemans, 1989).
• Germany: Siegerland; Siβ Interval Zone; late Lochkovian (Steemans, 1989).
• Libya: Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *Apiculiretusispora* sp. E Biozone?; middle Pridoli (Rubinstein & Steemans, 2002).
• Morocco: Doukkala Basin; Palynozone DI1; late Pragian (Rahmani-Antari & Lachkar, 2001).
• Poland: Random-Lublin area; Borehole Terebin IG 5; Czarnolas Formation; MN Oppel Zone; Lochkovian. (Turnau et al., 2005).

- Saudi Arabia: Borehole BAQA-1 and wells FWRH-1, UTMN-1830; Jauf Formation; A2-A3a; ?late Pragian-Emsian.
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.
- United Kingdom: Welsh Borderland and South Wales; Middle Ditton Group; Dittonian (Richardson & Lister, 1969).

Cymbosporites echinatus Richardson & Lister, 1969

Pl. 40, fig. 17

1967 *Cymbosporites*; Richardson Pl. 1, fig. f.
1969 *Cymbosporites echinatus* Richardson & Lister, p. 239, Pl. 42, figs 1-5.
non 1983 *Cymbosporites echinatus* Richardson & Lister; Le Hérissé, p. 50, Pl. 7, figs 10.

Description: Trilete patinate spores with subtriangular amb. Laesurae not observed because the thin proximal face has frequently collapsed. Exine thicker outside the contact areas, 2-5 µm thick equatorially, laevigate to infragranular. Equatorial and distal regions sculptured with dominantly biform, broad bases rounded in plan, 2-5 µm wide, surmounted by short parallel-sided spines, or coni, 0.5-2 µm wide at base. Tips occasionally pointed, but usually flat. Total height of elements 2-4.5 µm. Ornamentation discrete, or coalescing into small groups of 2, 3 or more elements.

Dimensions: 52 (53) 54 µm, 2 specimens measured.

Remark: *Cymbosporites echinatus* Richardson & Lister, 1969 frequently occurs in tetrads according to the authors.

Comparison: *Cymbosporites cyathus* Allen, 1965 has more densely packed elements which are spinose-tipped and appears different from the sculptural elements described above. Moreover, it has a thicker patina.

Stratigraphic and palaeogeographic occurrence:
- Belgium: Dinant, Verviers Synclinoriums and Theux Window; R-Z Interval Zones; Lochkovian (Steemans, 1989).
- Romania: Moesian Platform, Chilia well; Siα-G Interval Zones; Lochkovian (Steemans, 1989).
- Saudi Arabia: Borehole BAQA-1; Jauf Formation; A2; ?late Pragian-early Emsian.
- United Kingdom: Welsh Borderland and South Wales; Downton Castle Sandstone and Temeside Shales Groups; Downtonian (Richardson & Lister, 1969).

Cymbosporites ocularis (Raskatova) comb. nov.

Pl. 40, figs 18, 19

1969 *Archaeozonotriletes ocularis* Raskatova.
1993 *Archaeozonotriletes ocularis* Raskatova; Avkhimovitch et al., Pl. 8, fig. 9.

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae straight, simple and extending to the inner margin of patina. Exine proximally thin, distally and equatorially patinate, 5-10 µm thick equatorially. Proximal surface laevigate, patina sculptured distally with grana or small and low verrucae, 0.5-3 µm wide, up to 1.5 µm apart, sometimes adjoining.

Dimensions: 40 (41) 42 µm, 3 specimens measured.

Remark: *Archaeozonotriletes ocularis* Raskatova, 1969 is herein moved into the genus *Cymbosporites* Allen, 1965. The latter corresponds to ornamented patinate spores while *Archaeozonotriletes* Naumova emend. Allen, 1965 has a laevigate or punctate patina.

Stratigraphic and palaeogeographic occurrence:
• Tunisia: Borehole MG-1; Awaynat Wanin III Formation; A8; late Givetian-?early Frasnian.

Cymbosporites rarispinosus Steemans, 1989

Pl. 40, figs 20-24

1981 *Cymbosporites* sp. G; Steemans, p. 53, Pl. 2, fig. 9.
1984 *Cymbosporites* sp. 1; Steemans & Gerrienne, Pl. 2, fig. 11.
1989 *Cymbosporites rarispinosus* Steemans, p. 124, Pl. 32, figs 26-28, Pl. 33, figs 1, 2.

Description: Trilete patinate spores with subcircular amb. Patina 1.5-4 µm thick. Laesurae straight, slightly sinuous, 1-2 µm thick. Folds can accompany the trilete mark and reach the inner side of the patina. Proximal surface, sometimes absent, is laevigate. Patina distally and equatorially sculptured with spines, irregularly and loosely distributed, 1.5-5 µm high, 0.75-3 µm wide at base and 1-5 µm apart. Spines are straight or flexuous.

Dimensions: 39 (47) 54 µm, 9 specimens measured.

Comparison: Ornamentation, comprising irregularly distributed rare spines, differs from other species of *Cymbosporites* Allen, 1965.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant, Verviers Synclinoriums and Theux Window; Siβ Interval-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
• Brazil: Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005).
• Germany: Siegerland; Siβ Interval Zone; late Lochkovian (Steemans, 1989).
• Saudi Arabia: Boreholes BAQA-1, 2 and well KHRM-2; Jauf Formation; A1-A2; late Pragian-?early Emsian.

Cymbosporites senex McGregror & Camfield, 1976

Pl. 41, figs 1-11

1970 New species; McGregor et al., Pl. 1, fig. 7.
1976 *Cymbosporites*? *senex* McGregor & Camfield, p. 16, Pl. 2, figs 1-4, fig. 14.

Description: Trilete spores with subcircular amb. Laesurae straight, simple or accompanied by labra, 1-3.5 µm in overall width and length 2/3 to 9/10 the spore radius. Exine distally and equatorially 2-7 µm thick, proximally apparently somewhat thiner Contact areas laevigate or sculptured with grana, coni, and parallel-sided ornaments 0.5-1.5 µm at base, 0.5-2 high.

Contact areas delimited by low ridges, up to 3.5 µm high, or by change of ornamentation. Proximo-equatorial and distal regions sculptured with spines, bacula, coni or, rarely, grana and biform sculptural elements, 1-3.5 µm high, 0.5-2 µm wide at base, 1-5 µm apart, evenly distributed.

Dimensions: 47 (60) 72 µm, 28 specimens measured.

Remarks: The deciding factors for the questioned assignement of this species to *Cymbosporites* Allen, 1965 were its general resemblance to extreme forms of *Cymbosporites proteus* McGregor & Camfield, 1976, and the apparently slightly greater thickness of the distal face compared to the contact areas (McGregor & Camfield, 1976). Examination of the population presented here has proved that this form is clearly patinate and its attribution to the genus *Cymbosporites* Allen, 1965 is no more questionable.

Comparisons: *Dibolisporites eifeliensis* (Lanninger) McGregor, 1973 is smaller, lacks curvaturae, and its distal ornaments are predominantly flask-shaped and commonly expanded at the tip. *Cymbosporites proteus* McGregor & Camfield, 1976 is smaller, with sculpture consisting of grana and minute cones only. *Cymbohilates comptulus* Breuer et al., 2007c is very similar and has the same size but is hilate.

Stratigraphic and palaeogeographic occurrence:

- Canada: Ontario, Moose River Basin; Kenogami River, Stooping River and Sextant Formations; *mircrornatus-proteus* to *annulatus-lindlarensis* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).
- Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4 and wells ABSF-29, FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830; Jauf and Jubah Formation; A2-A4; ?late Pragian-Eifelian.

Cymbosporites sp. 1

Pl. 42, figs 1-14

2007a *Cymbosporites* sp. 1; Breuer et al., fig. 1-3a.
2007b Unnamed spore; Breuer et al., fig. 1-1.

Description: Trilete patinate spores with subcircular to roundly triangular amb. Laesurae straight, simple, often indistinct, length commonly 2/3 to 4/5 spore radius. Exine proximally thin, equatorially and distally patinate, commonly 2-5 µm thick, homogeneous. Proximal surface laevigate, often torn or collapsed, patina sculptured with densely distributed grana, coni or small verrucae, 0.5-2 µm wide at base and high, 0.5-2 µm apart. Elements are evenly distributed and sometimes locally merged at the base.

Dimensions: 47 (58) 73 µm, 54 specimens measured.

Remarks: *Cymbosporites* sp. 1 constitutes an end-member of the *Dictyotriletes biornatus* Morphon (Tab. 1, p. 185) which includes *Cymbosporites* sp. 2, *Cymbosporites* sp. 3, *Dictyotriletes biornatus* Breuer et al., 2007c and *Dictyotriletes* sp. 1. The ornament and its organization on the spore distal surface varies between the two end-members which correspond to two distinct genera: *Cymbosporites* Allen, 1965 and *Dictyotriletes* Naumova, 1939 ex Ishchenko, 1952. All intermediary forms between the two end-members co-occur in the assemblages. In the simplest form of the spore, sculptural elements are evenly distributed on the distal surface (*Cymbosporites* sp. 1). In the intermediary forms (*Cymbosporites* sp. 2 and *Cymbosporites* sp. 3) elements organize progressively and combine until they form a pseudo-reticulum, the walls of which are constituted by lines of discrete ornaments (*Dictyotriletes biornatus* Breuer et al., 2007c). In the most complex spore form, ornaments merge to form elongated muri which constitutes a perfectly closed reticulum (*Dictyotriletes* sp. 1). Thus a progressive organization of the ornamentation appears from the simplest spores to the most complex ones.

Comparisons: *Cymbosporites catillus* Allen, 1965 has a generally thicker patina and distinct laesurae straight accompanied by labra. *Cymbosporites* sp. 2 has more irregularly distributed ornaments. As the two species intergrade (see discussion above), it is sometimes difficult to discriminate between them.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4; Jauf Formation; A2; ?late Pragian-Emsian.

***Cymbosporites* sp. 2**

Pl. 43, figs 1-14

2007a *Cymbosporites* sp. 2; Breuer et al., fig. 1-3b.
2007b Unnamed spore; Breuer et al., fig. 1-2.

Description: Trilete patinate spores with subcircular to roundly triangular amb. Laesure straight, simple, often indistinct, length commonly 3/5 to 4/5 spore radius. Exine proximally thin, equatorially and distally patinate, commonly 2-5 µm thick, homogeneous. Proximal surface laevigate, often torn or collapsed, patina sculptured with grana, coni or small verrucae, 0.5-2 µm wide at base and high, 0.5-3 µm apart. Elements are irregularly packed and often merged at the base forming patches of several elements.

Dimensions: 45 (56) 70 µm, 46 specimens measured.

Comparison: *Cymbosporites* sp. 1 has more regularly distributed ornaments. *Cymbosporites* sp. 3 shows clearly a more advanced organization of elements.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4 and well KHRM-2; Jauf Formation; A2; ?late Pragian-Emsian.

***Cymbosporites* sp. 3**

Pl. 44, figs 1-14

2007a *Cymbosporites*? sp. 3; Breuer et al., fig. 1-3c.
2007b Unnamed spore; Breuer et al., fig. 1-3.

Description: Trilete patinate spores with subcircular to roundly triangular amb. Laesure straight, simple, often indistinct, length commonly 3/5 to 4/5 spore radius. Exine proximally thin, equatorially and distally patinate, commonly 2-5 µm thick, homogeneous. Proximal surface laevigate, often torn or collapsed, patina sculptured with grana, coni or small verrucae, 0.5-2 µm wide at base and high, 0.5-7 µm apart. Elements are distributed into an irregular to almost imperfect reticulate pattern. Elements are often merged at the base forming elongated elements or patches of several ornaments.

Dimensions: 47 (57) 68, 34 specimens measured.

Comparisons: *Cymbosporites* sp. 2 has more regularly distributed ornament. *Dictyotriletes biornatus* Breuer et al., 2007c has all the ornament disposed in a perfect recticulate pattern. However, perfect lumina can occur locally in *Cymbosporites* sp. 3, others are incomplete or have isolated elements within the reticulum.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4; Jauf Formation; A2; ?late Pragian-Emsian.

***Cymbosporites* sp. 4**

Pl. 45, figs 1-16

1972 cf. *Cymbosporites cyathus* Allen; Mortimer & Chaloner, p. 11, Pl. 1, fig. 4.
1989 *Verrucosisporites bulliferus* Richardson & McGregor; Loboziak & Streel, Pl. 1, fig. 6.
? 1992 *Cymbosporites* sp. cf. *C. magnificus* (McGregor) McGregor & Camfield; McGregor & Playford, Pl. 5, figs 5, 6.
1992 *Geminospora piliformis* Loboziak et al.; Loboziak et al., Pl. 3, fig. 11.

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae straight, simple and extending to or almost to the inner margin of patina. Exine proximally thin, equatorially and distally patinate, commonly 2-5 µm thick, homogeneous to infragranulate. Proximal surface infragranular to granular, patina sculptured with a variable concentration of low verrucae or baculae, flat-topped or sligthly rounded in profile, subcircular, polygonal or irregular in plan view, 0.5-4 µm wide, up to 1.5 µm high, 0.5-3 µm apart. Elements are sometimes irregularly packed with some small zones without any elements.

Dimensions: 38 (48) 60 µm, 26 specimens measured.

Remark: Some specimens (e.g. Pl. 41, figs 11, 15) give the impression of having a partly separate inner body as in the genus *Geminospora* Balme, 1962. That is typical of a thick patinate structure of *Cymbosporites* Allen, 1965.

Comparisons: The elements of cf. *Cymbosporites cyathus* Allen, 1965 in Mortimer & Chaloner (1972) are flat-topped as the form described herein. The specimens figured as *Cymbosporites* sp. cf. *C. magnificus* (McGregor) McGregor & Camfield in McGregor & Playford (1992) could be similar, but no description of the observed specimens is given. The specimen figured as *Geminospora* piliformis Loboziak et al., 1988 in Loboziak et al. (1992) could be misinterpreted since it seems to bear low verrucae an to be single-layered. Consequently it is similar to the taxon described herein. *Geminospora piliformis* Loboziak et al., 1988 is two-layered and bears pila. *Cymbosporites magnificus* (McGregor) McGregor & Camfield, 1982 is larger and sculptured with verrucae, mammae, and rounded coni, discrete or joined laterally into short irregularly-trending ridges while *Cymbosporites cyathus* Allen, 1965 bears mainly coni. *Verrucosisporites bulliferus* Richardson & McGregor, 1986 has generally larger verrucae (2.5-5 µm), is proximally laevigate and not patinate. However *Verrucosisporites bulliferus* Richardson & McGregor, 1986 illustrated in Loboziak & Streel (1989) has been re-observed under microscope and is exactly the same as *Cymbosporites* sp. 4. As none *Verrucosisporites bulliferus* Richardson & McGregor, 1986 sensu stricto has been found in all studied samples, the specimens described here cannot been mixed up with the index species of Richardson & McGregor (1986).

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin III Formation; BM Oppel Zone; Frasnian (Loboziak & Streel, 1989); Boreholes A1-69; Awaynat Wanin II Formation; A6-A8; Givetian-?early Frasnian.
• Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.

Genus *Cyrtospora* Winslow, 1962

Type species: *Cyrtospora cristifera* (Luber) Van der Zwan, 1979.

Description: Trilete spores, asymmetrically subprolate, proximal and flattened, distal end extended, subcircular to subtriangular in transverse outline. Trilete suture distinct, extending nearly to equator; suture margins simple; contact surfaces smooth and not defined equatorially. Distal surface laevigate with a large irregular intumescent or glebous mass and tubercules. Distal mass consists of spore coat material, variously situated as an integral part of the distal wall. Tubercules irregularly scattered, short, truncated, mostly 3-5 µm height and nearly as broad, some fused together basally on the glebous area of the coat. Proximal wall thinner than the distal pole which becomes very thick and dense in tumid areas.

Comparison: *Archaeozonotriletes* Naumova emend. Allen, 1965 has a patina which is commonly uniform in thickness or thickest in the distal polar region.

***Cyrtospora* sp. 1**

Pl. 46, figs 5-14

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae simple, straight, length 2/3 to full central area radius. Patina homogeneous or with sometimes scattered infrapuncta, 2-21 µm thick. Contact areas thinner and laevigate. Patina of irregular shape in plan view and dissected into irregularly distributed, large, broad based, rounded verrucae, coni, tubercules or protuberances, 1.5-28 µm wide at base, 1.5-14 µm high.

Dimensions: 39 (59) 72, 11 specimens measured.

Remark: This population cannot belong to the genus *Archaeozonotriletes* Naumova emend. Allen, 1965 because their patina are far from being uniform.

Comparisons: *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965 also has a laevigate or finely punctate and irregular patina which is not dissected into ornament or protuberances. However, some specimens (e.g. Pl. 17, figs 15, 21) may locally show slightly convex and concave zones on the patina. We think *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965 could intergrade with *Cyrtospora* sp. 1 in a same morphon (Tab. 1, p. 185). *Lophozonotriletes media* Taugourdeau-Lantz, 1967 is densely punctate and bears above all equatorially blunt pointed or rounded verrucae. The latter is rather cingulate but extreme variants could intergrade with *Cyrtospora* sp. 1. *Cyrtospora cristifer* (Luber) Van Der Zwan, 1979 has a distal ornamentation mainly consisting of bacula of variable shape and size and to a minor degree coni and verrucae (1-8 µm high, 1-7 µm wide).

Stratigraphic and palaeogeographic occurrence:
- Libya: Boreholes A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.

Genus *Densosporites* (Berry) Butterworth et al. in Staplin & Jansonius (1964)

Type species: *Densosporites covensis* Berry, 1937.

Description: Trilete spores with subcircular to convexly triangular amb. Two-layered: nexine (central body) thin, laevigate or scabrate, laesurae indistinct, apical papillae sometimes present; proximal surface of outer layer evenly arched or with zona slightly raised above central proximal area. Suturae ridges weak to strong, sometimes connected at their extremities to the zonal region. Proximal sculpture generally absent or minor except for scalloping of the zona in some species, faint roughening or granulosity of the central proximal area, and granules, spines, or apiculae on the zone. Sculpture of central distal area usually differentiated from distal zonal surface, usually granulose. Zona psilate, granulose, spinose, apiculose, verrucose, etc. Internal vacuoles ('rods') rare or absent.

***Densosporites devonicus* Richardson, 1960**

Pl. 47, figs 1-7, Pl. 119, figs 4-9

1960 *Densosporites devonicus* Richardson, p. 57, Pl. 14, figs 10, 11, text-fig. 7.
1965 *Densosporites orcadensis* Richardson, p. 580, Pl. 92, figs 1, 2.
1976 *Hymenozonotriletes propolyacanthus* Arkhangelskaya, p. 55, Pl. 10, figs 3, 4.
1976 *Densosporites orcadensis* Richardson; McGregor & Camfield, p. 17, Pl. 6, fig. 3.

Description: Trilete zonate spores with rounded-subtriangular or subcircular amb. Laesurae straight, commonly obscured by fold-like labra about 2-10 µm in height and combined width, extending to the inner edge of the zona or beyond. Exine thin in contact areas, considerably thicker distally, extended laterally as a zona. Dark inner part of the equatorial zona about 6-18 µm wide, overlaps central area, bounded equatorially by an outer, less thickened, flange-like light zone 6-18 µm wide (rarely up to 29 µm). Dark zone may be narrower, equal to, or wider than light zone. Distal and proximo-equatorial regions sculptured with spinae or coni that taper with slender extensions. Sculptural elements pointed or with a minutely expanded or bifurcate tip. Elements commonly 1-10 µm long, 1-5 wide at the base, and about 1-7 µm apart, the smallest commonly occurring in the distal polar region. Mammillate biform elements, blunt cones, and small verrucae may also be present, especially towards the distal pole. Sculptural elements mostly discrete except proximally at the outer edge of the dark zone, where their bases tend to coalesce.

Dimensions: 77 (96) 126, 23 specimens measured.

Remark: In lateral compression, proximal face flattened-pyramidal, distal region strongly rounded (McGregor & Camfield, 1982).

Comparisons: Richardson (1965) gave the sculptural details and the relative widths of the light and dark zones of the cingulum as criteria for distinguishing *Densosporites devonicus* Richardson, 1960 from *Densosporites orcadensis*, 1960. However, these criteria were used by Marshall & Allen (1982) in an attempt to substantiate the differences between the two species, but no systematic variation of these characters, as alleged by Richardson (1965). Thus McGregor & Camfield (1982) and Marshall & Allen (1982) consider that *Densosporites devonicus* Richardson, 1960 and *Densosporites orcadensis* Richardson, 1960 intergrade and it is impractical to separate them. *Densosporites weatherallensis* McGregor & Camfield, 1982 differs from *Densosporites devonicus* Richardson, 1960 in its broader spines that rarely expand at the tip, in the close spacing or basal fusion of its sculpture towards the distal pole, and its less conspicuous dark zone. *Densosporites inaequus* (McGregor) McGregor & Camfield, 1982 has more prominent spines which do not bifurcate but have papillate tips. *Densosporites concinnus* (Owens) McGregor & Camfield, 1982 is smaller in size and less elongate, with a predominantly pointed sculpture but intergrades with extreme variants of *Densoporites devonicus* Richardson, 1960 (McGregor & Camfield, 1982).

Stratigraphic and palaeogeographic occurrence:
• Canada: Arctic Archipelago, Melville and Bathurst Islands; Bird Fiord, Weatherall and Hecla Bay Formations; late Eifelian-Givetian (McGregor & Uyeno, 1972; McGregor & Camfield, 1982). Ontario, Moose River Basin; Moose River, and Williams Island Formations; *devonicus-orcadensis* Provisional Assemblage Zone; Eifelian-Givetian (McGregor & Camfield, 1976).
• Germany: Rheinland, Eifel; Nohn Formation; early Eifelian (Riegel, 1973). Schwarzbachtal 1 borehole; late Eifelian-early Givetian (Streel & Paproth, 1982). Eifel, Prüm Syncline; Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages C-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; Eifelian-Givetian (Loboziak et al., 1990).
• Libya: Cyrenaica; AD Oppel Zone; late Eifelian (Streel et al., 1988).
• Norway: Spitsbergen; Upper Mimer Valley Series; Givetian (Allen, 1965).
• Poland: Western Pomerania; Studnica, Jamno, Miastko and Sianowo Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A7; ?late Emsian-Givetian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Wick Flagstone Group, Achanarras fish Beds and Eday Group; Eifelian-Givetian (Richardson, 1965). Shetland, Fair Isle; Ward Hill, Observatory and Bu Ness Groups; late Givetian (Marshall & Allen, 1982). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

Genus *Diaphanospora* Balme & Hassell, 1962

Type species: *Diaphanospora riciniata* Balme & Hassell, 1962.

Description: Trilete two-layered spores with circular to subtriangular amb. A thin translucent perispore envelops spore body. Labra may be strongly developed. Spore body fairly thick, laevigate, scrabrate or ganulate. Sexine thin, translucent and fitting fairly closely about the nexine. Surface of outer layer wrinkled by fine randomly disposed folds.

Comparison: *Proprisporites* Neves, 1958 has an outer layer wrinkled to form long folds and free lobes, mainly on the distal surface.

***Diaphanospora* sp. 1**

Pl. 48, figs 1-14

2007a sp. 1; Breuer et al., figs 1.4.a, b.

Description: Trilete two-layered spores with subcircular amb. Laesurae straight, simple or rarely accompanied by narrow labra, about 1 µm in overall width, length 3/5 to 3/4 the spore radius, connected by curvaturae perfectae not always well-visible and often obscured by the folds of sexine. Nexine laevigate, commonly 1-2 µm thick. A darker apical area subtriangular, with straight, slightly concave or convex sides, extends almost or to the end of laesurae. This thickened area is 3-6 µm wide interradially in greatest width. An inner lighter subtriangular area (with a thinner nexine), generally with slightly concave sides is present at the proximal pole. Sexine extremly thin, transparent, closely appressed to the spore body and attached proximally close by the curvaturae. Surface of exine randomly and finely folded.

Dimensions: 30 (40) 51 µm, 17 specimens measured.

Remarks: Specimens in which the outer layer is locally detached are not uncommon. Specimens in which the outer layer is missing are common in the less well-preserved palynological assemblages and consequently correspond to *Retusotriletes* sp. 2 described below. Indeed, the very delicate sexine may have been torn off by sedimentary or taphonomic processes. The two form-species *Diaphanospora* sp. 1 and *Retusotriletes* sp. 2 represent thus a unique biological species with the different states of preservation between both. They are grouped in the *Diaphanospora* sp. 1 Morpon (Tab. 1, p. 185). Besides they sometimes co-occur and have comparable stratigraphical ranges.

Comparison: *Diaphanospora riciniata* and *Diaphanospora perplexa* Balme & Hassell, 1962 are labrate and does not have a thickened apical area on the spore body.

Stratigraphic and palaeogeographic occurrence:
• Libya: Boreholes A1-69; Ouan-Kasa Formation; A3a; Emsian.
• Saudi Arabia: Borehole BAQA-1 and wells FWRH-1, KHRM-2, UTMN-1830; Jauf Formation; A2-A3a; ?late Pragian-Emsian.

Genus *Diatomozonotriletes* Naumova emend. Playford, 1962

Type species: *Diatomozonotriletes saetosus* (Hacquebard & Barss) Hughes & Playford, 1961.

Description: Trilete spores with triangular or subtriangular amb. Laesurae usually well-defined, long, simple or labrate. Spore body almost entirely encompassed by prominent zona (corona) consisting of numerous, strongly developed, mainly discrete fimbriae emanating radially from the equatorial margin of the spore body. Frimbriae are particularly well-developed in central interradial equatorial regions, characteristically exhibiting a gradual diminution in size towards the triangular apices of the spore, where they may be either absent or considerably reduced. Fimbriae pointed or blunt, sometimes fused, at least in part, but always remain recognizable individually within the corona as distinct structural entities. Exine often sculptured, particularly on distal surface.

Diatomozonotriletes franklinii **McGregor & Camfield, 1982**

Pl. 48, figs 15-22

1966 *Diatomozonotriletes devonicus* Naumova; Mikhailova, Pl. 1, fig. 2.
1972 *Diatomozonotriletes devonicus* Naumova; McGregor & Uyeno, Pl. 2, fig. 6.
1976 *Anapiculatisporites petilus* Richardson; Massa & Moreau-Benoit, Pl. 3, fig. 4.
1979 *Anapiculatisporites petilus* Richardson; Moreau-Benoit, p. 32.
1985 *Anapiculatisporites petilus* Richardson; Massa & Moreau-Benoit, Pl. 1, fig. 2.
1982 *Diatomozonotriletes franklinii* McGregor & Camfield, p. 36, Pl. 7, figs 10-13.

Description: Trilete spores with subtriangular to triangular amb, rounded corners, and convex, straight, or slightly concave interradial margins. Exine 1-2 µm thick, may be slightly thicker interradially, may be darkened proximally between rays. Laesurae straight, simple or accompanied by narrow labra, up to 2 µm in overall width, length 2/3 to full spore radius. Proximal face laevigate or scabrate, or with small scattered grana. Sculpture at the equator consists interradially of closely spaced spinae 0.5-1 µm wide at base, 1.5-5 µm long in the middle of the interradial margins, diminishing in length towards the radial angles. Radial extremities laevigate or with sculpture like that of the distal region. Distal region sculptured with small evenly distributed grana and coni up to 2 µm wide and high, commonly 0.5-1 µm apart, polygonal or subcircular in plan view.

Dimensions: 35 (40) 50 µm, 12 specimens measured.

Comparisons: *Diatomozonotriletes devonicus* Naumova, illustrated but not described by Mikhailova (1966), appears identical. However, *Diatomozonotriletes devonicus* Naumova in Tchibrikova (1959) has a quite different appearance and description, and is evidently another species. No description of a species of this name was ever published by Naumova, so the species was validated by McGregor & Camfield (1982). *Diatomozonotriletes oligodontus* Tchibrikova, 1962 has predominantly wider, less closely spaced sculptural elements. *Diatomozonotriletes* sp. in Allen (1965) closely resembles *Diatomozonotriletes franklinii* McGregor & Camfield, 1982, except for a greater tendancy towards concave-triangular amb. *Camarozonotriletes sextantii* McGregor & Camfield, 1976 has similar sculpture but has a prominent interradial cingulum.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin; Orsine Formation; late Emsian-early Eifelian (Moreau-Benoit et al., 1992).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Oppel Zone; Eifelian-Givetian (Loboziak et al., 1988). Amazon Basin; Maecuru and Ererê Formations; GS-Per Interval Zones; late Emsian- Eifelian/Givetian (Melo & Loboziak, 2003).
- Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; late Eifelian-early Givetian (McGregor & Uyeno, 1972).

• Libya: Ghadames Basin; Palynozones 3-6; Emsian-early Givetian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A7; ?late Emsian-Givetian.
• Morocco: Doukkala Basin; Palynozones DI2-DM2; Emsian-Eifelian (Rahmani-Antari & Lachkar, 2001).
• Saudi Arabia: Borehole JNDL-3; Jauf Formation; A3a; Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A8; ?late Emsian-?early Frasnian.

Genus *Dibolisporites* Richardson, 1965

Type species: *Dibolisporites echinaceus* (Eisenack) Richardson, 1965.

Description: Trilete, azonate spores with subcircular to subtriangular amb. Sculptural elements dominantly biform but otherwise vary variable, consisting of cones, rod-like processes, pila, verrucae, and spines.

Comparisons: *Biharisporites* Potonié, 1956 contains megaspores with similar sculpture. *Apiculiretusispora* Streel, 1964 shows a variable sculpture of small grani, coni, or spinae which measure less than 1 µm high.

***Dibolisporites bullatus* (Allen) Riegel, 1973**

Pl. 49, figs 1-6

1965 *Bullatisporites bullatus* Allen, p. 703, Pl. 96, figs 5-7.
1973 *Dibolisporites bullatus* Allen; Riegel, p. 84, Pl. 10, figs 10-12, Pl. 11, figs 1, 2.

Description: Trilete spores with subcircular amb. Laesurae straight, accompanied and frequently obscured by labra, up to 5 µm in overall width, length 1/2-3/4 spore radius. Exine 1-2 µm thick. Contact areas infragranular to granular. Proximo-equatorial and distal regions sculptured with bulbous spinae and pila, 1.5-6 µm high, up to 2.5 µm wide at base, 0.5-3 µm apart, the process frequently supports at its apex a minute spine.

Dimensions: 65 (73) 84, 10 specimens measured.

Remark: Hower McGregor & Camfield (1982) consider *Dibolisporites bullatus* (Allen) Riegel, 1973 as synonymous with *Dibolisporites echinaceus* (Eisenack) Richardson, 1965, these two species are easily differentiated here and consequently not considered as synonymous.

Comparisons: This taxon was placed by some authors (e.g. McGregor, 1973; McGregor & Camfield, 1982) in synonymy with *Dibolisporites echinaceus* (Eisenack) Richardson, 1965. Indeed, McGregor (1973) observed an intergradation from spores like the holotype of *Dibolisporites echinaceus* (Eisenack) Richardson, 1965 to those like the holotype of *Dibolisporites bullatus* (Allen) Riegel, 1973 which is figured in Allen (1965). However, the two species are easily distinguishable, in this work, because the specimens of *Dibolisporites echinaceus* (Eisenack) Richardson, 1965 are more densely sculptured with elongate, more or less parallel-sided spinae.

Stratigraphic and palaeogeographic occurrence:
- France: Boulonnais, railroad trench Caffiers-Ferques; Blacourt and Beaulieu Formations; late Givetian-early Frasnian (Brice et al., 1979; Loboziak & Streel, 1980).
- Germany: Rheinland, Eifel; Heisdorf, Lauch and Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Eifel, Hillesheim Syncline; Freilingen, Ahbach and Cürten Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).
- Norway: Spitsbergen; Dicksonfjorden, Reuterskiøldfjellet Sandstone and Lower Mimer Valley Series; Siegenian-Eifelian (Allen, 1965).
- Saudi Arabia: Borehole BAQA-1 and well UTMN-1830; Jauf Formation; A2; ?late Pragian-Emsian.

Dibolisporites echinaceus (Eisenack) Richardson, 1965

Pl. 50, figs 1-4

	1944	*Triletes echinaceus* Eisenack, p. 113, Pl. 2, fig. 5.
?	1953	*Retusotriletes devonicus* Naumova, Pl. 22, fig. 108.
?	1962	*Retusotriletes devonicus* Naumova var. *echinatus* Tchibrikova, p. 393, Pl. 1, fig. 9.
	1965	*Dibolisporites echinaceus* Eisenack; Richardson, p. 568, P. 89, figs 5-6, text-figs 3b-3d.
non	1973	*Dibolisporites bullatus* Allen; Riegel, p. 84, Pl. 10, figs 10-12, Pl. 11, figs 1, 2.
	1975	*Dibolisporites triangulatus* Tiwari & Schaarschmidt, p. 21, Pl. 7, figs. 3, 4, Pl. 8, figs. 1, 2, text-fig. 9.

Description: Trilete spores with circular to subcircular to subtriangular amb. Laesurae straight, accompanied by labra, up to 4 µm in overall width, length 1/2 to 4/5 spore radius. Curvaturae sometimes visible. Exine thin, up to 1.5 µm thick. Contact areas laevigate or infragranular. Proximo-equatorial and distal regions densely sculptured with elongate, more or less parallel-sided spinae, pila and verrucae, 1-4 µm high, 0.5-1.5 µm wide at base, 0.5-1.5 µm apart. Sculptural elements commonly surmounted by a minute apical spine. Different types of ornament may occur on a single specimen.

Dimensions: 61 (98) 129 µm, 6 specimens measured.

Comparisons: *Dibolisporites triangulatus* Tiwari & Schaarschmidt, 1975 is identical to *Dibolisporites echinaceus* Richardson, 1965. *Retusotriletes devonicus* figured but not described by Naumova (1953) could be synonymous with *Dibolisporites echinaceus* Richardson, 1965 but the details of the ornament cannot be seen. *Retusotriletes devonicus* var. *echinatus* Tchibrikova, 1962 could be also synonymous. *Dibolisporites* cf. *gibberosus* var. *major* (Kedo) Richardson, 1965 has shorter sculptural elements. *Dibolisporites pseudoreticulatus* Tiwari & Schaarschmidt, 1975 has relatively high and wide curvatural ridges. However *Dibolisporites radiatus* Tiwari & Schaarschmidt, 1975 is considered as synonymous with *Dibolisporites echinaceus* (Eisenack) Richardson, 1965 according to McGregor (1973), they are here distinguished because *Dibolisporites radiatus* Tiwari & Schaarschmidt, 1975 has larger sculptural elements disposed in a regular radial pattern. *Dibolisporites varius* Tiwari & Schaarschmidt, 1975 has a baculate ornamentation. However *Dibolisporites bullatus* (Allen) Riegel, 1973 is often placed in synonymy with *Dibolisporites echinaceus* (Eisenack) Richardson, 1965, it has more bulbous, wider spinae. All these species described display only minor differences between them and *Dibolisporites echinaceus* (Eisencack) Richardson, 1965, so their assignation may be sometimes difficult.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin, borehole TRN 3; Gazelle Inférieure Formation; early Givetian (Boumendjel et al., 1988). Illizi Basin; Orsine Formation; Emsian (Moreau-Benoit et al., 1992).
- Belgium: Dinant Synclinorium; late Emsian-Eifelian (Lessuise et al., 1979). Dinant, Neufchâteau-Eifel, Verviers Synclinoriums and Theux Window; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
- Bolivia: Bermejo-La Angostura outcrop; Huamampampa and Los Monos-Iquiri Formations; ?AP-AD Oppel Zone; late Emsian-late Eifelian (Perez-Leyton, 1990).
- Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Arctic Archipelago, Melville and Bathurst Islands; Stuart Bay, Eids, Blue Fiord, Bird Fiord, Cape De Bray, Weatherall and Hecla Bay Formations; Emsian-Givetian (McGregor & Uyeno, 1972; McGregor & Camfield, 1982). Ontario, Moose River Basin; Stooping River, Sextant, Kwataboahegan and Williams Island Formations; *annulatus-lindlarensis* to *devonicus-orcadensis* Provisional Assemblage Zone; Emsian-Givetian (McGregor & Camfield, 1976).
- China: Yunnan; Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
- France: Boulonnais, railroad trench Caffiers-Ferques; Blacourt and Beaulieu Formations; late Givetian-early Frasnian (Brice et al., 1979; Loboziak & Streel, 1980). Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 2 to 3; Pragian-early Emsian (Le Hérissé, 1983).
- Germany: Soutwestern Eifel; Heisdorfer Formation; Emsian (Lanninger, 1968). Rheinland, Lindlar; Eifelian (Riegel, 1968).Rheinland, Eifel; Heisdorf, Lauch and Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Eifel, Prüm Syncline; Berle, Wiltz, Heisdorf, Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages A-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Schwarzbachtal 1 borehole; late Eifelian-early Givetian (Streel & Paproth, 1982). Siegerland; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh and Cürten Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).
- Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zones III-IV; late Emsian-early Givetian (Ghavidel-Syooki, 2003).
- Libya: Cyrenaica; early or middle Emsian-early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 2-6; Pragian-early Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A5; Eifelian.
- Poland: Western Pomerania; Studnica, Jamno, Miastko and Sianowo Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999). Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; AP Oppel Zone; uppermost Emsian-?basal Eifelian (Turnau et al., 2005).
- Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Borehole JNDL-1; Jauf and Jubah Formation; A3b-A4; ?late Emsian-Eifelian.
- United Kingdom: Northeast Scotland, Orcadian Basin; Thurso Flagstone and Eday groups; Givetian (Richardson, 1965). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

Dibolisporites eifeliensis (Lanninger) McGregor, 1973

Pl. 50, figs 5-14

1966 cf. *Archaeotriletes setigerus* Kedo; McGregor & Owens, Pl. 3, fig. 12.
1967 *Acanthotriletes inferus* Naumova; Beju, Pl. 1, fig. 14.
1968 *Anapiculatisporites eifeliensis* Lanninger, p. 124, Pl. 22, fig. 11.
1973 *Dibolisporits eifeliensis* (Lanninger) McGregor, p. 31, Pl. 3, figs 17-22, 26.
non 1988 *Dibolisporites eifeliensis* (Lanninger) McGregor; Ravn & Benson, Pl. 3, figs 16-23.

Description: Trilete spores with subcircular to broadly subtriangular amb. Laesurae straight, simple, often obscured by folds of the exine, length 3/5 to 9/10 spore radius. Exine sometimes darker adjacent to laesurae, forming a concave triangular zone around the proximal pole and extending to the end of laesurae. Exine 1-2 µm thick. Proximal surface punctate or scabrate. Distal and equatorial regions sculptured with tubercules 1.5-4.5 µm high, 0.5-2 µm wide at base, about 1 to 2.5 times as long as basal width. Basal part of elements bulbous or slightly to strongly tapering. Apical part of tubercules, baculate, commonly slightly expanded at the tip on well-preserved specimens. Elements commonly subcircular in plan view and 1-5 µm apart. Usually the larger tubercules occur on the larger spores.

Dimensions: 29 (42) 60 µm, 20 specimens measured.

Comparisons: *Acanthotriletes inferus* Naumova in Beju (1967) appears from the illustration to be similar to the specimens described here. The elements of *Acanthotriletes longspinosus* Moreau-Benoit, 1966 are commonly bifurcate and do not have a bulbous base. *Archaeotriletes setigerus* Kedo, 1955 is larger, with longer spines. *Dibolisporites quebecensis* McGregor, 1973 has smaller sculptural elements consisting of bacula and verrucae as well as tubercules. *Anapiculatisporites petilus* Richardson, 1965 has more loosely spaced thinner pointed elements and about fifteen ones around the periphery.

Stratigraphic and palaeogeographic occurrence:
- Belgium: Dinant, Neufchâteau-Eifel, Verviers Synclinoriums and Theux Window; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
- Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Quebec, Gaspé Peninsula; York River, Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River and Kwataboahegan Formations; *caperatus-emsiensis* to *annulatus-lindlarensis* Provisional Assemblage Zone; Emsian (McGregor & Camfield, 1976).
- China: Yunnan; Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
- Germany: Soutwestern Eifel; Wetteldorfer Formation; Emsian (Lanninger, 1968). Siegerland; E Interval Zone; late Lochkovian-?earliest Pragian (Steemans, 1989).
- Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone III; Emsian (Ghavidel-Syooki, 2003).
- Libya: Cyrenaica; early or middle Emsian (Paris et al., 1985). Ghadames Basin; Palynozones 2-4; Pragian-earliest Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa and Awaynat Wanin I Formations; A3a; Emsian, the isolated occurrence of two specimens in the Awaynat Wanin I Formation may be due to reworking.
- Morocco: Doukkala and Essaouira Basins; Palynozones DI1-DM1; late Pragian-Eifelian (Rahmani-Antari & Lachkar, 2001).

• Poland: Random-Lublin area; Borehole Terebin IG 5; Zwoleń Formation; PoW Oppel Zone; Pragian-?basal Emsian. Borehole Giezczezw PIG 5; Terrigenous Suite; FD?-AP Oppel Zones; upper Emsian-?basal Eifelian (Turnau et al., 2005).
• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, JNDL-3, JNDL-4, and wells FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3a; Emsian, the isolated occurrence of a specimen in the Awaynat Wanin I Formation may be due to reworking.

Dibolisporites farraginis McGregor & Camfield, 1982

Pl. 51, figs 1-11

1982 *Dibolisporites farraginis* McGregor & Camfield, p. 38, Pl. 8, figs 3, 4, text-fig. 54.

Description: Trilete spores with subcircular amb. Laesurae simple, straight, length 1/2-4/5 the spore radius. Exine 1.5-4.5 µm thick. Proximo-equatorial and distal regions sculptured with a heterogeneous mixture of spinae, coni, bacula and verrucae, 1-3 (rarely up to 5) µm high, 0.5-3 µm (rarely up to 4 µm) wide at base, some of which may be locally fused at base. Sculptural elements generally densely distributed but sometimes up to 6 µm apart. Contact areas with similarly shaped but smaller and more widely scattered sculpture.

Dimensions: 42 (60) 77, 18 specimens measured.

Remarks: Specimens assigned to this species belong to a more or less intergrading series from those with predominantly conate and small verrucose sculpture (*Dibolisporites farraginis* McGregor & Camfield, 1982 and *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982) to those with large verrucate sculptural elements, and thus conform rather closely to the diagnosis of *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 and *Verrucosisporites premnus* Richardson, 1965. All these forms belong to the *Verrucosisporites scurrus* Morphon defined by McGregor & Playford (1992) (Tab. 1, p. 185). Therefore, the *Dibolisporites farraginis* Morphon also defined by McGregor & Playford (1992) is considered as belonging to the *Verrucosisporites scurrus* Morphon.

Comparisons: *Dibolisporites farraginis* McGregor & Camfield, 1982 is distinguished from *Dibolisporites vegrandis* McGregor & Camfield, 1982 by larger, more elongate sculptural elements, and from *Dibolisporites* cf. *correctus* (Naumova) Richardson, 1965 by relatively narrower based, more varied sculptural elements. *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982 has larger sculptural elements but intergrades with *Dibolisporites farraginis* McGregor & Camfield, 1982 as it was noted as an element of the *Dibolisporites farraginis* Morphon in McGregor & Playford (1992, Tab. 4). This morphon includes subcircular forms sculptured with a mixture of mostly discrete grana, coni, spinae, biform elements and verrucae of various sizes, laesurae of which are simple.

Stratigraphic and palaeogeographic occurrence:
• Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; late Eifelian-early Givetian (McGregor & Camfield, 1982).

• Libya: Ghadames Basin; Palynozones 5-6; early Eifelian-early Givetian (Moreau-Benoit, 1989).Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.
• Saudi Arabia: Borehole S-462; Jubah Formation; ?A5-A6; ?Eifelian-Givetian.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.

Dibolisporites gaspiensis (McGregor) comb. nov.

Pl. 52, figs 1-8

1966 cf. *Geminospora svalbardiae* (Vigran) Allen, McGregor & Owens, Pl. 5, fig. 16.
1970 ?*Apiculiretusispora* sp., McGregor et al., Pl. 2, fig. 11.
1973 *Apiculiretusispora gaspiensis* McGregor, p. 28, Pl. 3, figs 1-4.
1974 Large spores of *Chaleuria cirrosa* Andrews et al., p. 394, 398, Pl. 56, figs 1, 2, Pl. 57, fig. 4.
1976 *Apiculiretusispora gaspiensis* McGregor; McGregor & Camfield, p. 11, Pl. 6, figs 11, 12.

Description: Trilete spores with subcircular amb. Laesurae straight or sometimes sinuous, accompanied by labra, 2-4 µm in overall width, length 2/3 to 4/5 spore radius. Laesurae connected by faint, low curvaturae that may be obscured by ornamentation and concentric folding of the wall. Exine 2-5 µm thick equatorially. Contact areas laevigate to infragranular. Proximo-equatorial and distal regions densely sculptured with pila, bacula, parallel-sided elements with apices flat-topped, rounded or in the shape of capita. Elements commonly 0.5-2 µm high and up to 1 µm wide at base.

Dimensions: 53 (65) 80 µm, 16 specimens measured.

Remarks: McGregor (1973) described this form as two-layered. Nevertheless, specimens described here are single-layered but the concentric equatorial folding sometimes gives the impression of a two-layered spore. This taxon is transferred here in the genus *Dibolisporites* Richardson, 1965 because it is sculptured with short pila, bacula or biform elements and not spinae characteristic of the genus *Apiculiretusispora* (Streel) Streel, 1967.

Comparisons: This species differs from *Apiculiretusispora arenorugosa* McGregor, 1973 and *Apiculiretusispora plicata* (Allen) Streel, 1967 in possessing a more rigid-looking wall because of the thicker exine. *Geminospora svalbardiae* (Vigran) Allen, 1965 has well-separated two layers.

Stratigraphic and palaeogeographic occurrence:
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Kwataboahegan and Williams Island Formations; *annulatus-lindlarensis* to *devonicus-orcadensis* Provisional Assemblage Zone; Emsian-Givetian (McGregor & Camfield, 1976).
• Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A5; Eifelian.
• Saudi Arabia: Borehole JNDL-1 and well HWYH-956; Jauf and Jubah Formation; A3b-A4; ?late Emsian-Eifelian.
• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.

Dibolisporites pilatus Breuer et al., 2007c

Pl. 53, figs 1-8

2007 *Dibolisporites pilatus* Breuer et al., p. 50, Pl. 6, figs 10-13.

Description: Trilete spores with subtriangular to subcircular amb. Laesurae distinct, straight to slightly sinuous and accompanied by labra up to 4 µm in overall width. Exine 3-6.5 µm thick equatorially. Contact faces laevigate. Distal surface sculptured with pila or other constricted parallel-sided ornaments which always possess a rounded top. The elements are commonly 2-4 µm wide at base and 4-7 µm high, rarely 10 µm high. The ornament size is very variable on the same specimen; short and tall elements are irregularly distributed.

Dimensions: 54 (68) 79 µm, 29 specimens measured.

Remark: This taxon is not attributed to the genus *Raistrickia* Schopf et al. emend. Potonié & Kremp, 1954 because this latter includes forms sculptured with rather abruptly blunted elements.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.

Dibolisporites turriculatus Balme, 1988

Pl. 54, figs 1-6, Pl. 55, figs 1, 2

1962 *Apiculatisporis* sp., Balme, p. 4, Pl. 1, fig. 14.
1975 *Dibolisporites* sp., Grey, fig. 61h.
1988 *Dibolisporites turriculatus* Balme, p. 128, Pl. 5, figs 10-14.
1992 *Dibolisporites* sp. cf. *D. turriculatus* Balme; Grey, Pl. 14, figs. 5, 6.

Description: Trilete spores with circular to subcircular amb. Laesura straight, simple or accompanied by labra, up to 3 µm in overall width, length 2/3 to 9/10 the spore radius. Curvaturae often visible. Exine 1.5-4 µm thick equatorially. Proximo-equatorial regions sculptured with scattered biform elements 1-3.5 µm high, 0.5-2 µm wide at base, 1-6 µm apart. Biform elements, subcircular in plan view, consisting of a tapering conical stem, surmounted by an expanded tip less than 1 µm in diameter. Contact areas laevigate or scabrate.

Dimensions: 63 (82) 114 µm, 20 specimens measured.

Remark: Balme (1988) described some specimens showing laesurae set in a proximal slightly thinner concavo-triangular area but this character is not recognized in the population studied here.

Comparisons: *Dibolisporites eifeliensis* (Lanninger) McGregor, 1973 is smaller. Although *Dibolisporites* sp. 1, described herein, is smaller and has more massive sculptural elements, extreme forms characterized by thinner elements have the same sculpture than *Dibolisporites turriculatus* Balme, 1988.

Stratigraphic and palaeogeographic occurrence:
- Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1962, 1988). Adavale Basin; Log Creek Formation and Lissoy Sandstone; *devonicus-naumovii* Assemblage Zone; early Eifelian-early Givetian (Hashemi & Playford, 2005).
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.

Dibolisporites uncatus (Naumova) McGregor & Camfield, 1982

Pl. 55, figs 3-7

1953 *Acanthotriletes uncatus* Naumova, p. 26, 28, Pl. 1, figs 23, 24, Pl. 5, fig. 36.
1960 *Verrucosisporites variabilis* McGregor, p. 30, Pl. 11, fig. 15.
1964 *Lophotriletes uncatus* (Naumova) Vigran, p. 13, Pl. 1, figs 3, 4.
1964 Unnamed; Regali, fig. 2, n° 6.
1965 *Verrucosisporites* cf. *uncatus* (Naumova) Richardson, p. 572, Pl. 89, fig. 13.
1967 *Raistrickia* sp.; Scott & Doher, fig. 3m.
1971 *Dibolisporites variabilis* (McGregor) Smith, p. 83.
1982 *Dibolisporites uncatus* (Naumova) McGregor & Camfield, p. 38, Pl. 8, figs 5, 6, 11, text-fig. 55.

Description: Trilete spores with subcircular amb. Laesura straight, simple, length 1/2-9/10 the spore radius. Exine 1.5-4.5 µm thick. Proximo-equatorial and distal regions sculptured with a mixture of grana, coni, spinae with blunt, pointed, or widened tips, and verrucae. Sculptural elements up to 9 µm high, 0.5-9 µm (commonly 1-4.5 µm) wide at base, mostly longer than wider, subcircular or irregular in plan view. Sculptural elements may be adjoined at base but mostly discrete and up to 8 µm apart. Most specimens carry more spinae than verrucae and coni. Contact areas laevigate or with sculpture like that of distal face but greatly reduced in size.

Dimensions: 30 (52) 68 µm, 13 specimens measured.

Remarks: *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982 could perhaps be placed in *Verrucosiporites* Ibrahim emend. Smith & Butterworth with equal justification but *Dibolisporites* Richardson, 1965 is preferred as it is mostly sculptured with spinae and coni. This taxon belongs to the *Verrucosisporites scurrus* Morphon (Tab. 1, p. 185) defined by Playford & McGregor (1992). Indeed specimens assigned to this species belong to a more or less intergrading series from those with predominantly conate and small verrucose sculpture (*Dibolisporites farraginis*) to those with large verrucate sculptural elements, and thus conform rather closely to the definition of *Verrucosisporites scurrus*.

Comparisons: However extreme forms of *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 intergrade with *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982, *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 has slightly larger, more closely spaced sculptural elements, a greater proportion of them flat-topped. *Verrucosiporites premnus* Richardson, 1965 has much larger, mostly flat-topped, non biform verrucae and bacula. *Dibolisporites farraginis* McGregor & Camfield, 1982 has smaller sculptural elements but intergrades with *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982 within the *Dibolisporites farraginis* Morphon. *Convolutispora crassata*? (Naumova) McGregor & Camfield, 1982 has larger, commonly more closely crowded sculptural elements fused into ridges.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to BJ Oppel Zone; Givetian-early Frasnian (Loboziak et al., 1988).
• France: Boulonnais; Blacourt, Beaulieu and Ferques Formations; late Givetian-early Frasnian; TLa-BM Oppel Zones (Brice et al., 1979; Loboziak & Streel, 1980, 1988).
• Canada: Arctic Archipelago, Melville Island; Cape De Bray, Weatherall and Hecla Bay Formations; late Eifelian-early Givetian (McGregor & Camfield, 1982).
• Germany: Eifel, Hillesheim Syncline; Freilingen, Ahbach Formation; AD-Ref-Lem Interval Zones; latest Eifelian (Loboziak et al., 1990).
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A5-A7; Eifelian-Givetian.
• Norway: Spitsbergen; Upper Svalbardia Sandstone; Frasnian (Vigran, 1964).
• Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A6-A8; Givetian-?early Frasnian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A8; ?late Emsian-?early Frasnian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Eday Group; Givetian (Richardson, 1965).

***Dibolisporites* sp. 1**

Pl. 55, figs 8-10, Pl. 56, figs 1-12

1988 *Dibolisporites eifeliensis* (Lanninger) McGregor; Ravn & Benson, Pl. 3, figs 16-23.

Description: Trilete spores with circular to subcircular amb. Laesura straight, simple or accompanied by labra, up to 3 µm in overall width, length 3/5 to 9/10 the spore radius. Curvaturae often visible or perceptible. Exine 1.5-3 µm thick equatorially. Proximo-equatorial regions sculptured with scattered biform elements, tubercules, bacula 1.5-4.5 µm high, 1-3.5 µm wide at base, 1-5 µm apart. Biform elements, subcircular in plan view, consisting of a tapering conical stem, surmounted by an expanded tip less than 2 µm in diameter. Contact areas laevigate, scabrate or granulate.

Dimensions: 43 (56) 69 µm, 24 specimens measured.

Comparisons: Ravn & Benson (1988) have identified figured specimens as *Dibolisporites eifeliensis* (Lanninger) McGregor, 1973. Although no description of the latter is present, they have too coarse sculptural elements for *Dibolisporites eifeliensis* (Lanninger) McGregor, 1973. On the contrary, they have the same sculpture as *Dibolisporites* sp. 1 described here. *Dibolisporites quebecensis* has smaller tubercules and bacula. Sculptural elements of *Dibolisporites eifeliensis* (Lanninger) McGregor, 1973 have less or no expansion at the tip.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A5-A7; Eifelian-Givetian.
• Saudi Arabia: Boreholes JNDL-1 and S-462; Jubah Formation; A3b-A5; ?late Emsian-Eifelian.
• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.
• U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

Dibolisporites sp. 2

Pl. 57, figs 1-3

Description: Trilete spores with subcircular to subcircular amb. Laesura straight, simple, length about 3/4 the spore radius. Curvaturae often visible or perceptible. Exine 1-2 µm thick equatorially. Proximo-equatorial regions sculptured with scattered spinae 1.5-3.5 µm high, 1-2 µm wide at base. Sculptural elements subcircular in plan view and 1-3 µm apart. Contact areas granulate.

Dimensions: 23 (28) 33 µm, 3 specimens measured.

Comparison: *Dibolisporites eifeliensis* (Lanninger) McGregor, 1973 is larger with no acute-tipped elements.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Borehole BAQA-2; Jauf Formation; A2; ?late Pragian-earliest Emsian.

Dibolisporites sp. 3

Pl. 57, figs 4-6

Description: Trilete spores with subcircular to subtriangular amb. Laesura straight, simple length 2/3 to 3/4 the spore radius. Exine 1-2 µm thick equatorially. Proximo-equatorial regions sculptured with a mixture of densely distributed parallel-sided elements, tubercules, bacula, spinae, 0.5-3 µm high, 0.5-1 µm wide at base. Sculptural elements, subcircular to polygonal in plan view and generally about 0.5 µm apart. Different types of ornament may occur on a single specimen. Contact areas granulate.

Dimensions: 38 (45) 50 µm, 3 specimens measured.

Comparison: *Dibolisporites echinaceus* (Eisenack) Richardson, 1965 has a larger amb and laevigate or infragranular contact areas.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formtion; A2; ?late Pragian-earliest Emsian.

Dibolisporites sp. 4

Pl. 57, figs 7, 8

Description: Trilete spores with circular to subcircular amb. Laesura straight, simple, length around 4/5 the spore radius. Exine 1-2 µm thick equatorially. Proximo-equatorial regions sculptured with irregularly scattered spinae and coni, up to 2 µm high, 0.5-1 µm wide at base. Sculptural elements, subcircular in plan view and 0.5-6 µm apart. Contact areas laevigate to infragranulate.

Dimensions: 43 (44) 45 µm, 2 specimens measured.

Comparison: *Cymbosporites rarispinosus* Steemans, 1989 is patinate and sculptured with larger spinae.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Borehole BAQA-2; Jauf Formation; A1-A2; late Pragian-?earliest Emsian.

Dibolisporites sp. 5

Pl. 57, figs 9, 10

Description: Trilete spores with circular to subcircular amb. Laesura straight, simple, extending to, or almost to, the equator. Exine 1-2 µm thick equatorially. Proximo-equatorial regions sculptured with irregularly scattered spinae and coni, 1.5 to 3.5 µm high, 1-3 µm wide at base. Sculptural elements, subcircular in plan view and 0.5-10 µm apart. Contact areas laevigate.

Dimensions: 32 (38) 44 µm, 2 specimens measured.

Comparison: *Cymbosporites rarispinosus* Steemans, 1989 is patinate and sculptured with spinae more flared at the base and showing a more flexuous appearance.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin I Formation; A4-A5; Eifelian.

Genus *Dictyotriletes* Naumova, 1939 ex Ishchenko, 1952

Type species: *Dictyotriletes bireticulatus* (Ibrahim) Potonié & Kremp, 1955.

Description: Trilete spores, characterized by a reticulate equatorial and distal face. Reticulum is perfectly closed.

Dictyotriletes biornatus Breuer et al., 2007c

Pl. 58, figs 1-15

2007c *Dictyotriletes biornatus* Breuer, p. 50, Pl. 7, figs 1-9.

Description: Trilete spores with subcircular to triangular amb. Laesurae rarely visible. Exine 1-3 µm thick and thinner proximally, laevigate. Proximo-equatorial and distal regions are reticulate. Muri of reticulum formed by orientated discrete rows of grana (1-2 µm wide and high) that are commonly slightly merged at the base. Polygonal lumina of reticulum 4-9 µm in greatest diameter, about 30 to 40 in total number .

Dimensions: 47 (58) 72 µm, 55 specimens measured.

Comparisons: *Dictyotriletes* sp. 1 show a further merger of several grana so as to form solid muri. *Cymbosporites* sp. 3 have no real lumina but rather pseudo-lumina with some grana occurring inside. All these forms are related and belong to the *Dictyotriletes biornatus* Morphon (Table 1; see discussion in *Cymbosporites* sp. 1).

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4 and well UTMN-1830; Jauf Formation; A2-A3a; ?late Pragian-Emsian.

***Dictyotriletes emsiensis* (Allen) McGregor, 1973**

Pl. 59, figs 1-7

1965 *Reticulatisporites emsiensis* Allen, p. 705, Pl. 97, figs 9-11.
? 1967 *?Dictyotriletes*; Richardson, Pl. 4, fig. c.
non 1968 *Reticulatisporites emsiensis* Allen; Lanninger, p. 131, Pl. 23, fig. 4.
1973 *Dictyotriletes emsisensis* (Allen) McGregor, p. 42, Pl. 5, fig. 15.
1976 *Dictyotriletes* cf. *D. emsisensis* (Allen) McGregor; McGregor & Camfield, p. 21, Pl. 3, figs 5, 6.
1979 *Dictyotriletes* sp. A; D'Erceville, p. 94, Pl. 3, fig. 6.
1984 *Dictyotriletes* aff. *emsiensis* (Allen) McGregor, p. 37, Pl. 6, fig. 5.
1984 *Dictyotriletes subgranifer* McGregor, p. 37, Pl. 6, figs 4, 6.
1984 cf. *Dictyotriletes subgranifer* McGregor, McGregor, p. 27, Pl. 2, fig. 2, Pl. 5, fig. 27.
1984 *Dictyotriletes* sp. 1 in McGregor, p. 27, Pl. 2, fig. 5, Pl. 6, fig. 6.
1989 *Dictyotriletes granulatus* Steemans, p. 133, Pl. 36, figs 3-10.
1995 *Dictyotriletes subgranifer* McGregor; Dino & Rodrigues, Pl. 2, fig. 26.
1995 *Dictyotriletes* sp. 1; Dino & Rodrigues, Pl. 2, fig. 27.
1995 *Dictyotriletes* sp. 2; Dino & Rodrigues, Pl. 2, fig. 29.
2005 *Dictyotriletes emsiensis* Morphon; Rubinstein et al., Pl. 3, figs 8, 10, 12, 13.

Description: Trilete spores with subcircular to subtriangular amb. Proximal face low-pyramidal, distal face approaching hemispherical. Laesurae commonly not visible. Exine 1.5-3 µm thick equatorially. Exine proximally thinner, laevigate, scabrate. Proximo-equatorial and distal regions reticulate. Muri of reticulum varied in thickness from about 1 µm to as much as 6 µm in basal width between junctions, usually wider at muri junctions. Muri 2-5 µm high; on some specimens there may be stout papillae or spines up to 4 µm high at the muri junctions. Lumina diameters vary from 6 µm to 20 µm, and the number of lumina per specimen varies from about 12 to 32 complete lumina distally and 10 to 18 equatorially. Muri taper upwards. On some specimens the muri merge into the floors of the lumina with no sharp boundary, but on others they form distinct lines where they emanate from the exine.

Dimensions: 44 (64) 80 µm, 21 specimens measured.

Remark: The *Dictyotriletes emsiensis* Morphon defined by Rubinstein et al. (2005) includes the species *Dictyotriletes emsiensis* (Allen) McGregor, 1973, *Dictyotriletes granulatus* Steemans, 1989, some specimens incorrectly attributed to *Dictyotriletes subgranifer* McGregor, 1973, and some specimens in open nomenclature listed above. These species share very similar morphological features. They are characterized by a proximo-equatorial reticulum, with robust muri that are commonly widened and bear papillae or spinae at their junctions. Muri taper upward but are never serrated along the upper edge. Lumina diameters are greatly variable. Proximal face are laevigate to granulate. *Dictyotriletes granulatus* Steemans, 1989 is closely comparable with *Dictyotriletes emsiensis* (Allen) McGregor, 1973 but is smaller and has lower muri. The species in open nomenclature in the list of synonymy could represent intermediate forms between the species cited above (Rubinstein et al., 2005).

Comparisons: The undescribed spore referred as ?*Dictyotriletes* in Richardson (1967) could resemble *Dictyotriletes emsiensis* (Allen) McGregor. *Dictyotriletes* cf. *bireticulatus* (Ibrahim) Potonié & Kremp, 1955 in Streel (1967) is smaller and has lower muri, smaller lumina 3 to 10 µm in diameter, and an infrareticulate exine. *Dictyotriletes nigratus* Naumova, 1953 may be similar to this taxon, but lack of detail in the description makes close comparison impossible. *Dictyotriletes subgranifer* McGregor, 1973 has narrower, lower muri that are serrated along the upper edge, and not widened or papillate at the junctions. In addition the lumina tend to be smaller in diameter in *Dictyotriletes subgranifer* McGregor, 1973. *Dictyotriletes* sp. 1 described below has lower muri.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin, borehole TRN 3; Hassi-Tabankort Formation; Pragian (Boumendjel et al., 1988).
- Argentina: San Juan Precodillera, Cerro del Fuerte Section; Talacasto Formation; Emsian (Le Hérissé et al., 1996). Precordillera of Mendoza; Villavicencio Formation; Ems Interval Zone; late Pragian-early Emsian (Rubinstein & Steemans, 2007).
- Belgium: Dinant, Neufchâteau-Eifel, Verviers Synclinoriums and Theux Window; E-Su Interval Zones; ?late Lochkovian-late Pragian (Steemans, 1989).
- Bolivia: Cordillera Oriental, Laurani section; Santa Rosa, Icla and Huamampampa Formations; Dowtonian-Eifelian (McGregor, 1984).
- Brazil: Amazon Basin; Maecuru and Ererê Formations; Ems-GS Interval Zones; late Lochkovian-early Eifelian (Melo & Loboziak, 2003). Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
- Canada: Quebec, Gaspé Peninsula; York River and Battery Point Formations; Emsian (McGregor, 1973). Ontario, Moose River Basin; Kenogami River and Stooping River Formations; *caperatus-emsiensis* to *annulatus-lindlarensis* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).
- China: Yunnan; Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
- France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).
- Germany: Siegerland; E Interval Zone-AB Oppel Zone; ?late Lochkovian-Emsian (Steemans, 1989).
- Libya: Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
- Morocco: Doukkala and Essaouira Basins; Palynozone DI1-DI2; late Pragian-Emsian (Rahmani-Antari & Lachkar, 2001).
- Norway: Spitsbergen; Reuterskiøldfjellet Sandstone and Lower Mimer Valley Series; Emsian (Allen, 1965).
- Saudi Arabia: Well DMMM-45; Tawil Formation; Pa Interval Zone, Pragian (Steemans, 1995). Boreholes BAQA-1, 2, JNDL-3, 4 and wells FWRH-1, HWYH-956, KHRM-2, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-Emsian.
- Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin III Formations; A3b-A4; ?late Emsian-Eifelian, the isolated occurrence of specimen in the Givetian part of the Awaynat Wanin III Formation is probably due to reworking.

Dictyotriletes favosus **McGregor & Camfield, 1976**

Pl. 59, figs 8-16

? 1973 *Dictyotriletes* sp.; McGregor, p. 44, Pl. 6, figs 1-2.
1976 *Dictyotriletes favosus* McGregor & Camfield, p. 21, Pl. 2, figs 5, 6.
1989 *Chelinospora favosa* (McGregor & Camfield) Steemans, p. 117, Pl. 29, figs 1-3.
non 2005 *Chelinospora favosa* (McGregor & Camfield) Steemans; Rubinstein et al., Pl. 2, fig. 4.

Description: Trilete spores with subcircular to subtriangular amb. Distal hemisphere rounded, proximal hemisphere pyramidal or flattened. Laesurae straight, accompanied by folds up to 2.5 µm wide when proximal face is not missing, length about 7/10 the spore radius. Exine 2-6 µm thick. Proximal surface slightly to markedly thinner than distal. Contact areas laevigate. Proximo-equatorial and distal regions reticulate. Lumina polygonal to irregular, vary in size and shape, greatest diameter commonly 1-4 µm. Muri up to 1.5 µm high, up to 1 µm wide, slightly thicker and higher at junctions.

Dimensions: 36 (43) 52 µm, 21 specimens measured.

Remark: The Saudi population of *Dictyotriletes favosus* McGregor & Camfield, 1976 is smaller in size than that from Canada describe by McGregor & Camfield (1976).

Comparisons: Synonymy with *Dictyotriletes* sp. of McGregor (1973) is uncertain because it has slightly more robust muri with more pronounced elongations at their junctions.

Stratigraphic and palaeogeographic occurrence:
- Brazil: Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005).
- Belgium: Dinant, Verviers Synclinoriums and Theux Window; Siα-E Interval Zones; late Lochkovian-?earliest Pragian (Steemans, 1989).
- Canada: Ontario, Moose River Basin; Kenogami River and Stooping River Formations; *mircrornatus-proteus* to *caperatus-emsiensis* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).
- France: Armorican Massif, la Haye-du-Puits Syncline, Saint-Germain-sur-Ay Outcrop; Mα Interval Zone; Lochkovian (Steemans, 1989). Artois, Liévin borehole ; Siα Interval Zone; late Lochkovian (Steemans, 1989).
- Germany: Siegerland; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
- Libya: Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
- Saudi Arabia: Well DMMM-45; Tawil Formation; Pa Interval Zone; Pragian (Steemans, 1995). Boreholes JNDL-3, 4 and wells KHRM-2, UTMN-1830; Jauf Formation; A2-A3a; ?late Pragian-Emsian.

Dictyotriletes ?gorgoneus Cramer, 1966a in McGregor (1973)

Pl. 60, figs 1-3

1954 Unnamed; Radforth & McGregor, Pl. 2, fig.61.
1965 *Reticulatisporites* sp. cf. *Dictyotriletes minor* Naumova; Allen, p. 706, Pl. 97, figs 12, 13.
1966 *Reticulatisporites* sp. cf. *Dictyotriletes minor* Naumova in Allen; McGregor & Owens, Pl. 3, fig. 18.
? 1966a *Dictyotriletes gorgoneus* Cramer; p. 265, Pl. 3, figs 69, 72.
? 1966 *Dictyotriletes minor* Naumova var. *nigritellus* Nadler, Pl. 1, fig. 8.
1967 *Dictyotriletes* sp.; McGregor, Pl. 1, fig. 4.
1973 *Dictyotriletes ?gorgoneus* Cramer; McGregor, p. 43, Pl. 5, figs 12, 17.
1979 *Dictyotriletes ?gorgoneus* Cramer; Lessuise et al., p. 337, Pl. 5, figs 16, 17.

Description: Trilete spores with subcircular amb. Laesurae straight and simple. Exine about 1 µm thick. Contact areas laevigate. Equatorial and distal regions reticulate. Lumina of reticulum, irregular in plan view, 1.5 to 7 µm in greatest diameter. Muri generally about 0.5 µm high and wide at base.

Dimensions: 26 (31) 35 µm, 4 specimens measured.

Remark: In McGregor (1973), assignement to *Dictyotriletes gorgoneus* Cramer, 1966a is questioned because Cramer did not observe a trilete mark on this species.

Comparison: *Reticulatisporites* sp. cf. *Dictyotriletes minor* Naumova, 1953 in Allen (1965) is considered here as similar to *Dictyotriletes* ?*gorgoneus* Cramer, 1966a in McGregor, 1973. Allen (1965) mentioned the higher muri of *Dictyotriletes minor* Naumova, 1953 but expressed some doubt that this feature is of sufficient importance to distinguish his specimens from those assigned by Naumova to *Dictyotriletes minor*. However, *Dictyotriletes minor* also has wider muri than *Dictyotriletes* ?*gorgoneus* Cramer, 1966a in McGregor, 1973.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant Synclinorium; late Emsian (Lessuise et al., 1979). Dinant, Verviers Synclinoriums and Theux Window; G-Su Interval Zones; late Lochkovian-late Pragian (Steemans, 1989).
• Canada: Quebec, Gaspé Peninsula; York River and Battery Point Formations; Emsian (McGregor & Owens, 1966; McGregor, 1973).
• Germany: Siegerland; Po Interval Zone-AB Oppel Zone; early Pragian-Emsian (Steemans, 1989).
• Norway: Spitsbergen; Reuterskiøldfjellet Sandstone and Mimer Valley Series; Emsian-Givetian (Allen, 1965).
• Saudi Arabia: Boreholes BAQA-1, 2 and well KHRM-2; Jauf Formation; A2; ?late Pragian-Emsian.

Dictyotriletes subgranifer **McGregor, 1973**

Pl. 60, figs 4-13

1956 Unnamed; Radforth & McGregor, Pl. 2, fig. 8.
1966 cf. *Reticulatisporites emsiensis* Allen; McGregor & Owens, Pl. 4, fig. 3.
? 1967 *Dictyotriletes*; Richardson, Pl. 4, fig. c.
? 1967 *Dictyotriletes minor* Naumova; Beju, Pl. 1, fig. 15.
1968 ?*Dictyotriletes*, cf. *Reticulatisporites emsiensis* Allen; Jardiné & Yapaudjian, Pl. 1, figs 22, 24.
? 1968 *Reticulatisporites emsiensis* Allen; Lanninger, p. 131, Pl. 23, figs 4a, 4b.
1970 *Reticulatisporites* ?*emsiensis* Allen; McGregor, Pl. 31, fig. 4.
1973 *Dictyotriletes subgranifer* McGregor, p. 43, Pl. 5, figs 16, 18-20.

Description: Trilete spores with subcircular to broadly triangular amb. Laesurae straight, simple or accompanied by labra up to 3 µm in overall width and extending to the equator. Exine 2-3 µm thick equatorially. Contact areas granulate, grana less than 1 µm wide and high, and up to about 1 µm apart. Distal surface reticulate. Muri 0.5-1.5 µm wide at base, 1.5-3.5 µm high, unevenly jagged along the upper edge. Lumina irregular in plan view, 3-15 µm in diameter, various in size and shape on a same specimen, 12-26 situated around the equator.

Dimensions: 34 (53) 75 µm, 14 specimens measured.

Comparison: *Dictyotriletes emsiensis* (Allen) McGregor, 1973 has more robust muri that are commonly widened at the junctions, and not serrated along the upper edge.

Stratigraphic and palaeogeographic occurrence:
- Belgium: Dinant Synclinorium; Su Interval Zone-AB Oppel Zone; late Pragian-Emsian (Steemans, 1989).
- Brazil: Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River and Sextant Formations; *caperatus-emsiensis* to *annulatus-lindlarensis* Provisional Assemblage Zone; Emsian (McGregor & Camfield, 1976).
- China: Yunnan; Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
- France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).
- Germany: Siegerland; Su Interval Zone-AB Oppel Zone; late Pragian-Emsian (Steemans, 1989).
- Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A3a; Emsian, the isolated occurrence of specimens in the youngest part of the section may be due to reworking.
- Luxembourg: Oesling region; FD-AP Oppel Zones; middle-late Emsian (Steemans et al., 2000).
- Morocco: Doukkala Basin; Palynozone DI1; late Pragian (Rahmani-Antari & Lachkar, 2001).
- Poland: Random-Lublin area; Borehole Terebin IG 5; Zwoleń Formation; PoW Oppel Zone; Pragian-?basal Emsian. (Turnau et al., 2005).
- Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-3, 4; Jauf Formation; A1-A3; late Pragian-Emsian.
- Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A2-A3b; ?late Pragian-Emsian, the isolated occurrence of specimens in the youngest part of the section are probably due to reworking.
- United Kingdom: Scotland, Rhynie outlier; White Sandstones, Lower Shales, Rhynie Chert, Upper Shales, and Windyfield Sandstones and Shales and Chert Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).
- U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

***Dictyotriletes* sp. 1**

Pl. 60, figs 14-20

2007a *Dictyotriletes* sp. 1; Breuer et al., fig. 1-3e.
2007b Unnamed spore; Breuer et al., fig. 1-5.

Description: Trilete spores with subcircular to subtriangular amb. Exine 1-3 µm thick equatorially. Exine thinner proximally, laevigate. Proximo-equatorial and distal regions reticulate. Muri of reticulum constituted by discontinuous or irregular elongated elements, 0.5-2 µm high and wide. The elongated elements appear generally to be the result of the merger of several discrete elements. In addition, some discrete elements (grana) may be present in low numbers lined up on the reticulum. Sculptural elements vary in thickness and shape. Polygonal lumina of reticulum 4-9 µm in greatest diameter, about 30 to 40 in number.

Dimensions: 40 (53) 67 µm, 27 specimens measured.

Remark: *Dictyotriletes* sp. 1 represents the end-member of a lineage comprising several form-species (see discussion in *Cymbosporites* sp. 1).

Comparisons: *Dictyotriletes biornatus* Breuer et al., 2007 is considered as sculptured with muri only formed by discrete elements, however they are slightly merged at base. *Dictyotriletes emsiensis* (Allen) McGregor, 1973 has more robust, continuous and regular muri.

Stratigraphic and palaeogeographic occurrence:

• Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A2; ?late Pragian-Emsian.

***Dictyotriletes* sp. 2**

Pl. 61, figs 1-9

? 1966 *Dictyotriletes* sp.; McGregor & Owens, Pl. 4, figs 1, 2.
? 1973 *Dictyotriletes* sp.; McGregor, p. 44, Pl. 6 figs 1, 2.
? 1992 *Dictyotriletes australis*? de Jersey; McGregor & Playford, Pl. 7, figs 15, 16.

Description: Trilete spores with subcircular amb. Laesurae straight and simple, length 3/5 to 4/5 the spore radius. Exine 1-4 µm thick equatorially, sexine layer locally detached on some specimens. Contact areas laevigate or infragranular. Proximo-equatorial and distal regions reticulate. Lumina of reticulum, subcircular to polygonal in plan view, 2 to 8 µm (rarely up to 12 µm) in greatest diameter. Muri low, less than 1.5 µm wide at base, wider at junctions. Bacula with flared base at the muri junctions, 0.5-3.5 µm high, 0.5-2 wide at base. The tops of elements are flat or slightly concave, with bifurcate shape.

Dimensions: 46 (59) 80 µm, 24 specimens measured.

Comparison: Some extreme specimens of *Dictyotriletes* sp. 2 may have a foveolate appearance and somewhat resemble *Brochotriletes bellatulus* Steemans, 1989 but they are distinguished from it by the tops of sculptural elements commononly being bifurcate. *Dictyotriletes* sp. figured in McGregor & Owens (1966) and McGregor (1973) resemble the specimens described here but it has rounded and has smaller elongations at the muri junctions. McGregor & Playford (1992) figure a specimen resembling *Dictyotriletes* sp. 2 (except for the proximal dark triangular area) without giving a description. *Dictyotriletes australis* de Jersey, 1966 is smaller and devoid of discrete ornaments at muri junctions.

Stratigraphic and palaeogeographic occurrence:

• Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; ?A5-A7; ?Eifelian-Givetian, some specimens may be caved in older strata.

***Dictyotriletes* sp. 3**

Pl. 61, figs 10-13, Pl. 62, figs 1, 2

Description: Trilete spores with subcircular amb. Laesurae straight, simple, length 7/10 to 9/10 the spore radius. Exine 1-2 µm thick equatorially. Contact areas infragranulate. Distal surface reticulate. Muri 0.5-1 µm high and wide at base, unevenly jagged along the upper edge. Lumina irregular in plan view, 1.5-6 µm in diameter, various in size and shape on a same specimen, about 30-50 situated at equator.

Dimensions: 39 (49) 55 µm, 6 specimens measured.

Comparison: *Dictyotriletes subgranifer* McGregor, 1973 has larger lumina and higher muri. The number of lumina is also smaller.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes JNDL-4; Jauf Formation; A2; ?late Pragian-Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2-A4; ?late Pragian-Eifelian, the specimens of A2 are probably reworked in younger strata.

***Dictyotriletes* sp. 4**

Pl. 62, figs 3, 4

Description: Trilete patinate spores with subcircular to subtriangular amb. Laesurae straight and simple, extending to the inner edge of the patina. Exine 1-4 µm equatorially thick. Contact areas laevigate. Patina reticulate. Lumina of reticulum, polygonal in plan view, 2 to 6 µm in greatest diameter. Muri low, less than 1 µm wide at base, Bacula with bifurcate tips at the muri junctions, 1-3 µm high, 0.5-2 wide at base.

Dimensions: 44 (49) 55 µm, 2 specimens measured.

Comparison: The reticulum of described specimens looks like very much that of *Dictyotriletes* sp. 2 but ornaments at muri junctions of the latter are less clearly bifurcate. In addition it is not patinate. We have thus separated these specimens from *Dictyotriletes* sp. 2. However, other new specimens may prove the contrary in further investigations.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Borehole BAQA-1; Jauf Formation; A2; ?late Pragian-Emsian.

Genus *Elenisporis* Arkhangelskaya, 1985

Type species: *Elenisporis biformis* (Arkhangelskaya) Jansonius & Hills, 1987.

Description: Trilete spores with circular to subtriangular amb. Laesurae simple or accompanied by labra. Exine two-layered. Layers tightly appressed on distal side, without any space between them. Along equator a rather narrow cingulum with a distinctly if finely denticulate outer edge. Sexine thick, on distal side unscuptured or may have various small ornament, consisting of grana, coni, tubercules and other elements. The proximal face is covered by ribs or rolls, sometimes consisting of rows of tubercules and not always clearly expressed. Their orientation is such that at one end they reach the edge of the cingulum, while the other end abuts the laesurae. Nexine is unsculptured.

Comparison: This genus differs from *Emphanisporites* McGregor, 1961 in the equatorial cingulum, the less clearly delimited rolls on the proximal face and their orientation, as they are not radiating out from the proximal pole, but rather abut the laesurae.

Elenisporis **sp. 1**

Pl. 62, figs 7-9, Pl. 63, figs 1-4

Description: Cingulate trilete spores with subcircular amb. Exine two-layered; layers tightly appressed but local detachments sometimes occur equatorially. Nexine 2-7 µm thick and sexine thin. Laesurae from inner layer simple and straight but characterized by triradiate sinuous fold-like labra from the outer layer, about 2-7 µm high in total width, length about 3/4 the spore radius. Curvaturae join the laesurae and are suggested by a narrow crassitude, 2-4 µm thick along the curvaturae, the outer edge of which can be denticulate. Proximal surface supporting radial sculpture of somewhat tortuous rolls, of uneven width but approximately uniform to their very end, 1-2.5 µm (rarely up to 4 µm) wide and more or less parallel to each other from the crassitude to laesurae. As they are closely spaced, they are often barely distinguishable. Distal surface sculptured with various elements such as coni, spines, bacula or rounded verrucae, 1-6 µm high and up to 1-2 µm wide at their base, commonly 1-3 µm apart.

Dimensions: 65 (81) 92 µm, 17 specimens measured.

Comparisons: *Elenisporis biformis* (Arhangelskaya) Jansonius & Hills, 1987 shows wider rolls. Moreover, it is finely granulate and is sometimes sculptured distally with small, short elements. *Elenisporis* sp. 2 has also wider rolls and is more poorly sculptured distally.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Borehole S-462; Jubah Formation; A5; Eifelian.
- Tunisia: Borehole MG-1; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A8; Eifelian-Givetian.

Elenisporis **sp. 2**

Pl. 63, figs 5, 6

Description: Cingulate trilete spores with subcircular to subtriangular amb. Laesurae, straight to sinuous, characterized by triradiate fold-like labra about 4-9 µm high in total width, extending to the crassitude. Curvaturae join the Laesurae and are suggested by a narrow crassitude, 2-4 µm thick along the curvaturae. Exine 4-8 µm thick. Proximal surface supporting radial sculpture of somewhat tortuous rolls, of uneven width but approximately uniform to their very end, 2-6 µm wide and more or less paralleled from the crassitude to laesurae. Distal surface sculptured with small, sometimes barely noticeable, widely spaced spines, 0.5-3 µm high and up to 1 µm wide at their base.

Dimensions: 71 (92) 110 µm, 6 specimens measured.

Comparisons: *Elenisporis biformis* (Arkhangelskaya) Jansonius & Hills, 1987 is very close to *Elenisporis* sp. 2 but has narrow, straight laesurae and its cingulum is thicker. *Elenisporis* sp. 1 has thinner rolls and is sculptured distally with larger elements.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Borehole S-462; Jubah Formation; ?A7-A8; Givetian.

• Tunisia: Borehole MG-1; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A6; Eifelian-Givetian.

Genus *Emphanisporites* McGregor, 1961

Type species: *Emphanisporites rotatus* McGregor emend. McGregor, 1973.

Description: Trilete spores with subtriangular to subcircular amb. Contact areas ornamented proximally by radially disposed ridges that extend almost to the equator of the spore and are present on the contact areas.

Comparisons: *Costaspora* Staplin & Jansonius in Staplin (1960) may have ridges extending onto the distal hemisphere. According to McGregor (1973) *Radiaspora* Hoffmeister et al. in Balme (1962) is probably a junior synonym of *Emphanisporites* McGregor, 1961. However the radial ridges are on the distal surface according to the diagnosis of Hoffmeister et al. (1955) and Balme (1962).

***Emphanisporites annulatus* McGregor, 1961**

Pl. 64, figs 1-10

1956 Unnamed; Radforth & McGregor, Pl. 1, fig. 6.
1961 *Emphanisporites annulatus* McGregor, p. 3, Pl. 1, figs 5, 6.
1962 *Radiaspora* sp., Balme, p. 6, Pl. 1, fig. 13.
1963 *Emphanisporites erraticus* (Eisenack) McGregor, Chaloner, p. 103, fig. 1.
1967 *Emphanisporites* cf. *erraticus* McGregor, Daemon et al., p. 106, Pl. 1, fig. 10.

Description: Trilete spores with subcircular to broadly subtriangular amb. Laesurae straight, simple or accompanied by labra up to 6 µm in overall width, extending almost to the equator. Labra of about the same optical density (the same thickness?) as the interradial ridges. Exine 1.5-3.5 µm equatorially thick. Proximal ridges 2-5 µm wide and up to about 2 µm high at the equator, sometimes divided near the equator. A ring of exinal thickening (annulus) 2-7 µm (commonly about 4 µm) wide occurs on the distal face. The annulus radius equals 5/8 to 7/8 spore radius.

Dimensions: 41 (48) 60 µm, 15 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Alrar Formation; early Givetian (Boumendjel et al., 1988). Illizi Basin; Orsine Formation; Emsian-early Eifelian (Moreau-Benoit et al., 1992).
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1962, 1988).
• Belgium: Dinant Synclinorium; late Emsian-Eifelian (Lessuise et al., 1979). Dinant Synclinorium; middle-late Emsian (Streel, 1967). Dinant Synclinorium; AB Oppel Zone; Emsian (Steemans, 1989).
• Bolivia: Cordillera Oriental, Laurani section; Icla and Huamampampa Formations; Emsian-Eifelian (McGregor, 1984).
• Brazil: Central Parnaíba Basin; Itaim Formation; AD-pre Lem Interval Zone; Eifelian-earliest Givetian (Loboziak et al., 1992b). Amazon Basin; Maecuru and Ererê Formations; GS-LLi Oppel Zones; late Emsian-early Givetian (Melo & Loboziak, 2003).

• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-?early Eifelian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River and Sextant Formations; *annulatus-lindlarensis* Provisional Assemblage Zone; Emsian (McGregor & Camfield, 1976).
• China: Yunnan; Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
• France: Armorican Massif, Laval Syncline; Montguyon Formation; Assemblage 3; early Emsian (Le Hérissé, 1983).
• Germany: Soutwestern Eifel; Wetteldorfer and Heisdorfer Formations; Emsian (Lanninger, 1968). Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Klerfer Formation; Emsian (Schultz, 1968). Rheinland, Eifel; Nohn Formation; early Eifelian (Riegel, 1973). Siegerland; AB Oppel Zone; Emsian (Steemans, 1989).
• Libya: Cyrenaica; early or middle Emsian-late Eifelian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 3-6; Emsian-early Givetian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A6; ?late Emsian-Givetian.
• Luxembourg: Oesling region; FD-AP Oppel Zones; middle-late Emsian (Steemans et al., 2000).
• Morocco: Doukkala and Essaouira Basins; Palynozones DI2-DM1; Emsian-Eifelian (Rahmani-Antari & Lachkar, 2001).
• Poland: Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; FD?-FD Oppel Zones; upper Emsian (Turnau et al., 2005).
• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).
• Saudi Arabia: Boreholes JNDL-1, S-462 and wells ABSF-29, YBRN-1; Jauf and Jubah Formations; A3a-A7; Emsian-Givetian.
• Spain: Northwestern provinces; Naranca and Huergas Formations; Couvinian-Givetian (Cramer, 1966a). Asturias; *Gosselatia* Sandstone Formation; Eifelian-Givetian (Cramer, 1969).
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A8; Emsian-Givetian.
• U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

Emphanisporites cf. _E. biradiatus_ Steemans, 1989

Pl. 64, figs 11, 12

cf. 1989 *Emphanisporites biradiatus* Steemans, p. 136, Pl. 37, figs 11-13.

Description: Trilete spores with subcircular to broadly subtriangular amb. Laesurae straight, simple or accompanied by labra about 2 µm in overall width, extending almost to the equator. Exine 1-2 µm equatorially thick. Proximal ridges up to 1.5 µm wide at the equator, divided to form pair of ridges. Each contact area present about 4 pairs. Distance between pairs of ridges larger than two ridges of the same pair. A single ridge may occur between pairs. Distal face laevigate.

Dimensions: 37 (42) 47 µm, 2 specimens measured.

Comparisons: *Emphanisporites biradiatus* Steemans, 1989 is granulate distally and possesses 6 to 8 pairs of ridges per each contact area. *Emphanisporites rotatus* McGregor emend. McGregor, 1973 occasionally presents some pairs of ridges.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes JNDL-1, 4. Jauf and Jubah Formations; A2-A4; Emsian-Eifelian.

Emphanisporites decoratus **Allen, 1965**

Pl. 64, figs 13-17

1965 *Emphanisporites decoratus* Allen, p. 708, Pl. 97, figs 15-18.
1981 *Emphanisporites* sp. K; Steemans, p. 53, Pl. 2, fig. 3.
2006 *Emphanisporites* cf. *decoratus* Allen; Wellman, p. 186, Pl. 15, figs g-i.

Description: Trilete spores with subcircular or occasionally oval amb. Laesurae straight to slightly sinuous, simple or occasionally accompanied by labra, individually up to about 1 µm wide, length 2/3 to almost full spore radius. Exine 1-3.5 µm equatorially thick. Proximal radially disposed ridges variable in number and vary from faint to more distinct ridges up to 2 µm wide near the equator, tapering towards proximal pole. Equator and distal regions sculptured with coni and spinae, 0.5-3 µm high, 0.5-2 µm wide, 1-4 µm apart.

Dimensions: 31 (45) 59 µm, 7 specimens measured.

Comparisons: The characteristics of *Emphanisporites* cf. *decoratus* Allen, 1965 in Wellman (2006) is not in contradiction to the variability of the population presented here. *Emphanisporites neglectus* Vigran, 1964 is occasionally sculptured, but then, only with very fine granules. *Emphanisporites novellus* McGregor & Playford, 1976 and *Emphanisporites micrornatus* Richardson & Lister, 1969 var. *micrornatus* Steemans & Gerrienne, 1984 differs in finer granulate ornamentation. *Emphanisporites micrornatus* Richardson & Lister, 1969 var. *sinuosus* Steemans & Gerrienne, 1984 exhibits sinuous radial ridges.

Stratigraphic and palaeogeographic occurrence:
- Belgium: Dinant, Verviers Synclinoriums and Theux Window; Siβ-Su Interval Zones; late Lochkovian-late Pragian (Steemans, 1989).
- Canada: Ontario, Moose River Basin; Kenogami River, Stooping River and Kwataboahegan Formations; *mircrornatus-proteus* to *annulatus-lindlarensis* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).
- France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 2; Pragian and late Siegenian (Le Hérissé, 1983).
- Germany: Rheinland, Eifel; Klerfer Formation; Emsian (Schultz, 1968).
- Norway: Spitsbergen; Reuterskiøldfjellet Sandstone; Siegenian (Allen, 1965).
- Saudi Arabia: Boreholes JNDL-1, 4 and wells FWRH-1, KHRM-2, UTMN-1830; Jauf Formation; A3; Emsian-?early Eifelian.
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3b; late Emsian-?early Eifelian.
- United Kingdom: Scotland, Rhynie outlier; White Sandstones, Shales and Muddy Sandstones, Lower Shales, Rhynie Chert, Upper Shales, Windyfield Sandstones and Shales and Chert Units, and Longcroft Tuffs Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

***Emphanisporites* cf. *E. edwardsiae* Wellman, 2006**

Pl. 64, fig. 18

cf. 2006 *Emphanisporites edwardsiae* Wellman, p. 188, Pl. 16, figs a-f.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple or accompanied by labra up to 2 µm in overall width, length 3/4 to 9/10 the spore radius. Exine 2-3 µm thick equatorially. Proximal radially arranged ridges, about 0.5 µm wide, evenly distributed and straight. Each contact area present numerous ridges, between 20-30 in number. The central region of the proximal pole is laevigate but with a darker (?thickened) subtriangular to subcircular area including a paler (?thinner) subtriangular area with convex sides centred on the proximal pole. Distal face laevigate.

Dimensions: 57 µm, 1 specimens measured.

Comparisons: *Emphanisporites edwardsiae* Wellman, 2006 does not have a thin triangular area inside the apical darker area. *Retusotriletes phillipsii* Clendening et al., 1980 possesses scattered grana on the proximal face and muri are straight to sinuous. *Scylaspora rugulata* (Riegel) Breuer et al., 2007c is sculptured with fine, more or less radially oriented rugulate or subreticulate muri.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Borehole BAQA-1; Jauf Formation; A2; ?late Pragian-Emsian.

***Emphanisporites erraticus* (Eisenack) McGregor, 1961**

Pl. 65, fig. 1

1944 *Triletes erraticus* Eisenack, p. 114, Pl. 2, fig. 9.
1954 Unnamed; Radforth & McGregor, Pl. 2, fig. 59.
1956 Unnamed; Radforth & McGregor, Pl. 3, fig. 1.
1961 *Emphanisporites erraticus* (Eisenack) McGregor, p. 4, Pl. 1, figs 7-11.
1967 *Emphanisporites* cf. *erraticus* (Eisenack) McGregor, Richardson, Pl. 4, fig. A.

Description: Trilete spores with subcircular amb. Laesurae straight, accompanied by labra about 1 µm wide individually, extending almost to the equator. Exine 2.5-6 µm thick equatorially. Each contact area bears ridges that radiate from a focus about 1/3 the way from the pole to the equator. The ridges are 1.5-7 µm wide, up to 2.5 µm high at the equator, and tapering towards the focus. The ridges are separated by grooves of equal or lesser width than the ridges. A ring of exinal thickening (annulus) 6-8 µm wide occurs on the distal face enclosing a thinner polar zone about 20 µm in diameter.

Dimensions: 51 (52) 53 µm, 2 specimens measured.

Comparison: *Emphanisporites schultzii* McGregor, 1973 possesses also a proximal rosette pattern but does not have a distal annulus.

Stratigraphic and palaeogeographic occurrence:
- Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor & Owens, 1966; McGregor, 1973).

• Germany: Soutwestern Eifel; Stadtfelder, Klerfer and Wetteldorfer Formations; Emsian (Lanninger, 1968). Rheinland, Eifel; Klerfer Formation; Emsian (Schultz, 1968).
• Libya: Cyrenaica; early or middle Emsian (Paris et al., 1985).
• Poland: Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; FD Oppel Zone; upper Emsian (Turnau et al., 2005).
• Saudi Arabia: Borehole JNDL-3; Jauf Formation; A3a; Emsian.
• Spain: Northwestern provinces; Naranca and Huergas Formations; Couvinian-Givetian (Cramer, 1966a).

Emphanisporites mcgregorii Cramer, 1966a

Pl. 65, figs 2-8

1961 *Emphanisporites* sp., McGregor, Pl. 1, fig. 12.
1966a *Emphanisporites mcgregorii* Cramer, p. 263, Pl. 3, fig. 59.
1968 *Emphanisporites spinaeformis* Schultz, p. 27, Pl. 3, figs. 10, 10a.
1968 *Emphanisporites* sp. 1; Jardiné & Yapaudjian, Pl. 1, fig. 3.
non 1968 *Emphanisporites macgregori* Schultz, p. 28, Pl. 3, figs 12, 12a.
non 1968 *Emphanisporites macgregori* Schultz; Lanninger, p. 136, Pl. 23, fig. 15.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple or accompanied by labra up to 2 µm in overall width, extending almost to the equator. Exine 1-3 µm equatorially thick. Proximal ridges, up to 3.5 µm wide, aligned approximately parallel to one another, extending from the equator to the margin of laesurae forming a herringbone pattern. Distal face laevigate.

Dimensions: 36 (46) 55 µm, 12 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Orsine and Tin Meras Formations; late Emsian-middle Givetian (Moreau-Benoit et al., 1992).
• Belgium: Dinant Synclinorium and Theux Window; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
• Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Germany: Soutwestern Eifel; Klerfer and Wetteldorfer Formations; Emsian (Lanninger, 1968). Rheinland, Lindlar; Eifelian (Riegel, 1968). Siegerland; Su Interval Zone-AB Oppel Zone; late Pragian-Emsian (Steemans, 1989).
• Libya: Cyrenaica; early Eifelian-early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 2-5; Pragian-early Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A7; Eifelian-Givetian.
• Saudi Arabia: Boreholes BAQA-1, 2, JNDL-1, 3, 4, S-462 and wells ABSF-29, KHRM-2, YBRN-1; Jauf and Jubah Formations; A1-A7; late Pragian-Givetian.
• Spain: Northwestern provinces; La Vid Shales and Naranca Formation; Siegenian-Givetian (Cramer, 1966a). Asturias; *Gosselatia* Sandstone Formation; Eifelian-Givetian (Cramer, 1969).
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A8; ?late Emsian-?early Frasnian.

Emphanisporites rotatus McGregor emend. McGregor, 1973

Pl. 5, figs 8, 9, Pl. 65, figs 9-20

1973 *Emphanisporites rotatus* McGregor emend. McGregor, p. 46, Pl. 6, figs 9-13.
For an exhaustive synonymy, see McGregor (1973, p. 46, 47), Le Hérissé (1983, p. 39) and Steemans (1989, p. 142).

Description: Trilete spores with circular to subtriangular amb. Laesurae straight, simple or accompanied with low, narrow labra, up to 1 µm wide individually, extending to or almost to the equator. Laesurae commonly flanked by ridges. Exine 1.5-3.5 µm equatorially thick. Proximal radially arranged ridges, 0.5-3.5 µm wide at equator, low, tapering towards proximal pole and commonly fused to form a thick, slightly darker zone around the proximal pole. Each contact area present between 4-20 ridges. On some specimens there may be little or no merger of the ridges at the pole, and on some, the ridges may extend only part way towards the equator. Distal face laevigate.

Dimensions: 34 (44) 55 µm, 32 specimens measured.

Remark: Rare monolete specimens have been found (Pl. 5, figs 8, 9).

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Hassi-Tabankort and Alrar Formations; Pragian-early Givetian (Boumendjel et al., 1988). Illizi Basin; Orsine and Tin Meras Formations; Emsian-Frasnian (Moreau-Benoit et al., 1992).
• Antarctica: Ohio Range; Horlick Formation; early Emsian (Kemp, 1972).
• Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988). Canning Basin; middle Givetian (Grey, 1991).
• Belgium: Bolland Borehole; ?Emsian (Streel, 1967). Dinant Synclinorium; late Emsian-Eifelian (Lessuise et al., 1979). Dinant, Neufchâteau-Eifel, Verviers Synclinoriums and Theux Window; Nβ Interval Zone-AB Oppel Zone; early Lochkovian-Emsian (Steemans, 1989).
• Bolivia: Cordillera Oriental, Tarabuco and Laurani section; Tarabuco, Santa Rosa, Icla and Huamampampa Formations; Downtonian-Eifelian (McGregor, 1984).
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem Oppel Zone to Zone IV; Eifelian-Frasnian (Loboziak et al., 1988). Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Canada: Quebec, Gaspé Peninsula; York River, Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Arctic Archipelago, Melville and Baturst Islands; Bathurst, Stuart Bay, Eids, Blue Fiord, Bird Fiord, Cape De Bray, Weatherall and Hecla Bay Formations; Siegenian-Givetian (McGregor & Uyeno, 1972; McGregor & Camfield, 1982). Ontario, Moose River Basin; Stooping River, Sextant, Kwataboahegan, Moose River and Williams Island Formations; *caperatus-emsiensis* to *devonicus-orcadensis* Provisional Assemblage Zone; Emsian-Givetian (McGregor &

Camfield, 1976). Western Newfoundland; Clam Bank Formation; *Apiculiretusispora* sp. E Zone; Lochkovian (Burden et al., 2002).

• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).

• Germany: Soutwestern Eifel; Stadtfelder, Klerfer, Wetteldorfer and Heisdorfer Formations; Emsian (Lanninger, 1968). Rheinland, Eifel; Nohn Formation; early Eifelian (Riegel, 1973). Eifel, Prüm Syncline; Wiltz and Lauch Formations; Assemblages B, E; late Emsian-early Eifelian (Tiwari & Schaarschmidt, 1975). Siegerland; Nβ Interval Zone-AB Oppel Zone; early Lochkovian-Emsian (Steemans, 1989). Eifel, Hillesheim Syncline; Freilingen, Ahbach and Loogh Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).

• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone IV; Eifelian-early Givetian (Ghavidel-Syooki, 2003).

• Libya: Ghadames Basin, borehole C1-34; Acacus Formation; Downtonian (Richardson & Ioannides, 1973). Cyrenaica; early or middle Emsian-early Eifelian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 2-8; Pragian-late Frasnian (Moreau-Benoit, 1989). Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *Apiculiretusispora* Subbiozone? to *Apiculiretusispora* sp. E Biozone?; Ludlow-middle Pridoli (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A7; Emsian-Givetian.

• Luxembourg: Oesling region; Pow-AP Oppel Zones; middle Pragian-late Emsian (Steemans et al., 2000).

• Norway: Spitsbergen; Reuterskiøldfjellet Sandstone and Lower Mimer Valley Series; Siegenian-early Eifelian (Allen, 1965).

• Poland: Holy Cross Mountains; Bodzentyn Syncline; Świetomarz beds; Ex Zone; Givetian (Turnau & Racki, 1999). Random-Lublin area; Borehole Terebin IG 5; Czarnolas Formation; MN Oppel Zone; Lochkovian. Borehole Giezcezw PIG 5; Terrigenous Suite; FD?-AP Oppel Zones; upper Emsian-?basal Eifelian (Turnau et al., 2005).

• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).

• Romania: Moesian Platform, Chilia well; G Interval Zone; late Lochkovian (Steemans, 1989).

• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4, S-462 and wells ABSF-29, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830, YBRN-1; Jauf and Jubah Formations; A1-A8; late Pragian-?early Frasnian.

• Spain: Northwestern provinces; La Vid Shales and Naranca Formation; Siegenian-Givetian (Cramer, 1966a). Asturias; *Gosselatia* Sandstone Formation; Eifelian-Givetian (Cramer, 1969). Cantabrian Mountains; San Pedro Formation; Lludlovian-early Siegenian (Rodriguez, 1978b).

• Tunisia: Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A2-A8; ?late Pragian-?early Frasnian, the specimens of A2 are reworked in younger strata.

• United Kingdom: Welsh Borderland and Southern Britain; Senni Beds; Gedinnian-Siegenian (Mortimer, 1967). Shetland, Fair Isle; Observatory and Bu Ness Groups; late Givetian (Marshall & Allen, 1982). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian

(Marshall, 2000). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002). Scotland, Rhynie outlier; White Sandstones, Shales and Muddy Sandstones, Lower Shales, Rhynie Chert, Upper Shales, Windyfield Sandstones and Shales and Chert Units, and Longcroft Tuffs Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).
• U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

***Emphanisporites schultzii* McGregor, 1973**

Pl. 66, figs 1-8

1966 *Emphanisporites* sp.; McGregor & Owens, Pl. 4, fig. 10.
non 1966a *Emphanisporites mcgregorii* Cramer, p. 263, Pl. 3, fig. 59.
1967 *Emphanisporites* sp.; McGregor, Pl. 1, fig. 2.
1968 *Emphanisporites macgregori* Schultz, p. 28, Pl. 3, figs 12, 12a.
1968 *Emphanisporites pseudoerraticus* Schultz, p. 29, Pl. 3, figs 15, 15a.
1968 *Emphanisporites macgregori* Schultz; Lanninger, p. 136, Pl. 23, fig. 15.
1970 *Emphanisporites macgregori* Schultz; McGregor et al., Pl. 2, fig. 4.
1970 *Emphanisporites* sp.; McGregor, Pl. 31, fig. 2.
1973 *Emphanisporites schultzii* McGregor, p. 48, Pl. 6, fig. 14.

Description: Trilete spores, amb broadly oval to subcircular. Laesurae straight, simple or accompanied by labra about 1 µm wide individually, extending to or almost to the equator. Exine 1.5-4 µm thick equatorially. Each contact area bears ridges that radiate from a focus about 1/2 to 3/4 the way from the pole to the equator. The ridges are 0.5-4 µm wide, up to 2.5 µm high at the equator, and tapering towards the focus. Ridges separated by grooves of equal or lesser width than the ridges. Distal face laevigate.

Dimensions: 36 (52) 75 µm, 13 specimens measured.

Remark: This species was first described by Schultz (1968) as *Emphanisporites macgregori*. However, this name was rejected because it is a later homonym (orthographic variant) of *Emphanisporites mcgregorii* Cramer, 1966a.

Comparisons: According to Schultz (1968) *Emphanisporites schultzii* McGregor, 1973 differs from *Emphanisporites pseudoerraticus* Schultz, 1968 notably in the fact that the centre of the rosette pattern of each contact area is not strongly displaced towards the proximal pole. However *Emphanisporites pseudoerraticus* Schultz, 1968 is considered here as a junior synonym of *Emphanisporites schultzii* McGregor, 1973 because the centre of the rosette pattern seems relatively variable in the present studied material. *Emphanisporites erraticus* (Eisenack) McGregor, 1961 has a distal annulus.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant Synclinorium; Paβ Interval Zone-AB Oppel Zone; middle Pragian-Emsian (Steemans, 1989).
• Canada: Quebec, Gaspé Peninsula; York River and Battery Point Formations; Emsian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River; *annulatus-lindlarensis* Provisional Assemblage Zone; Emsian (McGregor & Camfield, 1976).

• Germany: Soutwestern Eifel; Klerfer and Wetteldorfer Formations; Emsian (Lanninger, 1968). Rheinland, Eifel; Klerfer Formation; Emsian (Schultz, 1968). Siegerland; Su Interval Zone-AB Oppel Zone; late Pragian-Emsian (Steemans, 1989).
• Luxembourg: Oesling region; Pow-FD Oppel Zones; late Pragian-early Emsian (Steemans et al., 2000).
• Saudi Arabia: Boreholes BAQA-1, JNDL-1, 3, 4 and wells HWYH-956, KHRM-2, UTMN-1830, YBRN-1; Jauf and Jubah Formations; A2-A3b; ?late Pragian-?early Eifelian, the isolated occurrence of the two specimens from the Jubah Formation are probably reworked.
• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; the unique specimen may be reworked in Eifelian strata.

***Emphanisporites* sp. 1**

Pl. 66, figs 9-12

Description: Trilete spores with circular to subtriangular amb. Laesurae straight, simple or accompanied with low, narrow labra, up to 1.5 µm wide individually, extending to or almost to the equator. Exine 1-3.5 µm equatorially thick. Proximal radially arranged ridges, 0.5-2.5 µm wide at equator, low, tapering towards proximal pole. Each contact area present between 8-16 ridges. Distal face laevigate and bearing fine concentric subparallel folds.

Dimensions: 40 (51) 63 µm, 9 specimens measured.

Remark: *Emphanisporites rotatus* McGregor emend. McGregor, 1973 is similar. However, the presence of the distal concentric folds of *Emphanisporites* sp. 1 occurs only on these specimens and is regarded as the principal characteristic feature of this new taxon.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Borehole JNDL-1; Jubah Formation; A3b-A4; ?late Emsian-Eifelian.

***Emphanisporites* sp. 2**

Pl. 66, figs 13-15, Pl. 67, fig. 1

? 1981 *Emphanisporites rotatus* McGregor var. B; Streel et al., Pl. 1, figs 15, 16.

Description: Trilete spores with subcircular amb. Laesurae straight, simple and extending almost to the equator. Exine laevigate or infragranular, 2-4 µm thick equatorially. Proximal radially arranged ridges, 4-13 µm wide at equator, up to 5 µm high, tapering towards proximal pole. Ridges extend from the proximal pole and over the equator, resulting in strongly undulating equator in plan view. Each contact area present between 3-5 ridges. Distal face laevigate.

Dimensions: 48 (62) 78 µm, 4 specimens measured.

Comparisons: *Emphanisporites rotatus* McGregor var. B in Streel et al. (1981) which shows muri extending over the equator and may be similar. *Emphanisporites robustus* McGregor, 1961 has ridges that extend from the proximal pole as far as, but not over, the equator.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A6; Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin I and Awaynat Wanin II Formations; A6-A8; Givetian-?early Frasnian.

Emphanisporites sp. 3

Pl. 67, figs 2-9

Description: Trilete spores with circular to subtriangular amb. Laesurae straight or slightly undulating, simple, length 3/5 to 4/5 the spore radius. Laesurae commonly flankened by ridges. Exine 2-5 µm thick equatorially. Proximal radially arranged ridges, 3-12 µm in greatest width, low, tapering towards proximal pole. Ridges extend from the proximal pole and fade inside the contact area before reaching the equator. Each contact area present almost always 3 ridges. Distal face laevigate.

Dimensions: 61 (67) 75 µm, 13 specimens measured.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Borehole S-462; A8; Givetian-?early Frasnian.
- Tunisia: Borehole MG-1; Awaynat Wanin III Formation; A8; Givetian-?early Frasnian.

Genus *Geminospora* Balme, 1962

Type species: *Geminospora lemurata* Balme, 1962.

Description: Trilete camerate spores with subcircular to subtriangular amb. Distal side hemispherical, proximal side flattened or pyramidal. Laesurae straight, strongly developed, sometimes extending to proximo-distal margin. Labra usally developed along the laesurae but this feature is not always visible. Sexine heavily thickened, particularly on distal face, intexinal development is usual but not invariable. Nexine appears as a faintly thin laevigate inner body of variable diameter inside the central cavity of the spore. Sexine ornamented on distal side with close packed grana, short cones and infrabaculae. Proximal contact faces laevigate or faintly ornamented.

Geminospora lemurata Balme emend. Playford, 1983

Pl. 5, fig. 10, Pl. 6, figs 1-6, Pl. 68, figs 1-14

1962 *Geminospora lemurata* Balme, p. 5, Pl. 1, figs 5-10.
non 1965 *Geminospora svalbardiae* (Vigran) Allen, p. 696, Pl. 94, figs 12-16.
1965 *Geminospora tuberculata* (Kedo) Allen, p. 696, Pl. 94, figs 10, 11.
1965 *Rhabdosporites parvulus* Richardson (pars), p. 588, Pl. 93, figs 5, 6.
1982 *Geminospora micromanifesta* (Naumova) McGregor & Camfield var. minor Naumova, p. 40, Pl. 8, figs 14, 15, 19-22.
1983 *Geminospora lemurata* Balme emend. Playford, p. 316, figs 1-9.

Description: Trilete camerate spores (rarely monolete or tetralete) with subtriangular amb, occasionally subcircular to oval. Laesurae straight, simple or accompanied by labra up to 4 µm in overall width, extending approximately to margin of nexine. Laesurae sometimes connected by curvatural ridges up to about 3 µm wide and which are generally coincident with the nexine diameter and obscure it. The thick sexine encompasses a proximal attached, distinct to perceptible nexine, that is detached distally and (usually to a lesser degree) equatorially and thus constitutes a more or less discrete inner body. The two layers are closely appressed or show a variable separation which is visible at the equatorial margin. Sexine 1.5-6 µm thick equatorially, both proximal and distal sexine normally appreciably thinner than equatorial sexine. Distal sexine may be slightly thicker on average than proximal sexine, but is not invariably so. In polar view, outline of nexine subtriangular usually more or less conformable with amb though apices may be acute. Nexine laevigate, less than 1 µm thick, sometimes displaying compression folds independent of sexine. Proximo-equatorial and distal regions sculptured with densely distributed, small apiculate elements such as grana, small coni, spinae or short bacula, rarely up to 1.5 µm µm high and wide at base. Sculptural elements discrete rarely as much as 2 µm apart or basally coalescent. Contact faces scabrate, as distal surface between apiculate elements.

Dimensions: 40 (53) 72 µm, 47 specimens measured.

Comparisons: Specimens of *Geminospora micromanifesta* (Naumova) McGregor & Camfield, 1982 var. *minor* Naumova, 1953 possess a spectrum of morphological variation comparable to specimens of *Geminospora lemurata* Balme, 1962 emended by Playford (1983). Then *Geminospora lemurata* 'early form' in Marshall (1996) differ from typical *Geminospora lemurata* in being both smaller (mean 55 µm), in only very rarely showing any appreciable separation between the nexine and sexine, the two layers being appressed although still distinguishable and in possessing a thicker sexine (2-7 µm) where measured at the equatorial margin. *Rhabdosporites langii* (Eisenack) Richardson, 1960 has a generally thinner sexine and a less rigid appearance. In addition, it is larger. *Geminospora svalbardiae* (Vigran) Allen, 1965 is not considered here as synonymous with *Geminospora lemurata* Balme emend. Playford, 1983 because it can be distinguished from the typical *lemurata* form. *Geminospora svalbardiae* (Vigran) Allen, 1965 has a generally thinner sexine resulting in more numerous folds. Thus its appearance is clearly less rigid.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin, borehole TRN 3; Alrar and Gazelle Inférieure Formations; early Givetian (Boumendjel et al., 1988). Illizi Basin; Tin Meras Formation; middle Givetian-late Famennian (Moreau-Benoit et al., 1992).
- Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
- Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1962, 1988). Canning Basin; Gogo Formation, Sandler and Pillara limestones; *lemurata-magnificus* to *optivus-triangulatus* Zones; middle Givetian (Grey, 1991). Adavale Basin; Etonvale Formation; *optivus-triangulatus* and *ovalis-bulliferus* Assemblage Zones; late Givetian-early Frasnian (Hashemi & Playford, 2005).
- Belgium: Campine Basin, Booischot borehole; ?TA Oppel Zone to Zone IV; ?Givetien-Frasnien (Streel & Loboziak, 1987).
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; AD Oppel Zone-LE Interval Zone; late Eifelian-Famennian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira, Longá and Poti Formations; AD-Lem Interval Zone to PC Oppel Zone; early Givetian-late Tournaisian (Loboziak et al., 1992b). Amazon Basin; Ererê and Barreirinha Formations; LLi-TP Interval Zones; early Givetian-?middle Famennian (Melo & Loboziak, 2003).

• Canada: Arctic Archipelago, Melville Island; Hecla Bay Formation; middle Givetian (McGregor & Camfield, 1982).
• France: Boulonnais; Blacourt, Beaulieu, Ferques and Hydrequent Formations; late Givetian-early Famennian; TCo Oppel Zone to Zone V (Brice et al., 1979; Loboziak & Streel, 1980, 1988).
• Germany: Eifel, Hillesheim Syncline; Ahbach, Cürten and Kerpen Formations; AD-Lem Interval Zone to TA Oppel Zone; latest Eifelian-Givetian (Loboziak et al., 1990).
• Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone V; Givetian (Ghavidel-Syooki, 2003).
• Libya: Cyrenaica; AD-Lem Interval Zone to Zone IV; early Givetian-?early Famennian (Streel et al., 1988). Ghadames Basin; Palynozones 7-?12; middle Givetian-?Tournaisian (Coquel & Moreau-Benoit, 1986; Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6-A8; Givetian-?early Frasnian.
• Norway: Spitsbergen; Upper Mimer Valley Series; Givetian (Allen, 1965).
• Poland: Western Pomerania; Studnica, Jamno, Miastko and Sianowo Formations; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).
• Russia: central and eastern parts of European Russia; Staryi Oskol Group; Ex Zone; middle Givetian (Arkhangelskaya & Turnau, 2003).
• Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; A6-A8; Givetian-?early Frasnian, specimens from borehole S-462 may be caved in older strata.
• Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.
• United Kingdom: Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000).

Geminospora libyensis **Moreau-Benoit, 1980b**

Pl. 69, figs 1-3

1976 *Geminospora libyensis* n. sp.; Massa & Moreau Benoit, Pl. 6, fig. 4.
1980b *Geminospora libyensis* Moreau-Benoit, p. 44, Pl. 13, fig. 6.

Description: Trilete camerate spores with subcircular to subtriangular amb. Laesurae straight, simple or accompanied by fold-like labra up to 5 µm in overall width, extending to equator. Nexine laevigate, circular to subcircular in polar view, about 2/3 to 3/4 the spore radius, single or double-layered and thus rather closely appressed. Proximo-equatorial and distal regions sculptured with biform elements (bulbous bases supporting apical spinae), round to polygonal in plan view, 2-5 µm high and 2-4 µm wide closely spaced, discrete or joined to form ridges of varied length. Contact faces scabrate or with scattered verrucae up to 2 µm wide.

Dimensions: 66 (94) 115 µm, 4 specimens measured.

Remark: This taxon has rather the structure of the genus *Grandispora* Hoffmeister et al. emend. Neves & Owens, 1966. However a species of the same name (*Grandispora libyensis* Moreau-Benoit, 1980b) already exists. This form is thus let in the genus *Geminospora* Balme, 1982.

Comparison: *Acinosporites lindlarensis* Riegel, 1968 has the same sculpture but has never the outer layer as separated as *Geminospora libyensis* Moreau-Benoit, 1980b.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
- Libya: Ghadames Basin; Palynozones 4-7; late Emsian/earliest Eifelian-early Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5; Eifelian.
- Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.
- Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.

Geminospora punctata Owens, 1971

Pl. 69, figs 4-11

1965 Unidentified spore types; Kerr et al., Pl. 4, figs 15, 16.
1966 *Geminospora* sp.; McGregor & Owens, Pl. 15, figs 7-10.
1971 *Geminospora punctata* Owens, p. 61, Pl. 19, figs 1-9.

Description: Trilete camerate spores with subcircular to subtriangular amb. Laesurae straight, simple or more rarely accompanied by labra up to 4 µm in overall width, extending approximately to margin of nexine. The thick sexine encompasses a proximal attached, distinct to perceptible nexine, that is detached distally and (usually to a lesser degree) equatorially and thus constitutes a more or less discrete inner body. The two layers are closely appressed or show a variable separation which is visible at the equatorial margin. Sexine 2-7 µm thick equatorially, both the proximal and distal sexine is normally appreciably thinner than equatorial sexine. Distal sexine may be slightly thicker on average than proximal sexine, but is not invariably so. In polar view, outline of nexine subtriangular usually more or less conformable with amb. Nexine laevigate, less than 1 µm thick, sometimes displaying compression folds independent of sexine. Sexine sculptured with densely distributed punctuations.

Dimensions: 43 (57) 80 µm, 16 specimens measured.

Comparison: *Geminospora lemurata* Balme emend. Playford, 1983 is closely comparable in general construction but has a discrete positive ornamentation.

Stratigraphic and palaeogeographic occurrence:
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem Oppel Zone to Zone IV; Eifelian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira and Poti Formations; AD-Lem Interval Zone to PC Oppel Zone; early Givetian-late Tournaisian (Loboziak et al., 1992b). Amazon Basin; Ererê Formation; LLi Interval Zone; early Givetian (Melo & Loboziak, 2003).
- Canada: Arctic Archipelago, Queen Elisabeth Island; Griper Bay Formation; Frasnian (McGregor & Owens, 1966; Owens, 1971).

• Germany: Eifel, Hillesheim Syncline; Ahbach, Loogh, Cürten and Kerpen Formations; AD-Lem Interval Zone to TA Oppel Zone ; latest Eifelian-Givetian (Loboziak et al., 1990).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone VI; Frasnian (Ghavidel-Syooki, 2003).
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A6-A8; Givetian-?early Frasnian.
• Poland: Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
• Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A6-A8; Givetian-?early Frasnian.
• Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.

Geminospora svalbardiae (Vigran) Allen, 1965

Pl. 70, figs 1-9

1964 *Lycospora svalbardiae* Vigran, p. 23, Pl. 3, figs 4, 5, Pl. 4, figs 1, 2.
1965 *Geminospora svalbardiae* (Vigran) Allen, p. 696, Pl. 94, figs 12-16.
non 1974 *Geminospora svalbardiae* (Vigran) Allen; Becker et al., Pl. 16, figs 16-19.
1988 *Geminospora lemurata* Balme emend. Playford; Boumendjel et al., Pl. 1, figs 18, 19.
? 1996 *Geminospora lemurata* Balme emend. Playford 'early form'; Marshall, p. 171, Pl. 2, figs 2-5.
2007c *Geminospora lemurata* Balme emend. Playford; Breuer et al., Pl. 8, figs 7-9.

Description: Trilete camerate spores with subcircular to subtriangular amb. The inner body radius equals about 3/4 to 9/10 of the whole amb radius. Laesurae straight, accompanied by fold-like labra up to 4 µm in overall width, extending approximately to margin of nexine. The two layers are closely appressed or show a variable separation which is visible at the equatorial margin. Sexine 1-3 µm thick equatorially, often folded. In polar view, outline of nexine usually more or less conformable with amb. Nexine laevigate, sligthly less thick, sometimes displaying compression folds. Proximo-equatorial and distal regions sculptured with densely distributed coni, spinae or short bacula 0.5-2.5 µm high and 0.5-1.5 wide at base. Sculptural elements discrete rarely as much as 2 µm apart. Contact faces laevigate to granulate.

Dimensions: 49 (68) 87 µm, 44 specimens measured.

Comparison: *Geminospora lemurata* Balme emend. Playford, 1983 is often smaller and has generally a thicker sexine resulting as a more rigid appearance. *Geminospora lemurata* 'early form' seems to be similar to *Geminospora svalbardiae* (Vigran) Allen, 1965 at the first quick look but they have an equatorially thicker sexine (2-7 µm).

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Orsine Formation; Emsian-early Eifelian (Moreau-Benoit et al., 1992).
• Libya: Ghadames Basin; Palynozones 3-8; Emsian-late Frasnian (Moreau-Benoit, 1989).
Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A6; Eifelian-Givetian.
• Norway: Spitsbergen; Wijde Bay Series, Mimer Valley Series, Reuterskiøldfjellet and Upper Svalbardia Sandstones; Emsian-Frasnian (Vigran, 1964; Allen, 1965).
• Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.
• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A4-A5; Eifelian.

• United Kingdom: Shetland, Fair Isle; Ward Hill, Observatory and Bu Ness Groups; late Givetian (Marshall & Allen, 1982).

Geminospora sp. 1

Pl. 71, figs 1-7

Description: Trilete camerate spores with subcircular to subtriangular amb. The inner body radius equals 3/4 to 9/10 of the whole amb radius. Laesurae straight, simple or bordered by lips up to 3 µm in total thickness, extending to the outer margin of the inner body. Nexine 1-3 µm thick, laevigate. Sexine 1.5-3 µm thick, densely sculptured proximo-equatorially and distally with cones, spines, and biform processes (flask-shaped or mammate). Sculptural elements on the distal hemisphere round to polygonal in plan view, 1-3 µm wide at their base, 1-2 µm high, closely spaced and joined to form ridges of varied length. Proximal surface laevigate or with scattered grana.

Dimensions: 52 (69) 84 µm, 9 specimens measured.

Comparisons: *Acinosporites lindlarensis* Riegel, 1968 is morphologically very close but its ornamentation is generally larger and the inner layer is generally partially separated from the sexine. *Geminospora libyensis* Moreau-Benoit, 1980b is sculptured with shorter elements and has a nexine closely appressed to sexine.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A4; Eifelian.
• Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.

Geminospora sp. 2

Pl. 71, figs 1, 2

Description: Trilete camerate spores with subtriangular amb. Laesurae straight, simple and extending approximately to margin of nexine. The two layers are closely appressed. Sexine 3-6 µm thick equatorially, both proximal and distal sexine normally appreciably thinner than equatorial sexine. In polar view, outline of nexine more or less conformable with amb. Nexine laevigate, less than 1 µm thick. Proximo-equatorial and distal regions sculptured with closely spaced type of low verrucae, irregular in plan view, 1-4.5 µm wide. Contact faces scabrate.

Dimensions: 60 (62) 63 µm, 2 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.

Genus *Grandispora* Hoffmeister et al. emend. Neves & Owens, 1966

Type species: *Grandispora spinosa* Hoffmeister et al., 1955.

Description: Trilete, camerate spores with circular, subcircular, to broadly rounded triangular amb. Laesurae simple, usually distinct, extending to the margin of the Nexine. The sexine is attached to the nexine only in the region of the trilete rays. Nexine thin, laevigate, punctate, or finely granulose. Sexine thin, punctate or granulose, or laevigate with a prominent ornament of scattered spines, and/or cones. Ornament predominantly located on the distal surface, but may also extend on to the more equatorial parts of the proximal surface. Equatorial margin of the sexine may form a distinct 'wall thickness feature' that may simulate a narrow limbus.

Remarks: Large, camerate spores with apparently similar exinal sculpture are common in Emsian to Givetian rocks, and considerable weight is ascribed to sculpture as a criterion for circumscribing species. However, most authors do not record the range of variation in shape and size of the sculptural elements. Consequently it is difficult to make meaningful comparisons between many of the described species of this complex on the basis of ornamentation, without first re-examining the original specimens of each species to determine the range of sculptural variation. In addition, relatively minor distinctions in sculpture form and distribution are apt to become untenable because of intergradation of many specimens from several populations of spores (McGregor, 1973).

Comparison: The genus name *Calyptosporites* Richardson, 1962 has the same structure as *Grandispora* Hoffmeister el al. emend. Neves & Owens, 1966 and differs from the latter by criteria which are more typically used in a specific level. Consequently, it is considered as a junior synonym of *Grandispora* Hoffmeister el al. emend. Neves & Owens, 1966. The spinose sexine distinguishes this genus from *Endosporites* Wilson & Coe, 1940.

Grandispora cassidea **(Owens) Massa & Moreau-Benoit, 1976**

Pl. 72, figs 3-8, Pl. 119, figs 10-15

1966 *Spinozonotriletes* sp.; McGregor & Owens, Pl. 18, fig. 8.
1971 *Spinozonotriletes cassideus* Owens, Pl. 17, figs 3-5, text-fig. 11.
1976 *Grandispora cassidea* (Owens) Massa & Moreau-Benoit, tab.-fig. 5.
1980b *Grandispora cassidea* (Owens) Moreau-Benoit, p. 31, Pl. 10, fig. 6, Pl. 15, fig. 5.
1989 *Spinozonotriletes* cf. *cassideus* Owens; Moreau-Benoit, p.13.

Description: Trilete camerate spores with circular to subcircular amb. Laesurae straight, often accompanied by fold-like labra, up to 5 µm in overall width, extending to, or almost to, the equator. Inner body commonly conformable to general amb, radius equals 1/2 to 4/5 amb radius. Inner body may possess concentrically arranged folds on its distal surface. Sexine of undetermined thickness with a spongy appearance. Proximal region laevigate, equatorial and distal regions sculptured with densely distributed coni and spinae, 4-13 µm high, 3-10 µm wide at base. The ornamentation is composed either broad-based conate or spinose elements with circular basal outlines or coarse biform elements consisting of a bulbous base with a circular or subcircular basal outline surmounted by a small, cone or spine-like projection.

Dimensions: 95 (123) 163 µm, 7 specimens measured.

Comparison: *Grandispora incognita* (Kedo) McGregor & Camfield, 1976 appears comparable in general construction but the elements are more slender.

Stratigraphic and palaeogeographic occurrence:
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to BJ Oppel Zone; Givetian-Frasnian (Loboziak et al., 1988).
- Canada: Arctic Archipelago, Queen Elisabeth Island; Griper Bay Formation; Frasnian (McGregor & Owens, 1966; Owens, 1971).

• Libya: Ghadames Basin; Palynozones 7-8; middle Givetian-late Frasnian (Moreau-Benoit, 1989).
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin III Formations; A4-A8; Eifelian-?early Frasnian.

Grandispora douglastownense McGregor, 1973

Pl. 72, fig. 9, Pl. 73, figs 1-9, Pl. 119, figs 16-24

? 1968 *Calyptosporites pilaspinosus* Lanninger, p. 153, Pl. 26, fig. 1.
1973 *Grandispora douglastownense* McGregor, p. 62, Pl. 8, figs 8, 9, 12-14.
? 1988 *Grandispora* sp. B; Ravn & Benson, p. 191, Pl. 6, figs 1, 2.

Description: Trilete camerate spores with subcircular to subtriangular amb. Laesurae straight, accompanied by straight to convoluted fold-like labra, up to 7 µm wide and high, extending to the equator. Diameter of inner body more or less 1/2 to 2/3 total spore diameter. Nexine laevigate. Proximal region laevigate, equatorial and distal regions sculptured with loosely or more densely distributed, prominent spinae. Sculptural elements subcircular in plan view, 1.5-9 µm wide at base, 2.5-17 µm long, commonly at least 3 times as long as basal width, parallel-sided or tapered upwards for more than half of their length, rounded- or acute-tipped, and on well preserved specimens surmounted by a delicate, hair-like extension that may be sharp-pointed or more rarely with a minute, bifurcate or expanded tip. Ornaments showing the full spectrum of shapes may occur on a single specimen.

Dimensions: 88 (126) 156 µm, 21 specimens measured.

Comparisons: *Calyptosporites pilaspinosus* Lanninger, 1968 is similar to *Grandispora douglastownense* McGregor, 1973, except that it is smaller and does not include specimens with bifurcate spine tips. *Grandispora diamphida* Allen, 1965 is smaller, and the inner body is larger relative to the total size of the spore in the illustrated specimens. *Calyptosporites microspinosus* Richardson, 1965 is larger, always bifurcate tipped and has shorter spines. *Grandispora ?naumovii* (Kedo) McGregor, 1973 has longer spines. *Grandispora libyensis* Moreau-Benoit, 1980b is slightly larger with a strongly thickened sexine. Its general amb shape tends to be more triangular. *Grandispora protea* (Naumova) Moreau-Benoit, 1980b has smaller, generally bulbous and loosely distributed sculptural elements but some specimens intergrade with the population of *Grandispora douglastownense* McGregor, 1973. The two species are included in the *Grandispora protea* Morphon defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Orsine Formation; late Emsian-early Eifelian (Moreau-Benoit et al., 1992).
• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; ?BM Oppel Zone; Frasnian (Perez-Leyton, 1990).
• Brazil: Central Parnaíba Basin; Itaim and Pimenteira Formations; AD-pre Lem Interval Zone; Eifelian-earliest Givetian (Loboziak et al., 1992b). Amazon Basin; Maecuru and Ererê Formations; GS-LLi Interval Zones; late Emsian-early Givetian (Melo & Loboziak, 2003).
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor, 1973). Ontario, Moose River Basin; Sextant, Kwataboahegan and Williams Island Formations; *annulatus-lindlarensis* to *devonicus-orcadensis* Provisional Assemblage

Zone; Emsian-Givetian (McGregor & Camfield, 1976). Arctic Archipelago, Melville Island; Weatherall Formation; late Eifelian (McGregor & Camfield, 1982).
• France: Boulonnais, railroad trench Caffiers-Ferques; Blacourt Formation; Givetian (Loboziak & Streel, 1980).
• Germany: Eifel, Hillesheim Syncline; Freilingen and Ahbach Formations; AD-Ref Interval Zone; Eifelian (Loboziak et al., 1990).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zones III-IV; late Emsian-early Givetian (Ghavidel-Syooki, 2003).
• Libya: Ghadames Basin; Palynozones 3-7; Emsian-middle Givetian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A5; ?late Emsian-Eifelian.
• Saudi Arabia: Borehole JNDL-1 and well ABSF-29; Jubah Formation; A4-A7; Eifelian-Givetian.
• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.

Grandispora fibrilabrata Balme, 1988

Pl. 74, figs 1-8, Pl. 119, figs 25-27

1988 *Grandispora*? *fibrilabrata* Balme, p. 140, Pl. 9, figs 6-8.

Description: Trilete camerate spores with subtriangular to subcircular amb. Laesurae straight, accompanied by narrow, straight or sinuous elevated labra, up to 12 µm high and tapering towards the equatorial margin, extending to or almost to the equator. Inner body subcircular, radius equals 3/4 to 9/10 amb radius. Nexine thin sometimes with a fairly broad, marginal concentric folds. Sexine scabrate, thicker than nexine with a rigid and spongy appearance. Proximal region laevigate, proximo-equatorial and distal regions sculptured with coni and spinae, 1-2 µm wide and high, and about 1-5 µm apart.

Dimensions: 87 (95) 105 µm, 12 specimens measured.

Remark: The population of this taxon described by Balme (1988) is larger (144-255 µm). Although, Balme (1988) was not certain of the allocation of this form to *Grandispora* Hoffmeister et al. emend. Neves & Owens, 1966, the specimens described here present all typical characters of this genus.

Stratigraphic and palaeogeographic occurrence:
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988).
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A7; Givetian.
• Saudi Arabia: Borehole S-462; Jubah Formation; A7-A8; Givetian-?early Frasnian.

Grandispora gabesensis Loboziak & Streel, 1989

Pl. 75, figs 1-3, Pl. 120, figs 1-3

1989 *Grandispora gabesensis* Loboziak & Streel, p. 181, Pl. 6, figs 2-4, Pl. 9, figs 17-20.

Description: Trilete camerate spores with subcircular to roundly triangular amb. Laesurae straight, accompanied by fold-like labra, up to 6 µm high, usually extending to the equator.

Inner body more or less conformable to the general amb, radius equals about 1/2 to 4/5 amb radius. Nexine laevigate, sometimes with arcuate folds near the margin, 1.5-3 µm thick. Sexine thinner than nexine. Proximal region laevigate, proximo-equatorial and distal regions sculptured with irregularly spaced coni, spinae, capilli and biform elements, 1-4.5 µm high, 0.5-1.5 µm wide.

Dimensions: 65 (96) 133 µm, 13 specimens measured.

Comparisons: *Grandispora inculta* Allen, 1965 and *Grandispora permulta* (Daemon) Loboziak et al., 1999 have different ornaments.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Orsine and Tin Meras Formations; late Emsian-Frasnian (Moreau-Benoit et al., 1992).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone; Givetian (Loboziak et al., 1988).
- Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A6; Eifelian-Givetian.
- Morocco: Essaouira Basin; Palynozones DM2; Emsian (Rahmani-Antari & Lachkar, 2001).
- Saudi Arabia: Well ABSF-29; Jubah Formation; A6-A7; Givetian.
- Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3b-A5; ?late Emsian-Eifelian.

Grandispora incognita **(Kedo) McGregor & Camfield, 1976**

Pl. 75, figs 4-8, Pl. 76, figs 1-3, Pl. 120, figs 4-12

1955 *Archaeozonotriletes incognitus* Kedo, p. 33, pl. 4, fig. 9.
1976 *Grandispora incognita* (Kedo) McGregor & Camfield, p. 23, Pl. 6, figs 9, 10.
1976 *Grandispora tomentosa* Taugourdeau-Lantz; McGregor & Camfield, p. 24, Pl. 6, figs 4, 5, 8.
1976 *Grandispora* cf. *G. tomentosa* Taugourdeau-Lantz; McGregor & Camfield, p. 24, Pl. 7, figs 2, 3.
1992 *Grandispora tomentosa* Taugourdeau-Lantz; McGregor & Playford, Pl. 15, fig. 10.

Description: Trilete camerate spores with subcircular to subtriangular amb. Laesurae straight, often accompanied by straight fold-like labra, up to 7 µm wide and 30 µm high, extending to, or almost to, the equator. Inner body commonly conformable to the general amb, radius equals about 3/5 to 9/10 amb radius. Nexine laevigate, more or less as thick as sexine. Sexine with spongy appearance. Proximal region laevigate, equatorial and distal regions sculptured with long, slender spinae commonly with flared bases. Sculptural elements subcircular in plan view, 1.5-8 µm wide at base, 3-16 µm long. The larger specimens have longer spinae.

Dimensions: 84 (127) 227 µm, 15 specimens measured.

Comparisons: McGregor & Camfield (1976) illustrated both *Grandispora tomentosa* Taugourdeau-Lantz, 1967 and *Grandispora* cf. *G. tomentosa* Taugourdeau-Lantz, 1967 which are similar to specimens figured as *Grandispora incognita* (Kedo) McGregor & Camfield, 1976. *Grandispora cassidea* (Owens) Massa & Moreau-Benoit, 1976 has broad-based conate or spinose elements with a bulbous appearance. *Grandispora ?naumovii* (Kedo) McGregor, 1973 has longer spinae comparatively to general amb but some specimens intergrade with *Grandispora incognita* (Kedo) McGregor & Camfield, 1976. The *Grandispora incognita*

Morphon is thus defined and include specimens characterized by slender spinae (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:

- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988).
- Canada: Ontario, Moose River Basin; Moose River and Williams Island Formations; *devonicus-orcadensis* Provisional Assemblage Zone; Eifelian-Givetian (McGregor & Camfield, 1976).
- Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone V; Givetian (Ghavidel-Syooki, 2003).
- Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.
- Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A6-?A8; Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-Givetian.

Grandispora inculta **Allen, 1965**

Pl. 76, figs 4, 5, Pl. 120, fig. 13

1965 *Grandispora inculta* Allen, p. 734, Pl. 103, figs 7-9.

Description: Trilete camerate spores with subcircular amb. Laesurae straight to slightly sinuous, accompanied by labra, 2-4 µm in overall width, extending to the equator. Inner body more or less conformable to the general amb, radius equals about 1/2 to 2/3 amb radius. Nexine laevigate, 1.5-2 thick. Sexine more or less as thick as nexine. Proximal region laevigate. Poximo-equatorial and distal regions sculptured with densely distributed coni, 0.5-2 µm high.

Dimensions: 57 (60) 64 µm, 2 specimens measured.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin, borehole TRN 3; Alrar and Gazelle Inférieure Formations; early Givetian (Boumendjel et al., 1988). Illizi Basin; Orsine Formation and Tin Meras Formations; Emsian-Frasnian (Moreau-Benoit et al., 1992).
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; BJ-?BM Oppel Zones; Frasnian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone tp BJ Oppel Zone; Givetian-early Frasnian (Loboziak et al., 1988).
- Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; late Eifelian-early Givetian (McGregor & Camfield, 1982).
- France: Armorican Massif, Maine-et-Loire, Four à Chaux d'Angers Quarry; late 'Siegenian'-Emsian (Moreau-Benoit, 1967). Boulonnais; Blacourt, Beaulieu, Ferques and Hydrequent Formations; late Givetian-late Frasnian; TLa Oppel Zone to Zone IV (Brice et al., 1979; Loboziak & Streel, 1980, 1988; Loboziak et al., 1983).
- Libya: Cyrenaica; AD-Mac-Lem Interval Zones; late Eifelian-early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 3-7; Emsian-middle Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6; Givetian.

- Morocco: Doukkala Basin; Palynozones DM1-DM2; Eifelian-Givetian (Rahmani-Antari & Lachkar, 2001).
- Norway: Spitsbergen; Upper Mimer Valley Series; Givetian (Allen, 1965).
- Poland: Western Pomerania; Studnica Formation; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999).
- Saudi Arabia: Borehole S-462; Jubah Formation; A7; Givetian.
- United Kingdom: Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988).

Grandispora libyensis Moreau-Benoit, 1980b

Pl. 76, figs 6, 7, Pl. 77, figs, 1-6, Pl. 120, figs 14-25, Pl. 121, figs 1-9

1967 *Spinozonotriletes echinatus* Moreau-Benoit, p. 230, Pl. 3, fig. 51, Pl. 4, figs 52, 53.
1967 *Spinozonotriletes mamillatus* Moreau-Benoit, p. 231, Pl. 4, figs 54, 55.
1967 *Grandispora* sp., Daemon et al., p. 115, Pl. 3, figs 37-39.
1969 *Hymenozonotriletes* sp. n° 2388; Lanzoni & Magloire, Pl. 7, fig. 19, Pl. 8, fig. 1.
1974 *Spinozonotriletes echinatus* Moreau-Benoit; Moreau-Benoit, p. 203, Pl. 15, fig. 6.
1974 *Spinozonotriletes mamillatus* Moreau-Benoit; Moreau-Benoit, p. 203, Pl. 15, fig. 7.
? 1974 *Spinozonotriletes* cf. *echinatus* Moreau-Benoit; Bär & Riegel, p. 44, Pl. 1, fig. 14.
1976 *Grandispora echinata* (Moreau-Benoit) Massa & Moreau-Benoit, Pl. 4, fig. 1, tabl.-fig. 5.
1980b *Grandispora libyensis* Moreau-Benoit, p.33, Pl. 11, figs 2, 3.
1989 *Spinozonotriletes libyensis* (Moreau-Benoit) Coquel & Moreau-Benoit, p. 96, Pl. 3, fig. 5, Pl. 4, fig. 3.

Description: Trilete, camerate spores with subtriangular to roundly triangular amb. Laesurae often indistinct, straight, accompanied by labra, usually 3-10 µm in the largest overall width, tapering towards the equator and extending to, almost or to, the equator. Inner body subcircular, laevigate radius equals about 2/5 to 2/3 amb radius. Nexine 1-3 µm thick. Sexine 2-10 µm thick equatorially. Proximal region laevigate, equatorial and distal regions sculptured with spines or biform elements with bulbous bases, 1.5-7 µm wide, commonly 3-10 µm high (rarely up to 13 µm), the rounded apices supporting a small spine. The longest spinae are situated in the equatorial region. The sculptural elements are usually densely spaced.

Diamensions: 133 (166) 194 µm, 22 specimens measured.

Remark: It appears that *Grandispora libyenis* Moreau-Benoit, 1980b show a continuous morphological variation in ornamentation, intergrading from a morphotype with rather slender spines to one characterized by bulbous biform elements. Although two end-members exist, all the intermediate forms are present. The morphotype characterized by the most massive sculptural elements seems to appear later than the morphotype with more slender ornaments, but in the youngest samples, the two-end members co-occur (Breuer et al., 2007a).

Comparisons: *Grandispora douglastownense* McGregor, 1973 is slightly smaller and not so thickened equatorially. Moreover, the ornament is less bulbous based. *Grandispora velata* (Richardson) McGregor, 1973 is more loosely sculptured with commonly smaller pointed spinae and coni. In addition, the sexine is not equatorially thickened as in *Grandispora libyensis* Moreau-Benoit, 1980b.

Stratigraphic and palaeogeographic occurrence:

• Algeria: Illizi Basin, borehole TRN 3; Alrar and Gazelle Inférieure Formations; early Givetian (Boumendjel et al., 1988). Illizi Basin; ?Strunian-early Visean (Coquel & Moreau-Benoit, 1989). Illizi Basin; Orsine and Tin Meras Formations; Emsian-Frasnian (Moreau-Benoit et al., 1992).

• Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).

• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to BJ Oppel Zone; Givetian-Frasnian (Loboziak et al., 1988). Amazon Basin; Ererê Formation; Per-LLi Interval Zones; early Eifelian-early Givetian (Melo & Loboziak, 2003).

• France: Armorican Massif, Maine-et-Loire, Four à Chaux d'Angers Quarry; middle-late 'Siegenian' (Moreau-Benoit, 1967).

• Libya: Cyrenaica; AD-Lem Interval Zone; early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 3-?12; late Emsian-?Tournaisian (Coquel & Moreau-Benoit, 1986; Moreau-Benoit, 1989). Murzuk Basin; ?Strunian-Tournaisian (Coquel & Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.

• Morocco: Doukkala Basin and Erfoud outcrop; Palynozones ST1-ST2; 'Strunian'-'Tournaisian' (Rahmani-Antari & Lachkar, 2001).

• Saudi Arabia: Borehole S-462; Jubah Formation; A7-A8; Givetian.

• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.

Grandispora ?naumovii **(Kedo) McGregor, 1973**

Pl. 78, figs 1-10, Pl. 121, figs 10-18

1925 Spore-type H; Lang, p. 257, Pl. 1, figs 18, 19.
1955 *Archaeozontotriletes naumovii* Kedo, p.33, Pl. 4, fig. 8.
1965 ?*Spinozonotriletes* cf. *naumovii* (Kedo) Richardson, p. 583, Pl. 92, figs 3-5, text-fig. 7.
1966 ?*Spinozonotriletes* cf. *naumovii* (Kedo) Richardson; McGregor & Owens, Pl. 7, fig. 5.
1966 *Spinozonotriletes* sp. cf. *S. naumovii* (Kedo) Richardson; de Jersey, p. 18, Pl. 9, figs 1-4, 6.
1966 *Spinozonotriletes tuberculatus* Neves & Owens, p. 356, Pl. 3, figs 4, 5.
? 1967 *Spinozonotriletes naumovii* (Kedo); Hemer & Nygreen, Pl. 2, fig. 9.
1968 *Spinozonotriletes* cf. *naumovii* (Kedo) Richardson; Lanninger, p. 150, Pl. 25, fig. 10.
? 1969 *Spinozonotriletes* cf. *tuberculatus* Neves & Owens; Peppers & Damberger, p. 16, Pl. 5, fig. 1.
? 1969 *Spinozonotriletes* cf. *naumovii* (Kedo) Richardson; Peppers & Damberger, p. 16, Pl. 5, fig. 2.
1970 *Spinozonotriletes naumovii* (Kedo) Richardson; McGregor et al., Pl. 2, fig. 13.
1973 *Grandispora ?naumovii* (Kedo) McGregor, p. 61, Pl. 9, figs 1-3.
1986 *Grandispora naumovii* (Kedo) McGregor; Richardson & McGregor, Pl. 13, fig. 1.

Description: Trilete camerate spores with subcircular to subtriangular amb. Laesurae straight to sinuous, accompanied by fold-like labra, 2-6 µm wide and up to 7 µm high, extending to the equator. Inner body commonly conformable to general amb, radius equals 1/2 to 9/10 spore radius. Sexine of undetermined thickness but often optically dense and rarely folded, scabrate with a spongy appearance. Proximal region laevigate, equatorial and distal regions sculptured with loosely or densely distributed spinae, 10-35 µm long, 3-10 µm wide at base. Sculptural elements may arise from bulbous or slightly flared base or, more usually, taper consistently from base to a delicate pointed tip.

Dimensions: 87 (110) 135 µm, 10 specimens measured.

Remarks: The range of variation in this species includes those with mostly rather small, delicate-looking spines and those with large, rigid-looking spines. Mostly commonly, but not invariably, the larger spores bear the most robust spines.

Comparisons: *Acanthotriletes* cf. *horridus* Hacquebard, 1957 in Richardson (1965) is possibly the same as *Grandispora* ?*naumovii* (Kedo) McGregor, 1973, but the two specimens recorded by Hacquebard are so dark that the body, if present, is obscured. *Grandispora incognita* (Kedo) McGregor & Camfield, 1976 has generally smaller spinae which are also shorter comparatively to general amb,but the two species intergrade in the *Grandispora incognita* Morphon (Tab. 1, p. 185). In *Archaeotriletes villosus* Tchibrikova, 1959 the spines are adjoined at their bases, and the sexine is thickened at the equator.

Stratigraphic and palaeogeographic occurrence:
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988).
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973).
• Germany: Soutwestern Eifel; Heisdorfer Formation; Emsian (Lanninger, 1968).
• Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A8; Eifelian-?early Frasnian.
• Poland: Holy Cross Mountains; Bodzentyn Syncline; Skaly and Świetomarz beds; Ex Zone; Givetian (Turnau & Racki, 1999).
• Saudi Arabia: Borehole S-462; Jubah Formation; A8; Givetian-?early Frasnian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Eday Group; Givetian (Richardson, 1965). Shetland, Fair Isle; Observatory Group; late Givetian (Marshall & Allen, 1982).

Grandispora permulta (Daemon) Loboziak et al., 1999

Pl. 79, figs 1-7, Pl. 121, figs 19-24, Pl. 122, figs 1-3

1967 *Calyptosporites* sp. A; Daemon et al., p. 114, Pl. 3, figs 31-34.
1967 *Calyptosporites* sp. B; Daemon et al., p. 114, Pl. 3, figs 35-36.
1974 *Calyptosporites* sp. B; Bär & Riegel, Pl. 1, fig. 13.
1974 *Contagiporites permultus* Daemon, p. 574, Pl. 3, figs 4, 5.
1980b *Grandispora velata* (Eisenack) McGregor (pars); Moreau-Benoit, Pl. 12, fig. 3.
1985 *Grandispora macrotuberculata* (Archangelskaya) McGregor; Massa & Moreau-Benoit, Pl. 1, fig. 6.
1985 *Grandispora* sp. A; Paris et al., Pl. 24, figs 8, 9.
1985 *Grandispora* sp. B; Paris et al., Pl. 24, fig. 10.
1987 *Grandispora* sp. A; Schrank, Pl. 1, fig. 11.
1989 *Grandispora riegelii* Loboziak & Streel, p. 190, Pl. 5, figs 1-5, Pl. 9, figs 10-13.
1992 *Grandispora riegelii* Loboziak & Streel; Loboziak et al., Pl. 1, fig. 16.
1995a *Grandispora riegelii* Loboziak & Streel; Loboziak & Streel, Pl. 1, fig. 1.
1995b *Grandispora riegelii* Loboziak & Streel; Loboziak & Streel, Pl. 1, fig. 1.
1999 *Grandispora permulta* (Daemon) Loboziak et al., p. 99, Pl. 1, figs 1-6.

Description: Trilete camerate spores with subcircular to subtriangular amb. Laesurae straight, accompanied by labra, up to 6 µm in overall width, generally extending to the equator. Inner body conformable to or slightly more circular than general amb, radius equals generally 3/5 to 9/10 amb radius. Nexine laevigate, 2-4.5 thick. Sexine thinner than nexine. Proximal region laevigate and proximo-equatorial and distal regions sculptured with dominant mammillate and biform conical elements, but also grana, verrucae and coni, 1-3 µm high, 1-2 wide, irregularly distributed but closely spaced.

Dimensions: 68 (99) 125 µm, 30 specimens measured.

Comparisons: *Grandispora inculta* Allen, 1965 is smaller and bears mainly coni. *Grandispora gabesensis* Loboziak & Streel, 1989 has spinae and capilli in addition to coni and biform elements. Its ornaments are also larger than in *Grandispora permulta* (Daemon) Loboziak et al., 1999.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
- Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; AP-BJ Oppel Zones; late Eifelian-early Frasnian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem Oppel Zone to Zone IV; Eifelian-Frasnian (Loboziak et al., 1988). Amazon Basin; Ererê Formation; Per-LLi Interval Zones; early Eifelian-early Givetian (Melo & Loboziak, 2003).
- Libya: Cyrenaica; AP Oppel Zone to AD-Lem Interval Zone; early Eifelian-early Givetian (Paris et al., 1985; Streel et al., 1988). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.
- Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; A5-A8; Eifelian-?early Frasnian.
- Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A7; ?late Emsian-Givetian.

Grandispora protea (Naumova) Moreau-Benoit, 1980b

Pl. 80, figs 1-11, Pl. 122, figs 4-15

1953 *Hymenozonotriletes proteus* Naumova,p. 40, Pl. 4. fig. 5.
1955 *Hymenozonotriletes proteus* var. *eximius* Kedo, p. 31, Pl. 4, fig. 3.
1965 *Calyptosporites proteus* (Naumova) Allen, p. 735, Pl. 103, figs 10, 11.
1968 *Calyptosporites proteus* (Naumova) Allen, Lanninger, p. 153, Pl. 25, fig. 14.
1968 *Calyptosporites proteus* (Naumova) Allen; Riegel, p. 91, Pl. 20, figs 2-4.
? 1968 ?*Hymenozonotriletes* sp.; Jardiné & Yapaudjian, Pl. 2, fig. 9.
? 1973 *Grandispora ?macrotuberculata* (Arkhangelskaya) McGregor, p. 59, Pl. 8, figs 1-5.
1975 *Calyptosporites proteus* (Naumova) Allen, Tiwari & Schaarschmidt, p. 41, pl. 23, fig. 1, text-fig. 30.
1976 *Grandispora protea* (Naumova) Massa & Moreau-Benoit, Pl. 4, fig. 1, tabl.-fig. 5.
1980b *Grandispora protea* (Naumova), Moreau-Benoit p. 37, Pl. 11, fig. 6.

Description: Trilete camerate spores with subtriangular amb. Laesurae straight, accompanied by elevated labra, individualy 1-3 µm wide, up to 8 µm high, extending to, almost or to, the equator. Inner body subtriangular to subcircular, radius equals 2/5 to 3/4 amb radius. Nexine laevigate very often distinct, but sometimes indistinct, 1-4 µm thick. Sexine 1-3 µm thick, laevigate or infragranulate. Proximal surface laevigate, distal surface sculptured with rounded coni and spinae often biform (bulbous base supporting a small spine) 1.5-7 µm high, 1.5-5 µm wide. The ornament is usually sparse, but is occasionally more dense. Distal folding of the sexine frequent.

Dimensions: 73 (122) 152 µm, 22 specimens measured.

Comparisons: Forms that may be similar are ?*Hymenozonotriletes* sp. in Jardiné & Yapaudjian (1968) and *Grandispora ?macrotuberculata* (Arkhangelskaya) McGregor, 1973. *Grandispora megaformis* (Richardson) McGregor, 1973 is larger and has wider ornaments. *Grandispora velata* (Richardson) McGregor, 1973 is very similar in size, but has an ornament of much smaller spinae and coni, which have acute rather than rounded apices. *Grandispora megaformis* (Richardson) McGregor, 1973 has the same ornamentation but is larger in diameter. *Calyptosporites microspinosus* (Richardson) Richardson, 1962 is considerably larger and has bifurcate spinae. *Grandispora douglastownense* McGregor, 1973 has longer spinae and is more densely sculptured but some specimens intergrade with *Grandispora protea* (Naumova) Moreau-Benoit, 1980b; the two species are thus included here in the *Grandispora protea* Morphon (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin; Orsine Formation; late Emsian-early Eifelian (Moreau-Benoit et al., 1992).
- Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
- Belgium: Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; AD Oppel Zone; Eifelian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem Oppel Zone to Zone IV; Eifelian-Frasnian (Loboziak et al., 1988). Amazon Basin; Maecuru and Ererê Formations; AP-AD Oppel Zones; late Emsian-late Eifelian (Melo & Loboziak, 2003).
- Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; Eifelian-early Givetian (McGregor & Uyeno, 1972; McGregor & Camfield, 1982). Ontario, Moose River Basin; Stooping River and Kwataboahegan Formations; *annulatus-lindlarensis* to *velata-langii* Provisional Assemblage Zone; Emsian-Eifelian (McGregor & Camfield, 1976).
- Germany: Soutwestern Eifel; Wetteldorfer and Heisdorfer Formations; Emsian (Lanninger, 1968). Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Heisdorf, Lauch and Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Eifel, Prüm Syncline; Wiltz, Lauch, Nohn, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages B, E-G, I, J, L-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen Formation; AD-Ref Interval Zone; Eifelian (Loboziak et al., 1990).
- Libya: Ghadames Basin; Palynozones 3-5; Emsian-early Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A5; ?late Emsian-Eifelian.
- Norway: Spitsbergen; Mimer Valley Series; ?late Eifelian-Givetian (Allen, 1965).
- Poland: Western Pomerania; Studnica Formation; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996).
- Saudi Arabia: Borehole JNDL-1; Jauf and Jubah Formation; A3b-A4; ?late Emsian-Eifelian.
- Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A5; ?late Emsian-Eifelian.
- United Kingdom: Shetland, Fair Isle; Ward Hill, Observatory and Bu Ness Groups; late Givetian (Marshall & Allen, 1982). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, Orcadian Basin; Clava

Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

Grandispora rarispinosa Moreau-Benoit, 1980b

Pl. 81, figs 1-6, Pl. 122, figs 16-21

1976 *Grandispora rarispinosa* Massa & Moreau-Benoit, Pl. 5, fig. 7.
1980b *Grandispora rarispinosa* Moreau-Benoit, p. 38, Pl. 12, fig. 1.

Description: Trilete camerate spores with subcircular to subtriangular amb. Laesurae straight, accompanied by fold-like labra, 2-5 µm in overall width, extending to the equator. Inner body, subcircular to subtriangular, radius generally equals about 1/2 (rarely up to 3/4) amb radius. Inner body may possess folds on its distal surface. Nexine laevigate, 1.5-3.5 thick. Sexine of undetermined thickness with a spongy appearance. Proximal region laevigate, equatorial and distal regions sculptured with spinae and coni, 2-6 µm high, 1-5 wide, irregularly and loosely distributed.

Dimensions: 66 (86) 108 µm, 7 specimens measured.

Comparison: *Grandispora protea* (Naumova) Moreau-Benoit, 1980b is larger and does not have this spongy appearance of the sexine.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Alrar and Gazelle Inférieure Formations; early Givetian (Boumendjel et al., 1988). Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
• Libya: Ghadames Basin; Palynozones 5-8; early Eifelian-late Frasnian (Moreau-Benoit, 1989).
• Saudi Arabia: Borehole S-462; Jubah Formation; A8; Givetian-?early Frasnian.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.

Grandispora stolidotus (Balme) comb. nov.

Pl. 81, figs 7-13, Pl. 82, figs 1-3, Pl. 122, figs 22-24

1988 *Calyptosporites stolidotus* Balme, p. 141, Pl. 10, figs 8-10.

Description: Trilete camerate spores with subcircular to oval, distorted by folding in most specimens. Laesura distinct to scarcely perceptible, often accompanied by heavy folds extending to almost or to the equator. Inner body subcircular to oval, distorted by independent folding in most specimens apparently appressed to the sexine in the area of the proximal pole, but, elsewhere free, radius equals 2/5 to 1/2 amb radius. Nexine laevigate, about 1-2 µm thick. Sexine of undetermined thickness, usually with heavy compressional folds, sculptured distally and proximo-equatorially with closely packed coni, spinae and variable bulbous biform elements, 1-2.5 µm wide at base and 1-4 µm high.

Dimensions: 103 (125) 161 µm, 14 specimens measured.

Remark: Since *Calyptosporites* Richardson, 1962 is considered as a junior synonym of *Grandispora* Hoffmeister el al. emend. Neves & Owens, 1966, *Calyptosporites stolidotus* Balme, 1988 is transferred here.

Comparisons: According to Balme (1988), *Grandispora uyenoi* McGregor & Camfield, 1982 and *Rhabdosporites* sp. in McGregor & Camfield, 1982 is of the same morphology as *Grandispora stolidotus* (Balme) comb. nov. However *Grandispora uyenoi* McGregor & Camfield, 1982 differs in possessing curvaturate contact faces and *Rhabdosporites* sp. in McGregor & Camfield, 1982 has a more uniform sculpture without biforme elements.

Stratigraphic and palaeogeographic occurrence:
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988). Canning Basin; middle Givetian (Grey, 1991).
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A5-A7; Eifelian-Givetian.
• Saudi Arabia: Borehole S-462 and well ABSF-29; Jubah Formation; A5-?A8; Eifelian-Givetian, specimens may be caved in older strata.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-Givetian.

Grandispora velata (Richardson) McGregor, 1973

Pl. 82, figs 4-9, Pl. 122, figs 25-30

1944 *Triletes velatus* Eisenack (pars), p. 108, Pl. 1, figs 1-3.
1960 *Cosmosporites velatus* (Eiseneack) Richardson, p. 52, Pl. 14, fig. 4.
1962 *Calyptosporites velatus* (Eisenack) Richardson, p. 192.
1965 *Calyptosporites velatus* (Eisenack) Richardson, p. 587, Pl. 93, fig. 4.
1973 *Grandispora velata* (Richardson) McGregor, p. 61, Pl. 8, figs 10, 11.

Description: Trilete camerate spores with subtriangular or subcircular amb. Laesurae straight often accompanied by fold-like labra extending to or almost to the equator. Inner body subtriangular to subcircular, radius equals 2/5 to 3/4 amb radius. Sexine laevigate or infragranular. Proximal surface laevigate, distal surface sculptured with pointed coni and spinae, 1-7 µm high, 1-3 µm wide at base, and about 2-8 µm apart.

Dimensions: 106 (131) 170 µm, 18 specimens measured.

Comparison: *Grandispora libyensis* Moreau-Benoit, 1980b is densely sculptured with commonly larger spinae which can be bulbous. In addition, the sexine is thickened equatorially.

Stratigraphic and palaeogeographic occurrence:
• Australia: Adavale Basin; Log Creek Formation and Lissoy Sandstone; *devonicus-naumovii* Assemblage Zone; early Eifelian-early Givetian (Hashemi & Playford, 2005).
• Belgium: Dinant Synclinorium; Eifelian (Lessuise et al., 1979).
• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; AD Oppel Zone; Eifelian (Perez-Leyton, 1990).
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to BJ Oppel Zone; Givetian-early Frasnian (Loboziak et al., 1988).

• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Arctic Archipelago, Queen Elisabeth, Melville and Bathurst Islands; Eids, Blue Fiord, Bird Fiord, Cape De Bray, Weatherall, Hecla Bay and Griper Bay Formations; Eifelian-Frasnian (McGregor & Owens, 1966; McGregor & Uyeno, 1972; McGregor & Camfield, 1982). Ontario, Moose River Basin; Williams Island Formation; *devonicus-orcadensis* Provisional Assemblage Zone; Givetian (McGregor & Camfield, 1976).
• China: Guizhou and Yunnan; Assemblage Zone V; Eifelian (Gao Lianda, 1981).
• France: Armorican Massif, Anjou, Fléchay Outcrop; Emsian (Moreau-Benoit, 1966). Armorican Massif, Maine-et-Loire, Four à Chaux d'Angers Quarry; middle-late 'Siegenian' (Moreau-Benoit, 1967). Boulonnais; Blacourt Formation; late Givetian; TLa-TCo Oppel Zones (Brice et al., 1979; Loboziak & Streel, 1980, 1988).
• Germany: Soutwestern Eifel; Heisdorfer Formation; Emsian (Lanninger, 1968). Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Heisdorf, Lauch and Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Eifel, Prüm Syncline; Wiltz, Heisdorf, Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages B, D-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; Eifelian-Givetian (Loboziak et al., 1990).
• Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone IV; Eifelian-early Givetian (Ghavidel-Syooki, 2003).
• Libya: Cyrenaica; AD Oppel Zone; late Eifelian (Streel et al., 1988). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A6; Eifelian-Givetian.
• Poland: Western Pomerania; Studnica, Jamno, Miastko and Sianowo Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996).
• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).
• Saudi Arabia: Boreholes JNDL-1 and S-462; Jubah Formation; A4-A5; Eifelian.
• Spain: Asturias; *Gosselatia* Sandstone Formation; Eifelian-Givetian (Cramer, 1969).
• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Wick Flagstone Group, Achanarras fish Beds, Thurso Flagstone and Eday groups; Eifelian-Givetian (Richardson, 1965). Shetland, Fair Isle; Ward Hill, Observatory and Bu Ness Groups; late Givetian (Marshall & Allen, 1982). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).
• U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

Grandispora **sp. 1**

Pl. 83, figs 1-6, Pl. 123, 1-3

Description: Trilete camerate three-layered spores with amb subcircular. Diameter of inner body 3/4 to 9/10 total spore diameter. Diameter of the middle layer about 9/10 total spore diameter. The middle layer is rarely appressed to the inner body. Laesurae straight, accompanied by labra, 1.5-4 µm in total width and extending to equator of inner body. Inner body laevigate and middle layer commonly infragranular to granular. Outer layer laevigate, but sculptured distally and equatorially with closely spaced small spines, parallel-sided or tapered upwards, rounded- or acute-tipped, or biform elements with a more bulbous base supporting a delicate minute tip. Elements up to 3 µm high, up to 1.5 µm wide at base and 1-2 µm apart. Ornaments can be coalescent equatorially. Specimens are often folded distally.

Dimensions: 65 (76) 90 µm, 8 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A5; late Eifelian.
• Tunisia: Borehole MG-1; Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A5-A8; Eifelian-?early Frasnian.

Genus *Granulatisporites* Ibrahim emend. Potonié & Kremp, 1954

Type species: *Granulatisporites granulatus* Ibrahim, 1933.

Description: Acavate trilete spores with subtriangular to triangular amb. Distal surface bearing dense granular sculpture. The granula are approximately circular, of rather uniform size and often arranged in a more or less orderly fashion. In optical section the granula are flat or rounded.

Comparison: *Waltzispora* Staplin, 1960 has a triangular amb but with radial angles reflexed and expanded into mushroom, saddle, or T-shaped outline.

***Granulatisporites* sp. 1**

Pl. 84, figs 1-6

? 1976 *Granulatisporites muninensis* Allen; Massa & Moreau-Benoit, Pl. 3, fig. 5.
? 2003 *Granulatisporites granulatus* Ibrahim; Melo & Loboziak, Pl. 5, fig. 13.

Description: Trilete spores with triangular amb. The corners are rounded, while the margins are concave or straight. Exine 0.5-1 µm thick. Laesurae simple straight, 3/4 to 9/10 of the radius in length. Curvaturae visible. Distal and equatorial sculpture composed of densely distributed grana less than 0.5 µm high, less than 1 µm wide at their base, and 0.5-1 µm apart.

Dimensions: 31 (36) 40 µm, 6 specimens measured.

Comparisons: *Granulatisporites muninensis* Allen, 1965 has a triangular amb with straight to slightly convex margins. *Granulatisporites muninensis* illustrated in Massa & Moreau-Benoit (1976) may correspond to the species described herein, however no description is given. The original paper where *Granulatisporites granulatus* Ibrahim, 1933 was defined is missing in our palynological library, so it cannot be compared. However, the specimen of *Granulatisporites granulatus* Ibrahim, 1933 illustrated in Melo & Loboziak (2003) may be similar to *Granulatisporites* sp. 1.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A4; Emsian-Eifelian, the isolated occurrence of the specimen from the Awaynat Wanin II Formation may be due to reworking.
- Saudi Arabia: Borehole JNDL-1; Jauf and Jubah Formations; A3b-A4; late Emsian-Eifelian.

Genus *Hystricosporites* McGregor, 1960

Type species: *Hystricosporites delectabilis* McGregor, 1960.

Description: Trilete acavate spores bearing proximo-equatorially and distally discrete ornaments which taper throughout their length and support a bifurcate or multifurcate grapnel-shaped tip. Amb circular to subcircular.

Remark: However elevated labra are not typical of this genus, we have noted that lots of specimens described in *Hystricosporites* McGregor, 1960 and figured in the literature show this feature.

Comparison: *Ancyrospora* Richardson emend. Richardson, 1962 also bears grapnel-tipped ornaments but is saccate. It differs also from *Nikitinsporites* Chaloner, 1959 in the absence of greatly elevated labra forming an apical prominence, from *Archaeotriletes* Naumova, 1953 in lacking any equatorial flange or any apparent concentration of the appendages in the equatorial region.

***Hystricosporites* sp. 1**

Pl. 84, figs 7-9, Pl. 123, figs 4-6

Description: Trilete spores with circular to subcircular amb. Laesurae straight to sinuous, generally accompanied by elevated labra, 7-25 µm high. Exine 2.5-5 µm thick equatorially, laevigate. Proximo-equatorial and distal surfaces sculptured with grapnel-tipped ornaments, commonly 4-8 µm (rarely as much as 10 µm) long, 1.5-4 µm wide at their base, 3-6 µm apart.

Dimensions: 63 (79) 95 µm, 4 specimens measured.

Remark: However this form may correspond rather to the definition of the genus *Nikitinsporites* Chaloner, 1959, it is let in the genus *Hystricosporites* McGregor, 1960 because the elevated labra do not form here an apical prominence as in the first genus.

Stratigraphic and palaeogeographic occurrence:
- Tunisia: Borehole MG-1; Awaynat Wanin III Formation; A8; late Givetian-?early Frasnian.

***Hystricosporites* sp. 2**

Pl. 84, figs 10-12, Pl. 123, figs 7-9

Description: Trilete spores with circular to subcircular amb. Laesurae straight, length approximately 1/2 to 2/3 of the spore radius, accompanied by smooth, labra, 2-4.5 µm in total width. Curvaturae indistinct. Exine 3-6 µm thick equatorially, laevigate. Proximo-equatorial and distal surfaces sculptured with multifurcate grapnel-tipped ornament, 2-9 µm long, 2-10 µm wide at their base. Sculptural elements are 15-25 round the equatorial margin, their base are robust, grapnel-tipped or often divided upwards into two or three parts which are themselves grapnel-tipped. The first divided branches are 1-3 µm long and their grapnel-shaped tips are smaller. On the less well-preserved specimens, the grapnel-shaped tips are commonly broken.

Dimensions: 77 (91) 108 µm, 4 specimens measured.

Remark: This thickened taxon does not resemble any species of *Hystricosporites* McGregor, 1960. The unique feature which corresponds to this genus is the divided sculptural elements.

Stratigraphic and palaeogeographic occurrence:
- Tunisia: Borehole MG-1; Awaynat Wanin II Formation; A5-A7; Eifelian-Givetian.

Genus *Iberoespora* Cramer & Díez, 1975

Type species: *Iberoespora cantabrica* Cramer & Díez, 1975.

Description: Trilete cingulate spores with circular to subtriangular amb. Cingulum is simple, bi- or trizonate. If present, the inner zone of the cingulum is a furrow on the distal surface of the spore which separates the distal face from the cingulum. The laesurae are straight, not normally sinuous, and extend to the inner edge of the cingulum. Prominent, relatively low lips extend to the outer edge of the cingulum. If sculptured, their sculpture merges into that of the cingulum. Three or more inspissations (not: interradial papillae) may be developed, more or less symmetrically at the edges of the interradial areas. Additional inspissations may be present proximally, or more commonly, distally.

***Iberoespora cantabrica* Cramer & Díez, 1975**

Pl. 85, figs 1-3

1968 Spore trilète à papilles proximales sp. 2; Jardiné & Yapaudjian, Pl. 1, figs 8, 9.
1975 *Iberoespora cantabrica* Cramer & Díez, p. 339, Pl. 2, figs 24, 26-28, 30, 31.
1980a ?*Geminospora* sp. A; Moreau-Benoit, p. 73, Pl. 10, fig. 8.
1980a ?*Geminospora* sp. B; Moreau-Benoit, p. 73, Pl. 10, fig. 9.
1981 *Iberoespora glabella* Cramer & Díez; Steemans, Pl. 1, figs 8, 9.

Description: Trilete cingulate spores with circular to subtriangular amb. Laesurae straight or slightly sinuous, accompanied by low labra, up to 2 µm wide individually, extending to the inner margin of the cingulum. Cingulum, 1.5-6 µm wide. An inspissation is present on each interradial area on the proximal face. A narrow, straight-edged and flat-bottomed, slightly sinuous furrow, generally less than 1 µm wide, separates the cingulum from the distal face of the spore body. Distal face sculptured commonly with convolutoid rugulae, generally 1-2 µm wide and less than 1 µm apart, resulting in a pseudo-reticulum.

Dimensions: 26 (32) 41, 4 specimens measured.

Comparison: Specimens described here in *Iberoespora* cf. *I. guzmani* Cramer & Díez, 1975 have a cingulum well-divided by short radially oriented muri and do not seem to have proximal inspissations.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant, Verviers Synclinoriums and Theux Window; Nα-Su Interval Zones; early Lochkovian-late Pragian (Steemans, 1989).
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 2 to 3; Pragian-early Emsian (Le Hérissé, 1983). Armorican Massif, Laval and la Haye-du-Puits Synclines, Saint-Germain-sur-Ay and Saint-Cénéré Outcrops; Nβ-Mα Interval Zones; early Lochkovian (Steemans, 1989).
• Germany: Sauerland; N Interval Zone; early Lochkovian (Steemans, 1989).
• Libya: Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *Apiculiretusispora* sp. E Biozone?; middle Pridoli (Rubinstein & Steemans, 2002).
• Spain: Cantabrian Mountains; San Pedro Formation; Dittonian-early Siegenian (Cramer & Díez, 1975; Rodriguez, 1978).
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.

Iberoespora glabella Cramer & Díez, 1975

Pl. 85, figs 4, 5

1975 *Iberoespora glabella* Cramer & Díez, p. 339, Pl. 2, figs 22, 29.
1976 *Geminospora papillata* Moreau-Benoit, p. 41, Pl. 8, fig. 5.
1979 *Iberoespora* cf. *glabella* Cramer & Díez; D'Erceville, p. 98, Pl. 4, fig. 12.
non 1982 *Iberoespora glabella* Cramer & Díez; Steemans, Pl. 1, figs 8, 9.

Description: Trilete cingulate spores with subcircular to subtriangular amb. Laesurae straight or slightly sinuous, accompanied by low labra, up to 1.5 µm wide individually, extending to the inner margin of cingulum. Cingulum, 2-4 µm wide. An inspissation is present on each interradial area on the proximal face. Inspissations, 6-10 µm wide near the cingulum, up to 8 µm long from the cingulum towards the proximal pole. A narrow, straight-edged and flat-bottomed, slightly sinuous furrow, generally less than 1 µm wide, separates the cingulum from the distal face of the spore body. Distal face laevigate.

Dimensions: 30 (32) 34, 2 specimens measured.

Comparison: *Synorisporites papillensis* McGregor, 1973 has one papilla in each interradial area and may have verrucate distal surface. Moreover, no distal furrow is observed on this taxon.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Dinant and Verviers Synclinoriums; Mα-Su Interval Zones; early Lochkovian-late Pragian (Steemans, 1989).
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
• France: Armorican Massif, Laval Syncline; Montguyon Formation; Assemblage 2 to 3; late Siegenian-early Emsian (Le Hérissé, 1983). Armorican Massif, la Haye-du-Puits Syncline, Saint-Germain-sur-Ay Outcrop; Nβ Interval Zone; early Lochkovian (Steemans, 1989).
• Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A1-A2; late Pragian-?early Emsian.

• Spain: Cantabrian Mountains; San Pedro Formation; earliest 'Gedinnian' (Cramer & Díez, 1975). Cantabrian Mountains; San Pedro Formation; *elegans-cantabrica* to *micrornatus-newportensis* Assemblage Zones; early Lochkovian (Richardson et al., 2001).

Iberoespora cf. _I. guzmani_ Cramer & Díez, 1975

Pl. 85, figs 6-11

cf. 1975 *Iberoespora guzmani* Cramer & Díez, p. 340, Pl. 2, figs 23, 25, 32.

Description: Trilete cingulate spores with circular to subtriangular amb. Laesurae rarely visible, straight, accompanied by narrow labra, up to 1 µm wide in overall width, extending to the inner margin of cingulum. Cingulum, 2-4 µm wide, divided in short radially oriented muri, 0.5-2 µm wide giving a crenulate appearance to the cingulum. A narrow, straight-edged and flat-bottomed, slightly sinuous furrow, generally 1-2 µm wide, separates the cingulum from the distal face of the spore body. Distal face sculptured commonly with convolutoid rugulae, generally 1-2.5 µm wide and less than 1 µm apart, resulting in a pseudo-reticulum.

Dimensions: 32 (38) 43 µm, 7 specimens measured.

Remark: *Iberoespora* cf. *I. guzmani* Cramer & Díez, 1975 clearly exhibits inspissations on the interradial areas whereas the Saudi specimens seem to possess none. However, the proximal face may have been torn because the laesurae are rarely perceptible.

Comparisons: *Iberoespora noninspissatosa* Steemans, 1989 does not have inspissations and seems very close to specimens described here but it does not possess short radially oriented muri on the cingulum. The studied specimens beloging to *Iberoespora cantabrica* Cramer & Díez, 1975 are proximally sculptured with inspissations and do not have a crenulate cingulum.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Wells KHRM-2, UTMN-1830; Jauf Formation; A2-A3a; ?late Pragian-Emsian.

Genus *Jhariatriletes* Bharadwaj & Tiwari, 1970

Type species: *Jhariatriletes baculosus* Bharadwaj & Tiwari, 1970.

Description: Trilete megaspores with circular to subtriangular amb. Laesurae commonly prominent high, straight to sinuous, sometimes floppy, and more or less tapering. Labra closed or open, ending at curvaturae. Contact areas well defined with arcuate rims or low ridges, or by differential distribution of ornament. Sexine ornamented with small to large bacula (cylindrical or tapering), that may be blunt or obtuse but never pointed, usually more closely spaced outside contact areas, being very close on distal face, but in some specimens uniformly distributed. Sexine variably thick, nexine distinct to obscure, thin, subcircular.

Comparisons: *Bacutriletes* Potonié, 1956 lacks a well defined contact areas, its inner structure is not known. *Biharisporites* Potonié, 1956 is spinose (spinae, coni rather than bacula). *Raistrickia* Schopf et al. emend. Potonié & Kremp, 1954 is single-layered and is usually used for baculate microspores.

***Jhariatriletes emsiensis* (Moreu-Benoit) comb. nov.**

Pl. 85, figs 12-15, Pl. 86, figs 1, 2, Pl. 123, figs 10-12

1976 Mégaspore 1; Massa & Moreau-Benoit, tab.-fig. 5.
1979 *Verruciretusispora emsiensis* Moreau-Benoit, p. 43, Pl. 6, figs 1, 2.

Description: Small trilete megaspores with circular to subcircular amb. Laesurae straight, accompanied by labra, up to 8 µm in overall thickness, length about 3/4 spore radius. Curvaturae indistinct or visible. Exine 4-14 thick, two-layered; sexine spongy and nexine homogeneous with about the same thickness. Nexine indistinct to barely perceptible, apparently thin. Proximal region laevigate. Equatorial and distal regions sculptured with rounded or flat-topped bacula, pila or low verrucae, 2-10 µm high, 2-8 µm wide. Sculptural elements, subcircular to polygonal in plan view, very closely distributed to irregularly scattered.

Dimensions: 92 (177) 223 µm, 8 specimens measured.

Comparison: Mégaspore 1 in Massa & Moreau-Benoit (1976) and *Verruciretusispora emsiensis* Moreau-Benoit, 1979, which are described from the same area, are similar to the specimens described here. The genus *Jhariatriletes* Bharadwaj & Tiwari, 1970 is more appropriate because its species are two-layered unlike *Verruciretusispora* Owens, 1971. In addition, this last genus is for microspores. Although *Dibolisporites pilatus* Breuer et al., 2007c is a microspore, it is also relatively thick walled and has the same kind of distal sculpture. It differs from *Jhariatriletes emsiensis* (Moreau-Benoit) comb. nov. by its smaller size and single homogenous layered exine.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin I Formation; A4; Eifelian.

Genus *Knoxisporites* Potonié & Kremp emend. Neves, 1961

Type species: *Knoxisporites hagenii* Potonié & Kremp, 1954.

Description: Trilete spores with an equatorial cingulum which is of more or less uniform thickness throughout its width, possibly tapering slightly in the immediate vicinity of the equator. The distal hemisphere of the spores is characterized by a variable pattern of radial and/or concentric bands of thickening. The equatorial outline of the cingulum is more or less conformable to that of the spore body, only departing from it locally where the fusion of radial elements and the equatorial girdle produces a swollen node of thickening. Small thickened lobes may project from the cingulum onto the proximal surface of the spore body.

Comparisons: *Iberoespora* Cramer & Díez, 1975 has a distal furrow separating the cingulum from the distal face. *Synorisporites* Richardson & Lister, 1969 does not exhibit concentric or radial bands of thickening.

?*Knoxisporites riondae* Cramer & Díez, 1975

Pl. 86, figs 3-12

1968 Spore trilète à papilles soudées sp. 3; Jardiné & Yapaudjian, Pl. 1, fig. 10.

1968 Spore trilète à papilles distinctes sp. 3; Jardiné & Yapaudjian, Pl. 1, fig. 11.
1972 ?*Aneurospora* sp. (pars); Kemp, p. 115, Pl. 55, fig. 10.
1975 ?*Knoxisporites riondae* Cramer & Díez, p. 341, Pl. 1, figs 14, 16, 17.
1983 *Knoxisporites*? *riondae* Cramer & Díez Le Hérissé, p. 45, Pl. 8, figs 10-12.
1983 *Knoxisporites*? cf. *riondae* Cramer & Díez Le Hérissé, p. 45, Pl. 8, figs 16-19.
? 1985 *Aneurospora* sp. B; Paris et al., Pl. 18, fig. 7.

Description: Trilete cingulate spores with subcircular amb. Laesurae straight, accompanied by low labra, 0.5- 2 µm wide individually, extending to the inner margin of cingulum. Cingulum, 2-6 µm wide. A papilla or an inspissation is developed in each interradial area on the proximal face. Distal face sculptured with an irregular annulus, generally 1.5-3 µm wide, and often with other additional low irregular verrucae, more or less connected, resulting in a tangled distal sculpture.

Dimensions: 28 (31) 35 µm, 11 specimens measured.

Comparisons: *Knoxisporites*? *riondae* Cramer & Díez, 1975 and *Knoxisporites*? cf. *riondae* Cramer & Díez, 1975 described by Le Hérissé (1983) seems to represent extreme forms of the same species because they differ from each other only by the presence of additional distal verrucae. Paris et al. (1985) figure a specimen which resembles the population described here by having a distal annulus but no description was given. *Synorisporites papillensis* McGregor, 1973 does not exhibit a distal annulus but sometimes subcircular verrucae. As these two species intergrade, they are included in the *Synorisporites papillensis* Morphon defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
• Antarctica: Ohio Range; Horlick Formation; early Emsian (Kemp, 1972).
• Belgium: Dinant Synclinorium; Su Interval Zone; late Pragian (Steemans, 1989).
• Brazil: Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• France: Armorican Massif, Laval Syncline; Montguyon Formation; Assemblage 2 to 3; late Siegenian-early Emsian (Le Hérissé, 1983).
• Saudi Arabia: Boreholes BAQA-1, 2, JNDL-4 and well HWYH-956, SDGM-462; Jauf Formation; A2-A3a; ?late Pragian-Emsian.
• Spain: Cantabrian Mountains; San Pedro Formation; Lludlovian-earliest Gedinnian (Cramer & Díez, 1975; Rodriguez, 1978).
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.

Genus *Leiozosterospora* Wellman, 2006

Type species: *Leiozosterospora andersonii* Wellman, 2006.

Description: Trilete zonate spores that is entirely laevigate. The structure appears to consist of an inner body surrounded by an outer layer that is extended at the equator forming a pseudozona (*sensu* Wellman, 2001). There is no cameration between the two layers over the inner body and little or no cameration in the pseudozona.

Comparison: It is distinguished from all other genera of simple zonate spores in that both the inner body and the zona are entirely laevigate. *Perotrilites* Couper emend. Evans, 1970 may be sculptured.

Leiozosterospora cf. _L. andersonii_ Wellman, 2006

Pl. 86, figs 13-16

cf. 2006 *Leiozosterospora andersonii* Wellman, p. 194, Pl. 18, figs g-i.

Description: Trilete pseudozonate spores with subcircular amb. Laesurae straight, accompanied by labra, up to 1 µm wide, and associated with a narrow strip, 0.5-1 µm wide, of thinner exine on either side, extending to, or almost to, the edge of the zona. Curvaturae sometimes visible. The inner body subcircular, its radius equals about 1/2 to 3/4 of the whole amb radius.

Dimensions: 61 (65) 70 µm, 6 specimens measured.

Comparisons: According to Wellman (pers. comm., 2007) *Leiozosterospora andersonii* Wellman, 2006 is subtly different from the specimens described here. Indeed, the latter does not possess curvaturae and laesurae extend to the equator of the zona where they join a narrow limbus. *Auroraspora minuta* Richardson, 1965 is pseudosaccate with an inner body, only slightly smaller than the sexine. Its sexine is laevigate, infrapunctate or occasionally infragranular.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-2, JNDL-4 and well NFLA-1; Jauf Formation; A2-A3a; ?late Pragian-Emsian.

Genus *Lophotriletes* (Naumova) Potonié & Kremp, 1954

Type species: *Lophotriletes gibbosus* (Ibrahim) Potonié & & Kremp, 1954.

Description: Triletes spores with triangular amb, with convex or concave sides nerver tending to become subcircular. Distal sculptural elements vary from coni to verrucae.

Lophotriletes devonicus (Naumova ex Tchibrikova) McGregor & Camfield, 1982

Pl. 87, figs 1-3

1959 *Diatomozonotriletes devonicus* Naumova ex Tchibrikova, p. 80, Pl. 14, fig. 4.
1962 *Diatomozonotriletes devonicus* Naumova var. *contractus* Tchibrikova, p. 447, Pl. 16, fig. 3.
1962 *Diatomozonotriletes devonicus* Naumova var. *azonatus* Tchibrikova (pars), p. 447, Pl. 16, fig. 5.
1968 *Acanthotriletes* sp. 2 (pars); Jardiné & Yapaudjian, Pl. 1, fig. 14.
1972 *Lophotriletes* sp.; McGregor & Uyeno, Pl. 2, fig. 10.
1976 *Anapiculatisporites devonicus* var. *azonatus* (Tchibrikova) Vigran; Massa & Moreau-Benoit, Pl. 3, fig. 2.
1982 *Lophotriletes devonicus* (Naumova ex Tchibrikova) McGregor & Camfield, p. 54, Pl. 15, figs 5-11, text-fig. 86.

Description: Trilete spores with subtriangular amb and slightly convex, straight, or slightly concave interradial margins. Laesurae straight, simple or accompanied by labra, up to 2 µm in overall width, extending almost to the equator. Exine 1-2.5 µm equatorially thick. Proximal face laevigate or more commonly with densely distributed grana less than 1 µm (commonly less than 0.5 µm) wide. Distal and equatorial regions sculptured with irregularly spaced coni, truncated coni and verrucae 1.5-3.5 µm wide, 1-2.5 µm high. Sculptural elements variable in size on a same specimen, commonly reduced in size or lacking at the apices.

Dimensions: 38 (43) 48 µm, 4 specimens measured.

Remark: The distal sculptural elements of this species commonly resemble small verrucae in plan view. In lateral compression, however, they prove to be commonly broad-based, blunt coni in profile (McGregor & Camfield, 1982).

Comparisons: Tchibrikova (1962) indicated that both *Diatomozonotriletes devonicus* Naumova var. *contractus* and *Diatomozonotriletes devonicus* Naumova var. *azonatus* display considerable variation notably in disposition of the sculptural elements. However, neither these taxa nor *Diatomozonotriletes devonicus* Naumova ex Tchibrikova, 1959 possess the distinctive elongate equatorial-interradial sculpture characteristic of *Diatomozonotriletes* Naumova emend. Playford, 1962. *Anapiculatisporites devonicus* var. *azonatus* (Tchibrikova) Vigran, 1964 has slightly smaller sculptural elements. *Lophotriletes viluicus* Pashkevich, 1971 is larger and has smaller sculptural elements.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Orsine Formation; late Emsian-early Eifelian (Moreau-Benoit et al., 1992).
- Bolivia: Cordillera Oriental, Laurani section; Icla and Huamampampa Formations; ?Emsian-Eifelian (McGregor, 1984).
- Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; late Eifelian-early Givetian (McGregor & Uyeno, 1972; McGregor & Camfield, 1982).
- Libya: Ghadames Basin; Palynozones 3-5; Emsian-early Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A6; Emsian-Givetian.
- Morocco: Doukkala Basin; Palynozones DI2-DM2; Emsian-Eifelian (Rahmani-Antari & Lachkar, 2001).

Genus *Lophozonotriletes* Naumova, 1953

Type species: *Lophozonotriletes lebedianensis* Naumova, 1953.

Description: Trilete spores sculptured with coarse tubercules, protuberances that along the equatorial margin crowd together forming a narrow cingulum.

Lophozonotriletes media **Taugourdeau-Lantz, 1967**

Pl. 87, figs 4-11, Pl. 88, figs 1-4

1965 Unidentified spores types; Kerr et al., Pl. 4, figs 9, 11.
1967 *Lophozonotriletes media* Taugourdeau-Lantz, p. 52, Pl. 2, fig. 6.
1971 *Geminospora verrucosa* Owens, p. 63, Pl. 19, figs 10-12.
1989 *Spinozonotriletes verrucosus* (Owens) Coquel & Moreau-Benoit, p. 93.

Description: Trilete cingulate spores with subcircular to subtriangular amb. Laesurae straight, simple and extending to, or almost to, the inner margin of the equator. Cingulum commonly 3-10 µm thick. Exine distinctly punctate. Punctations are small, densely distributed and appear to pass completely through the exine at equatorial margin, thereby imparting a characteristic striated appearance to the equatorial margin of the spore. Proximal surface laevigate. Cingulum and distal regions variably sculptured with scattered coarse, broad based, blunt pointed and rounded protuberances and flat-topped verrucae, up to 10 µm high and up to 13 µm wide at base. Sculptural elements are very variable and may be merged locally to form more elongated elements or be very reduced and thus constituted only by an irregular cingulum.

Dimensions: 40 (65) 92 µm, 18 specimens measured.

Comparisons: The specimens figured by Owens (1971) of *Geminospora verrucosa* Owens, 1971 does not seem to have an inner body as alleged in the diagnosis. These specimens seems to correspond rather to *Lophozonotriletes media* Taugourdeau-Lantz, 1967. Note that lots of species of *Lophozonotriletes* Naumova, 1953 are described in the litterature and notably in Libya (Massa & Moreau-Benoit, 1976; Moreau-Benoit, 1979, 1980b). However it is impossible to compare all because their diagnose are poor. In addition, some of these species could be grouped together or be synonymous with *Lophozonotriletes media* Taugourdeau-Lantz, 1967 since the latter is a very variable form. *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965 is also finely punctate without protuberances. Some extreme variants of *Lophozonotriletes media* Taugourdeau-Lantz, 1967, which show a very reduced ornamentation, could intergrade with *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965 in the *Archaeozonotriletes variabilis* Morphon (Tab. 1, p. 185). As the latter includes variable and intergrading morphotypes, the concept of *Lophozonotriletes media* may appear challenging to constrain and larger here than in the literature. *Cyrtospora* sp. 1 may be infrapunctate commonly with larger protuberances. It might also intergrade with *Lophozonotriletes media* Taugourdeau-Lantz, 1967.

Stratigraphic and palaeogeographic occurrence:
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; BM Oppel Zone to Zone IV; Frasnian (Loboziak et al., 1988).
Amazon Basin; Barreirinha Formation; BPi-BMu Interval Zones; early Frasnian-late Frasnian (Melo & Loboziak, 2003).
• Canada: Arctic Archipelago, Queen Elisabeth and Melville Islands; Weatherall, Hecla Bay and Griper Bay Formations; late Eifelian-Frasnian (Owens, 1971; McGregor & Camfield, 1982).
• France: Boulonnais; Ferques and Hydrequent Formations; Frasnian; BM Oppel Zone to Zone IV (Loboziak et al., 1983, 1988).
• Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
• Libya: Cyrenaica; BM Oppel Zone to Zone IV; Frasnian-?early Famennian (Streel et al., 1988). Ghadames Basin; Palynozones 6-8; middle Eifelian-late Frasnian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A7-A8; Givetian-?early Frasnian.
• Poland: Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).

• Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.
• United Kingdom: Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996).

Genus *Lycospora* Schopf et al. emend. Potonié & Kremp, 1954

Type species: *Lycospora micropapillata* (Wilson & Coe) Schopf et al., 1944.

Description: Trilete cingulizonate spores with subcircular to subtriangular amb. Compression is generally parallel to the transverse plan with few or no folds, due to preferential orientation of the spores. Exine nearly laevigate or minutely granulate or rugate. Laesurae extend nearly to or beyond the inner margin of the zona. Typical flange is developed equatorially. Usually it is narrow and tapers evenly and rapidly away from the spore body. Exine relatively thin on proximal and distal surfaces, thicker at the equator where there is no easily defined line of demarcation between the equatorial flange and the body wall.

Remark: Most of authors, as Potonié & Kremp (1956), Staplin (1960), Wilson & Hoffmeister (1964), and Bhardwaj (1957) put spores characterized by a narrow zona in *Lycospora* Schopf et al. emend. Potonié & Kremp, 1954.

Comparisons: Potonié & Kremp (1956) point out that there are transitional forms between *Lycospora* Schopf et al. emend. Potonié & Kremp, 1954 and some *Densosporites* (Berry) Butterworth et al. in Staplin & Jansonius (1964). *Cirratriradites* Wilson & Coe, 1940 has the same structure but the original diagnosis notes one or a few foveae at the distal pole.

Lycospora culpa Allen, 1965

Pl. 88, figs 5-13, Pl. 89, figs 1, 2

1965 *Lycospora culpa* Allen, p. 713, Pl. 98, figs 7, 8.
1968 *Zonotriletes* sp. 5; Jardiné & Yapaudjian, Pl. 2, figs 4, 5.

Description: Zonate trilete spore with amb subcircular to subtriangular. Laesurae straight, accompanied by labra up to 3 µm wide in overall width, extending to the inner or outer margin of the zona. The central body conformable with the zona outline, its radius equals about 8/10 to 9/10 amb radius. Exine of the central body 1.5-3 µm thick equatorially. The thin equatorial flange is generally up to 6 µm wide. Zona can extend locally over the proximal face. Proximal surface laevigate and distal surface sculptured with small densely spaced grana and coni, less than 1 µm high and wide.

Dimensions: 32 (41) 48 µm, 12 specimens measured

Remark: According to Somers (1972), *Lycospora culpa* Allen, 1965 should be excluded from this genus because of the zonate nature of the equatorial flange.

Comparisons: The figured specimens of *Zonotriletes* sp. 5 in Jardiné & Yapaudjian (1968) are very similar to the present specimens but they are not described. *Lycospora uber* (Hoffmeister et al.) Staplin, 1960 is smaller and only faintly granulate. *Hymenozonotriletes millegranus*

Naumova, 1953 is bizonate and more densely sculptured. *Hymenozonotriletes limpidus* Naumova, 1953 is circular and is more densely sculptured. *Hymenozonotriletes mancus* Naumova, 1953 has a laevigate distal central area.

Stratigraphic and palaeogeographic occurrence:
• Norway: Spitsbergen; Reuterskiøldfjellet Sandstone; Siegenian (Allen, 1965).
• Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A1-A2; late Pragian-?early Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in younger strata.

Genus *Perotrilites* Couper emend. Evans, 1970

Type species: *Perotrilites granulatus* Couper, 1953.

Description: Zonate trilete spores with subcircular to subtriangular amb. Distal region sculptured with grana or coni, proximal region laevigate. Sexine fitting closely to, and as thin as, or thinner than, nexine. Equatorial flange thin, wide in proportion to diameter of intexinal body. Low labra may border laesurae.

***Perotrilites caperatus* (McGregor) Steemans, 1989**

Pl. 89, figs 3-11

1954 Spore type C5; Radforth & McGregor, Pl. 2, fig. 36.
1966 Unidentified; McGregor & Owens, Pl. 4, figs 20, 21.
1973 *Camptozonotriletes caperatus* McGregor, p. 52, Pl. 7, figs 1, 2.
1981 *Camptozonotriletes* cf. *aliquantus*; Steemans, p. 53, Pl. 2, fig. 14.
1981 *Camptozonotriletes* sp. D; Steemans, p. 53, Pl. 2, fig. 1.
1981 *Camptozonotriletes* cf. *caperatus*; Streel et al., p. 184, Pl. 3, fig. 14.
1981 *Camptozonotriletes* sp. F; Streel et al., p. 184, Pl. 3, fig. 15.
1989 *Perotrilites caperatus* (McGregor) Steemans, p. 150, Pl. 42, figs 12-14, Pl. 43, figs 1, 2.
2006 *Camptozonotriletes*? *caperatus* McGregor; Wellman, p. 190, Pl. 18, figs a-c.

Description: Trilete zonate-camerate spores with subcircular to broadly triangular amb. Laesurae simple, commonly gaping, often extending on to the equatorial flange, may be difficult to detect because of the close, verrucose-vermiculate sculpture of the sexine over the distal hemisphere of the central body. Central body radius equals 1/2 to 5/6 amb radius. Exine of the central body 1-2 µm thick equatorially. The equatorial flange is of equal width all around the body. Sexine folded into radial wrinkles commonly about 1-2 µm wide, extending from the proximal attachment region outward over the equator of the body. A thin line parallel to the outer margin of zona is visible and delimits camerate structure, resulting in a bizonate appearance. Camera width equals 1/5 to 3/4 zona width. Sexine laevigate or sculptured distally with coni less than 1 µm wide and high and about 0.5-2 µm apart. Sexine of central body densely sculptured distally with irregular verrucae-vermiculae, commonly 0.5-1 µm wide, sometimes forming an imperfect reticulum.

Dimensions: 54 (68) 95 µm, 9 specimens measured.

Remark: The zonate, zonate-camerate and camerate conditions may be difficult to differentiate in compressed specimens.

Comparisons: *Camptozonotriletes aliquantus* Allen, 1965 is both zonate and camerate, like *Camptozonotriletes caperatus* McGregor, 1973. According to McGregor (1973), the radially directed muri of *Camptozonotriletes aliquantus* are not similar to the fold-like structures of *Camptozonotriletes caperatus*. *Camptozonotriletes aliquantus* also differs in having prominent distal anastomosing muri. *Zonotriletes* sp. 2 in Jardiné & Yapaudjian (1968) is larger, only zonate and does not exhibit such a distal sculpture of the central body.

Stratigraphic and palaeogeographic occurrence:
- Argentina: Precordillera of Mendoza; Villavicencio Formation; Ems Interval Zone; late Pragian-early Emsian (Rubinstein & Steemans, 2007).
- Belgium: Dinant, Neufchâteau-Eifel, Verviers Synclinoriums and Theux Window; Siα Interval Zone-AB Oppel Zone, late Lochkovian-Emsian (Steemans, 1989).
- Brazil: Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Quebec; Gaspé Peninsula; York River and Battery Point Formations; *caperatus-emsiensis* and *annulatus-lindlarensis* Oppel Zones, Emsian (McGregor & Owens, 1966; McGregor, 1973, 1977). Ontario, Moose River Basin; Stooping River Formation, *caperatus-emsiensis* to *annulatus-lindlarensis* Provisional Assemblage Zone; Siegenian-Emsian (McGregor & Camfield, 1976).
- Germany: Siegerland; Z Interval Zone-AB Oppel Zone; late Lochkovian-Emsian (Steemans, 1989).
- Morocco: Doukkala Basin; Palynozone DI1; late Pragian (Rahmani-Antari & Lachkar, 2001).
- Poland: Pionki; Zwoleń Formation; Siegenian-Emsian (Turnau, 1986). Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; FD Oppel Zone; uppermost Emsian (Turnau et al., 2005).
- Romania: Moesian Platform, Chilia well; G Interval Zone; late Lochkovian (Steemans, 1989).
- Tunisia: Borehole MG-1, Ouan-Kasa Formation, A2-A4; ?late Pragian-Eifelian, the specimens of A2 are reworked in younger strata and the isolated occurrence of the uppermost specimen may be due to reworking too.

Scotland, Rhynie outlier; White Sandstones, Shales and Muddy Sandstones, Lower Shales, Rhynie Chert, Upper Shales, and Windyfield Sandstones and Shales and Chert Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

Genus *Raistrickia* Schopf et al. emend. Potonié & Kremp, 1954

Type species: *Raistrickia grovensis* Schopf et al., 1944.

Description: Trilete spores, exine mostly decorated with bacula, but in many cases distinct coni or spinae are interspersed among these. The base of the individual bacula is not or only marginally broader than the rest of its body, or widens only at the very root. At their tip the bacula are usually not or barely tapered or rounded, but rather abruptly blunted. The width from one baculum to the next may vary widely and even as much as double. The tips of the bacula are often dissected into two to numerous papillae.

***Raistrikia* sp. 1**

Pl. 90, figs 1-8

? 1968 *Raistrickia* sp.; Jardiné & Yapaudjian, Pl. 2, fig. 7.

Description: Trilete spores with subcircular to subtriangular, or occasionally oval amb. Laesurae straight, simple, length 5/10-9/10 the spore radius. Exine commonly 1.5-4 µm thick equatorially, homogeneous or punctate. Proximo-equatorial and distal regions irregularly sculptured with a variable mixture of coni, spinae, bacula and verrucae with blunt, flat-topped, pointed, or widened tips. Sculptural elements, 1-12 µm wide at base, 2-20 µm high, mostly longer than wider, are very variable in shape and in density, Contact areas laevigate or with sculpture like that of the distal face but reduced in size.

Dimensions: 55 (68) 96 µm, 13 specimens measured.

Comparisons: *Raistrickia aratra* Allen, 1965 is more densely sculptured with less elongated elements. *Raistrickia* cf. *clavata* Hacquebard, 1957 in Richardson (1965) has few sculptural elements around the equator and these are not really elongated as in *Raistrickia* sp. 1. *Raistrickia* sp. in Jardiné & Yapaudjian (1968) could be assignable to Raistrickia sp. 1, if a diagnosis existed.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A5-A6; Eifelian-Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A7-A8; Givetian-?early Frasnian.

***Raistrikia* sp. 2**

Pl. 91, figs 1-12

Description: Trilete spores with subtriangular to triangular amb. Laesurae straight, simple, length 6/10-9/10 the spore radius, but often indistinct because the proximal face seems to be usually torn. Exine 1-2 µm thick equatorially. Equatorial and distal regions usually irregularly sculptured with bacula, 1-3 µm wide at base, 2-5 µm high, 1-8 µm apart. The base of elements is generally flared. The tops of elements are flat or slightly concave, with generally a bifurcate shape. Contact areas laevigate.

Dimensions: 27 (36) 48 µm, 25 specimens measured.

Remark: Some of these specimens are preserved in tetrad.

Comparisons: *Raistrickia* sp. in McGregor (1973) may correspond to the description of the specimens presented here but it is subcircular and few specimens have been observed in the Gaspé assemblages. *Cymbosporites dammamesis* Steemans, 1995 is patinate and more densely sculptured with generally smaller bacula.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2 and well KHRM-2; Jauf Formation; A1-A3a; late Pragian-Emsian.

Genus *Retusotriletes* Naumova emend. Streel, 1964

Type species: *Retusotriletes simplex* Naumova, 1953.

Description: Trilete spores with subcircular to subtriangular amb. Contact areas well defined by curvaturae. Exine laevigate.

***Retusotriletes* cf. *R. crassus* Clayton et al., 1980**

Pl. 91, figs 13-18

cf. 1980 *Retusotriletes crassus* Clayton et al., p. 97, Pl. 3, figs d-h.
2005 *Retusotriletes* sp. A; Hashemi & Playford, p. 338, Pl. 2, fig. 12.

Description: Trilete spores with subcircular amb. Laesurae straight, simple or accompanied by labra, up to 3 µm in overall width, length 3/5 to 9/10 the spore radius, connected by curvaturae perfectae. Exine laevigate or scabrate, 1-2 µm thick. A darker proximal zone is present in each contact area. These thickened zones are variable in size and shape, and situated towards the proximal pole between the laesurae.

Dimensions: 49 (58) 77 µm, 8 specimens measured.

Comparison: *Retusotriletes crassus* Clayton et al., 1980 is slightly different because the latter has simple laesurae which, in addition, are rarely seen. *Retusotriletes aureoladus* Rodriguez, 1978a is smaller and has a paler ring around the proximal thickened zones. *Retusotriletes* sp. A in Hashemi & Playford (2005) is similar but slightly smaller.

Stratigraphic and palaeogeographic occurrence:
- Australia: Adavale Basin; Eastwood Formation and Lissoy Sandstone; *annulatus-sextantii* and *devonicus-naumovii* Assemblage Zones; Emsian-early Givetian (Hashemi & Playford, 2005).
- Saudi Arabia: Borehole JNDL-1 and wells KHRM-2, UTMN-1830,YBRN-1; Jauf and Jubah Formations; A2-A7; ?late Pragian-Givetian.

***Retusotriletes goensis* Lele & Streel, 1969**

Pl. 92, fig. 1

1969 *Retusotriletes goensis* Lele & Streel, p. 93, Pl. 1, figs 12-16.
non 1978b *Retusotriletes goensis* Lele & Streel; Rodriguez, p. 420, Pl. 2, fig. 25.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple, length 4/5 to 9/10 the spore radius, connected near the equator by curvaturae perfectae. Exine laevigate, about 1 µm thick or less. Dark apical area subcircular to subtriangular extending to 1/5 to 1/2 the spore radius. Few folds common.

Dimensions: 52 (78) 104 µm, 2 specimens measured.

Comparisons: *Retusotriletes rotundus* (Streel) emend. Lele & Streel, 1969 and *Retusotriletes tenerimedium* Tchibrikova, 1959 have a subtriangular apical area which is differentiated into two zones. *Retusotriletes* cf. *micrograulatus* (Vigran) Streel, 1967 is sculptured with micro-pila.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Verviers Synclinorium; Goé; Pepinster Formation; Givetian (Lele & Streel, 1969). The age was reviewed at the time of the cartography of the region and now is considered as late Eifelian (Laloux et al., 1996). Dinant Synclinorium; late Emsian (Lessuise et al., 1979).
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005).
• Libya: Ghadames Basin; Palynozones 5-6; early Eifelian-early Givetian (Moreau-Benoit, 1989).
• Saudi Arabia: Wells HWYH-956, YBRN-1; Jauf and Jubah Formations; Jauf and Jubah Formations; A2-A6; ?late Pragian-Givetian.

***Retusotriletes maculatus* McGregor & Camfield, 1976**

Pl. 92, figs 2-8

1967 *Leiotriletes* sp.; Mortimer, Pl. 1, fig. B.
1968 Spore trilète à papilles proximales sp. 4; Jardiné & Yapaudjian, Pl. 1, fig. 16.
1976 *Retusotriletes maculatus* McGregor & Camfield, p. 26, Pl. 1, fig. 6

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple or occasionally accompanied by narrow folds, extending almost to the equator, commonly connected near the equator by curvaturae perfectae. Exine laevigate, 1-2.5 µm thick. A dark, subcircular papilla, 4-9 µm in greatest diameter, is situated near the mid-point of each interradial area.

Dimensions: 29 (41) 55 µm, 12 specimens measured.

Remarks: Jardiné & Yapaudjian (1968) and Mortimer (1967) figure similar spores. *Ambitisporites* sp. B in Richardson & Ioannides (1973) is smaller and has an equatorial crassitude. *Retusotriletes ocellatus* McGregor (1973) has also proxmal papillae but is much larger. *Ambitisporites eslae* (Cramer & Díez) Richardson et al., 2001 is cingulate. *Scylaspora elegans* Richardson et al., 2001 is proximally microrugulate. However, this sculpture is more easily seen under the SEM.

Stratigraphic and palaeogeographic occurrence:
• Bolivia: Cordillera Oriental, Laurani section; Santa Rosa Formation; Gedinnian (McGregor, 1984). Bermejo-La Angostura; Los Monos-Iquiri Formation; ?AP Oppel Zone; late Emsian (Perez-Leyton, 1990).
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Canada: Ontario, Moose River Basin; Kenogami River and Stooping River Formations; *mircrornatus-proteus* to *caperatus-emsiensis* Provisional Assemblage Zone; Gedinnian-Emsian (McGregor & Camfield, 1976).
• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian-early Emsian (Le Hérissé, 1983).

• Libya: Ghadames Basin; Palynozones 1-4; early Lochkovian-earliest Eifelian (Moreau-Benoit, 1989). Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' and Tadrart Formations; *Apiculiretusispora* sp. E Biozone? to MN Oppel Zone?; middle Pridoli-early Lochkovian (Rubinstein & Steemans, 2002). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; the rare and isolated occurrence of some specimens in Eifelian and Givetian strata are probably due to reworking.
• Poland: Random-Lublin area; Borehole Terebin IG 5; Czarnolas Formation; MN Oppel Zone; Lochkovian (Turnau et al., 2005).
• Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3, 4 and wells FWRH-1, HWYH-956, KHRM-2, UTMN-1830; Jauf Formation; A1-A3a; late Pragian-late Emsian.
• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; Assemblage 2 to 4; ?late Pragian-late Emsian, the isolated occurrence of two specimens in Eifelian strata are probably due to reworking.
• United Kingdom: Welsh Borderland and Southern Britain; Senni Beds; Siegenian (Mortimer, 1967).

Retusotriletes rotundus **(Streel) emend. Lele & Streel, 1969**

Pl. 92, figs 9-11, Pl. 93, figs 1, 2

1964 *Phyllothecotriletes rotundus* Streel, Pl. 1, figs 1, 2.
1967 *Retusotriletes rotundus* (Streel) Streel, p. 25, Pl. 1, figs 11, Pl. 2, figs 16, 17.
1969 *Retusotriletes rotundus* (Streel) emend. Lele & Streel, p. 94, Pl. 1 figs 18-20.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple, length 4/5 to 9/10 the spore radius, connected near the equator by curvaturae perfectae. Exine laevigate, about 1 µm thick. Apical area subtriangular, with convex sides, extending commonly to 1/5 to 1/3 the spore radius, differentiated into two zones: an inner lighter zone with a relatively thinner exine than elsewhere, and an outer darker zone with a relatively thicker and more or less diffused outline exine. Relative proportion and prominence of the two zones variable. Few folds common.

Dimensions: 57 (85) 108 µm, 10 specimens measured.

Comparisons: *Retusotriletes tenerimedium* Tchibrikova, 1959 also has a differentiated proximal face but the thinner subtriangular apical area extends to about the 1/3 of the spore radius. Moreover this taxon is smaller and equatorially thicker. The dark apical area of *Retusotriletes goensis* Lele & Streel, 1969 may be larger and is not differentiated into two zones. *Retusotriletes triangulatus* (Streel) Streel, 1967 has a subtriangular thickened zone at the proximal pole but with concave sides.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Gazelle Supérieure Formation; Famennian (Boumendjel et al., 1988). Illizi Basin; Oued Karkaï Formation; Pridoli-Lochkovian (Moreau-Benoit et al., 1992).
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988). Canning Basin; middle Givetian (Grey, 1991). Adavale Basin; Eastwood Formation and Lissoy Sandstone; *annulatus-sextantii* and *devonicus-naumovii* Assemblage Zones; Emsian-early Givetian (Hashemi & Playford, 2005).

• Belgium: Verviers Synclinorium; Goé; Pepinster Formation; early Givetian (Streel, 1964; Lele & Streel, 1969). The age was reviewed at the time of the cartography of the region and now is considered as late Eifelian (Laloux et al., 1996). Dinant Synclinorium and Bolland Borehole; early Siegenian-early Couvinian (Streel, 1967). Dinant Synclinorium; Eifelian (Lessuise et al., 1979).
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River and Williams Island Formations; *annulatus-lindlarensis* to *devonicus-orcadensis* Provisional Assemblage Zone; Emsian-Givetian (McGregor & Camfield, 1976). Arctic Archipelago, Melville Island; Cape De Bray, Weatherall and Hecla Bay Formations; Eifelian-early Givetian (McGregor & Camfield, 1982).
• China: Yunnan; Assemblage Zone IV; late Siegenian-early Emsian (Gao Lianda, 1981).
• France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 1 to 3; Pragian and late Siegenian (Le Hérissé, 1983).
• Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; late Emsian-early Eifelian (Riegel, 1973). Schwarzbachtal 1 borehole; late Eifelian-early Givetian (Streel & Paproth, 1982).
• Libya: Ghadames Basin; Palynozones 1-5; early Lochkovian-early Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A6; Eifelian-Givetian.
• Morocco: Doukkala and Essaouira Basins; Palynozones DI1-DM2; late Pragian-Givetian (Rahmani-Antari & Lachkar, 2001).
• Poland: Western Pomerania; Studnica, Jamno and Miastko Formations; RL-Ex Zone; late Eifelian-Givetian (Turnau, 1996).
• Saudi Arabia: Boreholes BAQA-1, JNDL-4, S-462 and wells HWYH-956, KHRM-2, UTMN-1830, YBRN-1; Jauf and Jubah Formation; A2-A7; ?late Pragian-Givetian.
• Spain: Asturias; *Gosselatia* Sandstone Formation; Eifelian-Givetian (Cramer, 1969).
• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.
• United Kingdom: Welsh Borderland and Southern Britain; Senni Beds; Siegenian (Mortimer, 1967). Shetland, Fair Isle; Ward Hill, Observatory and Bu Ness Groups; late Givetian (Marshall & Allen, 1982). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).
• U.S.A.: Georgia; ?Emsian-Eifelian (Ravn & Benson, 1988).

Retusotriletes tenerimedium Tchibrikova, 1959

Pl. 94, figs 3-11

1959 *Retusotriletes tenerimedium* Tchibrikova, p. 52, Pl. 5, figs 9, 10.
1966 *Retusotriletes tenerimedium* Tchibrikova; de Jersey, p. 7, Pl. 2, fig. 4.
1968 *Retusotriletes tenerimedium* Tchibrikova; Schultz, p. 14, Pl. 1, fig. 15.
1967 *Retusotriletes triangulatus* (Streel) Streel; Richardson, Pl. 2, fig. A.

Description: Trilete spores with subcircular amb. Laesurae straight, simple or accompanied by narrow labra, up to 2 µm in overall width, length 1/2 to 9/10 the spore radius, connected by curvaturae perfectae. Curvaturae thickened on the badly preserved specimens, up to 3 µm wide. Exine scabrate or laevigate, 1-5 µm thick equatorially. Proximal exine differentially thickened. Thinner subcircular to subtriangular apical zone (diameter about 1/3 the spore radius) surrounded by a curved, thicker, darker zone, 2-10 µm, characterize by a sharp inner outline and a commonly diffused outer outline.

Dimensions: 36 (53) 86 µm, 31 specimens measured.

Comparison: *Retusotriletes asturicus* (Rodriguez) comb. nov. has a less pronounced subtriangular darker apical zone and elevated curvaturae and is commonly smaller.

Stratigraphic and palaeogeographic occurrence:
• Germany: Soutwestern Eifel; Wetteldorfer Formation; Emsian (Lanninger, 1968). Rheinland, Eifel; Klerfer Formation; Emsian (Schultz, 1968).
• Libya: Borehole A1-69; Awaynat Wanin II Formation; the isolated occurrence of the specimen in Givetian strata may be due to reworking.
• Saudi Arabia: BAQA-1 and wells ABSF-29, FWRH-1, HWYH-956, NFLA-1, SDGM-462, UTMN-1830; Jauf and Jubah Formations; A2-A3b; ?late Pragian-?early Eifelian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; the isolated occurrence of the specimen in Eifelian strata may be due to reworking.

Retusotriletes triangulatus **(Streel) Streel, 1967**

Pl. 94, figs 1-7

1964 *Phyllothecotriletes triangulatus* Streel, p. 5, Pl. 1, figs 3-5.
1967 *Retusotriletes triangulatus* (Streel) Streel, p. 24.
2006 *Retusotriletes* cf. *triangulatus* (Streel) Streel; Wellman, p. 175, Pl. 10, figs i-k.

Description: Trilete spores with subcircular amb. Laesurae straight, simple, length 3/4 to 9/10 of the spore radius, connected by curvaturae perfectae. Exine laevigate or scabrate, 1-2 µm thick. A dark subtriangular apical area with concave sides extends commonly to 1/3 to 2/3 the spore radius along the laesurae. An inner lighter zone of the same shape (with a thinner exine) is often present at the proximal pole. Few folds are common.

Dimensions: 40 (66) 87 µm, 22 specimens measured.

Comparison: *Retusotriletes rotundus* (Streel) emend. Lele & Streel, 1969 has a subtriangular apical area, with convex sides, which extends to 1/5 to 1/3 the spore radius.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Verviers Synclinorium; Goé; Pepinster Formation; early Givetian (Streel, 1964; Lele & Streel, 1969). The age was reviewed at the time of the cartography of the region and now is considered as late Eifelian (Laloux et al., 1996). Dinant Synclinorium and Bolland Borehole; early Siegenian-early Couvinian (Streel, 1967). Dinant Synclinorium; Eifelian (Lessuise et al., 1979).
• Bolivia: Bermejo-La Angostura; Saipuru Formation; LE Interval Zone; Famennian (Perez-Leyton, 1990).
• China: Eastern Yunnan, Qujing District, Cuifengshan; Xujiachong Formation; Emsian (Lu Lichang & Ouyang Shu, 1976). Guangxi and Yunnan; Assemblage Zones III-IV; late Gedinnian-early Emsian (Gao Lianda, 1981).

• Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Eifel, Prüm Syncline; Wiltz, Lauch, Nohn, Ahrdorf, Junkerberg, Freiling and Ahbach Formations; Assemblages B, E-N; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975).

• Libya: Cyrenaica; AD-Lem Interval Zone; early Givetian (Streel et al., 1988). Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *tripapillatus-spicula*? to *Apiculiretusispora* sp. E Biozone?; ?Ludlow-middle Pridoli (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A7; Emsian-Givetian.

• Poland: Western Pomerania; Studnica, Jamno and Miastko Formations; RL-Ex Zone; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999). Pomerania-Kujawy region; Polskie Laki IG-1; early-middle Eifelian (Turnau & Matyja, 2001).

• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-4, S-462 and wells ABSF-29, FWRH-1, HWYH-956, KHRM-2, NFLA-1, SDGM-462, UTMN-1830, YBRN-1; Jauf and Jubah Formations; A1-A6; late Pragian-Givetian.

• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3a-A5; Emsian-Eifelian.

• United Kingdom: Scotland, Rhynie outlier; White Sandstones, Shales and Muddy Sandstones, Lower Shales, Rhynie Chert, Upper Shales, Windyfield Sandstones and Shales and Chert Units, and Longcroft Tuffs Units; *polygonalis-emsiensis* Spore Assemblage Biozone or PoW Oppel Zone; late Pragian-?earliest Emsian (Wellman, 2006).

***Retusotriletes* sp. 1**

Pl. 95, figs 1-4

Description: Trilete spores with subcircular amb. Laesurae straight, simple, length 4/5 to 9/10 the spore radius, connected near the equator by curvaturae perfectae. Exine scabrate, 1-2 µm thick. An apical area triangular with more or less straight sides commonly extends to 2/5 to 3/5 the spore radius along the laesurae. Outer margin of the apical area delimited by a more or less diffused darker zone, 1-4 µm wide. The triangular area situated at proximal pole as thick as the rest of the spore body. Few folds common.

Dimensions: 51 (62) 81 µm, 4 specimens measured.

Comparisons: *Retusotriletes triangulatus* (Streel) Streel, 1967 is characterized by a more pronounced dark apical area subtriangular with concave sides. *Retusotriletes rotundus* (Streel) emend. Lele & Streel, 1969 has a proportionately less developed apical area subtriangular with convex sides. *Calamospora atava* McGregor, 1973 figured in McGregor & Camfield, 1982 has a similar apical area but does not have curvaturae and is commonly folded.

Stratigraphic and palaeogeographic occurrence:

• Libya: Borehole A1-69; Awaynat Wanin II Formation; A7; Givetian.

• Saudi Arabia: Borehole S-462; Jubah Formation; A7; Givetian.

• Tunisia: Borehole MG-1; Awaynat Wanin II Formation; A8; Givetian-?early Frasnian.

Retusotriletes sp. 2

Pl. 95, figs 5-13

Description: Trilete spores with subcircular amb. Laesurae straight, simple or rarely accompanied by narrow labra, about 1 µm in overall width, length 2/3 to 3/4 the spore radius, connected by curvaturae perfectae not always well-visible. Exine laevigate, commonly 1-2 µm thick. A darker apical area subtriangular, with sharp margins and straight, slightly concave or convex sides, extends almost or to the end of laesurae. This thickened area is 3-6 µm wide interradially in greatest width. An inner lighter subtriangular area (with a thinner exine), generally with slightly concave sides is present at the proximal pole.

Dimensions: 34 (42) 54 µm, 10 specimens measured.

Remark: *Retusotriletes* sp. 2 corresponds to specimens of *Diaphanospora* sp. 1 in which the outer layer is missing. Indeed, the very delicate outer layer of the second species may have been torn off by sedimentary or taphonomic processes. The two form-species *Retusotriletes* sp. 2 and *Diaphanospora* sp. 1 represent thus a unique biological species with the different states of preservation between both. They are grouped in the *Diaphanospora* sp. 1 Morpon (Tab. 1, p. 185). Besides they sometimes co-occur and have comparable stratigraphical ranges.

Comparison: *Retusotriletes tenerimedium* Tchibrikova, 1959 has an apical lighter area subtriangular with convex sides. Moreover, the darker area is diffuse at its outer margin and does not reach the end of laesurae. *Retusotriletes rotundus* (Streel) emed. Lele & Streel, 1969 and *Retusotriletes triangulatus* (Streel) Streel, 1967 are larger and their thickened apical area does not extend to the end of laesurae.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin I Formation; the isolated occurrence of the unique specimen in Eifelian strata may be due to reworking.
- Saudi Arabia: Wells FWRH-1, HWYH-956 and UTMN-1830; A2-A3a; ?late Pragian-Emsian.

Genus *Rhabdosporites* Richardson emend. Marshall & Allen, 1982

Type species: *Rhabdosporites langii* (Eisenack) Richardson, 1960.

Description: Trilete, camerate spores which has no limbus. Equatorial outline of both sexine and inner body (nexine) subcircular to elliptical. Spores originally spherical, or nearly so, with body attached on the proximal side. Sexine possesses an external ornamentation which covers the whole surface and consists of evenly distributed, closely packed rods which are parallel sided elements and have truncated tips.

Comparisons: Camerate spores with coarser sculpture are included in other genera (e.g. *Grandispora* Hoffmeister el al. emend. Neves & Owens, 1966). In widening the generic concept of *Rhabdosporites* of Richardson (1960), Marshall & Allen (1982) were aware of the close similarity between small specimens of *Rhabdosporites* and *Geminospora* Balme (1962), which are mentioned by other authors (e.g. Lele & Streel, 1969). *Geminospora* Balme, 1962 is typified by a thin-walled nexine either closely appressed to, or showing a variable degree of separation from, a sculptured sexine with a thickened distal surface. Further evidence for the similarity or inability to easily distinguish between *Rhabdosporites* Richardson emend. Marshall & Allen, 1982 and *Geminospora* Balme, 1962 comes from the study of in situ spores (Allen, 1980), where spores assignable to both genera are recorded from closely related progymnosperms (Marshall & Allen, 1982).

Rhabdosporites langii (Eisenack) Richardson, 1960

Pl. 96, figs 1-6

1925 Type B; Lang, p. 256, Pl. 1, figs 3-6.
1944 *Triletes langi* Eisenack, p. 112, Pl. 2, fig. 4.
1959 Spores of *Milleria* (*Protopteridium*) *thomsonii* (Dawson) Lang; Obrhel, p. 387, Pl. 2, fig. 6.
1960 *Rhabdosporites langi* (Eisenack) Richardson, p. 54, Pl. 14, figs 8, 9, text-figs 4, 6B.
1963 *Rhabdosporites firmus* Guennel, p. 256, fig. 12.
1964 *Calyptosporites plicatus* Vigran, p. 19, Pl. 6, fig. 4.
1965 *Rhabdosporites parvulus* Richardson (pars), p. 588, Pl. 93, figs 5, 6.
1967 Spores of *Tetraxylopteris schmidtii* Beck; Bonamo & Banks, p. 765, figs 34-36, 38, 40.
1969 ?*Rhabdosporites parvulus* Richardson; Lele & Streel, p. 103, Pl. 3, fig. 66-68.
1971 *Rhabdosporites micropaxillus* Owens, p. 49, Pl. 15, figs 3-7.
1971 Spores of *Milleria* (*Protopteridium*) *thomsonii* (Dawson) Lang; Leclercq & Bonamo, p. 98, Pl. 36, figs 24-33.
1972 *Rhabdosporites* n. sp.; McGregor & Uyeno, Pl. 3, fig. 5.
1974 *Rhabdosporites* sp.; Hamid, p. 202, Pl. 10, fig. 1.
1975 *Rhabdosporites* sp.; Tiwari & Schaarschmidt, p. 40, Pl. 21, fig. 7.
1977 Spores of *Rellimia thomsonii* (Dawson) Leclercq & Bonamo; Bonamo, p. 1277, figs 6, 7.

Description: Trilete camerate spores with circular to subtriangular oval amb. Exine two-layered, the inner layer (nexine) completely surrounded by sexine and attached to it in the region of the proximal pole. Laesurae simple or accompanied by labra, up to 4 µm in overall width, tapering towards the equatorial margin, but usually obscured by large folds which parallel their length. Nexine (inner body) circular to subtriangular, laevigate, darker than the sexine, 1-2 µm thick. Inner body radius equals 3/5 to 9/10 the spore radius. Sexine less than 1 µm thick and sculptured outside contact areas with densely packed coni, grana, generally less than 1 µm and up to 0.5 µm wide at base.

Dimensions: 62 (93) 128 µm, 69 specimens measured.

Remarks: *Rhabdosporites parvulus* Richardson, 1965 differs primarily in size in being smaller and has in addition a size ratio different from typical *Rhabdosporites langii* (Eisenack) Richardson, 1960. However, populations of *Rhabdosporites langii* (Eisenack) Richardson, 1960 in this study include continuous variation to specimens as small as *Rhabdosporites parvulus* Richardson, 1965 which encompass size variation defining the latter. As in Marshall & Allen (1982) and Marshall (1996), *Rhabdosporites parvulus* Richardson, 1965 is regarded as a junior synonym of *Rhabdosporites langii* (Eisenack) Richardson, 1960. However, the situation is more complex. According to Marshall (1996), the specimens attributed by Richardson (1965) to *Rhabdosporites parvulus* include both *Geminospora lemurata* Balme emend. Playford, 1983 and small specimens of *Rhabdosporites langii* (Eisenack) Richardson, 1960.

Comparisons: *Rhabdosporites minutus* Tiwari & Schaarschmidt, 1975 is commonly smaller and clearly less folded. In addition, this species often has an asymmetrical appearance with an elongate subtriangular or oval amb. Normally the separation of *Geminospora lemurata* Balme emend. Playford, 1983 and *Rhabdosporites langii* (Eisenack) Richardson, 1965 presents no difficulty as the latter is significantly larger and has a nexine which is significantly smaller than the sexine and thus well-developed cameration. In addition, its sexine is thinner and folded with the folds continuous across a significant proportion of the sexine diameter. Typically *Geminospora lemurata* Balme emend. Playford, 1983 shows only a small separation between nexine and sexine with the sexine being held relatively rigid on account of its greater thickness such that the nexine is usually centrally placed. *Geminospora svalbardiae* (Vigran) Allen, 1965 is often folded as *Rhabdosporites langii* (Eisenack) Richardson, 1965 but has a slightly thicker sexine and ornamentation is coarser.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Illizi Basin, borehole TRN 3; Alrar Formation; early Givetian (Boumendjel et al., 1988). Tin Meras Formation; middle Givetian-Frasnian (Moreau-Benoit et al., 1992).
- Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988). Adavale Basin; Etonvale Formation; *optivus-triangulatus* and *ovalis-bulliferus* Assemblage Zones; late Givetian-early Frasnian (Hashemi & Playford, 2005).
- Belgium: Verviers Synclinorium; Goé; Pepinster Formation; Givetian (Lele & Streel, 1969). The age was reviewed at the time of the cartography of the region and now is considered as late Eifelian (Laloux et al., 1996). Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).
- Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; AD Oppel Zone-LE Interval Zone; early or middle Eifelian-Famennian (Perez-Leyton, 1990).
- Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira Formation; AD-Lem Interval Zone to Zone IV; early Givetian-earliest Famennian (Loboziak et al., 1992b). Amazon Basin; Ererê Formation; LLi Interval Zone; early Givetian (Melo & Loboziak, 2003).
- Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Arctic Archipelago, Queen Elisabeth, Melville and Bathurst Islands; Bird Fiord, Cape De Bray, Weatherall, Hecla Bay and Griper Bay Formations; Eifelian-Frasnian (Owens, 1971; McGregor & Uyeno, 1972). Ontario, Moose River Basin; Stooping River, Kwataboahegan and Williams Island Formations; *annulatus-lindlarensis* to *devonicus-orcadensis* Provisional Assemblage Zone; Emsian-Givetian (McGregor & Camfield, 1976).
- China: Guangxi, Guizhou and Yunnan; Assemblage Zones V-VI; Eifelian-Givetian (Gao Lianda, 1981).
- France: Boulonnais; Blacourt, Beaulieu and Ferques Formations; late Givetian-Frasnian; TLa-BM Oppel Zones (Brice et al., 1979; Loboziak & Streel, 1980, 1988).
- Germany: Rheinland, Lindlar; Eifelian (Riegel, 1968). Rheinland, Eifel; Lauch and Nohn Formations; early Eifelian (Riegel, 1973). Eifel, Prüm Syncline; Berle, Wiltz, Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach and Loogh Formations; Assemblages A, B, E-O; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; Eifelian-Givetian (Loboziak et al., 1990).
- Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
- Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone IV; Eifelian-early Givetian (Ghavidel-Syooki, 2003).

• Libya: Cyrenaica; AD Oppel Zone; late Eifelian-early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 5-8; middle Eifelian-late Frasnian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6-A8; Givetian-?early Frasnian.
• Morocco: Doukkala and Essaouira Basins; Palynozones DM1-DS1; Eifelian-Frasnian (Rahmani-Antari & Lachkar, 2001).
• Norway: Spitsbergen; cannel coal bed; Givetian (Vigran, 1964).
• Poland: Western Pomerania; Studnica, Jamno, Miastko and Sianowo Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999).
• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).
• Russia: central and eastern parts of European Russia; Staryi Oskol Group; Ex Zone; middle Givetian (Arkhangelskaya & Turnau, 2003).
• Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; A6-A8; Givetian-?early Frasnian.
• Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A6-A8; Givetian-?early Frasnian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Wick Flagstone Group, Achanarras fish Beds, Thurso Flagstone and Eday groups; Eifelian-Givetian (Richardson, 1965). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

Rhabdosporites minutus **Tiwari & Schaarschmidt, 1975**

Pl. 97, figs 1-9

1975 *Rhabdosporites minutus* Tiwari & Schaarschmidt, p. 39, Pl. 21, figs 4-6.

Description: Trilete camerate spore with subcircular, subtriangular or oval amb. Laesurae straight, simple or accompanied by labra, up to 2 µm in overall width, length 2/3 to the whole inner body radius. Laesurae often asymmetrical with one angle between two of the laesurae smaller than the other two. Nexine (inner body) 1-2 µm thick, laevigate, more or less comformable with sexine. Inner body radius equals 3/4 to 9/10 the spore radius. Sexine outside contact areas sculptured with densely packed coni, grana, less than 1 µm high and wide.

Dimensions: 42 (59) 75 µm, 38 specimens measured.

Comparisons: *Rhabdosporites langii* (Eisenack) Richardson, 1960 is larger, commonly having smaller body in relation to the saccus, the latter being much folded. *Rhabdosporites scamnus* Allen, 1965 is larger and is typically folded distally. *Apiculiretusispora brandtii* Streel, 1964 presents the same kind of scultpure and the sexine is irregularly detached from nexine on some specimens whereas *Rhabdosporites minutus* Tiwari & Schaarschmidt, 1975 has a sexine completely detached equatorially from the spore body. The two species could belong to a same miospore lineage. Therefore, the two species are included in the *Apiculiretusispora brandtii* Morphon (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3a-A6; Emsian-Givetian.
• Germany: Eifel, Prüm Syncline; Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages E-G, I-P; early Eifelian-early Givetian (Tiwari & Schaarschmidt, 1975).
• Luxembourg: Oesling region; Pow-FD Oppel Zones; middle-late Emsian (Steemans et al., 2000).
• Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes JNDL-1, 3, 4 and well KHRM-2; Jauf and Jubah Formations; A3a-A4; Emsian-Eifelian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A6; ?late Emsian-Givetian, the isolated occurrence of the specimen from the Awaynat Wanin III Formation may be due to reworking.

Rhabdosporites streelii **Marshall, 1996**

Pl. 97, figs 10, 11

1965 *Rhabdosporites* sp. A; Richardson, p. 589, Pl. 93, fig. 7.
1967 *Rhabdosporites* sp. 2; Hemer & Nygreen, tab. 1, Pl. 2, fig. 5.
1967 spores of *Tetraxylopteris schmidtii* Bonamo & Banks, p. 765, figs 32-35.
1969 ?*Rhabdosporites Langi* (Eisenack) Richardson; Lele & Streel, p. 102, Pl. 3, fig. 65.
1972 ?*Calyptosporites* sp. A; Mortimer & Chaloner, p. 18, Pl. 2, fig. 4.
1976 *Rhabdosporites* sp. A, Richardson; Massa & Moreau-Benoit, tab.-fig. 5.
1980b *Rhabdosporites* sp. A, Richardson; Moreau-Benoit, p. 31, Pl. 10, fig. 4.
1982 *Rhabdosporites* sp. A, Marshall & Allen, p. 297, Pl. 32, figs 6, 7.
? 1988 *Rhabdosporites langii* (Eisenack) Richardson; Loboziak et al., p. 358, Pl. 7, fig. 1.
? 1989 *Rhabdosporites langii* (Eisenack) Richardson; Loboziak & Streel, p. 191, Pl. 3, fig. 4.
1996 *Rhabdosporites streelii* Marshall, p. 177, Pl. 3, figs 1-5.

Description: Trilete camerate spores with circular, subcircular or oval amb. Exine three-layered, the two inner layers (endonexine and ectonexine) completely surrounded by sexine and attached to it in the region of the proximal pole. Laesurae simple or accompanied by labra, up to 4 µm in overall width, tapering towards the equatorial margin, but usually obscured by large folds which parallel their length. Endonexine circular to oval, laevigate, and 0.5-2 µm thick. Endonexine radius equals 2/3 to 4/5 the whole spore radius. Ectonexine laevigate, and less than 1 µm thick. Ectonexine radius equals 4/5 to 9/10 the spore radius. Occasionally ectonexine is more closely conformable or even appressed locally to the sexine. Sexine thin but with a limbus at equator, 2-5 µm wide. Sexine outside contact areas sculptured with densely packed coni, grana, 0.5-1.5 µm high but generally less than 1 µm and up to 1 µm wide at base.

Dimensions: 111 (133) 184 µm, 4 specimens measured.

Remarks: As *Rhabdosporites streelii* Marshall, 1996 occurs within sporangia (Bonamo & Banks, 1967) containing also *Rhabdosporites langii* (Eisenack) Richardson, 1960, it could be regarded as a variant of *Rhabdosporites langii* (Eisenack) Richardson, 1960. *Rhabdosporites streelii* Marshall, 1996 is created by splitting of the nexine into ectonexine and endonexine. It represents a distinct evolutionary development within the sporangia of *Rhabdosporites* (Richardson) Marshall & Allen, 1982. As its stratigraphical range is short, it constitutes thus a potential stratigraphical marker species (Marshall, 1996).

Comparison: *Rhabdosporites streelii* Marshall, 1996 is clearly separable from all other species of *Rhabdosporites* (Richardson) Marshall & Allen, 1982 by the possession of three detached layers.

Stratigraphic and palaeogeographic occurrence:
• Belgium: Verviers Synclinorium; Goé; Pepinster Formation; Givetian (Lele & Streel, 1969). The age was reviewed at the time of the cartography of the region and now is considered as late Eifelian (Laloux et al., 1996).
• Libya: Ghadames Basin; Palynozones 6-7; middle Eifelian-middle Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6; Givetian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Eday Group; Givetian (Richardson, 1965). Shetland, Fair Isle; Observatory Group; late Givetian (Marshall & Allen, 1982).

Genus *Samarisporites* Richardson, 1965

Type species: *Samarisporites orcadensis* (Richardson) Richardson, 1965.

Description: Trilete zonate spores. Ornamention confined to the distal surface consists of conical to rounded conical projections, verrucae, or both which often bear cones or short spines. Elements may be clearly separated, arranged in concentric patterns, fused together in regular rows or groups, or fused into irregular convolute groups.

Comparisons: *Cristatisporites* Potonié & Kremp, 1954 is two-layered and may have sculpture both proximally and distally. The definition of *Cristatisporites* Potonié & Kremp, 1954 also restricts the distal sculpture to being dominantly mammoid in type, i.e., coni or spinae which are fused together at their bases into ridges carrying the spinose projections. *Cirratriradites* Wilson & Coe, 1940 does not have such prominent distal sculpture. *Hymenozonotriletes* in the emendation by Potonié (1958) is limited to spores with a distinct cingulum similar to that of *Densosporites* (Berry) Butterworth et al. in Staplin & Jansonius (1964).

Samarisporites angulatus (Tiwari & Schaarschmidt) Loboziak & Streel, 1989

Pl. 98, figs 1-4, Pl. 123, figs 13-15

1975 *Calyptosporites angulatus* Tiwari & Schaarschmidt, p. 44, Pl. 26, figs 4,5 , Pl. 27, fig. 1.
1989 *Samarisporites angulatus* (Tiwari & Schaarschmidt) Loboziak & Streel, p. 191, Pl. 5, figs 8-9.

Description: Zonate trilete spores with subtriangular to triangular amb. Laesurae straight or sinuous, simple and elevated up to 10 µm high at the pole, decreasing in height towards the equator and often extending on to the equatorial flange, and frequently to the equatorial margin. Central body radius equals 2/3 to 9/10 amb radius. The width of the equatorial flange up to 26 µm radially and up to 10 µm interradially. Exine of the central body 2-6 µm thick equatorially. Proximal surface laevigate, distal surface supporting spines, 1.5-5 µm wide, 2-8 µm high and 2-5 µm apart.

Dimensions: 84 (102) 131 µm, 18 specimens measured.

Comparisons: *Samarisporites eximius* (Allen) Loboziak & Streel, 1989 has often smaller spines and its equatorial flange is more or less the same around the central body but some specimens intergrade with *Samarisporites angulatus* (Tiwari & Schaarschmidt) Loboziak & Streel, 1989. Therefore, the two species are included in the *Samarisporites eximius* Morphon defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem Oppel Zone; Eifelian (Loboziak et al., 1988).
• Germany: Eifel, Prüm Syncline; Wiltz, Heisdorf, Lauch, Nohn, Ahrdorf, Junkerberg, Freilingen, Ahbach, Loogh and Cürten Formations; Assemblages B-I, L-P; late Emsian-early Givetian (Tiwari & Schaarschmidt, 1975). Eifel, Hillesheim Syncline; Ahbach, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; late Eifelian (Loboziak et al., 1990).
• Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A5; Eifelian.
• Tunisia: Borehole MG-1; Awaynat Wanin I Formation; A5; Eifelian.

Samarisporites eximius (Allen) Loboziak & Streel, 1989

Pl. 98, figs 5, 6, Pl. 99, figs 3-9, Pl. 123, figs 16-18

1965 *Perotrilites eximius* Allen, p. 731, pl. 102, figs 11-13.
1980b *Grandispora velata* (Eisenack) McGregor; Moreau-Benoit, p. 40, Pl. 12, fig. 3.
1982 *Grandispora eximia* (Allen) McGregor & Camfield, p. 44, Pl. 10, figs 2, 6, 7, text-fig. 64.
1989 *Samarisporites eximius* (Allen) Loboziak & Streel, p. 192, Pl. 4, figs 1-4.

Description: Zonate trilete spores with circular to subtriangular amb. Laesurae straight or sinuous, simple and elevated up to 11 µm high at the pole, decreasing in height towards the equator and often extending on to the equatorial flange, and frequently to the equatorial margin. Curvaturae not visible. Central body radius equals 3/5 to 9/10 amb radius. The width of the equatorial flange, generally 10-20 µm, rarely more, is commonly more or less the same around the central body. Exine of the central body 3-6 µm thick equatorially and the equatorial flange is 1-2.5 µm thick. Proximal surface laevigate, distal surface supporting generally discrete spines, 0.5-3.5 µm wide, 1-5 µm high and 2-5 µm apart. These may be rarely arranged in rugulae locally.

Dimensions: 95 (116) 145 µm, 25 specimens measured.

Comparison: *Samarisporites* sp. 2 possesses a pseudo-reticulum pattern formed by rugulae comprised of spines similar to *Samarisporites eximius* (Allen) Loboziak & Streel, 1989. Extreme forms of *Samarisporites eximius* intergrade with *Samarisporites* sp. 2 and *Samarisporites angulatus* (Tiwari & Schaarschmidt) Loboziak & Streel, 1989, which show larger spines and a more triangular flange. Therefore, the *Samarisporites eximius* Morphon is defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; AD Oppel Zone-LE Interval Zone; late Eifelian-Famennian (Perez-Leyton, 1990).
Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD pre Lem-BM Oppel Zones; Eifelian-Frasnian (Loboziak et al., 1988).
• Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; late Eifelian-early Givetian (McGregor & Camfield, 1982).

• Germany: Soutwestern Eifel; Heisdorfer Formation; Emsian (Lanninger, 1968). Rheinland, Eifel; Heisdorf, Lauch and Nohn Formations; late Emsian-early Eifelian (Riegel, 1973). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh and Cürten Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).
• Libya: Ghadames Basin; Palynozones 4-7; late Emsian/earliest Eifelian-early Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A6; Eifelian-Givetian.
• Norway: Spitsbergen; Dicksonfjorden, Reuterskiøldfjellet Sandstone and Lower Mimer Valley Series; Emsian-Eifelian (Allen, 1965).
• Saudi Arabia: Boreholes JNDL-1, S-462 and well ABSF-29; Jubah Formation; A4-A8; Eifelian-?early Frasnian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A8; ?late Emsian-?early Frasnian.

***Samarisporites triangulatus* Allen, 1965**

Pl. 99, figs 4-7, Pl. 100, figs 1-3, Pl. 123, figs 19-21

1964 *Cirratriradites* sp.; Vigran, p. 24, Pl. 3, fig. 6.
1965 *Samarisporites triangulatus* Allen, p. 716, Pl. 99, figs 1-6.

Description: Trilete spores with subtriangular amb with straight to slightly convex sides. Central area outline circular to rounded triangular. Laesurae straight, length 2/3 to full central area radius, accompanied by elevated labra, up to 25 µm high, individually 0.5-3 µm wide, extending on to the equatorial flange, and frequently to the equatorial margin. Exine of both central area and equatorial flange finely infragranulate. Exine of central area 1-5 µm thick. Proximal surface laevigate and distal region sculptured with closely spaced coni and spinae, commonly 2-5 µm high and wide at base. The coni occasionally support a small apical spine. Variation occurs in the basal sculpture of the elements, which may be separate, occasionally fused, or more comprehensively associated, forming an imperfect reticulum. The equatorial flange is distally laevigate or rarely with a sparse ornamentation of small elements. Equatorial flange acutely tapering, irregular, reaching its maximum width radially, frequently being only just perceptible in the interradial regions.

Dimensions: 40 (60) 94 µm, 40 specimens measured.

Remark: In the studied material *Samarisporites triangulatus* Allen, 1965 is preserved in proximo-distal or in lateral compression when specimens have very high laesurae (Pl. 99, figs 4, 6).

Comparions: The distinctive equatorial flange separates this species from others assigned to *Samarisporites* Richardson, 1965.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
• Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).
• Australia: Carnarvon Basin; Gneudna Formation; *optivus-triangulatus* Zone; early Frasnian (Balme, 1988). Canning Basin; *optivus-triangulatus* Zone; middle Givetian (Grey, 1991).

Adavale Basin; Etonvale Formation; *optivus-triangulatus* and *ovalis-bulliferus* Assemblage Zones; late Givetian-early Frasnian (Hashemi & Playford, 2005).
• Belgium: Dinant Synclinorium; Famennian (Becker et al., 1974). Campine Basin, Booischot borehole; ?TA Oppel Zone to Zone IV; ?Givetien-Frasnien (Streel & Loboziak, 1987). Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).
• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; TA Oppel Zone-LE Interval Zone; late Givetian-Famennian (Perez-Leyton, 1990).
• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; TA Oppel Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira Formation; AD-Lem Interval Zone to Zone IV; early Givetian-late Tournaisian (Loboziak et al., 1992b). Amazon Basin; Barreirinha Formation; BPi-TP Interval Zones; early Frasnian-?middle Famennian (Melo & Loboziak, 2003).
• France: Boulonnais; Blacourt, Beaulieu, Ferques and Hydrequent Formations; late Givetian-late Frasnian; TLa Oppel Zone to Zone IV (Brice et al., 1979; Lobozial & Streel, 1980, 1988; Loboziak et al., 1983).
• Germany: Eifel, Hillesheim Syncline; Kerpen Formation; TA Oppel Zone; Givetian (Loboziak et al., 1990).
• Greenland: Ella Ø; Ex Zone; middle Givetian (Friend et al., 1983; Marshall & Hemsley, 2003).
• Libya: Cyrenaica; BM Oppel Zone to Zone IV; Frasnian-?early Famennian (Paris et al., 1985; Streel et al., 1988). Borehole A1-69; Awaynat Wanin II Formation; A7-A8; Givetian-?early Frasnian.
• Norway: Spitsbergen; Upper Mimer Valley Series and Upper Svalbardia Sandstone; Givetian-Frasnian (Vigran, 1964; Allen, 1965).
• Poland: Western Pomerania; Sianowo Formation; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).
• Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; A7-A8; Givetian-?early Frasnian, specimens from borehole S-462 may be caved in older strata.
• Tunisia: Borehole MG-1; Awaynat Wanin II and Awaynat Wanin III Formations; A7-A8; Givetian-?early Frasnian.
• United Kingdom: Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996).

***Samarisporites* sp. 1**

Pl. 100, figs 4-6, Pl. 123, figs 22-24

1992 *Samarisporites* sp.; Loboziak et al., Pl. 1, fig. 1.

Description: Zonate to zonate-camerate trilete spores with subtriangular amb. Laesurae straight or slightly sinuous, elevated, up to 7 µm high, often extending on to the equatorial flange, and frequently to the equatorial margin. Central body subcircular to subtriangular and its radius equals 3/5 to 2/3 amb radius. The equatorial flange is wider opposite the trilete rays (12-24 µm wide) than interradially (6-14 µm wide). Exine may sometimes be folded radially. Camerate structure can give a bizonate appearance. Camera width equals 1/5 to 2/5 zona width. Proximal surface laevigate, distal surface supporting coni or spines, 0.5-1.5 µm wide, 1-2.5 µm high and 1-3 µm apart. Ornaments on the distal hemisphere of the central body are more densely distributed than those on the zona. Groups of ornament on the central body can be fused at their bases giving short ridges.

Dimensions: 73 (82) 88 µm, 6 specimens measured.

Comparisons: *Samarisporites eximius* (Allen) Loboziak & Streel, 1989 possesses a thicker central body and its ornamentation is commonly larger. *Samarisporites angulatus* (Tiwari & Schaarschmidt) Loboziak & Streel, 1989 has considerably larger sculptural elements. *Camptozonotriletes caperatus* McGregor, 1973 has smaller ornaments, often barely visible.

Stratigraphic and palaeogeographic occurrence:
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3a; Emsian.

Samarisporites sp. 2

Pl. 100, fig. 7, Pl. 101, figs 1-3, Pl. 123, figs 25-27

1985 ?*Calyptosporites* sp. A; Paris et al., Pl. 20, fig. 8.

Description: Zonate trilete spores with subcircular to subtriangular amb. Laesurae straight or slightly sinuous, simple and elevated from 4 to 8 µm high at the pole, decreasing in height to the outer margin of the zona. Curvaturae not visible. Central body radius equals 3/4 to 9/10 amb radius. The width of the equatorial flange, 5-17 µm is more or less the same around the central body. Exine of the central body 3-7 µm thick equatorially. Proximal surface laevigate, distal surface supporting spines, 1-2.5 µm wide, 2-4 µm high and 2-5 µm apart. Ornament on the distal hemisphere of the central body is arranged in rugulae composed of spines.

Dimensions: 79 (98) 114 µm, 10 specimens measured.

Comparisons: *Samarisporites eximius* (Allen) Loboziak & Streel, 1989 differs only by the possession of discrete elements on the distal surface of the central body however they can be locally fused in rugulae. Extreme forms of *Samarisporites* sp. 2 probably intergrade with *Samarisporites eximius* (Allen) Loboiak & Streel, 1989 in the *Samarisporites eximius* Morphon (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:
- Libya: Cyrenaica; AD Oppel Zone; Eifelian (Paris et al., 1985; Streel et al., 1988). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A4-A6; Eifelian-Givetian.
- Saudi Arabia: Borehole S-462; Jubah Formation; A7; Givetian.
- Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A7; ?late Emsian-Givetian.

Samarisporites sp. 3

Pl. 101, fig. 4

Description: Zonate trilete spores with subcircular to subtriangular amb. Laesurae straight, simple, extending 1/2 or almost to the inner margin of the zona. Curvaturae not visible. Central body radius equals 3/5 to 4/5 amb radius. Maximum width of the equatorial flange, 12-22 µm. Zona folded radially. Exine of the central body punctate and 2.5-5 µm thick equatorially. Distal hemisphere of central body sculptured with polygonal verrucae, commonly 2-5 µm wide (rarely up to 8 µm) and closely packed.

Dimensions: 90 (98) 107 µm, 3 specimens measured.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin I Formation; A4; Eifelian.
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3b; ?late Emsian-early Eifelian.

***Samarisporites* sp. 4**

Pl. 101, figs 5, 6, Pl. 123, figs 28-30

Description: Zonate trilete spores with subcircular to subtriangular amb. Laesurae straight, simple and elevated up to 8 µm high at the pole, decreasing in height to or almost to the outer margin of the zona. Curvaturae not visible. Central body radius equals more or less 3/4 amb radius. The equatorial flange is laevigate to infra-granulate and can be slightly wider opposite the laesurae than interradially; its maximum width is up to 25 µm. Distal surface of zona is ornamented with spines, 1-2.5 µm wide at base, 2-5.5 µm high and 1.5-5 µm apart. Exine of the central body and 4-7 µm thick equatorially. Exine of body entirely laevigate except the equatorial part which is ornamented with the same spines as the zona.

Dimensions: 116 (120) 123 µm, 3 specimens measured.

Comparisons: *Samarisporites eximius* (Allen) Loboziak & Streek, 1989 possesses a distally ornamented central body as S*amarisporites* sp. 1 which has a smaller ornamentation in addition.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Awaynat Wanin I Formation; A4-A5; Eifelian.

Genus *Scylaspora* Burgess & Richardson, 1995

Type species: *Scylaspora scripta* Burgess & Richardson, 1995.

Description: Trilete, equatorially crassitate spores. Proximal surface ornamented with irregularly orientated muri, rugulae and verrucae. Distal surface laevigate, or sculptured with grana, coni, spinae or biform elements.

Comparison: *Emphanisporites* McGregor, 1961 has proximal sculpture of radially aligned muri only. *Iberoespora* Cramer & Díez, 1975 lacks prominent proximal sculpture and is distinguished above all by a distal furrow separating the cingulum from the distal face.

***Scylaspora costulosa* Breuer et al., 2007c**

Pl. 102, figs 1-9

2005 *Retusotriletes rugulatus* Riegel; Hashemi & Playford, p. 337, Pl. 2, fig. 1.
2007c *Scylaspora costulosa* Breuer et al., p. 50, Pl. 10, figs 1-5.

Description: Trilete spores with circular to subcircular amb. Distal surface strongly convex. Proximal surface flattened pyramidal with weakly concave contact faces that are delimited equatorially by curvaturae perfectae. Trilete mark often gaping at the proximal pole. Laesurae distinct, simple and straight. There is marked encroachment of the distal surface due to invagination of curvaturae. Contact areas sculptured with radially oriented sinuous muri, about 1µm wide. They are obvious close to the curvaturae perfectae and commonly become faint towards the proximal pole. Exine outside the contact faces entirely laevigate, and 1-2.5 µm thick equatorially.

Dimensions: 45 (65) 91 µm, 24 specimens measured.

Comparison: The specimen of *Retusotriletes rugulatus* Riegel, 1973 illustrated in Hashemi & Playford, 2005 has radially oriented sinuous muri and does not has a darker subtriangular area at the proximal pole as described in Riegel (1973). *Retusotriletes rugulatus* Riegel, 1973 in Hashemi & Playford (2005) corresponds to the description of *Scylaspora costulosa* Breuer et al., 2007c and it is considered as synonymous. *Scylaspora rugulata* (Riegel) Breuer et al., 2007c has a darker subtriangular area at the proximal pole and the muri are more prominent, more angular and visible on the whole contact surface. *Scylaspora chartulata* (McGregor & Narbonne) Rubinstein & Steemans, 2002 appears very similar but may possess minute, closely spaced grana on the contact areas and is smaller (28-55 µm) than *Scylaspora costulosa* Breuer et al., 2007c. This area is surrounded by a discrete dark band of thickened exine. Moreover, this species is smaller (33-50 µm) than *Scylaspora costulosa* Breuer et al., 2007c.

Stratigraphic and palaeogeographic occurrence:

- Australia: Adavale Basin; Eastwood Formation; *annulatus-sextantii* Assemblage Zone; Emsian (Hashemi & Playford, 2005).
- Brazil: Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-1, 3, 4 and wells FWRH-1, HWYH-956, KHRM-2, SDGM-462, UTMN-1830; Jauf and Jubah Formations; A1-A3a; late Pragian-late Emsian, the isolated occurrence of a specimen from the Jubah Formation may be due to reworking.

Scylaspora rugulata (Riegel) Breuer et al., 2007c

Pl. 103, figs 1-7

1965 *Retusotriletes dubius* (Eisenack) Richardson (pars), p. 564, Pl. 88, fig. 6.
1966 *Retusotriletes* sp. (pars); McGregor & Owens, Pl. 9, fig. 2.
1967 *Retusotriletes* sp. 1, Hemer & Nygreen, Pl. 2, fig. 6.
1971 *Retusotriletes dubius* (Eisenack) Richardson; Owens (pars), p. 12, Pl. 1, fig. 10.
1973 *Retusotriletes rugulatus* Riegel, p. 82, Pl. 10, figs 2-5.
1974 *Stenozonotriletes extensus* Naumova; Hamid, Pl. 10, fig. 3.
non 2005 *Retusotriletes rugulatus* Riegel; Hashemi & Playford, p. 337, Pl. 2, fig. 1.
2007c *Scylaspora rugulata* (Riegel) Breuer et al., p. 50.

Desciption: Trilete spores with subcircular to rounded subtriangular amb. Distal surface strongly convex. Proximal surface more or less flattened pyramidal with contact faces that are delimited by curvaturae perfectae, up to 2 µm wide. Curvaturae perfectae may be confluent with equator for part of their length. There is marked encroachment of the distal surface due to invagination of adjacent curvaturae where they conjoin at the radial extremities. Laesurae straight, simple, length 2/3 to 9/10 of the spore radius. Exine 1-4 µm thick equatorially. Proximal polar region with dark subtriangular area of varied prominence. Entire contact areas sculptured with fine, more or less radially oriented rugulate or subreticulate muri, commonly less than 1 µm wide and high. Distal surface laevigate.

Dimensions: 53 (67) 85 µm, 12 specimens measured.

Remark: *Retusotriletes rugulatus* Riegel, 1973 was reassigned to the genus *Scylaspora* Burgess and Richardson, 1995 because it possesses the typical proximal sculpture of this genus (Breuer et al., 2007c).

Comparisons: *Emphanisporites* sp. in Tiwari & Schaarschmidt (1975) appears similar to *Scylaspora rugulata* (Riegel) Breuer et al., 2007c except for its prominent elevated labra. *Retusotriletes biarealis* McGregor, 1964 is thinner and bears a relatively faintly defined radial pattern in the contact areas. *Scylaspora costulosa* Breuer et al., 2007c has less prominent, more faded and less angular rugulae. This species do not exhibit a dark subtriangular area on the proximal polar region.

Stratigraphic and palaeogeographic occurrence:
- Belgium: Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).
- Canada: Arctic Archipelago, Queen Elisabeth and Melville Islands; Cape De Bray, Weatherall and Hecla Bay Formations; Eifelian-early Givetian (McGregor & Owens, 1966; Owens, 1971; McGregor & Camfield, 1982).
- France: Boulonnais; Blacourt and Beaulieu Formations; late Givetian-early Frasnian; TLa-TCo Oppel Zones (Brice et al., 1979; Loboziak & Streel, 1980, 1988).
- Germany: Rheinland, Eifel; Nohn Formation; early Eifelian (Riegel, 1973). Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh and Cürten Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).
- Libya: Cyrenaica; AP Oppel Zone to AD-Lem Interval Zone; early Eifelian-early Givetian (Streel et al., 1988). Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.
- Poland: Western Pomerania; Studnica, Jamno, Miastko and Sianowo Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999). Pomerania-Kujawy region; Polskie Laki IG-1 borehole; Silno Formation; early-middle Eifelian (Turnau & Matyja, 2001).
- Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; A5-A7; Eifelian-Givetian.
- Tunisia: Borehole MG-1; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A6; Eifelian-Givetian.
- United Kingdom: Northeast Scotland; Orcadian Basin; Wick Flagstone Group and Achanarras fish Beds; Eifelian-Givetian (Richardson, 1965). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000). Scotland, Orcadian Basin; Clava Mudstone and Easter Town Burn Siltstone Members; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

***Scylaspora* cf. *S. scripta* Burgess & Richardson, 1995**

Pl. 104, figs 1, 2

cf. 1995 *Scylaspora scripta* Burgess & Richardson, p. 17, Pl. 7, figs 5-9.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple, up to 2 µm wide, extending almost to the equator. Exine 1-2 µm thick equatorially. Contact areas sculptured with low, rounded, sinuous to convolute and anastomosing muri, 0.5-1.5 µm wide and commonly less than 1 µm apart. Muri radially aligned near equator, but randomly orientated towards the proximal pole. Distal surface laevigate.

Dimensions: 40 (41) 42 µm, 2 specimens measured.

Comparisons: *Scylaspora scripta* Burgess & Richardson, 1995 is equatorially and distally sculptured with scattered to regularly distributed grana and tiny verrucae. *Scylaspora downiei* Burgess & Richardson, 1991 is smaller with predominantly verrucate proximal sculpture. *Scylaspora costulosa* Breuer et al., 2007c is larger.

Stratigraphic and palaeogeographic occurrence:
- Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2; ?late Pragian-Emsian but probably reworked in Eifelian strata.

Genus *Squamispora* Breuer et al., 2007c

Type species: *Squamispora arabica* Breuer et al., 2007c.

Description: Trilete spores with a two-layered exine. The entire surface of the spore is covered by 'flakes' which are derived from the original outer layer. This discontinuous sculpture of exine gives a scaly appearance. The two layers are not normally separated but local detachments can occur.

Remark: The scaly appearance may be due to the taphonomy. The outer layer may have been dried by some unidentified processes and have finished off to crack.

Comparisons: *Camerosporites* Leschick emend. Clarke, 1965 is a monosulcate elongate-oval form showing the same kind of 'sculpture' as *Squamispora* Breuer et al., 2007c. *Diducites* Van Veen, 1981 is two-layered with a very thin outer layer folding and wrinkling frequently resulting as a rugulate appearance. *Squamispora* Breuer et al., 2007c cannot be compared to genera such *Verrucosisporites* Ibrahim, 1933 because the flakes do not constitute real positive sculptural elements.

***Squamispora arabica* Breuer et al., 2007c**

Pl. 104, figs 3-11

2007c *Squamispora arabica* Breuer et al., p. 51, Pl. 10, figs 6-10.

Description: Trilete spores with subcircular to subtriangular amb. Exine 1.5-4 µm thick equatorially. Laesurae distinct, simple and straight extending from the proximal pole for half to all of the way to the equator. No curvaturae visible. The whole surface of the miospore is covered by closely spaced flakes. They are commonly 0.5-15 µm in maximum length, size and shape being quite variable within the taxon and also on a single specimen. Large and small flakes do not constitute an ordered pattern but resembles an irregular mosaic. Except for the flakes, exine is entirely laevigate.

Dimensions: 39 (51) 63 µm, 43 specimens measured.

Remarks: *Squamispora arabica* Breuer et al., 2007c sometimes occurs in the studied material in clusters of several specimens. Some local detachments of the scaly layer can occur. Consequently, total detachment of this outer layer possibly due to bad preservation conditions could give specimens of *Retusotriletes* Naumova emend. Streel, 1964. Indeed, *Squamispora arabica* Breuer et al., 2007c specimens are currently recorded only in well-preserved assemblages.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.

Genus *Stellatispora* Burgess & Richardson, 1995

Type species: *Stellatispora inframurinata* (Richardson & Lister) Burgess & Richardson, 1995.

Description: Trilete spores. Contact surface thin and laevigate. Patina ornamented subequatorially by radially aligned muri.

Comparisons: The distal murornate sculpture of *Chelinospora* (Allen), 1965 does not include radial muri. *Archaeozonotriletes* Naumova emend. Allen, 1965 has been defined for laevigate spores, hence spores with distal radial sculpture cannot be accommodated in that genus.

***Stellatispora multicostata* Breuer et al., 2007c**

Pl. 104, figs 12, 13, Pl. 105, figs 1-7

2007c *Stellatispora multicostata* Breuer et al., p. 51, Pl. 11, figs 1-4.

Description: Trilete spores with subcircular to subtriangular amb. Contact surfaces are thin and smooth and can be sometimes collapsed or absent. When present, Laesurae are simple and straight. Outside the contact surfaces the exine is two-layered and thicker, 2-6 µm thick at the equator. Patina is ornamented with many straight radial costae, 0.5-1 µm wide and 6-17 µm long, which start proximo-equatorially from the curvaturae and disappear towards the distal pole. From the amb, their length corresponds to 1/5 to ½ of the amb radius. The number of costae varies between 25 and 45 on each interradial area, and are weak to absent opposite the trilete rays.

Dimensions: 54 (74) 93 µm, 17 specimens measured.

Comparisons: *Stellatispora inframurinata* var. *inframurinata* (Richardson & Lister) Burgess & Richardson, 1995 is smaller (30-49 µm) and displays a patina ornamented with thicker radial elongated elements (1-3.5 µm wide). In addition these can bifurcate 2-3 times, and are occasionally convolute and discontinuous. *Tholisporites salantaicus* (Arkhangelskaya)

Turnau, 1986 seems similar with *Stellatisporites multicostata* Breuer et al., 2007c but shows radial costae on the contact faces as well as on the distal side.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes JNDL-3, 4 and wells KHRM-2, UTMN-1830; Jauf Formation; A3a; Emsian.

Genus *Synorisporites* Richardson & Lister, 1969

Type species: *Synorisporites downtonensis* Richardson & Lister, 1969.

Description: Trilete spores with prominent curvaturae perfectae forming a more or less equatorial crassitude. Contact area laevigate or with interradial papillae, or variously sculptured. Distal surface laevigate or sculptured with verrucae and/or muri.

Comparison: *Streelispora* Richardson & Lister emend. Richardson et al., 1982 has a distal sculpture of grana, coni, spinae, or biform elements.

***Synorisporites* cf. *S. lobatus* Rodriguez, 1978a**

Pl. 105, figs 8-10

cf. 1978a *Synorisporites lobatus* Rodriguez, p. 216, Pl. 1, figs 13, 14.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, accompanied by labra, up to 2.5 µm wide individually, extending to the inner margin of the cingulum. Cingulum 3-5 wide. Proximal surface laevigate and distal surface sculptured with a convoluted subcircular thickening, about 6/10 the spore diameter. Additional verrucae, 1.5-5 µm wide may be present on the distal surface.

Dimensions: 39 (49) 58 µm, 3 specimens measured.

Remarks: According to its diagnosis, *Synorisporites lobatus* Rodriguez, 1978a is smaller and its subcircular thickening is developed on the proximal face.

Stratigraphic and palaeogeographic occurrence:
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2-A3b; ?late Pragian-?early Eifelian, the specimens of A2 are probably reworked in younger strata.

***Synorisporites papillensis* McGregor, 1973**

Pl. 106, figs 1-15

1966 Unidentified; McGregor & Owens, Pl. 2, fig. 32.
? 1968 Spore trilète à papilles proximales sp. 5; Jardiné & Yapaudjian, Pl. 1, fig. 7
1969 *Synorisporites* sp. A; Richardson & Lister, p. 234, Pl. 41, figs 1, 2.
1973 *Synorisporites papillensis* McGregor, p. 51, Pl. 6, figs 26-29.
1976 *Synorisporites ?papillensis* McGregor; McGregor & Camfield, p. 28, Pl. 1, figs 24, 27.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, accompanied by labra, 0.5-2 µm wide individually, extending to the inner margin of the cingulum. Cingulum regular or with an undulating appearance, 1.5-5 µm wide. A papilla, 3-7 µm wide, is developed in each interradial area on proximal face. Distal face laevigate to verrucate. Verrucae subcircular in plan view, commonly 1-3 µm (rarely up to 5 µm) wide.

Dimensions: 24 (32) 43 µm, 53 specimens measured.

Comparisons: *Synorisporites tripapillatus* Richardson & Lister, 1969 is smaller and has a distal sculpture consisting in convolute and anastomosing muri. Jardiné & Yapaudjian (1968) figure an undescribed species resembling strongly to *Synorisporites papillensis* McGregor, 1973. ?*Knoxisporites riondae* Cramer & Díez, 1975 is distinguished mainly by a distal annulus which is not always well visible. The taxonomic attribution of some intermediary specimens is difficult to choose because these two sepcies intergrade and constitute the *Synorisporites papillensis* Morphon defined here (Tab. 1, p. 185).

Stratigraphic and palaeogeographic occurrence:

- Belgium: Dinant Synclinorium; R-Su Interval Zones; early Lochkovian-late Pragian (Steemans, 1989).
- Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Kenogami River Formation; *mircrornatus-proteus* Provisional Assemblage Zone; Gedinnian (McGregor & Camfield, 1976).
- France: Armorican Massif, Laval Syncline; Saint-Cénéré Formation; Assemblage 1; Pragian (Le Hérissé, 1983).
- Libya: Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *Apiculiretusispora* sp. E Biozone?; middle Pridoli (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa and Awaynat Wanin I Formations; A3a-A4; Emsian-Eifelian.
- Saudi Arabia: Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4 and wells ABSF-29, FWRH-1, HWYH-956, KHRM-2, UTMN-1830; Jauf and Jubah Formation; A1-A4; late Pragian-Eifelian.
- Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3b-A4; ?late Emsian-Eifelian.
- United Kingdom: Welsh Borderland and South Wales; Middle Ditton Group; Dittonian (Richardson & Lister, 1969).

Synorisporites verrucatus Richardson & Lister, 1969

Pl. 106, figs 16-19

1969 *Synorisporites verrucatus* Richardson & Lister, p. 233, Pl. 40, figs 10-12.
1973 *Synorisporites*? *libycus* Richardson & Ioannides, p. 278, Pl. 7, figs 1-6.
1981 *Synorisporites* cf. *verrucatus* Richardson & Lister; Steemans, Pl. 1, figs 12, 13.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, accompanied by labra, 0.5-2 µm wide individually, extending to the inner margin of the cingulum. Cingulum regular or with an undulating appearance, 1.5-4 µm wide. Proximal face laevigate. Distal face sculptured with low verrucae subcircular in plan view, commonly 1-4 µm wide, 0.5-1.5 µm wide apart, occasionally fused into small groups to give a muronate appearance.

Dimensions: 28 (33) 40 µm, 7 specimens measured.

Comparisons: *Synorisporites tripapillatus* Richardson & Lister, 1969 is smaller and has a distal sculpture of convolute and anastomosing muri, and three proximal interradial papillae. *Synorisporites papillensis* McGregor, 1973 has also proximal papillae. *Synorisporites*? *libycus* Richardson & Ioannides, 1973 is considered hera as a junior synonym of *Synorisporites verrucatus* Richardson & Lister, 1969 because their diagnoses are similar execpt that the first species may sometimes have slightly larger verrucae.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin, borehole TRN 3; Méderba and Hassi-Tabankort Formations; Silurian-Pragian (Boumendjel et al., 1988).
• Belgium: Dinant Synclinorium; Nα-R Interval Zones; early Lochkovian (Steemans, 1989).
• Bolivia: Cordillera Oriental, Laurani section; Santa Rosa Formation; Gedinnian (McGregor, 1984).
• Brazil: Solimões Basin, Jandiatuba area, well 1-JD-1-AM; Jutaí Formation; BZ-Z Phylozone; late Lochkovian (Rubinstein et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
• Canada: Quebec, Gaspé Peninsula; Battery Point Formation; Emsian (McGregor, 1973).
• France: Armorican Massif, Laval Syncline; Saint-Cénéré Formation; Assemblage 1; Pragian (Le Hérissé, 1983). Armorican Massif, Laval Syncline, Saint-Cénéré Outcrop; N Interval Zone; Lochkovian (Steemans, 1989).
• Libya: Ghadames Basin, boreholes B2-34 and C1-34; Acacus Formation; Lludlovian-Downtonian (Richardson & Ioannides, 1973). Ghadames Basin, borehole A1-61; 'Alternance argilo-gréseuses' Formation; *tripapillatus-spicula*? to *Apiculiretusispora* sp. E Biozone?; ?Ludlow-middle Pridoli (Rubinstein & Steemans, 2002). Borehole A1-69; Ouan-Kasa and Awaynat Wanin I Formations; A3b-A5; ?late Emsian-Eifelian.
• Saudi Arabia: Wells DMMM-45 and UDYN-1; Qalibah and Tawil Formations; Ashgill or Early Silurian-Pragian (Steemans, 1995).
• Spain: Cantabrian Mountains; San Pedro Formation; Wenlockian-early Siegenian (Rodriguez, 1978b).
• Tunisia: Borehole MG-1; Ouan-Kasa and Awaynat Wanin I Formations; A3a-A5; Emsian-Eifelian.
• United Kingdom: Welsh Borderland and South Wales; Downton Castel Sandstone and Temeside Shales Groups; Downtonian (Richardson & Lister, 1969).

Genus *Verruciretusispora* Owens,1971

Type species: *Verruciretusispora dubia* (Eisenack) Richardson & Rasul, 1978.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae usually distinct, commonly accompanied with labra. Curvaturae connect the ends of laesurae. Contact areas laevigate or sculptured with reduced ornament. Exine outside contact areas sculptured with verrucae. The verrucae may be surmounted by small mammoid coni and spinae.

Comparisons: *Retusotriletes* Naumova emend. Streel, 1964 possesses a laevigate exine, but is similar in construction to *Verruciretusispora* Owens, 1971. *Verrucosisporites* (Ibrahim) Smith

& Butterworth, 1967 possesses a similar ornamentation but lacks clearly defined curvaturae and the consistent reduction or absence of the ornament in the contact areas. *Acinosporites* Richardson, 1965 has mammoid elements fused at base forming convoluted and anastomosing ridges.

Verruciretusispora dubia **(Eisenack) Richardson & Rasul, 1978**

Pl. 106, figs 20, 21

1944 *Triletes dubius* Eisenack (pars), p. 115, Pl. 2, fig. 7, text-fig. 14.
1966 *Verrucosisporites* sp.; McGregor & Owens, Pl. 6, fig. 2, Pl. 9, figs 3, 4.
1966 *Retusotriletes* sp. (pars); McGregor & Owens, Pl. 9, figs 3, 4.
1968 *Retusotriletes infrapunctatus* var. *macrotuberculatus* Schultz; Lanninger, p. 114, Pl. 21, fig. 4.
1968 *Retusotriletes multituberculatus* Schultz; Lanninger, p. 114, Pl. 21, fig. 5.
1971 *Verruciretusispora robusta* Owens; p. 21, Pl. 4, figs 7, 8, 10, 11.
1972 New genus n. sp.; McGregor & Uyeno, Pl. 1, fig. 11.
1973 *Verruciretusispora multituberculata* (Lanninger) McGregor, p. 36, Pl. 4, figs 13, 14.
1978 *Verruciretusispora dubia* (Eisenack) Richardson & Rasul, p. 443, Pl. 1, fig. 6.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple or accompanied by labra, up to 3 µm in overall width, length 7/10 to 9/10 the spore radius. Curvaturae perfectae are commonly confluent with equator for part of their length and invaginate proximally to join the extremities of laesurae. Exine 1.5-4 µm thick equatorially. Proximal region laevigate. Equatorial and distal regions irregularly sculptured with sparesely distributed verrucae, 1-8 µm wide, 1-3 µm high. Verrucae, subcircular in plan view, may be of various size on the same specimen.

Dimensions: 52 (56) 58 µm, 3 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Australia: Adavale Basin; Eastwood Formation and Lissoy Sandstone; *annulatus-sextantii* and *devonicus-naumovii* Assemblage Zones; Emsian-early Givetian (Hashemi & Playford, 2005).
• Canada: Quebec, Gaspé Peninsula; Battery Point and Malbaie Formations; Emsian-Eifelian (McGregor & Owens, 1966; McGregor, 1973). Arctic Archipelago, Queen Elisabeth, Melville and Bathurst Islands; Blue Fiord, Bird Fiord, Weatherall and Hecla Bay Formations; Eifelian-early Givetian (Owens, 1971; McGregor & Uyeno, 1972; McGregor & Camfield, 1982).
• Germany: Soutwestern Eifel; Klerfer, Wetteldorfer and Heisdorfer Formations; Emsian (Lanninger, 1968).
• Luxembourg: Oesling region; Pow-FD Oppel Zones; middle-late Emsian (Steemans et al., 2000).
• Poland: Western Pomerania; Jamno, Miastko and Sianowo Formations; Ex Zone; late Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly and Świetomarz beds; Ex Zone; Givetian (Turnau & Racki, 1999). Random-Lublin area; Borehole Giezcezw PIG 5; Terrigenous Suite; FD Oppel Zone; upper Emsian (Turnau et al., 2005).
• Saudi Arabia: Borehole JNDL-1 and well UTMN-1830; Jauf and Jubah Formations; A3a-A4; Emsian-Eifelian.
• United Kingdom: Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall,

2000). Scotland, Orcadian Basin; Easter Town Burn Siltstone Member; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; middle-late Eifelian (Marshall & Fletcher, 2002).

Genus *Verrucisporites* Chi & Hills, 1976

Type species: *Verrucisporites medius* Chi & Hills, 1976.

Description: Trilete megaspores with circular to subcircular amb. Laesurae accompanied by slightly elevated labra forming an apical prominence. Exine ornamented with irregularly spaced verrucae.

Remark: The key generic characteristics of this megaspore genus are the combination of verrucae that coalesce to a reticulate pattern, a prominent curvatural feature, and a trilete mark that is accompanied by labra, which although raised, are never as a prominent gula.

Comparisons: *Verrucisporites* Chi & Hills, 1976 differs from *Biharisporites* Potonié, 1956 in possessing elevated labra and in the absence of coni and spinae. *Verruciretusispora* Owens, 1971 possesses a similar ornamentation but lacks elevated labra and has well-defined curvaturae. In addition, *Verrucisporites* Chi & Hills, 1976 was erected as a genus specifically for megaspores. *Acinosporites* Richardson, 1965, mainly used for microspores, possess convoluted and anastomosing ridges formed by the coalescence of biform mammoid sculptural elements and does not have a prominent curvatural feature.

***Verrucisporites ellesmerensis* (Chaloner) Chi & Hills, 1976**

Pl. 106, figs 22, 23, Pl. 123, figs 31-33

1959 *Biharisporites ellesmerensis* Chaloner, p. 322, Pl. 55, fig. 2, text-fig. 1.
1976 *Verrucisporites ellesmerensis* (Chaloner) Chi & Hills, p. 701, Pl. 2, figs 9-16, Pl. 3, figs 1-6.
2007 *Verrucisporites yabrinensis* Marshall et al., p. 77, Pl. 1, figs 1-11, Pl. 2, figs 1, 2, 9, 10, fig. 2A.

Description: Trilete megaspores with circular to subcircular amb. Laesurae straight, or slightly sinuous, accompanied by elevated labra, up to 35 µm high at the proximal pole. Contact areas defined by fusion of the bulbous verrucae which form curvaturae and a narrow, thin pseudo-flange. Exine ornamented with small, elongate pits or foveolae. Proximo-equatorial and distal regions sculptured with bulbous verrucae or bacula, 4-10 µm wide at their bases, 4-12 µm high, commonly having a minute conus at each apex. The fusion of sculptural elements form an irregular rugulate or reticulate pattern. The density of the reticulum can vary from an open mesh showing beading of individual verrucae that give the sculpture a noded appearance to a dense cover of fused verrucae that are separated by occasional irregularly shaped lumina.

Dimensions: 265 (299) 350 µm, 26 specimens measured.

Remarks: Chi & Hills (1976) define three varieties of *Verrucisporites ellesmerensis* (Chaloner) which are slightly different in detail but the dimensions of ornamentation intergrade. As the specimens described here are very variable, they may belong to the different defined varieties. Consequently, they have been let in the same group because the morphological changes seem to be continuous.

Comparisons: *Verrucisporites yabrinensis* Marshall et al., 2007 was erected because its ornament does not correspond exactly to one of the three varieties of *Verrucisporites ellesmerensis* (Chaloner) defined by Chi & Hills, 1976. Indeed, Marshall et al. (2007) compare their population only with *Verrucisporites ellesmerensis* (Chaloner) var. *connatus* Chi & Hills, 1976 which have longer sculptural elements. According to Marshall (pers. comm., 2007), the dimensions of the ornament of *Verrucisporites yabrinensis* Marshall et al., 2007 correspond rather to those of *Verrucisporites ellesmerensis* (Chaloner) var. *parvus* Chi & Hills, 1976 but the sculpture is fused like that of *Verrucisporites ellesmerensis* (Chaloner) var. *ellesmerensis* Chi & Hills, 1976. Thus the characteristics of ornament of *Verrucisporites yabrinensis* Marshall et al., 2007 are included at least in the original definition of *Verrucisporites ellesmerensis* (Chaloner) Chi & Hills, 1976, i.e. at the specific level. In addition, Marshall et al. (2007) also erected a Saudi species different from Arctic Canada because they thought that the heterosporous plants are geographically limited by the large size of the megaspore (Marshall, pers. comm., 2007). *Verrucisporites yabrinensis* Marshall et al., 2007, that shows a certain morphological variability, needs to be objectively considered here as a junior synonym of *Verrucisporites ellesmerensis* (Chaloner) Chi & Hills, 1976.

Stratigraphic and palaeogeographic occurrence:

- Canada: Cape Terrace section, Weatherall and Hecla Bay Formations, Griper Bay Subgroup; Weatherall Bay section, Hecla Bay Formation, Griper Bay Subgroup; South McCormick Inlet section, Weatherall Formation; Mould Bay section, Weatherall and Hecla Bay Formations Griper Bay Subgroup; Imperial type section, Imperial Formation; *Delicatus* Zone to *Devonica* Zone, Givetian-Frasnian (Chi & Hills, 1976).
- Libya: Ghadames Basin; Palynozone 7; middle Givetian (Moreau-Benoit, 1989).
- Saudi Arabia: Borehole S-462 and well YBRN-1; Jubah Formation; A7-A8; Givetian-?early Frasnian.

Genus *Verrucosisporites* Ibrahim emend. Smith, 1971

Type species: *Verrucosisporites verrucosus* (Ibrahim) Ibrahim, 1933.

Description: Trilete azonate, acavate spores with circular to rounded triangular amb. Margin generally crenulate but may be undulate to irregularly lobate. Laesurae generally simple, if labrate, labra not exceeding height of ornamentation, length variable from one-half to length of spore radius. Exine predominantly verrucate but sculptural elements may include a small proportion of rugulae, coni or bacula. Sculpture generally comprehensive but the size of elements may be reduced in contact areas. In plan view shape circular, polygonal or irregular. In profile may be dome-shaped or the sides may taper to varying degrees and the apices may be flat, obliquely truncate or well-rounded, height equal to or less than breath. Sculptural elements generally not greater than maximum diameter of verrucae. Number of sculptural elements projecting from margin usually greater than 10 but rarely exceeding 100. Exine thickness (including sculpture) rarely exceeds 10 µm.

Remark: In *Verrucosisporites* Ibrahim emend. Smith, 1971 the sculptural elements may sometimes be fused at their bases but never anastomose to form a system of ridges, as in *Convolutispora* Hoffmeister et al., 1955.

Comparisons: *Verruciretusispora* Owens, 1971 possesses well-defined curvaturae. *Cyclogranisporites* Potonié & Kremp, 1954 has smaller, uniform, isodiametric grana.

Verrucosisporites polygonalis Lanninger, 1968

Pl. 107, figs 1-10

1954 Spore type H6'; Radforth & McGregor, p. 613, Pl. 2, fig. 51.
1954 Spore type H7'; Radforth & McGregor, p. 613, Pl. 2, fig. 52.
1966 *Verrucosisporites* sp.; McGregor & Owens, Pl. 1, fig. 34, Pl. 2, figs 20, 22, 34.
? 1968 Spore n° 3345; Magloire, Pl. 1, fig. 1.
1968 *Verrucosisporites polygonalis* Lanninger, p. 128, Pl. 22, fig. 19.
1973 *Verrucosisporites ?polygonalis* Lanninger; McGregor, p. 37, Pl. 4, figs 15, 21, 22.

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple or accompanied by labra, up to 4 µm in overall width, length 2/3 to 9/10 the spore radius. Exine 2.5-3 µm thick equatorially. Proximo-equatorial and distal regions scultpured with verrucae commonly 1-3.5 µm wide at base, 0.5-1.5 µm high. Basal width of ornaments usually equal to or greater than height. Sculptural elements, rounded or flat-topped in profile, polygonal to more rounded in plan view, and closely spaced resulting in a polygonal pattern. Proximal region laevigate, granulate or with reduced sculpture.

Dimensions: 31 (50) 90 µm, 21 specimens measured.

Comparisons: *Streelispora granulata* Richardson & Lister, 1969 is smaller, and has coni and grana (not flat-topped sculptural elements), and an equatorial crassitude that is thickest interradially. The highly carbonized spore specimen figured by Magloire may be assignable to *Verrucosisporites polygonalis* Lanninger, 1968.

Stratigraphic and palaeogeographic occurrence:
- Algeria: Illizi Basin; Orsine Formation; Emsian (Moreau-Benoit et al., 1992).
- Australia: Adavale Basin; Eastwood Formation; *annulatus-sextantii* Assemblage Zone; Emsian (Hashemi & Playford, 2005).
- Belgium: Dinant and Verviers Synclinoriums; Po Interval Zone-AB Oppel Zone; early Pragian-Emsian (Steemans, 1989).
- Brazil: Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Canada: Quebec, Gaspé Peninsula; Grand Grève, York River and Battery Point Formations; 'Siegenian'-Emsian (McGregor & Owens, 1966; McGregor, 1973). Ontario, Moose River Basin; Stooping River Formation; *caperatus-emsiensis* to *annulatus-lindlarensis* Provisional Assemblage Zone; Emsian (McGregor & Camfield, 1976).
- Germany: Soutwestern Eifel; Klerfer Formation; Emsian (Lanninger, 1968). Siegerland; Po Interval Zone-AB Oppel Zone; early Pragian-Emsian (Steemans, 1989).
- France: Armorican Massif, Laval Syncline; Montguyon and Saint-Cénéré Formations; Assemblage 2; Pragian and late Siegenian (Le Hérissé, 1983).
- Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone II; Pragian-Emsian (Ghavidel-Syooki, 2003).
- Libya: Ghadames Basin; Palynozones 3-4; Emsian-earliest Eifelian (Moreau-Benoit, 1989). Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
- Luxembourg: Oesling region; Pow-AP Oppel Zones; late Pragian-late Emsian (Steemans et al., 2000).
- Poland: Random-Lublin area; Borehole Terebin IG 5; Zwoleń Formation; PoW Oppel Zone; Pragian-?basal Emsian (Turnau et al., 2005).

• Saudi Arabia: Well DMMM-45; Tawil Formation; Pa Interval Zone, Pragian (Steemans, 1995). Well-1; Jauf Formation; *annulatus-sextantii* Assemblage Zone, Emsian (Al-Ghazi, 2007). Boreholes BAQA-1, 2, JNDL-1, 3, 4 and wells FWRH-1, HWYH-956, KHRM-2, SDGM-462, UTMN-1830; Jauf Formation; A1-A3b; late Pragian-?early Eifelian.
• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A3b; ?late Emsian-early Eifelian, the isolated occurrence of a unique specimen higher in Eifelian strata may be due to reworking.

Verrucosisporites premnus Richardson, 1965

Pl. 107, figs 11-16, Pl. 108, figs 1-3

1965 *Raistrikia* sp. A, Richardson, p. 574, Pl. 90, fig. 3.
1965 *Raistrikia* cf. *clavata* Hacquebard; Richardson, p. 575, Pl. 90, fig. 5.
1965 *Verrucosisporites premnus* Richardson, p. 572, Pl. 90, figs 1, 2.
non 1968 *Verrucosisporites premnus* Richardson; Lanninger, p. 128, Pl. 22, fig. 20.

Description: Trilete spores with circular to subcircular amb. Laesurae straight, simple, length 2/3 to nearly equal the spore radius. Exine 2-6 µm thick, slightly thinner proximaly. Proximal region laevigate. Equatorial and distal regions sculptured mainly with large, widely or closely packed, verrucae, 2-16 µm wide at base, 2-20 µm high. Sculptural elements, discrete or joined in small groups, in profile parallel-sided slightly tapered or narrower at base with flat, slightly curved, and lobed and serrate apices, but occasionally more conical elements with rounded or truncated apices occur. Sculptural elements circular to subcircular, polygonal or irregular in plan view. Note that the size and shape is variable on a single spore.

Dimensions: 30 (53) 85 µm, 20 specimens measured.

Remark: *Verrucosisporites premnus* Richardson, 1965 is included in the *Verrucosisporites scurrus* Morphon (Tab. 1, p. 185) defined by McGregor & Playford (1992). The latter comprises species characterized by varied, closely spaced or fused, evenly or asymmetrically distributed coni, bacula, verrucae. These taxa have simple laesurae and a subcircular amb. Consequently, some transitional form specimens are difficult to attribute.

Comparisons: *Raistrikia* sp. A and *Raistrickia* cf. *clavata* Hacquebard, 1957 in Richardson (1965) have most morphographic features in common with *Verrucosisporites premnus* Richardson, 1965. The major point of difference between these forms and *Verrucosisporites premnus* Richardson, 1965 is that they may bear spatulate or club-shaped sculptural elements in addition to bacula. Given the variation allowed according to the diagnosis of *Verrucosisporites premnus* Richardson, 1965, it is difficult to maintain taxonomic separation on this basis (McGregor & Camfield, 1982). *Raistrikia* sp. A and *Raistrickia* cf. *clavata* Hacquebard, 1957 in Richardson (1965) are thus considered as synonymous (McGregor & Camfield, 1982). *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 has the same structure but has smaller sculptural elements that are commonly tapered in profile.

Stratigraphic and palaeogeographic occurrence:
• Algeria: Illizi Basin; Tin Meras Formation; middle Givetian (Moreau-Benoit et al., 1992).
• Australia: Canning Basin; Gogo Formation; *lemurata-magnificus* Zone; middle Givetian (Grey, 1991).
• Belgium: Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).

• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri and Saipuru Formations; TA Oppel Zone-LE Interval Zone; late Givetian-Famennian (Perez-Leyton, 1990).
• Brazil: Central Parnaíba Basin; Pimenteira Formation; AD-Lem Interval Zone to Zone IV; early Givetian-earliest Famennian (Loboziak et al., 1992b). Amazon Basin; Ererê and Barreirinha Formations; Per-BPi Interval Zones; early Eifelian-early Frasnian (Melo & Loboziak, 2003).
• Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; middle Eifelian-early Givetian (McGregor & Camfield, 1982).
• France: Boulonnais; Blacourt and Beaulieu Formations; late Givetian-early Frasnian; TLa-TCo Oppel Zones (Brice et al., 1979; Loboziak & Streel, 1988).
• Germany: Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh and Cürten Formations; AD-Ref-Lem Interval Zones; Eifelian-Givetian (Loboziak et al., 1990).
• Iran: Zagros Basin, Faraghan Mountain; Zakeen Formation; Zone IV; Eifelian-early Givetian (Ghavidel-Syooki, 2003).
• Libya: Cyrenaica; early Givetian (Paris et al., 1985). Ghadames Basin; Palynozones 5-7; early Eifelian-middle Givetian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A6-A7; Givetian.
• Poland: Western Pomerania; Studnica, Jamno and Miastko Formations; RL-Ex Zones; late Eifelian-Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex Zone; Givetian (Turnau & Racki, 1999).
• Portugal: Rio Tinto area; Phyllite Quartzite Group; *optivus-triangulatus* Assemblage Zone or TCo Oppel Zone; late Givetian-early Frasnian (Lake et al., 1988).
• Saudi Arabia: Borehole S-462 and well ABSF-29; Jubah Formation; ?A5-A8; ?Eifelian-?early Frasnian, some specimens may be caved in older strata.
• Tunisia: Borehole MG-1; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A8; Eifelian-?early Frasnian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Eday Group; Givetian (Richardson, 1965). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000).

Verrucosisporites scurrus (Naumova) McGregor & Camfield, 1982

Pl. 108, figs 4-14

1953 *Lophozonotriletes scurrus* Naumova, p. 38, Pl. 3, figs 22, 23.
1955 *Lophozonotriletes grumosus* Naumova; Kedo, p. 43, Pl. 6, fig. 12.
1957 *Lophozonotriletes proscurrus* Kedo, p. 33, Pl. 2, fig. 32.
1963 *Verrucosisporites monticulatus* Guennel, p. 252, fig. 5.
1963 *Lophozonotriletes malevkensis* Naumova ex Kedo (pars), Pl. 10, fig. 242.
1963 *Lophozonotriletes bellus* Kedo, p. 87, Pl. 10, figs 243, 244.
1963 *Lophozonotriletes excisus* Naumova; Kedo, Pl. 11, fig. 256.
1964 *Raistrickia* cf. *clavata* Hacquebard; Vigran, p. 16, Pl. 2, fig. 10.
1965 *Verrucosisporites* cf. *proscurrus* Kedo; Richardson, p. 573, Pl. 90, figs 10, 11.
1965 *Raistrickia aratra* Allen, p. 701, Pl. 96, figs 3, 4.
1967 *Lophozonotriletes* sp. 1; Hemer & Nygreen, Pl. 2, fig. 3.
1979 *Raistrickia aratra* Allen; Moreau-Benoit, p. 38, Pl. 5, fig. 2.
1982 *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, p. 61, Pl. 18, figs 10-17, 22, text-fig. 96.

Description: Trilete spores with subcircular to subtriangular amb. Laesura straight, simple, length 2/3 to nearly equal the spore radius. Exine 2-5 µm thick, slightly thinner proximally.

Proximal region laevigate or with greatly reduced sculpture. Equatorial and distal regions sculptured with variable verrucae, rounded and flat-topped bacula, coni, and truncated coni 2-10 µm wide at base, 2-8 µm high, most about as high as their basal width and that may be surmounted by a small granule or cone. Sculptural elements, discrete or joined in small groups to form, short, irregular rugulae, evenly or asymmetrically distributed. Sculptural elements subcircular or irregular in plan view.

Dimensions: 35 (51) 90 µm, 19 specimens measured.

Remarks: Specimens herein assigned to this species belong to a more or less intergrading series from those with predominantly conate and small verrucose sculpture (see *Dibolisporites farraginis* McGregor & Camfield, 1982 and *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982) to those with large verrucate sculptural elements, and thus conform rather closely to the diagnosis of *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 and *Verrucosisporites premnus* Richardson, 1965. All these forms are included in the *Verrucosisporites scurrus* Morphon (Tab. 1, p. 185).

Comparisons: Consequently, extreme forms of *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 intergrade with *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982, *Verrucosisporites premnus* Richardson, 1965, *Verrucosisporites tumulentis* Clayton & Graham, 1974 and possibly *Chelinospora timanica* (Naumova) Loboziak & Streel, 1989. Typically *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982 has predominantly somewhat smaller and less crowded conate spinose sculpture. *Verrucosisporites premnus* Richardson, 1965 has larger, predominantly flat-topped, baculate-spatulate sculpture. *Chelinospora timanica* (Naumova) Loboziak & Streel, 1989 has predominantly convolute sculpture and a thicker wall. *Raistrickia nigra* Love, 1960 bears more regularly spaced ornaments of about the same size on each specimen. *Raistrickia* sp. 1 described above has more widely spaced, and more elongate baculate sculptural elements. *Pustulatisporites gibberosus* (Hacquebard) Playford, 1964 bears more or less evenly spaced sculptural elements that are wider than high and subcircular in plan view. *Acanthotriletes dentatus* Naumova, 1953 has more elongate sculpture.

Stratigraphic and palaeogeographic occurrence:

• Argentina: Tarija Basin, Quebrada Galarza well; Los Monos Formation; late Givetian-early Frasian (Ottone, 1996).

• Australia: Canning Basin; Gogo Formation; *lemurata-magnificus* Zone; middle Givetian (Grey, 1991). Adavale Basin; Lissoy Sandstone and Etonvale Formation; *devonicus-naumovii*, *optivus-triangulatus* and *ovalis-bulliferus* Assemblage Zones; early Givetian-early Frasnian (Hashemi & Playford, 2005).

• Belgium: Namur Synclinorium, Plan Incliné de Ronquières; Bois de Bordeaux Formation; TA Oppel Zone; middle Givetian (Gerrienne et al., 2004).

• Bolivia: Bermejo-La Angostura; Los Monos-Iquiri Formation; AD-BJ Oppel Zones; late Eifelian-early Frasnian (Perez-Leyton, 1990).

• Brazil: Parana Basin, borehole RSP-1; Ponta Grossa Formation; AD Lem Interval Zone to Zone IV; Givetian-Frasnian (Loboziak et al., 1988). Central Parnaíba Basin; Pimenteira Formation; AD-Lem Interval Zone to Zone IV; early Givetian-earliest Famennian (Loboziak et al., 1992b). Amazon Basin; Ererê Formation; LLi Interval Zone; early Givetian (Melo & Loboziak, 2003).

• Canada: Arctic Archipelago, Melville Island; Weatherall and Hecla Bay Formations; Eifelian-early Givetian (McGregor & Camfield, 1982).

• Germany: Eifel, Hillesheim Syncline; Freilingen, Ahbach, Loogh, Cürten and Kerpen Formations; AD-Ref Interval Zone to TA Oppel Zone; Eifelian-Givetian (Loboziak et al., 1990).
• Libya: Cyrenaica; AP Oppel Zone to AD-Lem Interval Zone; early Eifelian-early Givetian (Paris et al., 1985; Streel et al., 1988). Ghadames Basin; Palynozones 6-8; middle Eifelian-late Frasnian (Moreau-Benoit, 1989). Borehole A1-69; Awaynat Wanin II Formation; A5-A8; Eifelian-?early Frasnian.
• Norway: Spitsbergen; Upper Mimer Valley Series, cannel coal bed and Upper Svalbardia Sandstone; Givetian-Frasnian (Vigran, 1964; Allen, 1965).
• Poland: Western Pomerania; Studnica, Jamno, Miastko and Sianowo Formations; Ex Zone; Givetian (Turnau, 1996). Holy Cross Mountains; Bodzentyn Syncline; Skaly, Świetomarz and Nieczulice beds; Ex-Ok Zones; Givetian (Turnau & Racki, 1999).
• Russia: central and eastern parts of European Russia; Staryi Oskol Group; Ex Zone; middle Givetian (Arkhangelskaya & Turnau, 2003).
• Saudi Arabia: Borehole S-462 and wells ABSF-29, YBRN-1; Jubah Formation; A5-A8; Eifelian-?early Frasnian.
• Tunisia: Borehole MG-1; Ouan-Kasa, Awaynat Wanin I, Awaynat Wanin II and Awaynat Wanin III Formations; A3b-A8; ?late Emsian-?early Frasnian.
• United Kingdom: Northeast Scotland, Orcadian Basin; Eday Group; Givetian (Richardson, 1965). Scotland, East Orkney Basin, BP/Chevron well 14/6-1; latest Givetian-early Frasnian (Marshall et al., 1996). Shetland, Papa Stour; *devonicus-naumovii* Assemblage Zone or AD Oppel Zone; late Eifelian (Marshall, 1988). Shetland; Walls Group; *lemurata-magnificus* Assemblage Zone or Lem Interval Zone; early Givetian (Marshall, 2000).

***Verrucosisporites* sp. 1**

Pl. 109, figs 1-4

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple and extending to the equator. Exine 1-2 µm. Proximal region laevigate. Equatorial and distal regions sculptured with evenly distributed verrucae or truncated coni, 1.5-5 µm wide at base, 2-5 µm high and 0.5-3 µm apart. Sculptural elements circular or subcircular in plan view, parallel-sided or slightly tapered with flat or rounded apices in profile view, surmounting sometimes by one or two minute coni at each apex.

Dimensions: 34 (39) 45 µm, 4 specimens measured.

Comparison: *Cymbosporites dammamensis* Steemans, 1995 is patinate and bears small bacula generally with bifurcate-shaped apices. *Verrucosisporites* sp. 2 possesses a kyrtome on each interradial area.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Borehole JNDL-4 and well KHRM-2; Jauf Formation; A2-A3b; ?late Pragian-?early Eifelian.

***Verrucosisporites* sp. 2**

Pl. 109, figs 5-12

Description: Trilete spores with subcircular to subtriangular amb. Laesurae straight, simple and extending almost to the equator. Proximal region laevigate and bearing a kyrtome on each interradial area. Equatorial and distal regions sculptured with densely distributed verrucae, 1.5-4 µm wide at base, 1-2.5 µm high, generally less than 0.5 µm apart. Sculptural elements discrete, closely appressed or fused at base, subcircular or polygonal in plan view, rounded or slightly tapered with rounded or more or less flat apices in profile view, surmounting by one or some minute coni, about 0.5 µm wide and high, at each apex.

Dimensions: 36 (44) 53 µm, 14 specimens measured.

Remark: On the well-preserved specimens, the apex of verrucae, where the coni are present, presents a paler spot in polar view. That is interpreted as light reflection. On the more badly preserved specimens, this phenomenon is not observed.

Comparison: *Verrucosisporites* sp. 1 does not possess kyrtomes on its proximal face and is less densely sculptured.

Stratigraphic and palaeogeographic occurrence:
- Libya: Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
- Saudi Arabia: Boreholes BAQA-1, 2, JNDL-3 and well KHRM-2; Jauf Formation; A1-A3a; late Pragian-Emsian.

***Verrucosisporites* sp. 3**

Pl. 109, figs 13-16

Description: Trilete spores with subcircular, subtriangular or oval amb. Laesurae straight, simple and extending almost to the equator. Proximal region laevigate. Exine 1-3 µm. Equatorial and distal regions sculptured with verrucae, 3-9 µm wide at base, 3-7 µm high, up to 8 µm apart. Sculptural elements variably distributed, discrete or locally fused at base, subcircular in plan view, with concave sides (diabolo-shaped) or parallel-sided with flat or rounded apices (as wide as the base) in profile view.

Dimensions: 59 (65) 71 µm, 6 specimens measured.

Remark: Proximal region seems to be thinner because laesurae are not often observed.

Comparison: *Verrucosisporites premnus* Richardson, 1965 possess parallel-sided or slightly tapered sculptural elements that are commonly higher. The latter species and *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982 show an ornamentation much more variable in shape on the same specimen. *Cymbosporites dammamensis* Steemans, 1995 is sculptured with smal bacula.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A2; ?late Pragian-early Emsian.

***Verrucosisporites* sp. 4**

Pl. 110, figs 1-9

Description: Trilete spores with subcircular amb. Laesurae straight, simple, length 1/2 to 4/5 the spore radius. Curvaturae barely visible. Exine 0.5-2 µm thick. Proximal surface laevigate. Equatorial and distal regions sculptured with flat-topped verrucae and coni, 0.5-3 µm wide at base, 0.5-1 µm high and 0.5-2.5 µm apart. Sculptural elements discrete or locally fused at base, subcircular to angular and irregular in plan view.

Dimensions: 43 (56) 61 µm, 9 specimens measured.

Comparison: *Cyclogranisporites retisimilis* Riegel, 1968 has a darker apical area, subtriangular with concave sides.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes BAQA-1, 2; Jauf Formation; A1-A2; late Pragian-?early Emsian.

Genus *Zonotriletes* Luber & Waltz, 1938

Type species: None designated.

Description: Trilete zonate spores.

***Zonotriletes armillatus* Breuer et al., 2007c**

Pl. 110, figs 10-15, Pl. 111, figs 1-4

2007c *Zonotriletes armillatus* Breuer et al., p. 51, Pl. 11, figs 9-12, Pl. 12, figs 1, 2.

Description: Trilete zonate spores with subcircular to subtriangular amb. Laesurae distinct, straight to slightly sinuous, and accompanied by prominent labra, each up to 3 µm wide, extending to the inner margin of the zona. Curvaturae not visible. The central body is subtriangular, its radius equals 1/3 to 4/5 amb radius. Exine is commonly 2-4 µm thick equatorially, rarely up to 6 µm. The thin proximo-equatorial flange is generally 4-10 µm wide interradially but sometimes up to about 20 µm for the larger specimens. The flange is always narrower opposite the trilete rays. It is sometimes folded and can be folded back over the central body locally. Thin transverse attachment lines of the flange on the central body often can be distinguished on the proximal face. An annulus is present on the distal face and is 4-10 µm wide. The annulus radius equals 5/10 to 7/10 central body radius. The annulus is often homogeneous, darker than the distal exine and striped in some cases. A small circular dark area inside the annulus occurs at the distal pole. Proximal and distal surfaces laevigate.

Dimensions: 43 (64) 109 µm, 35 specimens measured.

Comparisons: *Breconisporites breconensis* Richardson et al., 1982 has a larger distal annulus which can be partially or completely coincident with the cingulum giving the appearance of a broad thickened zone. Moreover, the transverse attachment lines of the flange on the proximal face form plicate ridges up to 1.5 µm wide. Furthermore, the flange is commonly narrower in the radial zones. *Zonotriletes armillatus* Breuer et al., 2007c can be confused with

Zonotriletes simplicissimus Breuer et al., 2007c when the specimens are poorly preserved and dark colored, making the distal annulus difficult to discern. *Zonotriletes sp.* 5 has a more rounded appearance and a generally wider flange.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: BoreholesJNDL-1, Jubah Formation, A4; Eifelian.
- Tunisia: Borehole MG-1, Awaynat Wanin I Formation, A5; Eifelian.

Zonotriletes simplicissimus Breuer et al., 2007c

Pl. 111, figs 5-12

2007c *Zonotriletes simplicissimus* Breuer et al., p. 52, Pl. 12, figs 3-7.

Description: Trilete zonate spores with subcircular to subtriangular amb. Laesurae distinct, straight to slightly sinuous, 3-7 µm in overall width, extending to the inner margin of the zona. Curvaturae not visible. Central body radius equals 3/5 to 4/5 amb radius. Exine of the central body is 3-7 µm thick equatorially. The thin proximo-equatorial flange is commonly 4-13 µm wide interradially but sometimes larger, up to 18 µm. The flange is generally narrower opposite the trilete rays and is sometimes radially folded. Thin transverse attachment lines of the flange on the central body often can be distinguished. Proximal and distal surfaces entirely laevigate.

Dimensions: 38 (59) 82 µm, 26 specimens measured.

Remark: The smallest specimens commonly have a less well-developed proximo-equatorial flange when compared to the largest ones which can possess a very wide flange interradially.

Comparisons: *Perotrilites caperatus* (McGregor) Steemans, 1989 possesses a coarse wrinkled exine over the equatorial part of the proximal face and is distally verrucate or rugulate. *Cingulizonates glaber* Arkhangelskaya, 1978 seems morphologically close but it has a fairly large, rounded area of very thin, sometimes ruptured, wall at the proximal pole, 22-35 µm in diameter, and its laesurae are simple and slender. *Breconisporites simplex* Wellman, 1993 also seems similar, but it possesses narrower laesurae and folded contact areas. *Zonotriletes* sp. 3 in Jardiné & Yapaudjian (1968) appears similar to *Zonotriletes simplicissimus* Breuer et al., 2007c according to the figure, but there is no description to allow a detailed comparison.

Stratigraphic and palaeogeographic occurrence:
- Saudi Arabia: Boreholes JNDL-1 and S-462, Jubah Formation, A4-A5; Eifelian.
- Libya: Borehole A1-69; Awaynat Wanin II Formation; A5; Eifelian.

Zonotriletes sp. 1 in Jardiné & Yapaudjian (1968)

Pl. 112, figs 1-12

1968 *Zonotriletes* sp. 1; Jardiné & Yapaudjian, Pl. 2, fig. 6.
1976 *Perotriletes* sp.; Massa & Moreau-Benoit, Pl. 1, fig. 5.

Description: Zonate trilete spores with subcircular to subtriangular amb. Laesurae distinct, straight, simple or sometimes bordered with lips about 0.5 µm wide individually, extending almost to the inner margin of the zona. Curvaturae often visible. Central body radius equals commonly 8/10 to 9/10 amb radius. Exine of the central body 2-5 µm thick equatorially. The proximo-equatorial flange, commonly 2-8 µm wide, has originally the same width along the amb but is often folded back locally. Thin transverse attachment lines of the flange on the central body sometimes can be distinguished on the proximal face. Proximal and distal surfaces entirely laevigate.

Dimensions: 49 (59) 71 µm, 22 specimens measured.

Comparison: This taxon differs mainly from other species of *Zonotriletes* Luber & Waltz, 1938 by its narrow zona of regular width. *Zonotriletes simplicissimus* Breuer et al., 2007c is more robust and possesses wide lips bordering laesurae. Furthermore, its flange is generally narrower opposite the trilete rays.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Polignac Basin, Hassi-Tabankort Formation, Zones VI-VII, Gedinnian-Siegenian (Jardiné & Yapaudjian, 1968).
- Libya: Ghadames Basin, Tadrart and Ouan-Kasa Formations, Palynozones 1-2, Siegenian-Emsian (Massa & Moreau-Benoit, 1976). Borehole A1-69; Ouan-Kasa Formation; A3a; Emsian.
- Saudi Arabia: Boreholes BAQA-1, JNDL-1, 4 and well UTMN-1830, Jauf and Jubah Formations; A2-A4; ?late Pragian-Eifelian.
- Tunisia: Borehole MG-1, Ouan-Kasa and Awaynat Wanin I Formations; A4-A5; Eifelian.

Zonotriletes sp. 2 in Jardiné & Yapaudjian (1968)

Pl. 113, figs 1-5

1968 *Zonotriletes* sp. 2; Jardiné & Yapaudjian, Pl. 2, fig. 1.
1988 *Perotrilites* sp. cf. *Zonotriletes* sp. 2 in Jardiné & Yapaudjian, Boumendjel et al., Pl. 1, fig. 1.

Description: Zonate trilete spores with subcircular to subtriangular amb. Laesurae distinct, straight to slightly sinuous, sometimes elevated, extending to the outer margin of the zona. Curvaturae not visible. Central body radius equals 2/5 to 3/5 amb radius. Exine of the central body relatively thin equatorially. The equatorial flange is finely striated. Proximal and distal surfaces entirely laevigate.

Dimensions: 77 (129) 176 µm, 9 specimens measured.

Remark: As the equatorial flange is thin and very large, it is often broken and/or folded.

Stratigraphic and palaeogeographic occurrence:

- Algeria: Polignac Basin; Hassi-Tabankort Formation; Zones VI-VII, Gedinnian-Siegenian (Jardiné & Yapaudjian, 1968). Illizi Basin, borehole TRN 3; Hassi-Tabankort Formation; Pragian (Boumendjel et al., 1988).
- Brazil: Parnaíba Basin; Jaicós Formation; Su Interval Zone; latest Pragian-earliest Emsian (Grahn et al., 2005). Paraná Basin, Alto-Garças sub-Basin, Jaciara region; late Pragian-early Emsian (Mendlowicz Mauller et al., 2007).
- Saudi Arabia: Boreholes BAQA-1 and JNDL-4; A2-A3a; ?late Pragian-Emsian.

• Tunisia: Borehole MG-1; Ouan-Kasa Formation; A2-A3b; ?late Pragian-?early Eifelian, the specimens of A2 are probably reworked in younger strata.

***Zonotriletes* sp. 3**

Pl. 114, figs 1-4

Description: Zonate trilete spores with subcircular to subtriangular amb. Laesurae distinct, straight to slightly sinuous, simple or bordered with lips up to 3 µm wide individually and extending to the outer margin of the zona. Curvaturae not visible. Central body radius equals 3/5 to 4/5 amb radius. Exine of the central body 2-5 µm thick equatorially. Zona is divided entirely or partially into three individual proximo-equatorial flanges, the maximum width (commonly 14-25 µm) of which is opposite the trilete rays. Zona laevigate to infra-granular, generally folded back opposite the laesurae, resulting in a tri-lobed appearance. Thin transverse attachment lines of the flange on the central body can be distinguished on the proximal face. Proximal and distal surfaces of the central body laevigate.

Dimensions: 65 (82) 102 µm, 5 specimens measured.

Comparison: *Alatisporites* sp. 1 is more rounded and possess a zona divided into three individual sacci. Furthermore, the maximum width of the zona is opposite to the trilete rays.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin I Formation; A4; Eifelian.
• Saudi Arabia: Borehole JNDL-1; Jubah Formation; A4; Eifelian.

***Zonotriletes* sp. 4**

Pl. 114, figs 5, 6, Pl. 115, figs 1-5

Description: Zonate trilete spores with amb subcircular to subtriangular. Laesurae distinct, straight to slightly sinuous, simple and rarely elevated up to 2 µm, extending or almost to the inner margin of the zona. Curvaturae not visible. The central body radius equals commonly 7/10 to 8/10 amb radius. Exine of the central body is commonly 1-3 µm thick equatorially. The thin proximo-equatorial flange is generally 5-20 µm wide but up to 24 µm for the larger specimens. The flange can be folded back opposite the laesurae and radially folded. Thin transverse attachment lines of the flange on the central body sometimes can be distinguished on the proximal face. An annulus is present on the distal face and is 6-10 µm wide. The annulus radius equals 4/10 to 6/10 central body radius. In some specimens, the annulus is barely perceptible in a rounded darker zone than the distal exine. Proximal and distal surfaces laevigate.

Dimensions: 55 (83) 110 µm, 20 specimens measured.

Comparison: *Zonotriletes armillatus* Breuer et al., 2007c has a more triangular appearance and a generally less wide flange which is always narrower opposite the trilete rays.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin I and Awaynat Wanin II Formations; A5-A7; Eifelian-Givetian.

• Saudi Arabia: Borehole JNDL-1; Jauf and Jubah Formations A3b-A4; ?late Emsian-Eifelian.
• Tunisia: Borehole MG-1; Ouan-Kasa Awaynat Wanin I and Awaynat Wanin II Formations; A3b-A7; ?late Emsian-Givetian.

***Zonotriletes* sp. 5**

Pl. 115, figs 6, 7

Description: Zonate trilete spores with amb triangular with rounded corners. Laesurae distinct, straight to slightly sinuous, up to 4 µm high, extending to the inner margin of the zona. Curvaturae not visible. Central body radius equals more or less 9/10 amb radius. Exine of the central body thin equatorially. The thin proximo-equatorial flange is commonly 2.5-6 µm wide. Thin transverse attachment lines of the flange on the central body can be distinguished on the proximal face. Proximal and distal surfaces entirely laevigate.

Dimensions: 68 (74) 80 µm, 2 specimens measured.

Stratigraphic and palaeogeographic occurrence:
• Libya: Borehole A1-69; Awaynat Wanin II Formation; A6; Givetian.

***Zonotriletes* sp. 6**

Pl. 116, figs 1-3

Description: Zonate trilete spores with subcircular amb. Laesurae distinct and straight extending almost to the equatorial margin of the central body. Central body radius equals about 4/5 amb radius. Exine of the central body 2-4 µm thick equatorially. The equatorial flange is sculptured at its outer margin with flexuous spinae, 5-20 µm high, 2-6 µm µm wide at base. Proximal and distal surfaces entirely laevigate.

Dimensions: 57 (73) 88 µm, 3 specimens measured.

Comparison: *Cirratriradites diaphanus* Steemans, 1989 has proximal papillae developed on each interradial area. Moreover, its flange is not divided into sculptural elements but often damaged.

Stratigraphic and palaeogeographic occurrence:
• Saudi Arabia: Boreholes BAQA-1 and JNDL-4; Jauf Formation; A2; ?late Pragian-Emsian.

Table 1. Miospore morphons and their characterizing features referred to in the text.

Name	Constituent taxa	Morphological characters
Apiculiretusispora brandtii	*Apiculiretusispora brandtii* *Cymbosporites asymmetricus* *Rhabdosporites minutus*	Densely spaced, small coni, grana and spinae; exine partially or completely detached from nexine at the equator.
Archaeozonotriletes variabilis	*Archaeozonotriletes variabilis* *Cyrtospora* sp. 1 *Lophozonotriletes media*	Patinate spores; laevigate to variably sculptured with scattered coarse, rounded protuberances and flat-topped verrucae.
Chelinospora hemiesferica	*Chelinospora hemiesferica* *Chelinospora* cf. *hemiesferica* *Chelinospora* sp. 1 *Chelinospora* sp. 2	Patinate spores; distal region sculptured with loosely distributed or brain-like convoluted muri; laesurae simple; subcircular to triangular amb.
Clivosispora verrucata	*Clivosispora verrucata* var. *convoluta* *Clivosispora verrucata* var. *verrucata*	Patinate spores; distal region sculptured with coarse verrucae to convolute ridges.
Cristatisporites sp. 1	*Cristatisporites* sp. 1 *Cristatisporites* sp. 2	Zonate spores; distal region sculpured with fold-like ridges, bearing spinae.
Cymbosporites catillus	*Cymbosporites catillus* *Cymbosporites cyathus*	Patinate spores; distal region sculptured with densely packed grana, coni or spinae.
Dictyotriletes biornatus	*Cymbosporites* sp. 1 *Cymbosporites* sp. 2 *Cymbosporites* sp. 3 *Dictyotriletes biornatus* *Dictyotriletes* sp. 1	Patinate spores; distal region sculptured of coni, discrete or partly fused in elongate elements, evenly distributed to organized in a reticulum pattern; simple laesurae; subcircular to subtriangular amb.
Diaphanospora sp. 1	*Diaphanospora* sp. 1 *Retusotriletes* sp. 2	Strongly folded sexine possible; dark subtriangular apical area; subcircular amb.
Grandispora incognita	*Grandispora incognita* *Grandispora* ?*naumovii*	Camerate spores; distal region sculptured with slender spinae with flared bases.
Grandispora protea	*Grandispora douglastownense* *Grandispora protea*	Camerate spores; distal region sculptured with biform or parallel-sided spinae.
Samarisporites eximius	*Samarisporites angulatus* *Samarisporites eximius* *Samarisporites* sp. 2	Zonate spores; distal region sculpured with discrete spinae, sometimes arranged in rugulae; subcircular to triangular amb.
Synorisporites papillensis	?*Knoxisporites riondae* *Synorisporites papillensis*	Proximal papillae; distal region, laevigate, irregularly verrucate or showing an annulus
Verrucosisporites scurrus	*Dibolisporites farraginis* *Dibolisporites uncatus* *Verrucosisporites premnus* *Verrucosisporites scurrus*	Varied, spaced or partially fused, evenly or asymmetrically distributed, coni/spinae/ bacula/verrucae; simple laesurae; subcircular amb.

Glossary

Baculum (pl. bacula, adj. baculate): A cylindrical, free standing exine element more than 1µm in length and less than this in diameter (Potonié, 1934).

Camera (pl. camerae, adj. camerate): A cavity formed by the separation of two wall layers in spores that lacks an infrastructure (Neves & Owens, 1966).

Caput (pl. capita, adj. capitate): The expanded apex (head) of a columella (Erdtman, 1952).

Cingulum (pl. cingula, adj. cingulate): A thick outer structure of a spore that projects at the equator, but does not extend over the distal or proximal face (Potonié & Kremp, 1955).

Columella (pl. columellae, adj. columellate): A rod-like element of the surface of the spores**,** either supporting a tectum or a caput. The difference between a baculum and a columella in current usage is, that a baculum is always a free standing element of sculpturing, whereas a columella is part of the structure (Iversen & Troels-Smith, 1950)**.**

Contact area: Area on the proximal face of a spore interpreted as having been formed in contact with the other members of the tetrad (Potonié, 1934).

Conus (pl. coni): Cone-shaped elements on the surface of spores in which the height is less than two times the basal diameter and the apex is pointed, blunt or rounded (Potonié & Kremp, 1955).

Corona (pl. coronae, adj. coronate): An equatorial or subequatorial extension of a spore, resembling a cingulum, but divided into fringe-like elements (fimbria) (Potonié & Kremp, 1955).

Curvatura (pl. curvaturae): A line in trilete spores, extending from the extremities of the ends of the laesura and thus delimiting the contact areas. Comment: Curvaturae perfectae are continuous around the proximal face whereas curvaturae imperfectae are present as forked extensions that do not join (Potonié, 1934).

Ectonexine: Outer layer of nexine (Erdtman, 1952).

Endonexine: Inner layer of nexine (Erdtman, 1952).

Exine: The outer, very resistant of the two major layers forming the wall (sporoderm) of spores and pollen, consisting principally of sporopollenin, and situated immediately outside the intine. It is divided into two layers on the basis of being related to sculpture (sexine) or not so related (nexine) (Erdtman, 1952).

Fimbria (pl. fimbriae, adj. fimbriate): Long, hair-like appendages (Jackson, 1928).

Flange: A general term, used to describe equatorial extensions of spores (Jackson, 1928). Comment: This term is widely used in Palaeozoic spores, but is not precisely defined.

Foveola (pl. foveolae, adj. foveolate): A feature of ornamentation consisting of more or less rounded depressions or lumina more than 1 µm in diameter (Erdtman, 1952).

Granum (pl. grana): Element on the surface of spores which has approximately the same width as its height. The apex is rounded (Potonié, 1934).

Gula (pl. gulae, adj. gulate): A rather ornate projecting, neck-like, extension on the proximal face of the trilete mark (Potonié & Kremp, 1955).

Hilum (pl. hila, adj. hilate): Circular, indistinctly delimited, irregular aperture or thinning in spores (Erdtman, 1952).

Kyrtome: A more or less arcuate fold or band in the interradial areas outside the laesurae of trilete spores (Potonié & Kremp, 1955).

Laesura (pl. laesurae, suffix –lete): The arm of a proximal fissura or scar of a spore. Comment: A monolete spore has one laesura, a trilete spore three. A laesura comprises a commissure which may be bordered by a labra (Erdtman, 1946).

Laevigate (adj.): A general term for smooth (Jackson, 1928).

Lumen (pl. lumina): The space enclosed by the muri (Potonié, 1934).

Morphon: As defined by Van der Zwan (1979), a group of palynological species (form-species) united by continuous variation of morphological characteristics. Others use the term 'complex' in a very similar way.

Murus (pl. muri): A ridge that is part of the ornamentation and, for example, separates the lumina in a reticulate miospore or in a striate miospore (Erdtman, 1943).

Nexine: The inner, non-sculptured part of the exine, which lies below the sexine (Erdtman, 1952). This layer can exhibit an outer (ectonexine) and an inner layer (endonexine).

Patina (adj. Patinate): A thickening of the exine of spores that extends over the entire surface of one hemisphere (Butterworth & Williams, 1958).

Pilum (pl. pila, adj. pilate): Elements on the surface of spores consisting of a rod-like part (columella) and a swollen apical part (caput) (Erdtman, 1952).

Reticulum (pl. reticula, adj. reticulate): A network-like pattern consisting of lumina or other spaces wider than 1 µm bordered by elements narrower than the lumina (Praglowski & Punt, 1973).

Rugulate (adj., n. rugula, pl. rugulae): Describing a type of ornamentation consisting of elongated sexine elements more than 1 µm long, arranged in an irregular pattern that is intermediate between striate and reticulate (Iversen & Troels-Smith, 1950).

Sexine: The outer, sculptured layer of the exine, which lies above the nexine (Erdtman, 1952).

Spina (pl. spinae): A general word, applied in palynology to long and tapering pointed elements, exceeding 1µm.

Tectum (pl. tecta, adj. tectate): The layer of sexine, which forms a roof over the columellae, granules or other infratectal elements (Fægri & Iversen, 1950).

Trilete (adj.): Describing a spore with three laesurae, thus showing a trilete mark (Erdtman, 1943).

Verruca (pl. verrucae, adj. verrucate): A wart-like elements on the surface of spores, more than 1 µm wide, that is broader than it is high and is not constricted at the base (Iversen & Troels-Smith, 1950).

Zona (pl. zonae, adj. zonate): A thin outer structure of a spore that projects at the equator, but does not extend over the distal face or proximal face (Potonié & Kremp, 1955).

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Plates 1-130

Each figured specimen is identified by borehole, sample, slide number and England Finder Co-ordinate location. All figured specimens are at magnification x1000 except when it is mentioned. The described miospore species are illustrated in Plates 1-117. Sculptural elements of some selected species are figured at magnification x1000 in Plates 118-123. Some other palynological groups are represented in Plates 124-130 but most of these specimens are unidentified.

Plate 1.

1-8. *Artemopyra inconspicua* Breuer et al., 2007c.

1. JNDL-1, 495.0', 60855, E38/3.
2. BAQA-1, 227.1', G24/1. Hilum exhibits a pseudo-trilete mark.
3. JNDL-3, 368.2', W45.
4. BAQA-1, 223.5', F35/2.
5. BAQA-1, 219.2', F43-44. Hilum exhibits a pseudo-trilete mark.
6. JNDL-3, 273.8', L34/4.
7. JNDL-4, 285.5', H34/3.
8. JNDL-3, 273.8', J51/1.

9-17. *Artemopyra recticosta* Breuer et al., 2007c.

9. BAQA-1, 219.2', X31/2.
10. JNDL-1, 156.0', 60839, U44/4. Hilum exhibits a pseudo-trilete mark that does not reach curvatura.
11. JNDL-1, 156.0', 60839, J35-36.
12. JNDL-1, 495.0', 60854, U37/4.
13. JNDL-1, 155.6', 60838, O46.
14. JNDL-3, 368.8', N43.
15. JNDL-1, 155.6', 60837, A29/4.
16. JNDL-1, 155.6', 60837, P28/2.
17. JNDL-1, 155.6', 60837, L44.

Plate 1

Plate 2.

1-8. *Cymbohilates baqaensis* Breuer et al., 2007c.

1. BAQA-2, 54.8’, S44/1.
2. BAQA-2, 50.2’, S47/1.
3. BAQA-2, 133.0’, T29.
4. BAQA-2, 54.8’, S38/1.
5. BAQA-2, 52.0’, J33/1.
6. BAQA-2, 54.8’, Q23/4.
7. BAQA-2, 50.2’, V33/2.
8. BAQA-2, 50.8’, M28-29.

9-17. *Cymbohilates comptulus* Breuer et al., 2007c.

9. UTMN-1830, 13670.8’, 62382, V44.
10. BAQA-1, 205.8’, N50/2.
11. BAQA-1, 219.2’, D40-41.
12. BAQA-1, 376.4’, U25/1.
13. BAQA-1, 285.5’, V30.
14. MG-1, 2258 m, 62948, S48/2.
15. BAQA-1, 205.8’, K27/1.
16. BAQA-1, 285.5’, S47.
17. HWYH-956, 14214.1’, 47151(1), O57/2.

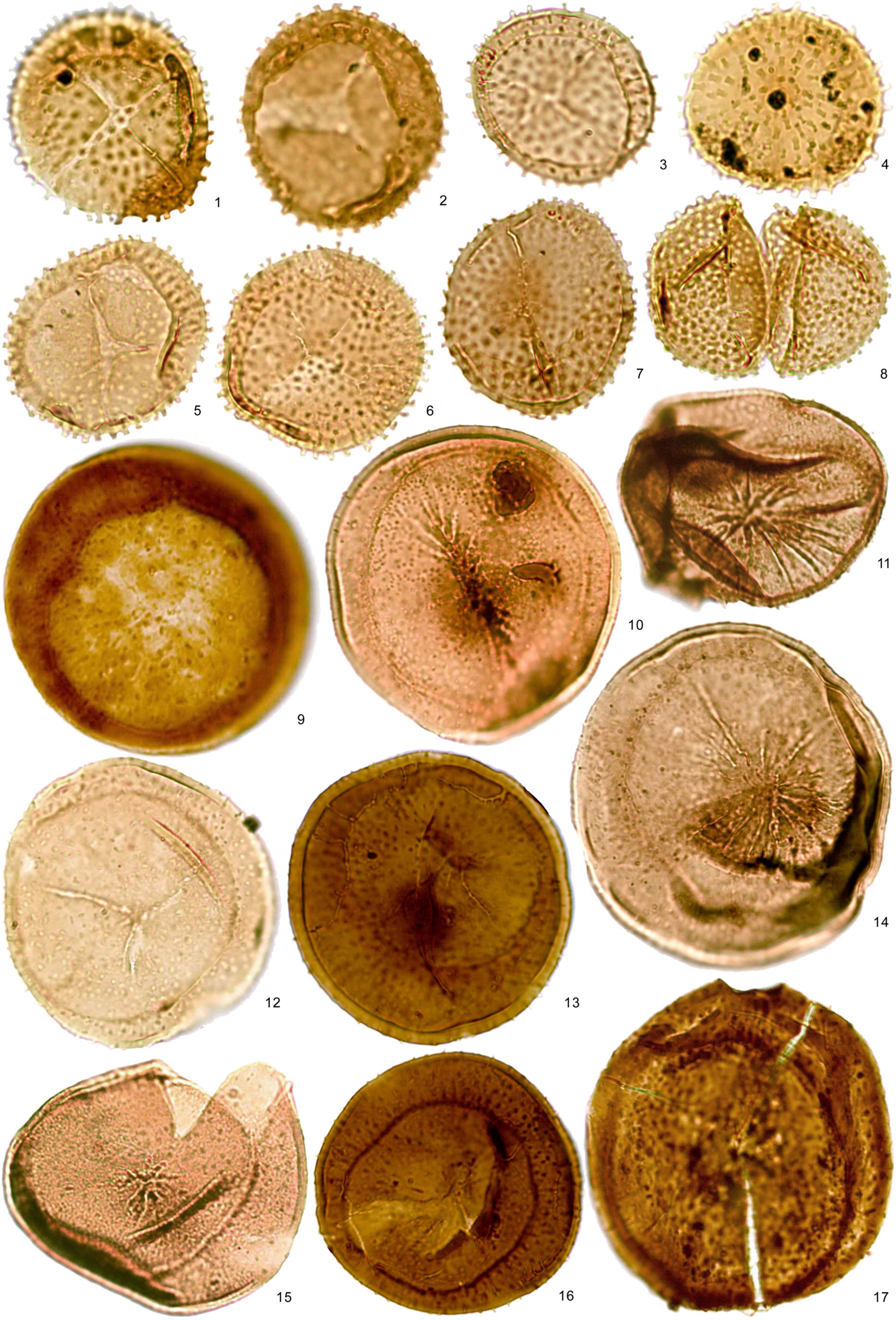

Plate 2

Plate 3.

1. *Cymbohilates cymosus* Richardson 1996. BAQA-2, 134.4’, M34/2. Permanent tetrad.

2-10. *Cymbohilates heteroverrucosus* Breuer et al., 2007c.

2. JNDL-1, 172.7’, 60845, L28.
3. JNDL-1, 177.0’, 60849, H44.
4. JNDL-1, 162.3’, 60841, G32/4.
5. JNDL-1, 177.0’, G33.
6. JNDL-1, 177.0’, 60850, P48/1.
7. JNDL-1, 172.7’, 60846, R30/1.
8. JNDL-1, 167.8’, 60843, X29/1.
9. JNDL-1, 167.8’, 60843, D27/3.
10. JNDL-1, 495.0’, S30.

11-13. *Cymbohilates* sp. 1.

11. MG-1, 2631.2 m, 62552, T43/1.
12. MG-1, 2631.2 m, 62552, N45.
13. MG-1, 2631.2 m, 62551, K29/2.

14. *Dyadaspora murusattenuata* Strother & Traverse, 1979. HWYH-956, 14186.0’, 60543, R39/3.

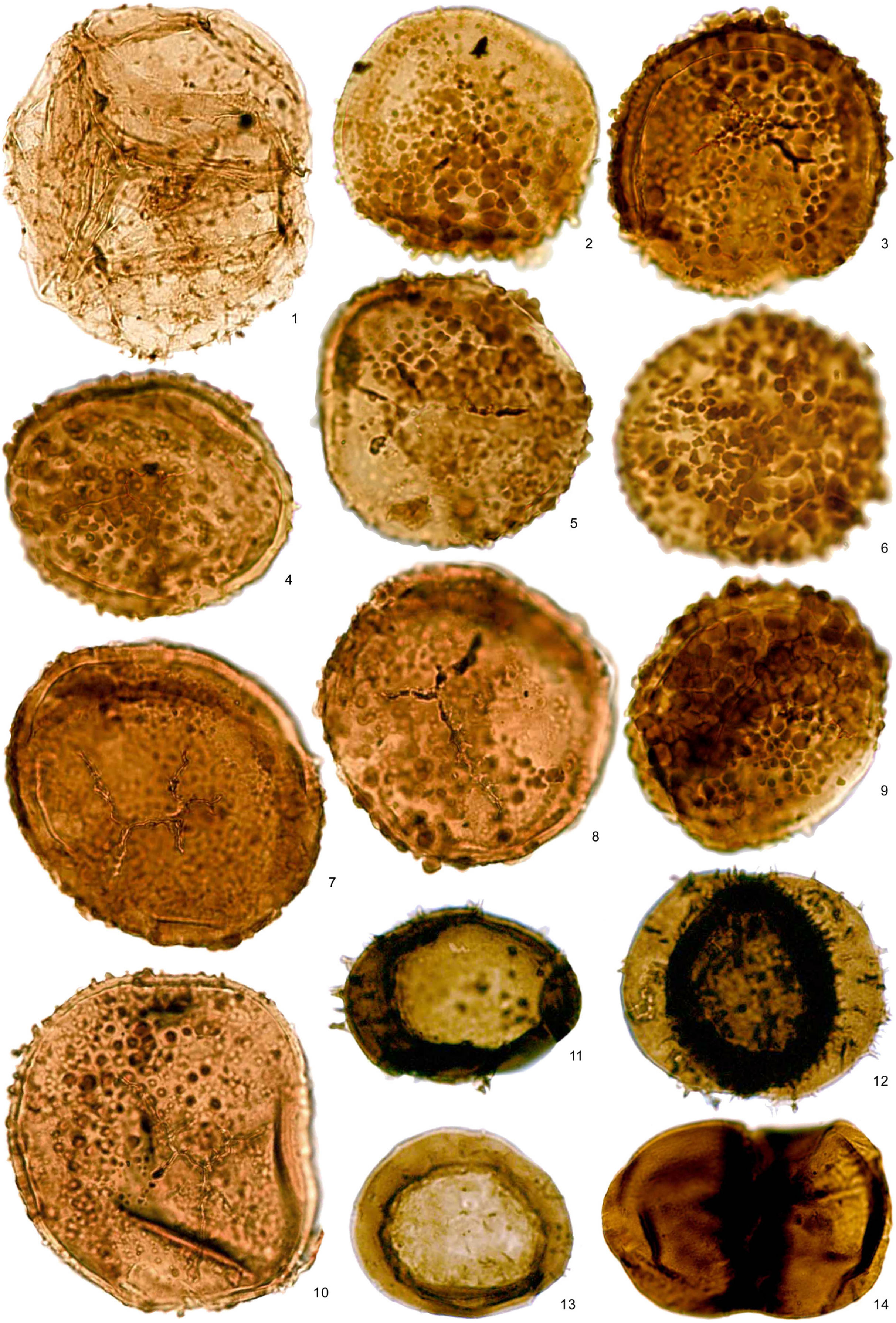

Plate 3

Plate 4.

1-9. *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *divellomedia*.

1. JNDL-1, 156.0', U32/1.
2. UTMN-1830, 13612.5', 62367, T29/2.
3. JNDL-1, 155.6', 60837, M27.
4. BAQA-1, 219.2', G49.
5. JNDL-3, 368.8', K44.
6. BAQA-2, 50.2', V24.
7. JNDL-1, 172.7', V34.
8. BAQA-2, 50.8', V35/2.
9. JNDL-1, 156.0', C45.

10-18. *Gneudnaspora divellomedia* (Tchibrikova) Balme, 1988 var. *minor* Breuer et al., 2007c.

10. UTMN-1830, 13613.2', 62370.
11. BAQA-2, 50.8', L38/1.
12. BAQA-2, 50.2', V30.
13. JNDL-1, 172.7', M49/3.
14. BAQA-2, 54.8', G49.
15. BAQA-2, 50.2', B49/2.
16. BAQA-2, 57.2', E25/4.
17. UTMN-1830, 13614.6', 62379, E28/1.
18. BAQA-2, 52.0', T32/3.

19. *Tetrahedraletes medinensis* Strother & Traverse, 1979. JNDL-1, 156.0', 60840, F43/4.

Plate 4

Plate 5.

1, 2. *Archaeoperisaccus* cf. *A. rhacodes* Hashemi & Playford, 2005.
1. MG-1, 2205 m, 62597, V40.
2. MG-1, 2264 m, 62950, G41/3.

3. *Cymbosporites catillus* Allen, 1965. MG-1, 2178 m, 62995, M42.

4-6. *Devonomonoletes* sp. 1.
4. BAQA-2, 133.0', M35/1.
5. BAQA-1, 376.4', N36/2.
6. BAQA-2, 133.0', E29.

7. *Devonomonoletes* spp. MG-1, 2212.5 m, 62530, Q27.

8, 9. *Emphanisporites rotatus* McGregor emend. McGregor, 1973.
8. MG-1, 2693 m, 62961, L37.
9. HWYH-956, 14188.5', 60547, N35/1.

10. *Geminospora lemurata* Balme emend. Playford, 1983. MG-1, 2180 m, 62972, U-V32.

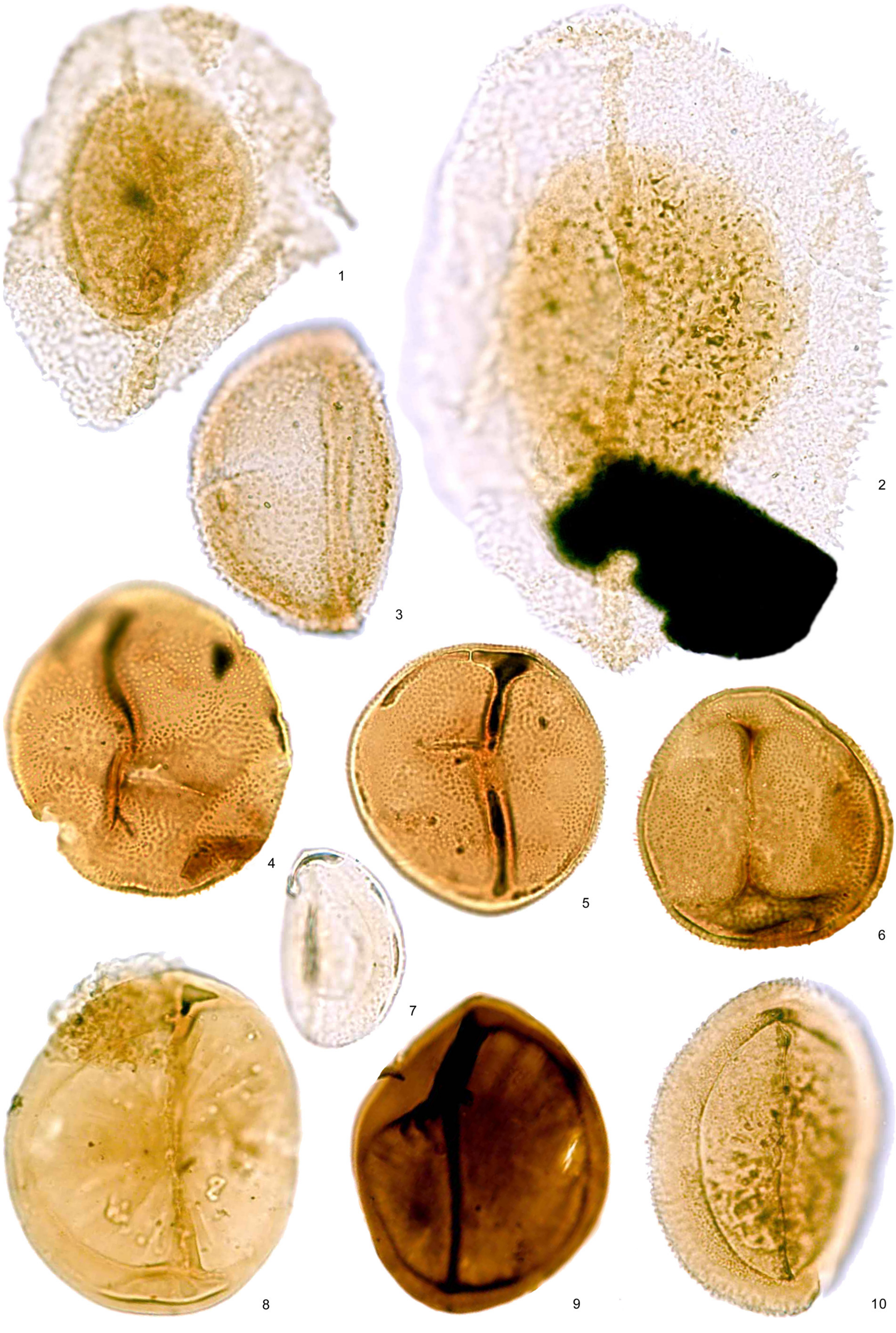

Plate 5

Plate 6.

1-5. *Geminospora lemurata* Balme emend. Playford, 1983.

1. MG-1, 2178 m, 62997, J44/3.
2. MG-1, 2160.6 m, 62746, V41.
3. MG-1, 2161.8 m, 62529, S38/3.
4. A1-69, 1109’, 27274, H50/1.
5. MG-1, 2182.4 m, 62526, S47/2.

6. *Geminospora* spp. MG-1, 2161.8 m, 62529, D34/3.

7-15. *Latosporites ovalis* Breuer et al., 2007c.

7. BAQA-2, 50.8’, T30/2.
8. BAQA-1, 345.5’, K23.
9. BAQA-1, 345.5’, K29/1.
10. BAQA-2, 54.8’, N26/4.
11. BAQA-2, 50.2’, H26/1.
12. BAQA-2, 54.8’, O40.
13. BAQA-2, 56.0’, S27.
14. BAQA-1, 222.5’, F40.
15. BAQA-1, 371.1’, R45.

Plate 6

Plate 7.

1-8. *Latosporites ovalis* Breuer et al., 2007c.
1. HWYH-956, 14205.4', 60552, J49/4.
2. BAQA-1, 227.1', E51.
3. HWYH-956, 14195.3', 47149(2), R61.
4. HWYH-956, 14195.3', 47149(3), M52/2.
5. HWYH-956, 14207.5', 60556, J44.
6. ABSF-29, 16741.8', 61989, O54/4.
7. ABSF-29, 16358.5', 61971, N35.
8. UTMN-1830, 13613.2', 62371, O34/2.

9-11. *Latosporites* sp. 1.
9. MG-1, 2241 m, 62964, V41/2.
10. MG-1, 2557.5 m, 62599, U30.
11. MG-1, 2639 m, 62779, X47.

12. *Latosporites* spp. MG-1, 2180 m, 62971, O46/4.

13-16. *Reticuloidosporites antarcticus* Kemp, 1972.
13. BAQA-1, 308.3', 62247, K46.
14. BAQA-1, 308.3', 62246, M-N33.
15. BAQA-1, 308.3', 62246, L29.
16. BAQA-1, 308.3', 62246, N44.

17-19. Unidentified monolete spores.
17. MG-1, 2222.7 m, 62680, O46.
18. MG-1, 2222.7 m, 62680, C52/4.
19. MG-1, 2212.5 m, 62530, D32/4.

Plate 7

Plate 8.

1-4. *Acinosporites acanthomammillatus* Richardson, 1965.
1. JNDL-1, 174.6’, 60848, U32.
2. JNDL-1, 162.3’, 60841, M33.
3. JNDL-1, 172.7’, 60846, K29.
4. JNDL-1, 174.6, 60848, E28/2.

5, 6. *Acinosporites apiculatus* (Streel) Streel, 1967.
4. JNDL-1, 495.0’, O29.
5. A1-69, 1850.0’, 26967, U32/2.

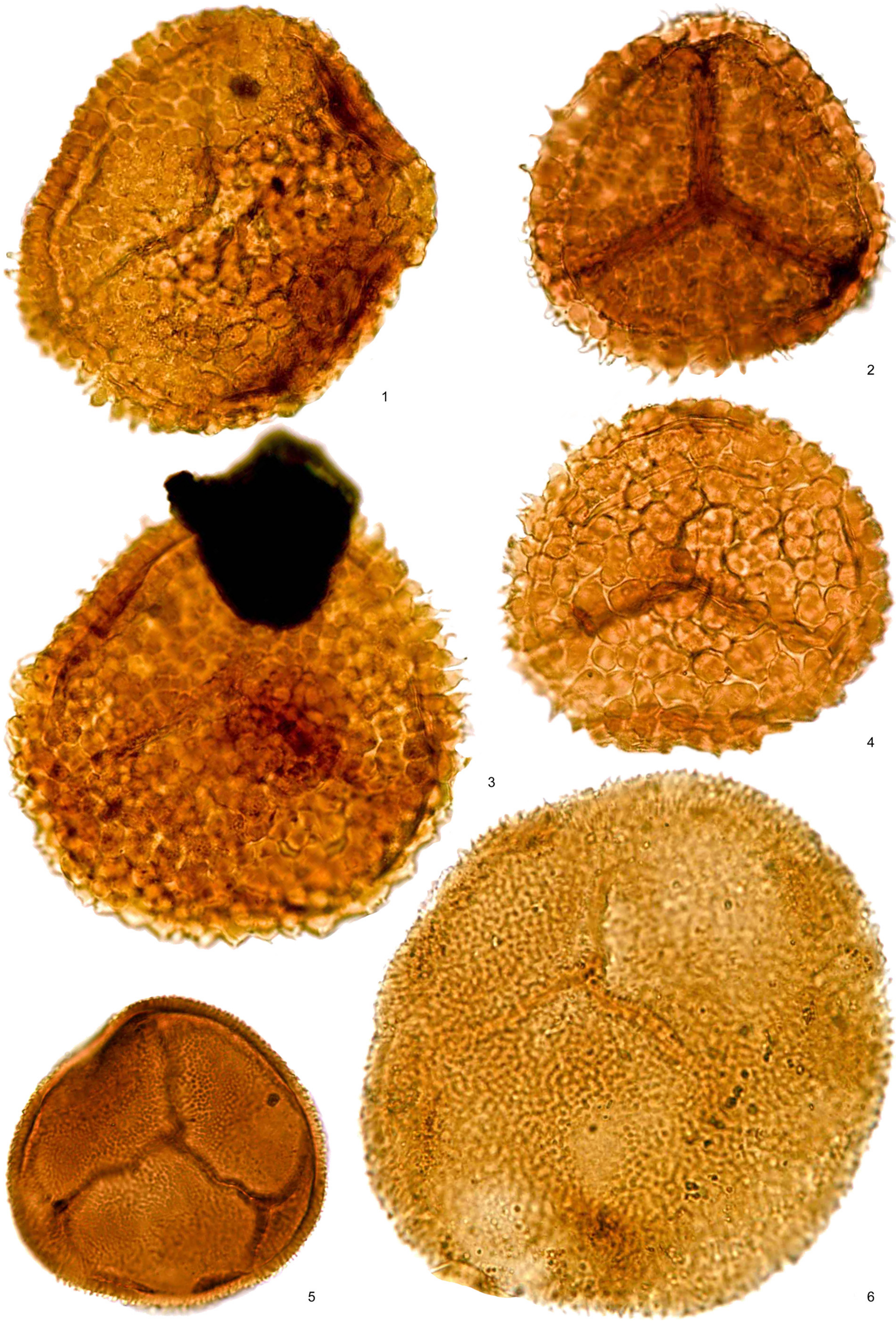

Plate 8

Plate 9.

1-4. *Acinosporites eumammillatus* Loboziak et al., 1988.

1. MG-1, 2520 m, 62593, S40.
2. MG-1, 2520 m, 62593, T49/1.
3. MG-1, 2520 m, 62594, H27/4.
4. MG-1, 2520 m, 62593, H47.

5. *Acinosporites hirsutus* (Brideaux & Radforth) McGregor & Camfield, 1982. JNDL-1, 177.0', E32.

6-10. *Acinosporites lindlarensis* Riegel, 1968.

6. JNDL-1, 172.7', 60846, H47/1.
7. JNDL-1, 177.0', 60850, J52/3.
8. JNDL-1, 174.6', L35/4.
9. JNDL-1, 162.3', P37/4.
10. A1-69, 1870', 26974, R46/2.

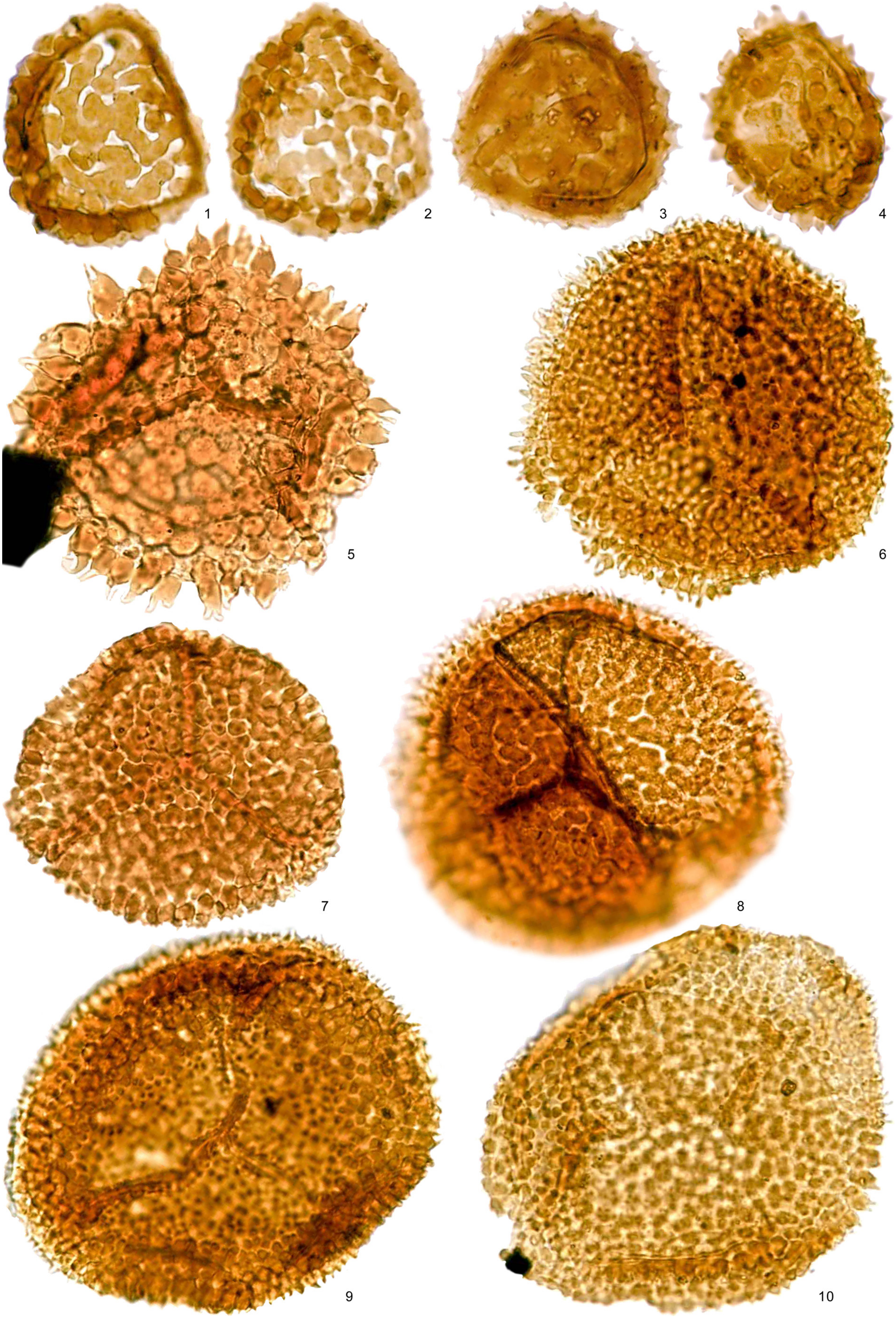

Plate 9

Plate 10.

1, 2. *Acinosporites lindlarensis* Riegel, 1968.

1. JNDL-4, 182.5', M-N42.
2. KHRM-2, 16269.0', 62114, V38.

3-6. *Acinosporites* sp. 1.

3. JNDL-1, 172.7', 60845, S40.
4. JNDL-1, 172.7', 60845, J30/1.
5. JNDL-1, 177.0', 60849, N43/2.
6. JNDL-1, 177.0', 60849, F35/1.

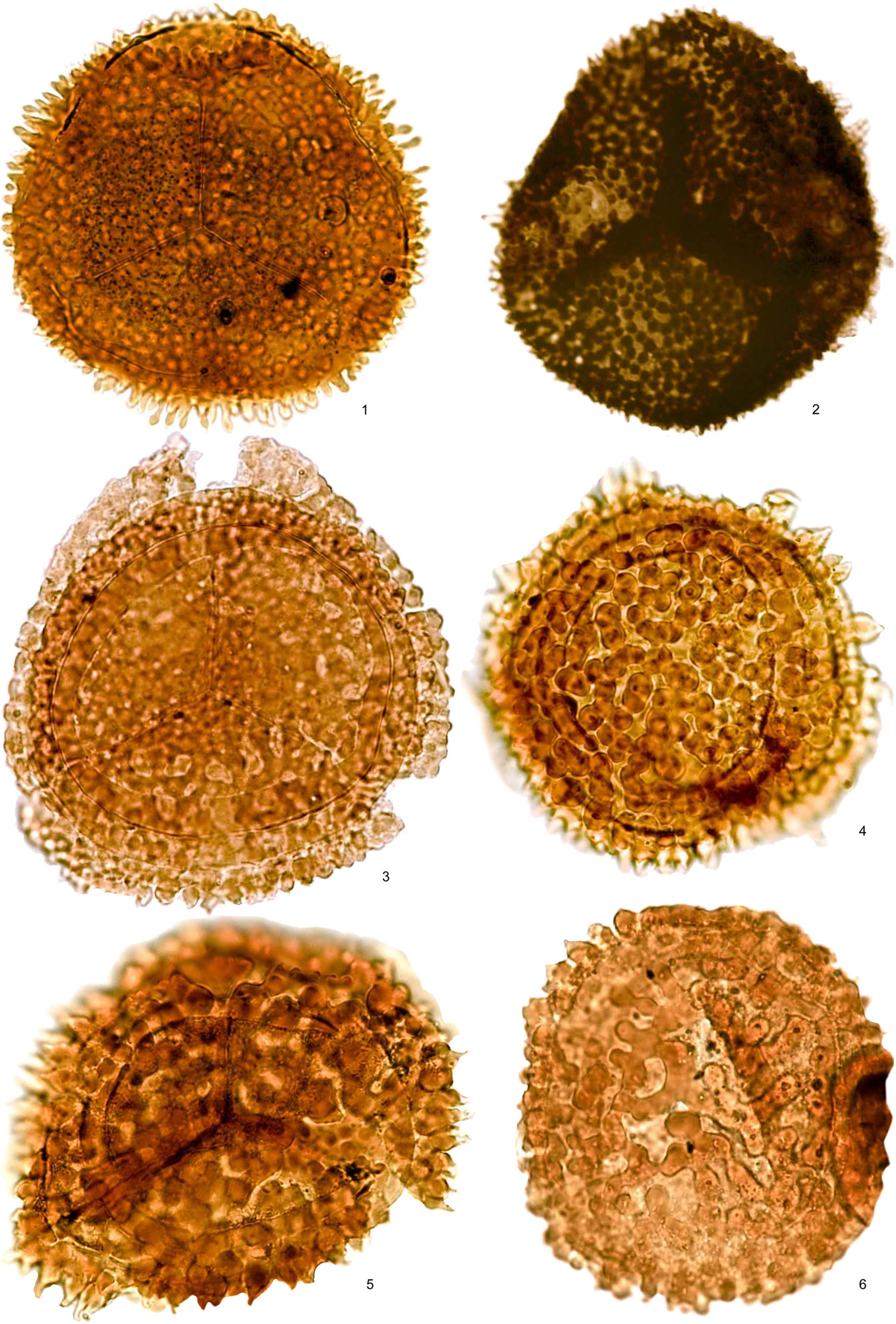

Plate 10

Plate 11.

1-3. *Alatisporites* sp. 1.
1. MG-1, 2713 m, 62810, M34.
2. JNDL-3, 353.8’, E52/4.
3. JNDL-4, 87.2’, W40/4.

4-9. *Ambitisporites asturicus* (Rodriguez) comb. nov.
4. MG-1, 2631.2 m, 62553, V49/1.
5. MG-1, 2631.2 m, 62552, O34.
6. MG-1, 2631.2 m, 62553, G44.
7. MG-1, 2631.2 m, 62552, K39/4.
8. MG-1, 2631.2 m, 62553, V28.
9. MG-1, 2631.2 m, 62552, Y54/3.

10-18. *Ambitisporites avitus* Hoffmeister, 1959.
10. BAQA-2, 52.0’, O27/1.
11. BAQA-2, 56.0’, S24.
12. BAQA-2, 54.8’, N28.
13. BAQA-2, 52.0’, H33/4.
14. BAQA-2, 57.2’, J47.
15. BAQA-2, 52.0’, O47/1.
16. BAQA-2, 50.8’, C40/4.
17. BAQA-2, 54.8’, V40/2.
18. BAQA-2, 50.2’, U35/3.

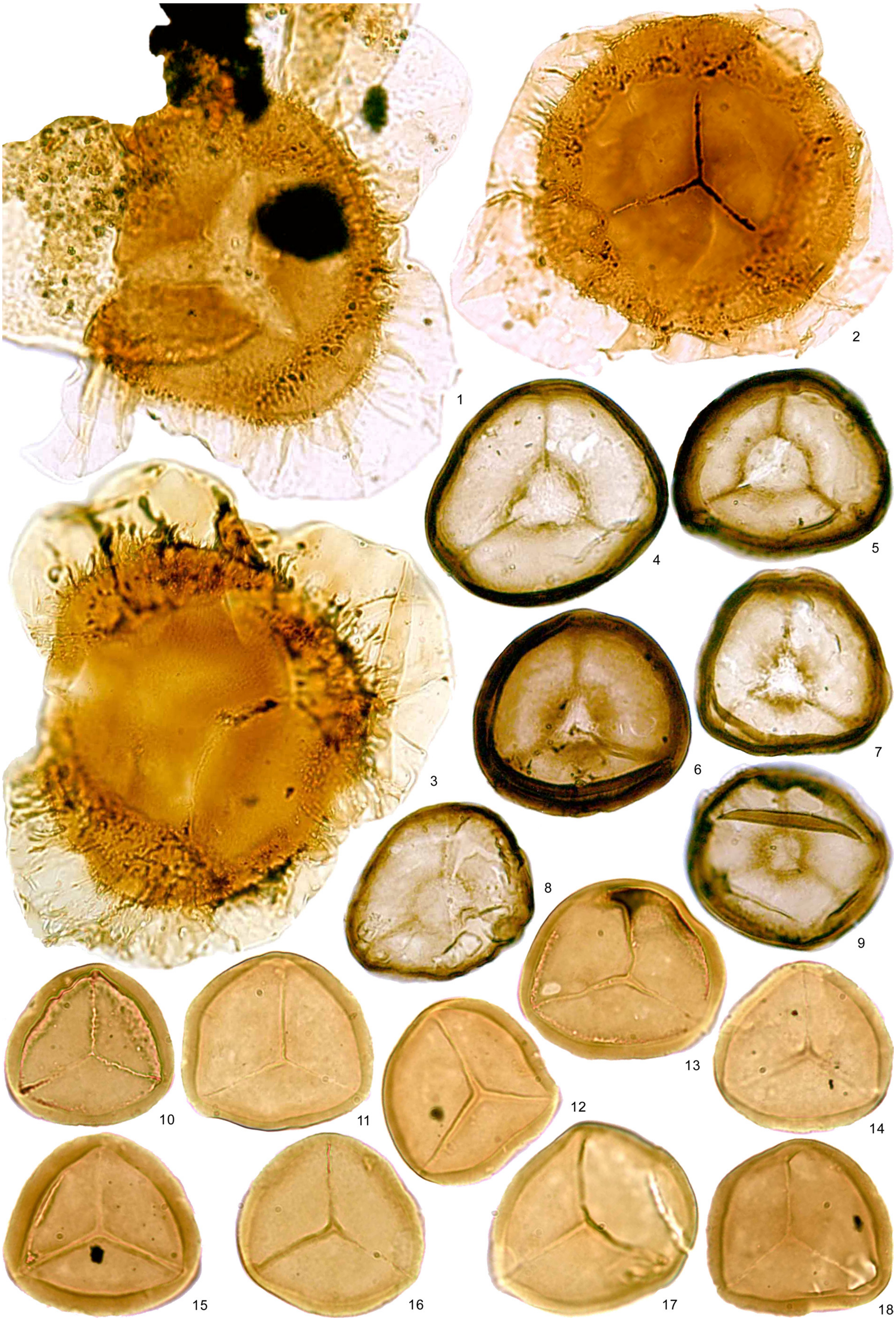

Plate 11

Plate 12.

1, 2. *Ambitisporites eslae* (Cramer & Díez) Richardson et al., 2001.

1. BAQA-2, 57.2’, P50/3.
2. BAQA-1, 371.1’, V36/3.

3-11. *Amicosporites jonkeri* (Riegel) Steemans, 1989.

3. MG-1, 2741.4 m, 62611, L45.
4. MG-1, 2741.4 m, 62610, F41/3.
5. MG-1, 2741.4 m, 62610, Q32.
6. MG-1, 2741.4 m, 62611, Q38/1.
7. MG-1, 2741.4 m, 62611, L41.
8. MG-1, 2741.4 m, 62611, V46/3.
9. MG-1, 2639 m, 62779, L46/1.
10. A1-69, 2108/2111, 62913, K51/3.
11. MG-1, 2741.4 m, 62611, K32.

12-25. *Amicosporites streelii* Steemans, 1989.

12. BAQA-2, 134.4’, Q39.
13. BAQA-1, 285.5’, H25/2.
14. BAQA-2, 54.8’, C43.
15. BAQA-1, 371.1’, F28/2.
16. BAQA-1, 395.2’, G26/3.
17. HWYH-956, 14195.3’, 47149(3), O53/2.
18. BAQA-1, 366.9’, K48.
19. BAQA-1, 285.5’, V44.
20. BAQA-2, 134.4’, Q33/4.
21. HWYH-956, 14195.3’, 47149(3), J46.
22. HWYH-956, 14195.3’, 47149(3), K57/1.
23. HWYH-956, 14195.3’, 47149(3), F62/2.
24. BAQA-2, 133.0’, F40/4.
25. BAQA-2, 56.0’, E48.

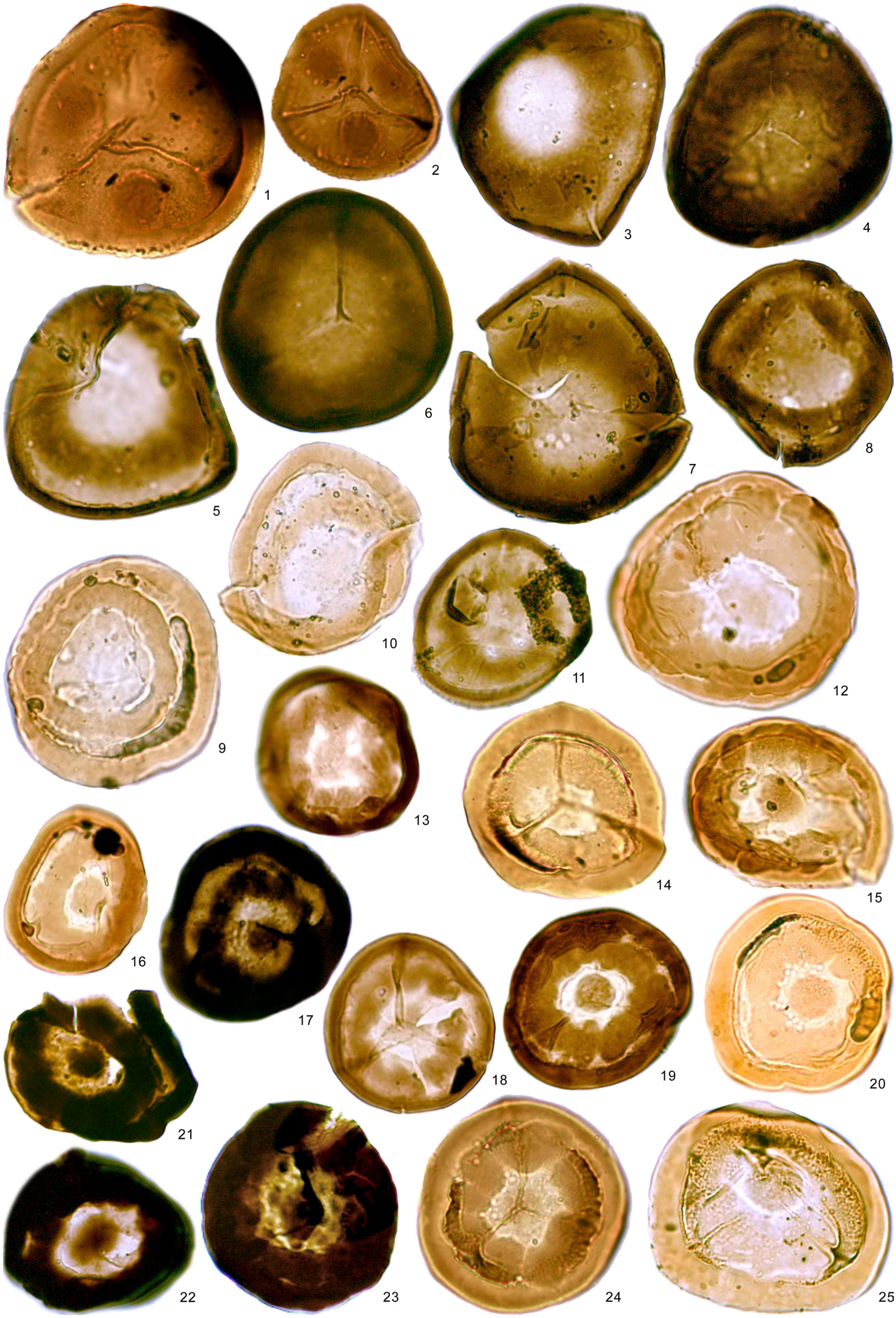

Plate 12

Plate 13.

1-8. *Ancyrospora langii* (Taugourdeau-Lantz) Allen, 1965. Magnification x500.

1. A1-69, 971’, 62638, J47/4.
2. A1-69, 971’, 62641, M39.
3. S-462, 1660-1665’, 63220, K44/3.
4. S-462, 1810-1815’, 63256, T36.
5. S-462, 1470-1475’, 63212, O28/3.
6. S-462, 1470-1475’, 63213, O-P39.
7. S-462, 1470-1475’, 63212, U30/4.
8. S-462, 1910-1915’, 63261, T35.

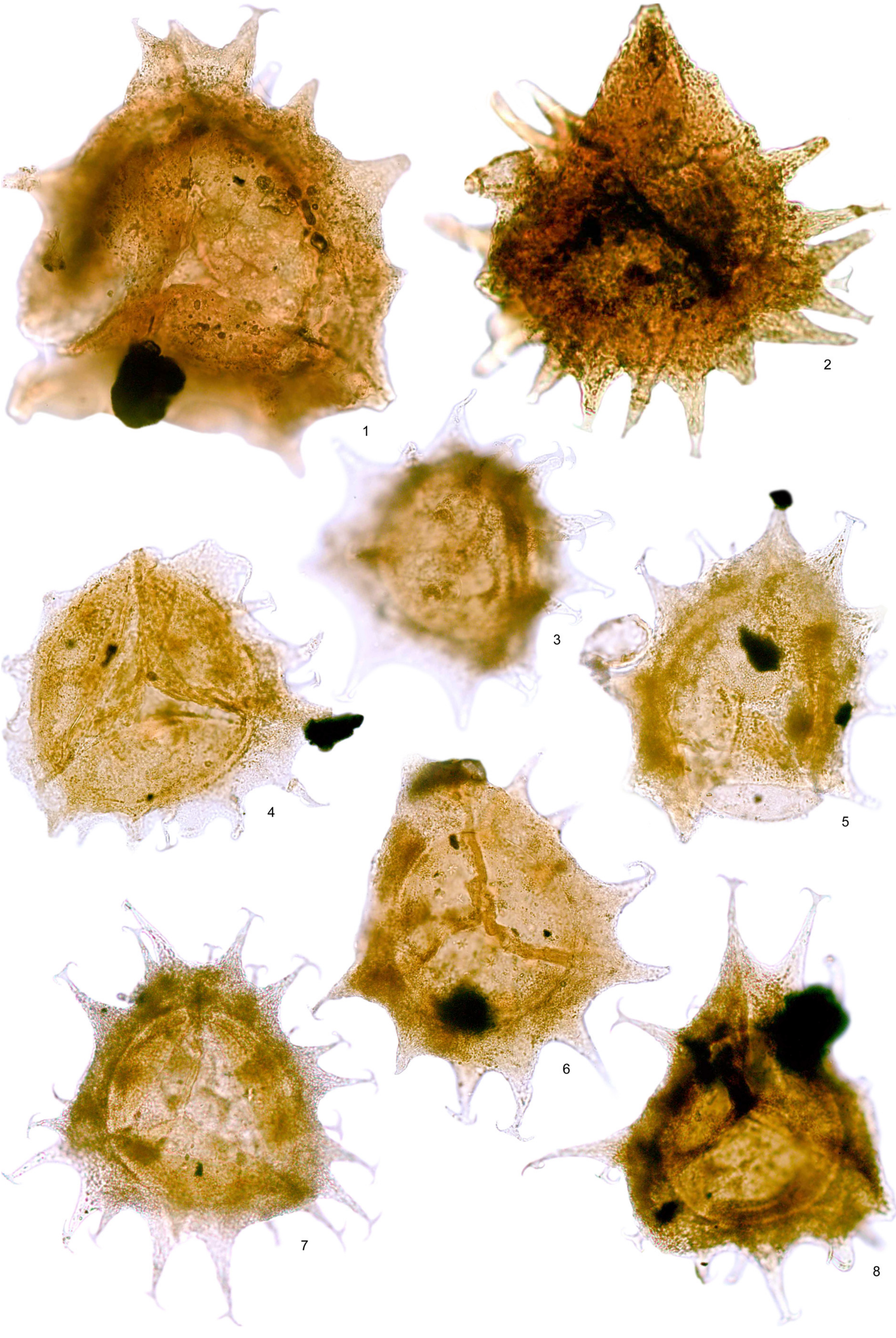

Plate 13

Plate 14.

1-6. *Ancyrospora nettersheimensis* Riegel, 1973. Magnification x500.

1. A1-69, 1596', 26990, S40.
2. A1-69, 1530', 26984, Q38.
3. A1-69, 1540', 26988, K35.
4. A1-69, 1596', 26990, S37/3.
5. A1-69, 1870', 26974, N55-56.
6. A1-69, 1596', 26989, S41/4.

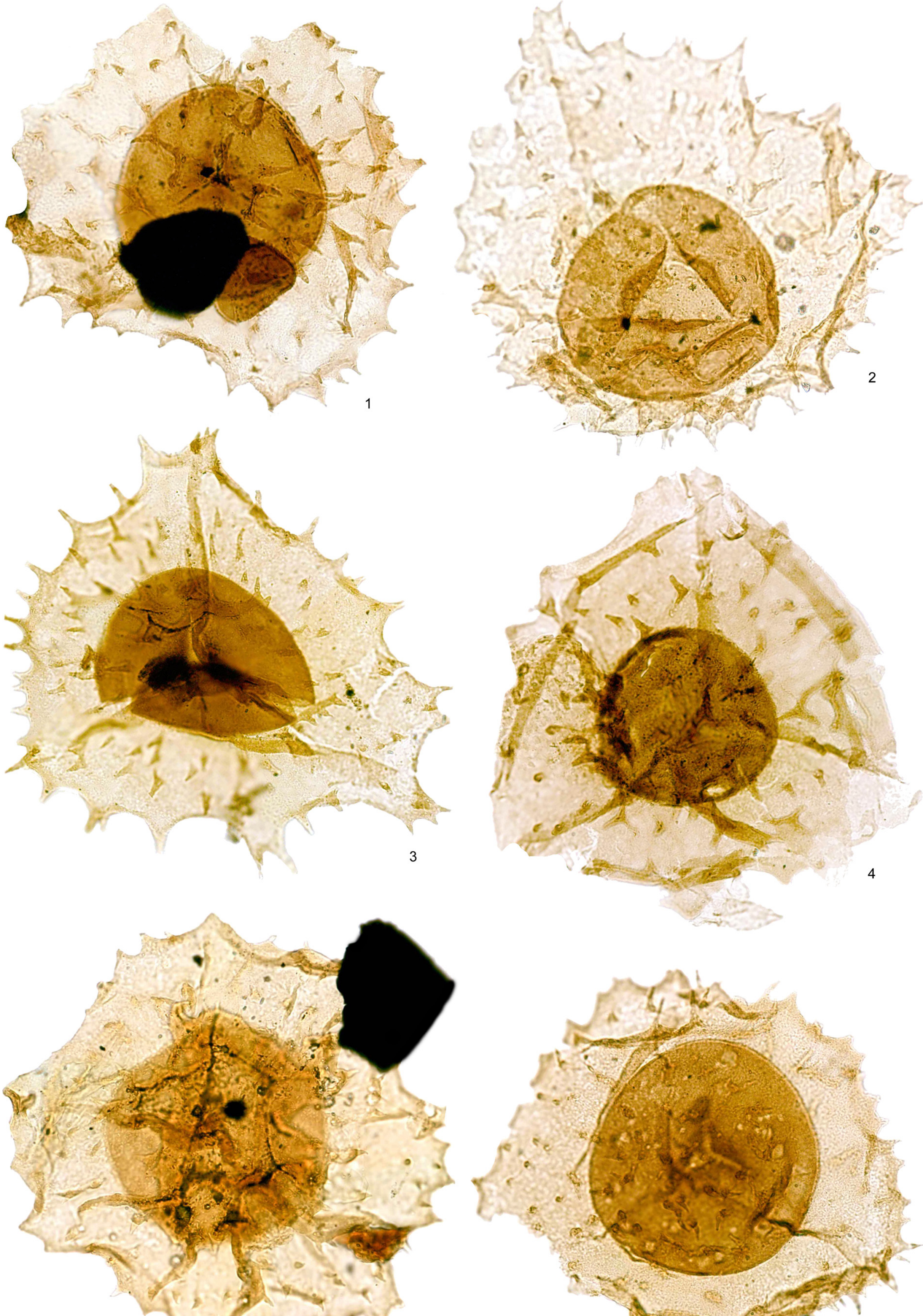

Plate 14

Plate 15.

1-7. *Aneurospora cf. A. bollandensis* Steemans, 1989.

1. UTMN-1830, 13689.7', 62319, Q43.
2. UTMN-1830, 13689.7', 62317, N34-35.
3. UTMN-1830, 13689.7', 62317, K43.
4. UTMN-1830, 13614.6', 62377, L27.
5. UTMN-1830, 13689.7', 62317, J36/2.
6. UTMN-1830, 13689.7', 62316, C37.
7. BAQA-1, 285.5', E31.

8-15. *Apiculiretusispora brandtii* Streel, 1964.

8. BAQA-1, 223.5', G-H23.
9. BAQA-1, 219.2', L41.
10. BAQA-1, 227.1', Q33/3.
11. BAQA-1, 219.2', U26/2.
12. JNDL-1, 156.0', 60839, T30/1.
13. BAQA-1, 227.1', L-M25.
14. BAQA-1, 285.5', J52/1.
15. HWYH-956, 14195.3', 47149(3), K58/4.

Plate 15

Plate 16.

1, 2. *Apiculiretusispora brandtii* Streel, 1964.
1. BAQA-1, 223.5’, V30.
2. JNDL-4, 182.5’, T31.

3-5. *Apiculiretusispora densa* Al-Ghazi, 2007.
3. KHRM-2, 16269.0’, 62115, E48/1.
4. BAQA-1, 308.3’, E43.
5. JNDL-1, 174.6’, 60848, V29.

6-14. *Apiculiretusispora plicata* (Allen) Streel, 1967.
6. BAQA-1, 169.1’, V34.
7. BAQA-1, 175.9’, B29/4.
8. BAQA-1, 169.1’, K25/4.
9. BAQA-1, 205.8’, G54/3.
10. BAQA-1, 175.9’, O27/2.
11. BAQA-1, 169.1’, V24.
12. BAQA-1, 169.1’, U24/3.
13. BAQA-1, 169.1’, X25/1.
14. HWYH-956, 14186.3’, 47148(1), W44.

Plate 16

Plate 17.

1-4. *Apiculiretusispora plicata* (Allen) Streel, 1967.
1. BAQA-1, 175.9’, G29/4.
2. BAQA-1, 175.9’, D25/3.
3. BAQA-1, 222.5’, U26.
4. BAQA-1, 219.2’, K26/2.

5-15. *Archaeozonotriletes chulus* (Cramer) Richardson & Lister, 1969.
5. JNDL-1, 156.0’, 60840, U49/1.
6. JNDL-1, 172.7’, U40/1.
7. JNDL-1, 167.8’, F39/3.
8. JNDL-1, 172.7’, 60845, T29/3.
9. JNDL-1, 172.7’, 60845, L47/4.
10. JNDL-1, 156.0’, 60839, G34/2.
11. JNDL-1, 162.3’, 60841, H45/3.
12. JNDL-1, 172.7’, 60845, D27/3.
13. JNDL-1, 162.3’, 60841, N32/2.
14. BAQA-2, 133.0’, Q25/1.
15. JNDL-1, 167.8’, 60842, G29.

16-21. *Archaeozonotriletes variabilis* Naumova emend. Allen, 1965.
16. MG-1, 2285 m, 62846, O43/3.
17. MG-1, 2181.2 m, 62524, H32.
18. MG-1, 2264 m, 62951, E45.
19. A1-69, 971’, 62641, M49.
20. MG-1, 2241 m, 62964, F34/1.
21. MG-1, 2292 m, 63025, H32.

Plate 17

Plate 18.

1, 2. *Auroraspora macromanifesta* (Hacquebard) Richardson, 1960. Magnification x750.

1. MG-1, 2241 m, 62966, U46.
2. MG-1, 2278 m, 62936, C45/3.

3-10. *Auroraspora minuta* Richardson, 1965. Magnification x750.

3. MG-1, 2280.3 m, 62550, M53/1.
4. MG-1, 2264 m, 62951, F34.
5. MG-1, 2258 m, 62946, Q36/4.
6. MG-1, 2258 m, 62948, U28/4.
7. MG-1, 2536 m, 62741, S36.
8. MG-1, 2181.2 m, 62525, O42.
9. MG-1, 2181.2 m, 62525, E37/4.
10. MG-1, 2222.7 m, 62678, X34.

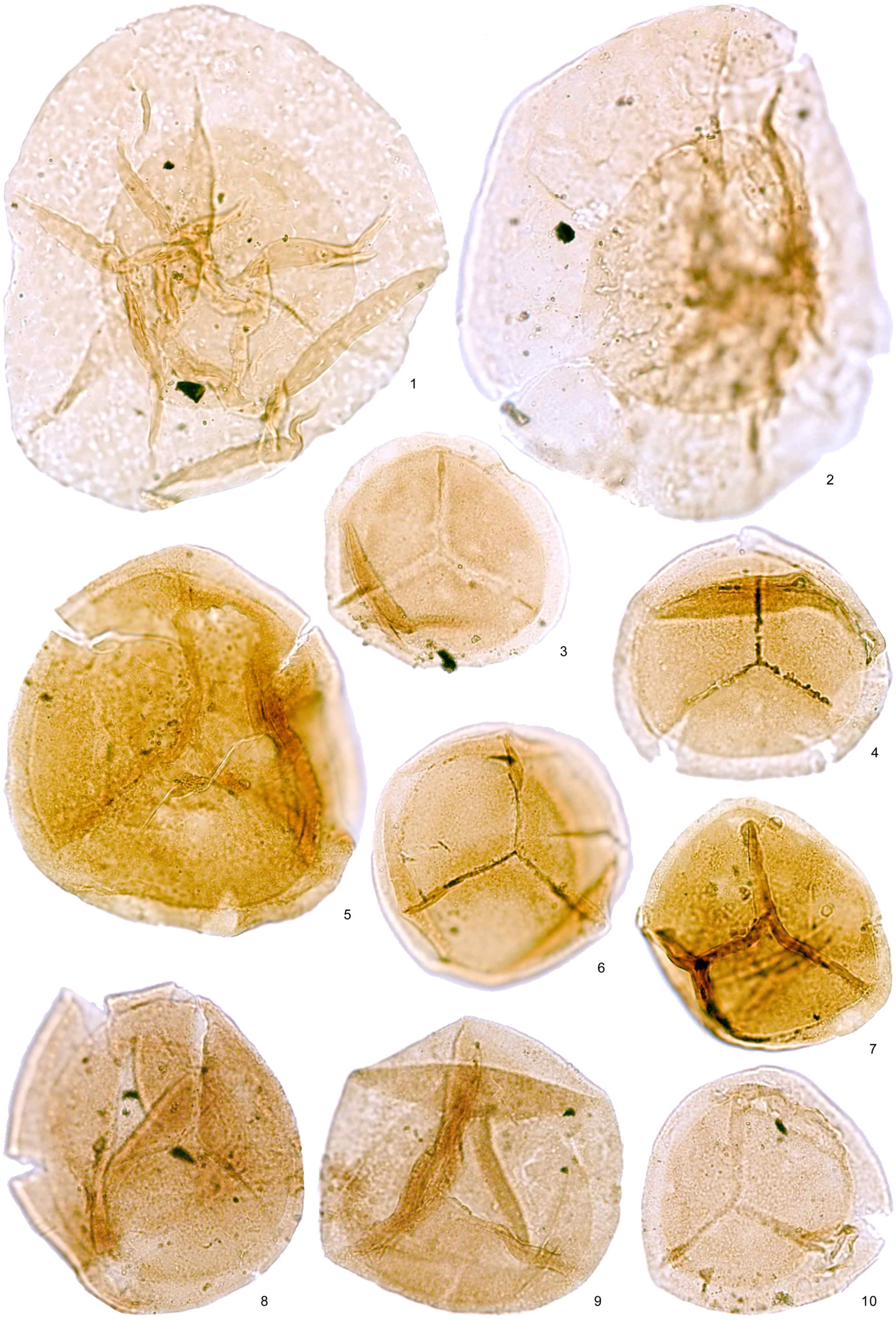

Plate 18

Plate 19.

1-24. *Biornatispora dubia* (McGregor) Steemans, 1989

1. JNDL-3, 499.5’, X35/2.
2. BAQA-2, 50.2’, U30.
3. JNDL-3, 413.2’, P26.
4. BAQA-2, 50.2’, N24/3.
5. HWYH-956, 14154.6’, 46983(1), N52/2.
6. HWYH-956, 14154.6’, 46983(1), D54/2.
7. HWYH-956, 14160,5’, 46984(1), M53/1.
8. HWYH-956, 14195.2’, 60551, P37.
9. JNDL-3, 499.5’, V37/3.
10. KHRM-2, 16224.7’, 62090, V44/1.
11. HWYH-956, 14152.7’, 60456, L28.
12. KHRM-2, 16224.7’, 62090, P49.
13. HWYH-956, 14154.6’, 60467, N27/3.
14. UTMN-1830, 13614.6’, 62379, T28/1.
15. UTMN-1830, 13614.1’, 62373, E34.
16. HWYH-956, 14154.6’, 46983(1), U58.
17. HWYH-956, 14154.6’, 46983(1), Q46/4.
18. HWYH-956, 14154.6’, 46983(2), U35.
19. UTMN-1830, 13614.6’, 62378, P-Q30.
20. HWYH-956, 14159.5’, 60521, H34.
21. JNDL-4, 331.9’, K38.
22. HWYH-956, 14160.5’, 46984(3), M44.
23. HWYH-956, 14155.1’, 60513, T45.
24. HWYH-956, 14154.6’, 46983(3), O55.

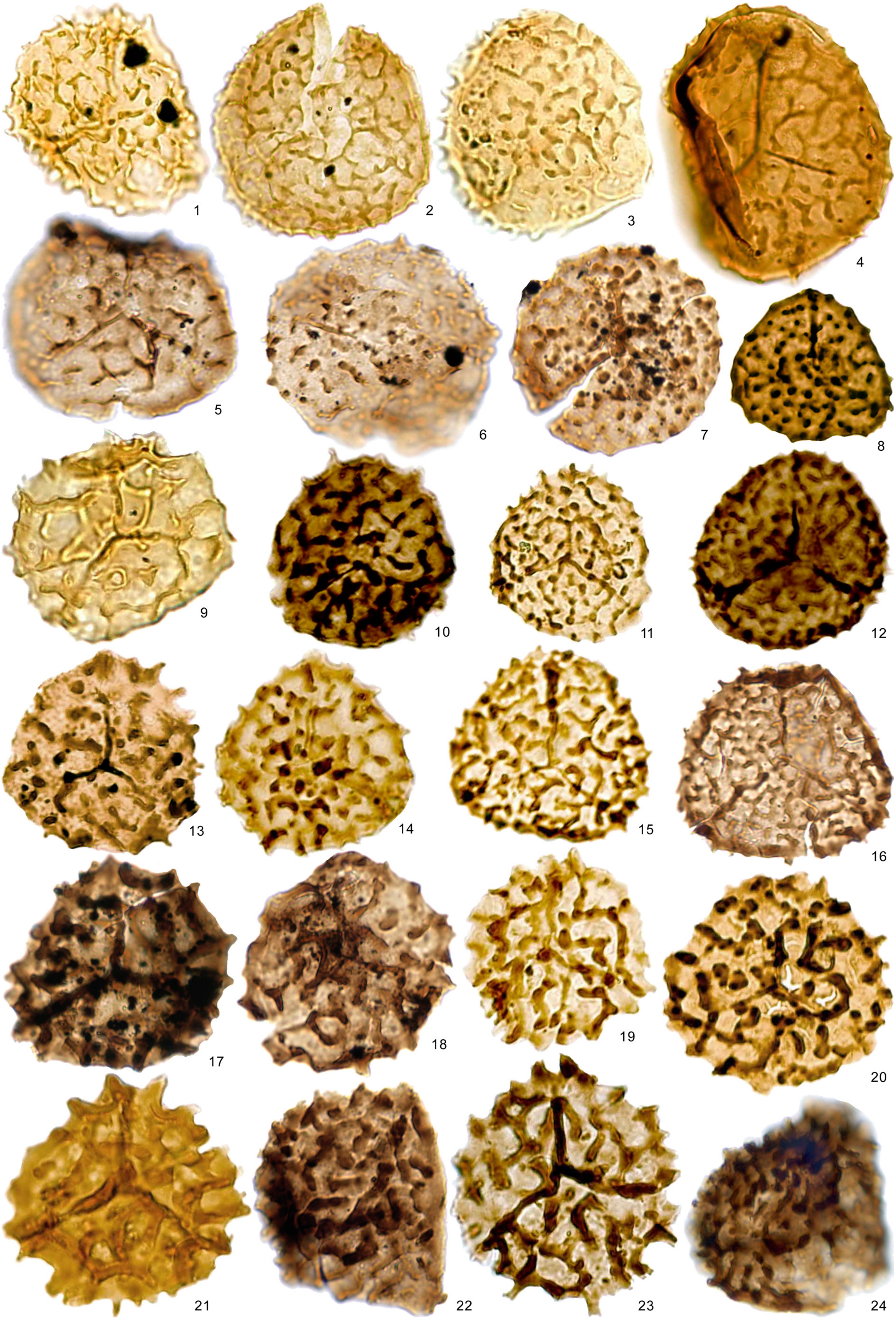

Plate 19

Plate 20.

1-4. *Biornatispora* sp. 1.
1. BAQA-2, 50.2’, H50/3.
2. BAQA-2, 52.0’, U44/1.
3. BAQA-2, 50.2’, V36/4.
4. BAQA-2, 50.8’, S31/3.

5-6. *Brochotriletes bellatulus* Steemans, 1989.
5. FWRH-1, 15919.7’, 63106, U33/4.
6. YBRN-1, 16684.3’, 62425, O38.

7-11. *Brochotriletes foveolatus* Naumova, 1953.
7. BAQA-1, 308.3’, X48/4.
8. BAQA-1, 169.1’, K39-40.
9. BAQA-1, 345.5’, T36/4.
10. BAQA-1, 285.5’, X35.
11. BAQA-1, 395.2’, V23/3.

Plate 20

Plate 21.

1-6. *Brochotriletes foveolatus* Naumova, 1953.

1. MG-1, 2161.8 m, 62529, P53/2.
2. BAQA-1, 223.5', T23/2.
3. BAQA-1, 395.2', R26/2.
4. BAQA-1, 345.5', H54/4.
5. A1-69, 1334', 27128, G39.
6. MG-1, 2258 m, 62948, F46.

7, 8. *Brochotriletes hudsonii* McGregor & Camfield, 1976.

7. BAQA-1, 395.2', 62277, U42/2.
8. BAQA-1, 395.2', 62272, V53/4.

9, 10. *Brochotriletes robustus* (Scott & Rouse) McGregor, 1973.

9. YBRN-1, 16642.3', 62407, S32.
10. YBRN-1, 16642.3', 62406, Q45.

11, 12 *Brochotriletes* sp. 1.

11. A1-69, 1109', 27273, P53/3.
12. A1-69, 1109', 27274, Q46/4.

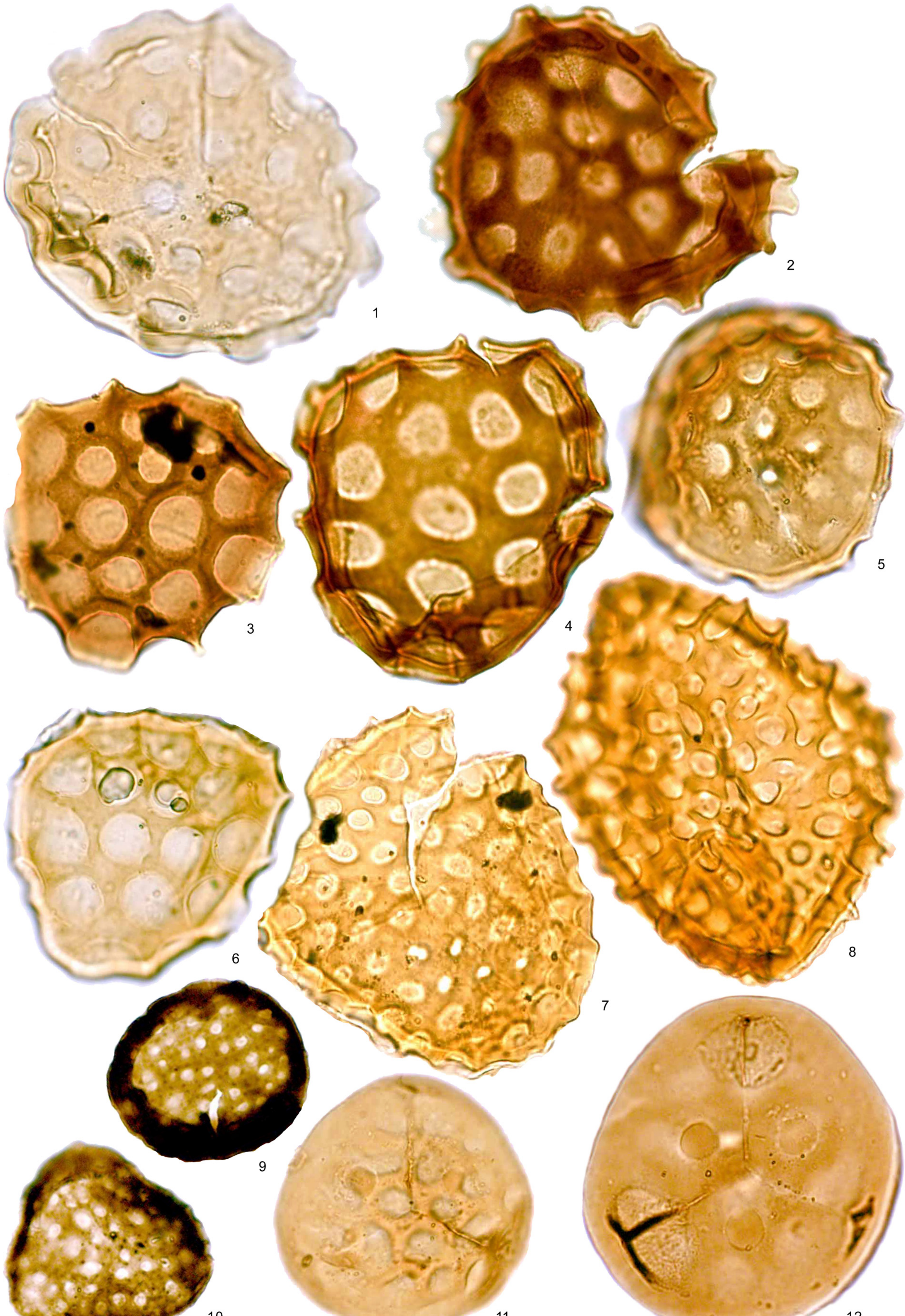

Plate 21

Plate 22.

1, 2. *Brochotriletes* sp. 1.

1. A1-69, 1334', 27127, O51. Focus on the proximal face.
2. A1-69, 1334', 27127, O51. Focus on the distal face.

3-9. *Brochotriletes* sp. 2.

3. A1-69, 1870', 26973, E38.
4. JNDL-1, 167.8', S40.
5. JNDL-1, 156.0', 60840, F47/3.
6. JNDL-1, 167.8', 60842, F50.
7. JNDL-1, 174.6', 60848, H35/3.
8. A1-69, 2108/2111', 26912, N-O50.
9. JNDL-1, 495.0', 60854, S44/1.

10-20.*Camarozonotriletes filatoffii* Breuer et al., 2007c.

10. BAQA-1, 222.5', J-K36. Tetrad.
11. BAQA-1, 227.1', Q47.
12. BAQA-1, 222.5', W30.
13. BAQA-1, 223.5', N24.
14. BAQA-1, 285.5', N51/2.
15. BAQA-1, 223.5', S48/4.
16. BAQA-1, 222.5', V44/4.
17. BAQA-1, 223.5', N45/2.
18. BAQA-2, 133.0', H25.
19. BAQA-1, 219.2', V39/1.
20. BAQA-1, 223.5', M37.

21-28. *Camarozonotriletes parvus* Owens, 1971.

21. MG-1, 2180 m, 62971, K38/3.
22. MG-1, 2178 m, 62995, X50.
23. MG-1, 2178 m, 62996, S48/1.
24. MG-1, 2178 m, 62997, Y33/2.
25. MG-1, 2178 m, 62995, O35/2.
26. MG-1, 2178 m, 62997, P38/3.
27. MG-1, 2180 m, 62971, M42/1.
28. MG-1, 2178 m, 62996, R48/1.

Plate 22

Plate 23.

1-11. *Camarozonotriletes rugulosus* Breuer et al., 2007c.

1. JNDL-1, 156.0’, J41/4.
2. JNDL-1, 172.7’, 60846, P46/2.
3. JNDL-1, 156.0’, 60840, T48.
4. JNDL-1, 156.0’, 60839, M49/3.
5. JNDL-1, 174.6’, L-M44.
6. JNDL-1, 172.7’, 60845, C47/4.
7. JNDL-1, 156.0’, 60840, V47/4.
8. JNDL-1, 167.8’, 60842, G51/4.
9. JNDL-1, 155.6’, 60838, J42/2.

10-25. *Camarozonotriletes sextantii* McGregor, 1973.

10. JNDL-1, 167.8’, 60843, F-G47.
11. JNDL-4, 75.0’, E32/1.
12. JNDL-4, 75.0’, Q-R29.
13. JNDL-4, 75.0’, P37/3.
14. MG-1, 2450.6’, 62604, N51/2.
15. MG-1, 2639 m, 62779, G32/3.
16. JNDL-4, 37.1’, R42.
17. JNDL-4, 75.0’, L26/4.
18. MG-1, 2639 m, 62779, M36/3.
19. MG-1, 2450.6 m, 62604, J49/2.
20. MG-1, 2713 m, 62810, L35/3.
21. UTMN-1830, 13612.5’, 62368, R27/4.
22. MG-1, 2450.6 m, 62604, G54-55.
23. MG-1, 2511 m, 62841, G49.
24. JNDL-3, 268.1’, C46/1.
25. JNDL-4, 75.0’, O36.

Plate 23

Plate 24.

1-8. *Camarozonotriletes* sp. 1.

1. MG-1, 2518 m, 62805, Q32/4.
2. A1-69, 1483', 26995, O52.
3. MG-1, 2160.6 m, 62747, X46/2.
4. MG-1, 2264 m, 62950, J47/2.
5. MG-1, 2413 m, 62777, C42/4.
6. MG-1, 2295 m, 63007, M38/3.
7. MG-1, 2247 m, 62941, O40/1.
8. MG-1, 2278 m, 62936, G43.

Plate 24

Plate 25.

1-10. *Camarozonotriletes*? *concavus* Loboziak & Streel, 1989.

1. A1-69, 1486’, 26977, W37.
2. A1-69, 1486’, 26977, R46.
3. A1-69, 1483’, 26995, G38.
4. A1-69, 1486’, 26977, P40/3.
5. A1-69, 1490’, 26979, R41.
6. A1-69, 1483’, 26995, B54.
7. A1-69, 1490’, 26979, B43.
8. ABSF-29, 16354.0’, 61959, M36/1.
9. ABSF-29, 16354.0’, 61959, O35.
10. A1-69, 1490’, 26979, L35/2.

11-19. *Chelinospora cantabrica* Richardson et al., 2001.

11. BAQA-2, 133.0’, V42.
12. BAQA-1, 395.2’, 62274, M49/4.
13. BAQA-2, 133.0’, C38/1.
14. BAQA-2, 134.4’, P40/1.
15. BAQA-1, 395.2’, R38.
16. BAQA-2, 54.8’, K42.
17. BAQA-1, 395.2’, 62276, N49/4.
18. BAQA-2, 133.0’, E30/1.
19. BAQA-1, 395.2’, 62277, K48/2.

Plate 25

Plate 26.

1-11 *Chelinospora concinna* Allen, 1965.

1. S-462, 1810-1815', 63256, S50/1. Focus on the proximal face.
2. MG-1, 2160.6 m, 62746, Q26.
3. A1-69, 971', 62641, T53/4.
4. MG-1, 2181.2 m, 62524, W44.
5. S-462, 1810-1815', 63256, S50/1. Focus on the distal face.
6. A1-69, 971', 62640, Q42. Focus on the proximal face.
7. MG-1, 2205 m, 62957, M43.
8. MG-1, 2161.8 m, 62528, V54/4.
9. A1-69; 971', 62639, S32/1.
10. A1-69, 971', 62640, Q42. Focus on the distal face.
11. MG-1, 2160.6 m, 62747, C28.

12-15. *Chelinospora hemiesferica* (Cramer & Díez) Richardson et al., 2001.

12. BAQA-2, 54.8', P-Q36.
13. BAQA-1, 408.3', F29/2.
14. BAQA-2, 50.8', R23/4.
15. BAQA-1, 416.6', P30.

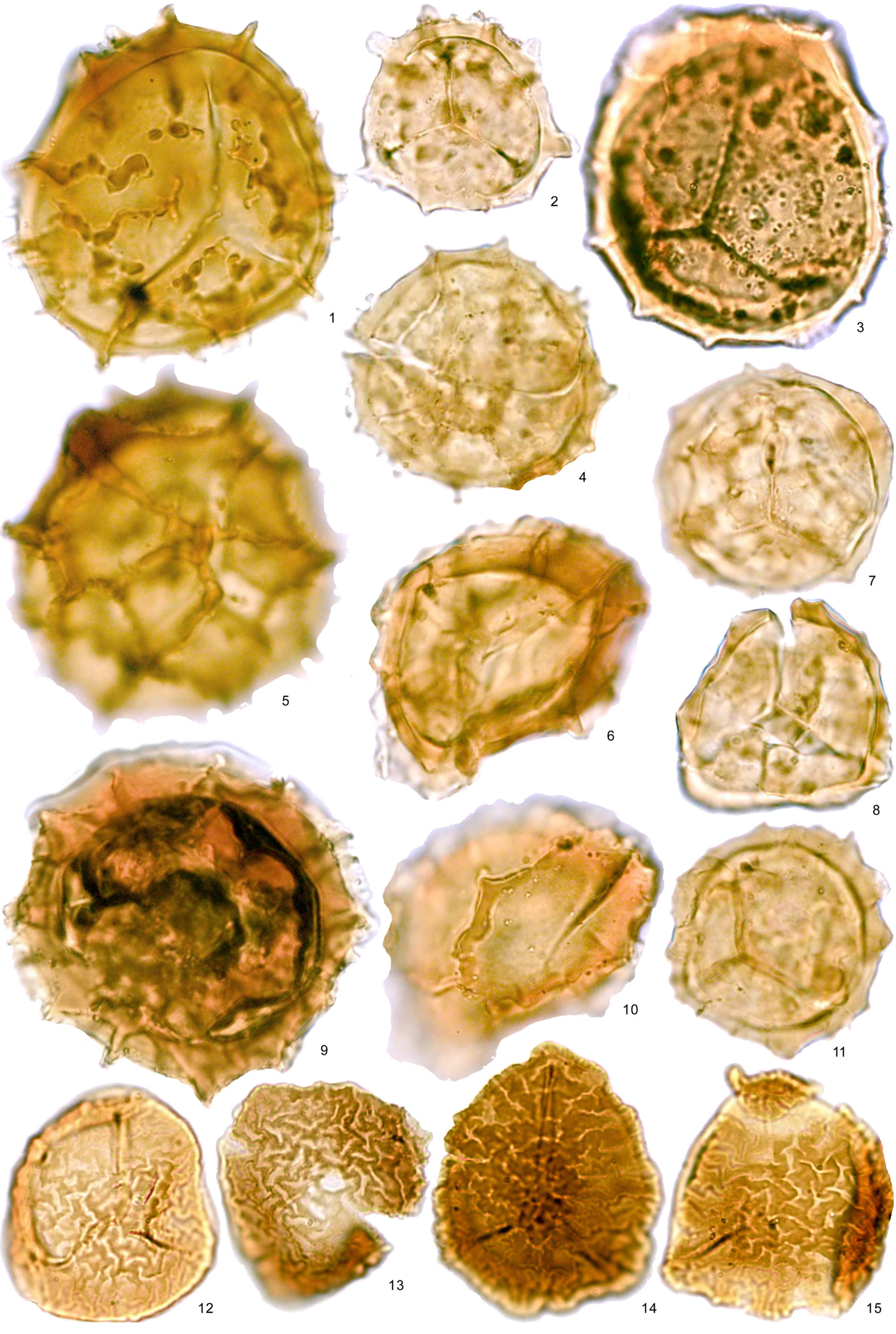

Plate 26

Plate 27.

1-11. *Chelinospora* cf. *hemiesferica* (Cramer & Díez) Richardson et al., 2001.

1. BAQA-1, 376.4', J49.
2. BAQA-1, 366.9', J38/4.
3. BAQA-2, 133.0', J52.
4. BAQA-1, 223.5', K29/3.
5. BAQA-2, 50.2', U42/1.
6. BAQA-1, 223.5', C52.
7. BAQA-1, 308.3', G44/2.
8. BAQA-2, 50.2', J35.
9. BAQA-1, 371.1', W39/3.
10. BAQA-2, 50.8', U25/2.
11. BAQA-1, 371.1', M-N41.

12-14 *Chelinospora sanpetrensis* (Rodriguez) Richardson et al., 2001.

12. MG-1, 2741.4 m, 62610, W34/4.
13. MG-1, 2741.4 m, 62611, D27/2.
14. MG-1, 2741.4 m, 62611, J41.

Plate 27

Plate 28.

1-14. *Chelinospora timanica* (Naumova) Loboziak & Streel, 1989.

1. MG-1, 2182.4 m, 62526, M32/1.
2. MG-1, 2247 m, 62942, X36/4.
3. MG-1, 2476 m, 63016, U36.
4. MG-1, 2270 m, 62847, M27/1.
5. MG-1, 2252.1 m, 62540, Y33.
6. A1-69, 971’, 62639, D39/3.
7. A1-69, 1277’, 62637, Q33.
8. MG-1, 2511 m, 62843, Y33/1.
9. S-462, 1860-1865’, 63258, K50/2.
10. MG-1, 2178 m, 62996, G48/1.
11. A1-69, 971’, 62638, H32/4.
12. MG-1, 2241 m, 62966, N41.
13. MG-1, 2178 m, 62996, Q43.
14. MG-1, 2178 m, 62997, S38.

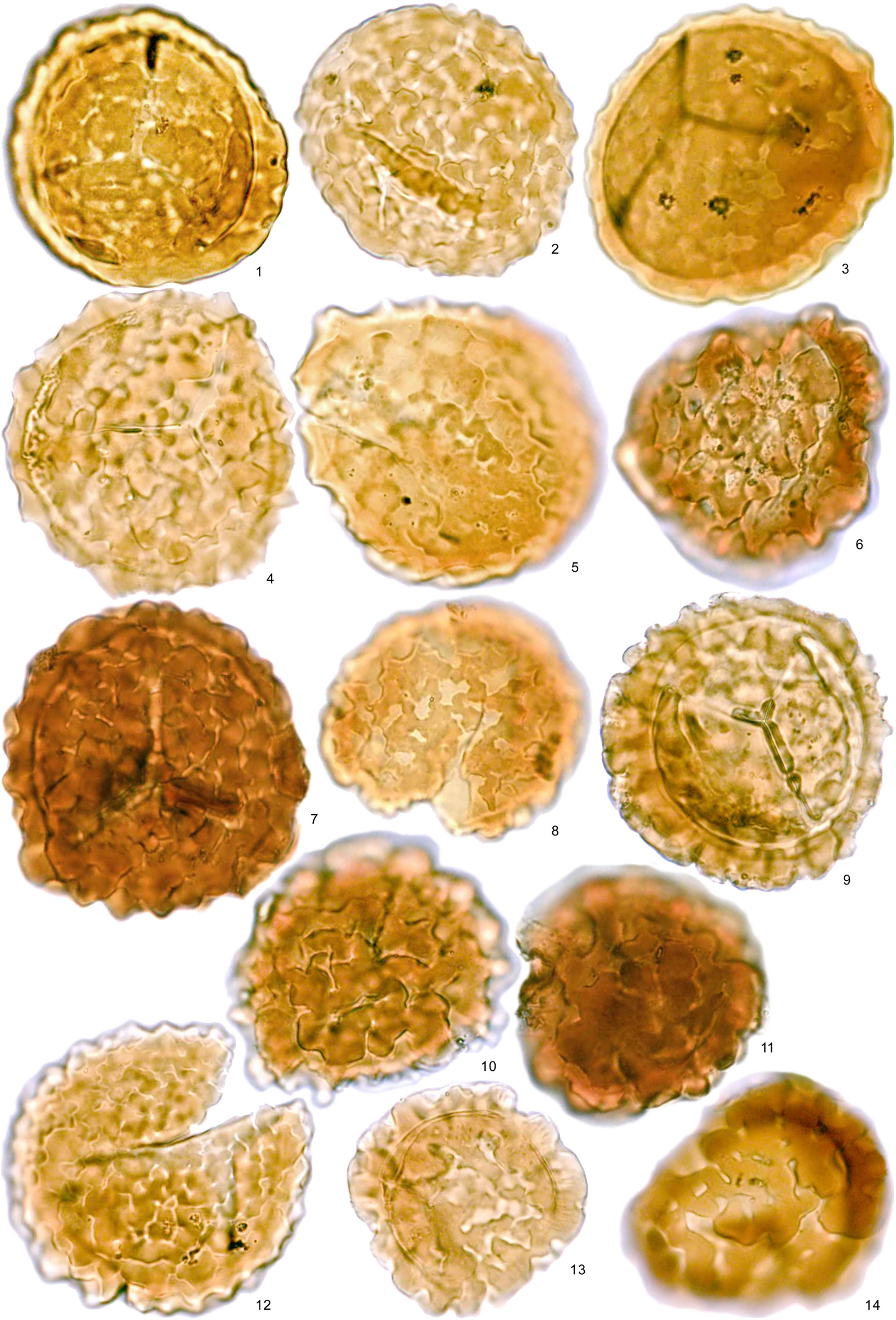

Plate 28

Plate 29.

1-3. C*helinospora* sp. 1.

1. BAQA-2, 64.5’, X29.
2. BAQA-2, 54.8’, U28/4.
3. BAQA-1, 371.1’, R29.

4-10. *Chelinospora* sp. 2.

4. BAQA-1, 308.3’, E-F53.
5. BAQA-1, 371.1’, G54/3.
6. BAQA-1, 219.2’, G31/2.
7. BAQA-1, 371.1’, H27/3.
8. BAQA-1, 371.1’, R48.
9. BAQA-1, 371.1’, H42/1.
10. BAQA-1, 371.1’, O54/2.

11-13. *Chelinospora* sp. 3.

11. A1-69, 971’, 62369, P44.
12. A1-69, 971’, 62368, H46/2.
13. A1-69, 971’, 62641, U52.

14-18. *Chelinospora* spp.

14. MG-1, 2161.8 m, 62528, T45/1.
15. UTMN-1830, 13614.1’, 62373, P34.
16. BAQA-1, 345.5’, J42.
17. BAQA-2, 50.8’, M50/1. Specimen maybe related to *Stellatispora* sp. aff. *S. inframurinata* var. *cambriensis* Burgess & Richardson, 1995 in Beck & Strother (2001)
18. BAQA-1, 371.1’, D47. Specimen maybe related to *Stellatispora* sp. aff. *S. inframurinata* var. *cambriensis* Burgess & Richardson, 1995 in Beck & Strother (2001)

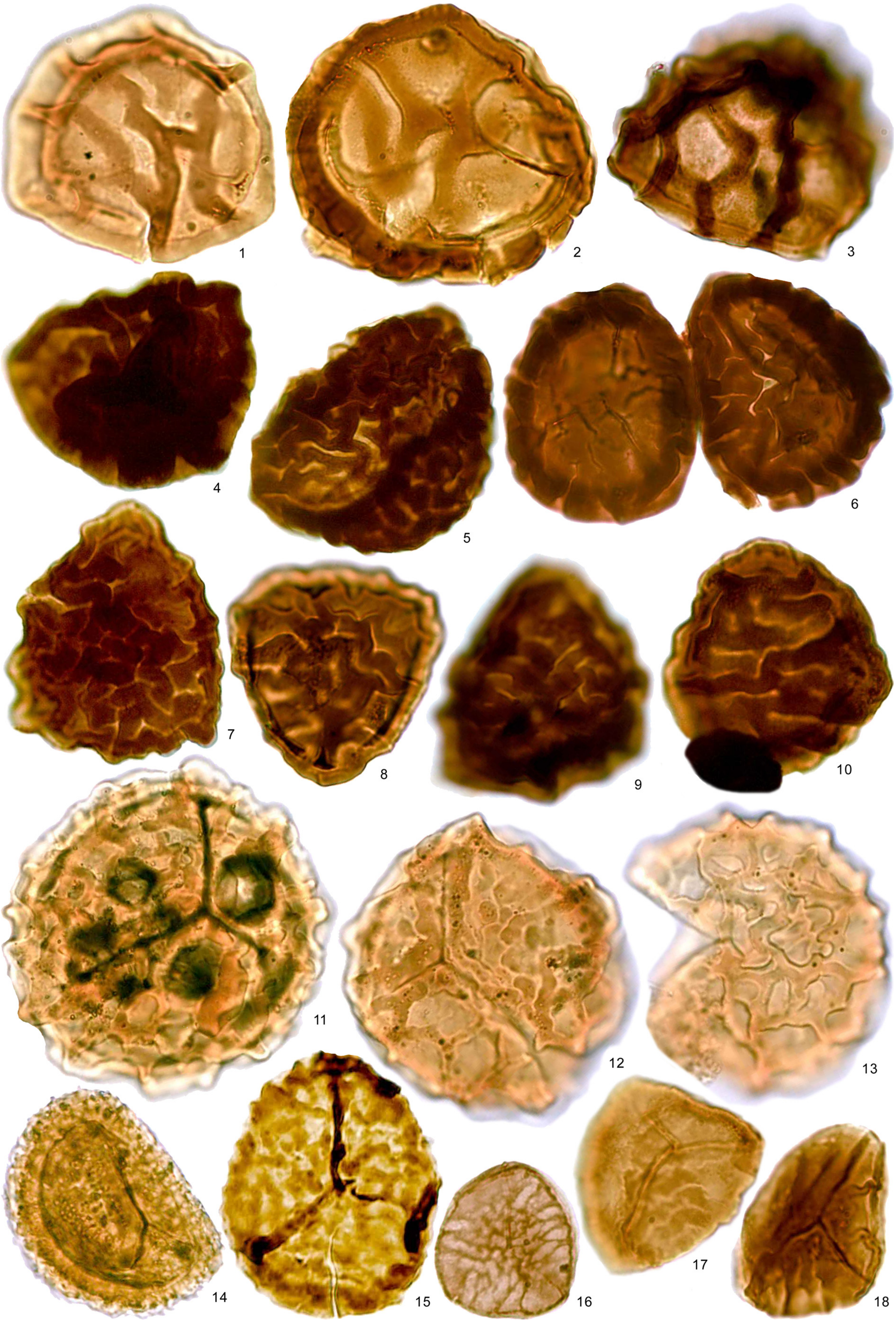

Plate 29

Plate 30.

1, 2. *Chelinospora* spp.

1. JNDL-1, 172.7’, G45/2.
2. S-462, 1710-1715’, 63223, Q30.

3-12. *Cirratriradites diaphanus* Steemans, 1989.

3. HWYH-956, 14160.5’, 46984(1), N42.
4. BAQA-1, 395.2’, D42/2.
5. BAQA-2, 50.2’, B45.
6. UTMN-1830, 13689.7’, 62317.
7. KHRM-2, 16226.0’, 62093, X33.
8. BAQA-1, 395.2’, V24/4.
9. BAQA-2, 50.2’, S26/2.
10. HWYH-956, 14156.0’, 60516, Q37.
11. JNDL-4, 295.9’, O26/3.
12. BAQA-2, 50.2’, J34.

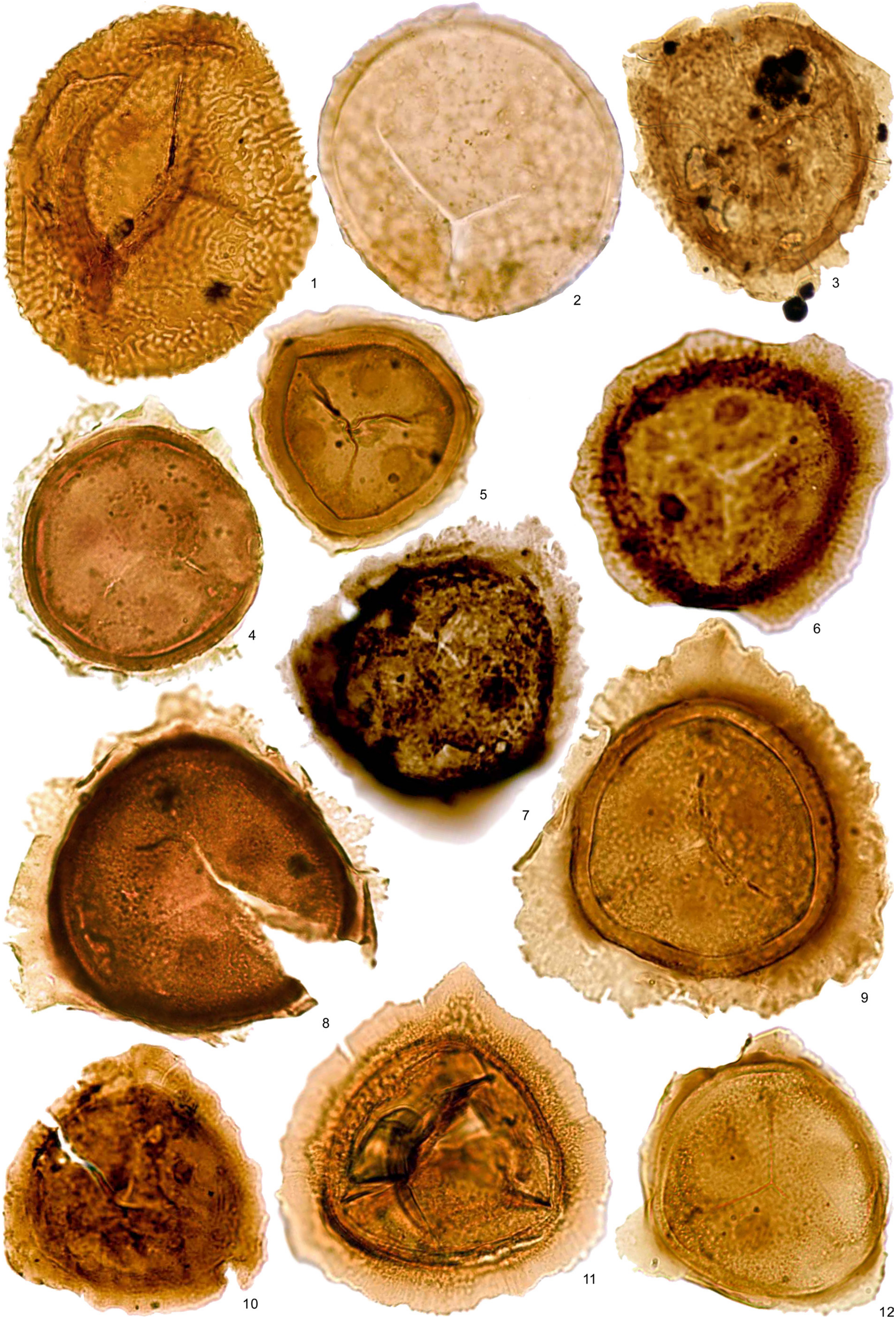

Plate 30

Plate 31.

1-6. *Clivosispora verrucata* McGregor, 1973 var. *convoluta* McGregor & Camfield, 1976.

1. BAQA-1, 371.1’, Q42/4.
2. BAQA-2, 133.0’, T39/2.
3. JNDL-4, 316.4’, K43/2.
4. UTMN-1830, 13689.7’, 62317, M30/1.
5. A1-69, 2108/2111’, 26913, R54.
6. FWRH-1, 15920.3’, 63110, Q43/2.

7-19. *Clivosispora verrucata* McGregor, 1973 var. *verrucata.*

7. NFLA-1, 16673.7’, 63209, N45/2.
8. FWRH-1, 15919.7’, 63108, D38/2.
9. BAQA-1, 285.5’, U35.
10. KHRM-2, 16224.7’, 62091, T46/2.
11. FWRH-1, 15893.9’, 63105, U41.
12. UTMN-1830, 13614.6’, 62378, N32.
13. JNDL-4, 87.2’, F34/1.
14. BAQA-1, 222.5’, M-N26.
15. BAQA-1, 175.9’, J37/2.
16. BAQA-1, 285.5’, R37/4.
17. NFLA-1, 16673.7’, 63211, D47.
18. BAQA-1, 395.2’, F47/1.
19. JNDL-1, 495.0’, N35/4.

Plate 31

Plate 32.

1-3. *Concentricosisporites sagittarius* (Rodriguez) Rodriguez, 1983.
1. BAQA-2, 54.8’, F29/3.
2. BAQA-1, 395.2’, H48.
3. MG-1, 2741.4 m, 62611, G30/2.

4, 5. *Contagisporites optivus* (Tchibrikova) Owens, 1971. Magnification x500.
4. S-462, 2110-2115’, 63273, N40/1.
5. S-462, 2260-2265’, 63281, Q28/2.

6-12. *Convolutispora subtilis* Owens, 1971.
6. MG-1, 2264 m, 62950, J35.
7. MG-1, 2247 m, 62941, N36/2.
8. MG-1, 2160.6 m, 62747, X26.
9. MG-1, 2160.6 m, 62727, Q28/1.
10. MG-1, 2181.2 m, 62525, V42.
11. MG-1, 2205 m, 62596, L43/4.
12. MG-1, 2160.6 m, 62727, R34.

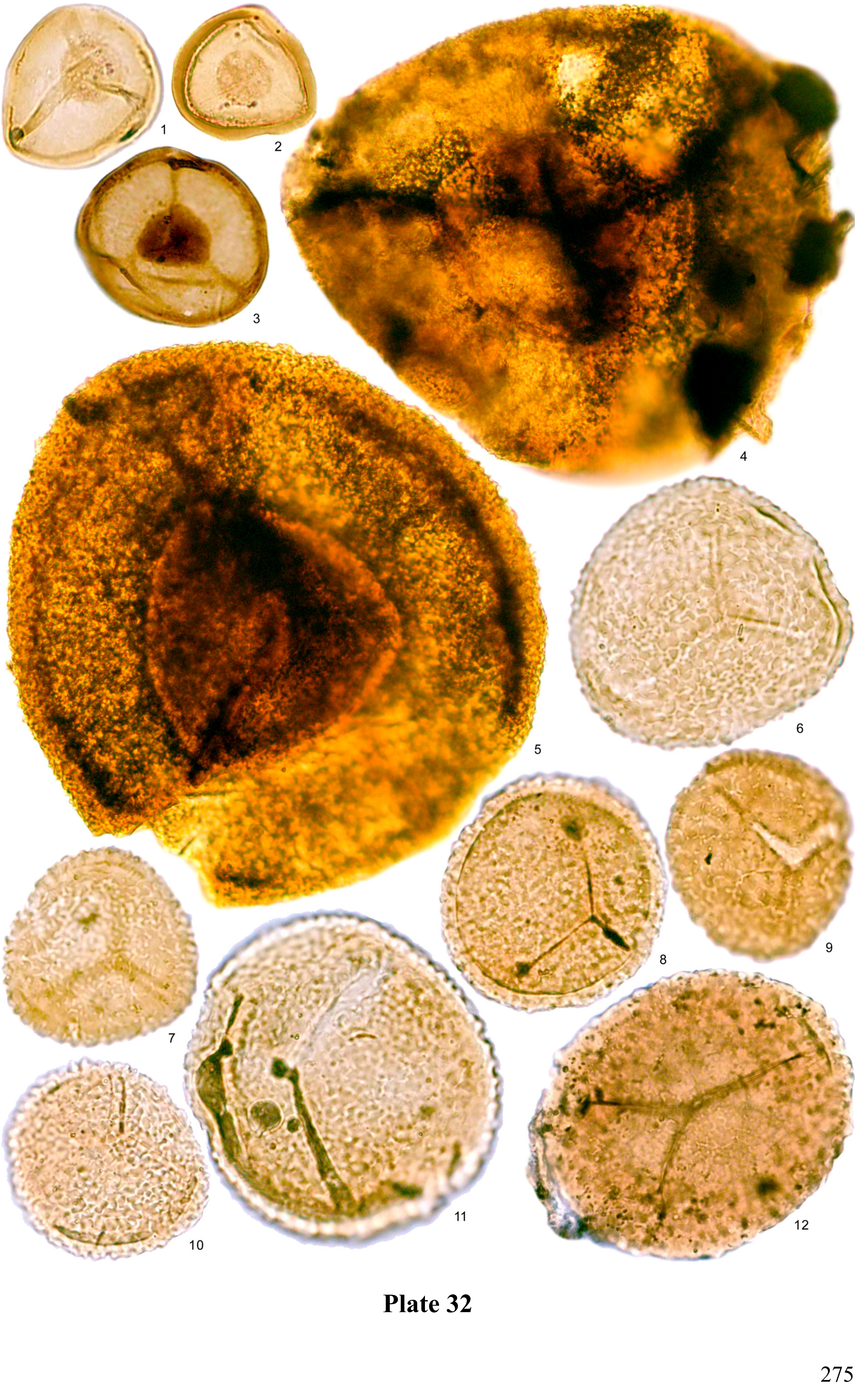

Plate 32

Plate 33.

1-3. *Corystisporites collaris* Tiwari & Schaarschmidt, 1975.
1. A1-69, 971’, 62639, T32.
2. S-462, 1760-1765’, 63255, P36/1.
3. A1-69, 1109’, 27274, O45/1.

4, 5. *Corystisporites multispinosus* Richardson, 1965. Magnification x750.

4. A1-69, 1530’, 26984, O43.
5. A1-69, 1700’, 62633, T43/2.

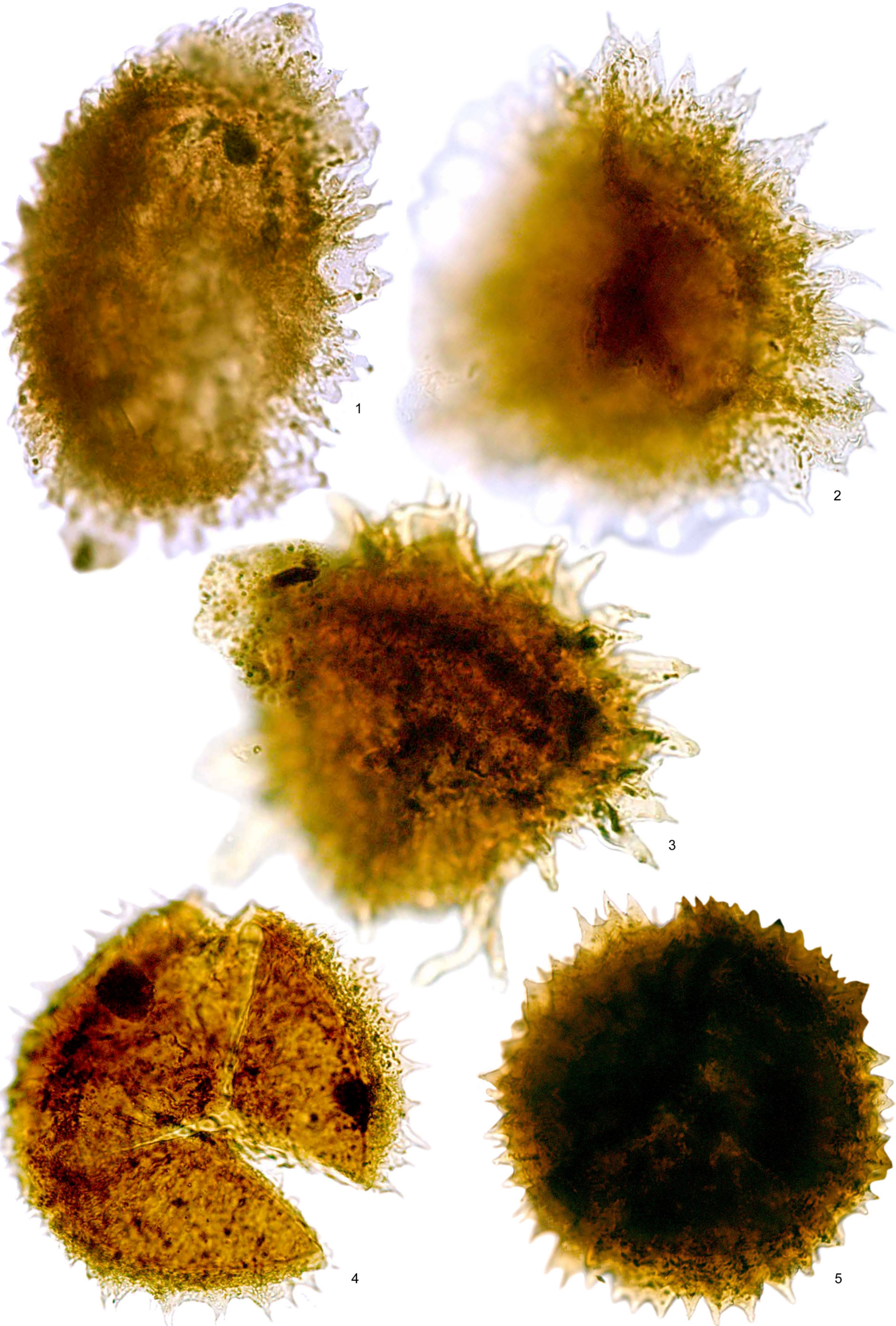

Plate 33

Plate 34.

1, 2. *Corystisporites multispinosus* Richardson, 1965.
1. A1-69, 1700’, 62632, R50.
2. A1-69, 1596’, 26989, T39.

3-8. *Corystisporites undulatus* Turnau, 1996. Magnification x500.
3. A1-69, 1334’, 27128, Q46/3.
4. A1-69, 1277’, 62636, E35/3.
5. A1-69, 1277’, 62636, R29/2.
6. A1-69, 1277’, 62637, V51/2.
7. A1-69, 971’, 62641, K46/2.
8. MG-1, 2180 m, 62972, G39.

Plate 34

Plate 35.

1-3. *Corystisporites undulatus* Turnau, 1996. Magnification x500.

1. MG-1, 2205 m, 62595, G30/2.
2. A1-69, 1109’, 27273, E50/4.
3. MG-1, 2295 m, 63005, X51/3.

4-7. *Craspedispora ghadamisensis* Loboziak & Streel, 1989.

4. A1-69, 1596’, 26990, D44.
5. A1-69, 1700’, 62634, M37/2.
6. A1-69, 1416’, 26992, S50.
7. A1-69, 1322’, 27125, K54/2.

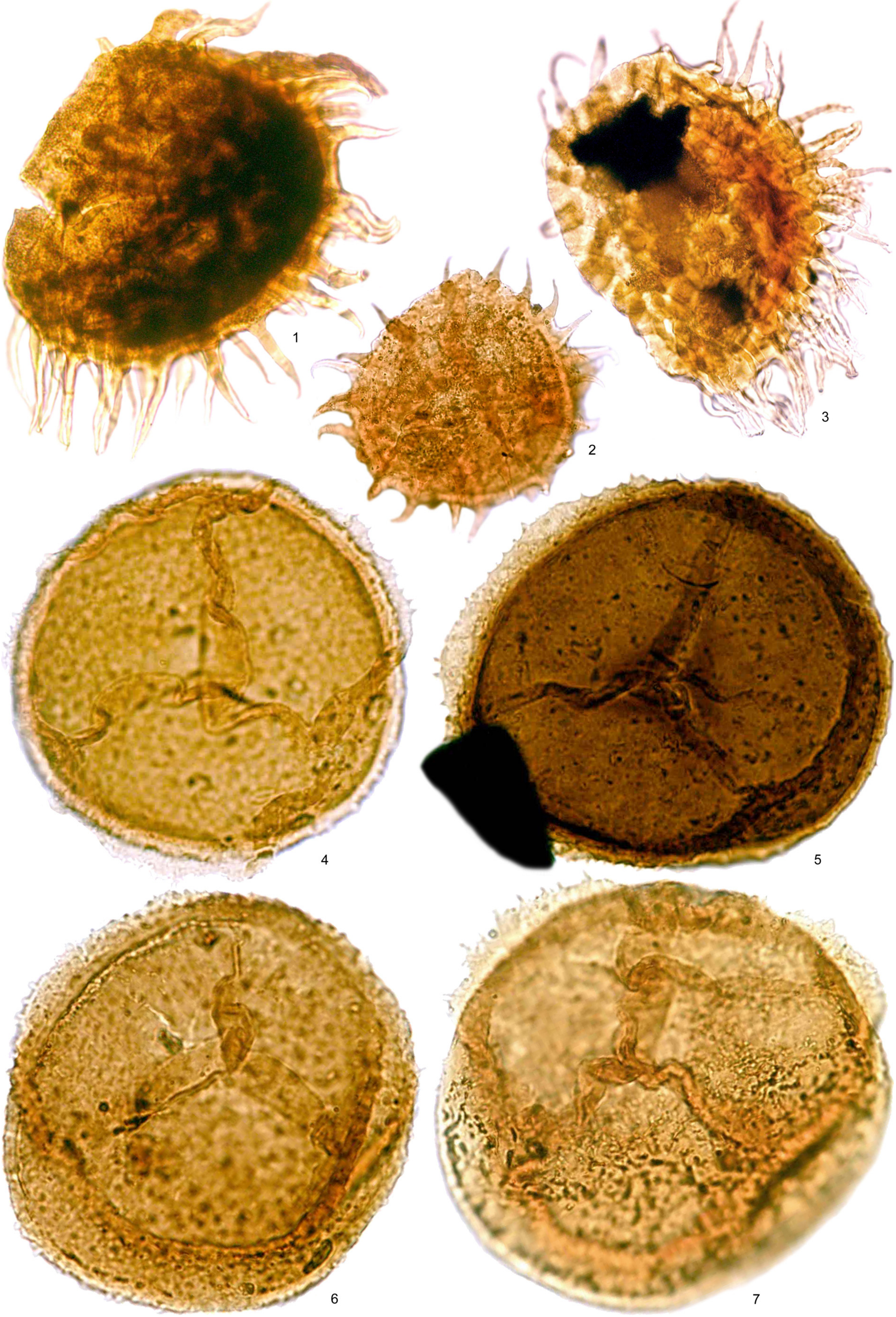

Plate 35

Plate 36.

1, 2. *Craspedispora* sp. in Paris et al., 1985.
1. A1-69, 2039/2040', 27279, M37/1.
2. A1-69, 2108/2111', 26913, L57-58.

3-7. *Cristatisporites* sp. 1. Magnification x750.
3. MG-1, 2264 m, 62951, V31/3.
4. A1-69, 1109', 27274, T41.
5. MG-1, 2713 m, 62811, H36.
6. MG-1, 2264 m, 62951, L42/3.
7. A1-69, 1109', 27273, J35.

8, 9. *Cristatisporites* sp. 2. Magnification x750.
8. MG-1, 2270 m, 62849, R42/3.
9. MG-1, 2241 m, 62964, T30/1.

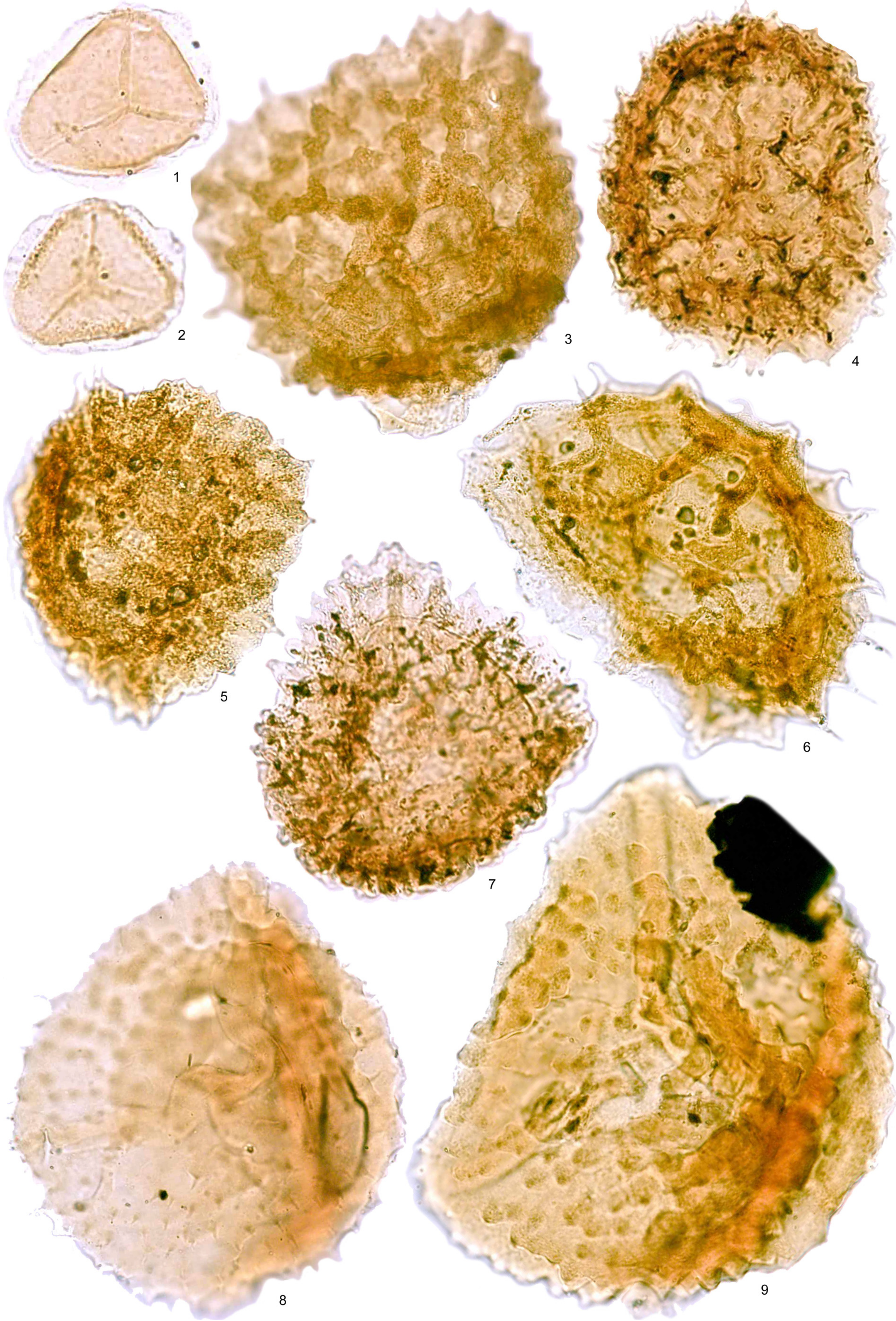

Plate 36

Plate 37.

1, 2. *Cristatisporites* sp. 2. Magnification x750.

1. MG-1, 2375 m, 62773, L33.
2. MG-1, 2241 m, 62964, H44/3.

3-14. *Cymbosporites asymmetricus* Breuer et al., 2007c.

3. JNDL-4, 160.7’, V42.
4. JNDL-3, 268.1’, G29.
5. JNDL-3, 394.0’, D50/3.
6. JNDL-4, 214.3’, V51.
7. JNDL-3, 368.8’, K48.
8. JNDL-4, 42.0’, R48.
9. JNDL-3, 413.2’, T42/1.
10. JNDL-3, 413.2’, C40.
11. JNDL-3, 294.0’, M29/1.
12. JNDL-3, 341.0’, O32.
13. JNDL-3, 368.8’, L49.
14. JNDL-3, 341.0’, Y37/3.

Plate 37

Plate 38.

1-15. *Cymbosporites catillus* Allen, 1965.

1. A1-69, 1109’, 27274, X38/4.
2. MG-1, 2180 m, 62972, T37.
3. A1-69, 1109’, 27274, M45.
4. MG-1, 2178 m, 62996, X39/2.
5. S-462, 2220-2215’, 63280, Y41/1.
6. A1-69, 1109’, 27273, J31/4.
7. S-462, 2010-2015’, 63399, P54.
8. S-462, 2010-2015’, 63399, O57/3.
9. S-462, 2010-2015’, 63399, L52.
10. S-462, 2010-2015’, 63399, N47.
11. S-462, 2010-2015’, 63399, L51.
12. YBRN-1, 16647.3’, 62410, F37/1.
13. S-462, 2010-2015’, 63399, L-M49.
14. A1-69, 1109’, 27274, L44/2.
15. YBRN-1, 16647.3’, 62410, Q26/3. This specimen is transitional between *Cymbosporites catillus* and *Cymbosporites cyathus* Allen, 1965.

Plate 38

Plate 39.

1-14. *Cymbosporites cyathus* Allen, 1965.

1. S-462, 2010-2015', 63399, K45.
2. S-462, 2010-2015', 63399, O47.
3. A1-69, 1109', 27273, M34/3.
4. S-462, 1710-1715', 63222, V41/4.
5. S-462, 2010-2015', 63399, S53/1.
6. S-462, 2010-2015', 63399, J44/1.
7. S-462, 1710-1715', 63224, N-O38.
8. S-462, 2010-2015', 63399, H57.
9. S-462, 2010-2015', 63399, E34/4.
10. A1-69, 1074', 62675, G42/2.
11. S-462, 2010-2015', 63399, H40.
12. S-462, 2010-2015', 63399, L43.
13. S-462, 2010-2015', 63399, M41.
14. YBRN-1, 16648.4', 62412, J31.

Plate 39

Plate 40.

1-10. *Cymbosporites dammamensis* Steemans, 1995.
1. MG-1, 2631.2 m, 62553, M50/4.
2. BAQA-2, 54.8’, L53/1.
3. BAQA-2, 134.4’, N42.
4. BAQA-2, 133.0’, R26/2.
5. BAQA-1, 371.1’, T54.
6. BAQA-2, 50.2’, J52.
7. HWYH-956, 14155.1’, 60513, P43/2.
8. KHRM-2, 16224.7’, 62090, F46/4.
9. BAQA-1, 345.5’, W41/1.
10. BAQA-1, 366.9’, H31/2.

11-16. *Cymbosporites dittonensis* Richardson & Lister, 1969.
11. UTMN-1830, 13614.1’, 62374, F46.
12. UTMN-1830, 13614.1’, 62372, V-W45.
13. FWRH-1, 15893.9’, 63105, O49/4.
14. MG-1, 2631.2 m, 62552, M47/2.
15. FWRH-1, 15893.9’, 63105, R43/1.
16. UTMN-1830, 13614.1’, 62372, O28-29.

17. *Cymbosporites echinatus* Richardson & Lister, 1969. BAQA-1, 366.9’, Q29.

18, 19. *Cymbosporites ocularis* (Raskatova) comb. nov.
18. MG-1, 2160.6 m, 62747, P43/4.
19. MG-1, 2181.2 m, 62524, V49.

20-24. *Cymbosporites rarispinosus* Steemans, 1989.
20. BAQA-2, 56.0’, U29/3.
21. KHRM-2, 16273.0’, 62121, V40.
22. BAQA-2, 134.4’, G28/4.
23. BAQA-2, 134.4’, P28/1.
24. KHRM-2, 16273.0’, 62121, G31.

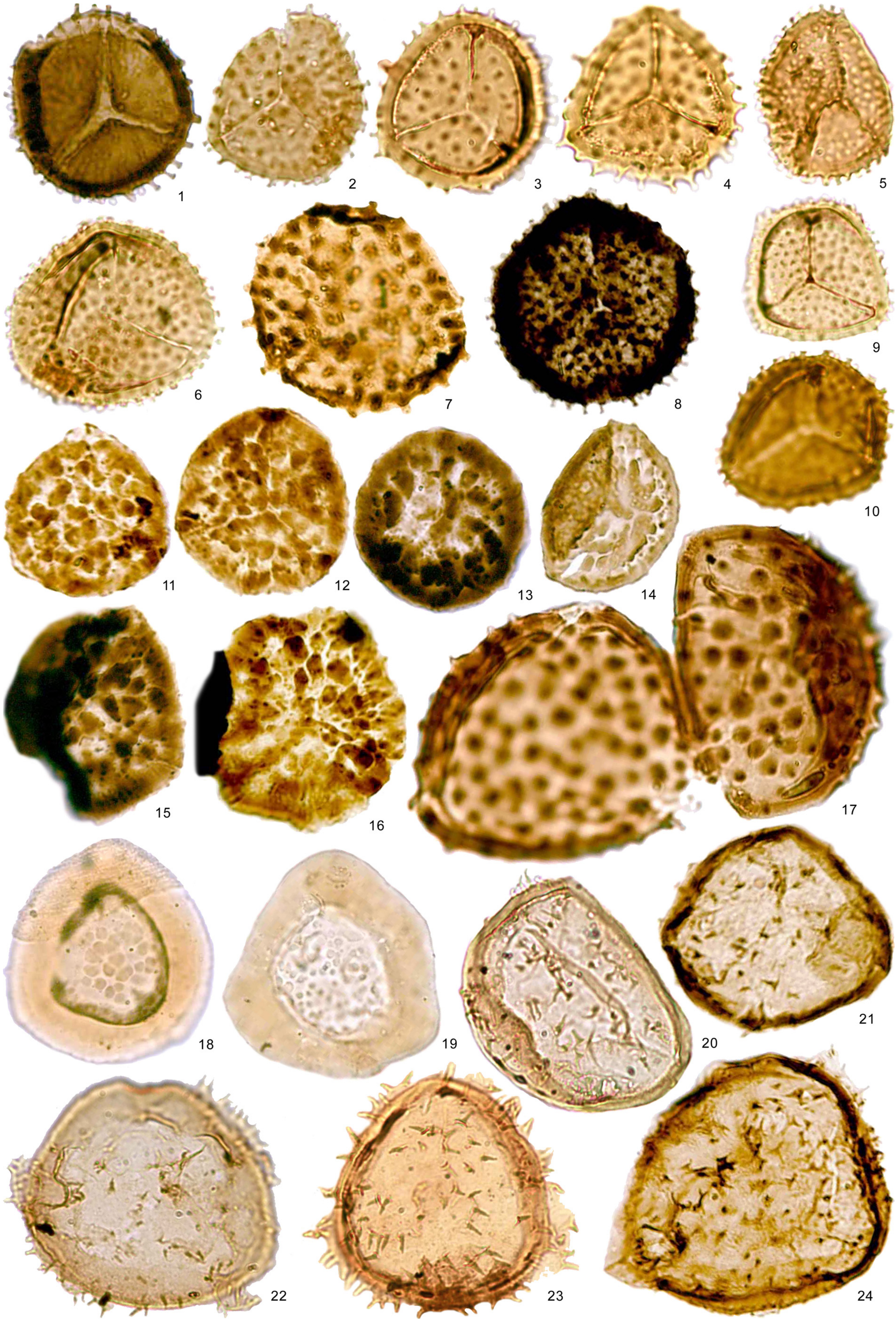

Plate 40

Plate 41.

1-11. *Cymbosporites senex* McGregor & Camfield, 1976.

1. BAQA-1, 285.5’, T22.
2. BAQA-1, 285.5’, O25.
3. HWYH-956, 14214.1’, 47151(1), J63/2.
4. UTMN-1830, 13612.5’, 62367, L31.
5. BAQA-1, 219.2’, R37/3.
6. UTMN-1830, 13670.8’, 62382, Q29.
7. JNDL-1, 495.0’, 60855, O30.
8. ABSF-29, 16737.8’, 61980, K43/3.
9. BAQA-1, 285.5’, D24.
10. HWYH-956, 14214.1’, 47151(1), U52.
11. UTMN-1830, 13670.8’, 62382, S-T32.

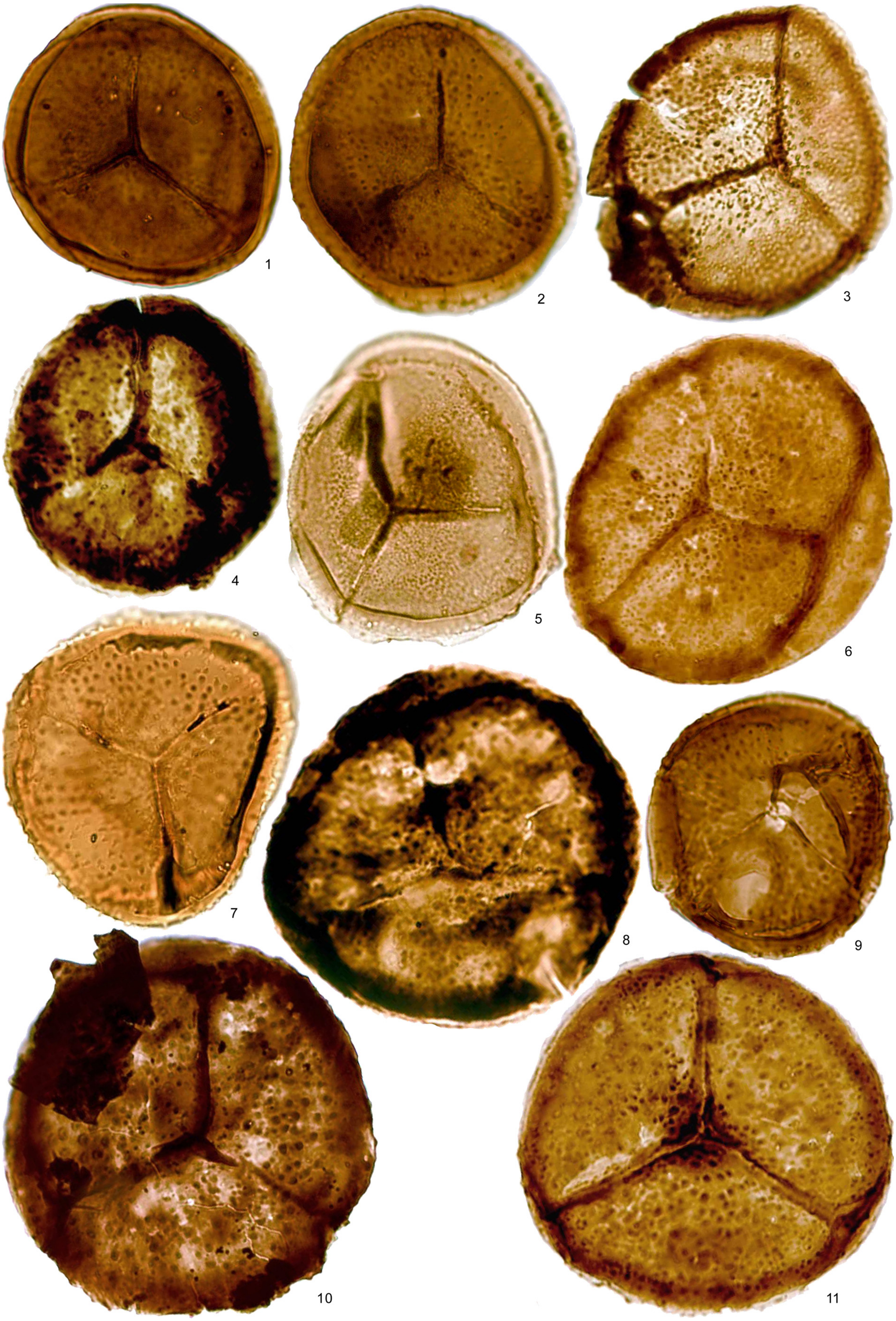

Plate 41

Plate 42.

1-14. *Cymbosporites* sp. 1.

1. BAQA-1, 395.2’, 62274, G37/3.
2. BAQA-1, 219.2’, 62237, K35.
3. BAQA-1, 366.9’, 62255, K32/3.
4. BAQA-1, 345.5’, 62248, R41.
5. BAQA-1, 366.9’, 62256, O39/1.
6. BAQA-1, 345.5’, 62253, P30.
7. BAQA-1, 345.5’, 62253, F40/4.
8. BAQA-1, 366.9’, 62254, Q32/3.
9. BAQA-1, 366.9’, 62255, H34/4.
10. BAQA-1, 366.9’, 62256, H32.
11. BAQA-1, 366.9’, 62256, K42/2.
12. BAQA-1, 345.5’, 62251, O52/4.
13. BAQA-1, 366.9’, 62257, F34.
14. BAQA-1, 366.9’, 62256, O39/2.

Plate 42

Plate 43.

1-14. *Cymbosporites* sp. 2.

1. BAQA-1, 345.5', 62249, U45.
2. BAQA-1, 345.5', 62253, X26/2.
3. BAQA-1, 395.2', 62273, F50/1.
4. BAQA-1, 395.2', 62277, Q-R35.
5. BAQA-1, 395.2', X43/1.
6. BAQA-1, 395.2', 62277, Q39/4.
7. BAQA-1, 308.3', 62244, K32/1.
8. BAQA-1, 345.5', 62250, H39/4.
9. BAQA-1, 345.5', 62248, R42/1.
10. BAQA-1, 366.9', 62258, K40.
11. BAQA-1, 366.9', 62258, H52/3.
12. BAQA-1, 366.9', 62255, T44/1.
13. BAQA-1, 366.9', 62257, M51/2.
14. BAQA-1, 366.9', 62257, F-G42.

Plate 43

Plate 44.

1-14. *Cymbosporites* sp. 3.

1. BAQA-1, 366.9', 62255, O46/3.
2. BAQA-1, 371.1', U43/3.
3. BAQA-1, 371.1', 62261, G-H47.
4. BAQA-1, 395.2', 62274, N38/3.
5. BAQA-1, 345.5', 62250, H37.
6. BAQA-1, 366.9', 62254, L29.
7. BAQA-2, 52.0', N29/2.
8. BAQA-1, 366.9', 62258, F41.
9. BAQA-1, 345.5', 62250, X38.
10. BAQA-1, 308.3', B36.
11. BAQA-1, 366.9', 62257, L33/2.
12. BAQA-1, 345.5', 62251, D45/2.
13. BAQA-1, 366.9', 62257, D33.
14. BAQA-1, 366.9', 62254, E43/4.

Plate 44

Plate 45.

1-16. *Cymbosporites* sp. 4.

1. MG-1, 2178 m, 62997, L29.
2. MG-1, 2178 m, 62995, U49/1.
3. MG-1, 2178 m, 62995, V35/4.
4. MG-1, 2178 m, 62996, S41/1.
5. MG-1, 2315 m, 62782, L51.
6. MG-1, 2182.4 m, 62527, U-V40.
7. MG-1, 2178 m, 62995, F43/2.
8. MG-1, 2160.6 m, 62727, R40.
9. MG-1, 2258 m, 62948, K37/3.
10. MG-1, 2161.8 m, 62529, M34/2.
11. A1-69, 1322', 27125, Q49/1.
12. MG-1, 2247 m, 62942, R40.
13. MG-1, 2247 m, 62940, F28/3.
14. MG-1, 2161.8 m, 62529, D34/4.
15. MG-1, 2161.8 m, 62529, W33/3.
16. MG-1, 2160.6 m, 62746, R28.

Plate 45

Plate 46.

1-4. *Cymbosporites* spp.

1. UTMN-1830, 13689.7’, 62316, P39.
2. MG-1, 2631.2 m, 62553, S29/3.
3. MG-1, 2741.4 m, 62612, N-O40.
4. BAQA-2, 133.0’, O-P23.

5-14. *Cyrtospora* sp. 1.

5. MG-1, 2264 m, 62951, E46/4.
6. MG-1, 2270 m, 62848, R31/1.
7. MG-1, 2421 m, 62736, T36/2.
8. MG-1, 2518 m, 62805, J36/2.
9. MG-1, 2435 m, 63018, R40/3.
10. MG-1, 2278 m, 62936, E32.
11. MG-1, 2456 m, 62737, H48.
12. MG-1, 2536 m, 62742, T32.
13. MG-1, 2182.4 m, 62526, V36.
14. MG-1, 2258 m, 62947, G40/2.

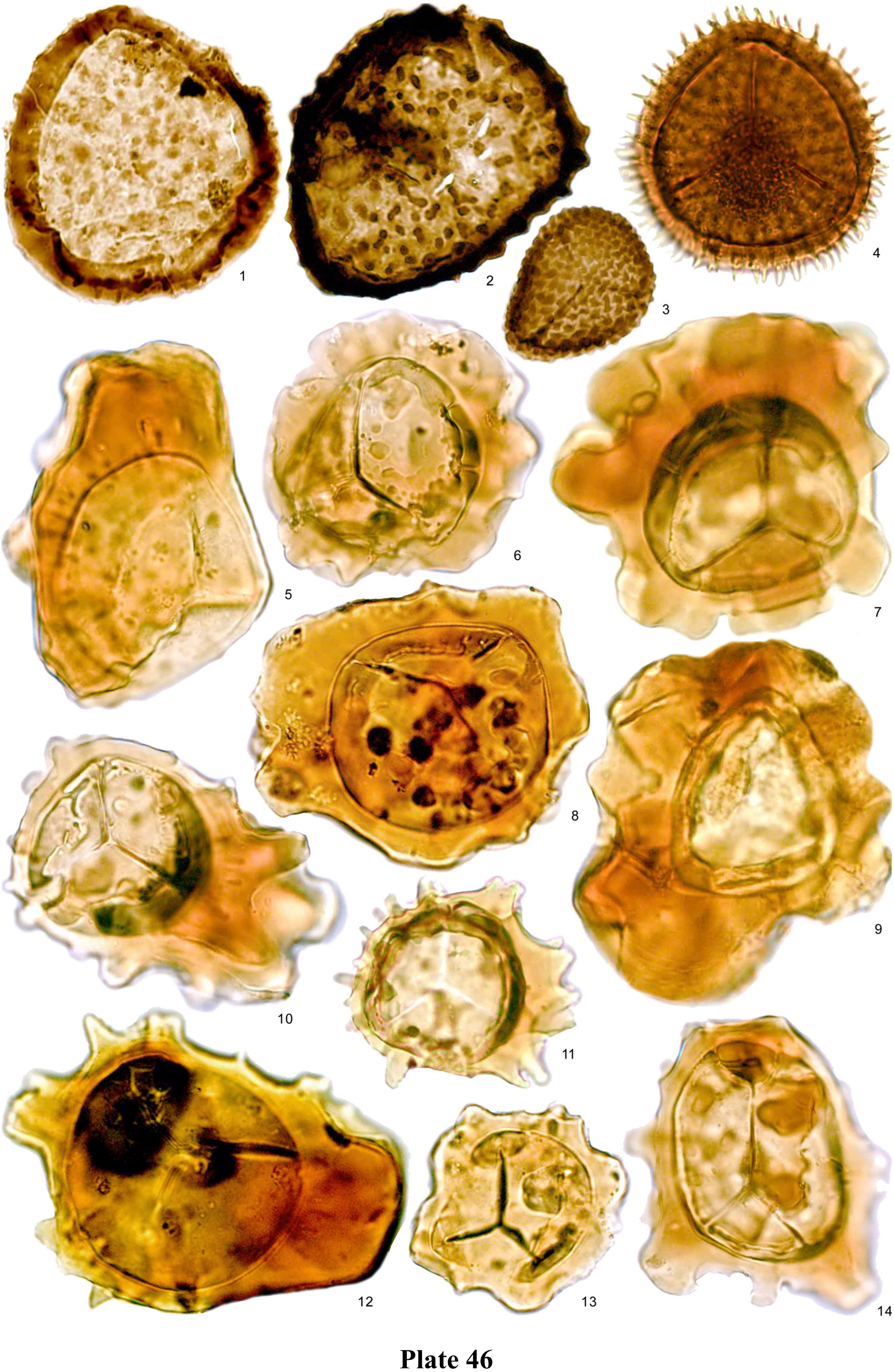

Plate 46

Plate 47.

1-7. *Densosporites devonicus* Richardson, 1960. Magnification x750.

1. MG-1, 2465 m, 62850, U36.
2. MG-1, 2527 m, 63003, G34/2.
3. MG-1, 2315 m, 62783, Q42.
4. MG-1, 2713 m, 62811, G42.
5. MG-1, 2247 m, 62942, H39/3.
6. MG-1, 2511 m, 62843, Q36.
7. MG-1, 2483 m, 62802, C37/4.

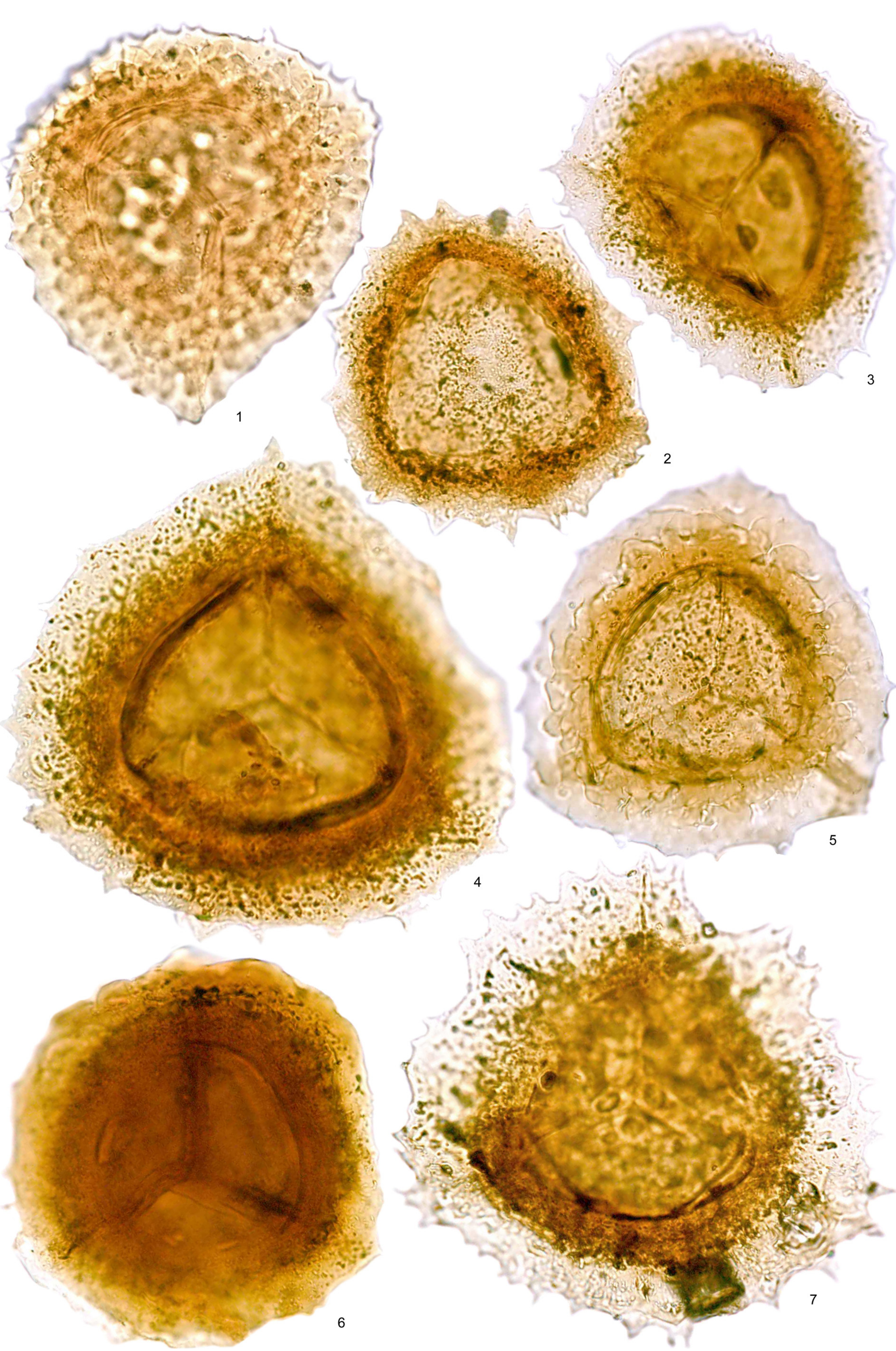

Plate 47

Plate 48.

1-14. *Diaphanospora* sp. 1.

1. UTMN-1830, 13689.7', 62318, T-U46.
2. UTMN-1830, 13689.7', 62317, N49/1.
3. BAQA-1, 227.1', F49/2.
4. BAQA-1, 345.5', E41/2.
5. BAQA-1, 222.5', G27/2.
6. UTMN-1830, 13689.7', 62319, F-G29.
7. BAQA-1, 223.5', X48/1.
8. UTMN-1830, 13689.7', 62317, H53/1.
9. FWRH-1, 15919.7', 63108, O28.
10. UTMN-1830, 13689.7', 62317, Y42/1.
11. UTMN-1830, 13689.7', 62316, J57.
12. UTMN-1830, 13689.7', 62317, J55.
13. UTMN-1830, 13689.7', 62317, E33/4.
14. UTMN-1830, 13689.7', 62316, H57/4.

15-22. *Diatomozonotriletes franklinii* McGregor & Camfield, 1982.

15. A1-69, 2039-2041', 27279, O37.
16. A1-69, 2039-2041', 27279, G32/2.
17. A1-69, 2039-2041', 27279, O52.
18. JNDL-3, 413.2', F41/3.
19. MG-1, 2518 m, 62806, M31.
20. MG-1, 2483 m, 62802, V28/2.
21. A1-69, 1830', 26961, U30/4.
22. A1-69, 1700', 62634, H39/2.

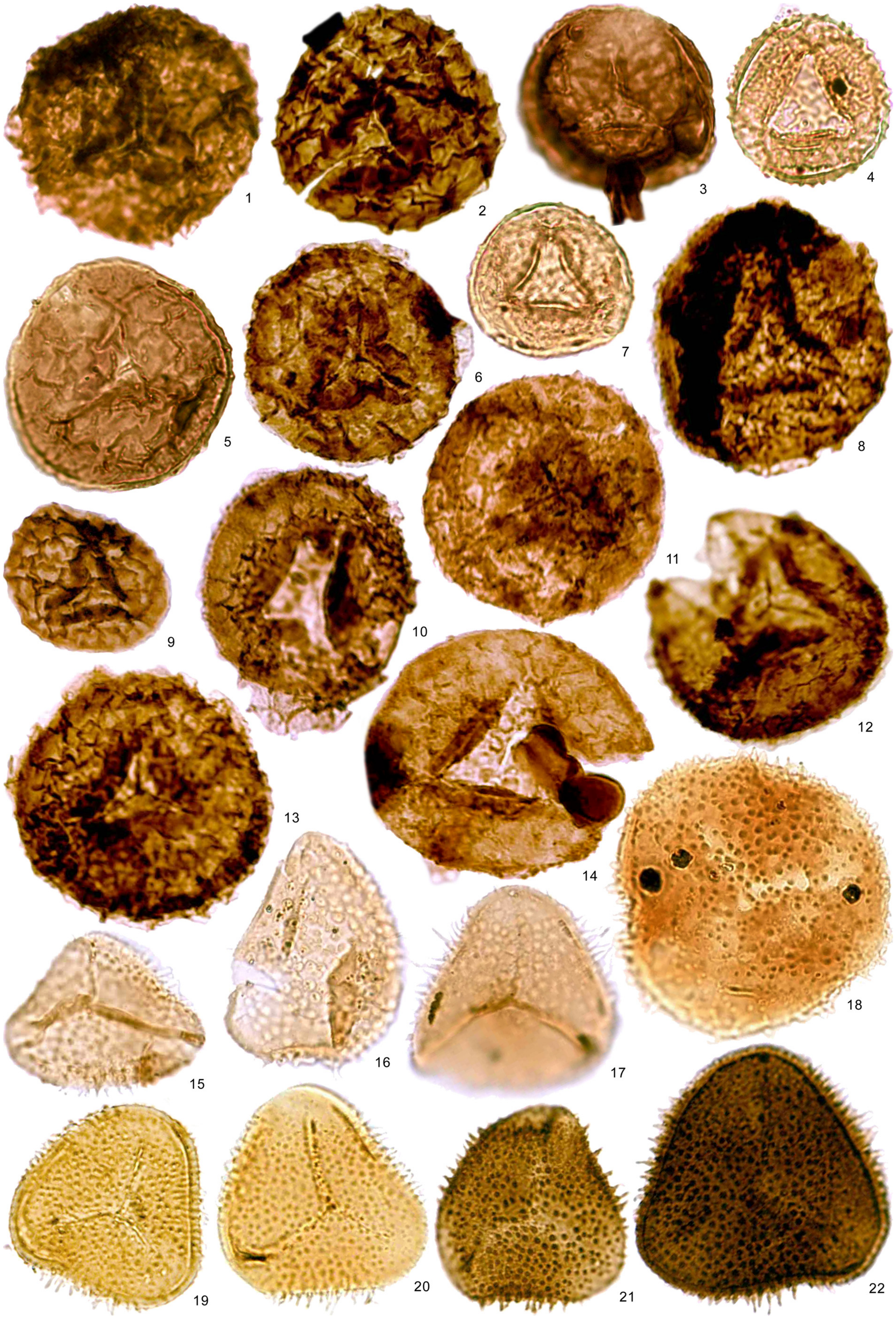

Plate 48

Plate 49.

1-6. *Dibolisporites bullatus* (Allen) Riegel, 1973.

1. BAQA-1, 223.5’, D40.
2. BAQA-1, 223.5’, K29/4.
3. UTMN-1830, 13738.5’, 62324, H49.
4. UTMN-1830, 13738.5’, 62323, K47/1.
5. UTMN-1830, 13738.5’, 62323, Q35/2.
6. UTMN-1830, 13738.5’, 62323, W32/1.

Plate 49

Plate 50.

1-4. *Dibolisporites echinaceus* (Eisenack) Richardson, 1965. Magnification x750.

1. A1-69, 1870’, 26974, D54.
2. JNDL-1, 495.0’, 26985, V35.
3. A1-69, 1530’, U54-55.
4. A1-69, 1596’, 26989, R48/3.

5-14. *Dibolisporites eifeliensis* (Lanninger) McGregor, 1973.

5. KHRM-2, 16269.0’, 62114, K29.
6. KHRM-2, 16224.7’, 62090, L35.
7. FWRH-1, 15886.3’, 63102, G29/4.
8. HWYH-956, 14195.2’, 60551, Q42.
9. KHRM-2, 16273.0’, 62121, F45.
10. UTMN-1830, 13689.7’, 62317, Q51/1.
11. BAQA-2, 134.4’, J30/1.
12. BAQA-1, 223.5’, F48/2.
13. BAQA-1, 223.5’, F37/2.
14. BAQA-1, 223.5’, J42.

Plate 50

Plate 51.

1-11. *Dibolisporites farraginis* McGregor & Camfield, 1982.

1. A1-69, 1596', 26989, X33/3.
2. A1-69, 1483', 26995, T38/3.
3. A1-69, 1334', 27127, L44.
4. A1-69, 1483', 26994, V33.
5. A1-69, 1483', 26994, G50/4.
6. A1-69, 1596', 26989, E37.
7. A1-69, 1322', 27125, T40/2.
8. A1-69, 1530', 26984, N32.
9. A1-69, 1416', 26993, M44/2.
10. A1-69, 1530', 26984, O32/4.
11. A1-69, 1596', 26989, H32/3.

Plate 51

Plate 52.

1-8. *Dibolisporites gaspiensis* (McGregor) comb. nov.

1. JNDL-1, 162.3’, 60841, J29/4.
2. JNDL-1, 155.6’, 60837, P37/4.
3. JNDL-1, 495.0’, 60855, P36.
4. JNDL-1, 162.3’, 60841, X35.
5. JNDL-1, 174.6’, 60848, L33/1.
6. JNDL-1, 155.6’, 60838, T28/4.
7. JNDL-1, 177.0’, 60849, V36.
8. JNDL-1, 172.7’, N42.

Plate 52

Plate 53.

1-8. *Dibolisporites pilatus* Breuer et al., 2007.

1. JNDL-1, 162.3’, O30/1.
2. JNDL-1, 167.8’, 60842, P46.
3. JNDL-1, 177.0’, N39.
4. JNDL-1, 156.0’, J41.
5. JNDL-1, 177.0’, 60850, K43/1.
6. JNDL-1, 167.8’, 60843, L38/3.
7. JNDL-1, 174.6’, 60847, M29/3.
8. JNDL-1, 167.8’, 60842, R42/3.

Plate 53

Plate 54.

1-6. *Dibolisporites turriculatus* Balme, 1988.

1. A1-69, 1277’, 62637, W41/1.
2. A1-69, 1416’, 26993, V-W36.
3. MG-1, 2181.2 m, 62525, S33.
4. A1-69, 1322’, 27125, V44/3.
5. MG-1, MG-1, 2161.8 m, 62529, F30.
6. A1-69, 1277’, 62636, O53/3.

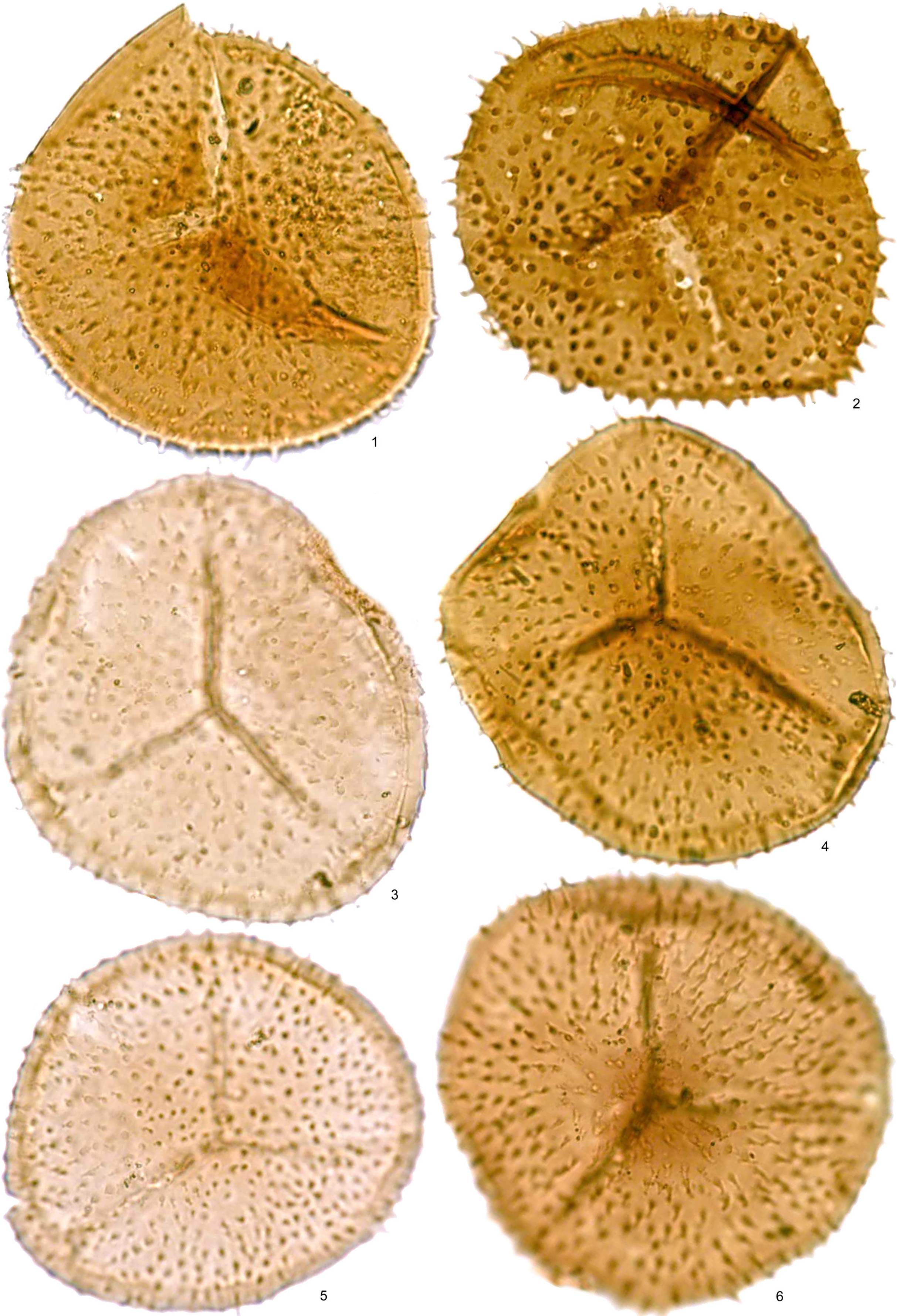

Plate 54

Plate 55.

1, 2. *Dibolisporites turriculatus* Balme, 1988.

1. A1-69, 1277’, 62637, N48/1.
2. A1-69, 1277’, 62636, P37.

3-7. *Dibolisporites uncatus* (Naumova) McGregor & Camfield, 1982.

3. A1-69, 1416’, 26992, J43/3.
4. A1-69, 1109’, 27273, M41.
5. A1-69, 1530’, 26984, U33/1.
6. A1-69, 1277’, 62637, V-W42.
7. A1-69, 1322’, 27126, M40.

8-10. *Dibolisporites* sp. 1.

8. JNDL-1, 177.0’, 60850, M44/4.
9. JNDL-1, 156.0’, W33.
10. JNDL-1, 177.0’, S31/3.

Plate 55

Plate 56.

1-12. *Dibolisporites* sp. 1.

1. JNDL-1, 177.0’, 60849, K28.
2. JNDL-1, 177.0’, 60850, P32.
3. JNDL-1, 177.0’, 60849, F34/1.
4. JNDL-1, 177.0’, 60850, O43.
5. JNDL-1, 177.0’, 60849, U36.
6. JNDL-1, 162.3’, 60841, F35/3.
7. JNDL-1, 177.0’, 60849, O43/2.
8. JNDL-1, 177.0’, 60850, J31/1.
9. JNDL-1, 172.7’, 60845, D50/3.
10. JNDL-1, 172.7’, 60845, Q39.
11. JNDL-1, 174.6’, 60847, C41/3.
12. JNDL-1, 177.0’, M46/4.

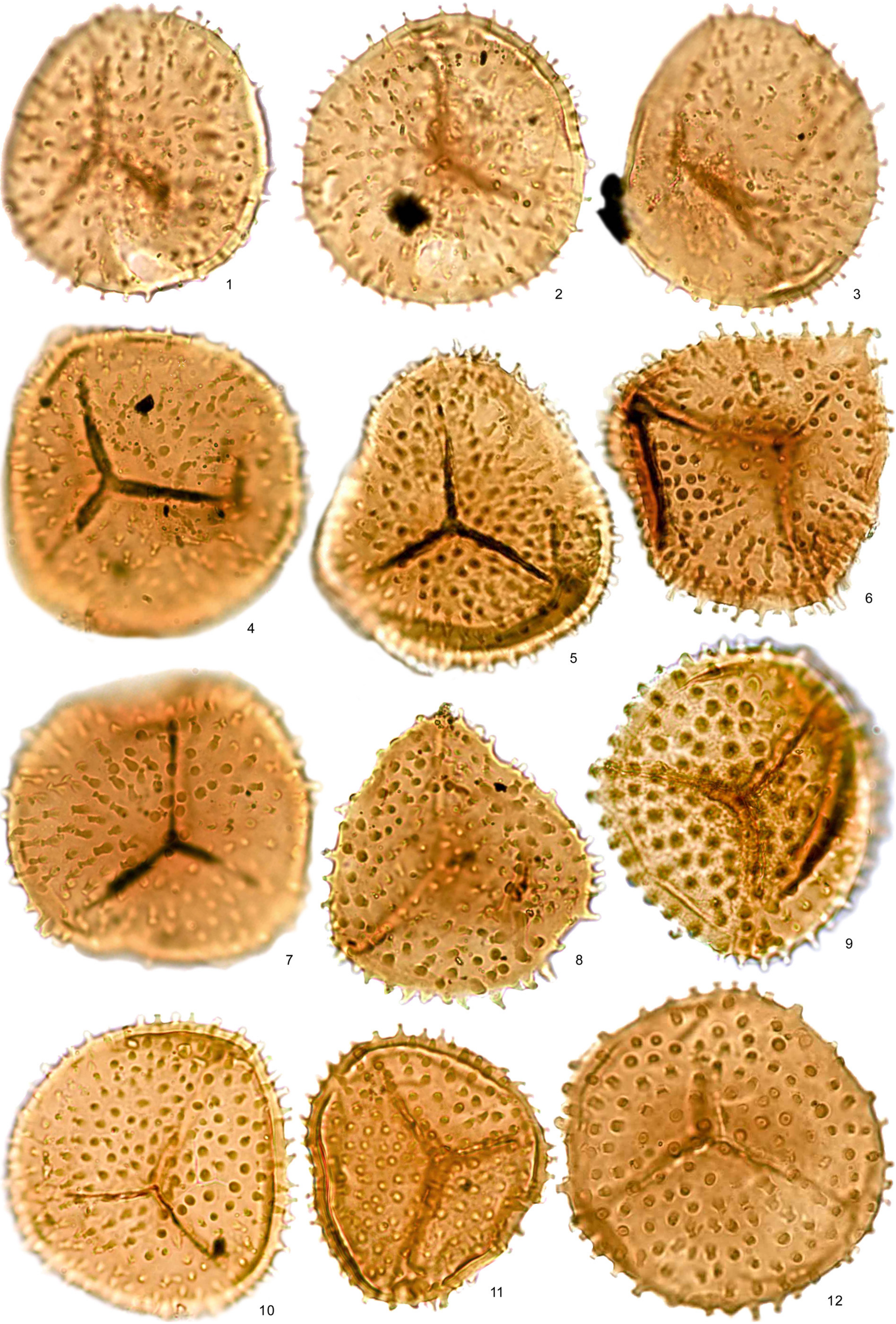

Plate 56

Plate 57.

1-3. *Dibolisporites* sp. 2.
1. BAQA-2, 50.2', G44/4.
2. BAQA-2, 50.8', K31.
3. BAQA-2, 52.0', F32/3.

4-6. *Dibolisporites* sp. 3.
4. BAQA-1, 406.0', E50.
5. BAQA-2, 50.8', P25/3.
6. BAQA-1, 406.0', D23.

7, 8. *Dibolisporites* sp. 4.
7. BAQA-2, 52.0', L44/3.
8. BAQA-2, 133.0', N30.

9, 10. *Dibolisporites* sp. 5.
9. A1-69, 1830', 26962, L43.
10. A1-69, 1596', 26990, H48/4.

11-16. *Dibolisporites* spp.
11. BAQA-1, 371.1', W43/1.
12. MG-1, 2631.2 m, 62552, P54/2.
13. MG-1, 2527 m, 63003, O30.
14. MG-1, 2212.5 m, 62530, P37/3.
15. A1-69, 1950', 27276, L54/2.
16. MG-1, 2258 m, 62946, N42.

Plate 57

Plate 58.

1-15. *Dictyotriletes biornatus* Breuer et al., 2007c.

1. JNDL-4, 464.1', M37/1.
2. JNDL-4, 448.6', U33/2.
3. BAQA-1, 308.3', E48/2.
4. BAQA-1, 219.2', L40/4.
5. BAQA-1, 366.9', L27/1.
6. BAQA-1, 345.5', O53.
7. BAQA-1, 366.9', 62259, D44/3.
8. BAQA-1, 308.3', 62244, D46.
9. BAQA-1, 345.5', 62248, W39.
10. BAQA-1, 219.2', P52.
11. BAQA-1, 169.1', K26.
12. JNDL-4, 495.2', L41/4.
13. BAQA-1, 395.2', 62274, G50/2.
14. BAQA-1, 366.9', 62257, L29.
15. JNDL-4, 495.2', K45/1.

Plate 58

Plate 59.

1-7. *Dictyotriletes emsiensis* (Allen) McGregor, 1973.

1. BAQA-2, 134.4', Q29/3.
2. MG-1, 2693 m, 62962, K51.
3. MG-1, 2678 m, 62970, F39/4.
4. MG-1, 2631.2 m, 62553, P52.
5. HWYH-956, 14195.3', 47149(2), M48/4.
6. BAQA-2, 56.0', X46.
7. MG-1, 2180 m, 62973, H34/2.

8-16. *Dictyotriletes favosus* McGregor & Camfield, 1976.

8. UTMN-1830, 13614.6', 62379, N50/4.
9. UTMN-1830, 13614.1', 62372, X41/2.
10. JNDL-4, 364.6', T37.
11. UTMN-1830, 13614.1', 62372, S45.
12. UTMN-1830, 13613.2', S47/2.
13. UTMN-1830, 13614.1', 62372, T42.
14. UTMN-1830, 13614.1', 62372, P35/4.
15. UTMN-1830, 13614.1', 62373, E32.
16. KHRM-2, 16226.0', 62093, H55.

Plate 59

Plate 60.

1-3. *Dictyotriletes* ?*gorgoneus* in McGregor, 1973.
1. BAQA-2, 50.8', W40/3.
2. BAQA-2, 50.8', D24.
3. BAQA-2, 50.8', G54.

4-13. *Dictyotriletes subgranifer* McGregor, 1973.
4. BAQA-1, 376.4', O26/3.
5. BAQA-2, 134.4', T39/2.
6. BAQA-1, 395.2', T33/2.
7. BAQA-2, 54.8', T27.
8. BAQA-1, 366.9', O31.
9. BAQA-1, 366.9', J43/3.
10. BAQA-1, 395.2', W41/2.
11. BAQA-1, 366.9', G28.
12. BAQA-1, 371.1', U52.
13. BAQA-1, 376.4', S35/4.

14-20. *Dictyotriletes* sp. 1.
14. BAQA-1, 408.3', G37/3.
15. BAQA-1, 395.2', 62275, J27/1.
16. BAQA-1, 345.5', 62251, U32/1.
17. BAQA-1, 345.5', 62252, H46.
18. BAQA-1, 345.5', 62249, U38.
19. BAQA-1, 371.1', C38.
20. BAQA-2, 50.8', D-E37.

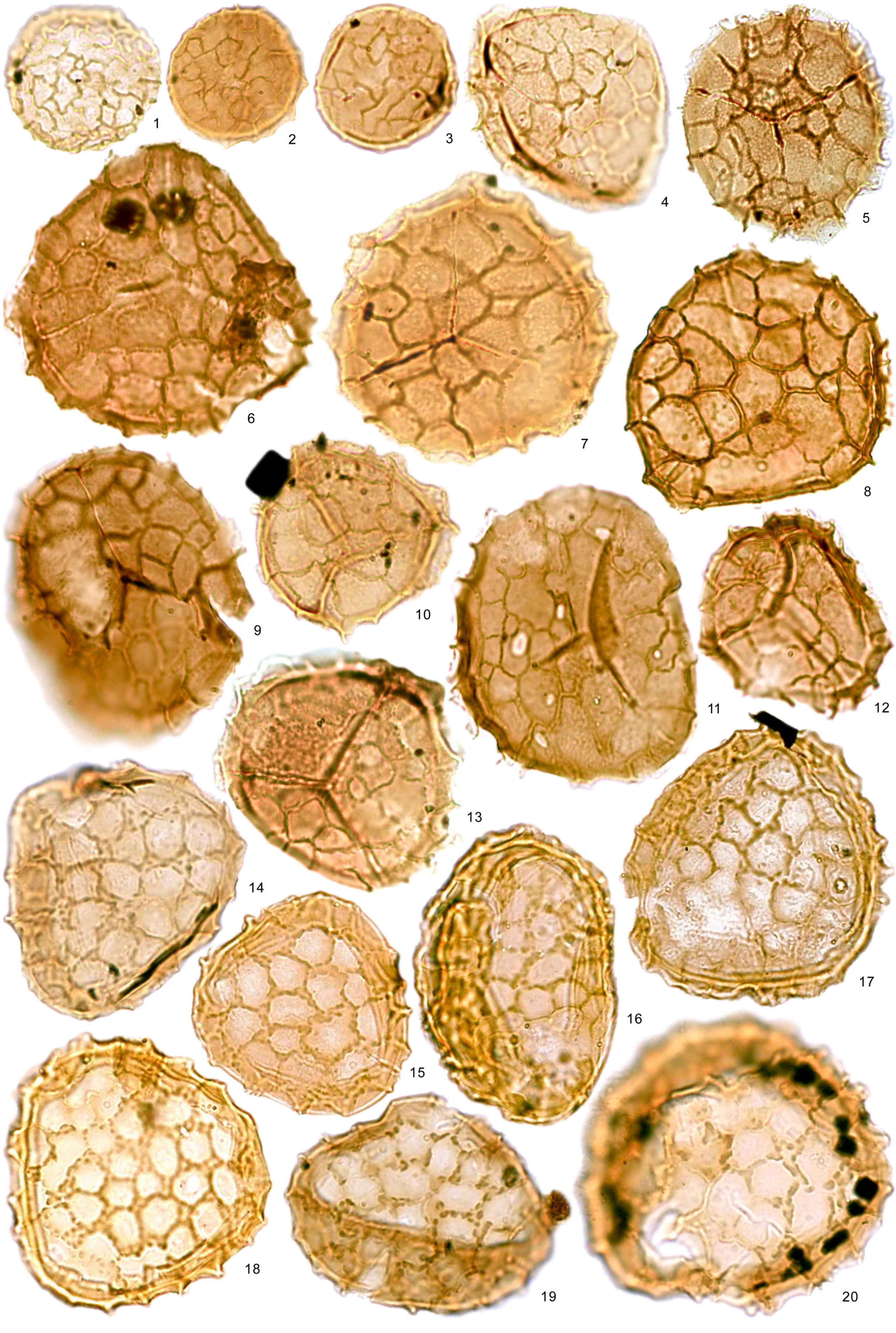

Plate 60

Plate 61.

1-9. *Dictyotriletes* sp. 2.

1. S-462, 2460-2465’, 63293, W39/2.
2. S-462, 2460-2465’, 63295, O50.
3. S-462, 2460-2465’, 63293, W41
4. S-462, 2510-2515’, 63297, T41/4.
5. YBRN-1, 16642.3’, 62407, E37.
6. S-462, 2460-2465’, 63293, L45/3.
7. ABSF-29, 16354.0’, 61958, T45/3.
8. ABSF-29, 16359.5’, 61969, L39/4.
9. S-462, 2460-2465’, 63293, J32.

10-13. *Dictyotriletes* sp. 3.

10. MG-1, 2631.2 m, 62552, U35/1.
11. MG-1, 2631.2 m, 62253, F50.
12. MG-1, 2639 m, 62780, B48/4.
13. MG-1, 2557.5 m, 62599, N39/1.

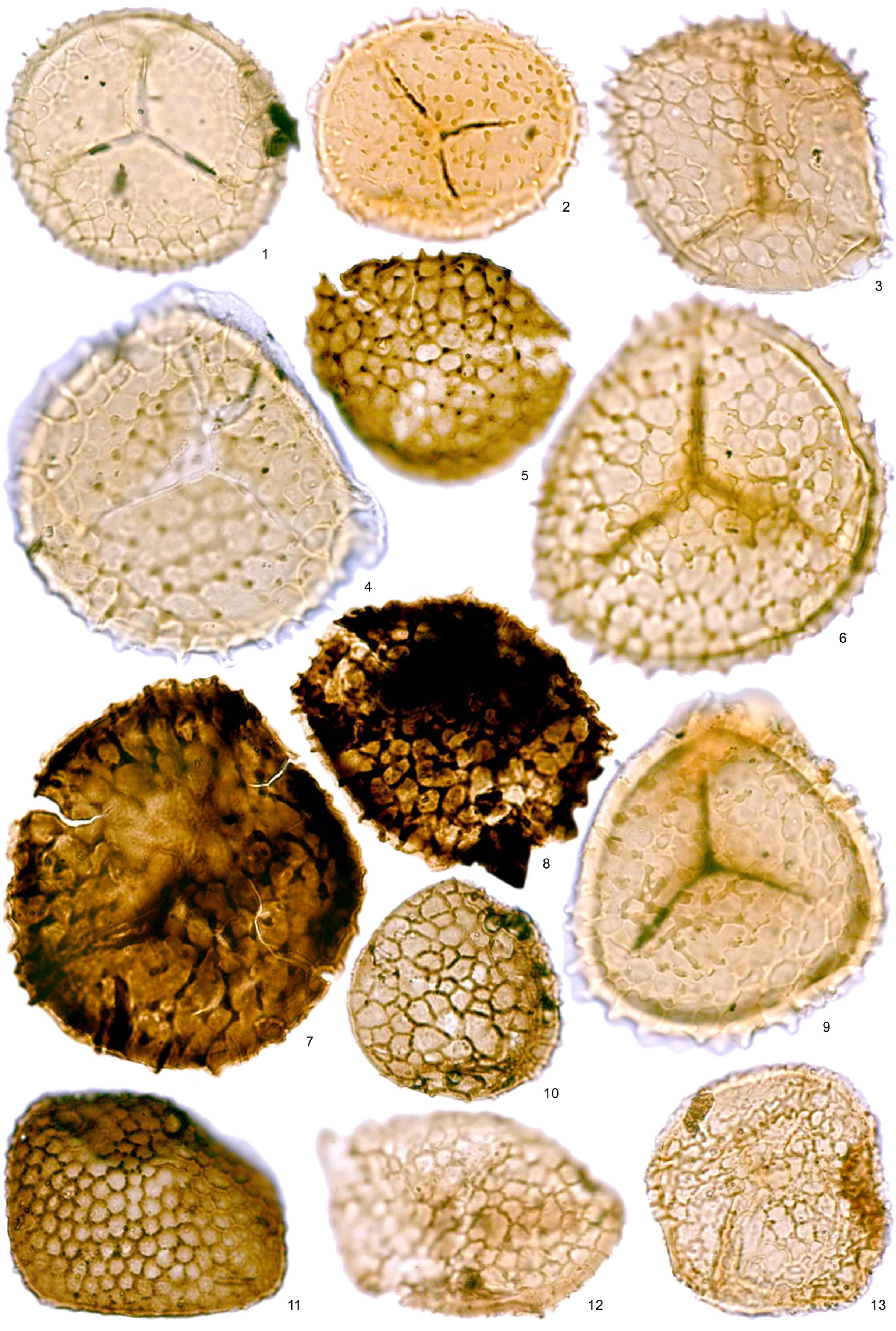

Plate 61

Plate 62.

1, 2. *Dictyotriletes* sp. 3.
1. JNDL-4, 471.6’, E33.
2. JNDL-4, 399.3’, S26/3.

3, 4. *Dictyotriletes* sp. 4.
3. BAQA-1, 366.9’, 62259, F39/4.
4. BAQA-1, 366.9’, 62259, T41-42.

5, 6. *Dictyotriletes* spp.
5. MG-1, 2160.6’, 62746, W26/2.
6. MG-1, 2741.4 m, 62605, E40.

7-9. *Elenisporis* sp. 1.
7. MG-1, 2241 m, 62966, U47.
8. MG-1, 2405 m, 62821, R39.
9. MG-1, 2241 m, 62965, N40/3.

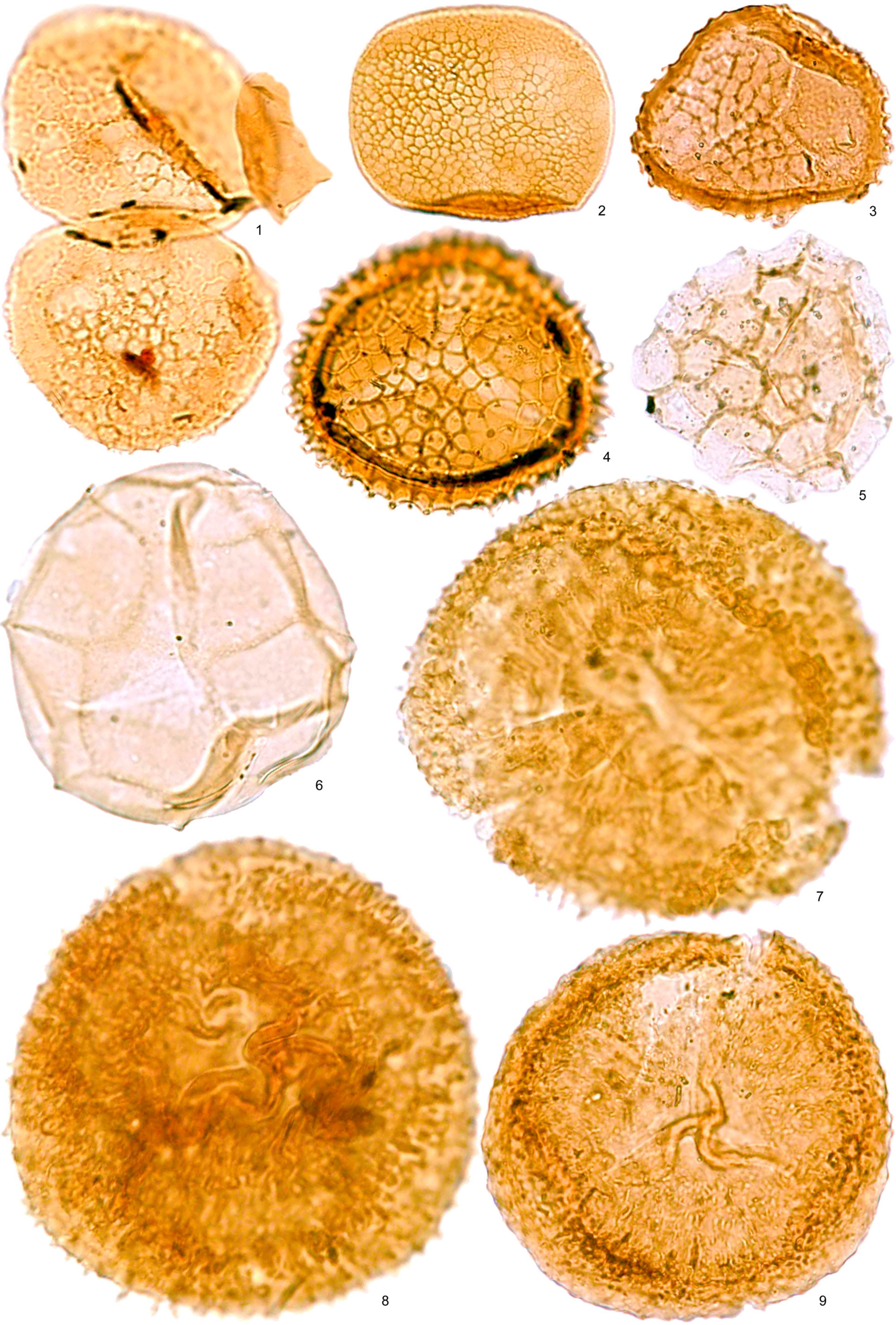

Plate 62

Plate 63.

1-4. *Elenisporis* sp. 1.

1. MG-1, 2241 m, 62966, H36/1.
2. MG-1, 2285 m, 62845, K36/2.
3. MG-1, 2205 m, 62597, W44/4.
4. MG-1, 2285 m, 62845, O29/4.

5, 6. *Elenisporis* sp. 2.

5. MG-1, 2456 m, 62739, O48.
6. MG-1, 2270 m, 62848, X34.

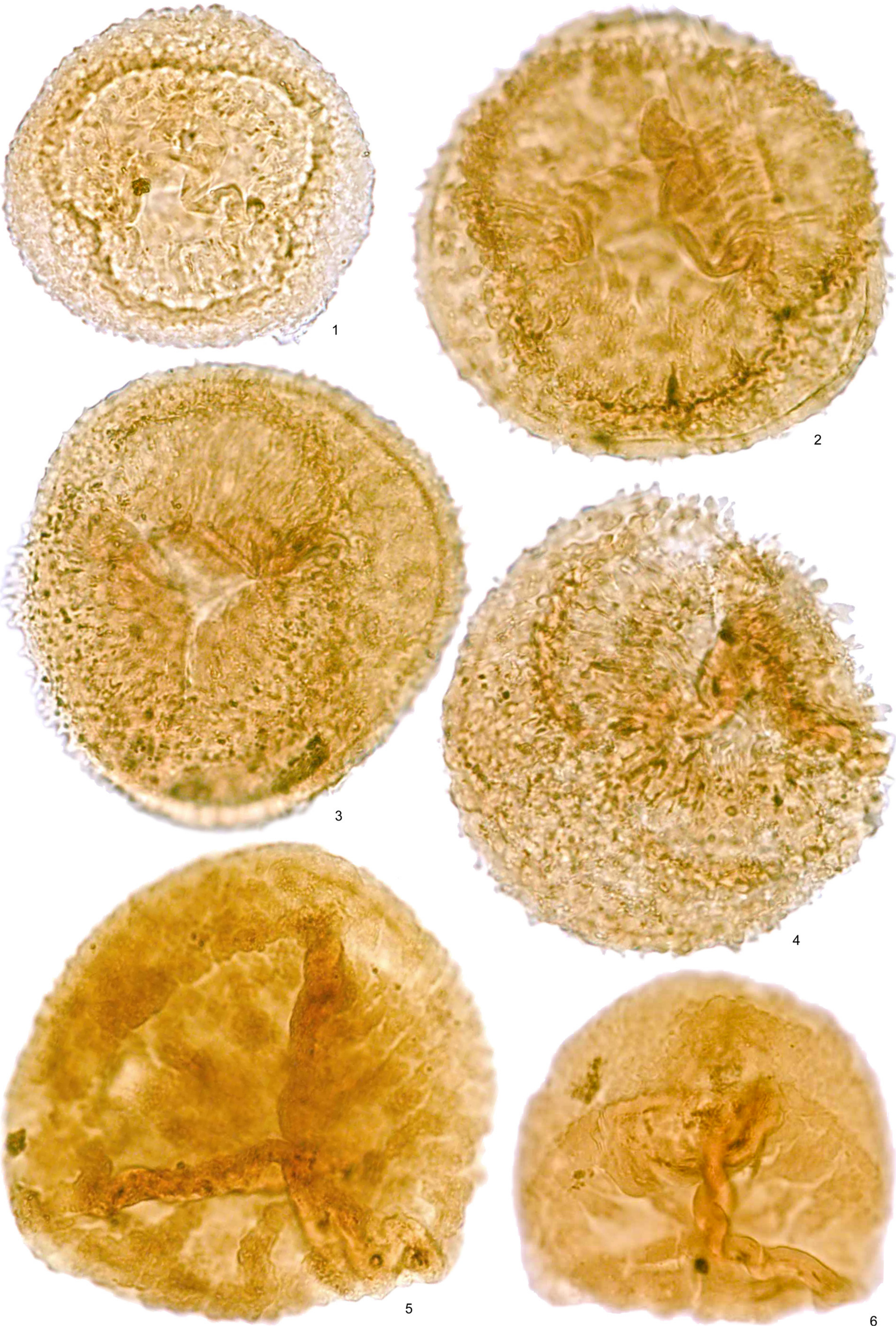

Plate 63

Plate 64.

1-10. *Emphanisporites annulatus* McGregor, 1961.
1. JNDL-1, 174.6', 60847, G31.
2. JNDL-1, 172.7', 60846, S30/2.
3. JNDL-1, 174.6', 60848, O47/1.
4. JNDL-1, 172.7', 60845, R38.
5. JNDL-1, 162.3', 60841, P37.
6. JNDL-1, 177.0', 60849, T42/1.
7. JNDL-1, 156.0', 60840, E48/4.
8. JNDL-1, 155.6', W37.
9. JNDL-1, 174.6', 60847, N31/1.
10. JNDL-1, 172.7', 60846, N33/3.

11, 12. *Emphanisporites* cf. *E. biradiatus* Steemans, 1989.
11. JNDL-4, 448.6', G37/1.
12. JNDL-1, 155.6', 60838, M51.

13-17. *Emphanisporites decoratus* Allen, 1965.
13. UTMN-1830, 13738.5', 62325, J49/4.
14. KHRM-2, 16273.0', 62121, M36.
15. KHRM-2, 16269.0', 62114, O34.
16. FWRH-1, 15920.3', 63109, L38.
17. UTMN-1830, 13689.7', Q50/1.

18. *Emphanisporites* cf. *E. edwardsiae* Wellman, 2006. BAQA-1, 285.5', D-E23.

Plate 64

Plate 65.

1. *Emphanisporites erraticus* McGregor, 1961. JNDL-3, 374.0’, V27/2.

2-8. *Emphanisporites mcgregorii* Cramer, 1966a.

2. MG-1, 2182.4’, 62526, D32.
3. MG-1, 2161.8 m, 62529, T50/4.
4. A1-69, 1490’, 26979, K38/3.
5. BAQA-2, 134.4’, E52.
6. MG-1, 2181.2’, 62525, V42/3.
7. A1-69, 1416’, 26992, D33.
8. JNDL-1, 177.0’, K47/3.

9-20. *Emphanisporites rotatus* McGregor emend. McGregor, 1973.

9. JNDL-1, 495.0’, G34.
10. BAQA-1, 366.9’, V38.
11. A1-69, 1074’, 62676, U33/3.
12. BAQA-1, 222.5’, L32/2.
13. BAQA-1, 222.5’, R23/2.
14. BAQA-1, 219.2’, K24/3.
15. BAQA-1, 175.9’, W50.
16. BAQA-1, 285.5’, O42.
17. JNDL-1, 495.0’, 60855, S47.
18. BAQA-1, 345.5’, H50/1.
19. BAQA-1, 285.5’, L22/3.
20. BAQA-1, 205.8’, S49/2.

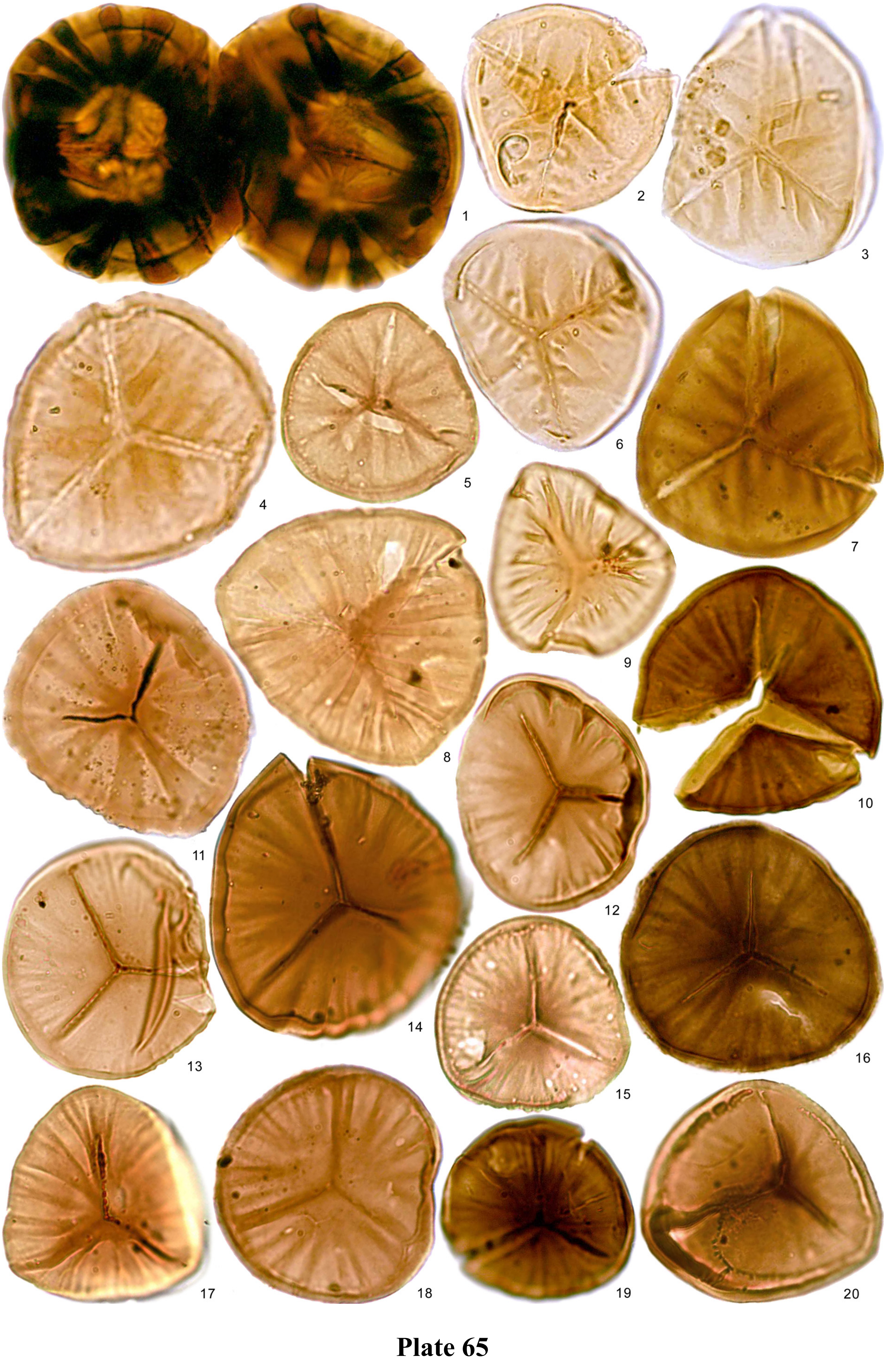

Plate 65

Plate 66.

1-8. *Emphanisporites schultzii* McGregor, 1973.
1. KHRM-2, 16273.0', 62122, Y30.
2. JNDL-4, 182.5', R38.
3. MG-1, 2520 m, 62593, T36.
4. BAQA-1, 395.2', G50.
5. UTMN-1830, 13613.2', 62371, P31/4.
6. YBRN-1, 16642.3', 62406, N43.
7. UTMN-1830, 13614.1', 62373, L33/2.
8. JNDL-1, 156.0', 60839, H47/1.

9-12. *Emphanisporites* sp. 1.

9. JNDL-1, 174.6', 60847, D43.
10. JNDL-1, 495.0', 60854, F43/3.
11. JNDL-1, 155.6', 60838, M52.
12. JNDL-1, 495.0', 60855, G37.

13-15. *Emphanisporites* sp. 2.

13. MG-1, 2160.6 m, 62746, K48/2.
14. MG-1, 2314 m, 62799, W39/2.
15. MG-1, 2181.2 m, 62524, E45.

Plate 66

Plate 67.

1. *Emphanisporites* sp. 2. MG-1, 2181.2 m, 62525, G42.

2-9. *Emphanisporites* sp. 3.

2. MG-1, 2182.4 m, 62526, X29.
3. MG-1, 2161.8 m, 62529, J50.
4. MG-1, 2161.8 m, 62528, S38.
5. MG-1, 2180 m, 62971, V35.
6. MG-1, 2181.2 m, 62525, M52/1.
7. MG-1, 2161.8 m, 62528, V36/4.
8. MG-1, 2181.2 m, 62524, S49.
9. MG-1, 2161.8 m, 62529, H40.

Plate 67

Plate 68.

1-14. *Geminospora lemurata* Balme emend. Playford, 1983.

1. A1-69, 1322', 27125, U34/1.
2. A1-69, 1174', 62673, T44.
3. S-462, 1470-1475', 63213, W47.
4. A1-69, 971', 62640, T27.
5. S-462, 1570-1575', 63215, S35/4.
6. A1-69, 1174', 62672, T39.
7. A1-69, 1334', 27128, R41/1.
8. S-462, 1470-1475', 63212, R32/3.
9. S-462, 2060-2065', 63270, P52.
10. S-462, 2060-2065', 63270, N28/4.
11. MG-1, 2315 m, 62783, O30.
12. YBRN-1, 16642.0', 62403, T-U40.
13. YBRN-1, 16642.0', 62402, R38/4.
14. A1-69, 971', 62641, P51.

Plate 68

Plate 69.

1-3. *Geminospora libyensis* Moreau-Benoit, 1980b. Magnification x750.

1. MG-1, 2483 m, 62802, S46/4.
2. JNDL-1, 172.7', 60845, H33/1.
3. A1-69, 1540', 26988, O44/2.

4-11. *Geminospora punctata* Owens, 1971.

4. A1-69, 1322', 27126, R35-36.
5. A1-69, 1322', 27125, O34/1.
6. A1-69, 1334', 27127, M34/1.
7. A1-69, 1174', 62672, K38.
8. A1-69, 1322', 27126, P51.
9. A1-69, 1322', 27126, X56/1.
10. A1-69, 1174', 62672, J36/3.
11. A1-69, 1074', 62677, S41/1.

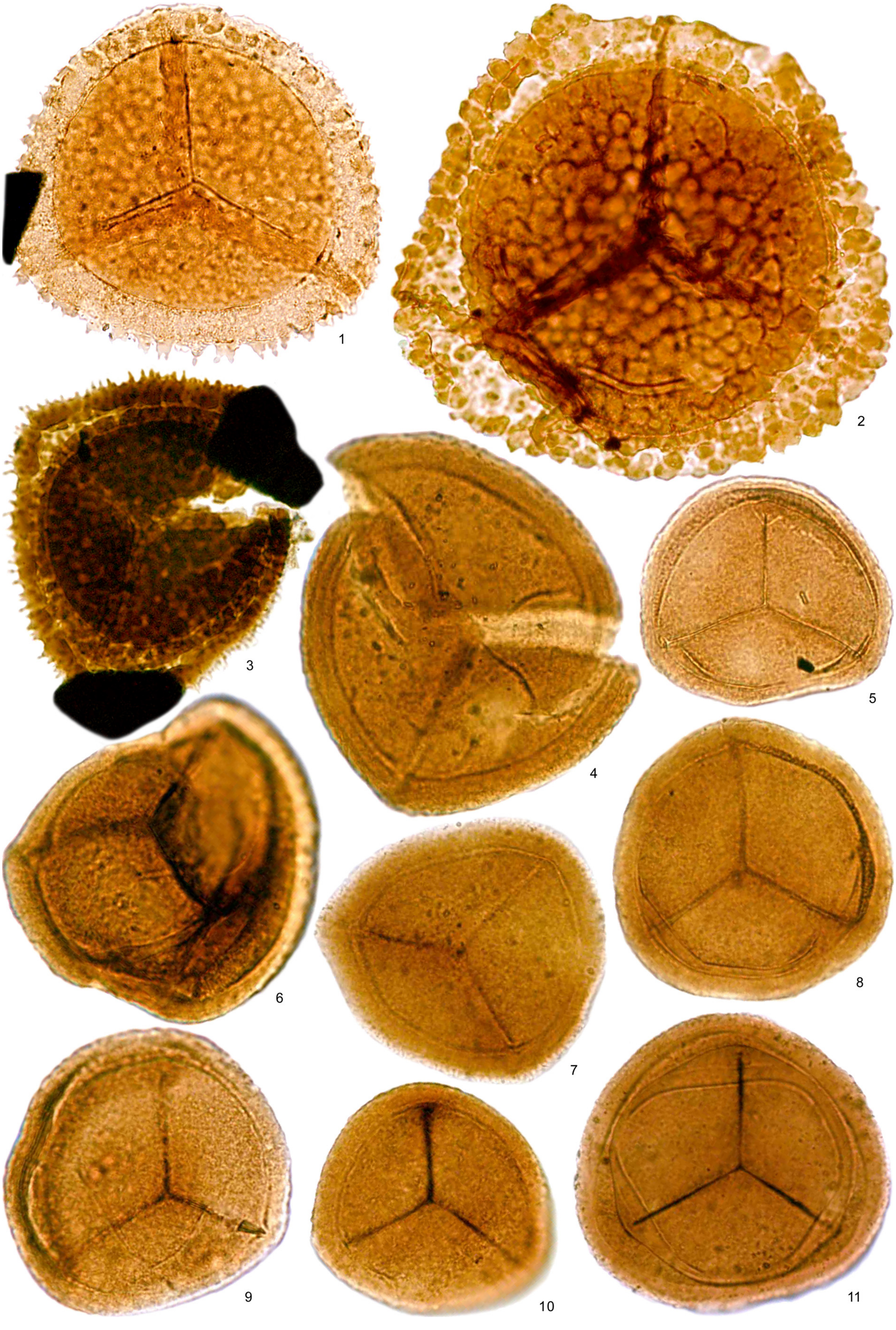

Plate 69

Plate 70.

1-9. *Geminospora svalbardiae* (Vigran) Allen, 1965.

1. JNDL-1, 172.7', L37/1.
2. JNDL-1, 167.8', H33.
3. A1-69, 1867', 26970, J39/1.
4. JNDL-1, 155.6', S40/1.
5. JNDL-1, 156.0', 60839, R26/4.
6. A1-69, 1833', 26965, S39/3.
7. JNDL-1, 172.7', W31/4.
8. A1-69, 1490', 26979, E40/4.
9. A1-69, 1867', 26969, F38/4.

Plate 70

Plate 71.

1-7. *Geminospora* sp. 1.

1. JNDL-1, 167.8’, M37/3.
2. JNDL-1, 177.0’, X41-42.
3. JNDL-1, 495.0’, 60855, K48.
4. JNDL-1, 495.0’, K37/1.
5. JNDL-1, 177.0’, 60849, D42/2.
6. JNDL-1, 177.0’, 60850, G47/2.
7. JNDL-1, 177.0’, 60849, V29/2.

Plate 71

Plate 72.

1, 2. *Geminospora* sp. 2.

1. A1-69, 1322’, 27126, R41/1.
2. A1-69, 1174’, 62673, Q30/1.

3-8. *Grandispora cassidea* (Owens) Massa & Moreau-Benoit, 1976. Magnification x500.

3. MG-1, 2536 m, 62740, L40.
4. MG-1, 2639 m, 62778, T42.
5. MG-1, 2465 m, 62852, R43/2.
6. MG-1, 2518 m, 62805, N27/4.
7. MG-1, 2161.8 m, 62529, J49/1.
8. MG-1, 2161.8 m, 62528, X52/2.

9. *Grandispora douglastownense* McGregor, 1973. Magnification x500. A1-69, 1962’, 27277, U54/3.

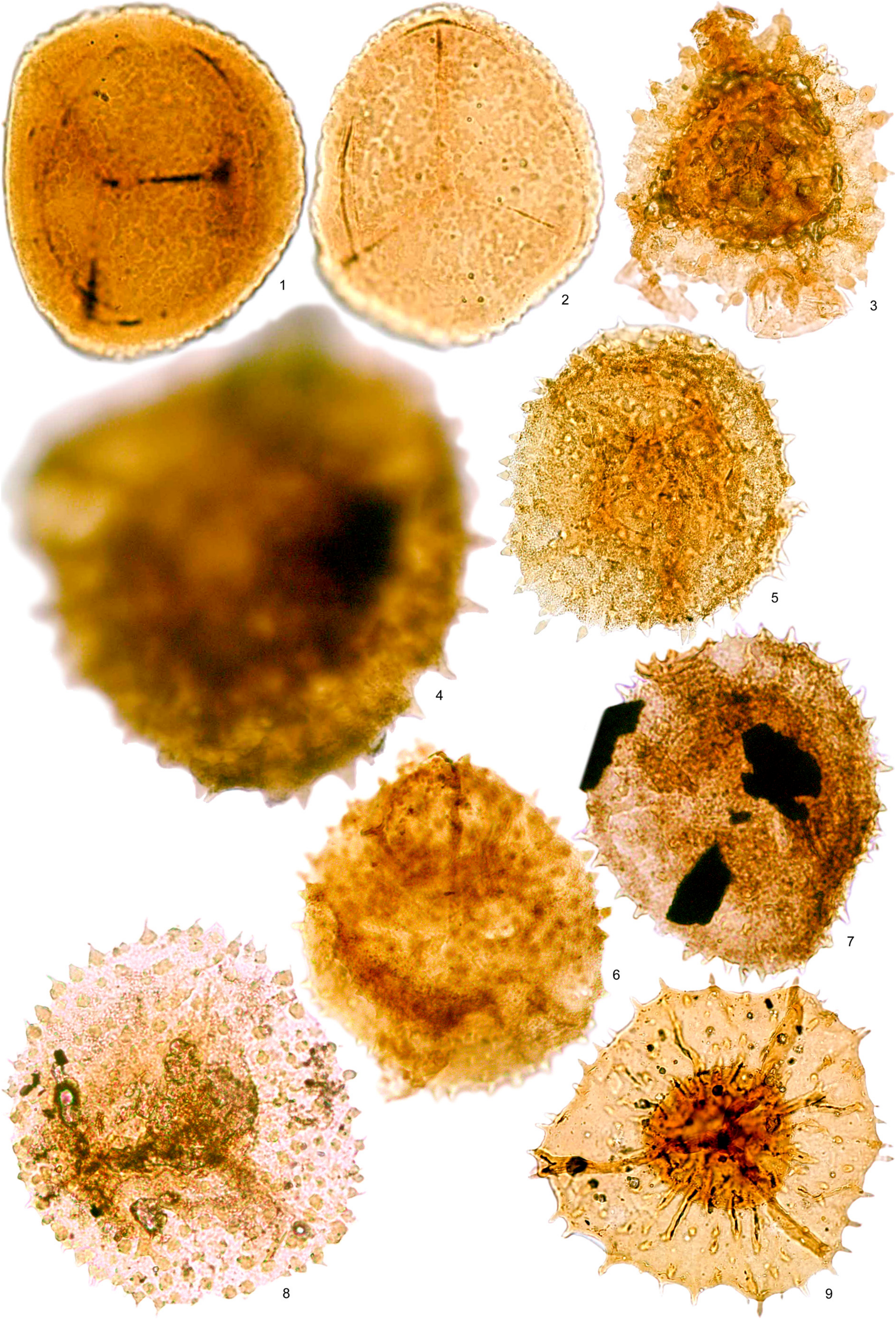

Plate 72

Plate 73.

1-9. *Grandispora douglastownense* McGregor, 1973. Magnification x500.

1. A1-69, 1962’, 27278, P44/3.
2. JNDL-1, 167.8’, N37.
3. JNDL-1, 174.6’, T32.
4. A1-69, 1540’, 26988, O47/3.
5. JNDL-1, 156.0’, P36/3.
6. JNDL-1, 162.3’, 60841, K44.
7. JNDL-1, 177.0’, 60850, P45/4.
8. A1-69, 1962’, 27277, O36-37.
9. ABSF-29, 16327.6’, E49.

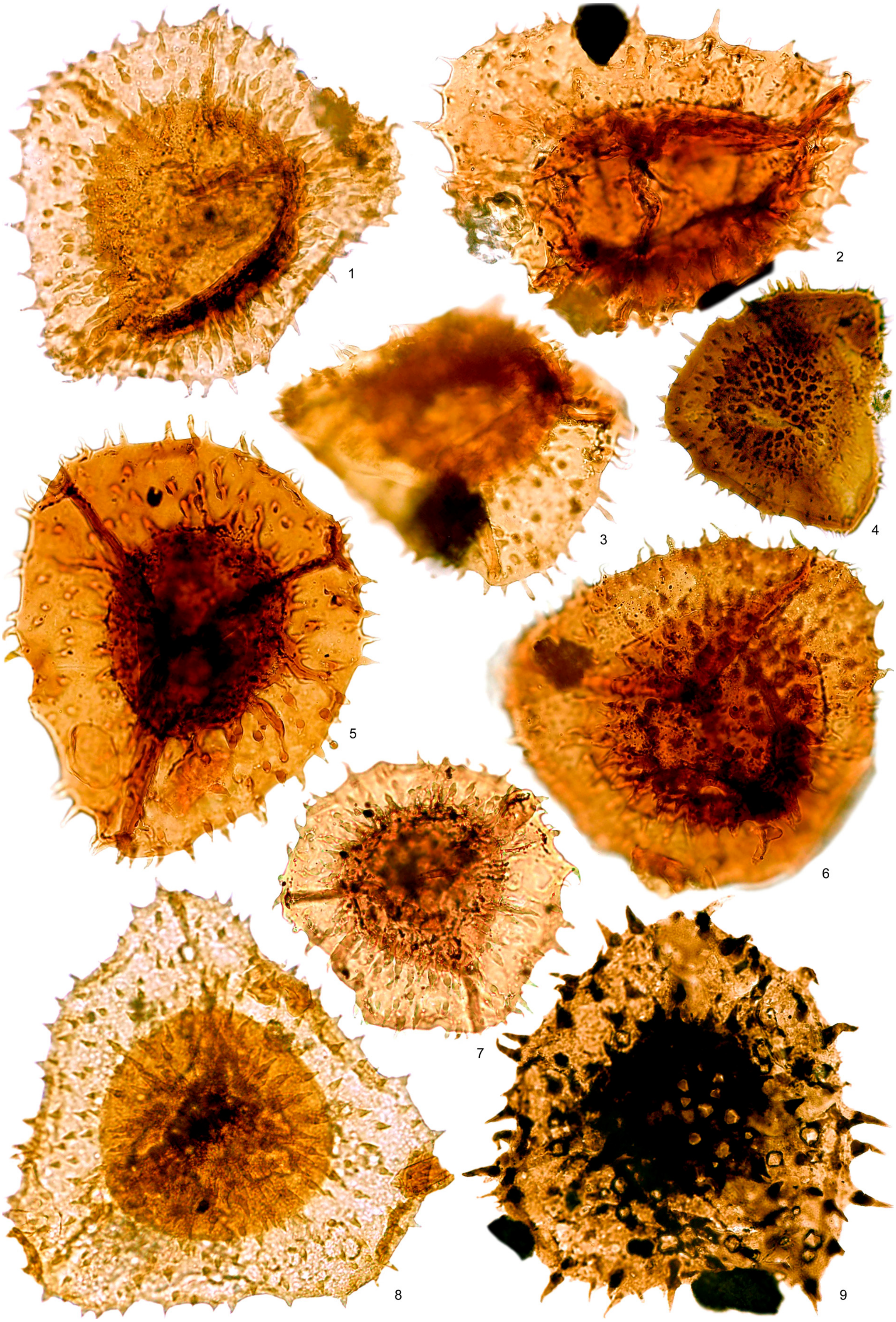

Plate 73

Plate 74.

1-8. *Grandispora fibrilabrata* Balme, 1988. Magnification x750.

1. S-462, 1810-1815', 63257, S-T31.
2. A1-69, 1277', 62637, L52/4.
3. S-462, 1570-1575', 63215, N45.
4. S-462, 2010-2015', 63266, S34.
5. S-462, 1960-1965', 63264, E39.
6. S-462, 1860-1865', 63259, P32/4.
7. S-462, 1810-1815', 63257, R48.
8. S-462, 1860-1865', 63258, P27/1.

Plate 74

Plate 75.

1-3. *Grandispora gabesensis* Loboziak & Streel, 1989. Magnification x750.

1. A1-69, 1962', 27278, H51.
2. A1-69, 1530', 26985, M48/4.
3. A1-69, 1596', 26990, P39/4.

5-9. *Grandispora incognita* (Kedo) McGregor & Camfield, 1976. Magnification x500.

4. A1-69, 1416', 26992, Q38/4.
5. A1-69, 1540', 26988, N40/3.
6. YBRN-1, 16684.3', 62427, D43.
7. A1-69, 1530', 26984, S39.
8. A1-69, 1277', 62636, K39.

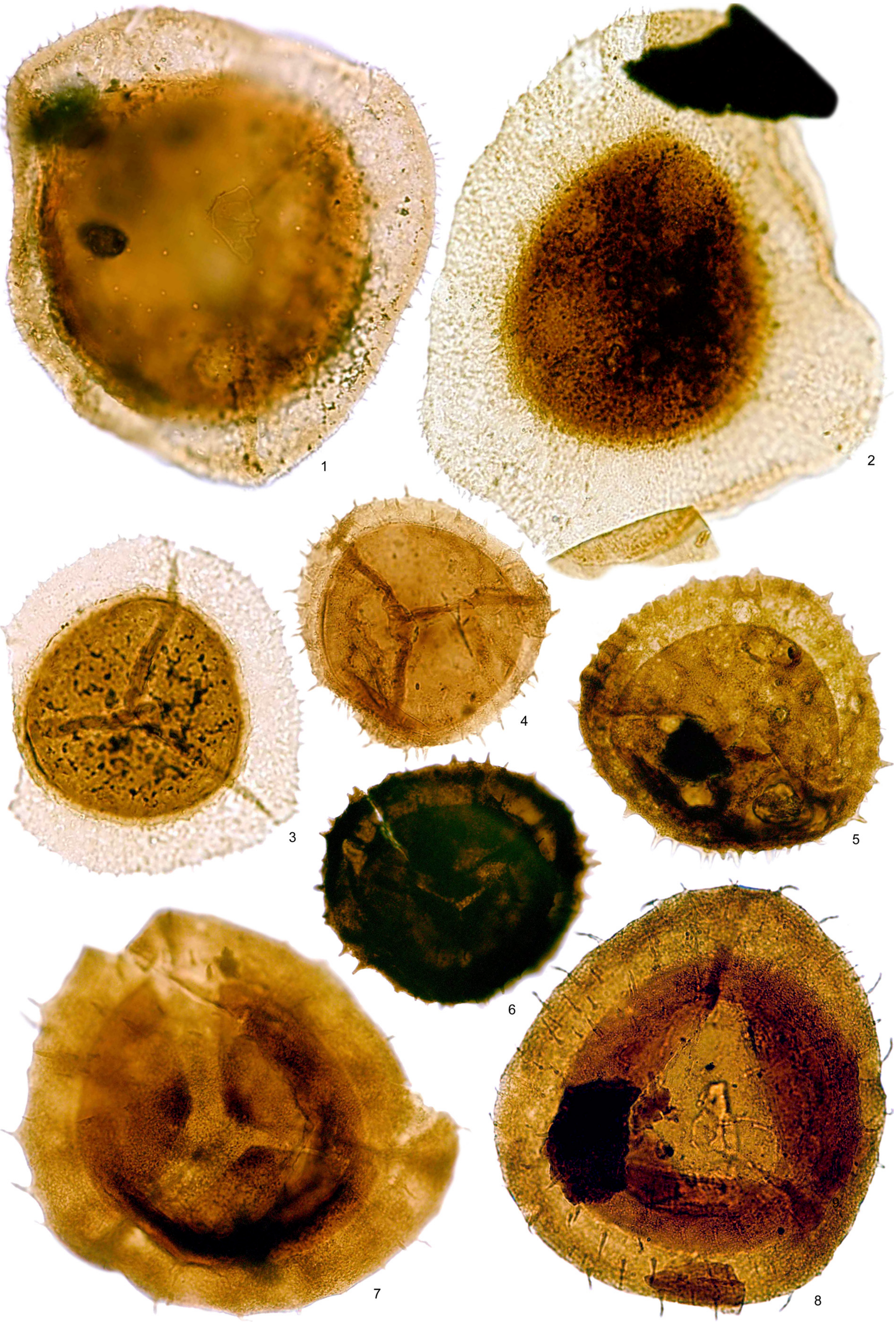

Plate 75

Plate 76.

1-3. *Grandispora incognita* (Kedo) McGregor & Camfield, 1976. Magnification x500.

1. A1-69, 1277’, 62636, O41/4.
2. A1-69, 1540’, 26987, H37/1.
3. A1-69, 1540’, 26988, Q37/2.

4, 5. *Grandispora inculta* Allen, 1965.

4. YBRN-1, 16642.3’, 62406, H44/1.
5. S-462, 2060-2065’, 63270. N30/3.

6, 7. *Grandispora libyensis* Moreau-Benoit, 1980b. Magnification x500.

6. A1-69, 1322’, 27126, H36.
7. A1-69, 1277’, 62635, Y31/2.

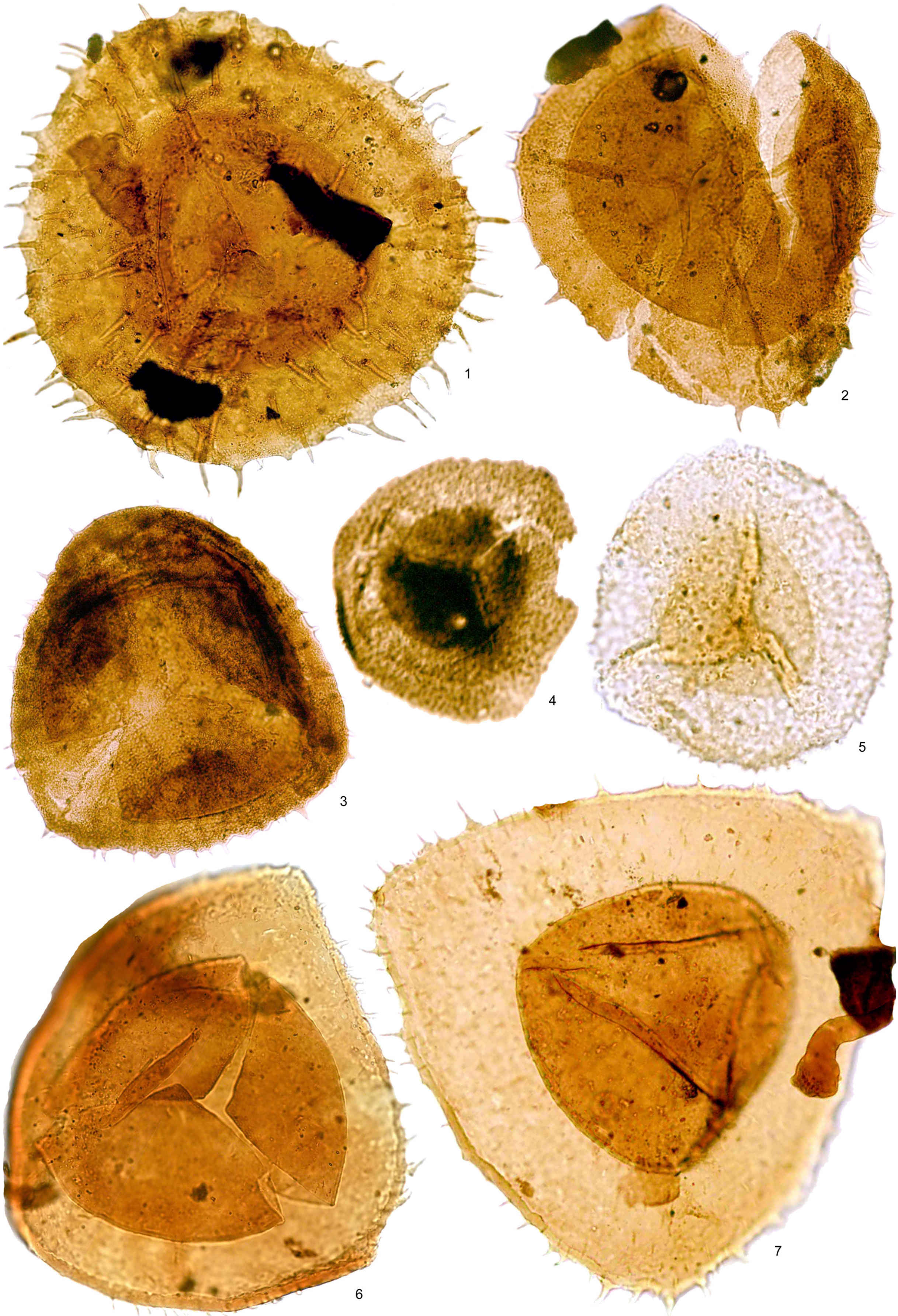

Plate 76

Plate 77.

1-6. *Grandispora libyensis* Moreau-Benoit, 1980b. Magnification x500.

1. A1-69, 1416', 26993, G31/3.
2. A1-69, 1416', 26993, K31/3.
3. A1-69, 1277', 62637, G37/1.
4. A1-69, 1296', 62645, F36.
5. A1-69, 1296', 62645, R43.
6. A1-69, 1296', 62644, T35/1.

Plate 77

Plate 78.

1-10. *Grandispora ?naumovii* (Kedo) McGregor, 1973. Magnification x500.

1. A1-69, 1530', 26984, J34/2.
2. A1-69, 1334', 27127, O47.
3. S-462, 1660-1665', 63219, L38/4.
4. S-462, 1710-1715', 63222, V40.
5. S-462, 1760-1765', 63254, J30.
6. A1-69, 1530', 26984, U47.
7. S-462, 1710-1715', 63222, G44/3.
8. S-462, 1470-1475', 63213, J41/3.
9. A1-69, 1530', 26984, E38-39.
10. S-462, 1710-1715', 63224, F49-50.

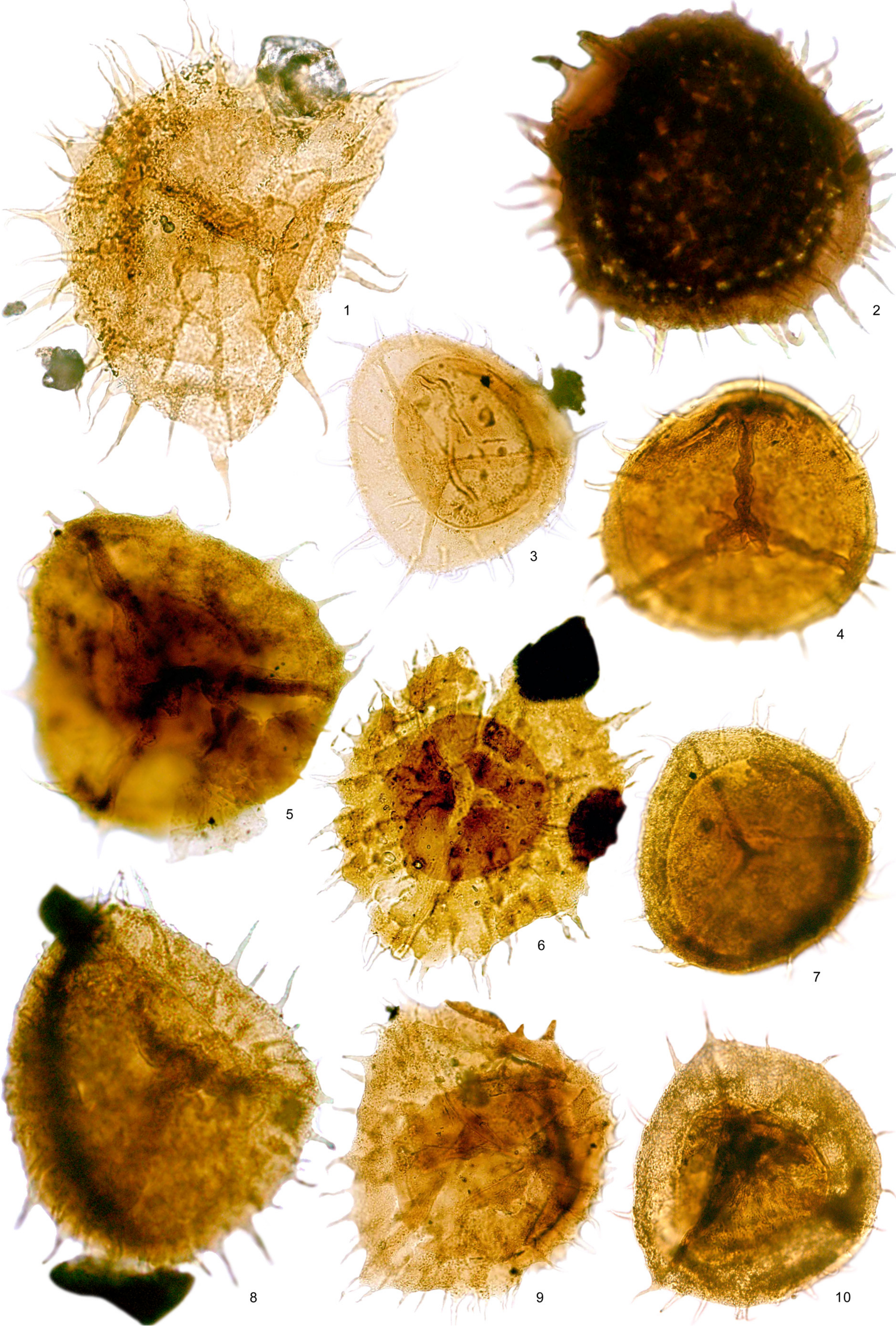

Plate 78

Plate 79.

1-7. *Grandispora permulta* (Daemon) Loboziak et al., 1999. Magnification x750.

1. A1-69, 1322', 27126, H53.
2. A1-69, 1483', 26995, W43/3.
3. ABSF-29, 16358.5', 61972, W31.
4. A1-69, 1277', 62637, U47/1.
5. A1-69, 1277', 62637, V49/1.
6. A1-69, 1296', 62643, G34/1.
7. A1-69, 1322', 27125, H39/4.

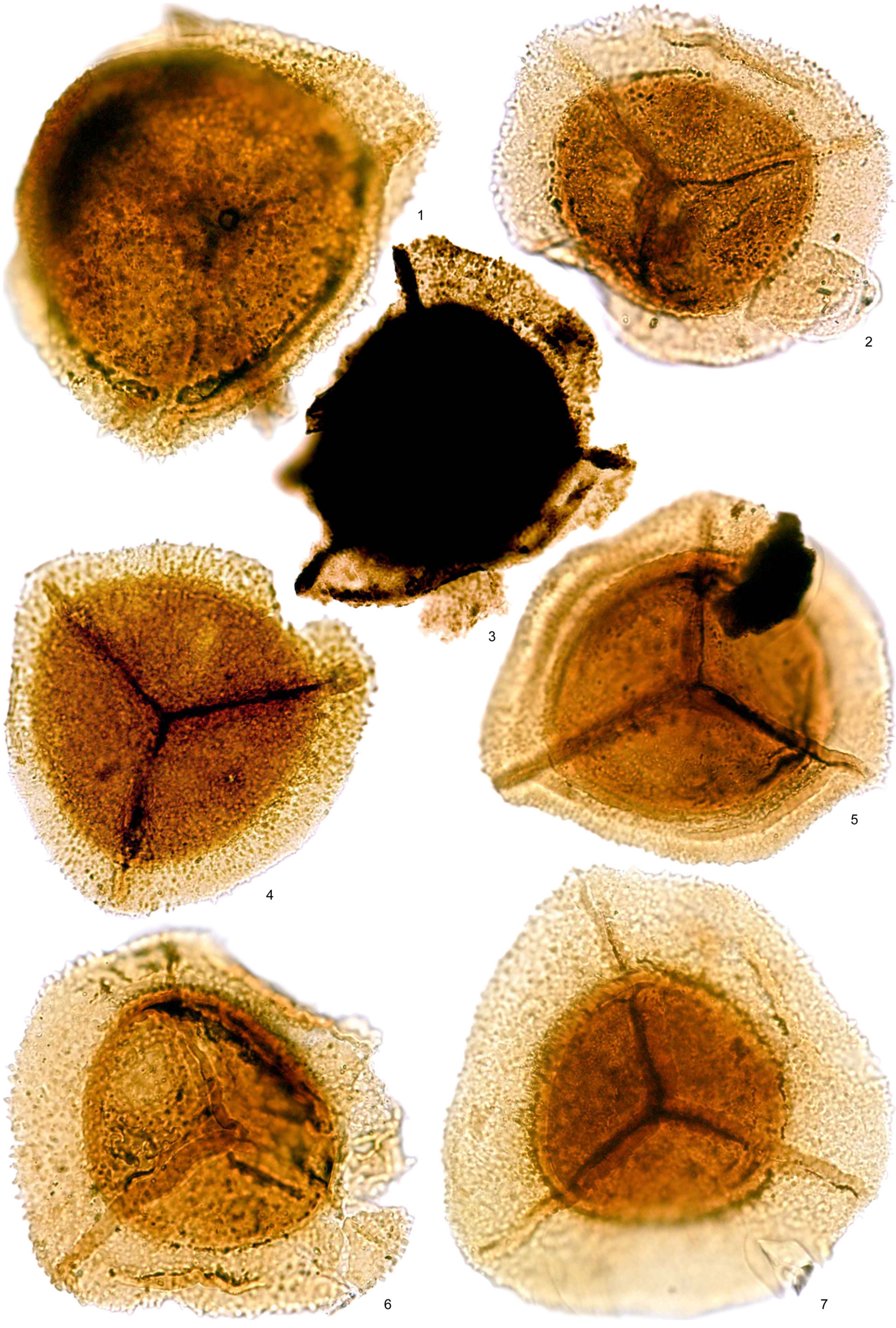

Plate 79

Plate 80

1-11. *Grandispora protea* (Naumova) Moreau-Benoit, 1980b. Magnification x500.

1. JNDL-1, 156.0’, H44/4.
2. A1-69, 1962’, 27278, V56/2.
3. A1-69, 1962’, 27278, T36/3.
4. JNDL-1, 155.6’, D32.
5. JNDL-1, 156.0’, 60840, Q32.
6. JNDL-1, 495.0’, 60854, P51.
7. A1-69, 1962’, 27278, M49/1.
8. A1-69, 1962’, 27278, T44/4.
9. MG-1, 2543 m, 62814, U42.
10. JNDL-1, 174.6’, 60848, P34.
11. JNDL-1, 174.6’, Q39/4.

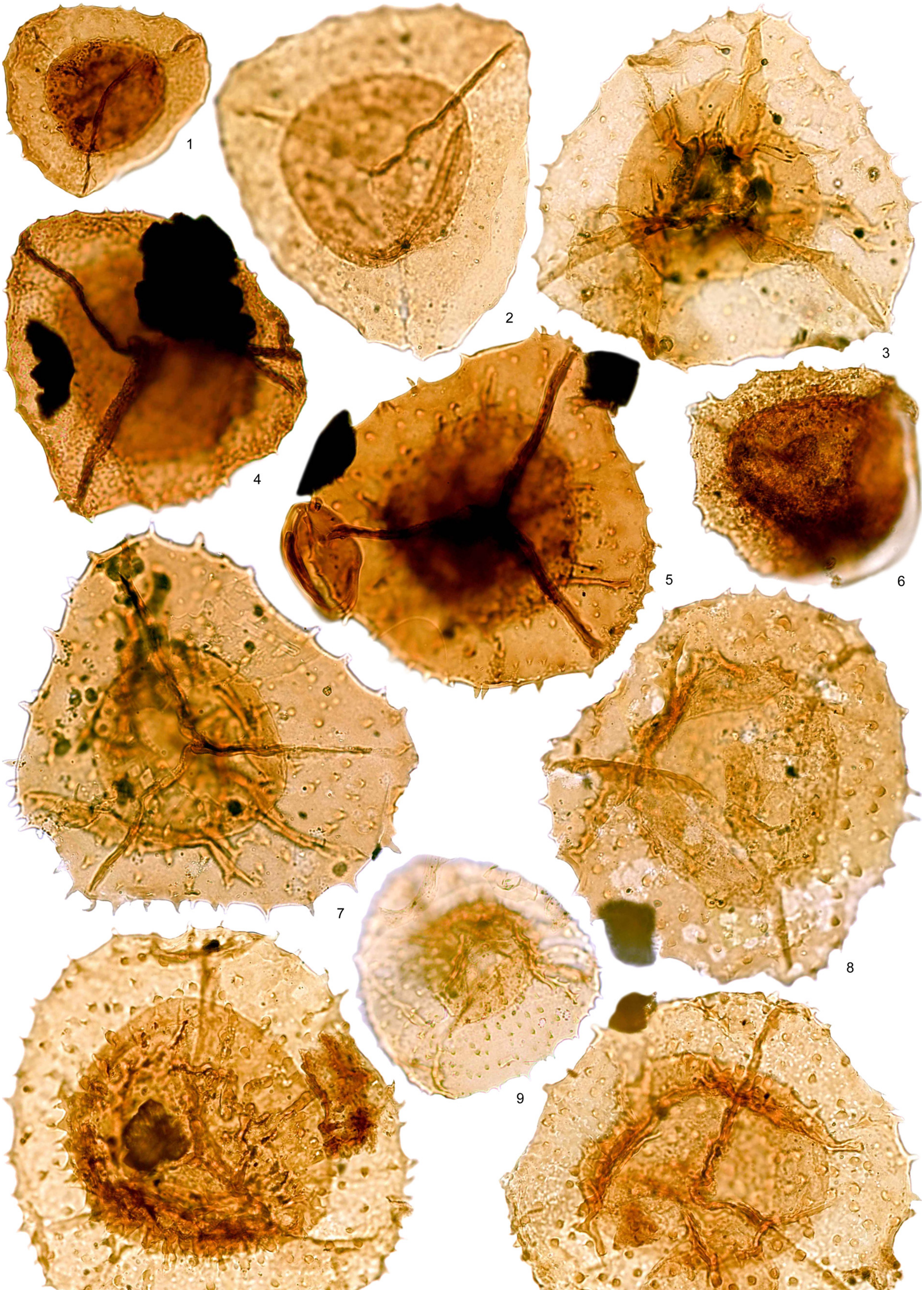

Plate 80

Plate 81.

1-6. *Grandispora rarispinosa* Moreau-Benoit, 1980b. Magnification x500.

1. S-462, 1710-1715’, 63222, X40.
2. MG-1, 2285 m, 62845, L26/3.
3. MG-1, 2161.8 m, 62529, E50/4.
4. MG-1, 2182.4 m, 62527, Q32.
5. MG-1, 2160.6 m, 62746, Q27/4.
6. MG-1, 2413 m, 62776, R35/2.

7-10. *Grandispora stolidotus* (Balme) comb. nov. Magnification x500.

7. S-462, 1960-1965’, 63264, L40/4.
8. MG-1, 2476 m, 63015, F44.
9. MG-1, 2476 m, 63015, P38.
10. A1-69, 1322’, 27126, R42.
11. MG-1, 2375 m, 62772, O25.
12. ABSF-29, 16359.5’, 61968, K42/4.
13. A1-69, 1322’, 27126, Q39/3.

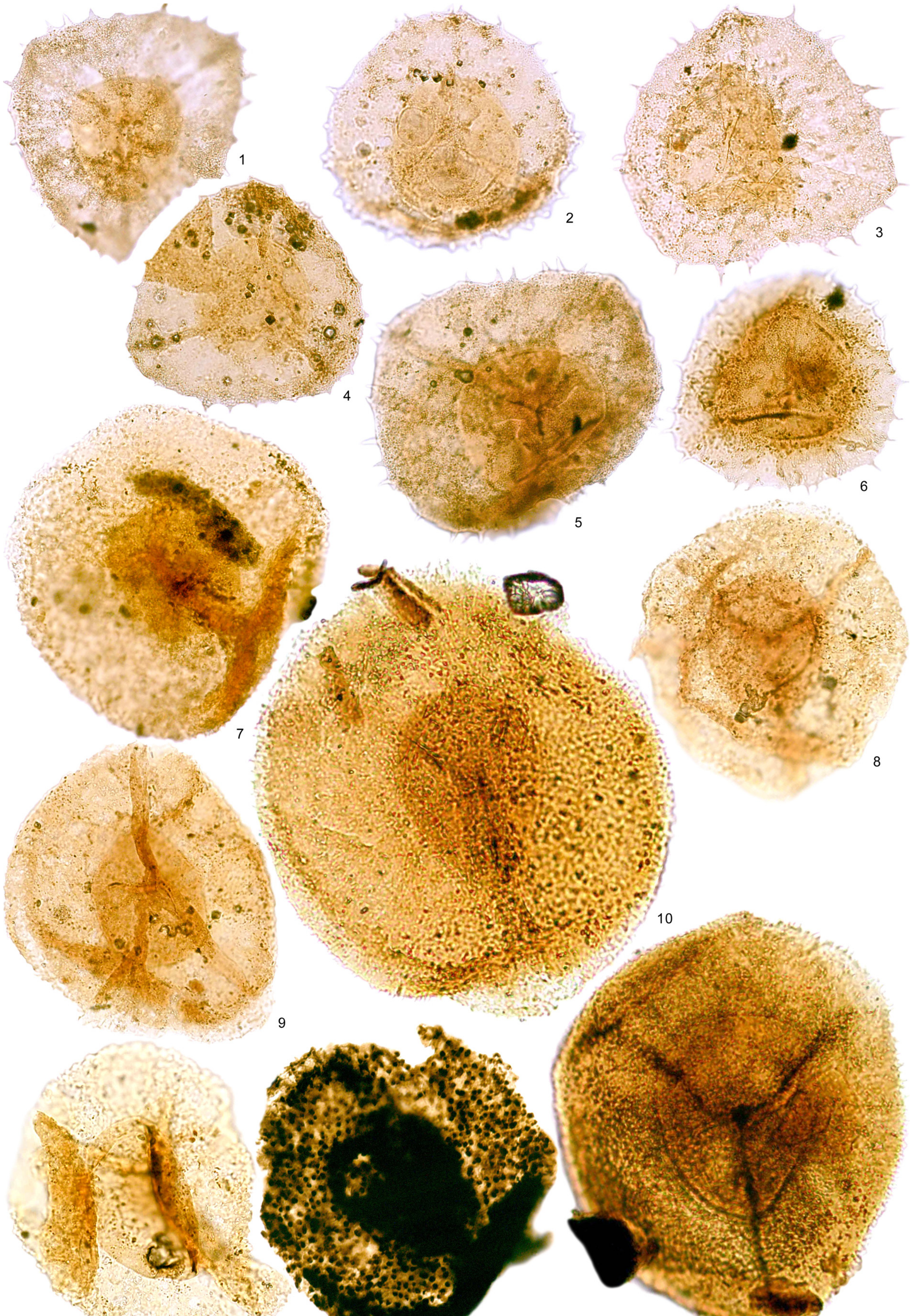

Plate 81

Plate 82.

1-3. *Grandispora stolidotus* (Balme) comb. nov. Magnification x500.
1. MG-1, 2465 m, 62852, L52/3.
2. MG-1, 2483 m, 62802, Q37.
3. MG-1, 2483 m, 62802, R42.

4-9. *Grandispora velata* (Richardson) McGregor, 1973. Magnification x500.
4. A1-69, 1867', 26969, R53/4.
5. A1-69, 1962', 27277, F32/4.
6. A1-69, 1416', 26992, U47/2.
7. A1-69, 1530', 26984, H40/1.
8. JNDL-1, 177.0', 60849, F32/1.
9. A1-69, 1540', 26987, F41.

10-11. *Grandispora* spp. Magnification x500.
10. MG-1, 2178 m, 62995, F42/3.
11. A1-69, 1596', 26990, M56.

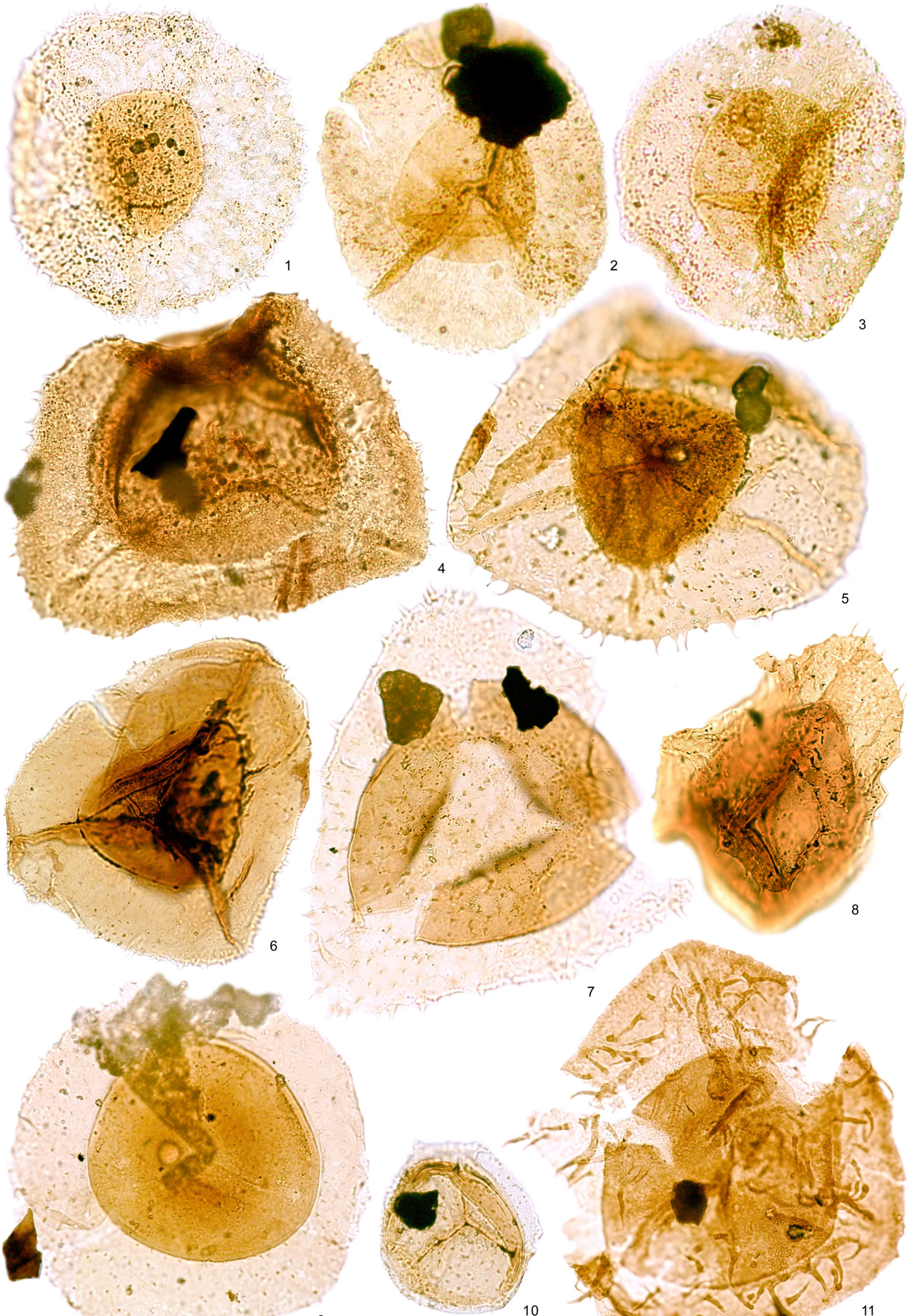

Plate 82

Plate 83.

1-6. *Grandispora* sp. 1.

1. MG-1, 2247 m, 62942, K37/3.
2. MG-1, 2222.7 m, 62678, W37/1.
3. MG-1, 2241 m, 62966, S39/1.
4. MG-1, 2465 m, 62852, H35.
5. MG-1, 2181.2 m, 62525, N34/4.
6. MG-1, 2292 m, 63025, Q51/4.

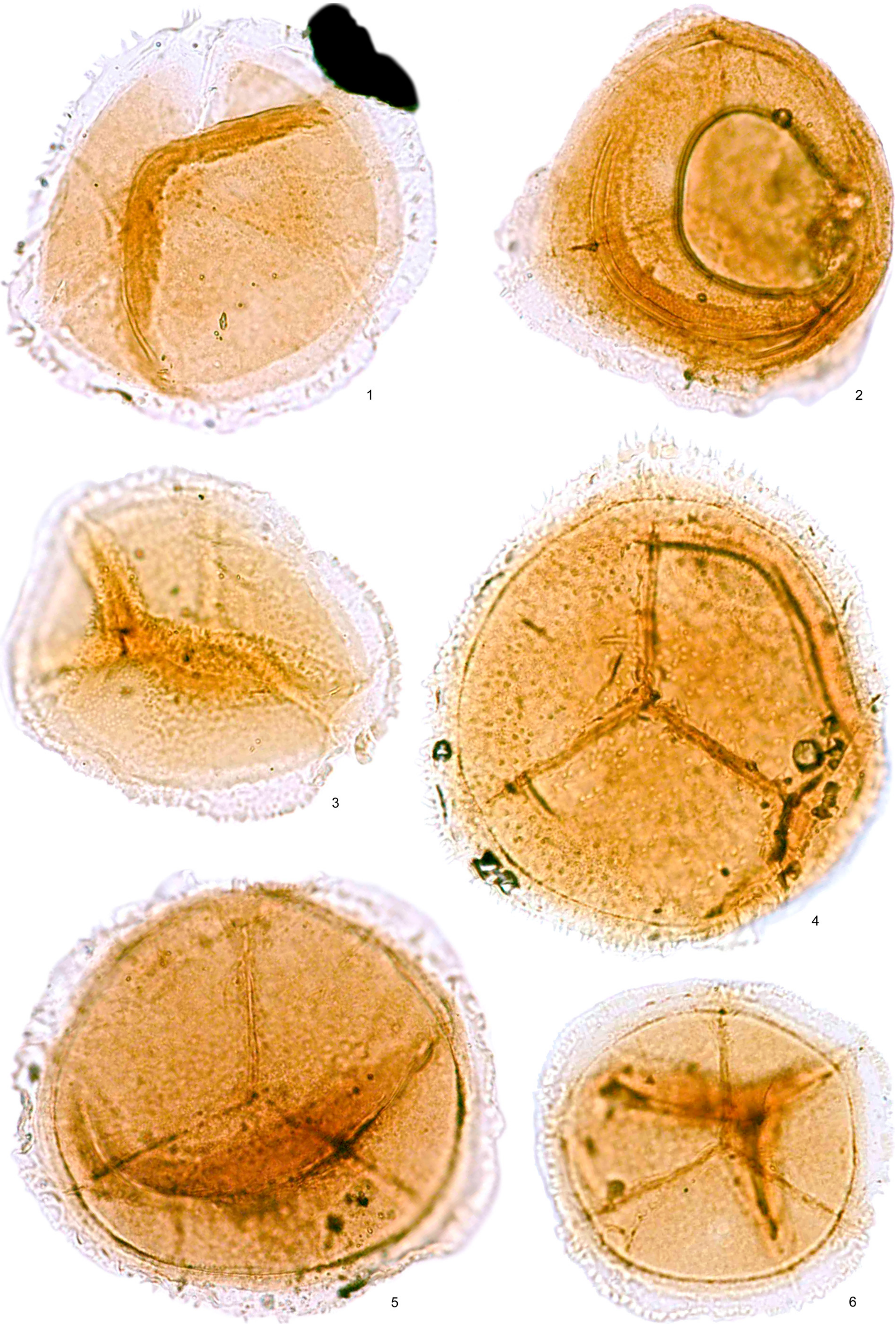

Plate 83

Plate 84.

1-6. *Granulatisporites* sp. 1.
1. A1-69, 2039/2041', 27279, N-N43.
2. JNDL-1, 495.0', 60855, L36/3.
3. JNDL-1, 162.3', C29/4.
4. A1-69, 2108/2111', 26913, L44/4.
5. JNDL-1, 156.0', 60840, N27-28.
6. A1-69, 1483', 26995, R33/3.

7-9. *Hystricosporites* sp. 1. Magnification x750.
7. MG-1, 2160.6 m, 62746, N49.
8. MG-1, 2161.8 m, 62528, Q44.
9. MG-1, 2160.6 m, 62727, E49.

10-12. *Hystricosporites* sp. 2. Magnification x750.
10. MG-1, 2295 m, 63006, L52/3.
11. MG-1, 2375 m, 62772, H34/1.
12. MG-1, 2295 m, 63007, P37.

Plate 84

Plate 85.

1-3. *Iberoespora cantabrica* Cramer & Díez, 1975.
1. MG-1, 2631.2 m, 62252, W41-1. Focus on proximal face.
2. MG-1, 2631.2 m, 62252, W41-1. Focus on distal face.
3. MG-1, 2631.2 m, 62252, V50.

4, 5. *Iberoespora glabella* Cramer & Díez, 1975.
4. BAQA-2, 133.0’, W52.
5. BAQA-1, 376.4’, U31/1.

6-11. *Iberoespora* cf. *I. guzmani* Cramer & Díez, 1975.
6. UTMN-1830, 13614.1’, 62373, J54-55.
7. UTMN-1830, 13689.7’, 62319, O47/3.
8. KHRM-2, 16224.7’, 62090, O39.
9. KHRM-2, 16224.7’, 62091, R48/4.
10. UTMN-1830, 13614.1’, 62372, K25.
11. KHRM-2, 16224.7’, 62090, S43.

12-15. *Jhariatriletes emsiensis* (Moreau-Benoit) comb. nov. Magnification x500.
12. A1-69, 1962, 27277, G55/4.
13. A1-69, 1962, 27277, T45/4.
14. A1-69, 1962, 27278, J42.
15. A1-69, 1962, 27277, Q40.

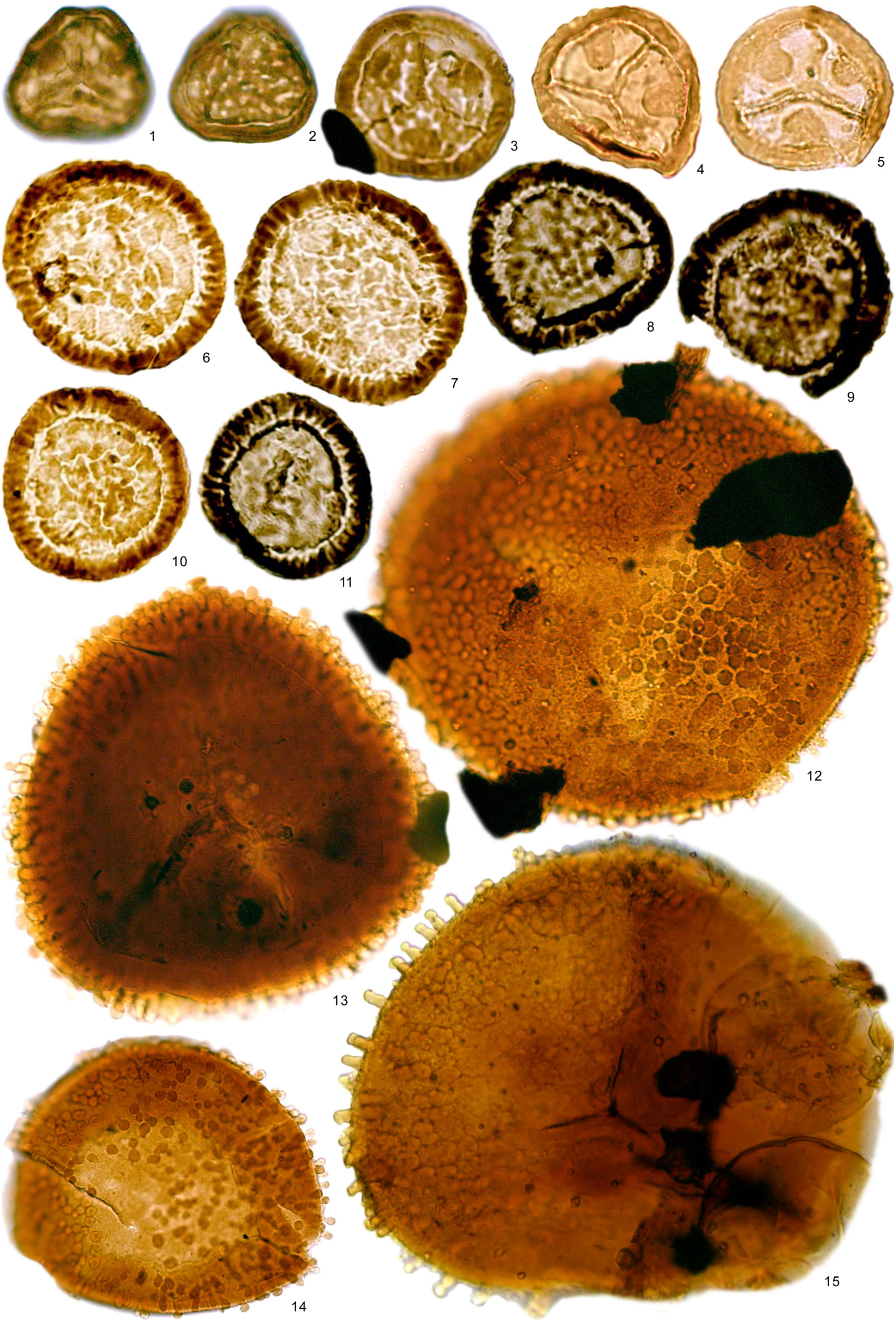

Plate 85

Plate 86.

1, 2. *Jhariatriletes emsiensis* (Moreau-Benoit) comb. nov. Magnification x500.

1. A1-69, 1962', 27277, R42.
2. A1-69, 1962', 27278, V54/2.

3-12. ?*Knoxisporites riondae* Cramer & Díez, 1975.

3. BAQA-1, 366.9', M32/2.
4. BAQA-1, 366.9', K27/1.
5. BAQA-1, 366.9', N35-36.
6. BAQA-1, 366.9', S42-43.
7. BAQA-1, 376.4', N46.
8. BAQA-1, 366.9', E27/4.
9. BAQA-1, 366.9', F32/1.
10. BAQA-1, 285.5', R48/3.
11. MG-1, 2631.2 m, 62553, D43/2.
12. BAQA-2, 133.0', Q51/1.

13-16. *Leiozosterospora* cf. *L. andersonii* Wellman, 2006.

13. BAQA-2, 64.5', T22/2.
14. NFLA-1, 16647.7', 63208, T35.
15. BAQA-2, 64.5', H41/1.
16. BAQA-2, 64.5', N49.

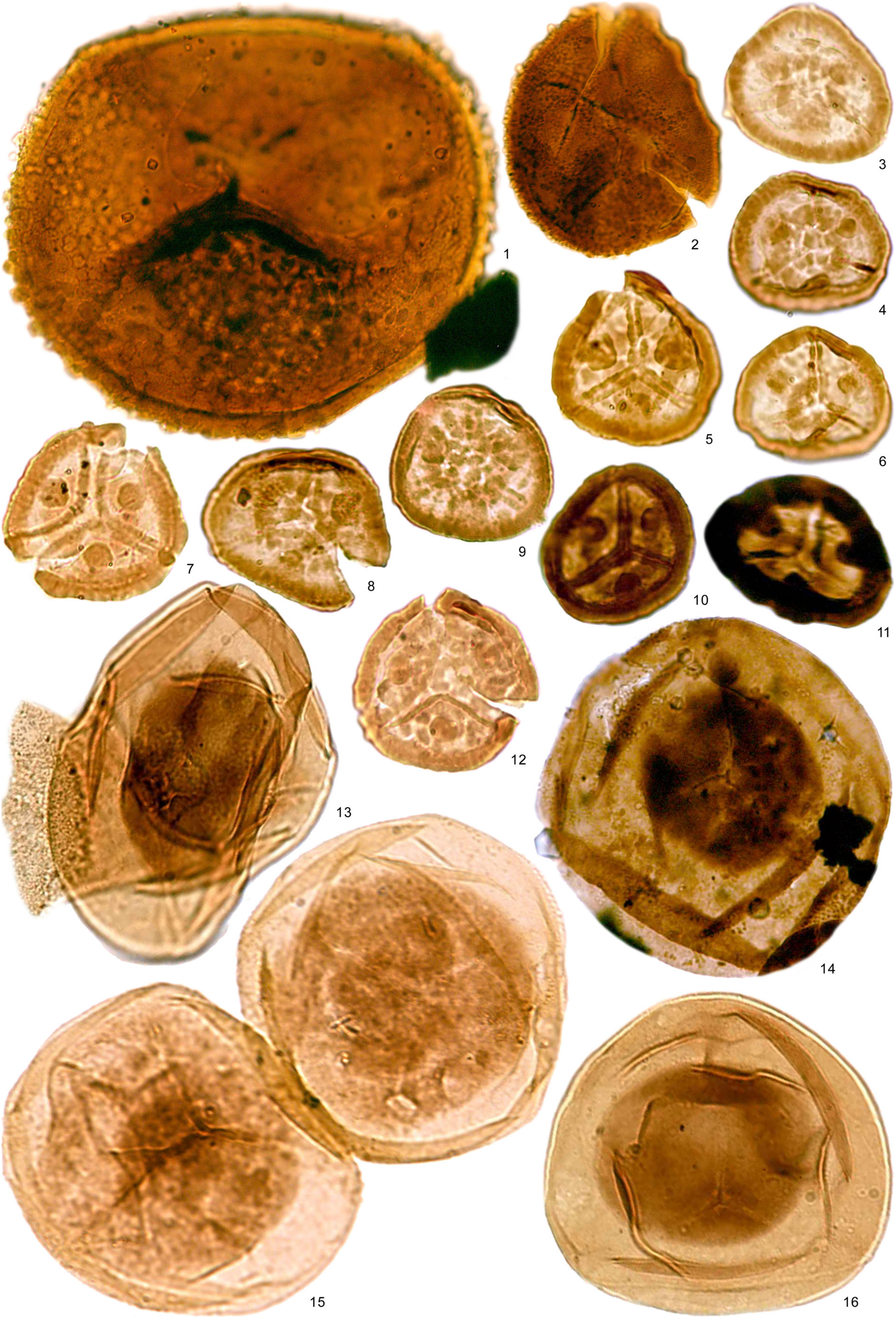

Plate 86

Plate 87.

1-3. *Lophotriletes devonicus* (Naumova ex Tchibrokova) McGregor & Camfield, 1982.

1. A1-69, 1867’, 26969, L46.
2. A1-69, 2108/2111’, 26913, G44.
3. A1-69, 1486’, 26977, R39.

4-11. *Lophozonotriletes media* Taugourdeau-Lantz, 1967.

4. A1-69, 1174’, 62672, K33.
5. MG-1, 2285 m, 62846, N33.
6. MG-1, 2252.1 m, 62540, H41/2.
7. MG-1, 2264 m, 62949, S39/1.
8. A1-69, 971’, 62640, X-Y49.
9. A1-69, 1174’, 62672, D35-36.
10. A1-69, 1074’, 62677, J49/1.
11. A1-69, 1174’, 62673, K-L32.

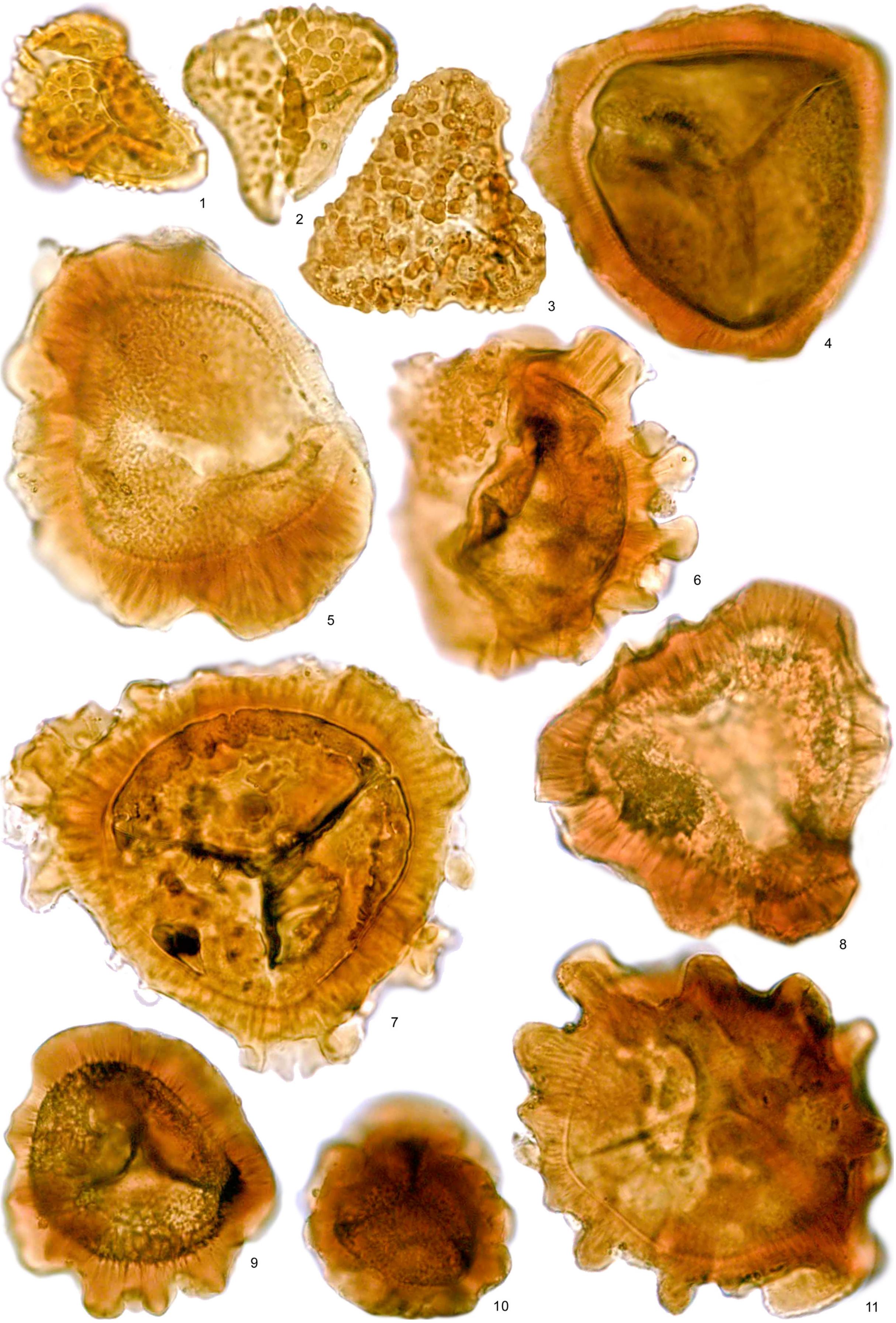

Plate 87

Plate 88.

1-4. *Lophozonotriletes media* Taugourdeau-Lantz, 1967.

1. A1-69, 1074', 62675, L49/1.
2. A1-69, 1174', 62672, L33/1.
3. A1-69, 1174', 62672, M42/1.
4. A1-69, 1174', 62673, F32.

5-13. *Lycospora culpa* Allen, 1965.

5. BAQA-1, 376.4', H48.
6. BAQA-2, 50.2', D43/2.
7. BAQA-2, 64.5', R31.
8. BAQA-2, 52.0', N27/1.
9. BAQA-2, 64.5', H41.
10. BAQA-2, 50.8', H26/3.
11. BAQA-2, 134.4', H35/4.
12. BAQA-2, 54.8', R38/3.
13. BAQA-2, 133.0', O41.

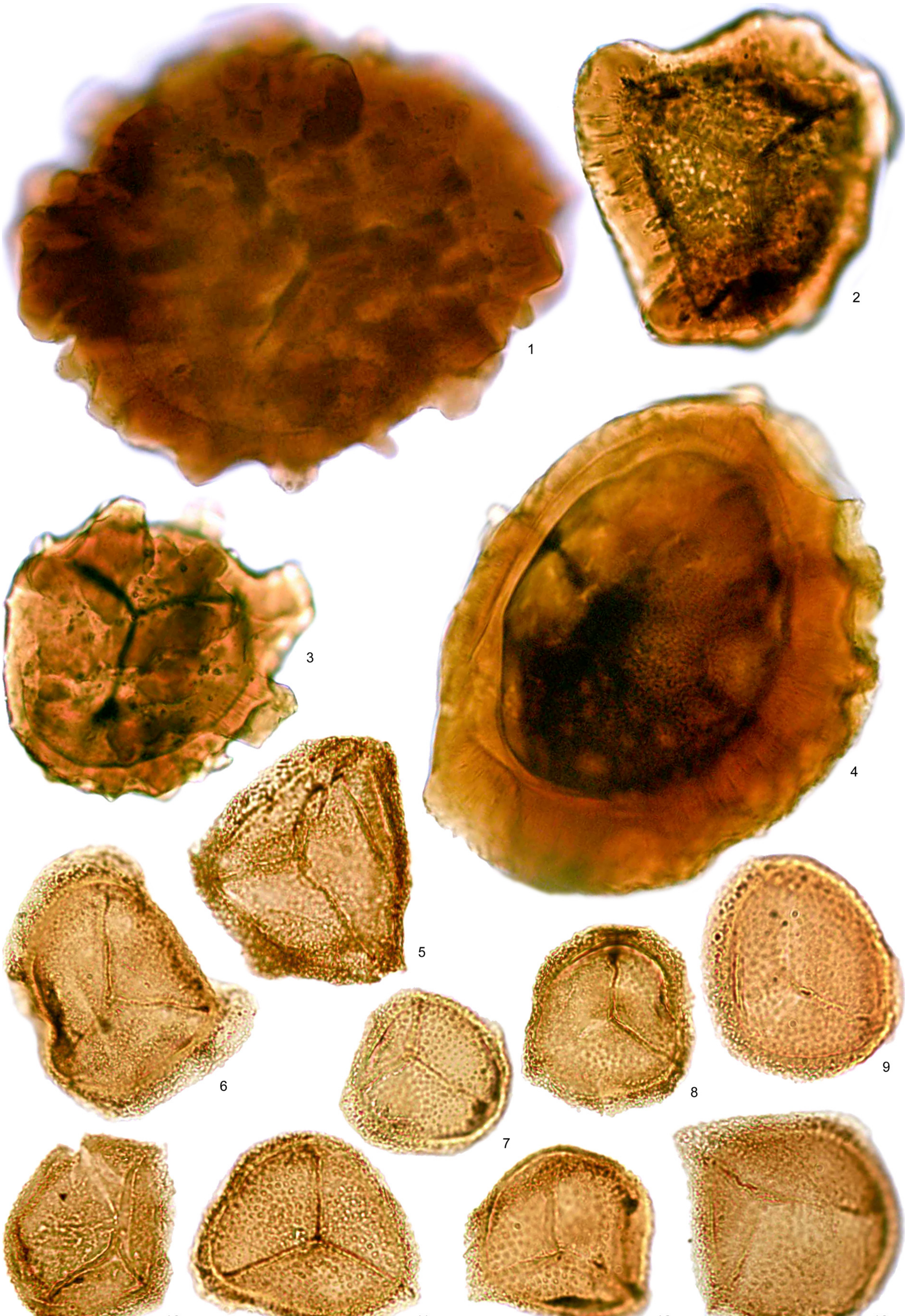

Plate 88

Plate 89.

1, 2. *Lycospora culpa* Allen, 1965.
1. MG-1, 2631.2 m, 62551, S42/2.
2. MG-1, 2631.2 m, 62552, H36/3.

3-11. *Perotrilites caperatus* (McGregor) Steemans, 1989.
3. MG-1, 2631.2 m, 62552, F48/3.
4. MG-1, 2741.4 m, 62612, N35.
5. MG-1, 2728 m, 62854, J28.
6. MG-1, 2693 m, 62961, F50/4.
7. MG-1, 2741.4 m, 62612, M29/1.
8. MG-1, 2557.5 m, 62599, F45.
9. MG-1, 2741.4 m, 62611, U40/3.
10. MG-1, 2741.4 m, 62605, K41-42.
11. MG-1, 2741.4 m, 62612, N29/3.

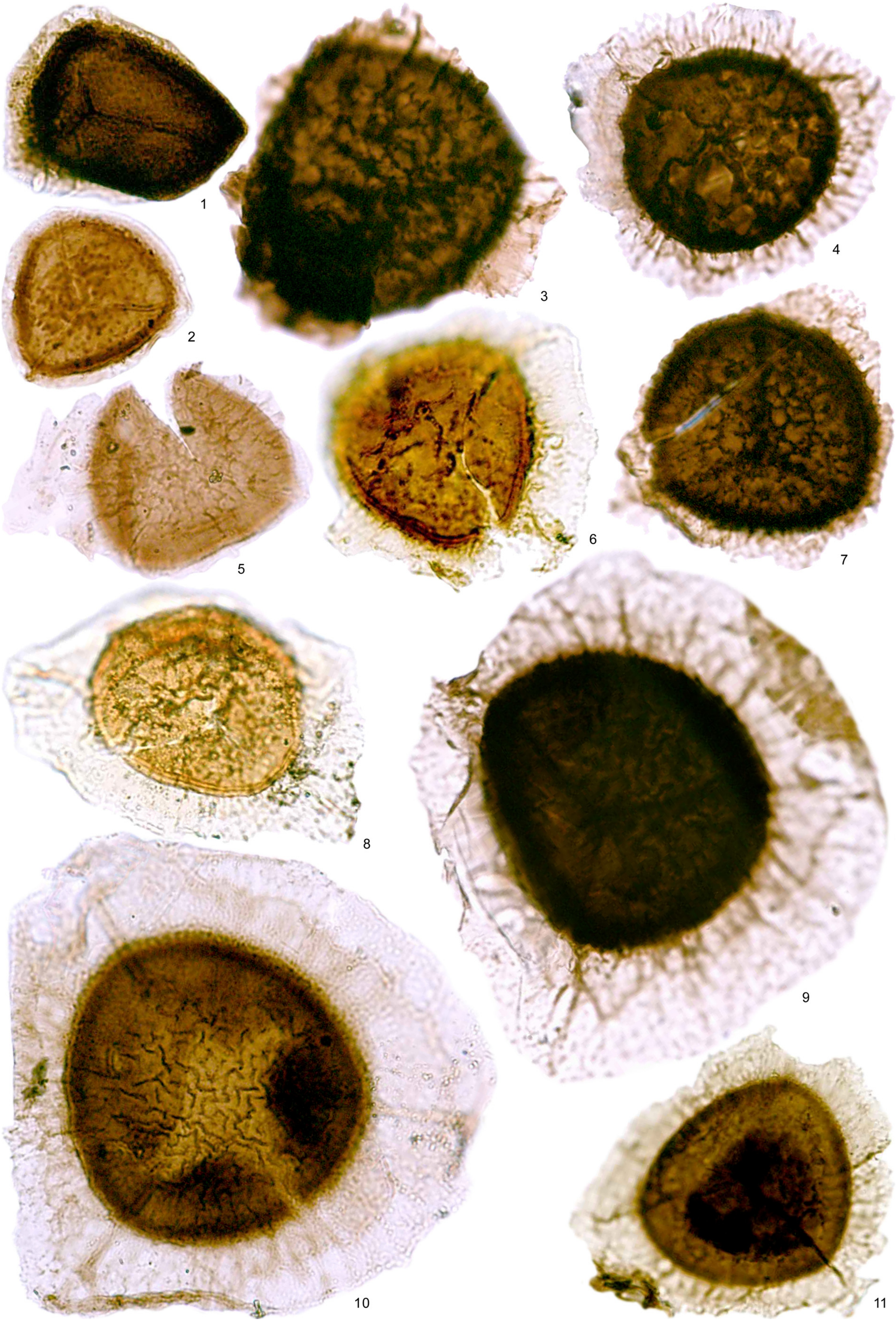

Plate 89

Plate 90.

1-8. *Raistrickia* sp. 1.

1. MG-1, 2258 m, 62948, T49.
2. MG-1, 2258 m, 62948, E42.
3. MG-1, 2160.6 m, 62746, G34.
4. MG-1, 2160.6 m, 62746, L26/2.
5. A1-69, 1334', 27127, L57/3.
6. MG-1, 2194 m, 63013, G29/4.
7. MG-1, 2247 m, 62942, J30.
8. MG-1, 2180 m, 62971, E44/1.

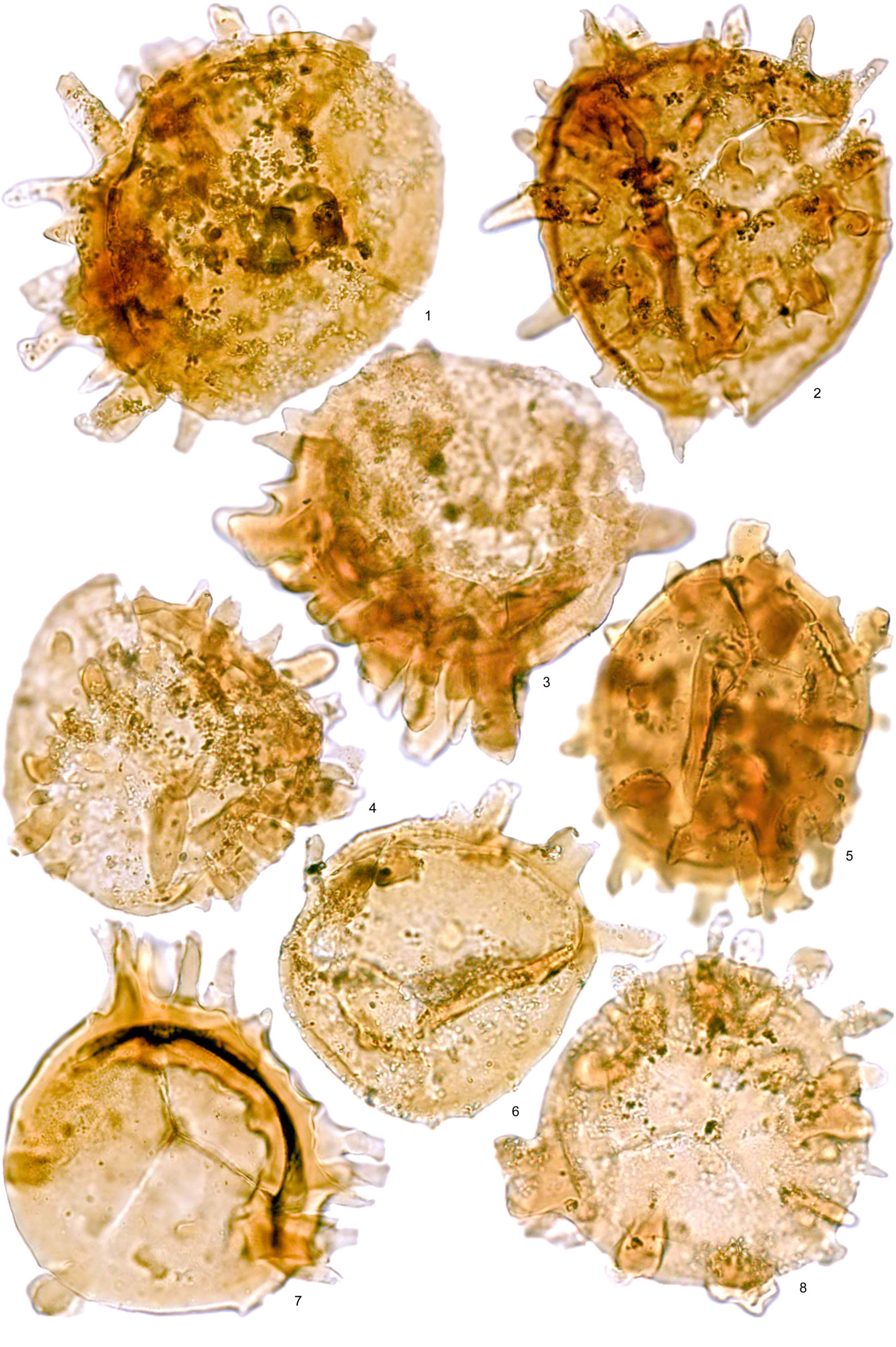

Plate 90

Plate 91.

1-12. *Raistrickia* sp. 2.

1. BAQA-1, 390.6’, N38.
2. BAQA-1, 222.5’, M31.
3. BAQA-1, 285.5’, N30/3.
4. BAQA-1, 371.1’, H47.
5. BAQA-1, 227.1’, P41.
6. BAQA-2, 54.8’, C33.
7. BAQA-1, 285.5’, W25/2.
8. KHRM-2, 16269.0’, 62114, L41/3.
9. BAQA-1, 371.1’, N26/3.
10. BAQA-1, 366.9’, T35/2.
11. BAQA-2, 134.4’, J41/4.
12. BAQA-1, 285.5’, H31/4.

13-18. *Retusotriletes* cf. *R. crassus* Clayton et al., 1980.

13. KHRM-2, 16273.0’, 62122, O34-35.
14. KHRM-2, 16316.6’, 62157, T48.
15. JNDL-1, 153.8’, 60834, O38/2.
16. UTMN-1830, 13614.1’, 62374, V31/4.
17. UTMN-1830, 13614.6’, 62739, O-P44.
18. YBRN-1, 16642.3’, 62406, G51.

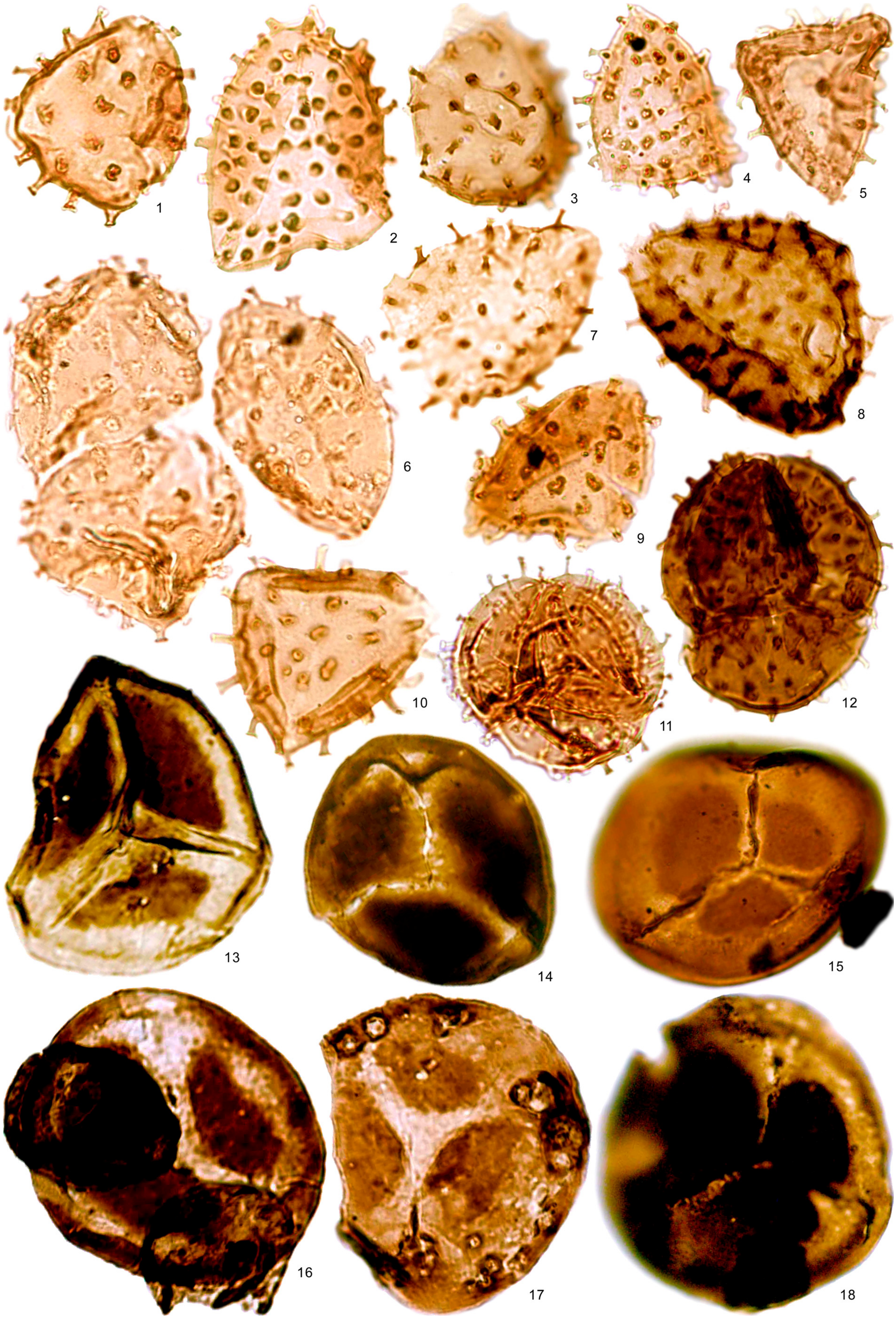

Plate 91

Plate 92.

1. *Retusotriletes goensis* Lele & Streel, 1969. YBRN-1, 16684.3', 62427, M33/2.

2-8. *Retusotriletes maculatus* McGregor & Camfield, 1976.

2. JNDL-4, 87.2', P34/3.
3. MG-1, 2557.5 m, 62599, O49.
4. BAQA-1, 219.2', F35.
5. UTMN-1830, 13689.7', 62316, E39.
6. UTMN-1830, 13612.5', 62367, K40/4.
7. BAQA-1, 395.2', N27/1.
8. BAQA-1, 285.5', Q34.

9-11. *Retusotriletes rotundus* (Streel) emend. Lele & Streel, 1969.

9. BAQA-1, 345.5', O36.
10. UTMN-1830, 13738.5', 62322, R52/4.
11. BAQA-1, 371.1', P33.

Plate 92

Plate 93.

1, 2. *Retusotriletes rotundus* (Streel) emend. Lele & Streel, 1969.

1. BAQA-1, 345.5', U34/2.
2. KHRM-2, 16217.1', 62083, J35/3.

3-11. *Retusotriletes tenerimedium* Tchibrikova, 1959.

3. UTMN-1830, 13738.5', 62325, G41.
4. SDGM-462, 13654.6', 61393, W45/1.
5. HWYH-956, 14154.0', 60464, C48/4.
6. UTMN-1830, 13738.5', 62322, U43.
7. UTMN-1830, 13738.5', 62323, O-P35.
8. BAQA-1, 285.5', U53.
9. UTMN-1830, 13738.5', 62325, S39/3.
10. BAQA-1, 285.5', C40/2.
11. BAQA-1, 366.9', O33/1.

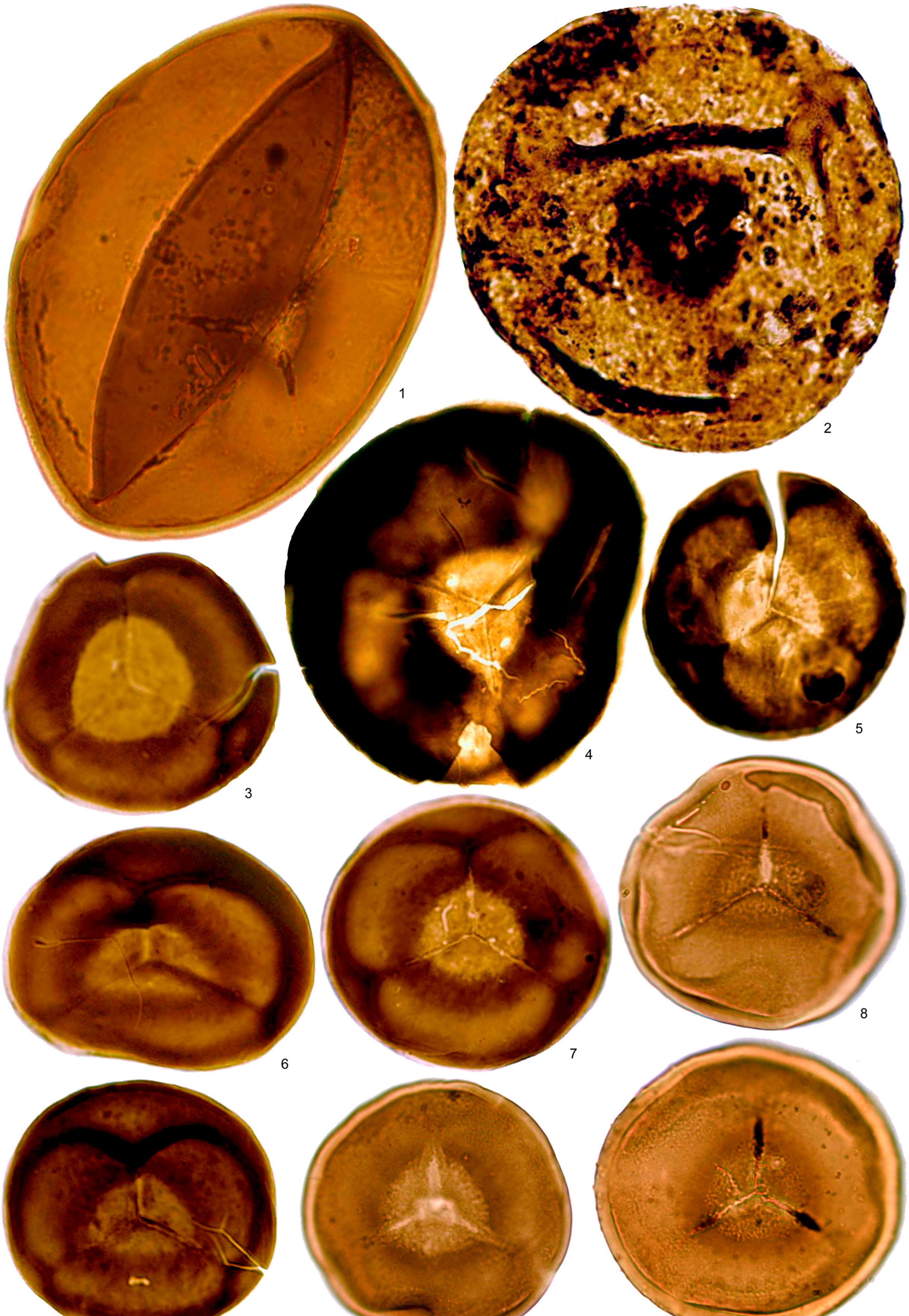

Plate 93

Plate 94.

1-7. *Retusotriletes triangulatus* (Streel) Streel, 1967.

1. BAQA-1, 345.5', M35/1.
2. BAQA-2, 50.8', M33/2.
3. BAQA-1, 399.0', P41/4.
4. BAQA-1, 376.4', E27/1.
5. BAQA-1, 371.1', O23.
6. BAQA-2, 50.8', P28/3.
7. BAQA-1, 376.4', F27/1.

Plate 94

Plate 95.

1-4. *Retusotriletes* sp. 1

1. A1-69, 1293', 63066, K32.
2. S-462, 1910-1915', 63260, E33/3.
3. MG-1, 2205 m, 62597, S44/3.
4. S-462, 2060-2065' 63269, L44/4.

5-13. *Retusotriletes* sp. 2.

5. HWYH-956, 14195.3', 47149(2), F60.
6. A1-69, 1829/1832', 26963, D52/4.
7. UTMN-1830, 13689.7', 62316, D-E57.
8. FWRH-1, 15937.6', 63116, S41/2.
9. HWYH-956, 14195.2', 60550, K35/1.
10. HWYH-956, 14195.3', 47149(1), R53/1.
11. UTMN-1830, 13689.7', 62317, J37/2.
12. UTMN-1830, 13689.7', 62316, V41/4.
13. UTMN-1830, 13670.8', 62383, M41/1.
14. UTMN-1830, 13689.7', 62318, E30.

15-18. *Retusotriletes* spp.

15. BAQA-1, 222.5', R30/3.
16. JNDL-1, 177.0', G46/4.
17. JNDL-1, 495.0', M30.
18. JNDL-1, 172.7', 60845, C40.

Plate 95

Plate 96.

1-6. *Rhabdosporites langii* (Eisenack) Richardson, 1960.

1. MG-1, 2241 m, 62964, O41.
2. MG-1, 2180 m, 62972, F32.
3. MG-1, 2278 m, 62936, M32.
4. MG-1, 2258 m, 62947, Q46/2.
5. MG-1, 2178 m, 62997, M31/3.
6. MG-1, 2180 m, 62973, N44.

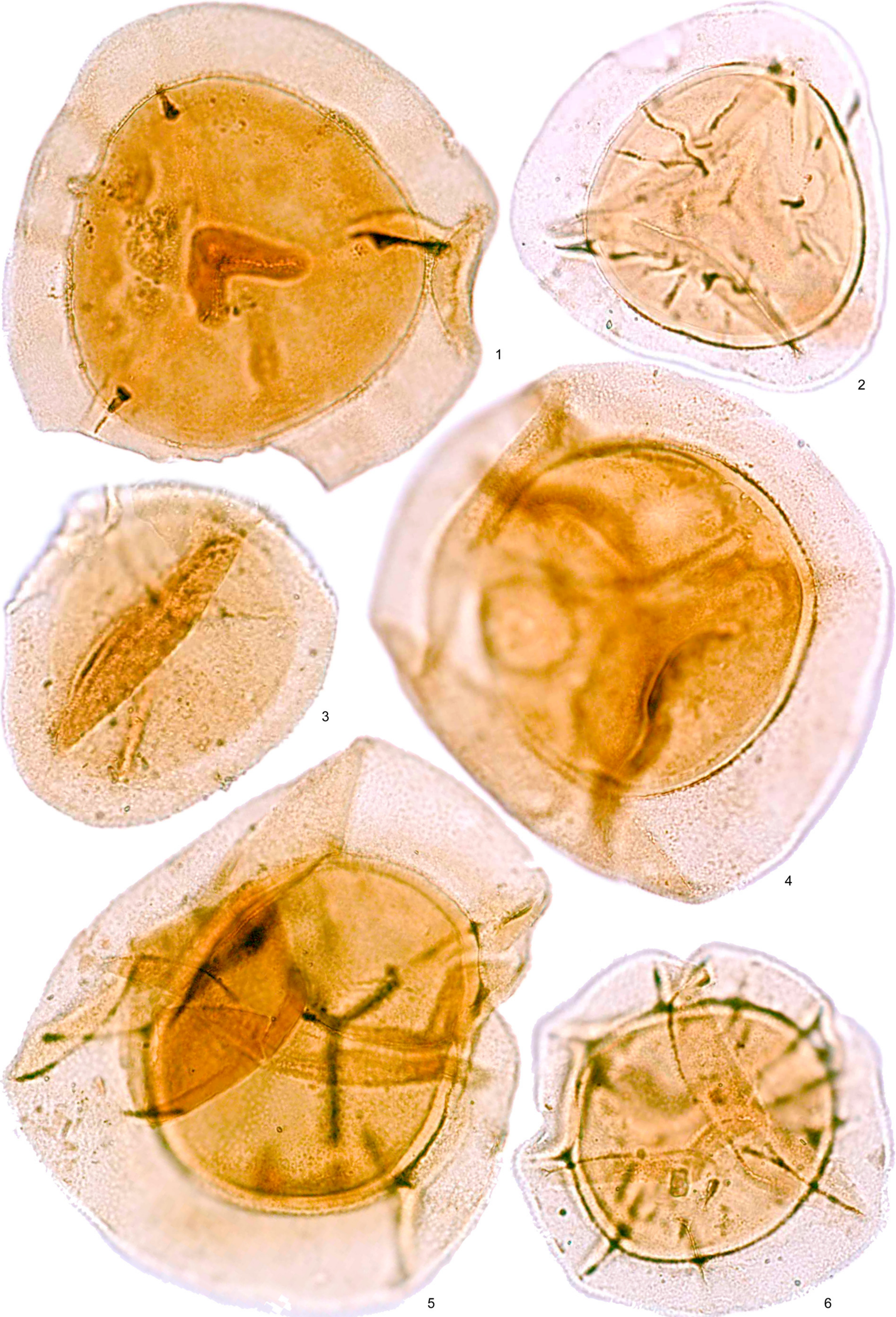

Plate 96

Plate 97.

1-9. *Rhabdosporites minutus* Tiwari & Schaarschmidt, 1975.

1. JNDL-3, 368.8', H45/1.
2. A1-69, 1596', 26990, G58/3.
3. JNDL-1, 174.6', O35/4.
4. JNDL-1, 155.6', Q38/2.
5. JNDL-1, 172.7', 60846, Q39/4.
6. JNDL-1, 156.0', 60840, N27/2.
7. JNDL-1, 156.0', 60839, E49/4.
8. JNDL-1, 156.0', 60839, S36.
9. JNDL-1, 154.5', 60835, T33.

10, 11. *Rhabdosporites streelii* Marshall, 1996. Magnification x750.

10. A1-69, 1322', 27126, U51/1.
11. A1-69, 1322', 27125, L36-37.

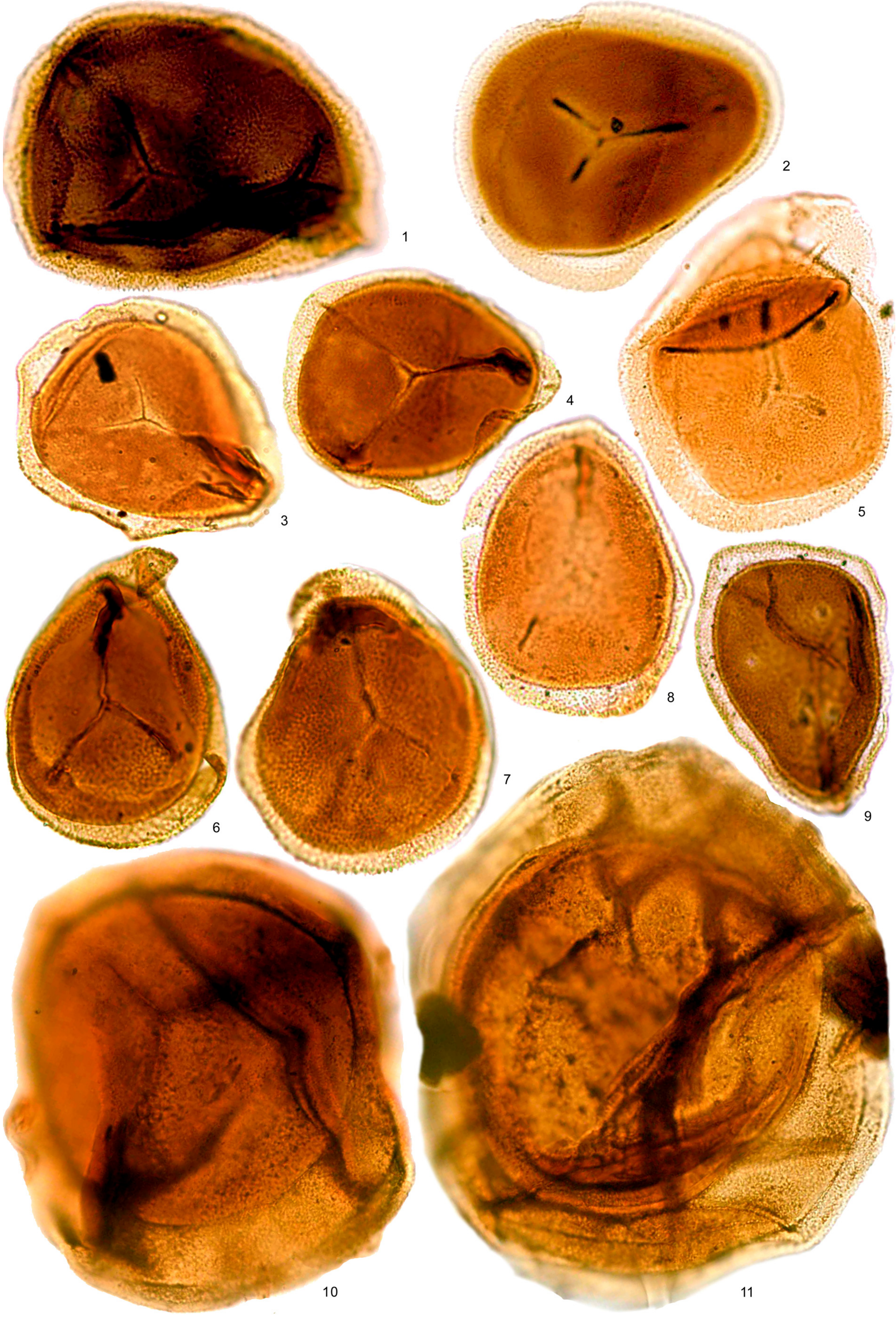

Plate 97

Plate 98.

1-4. *Samarisporites angulatus* (Tiwari & Schaarschmidt) Loboziak & Streel, 1989. Magnification x750.

1. A1-69, 1867', 26969, D37.
2. A1-69, 1334', 27127, L34/3.
3. A1-69, 1870', 26973, K41.
4. A1-69, 1596', 26990, K40/2.

5, 6. *Samarisporites eximius* (Allen) Loboziak & Streel, 1989. Magnification x750.

5. JNDL-1, 167.8', O34/2.
6. JNDL-1, 162.3', 60841, W28/3.

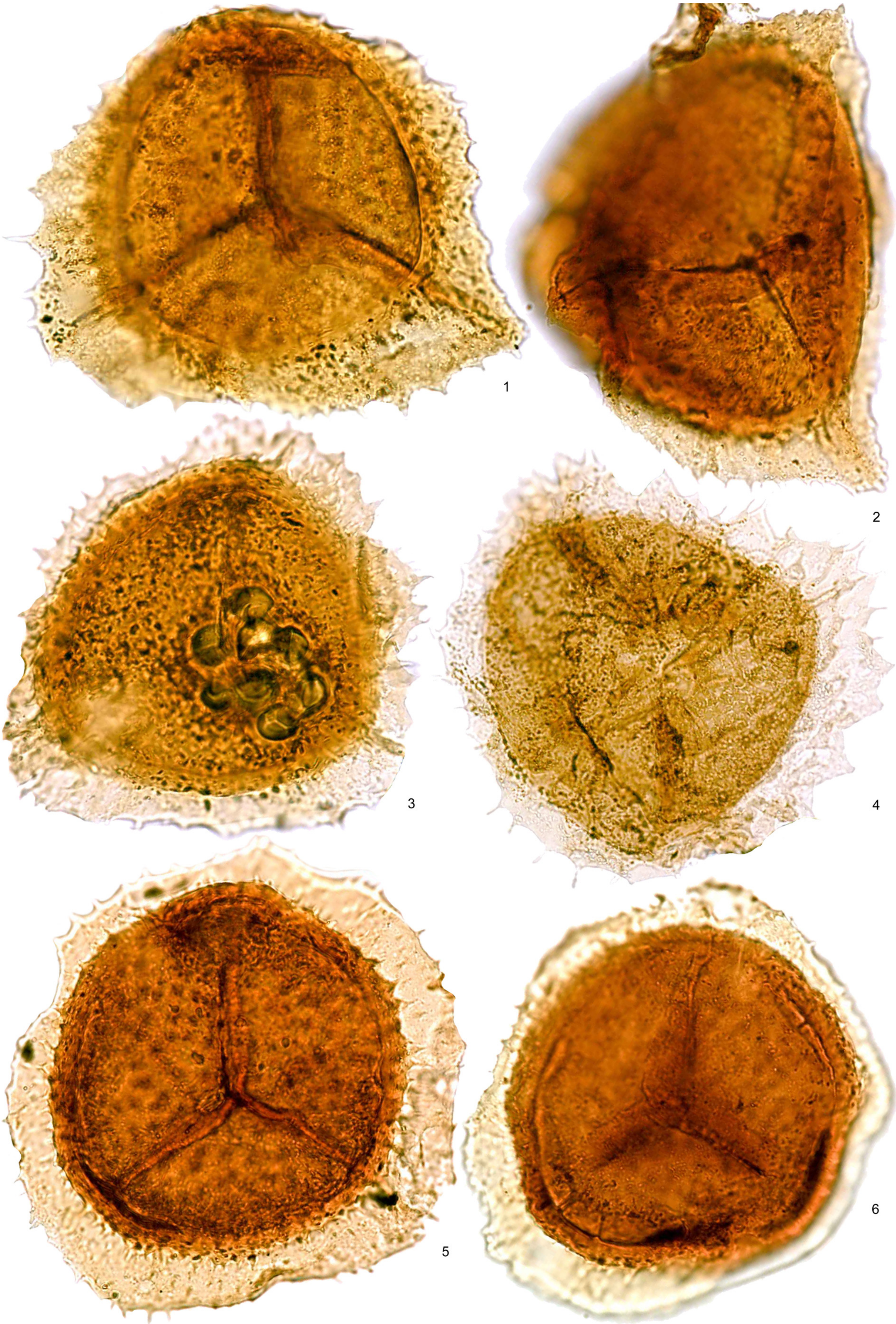

Plate 98

Plate 99.

1, 2. *Samarisporites eximius* (Allen) Loboziak & Streel, 1989. Magnification x750.

1. A1-69, 1334’, 27127, N53/2.
2. JNDL-1, 162.3’, S45/3.

3-9. *Samarisporites triangulatus* Allen, 1965.

3. MG-1, 2182.4 m, 62527, Q29/2.
4. A1-69, 1293’, 63068, F35/2.
5. MG-1, 2247 m, 62940, J48/1.
6. MG-1, 2161.8 m, 62528, L41/2.
7. MG-1, 2182.4 m, 62527, C46/4.
8. MG-1, 2181.2 m, 62525, B43/1.
9. ABSF-29, 16327.6’, D43/4.

Plate 99

Plate 100.

1-3. *Samarisporites triangulatus* Allen, 1965.
1. A1-69, 1277', 62637, T29/1.
2. A1-69, 1277', 62637, Q37/3.
3. A1-69, 1277', 62636, X31/1.

4-6. *Samarisporites* sp. 1.
4. MG-1, 2741.4 m, 62611, P39/2.
5. MG-1, 2741.4 m, 62612, W28.
6. MG-1, 2741.4 m, 62611, L28/1.

7. *Samarisporites* sp. 2. Magnification x750. MG-1, 2258 m, 62947, M39/2.

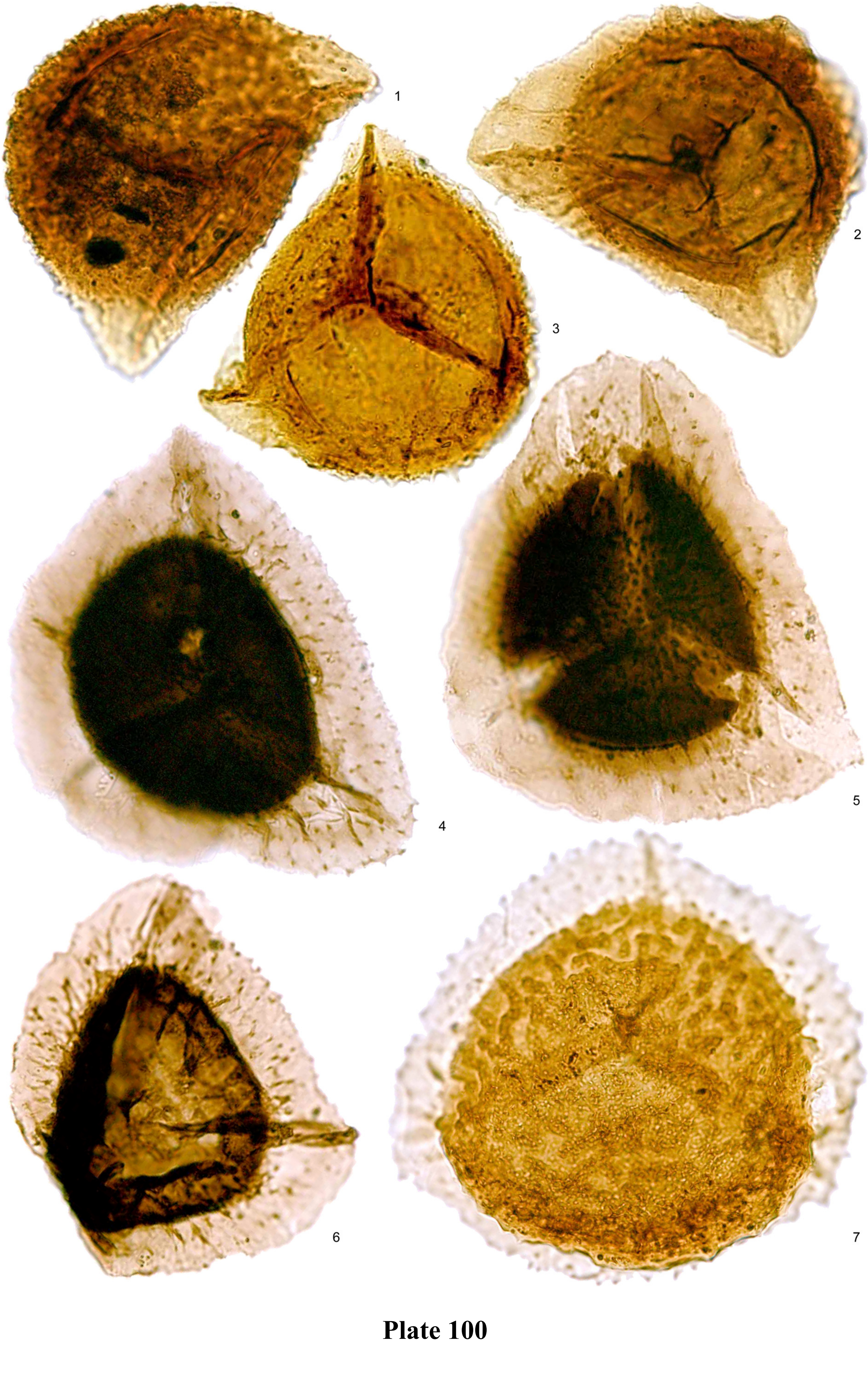

Plate 100

Plate 101.

1-3. *Samarisporites* sp. 2. Magnification x750.

1. MG-1, 2247 m, 62942, D31.
2. A1-69, 1334', 27127, K48.
3. MG-1, 2278 m, 62936, S35.

4. *Samarisporites* sp. 3. Magnification x750. A1-69, 1962', 27277, K37/4.

5, 6. *Samarisporites* sp. 4. Magnification x750.

5. A1-69, 1596', 26989, G38/1.
6. A1-69, 1870', 26973, M35.

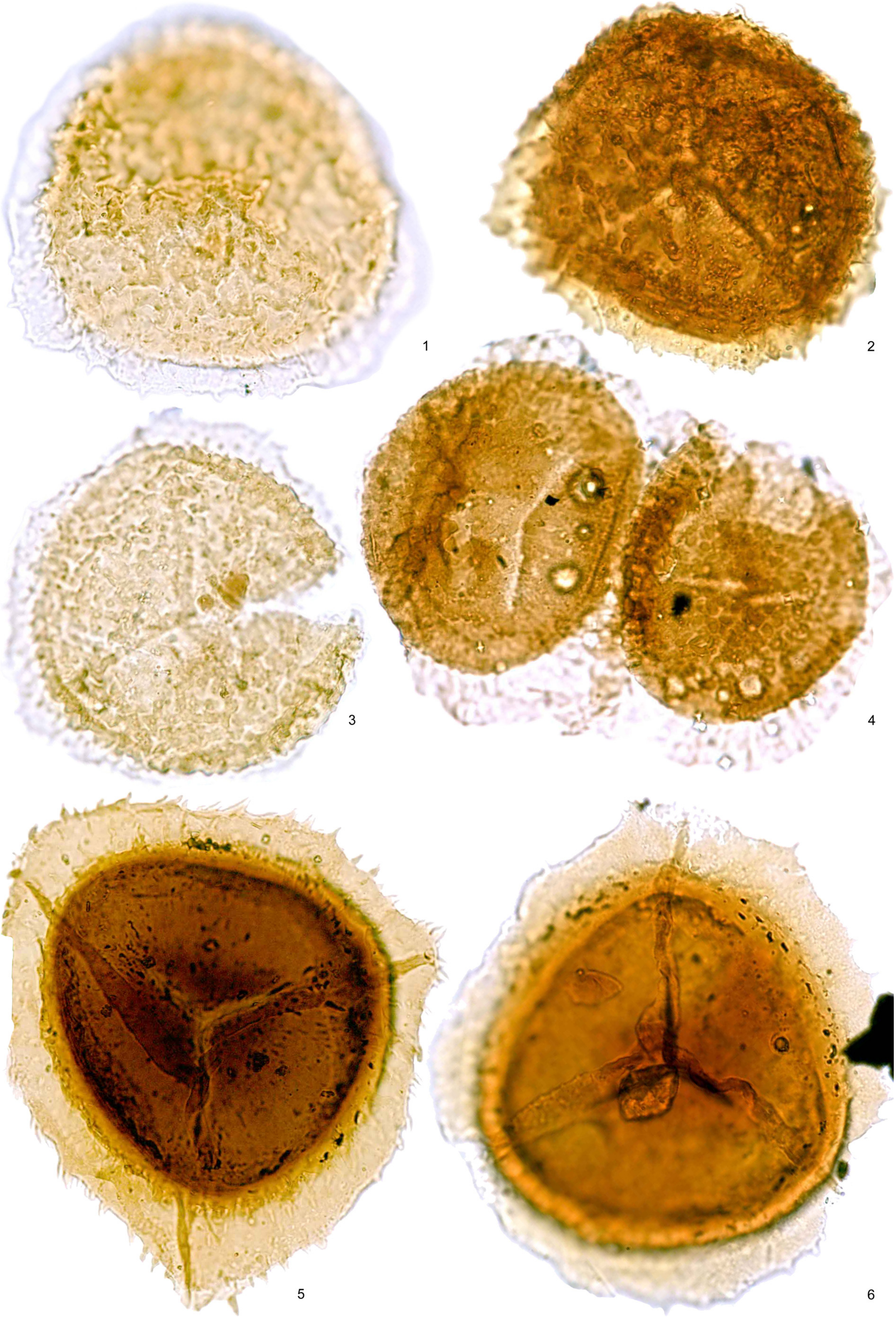

Plate 101

Plate 102.

1-9. *Scylaspora costulosa* Breuer et al., 2007c.

1. BAQA-1, 227.1', L24.
2. JNDL-3, 353.8', L33/3.
3. BAQA-2, 133.0', M45/1.
4. BAQA-1, 227.1', Q49/3.
5. HWYH-956, 14195.2', 60551, X50.
6. BAQA-2, 50.8', O49/1.
7. BAQA-1, 227.1', L44/4.
8. UTMN-1830, 13689.7', 62317, R33/4.
9. UTMN-1830, 13689.7', 62316, S34.

Plate 102

Plate 103.

1-7. *Scylaspora rugulata* (Riegel) Breuer et al., 2007c.

1. A1-69, 1530', 26985, E32/4.
2. A1-69, 1596', 26989, V47/4.
3. A1-69, 1540', 26987, N51/1.
4. YBRN-1, 16648.4', 62412, O54.
5. S-462, 2110-2115', 63272, M45.
6. YBRN-1, 16649.3', 62416, Q47/2.
7. YBRN-1, 16647.3', 62408, P33/3.

Plate 103

Plate 104.

1, 2. *Scylaspora* cf. *S. scripta* Burgess & Richardson, 1995.
1. MG-1, 2631.2 m, 62551, O30.
2. MG-1, 2631.2 m, 62553, J48.

3-11. *Squamispora arabica* Breuer et al., 2007c.
3. JNDL-1, 174.6', 60848, L40/2.
4. JNDL-1, 172.7', 60846, H29.
5. JNDL-1, 172.7', 60845, S-T27.
6. JNDL-1, 177.0', 60849, U31.
7. JNDL-1, 172.7', F33/3.
8. JNDL-1, 177.0', H45.
9. JNDL-1, 174.6', C43.
10. JNDL-1, 174.6', 60848, B43/3.
11. JNDL-1, 177.0', O35.

12-13. *Stellatispora multicostata* Breuer et al., 2007c.
12. JNDL-3, 341.0', F42.
13. JNDL-4, 182.5', U41/4.

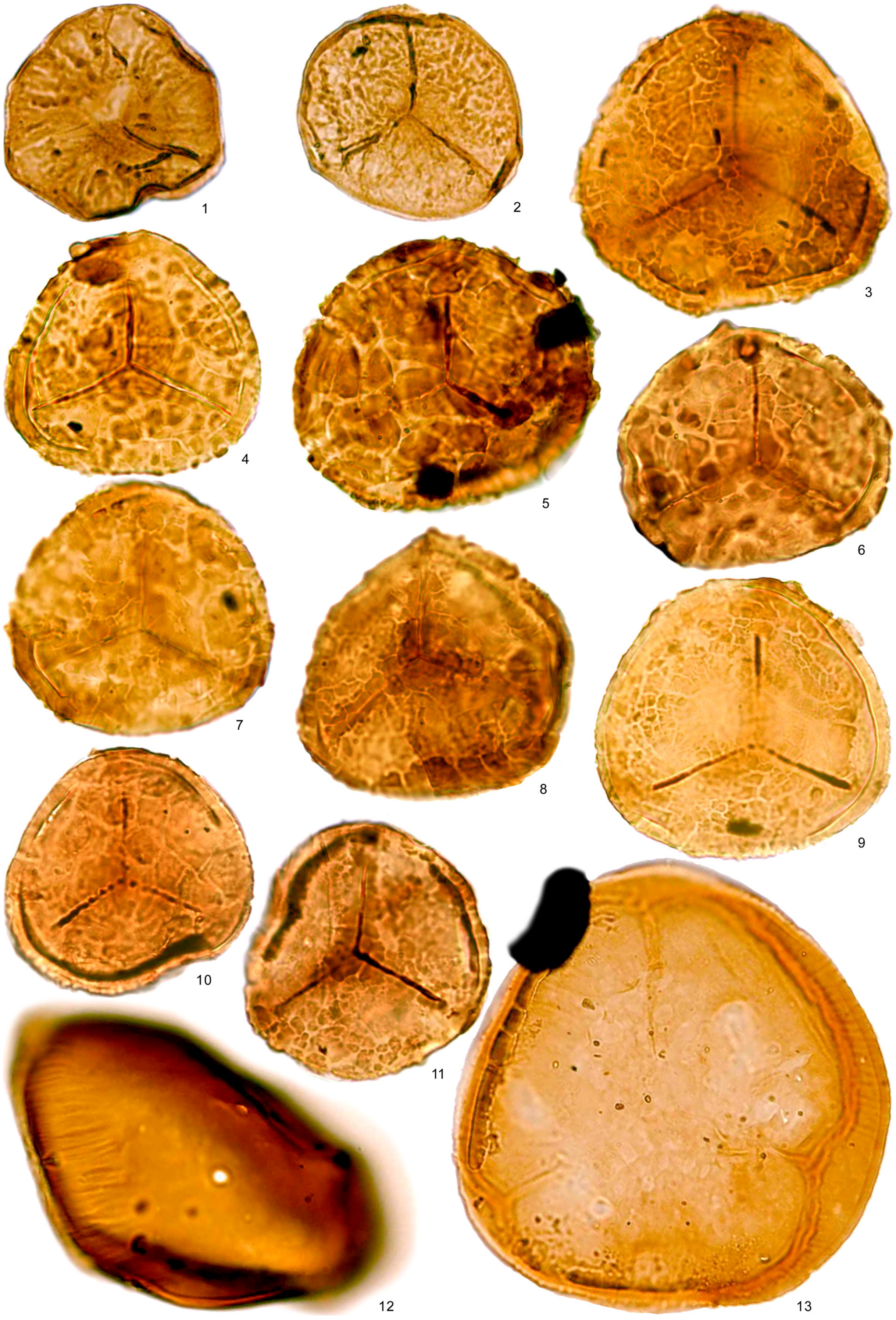

Plate 104

Plate 105.

1-7. *Stellatispora multicostata* Breuer et al., 2007c.
1. UTMN-1830, 13614.1', 62374, M36.
2. JNDL-4, 42.0', T36/2.
3. KHRM-2, 16224.7', 62090, J37/3.
4. JNDL-3, 462.3', H26.
5. JNDL-4, 111.0', D38/1.
6. JNDL-4, 87.2', B37.
7. JNDL-4, 52.3', J38/2.

8-10. *Synorisporites* cf. *S. lobatus* Rodriguez, 1978a.
8. MG-1, 2741.4 m, 62611, Q41.
9. MG-1, 2631.2 m, 62551, F37/4.
10. MG-1, 2741.4 m, 62611, Q41.

Plate 105

Plate 106.

1-15. *Synorisporites papillensis* McGregor, 1973.
1. BAQA-2, 50.2’, R26.
2. BAQA-2, 133.0’, T25/1.
3. BAQA-1, 308.3’, H40/4.
4. BAQA-2, 52.0’, U29/4.
5. BAQA-1, 376.4’, C26/3.
6. BAQA-1, 222.5’, M30/2.
7. BAQA-2, 54.8’, G45.
8. BAQA-1, 371.1’, R33/3.
9. BAQA-1, 222.5’, G39/1.
10. JNDL-1, 167.8’, F42/1.
11. BAQA-1, 308.3’, T44.
12. BAQA-1, 366.9’, K42/2.
13. BAQA-1, 308.3’, F50-51.
14. BAQA-1, 222.5’, W51/3.
15. FWRH-1, 15919.7’, 63108, N37.

16-19. *Synorisporites verrucatus* Richardson & Lister, 1969.
16. A1-69, 1962’, 27277, V40/3.
17. A1-69, 2039/2041’, 27279, J53/4.
18. MG-1, 2631.2 m, 62552, K34-35.
19. MG-1, 2741.4 m, 62605, Q38/4.

20, 21. *Verruciretusispora dubia* (Eisenack) Richardson & Rasul, 1978.
20. JNDL-1, 177.0’, J39.
21. UTMN-1830, 13613.2’, 62369, S31/4.

22, 23. *Verrucisporites ellesmerensis* (Chaloner) Chi & Hills, 1976. Magnification x250.
22. S-462, 1710-1715’, 63222, H31.
23. S-462, 2220-2215’, 63279, G41.

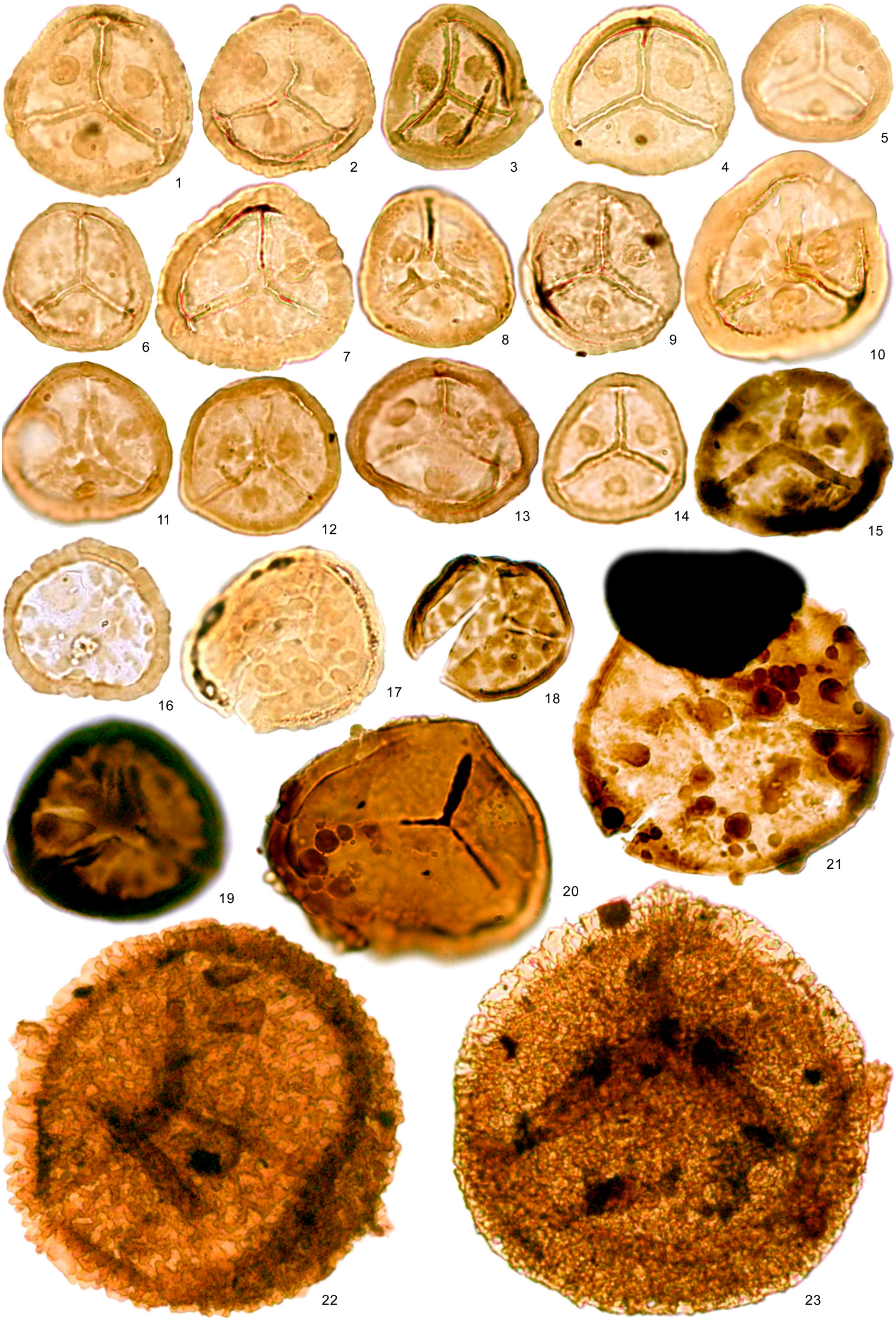

Plate 106

Plate 107.

1-10. *Verrucosisporites polygonalis* Lanninger, 1968.

1. BAQA-1, 169.1’, G35.
2. BAQA-1, 406.0’, M48/3.
3. BAQA-1, 169.1’, Q29.
4. MG-1, 2693 m, 62962, V48.
5. .JNDL-1, 495.0’, H30/4.
6. MG-1, 2713 m, 62811, Q40.
7. UTMN-1830, 13689.7’, 62316, S45/4.
8. BAQA-1, 169.1’, U52/4.
9. MG-1, 2606.6 m, 62733, W44/3.
10. BAQA-1, 371.1’, R25/4.

11-16. *Verrucosisporites premnus* Richardson, 1965.

11. MG1, 2405 m, 62821, V51/1.
12. A1-69, 1277’, 62636, X41/4.
13. MG-1, 2456 m, 62737, Y40.
14. A1-69, 1109’, 27273, J51/2.
15. MG-1, 2205 m, 62595, H46.
16. ABSF-29, 16327.6’, D34.

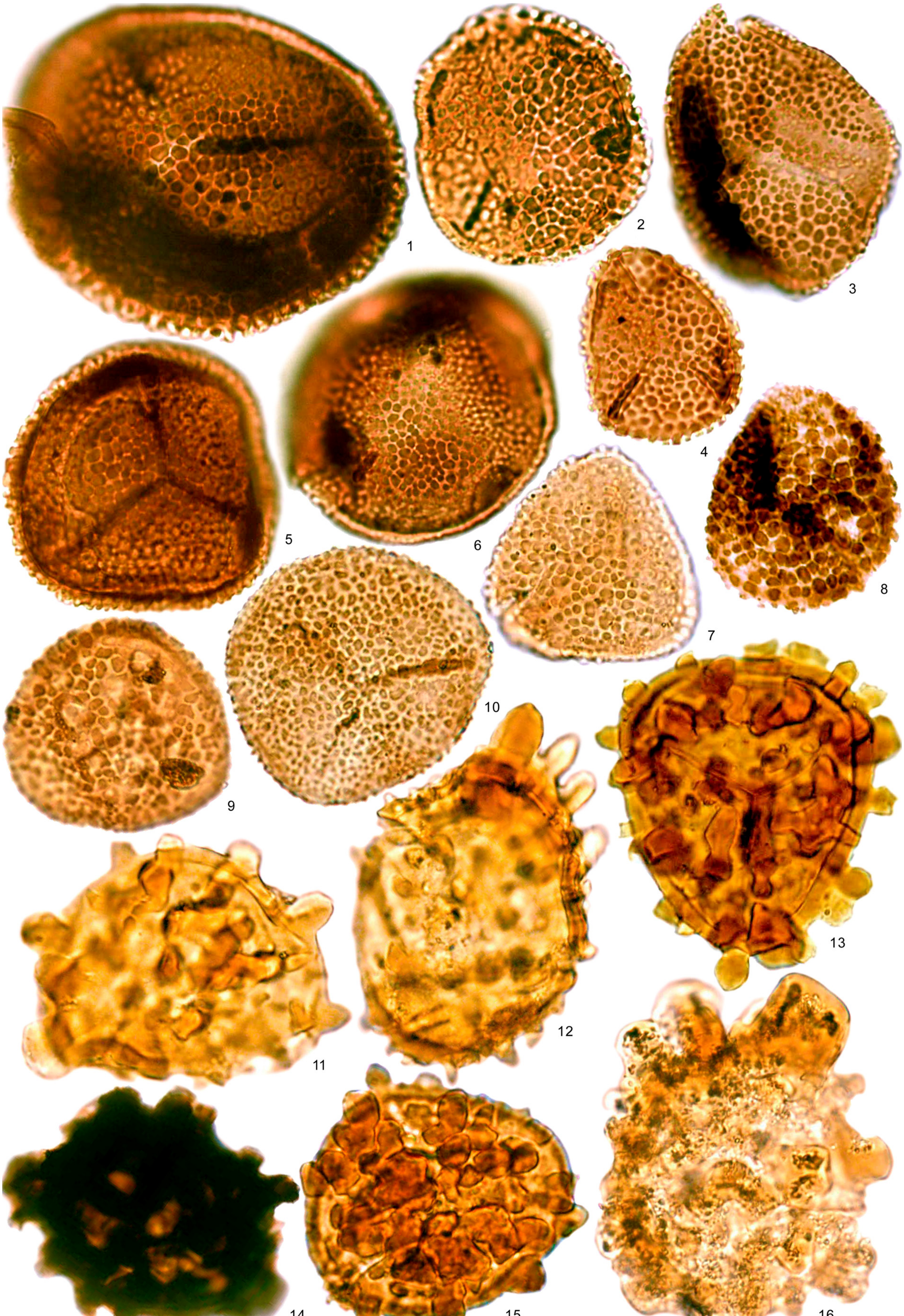

Plate 107

Plate 108.

1-3. *Verrucosisporites premnus* Richardson, 1965.

1. A1-69, 1416', 26993, M54/1.
2. MG-1, 2518 m, 62804, J34.
3. S-462, 2010-2015', 63266, G30.

4-14. *Verrucosisporites scurrus* (Naumova) McGregor & Camfield, 1982.

4. MG-1, 2161.8 m, 62528, M45/4.
5. A1-69, 1334', 27127, K40.
6. MG-1, 2181.2 m, 62525, J35/4.
7. A1-69, 1109', 27274, K41/3.
8. A1-69, 1483', 26994, H31/2.
9. A1-69, 1074', 62677, R48/49.
10. MG-1, 2713 m, 62810, P34.
11. A1-69, 1334', 27127, Q38.
12. MG-1, 2511 m, 62842, V36/2.
13. A1-69, 1490', 26979, U42.
14. A1-69, 1322', 27125, Y35.

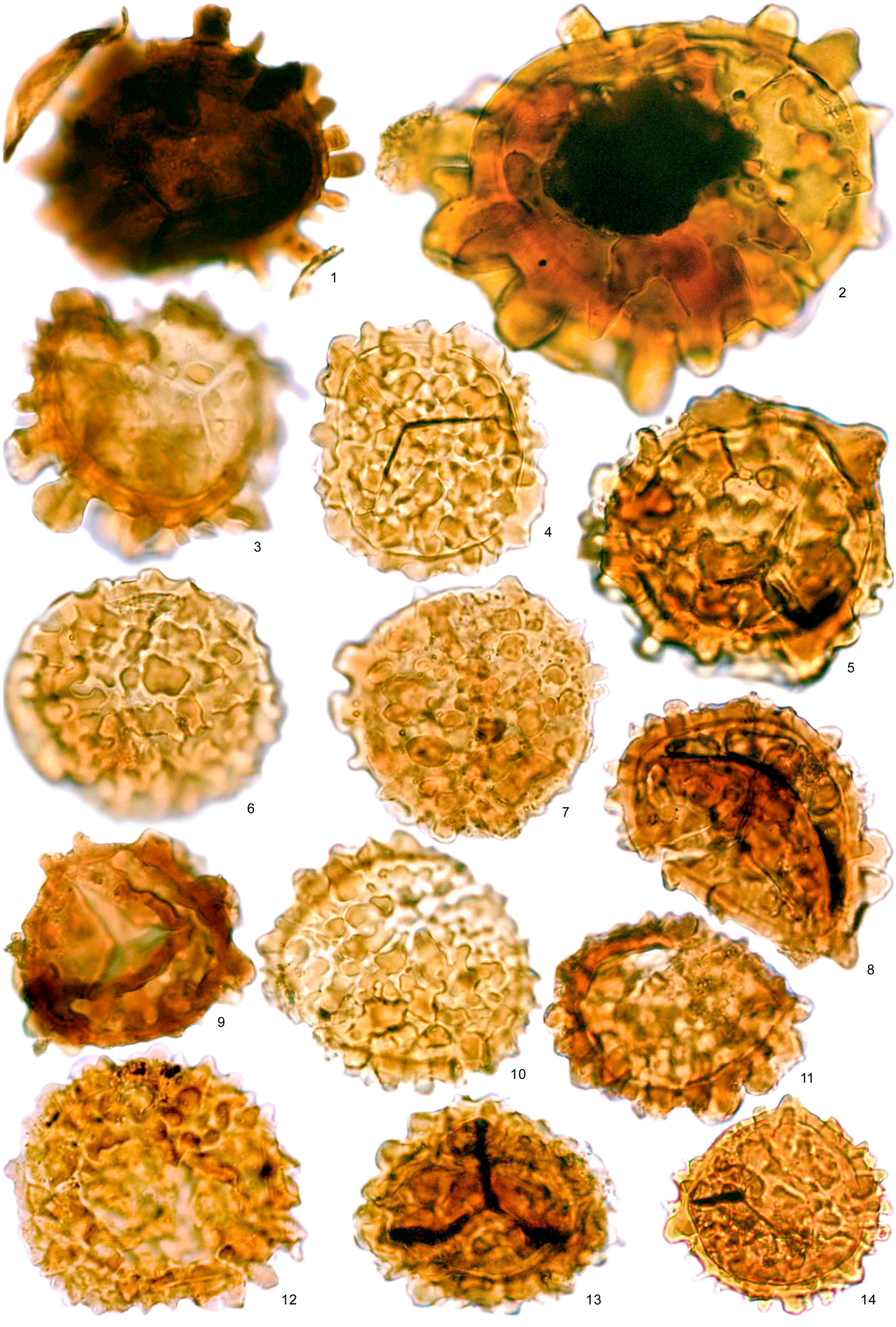

Plate 108

Plate 109.

1-4. *Verrucosisporites* sp. 1.

1. KHRM-2, 16273.0’, 62121, S52.
2. JNDL-4, 163.7’, V33/4.
3. JNDL-4, 411.5’, T45/2.
4. JNDL-4, 419.3’, M35/3.

5-12. *Verrucosisporites* sp. 2.

5. KHRM-2, 16273.0’, 62122, R36/3.
6. BAQA-1, 227.1’, K39/1.
7. BAQA-1, 395.2’, 62275, Q29-30.
8. BAQA-1, 395.2’, X45.
9. BAQA-1, 395.2’, 62272, V41.
10. BAQA-1, 395.2’, O28/1.
11. A1-69, 2108/2111’, 26913, U47/1.
12. BAQA-2, 134.4’, N27/4.

13-16. *Verrucosisporites* sp. 3.

13. BAQA-1, 366.9’, 62255, F48.
14. BAQA-2, 57.2’, M39/3.
15. BAQA-1, 371.1’, V38/4.
16. BAQA-1, 395.2’, 62272, O31-32.

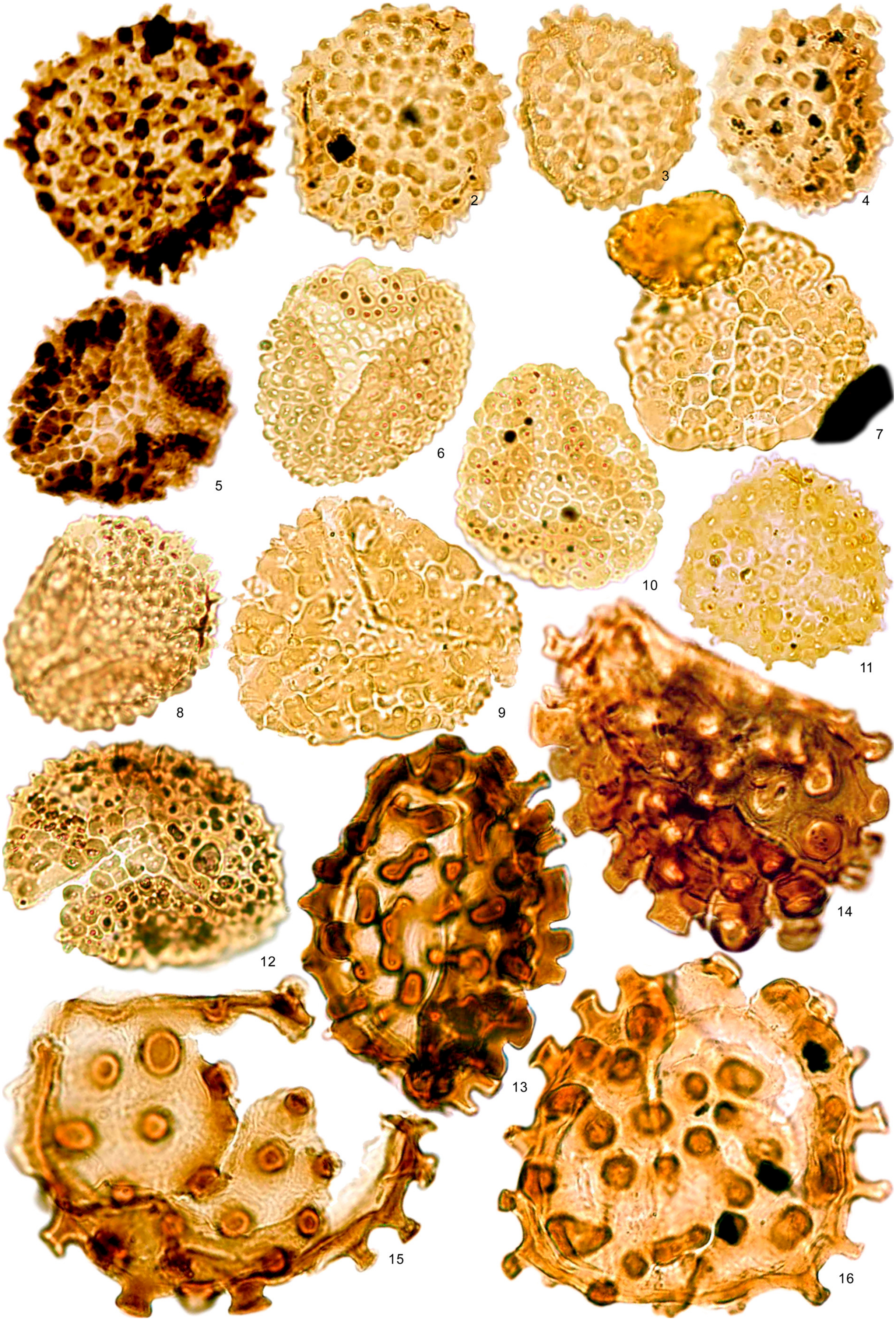

Plate 109

Plate 110.

1-4. *Verrucosisporites* sp. 4.

1. BAQA-2, 54.8’, J49/4.
2. BAQA-2, 64.5’, J30/2.
3. BAQA-1, 308.3’, J29/2.
4. BAQA-1, 227.1’, N35.
5. BAQA-1, 285.5’, C42/4.
6. BAQA-1, 285.5’, Q25/3.
7. BAQA-2, 64.5’, W50/3.
8. BAQA-2, 50.8’, H30/4.
9. BAQA-1, 308.3’, M30/2.

10-15. *Zonotriletes armillatus* Breuer et al., 2007c.

10. JNDL-1, 155.6’, 60838, J43/1.
11. JNDL-1, 156.0’, P43.
12. JNDL-1, 167.8’, 60843, O49/3.
13. JNDL-1, 155.6’, P30/4.
14. JNDL-1, 167.8’, 60843, L41.
15. JNDL-1, 156.0’, 60840, X32/3.

Plate 110

Plate 111.

1-4. *Zonotriletes armillatus* Breuer et al., 2007c.

1. JNDL-1, 172.7', 60846, T32.
2. JNDL-1, 155.6', T42/4.
3. JNDL-1, 155.6', 60837, O34.
4. JNDL-1, 155.6', 60838, N52/3.

5-12. *Zonotriletes simplicissimus* Breuer et al., 2007c.

5. JNDL-1, 172.7', D31.
6. JNDL-1, 177.0', P32/4.
7. JNDL-1, 156.0', 60840, S35/4.
8. JNDL-1, 172.7', 60845, F28/1. The transverse attachment lines of the flange on the central body are distinguishable.
9. JNDL-1, 177.0', 60850, K44/2. The transverse attachment lines of the flange on the central body are distinguishable.
10. JNDL-1, 177.0', R47/1.
11. JNDL-1, 177.0', 60849, G35/4.
12. JNDL-1, 177.0', 60849, K43/3.

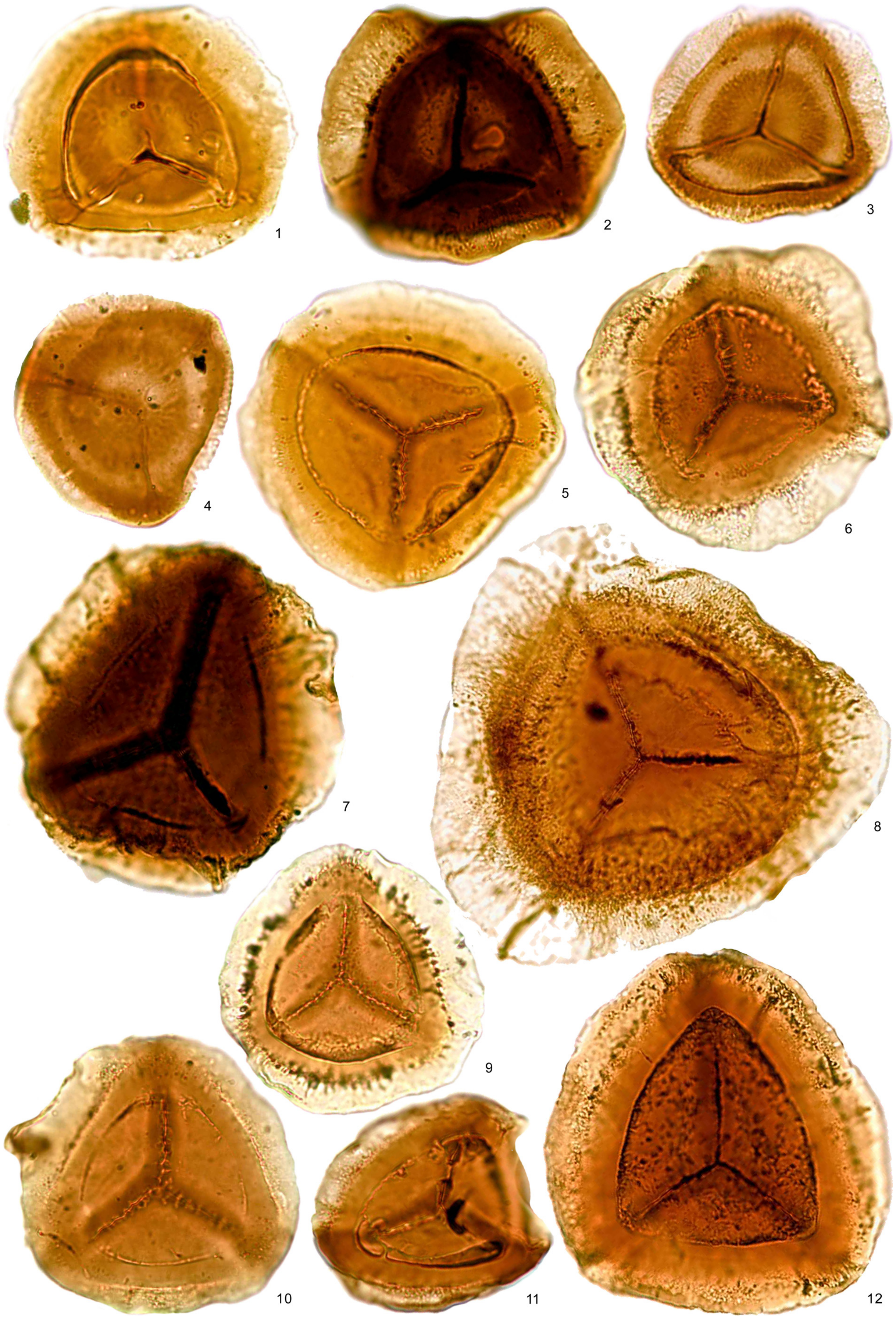

Plate 111

Plate 112.

1-12. *Zonotriletes* sp. 1 in Jardiné & Yapaudjian (1968).

1. MG-1, 2639 m, 62780, R37/1.
2. MG-1, 2639 m, 62780, L39.
3. MG-1, 2520 m, 62593, C29/3.
4. MG-1, 2639 m, 62779, Q46/3.
5. JNDL-4, 84.8', L44/3.
6. JNDL-4, 328.3', P35/4.
7. A1-69, 2108/2111', 26913, J44/4.
8. MG-1, 2520 m, 62594, P44.
9. BAQA-1, 219.2', J41/1.
10. UTMN-1830, 13614.6', 62376, T52/4.
11. JNDL-4, 328.3', H36/2.
12. A1-69, 2108/2111', 26912, D55/1.

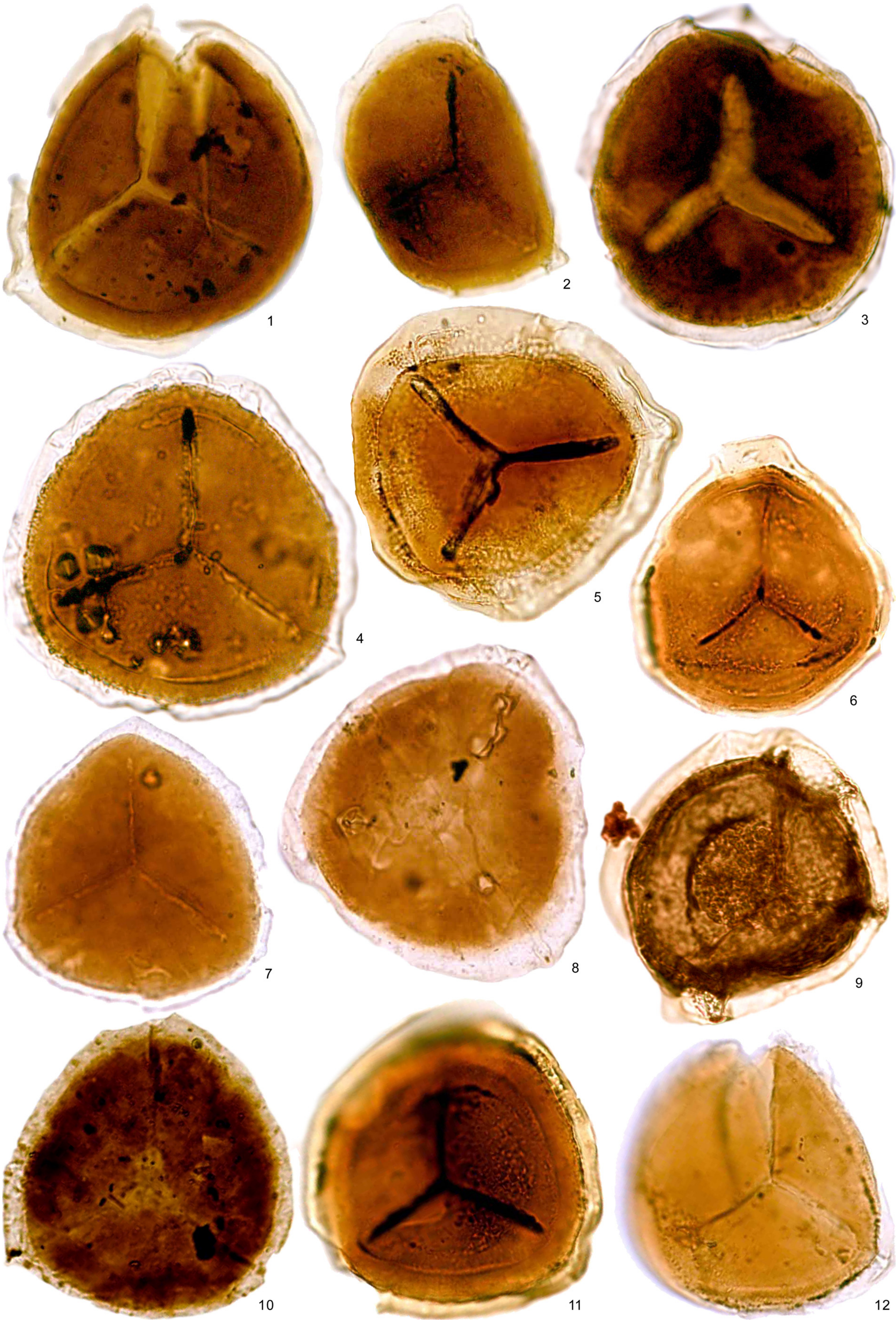

Plate 112

Plate 113.

1-5. *Zonotriletes* sp. 2 in Jardiné & Yapaudjian (1968). Magnification x750.

1. BAQA-1, 406.0’, L23/3.
2. MG-1, 2631.2 m, 62552, Q36/3.
3. MG-1, 2631.2 m, 62552, T33.
4. MG-1, 2693.0 m, 62961, D47/4.
5. MG-1, 2631.2 m, 62552, E33.

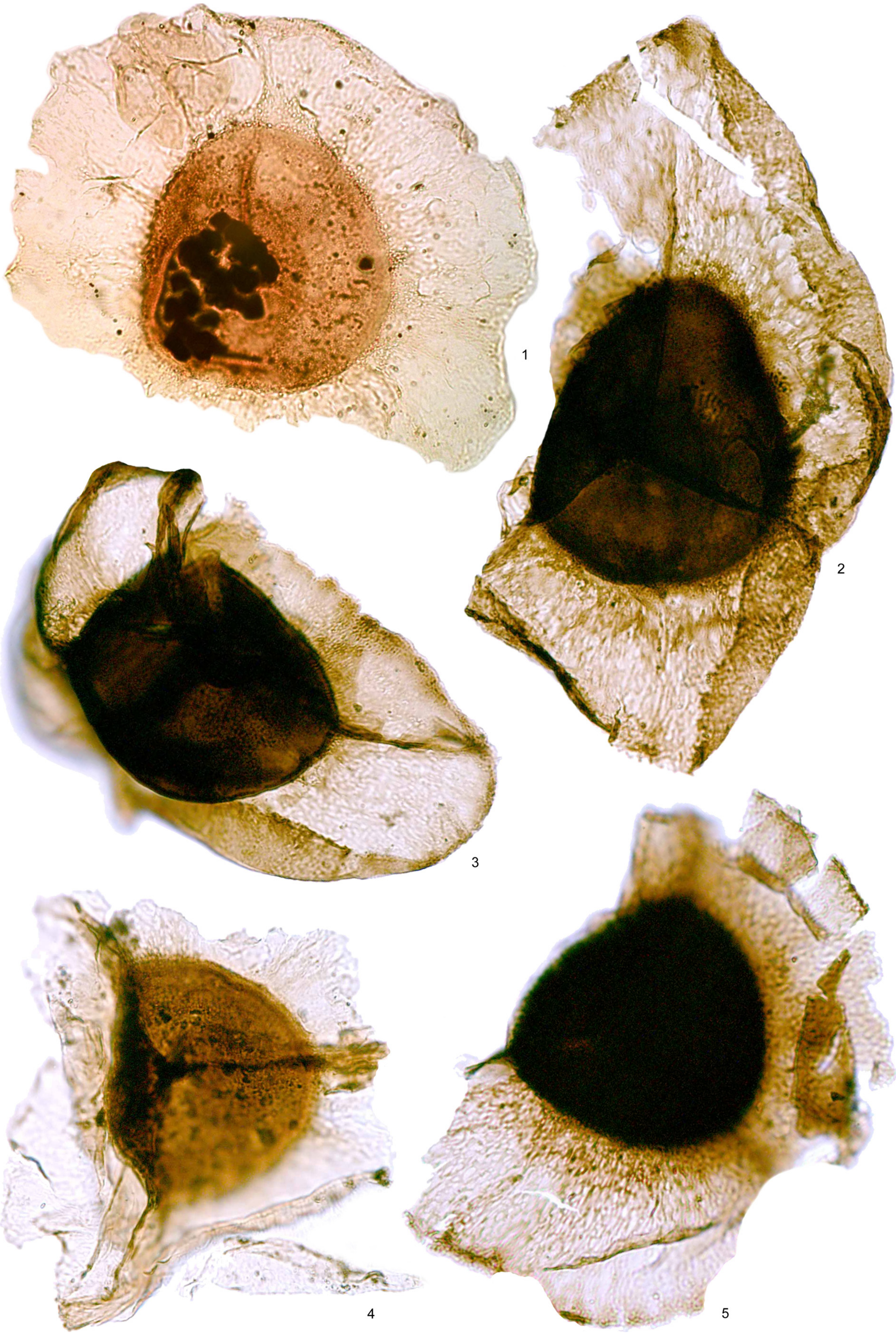

Plate 113

Plate 114.

1-4. *Zonotriletes* sp. 3.
1. JNDL-1, 177.0', 60849, H44/1.
2. JNDL-1, 162.3', 60844, T49/3.
3. JNDL-1, 162.3', 60844, L34.
4. JNDL-1, 156.0', K38/1.

5, 6. *Zonotriletes* sp. 4.
5. JNDL-1, 155.6', 60837, C50/1.
6. JNDL-1, 156.0', S43/4.

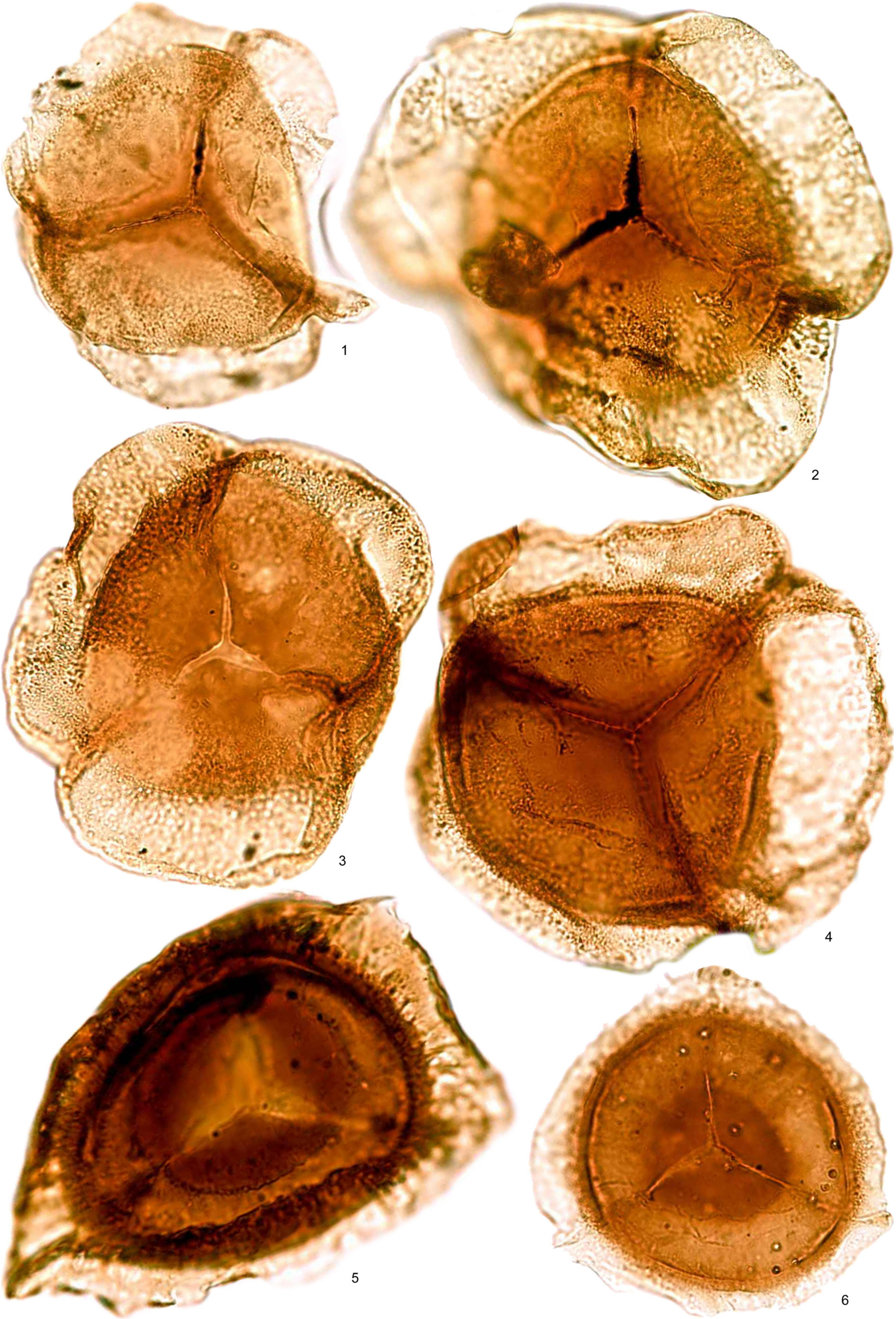

Plate 114

Plate 115.

1-5. *Zonotriletes* sp. 4.

1. A1-69, 1293', 63066, F29/4.
2. A1-69, 1486', 26976, H51/3.
3. JNDL-1, 155.6', 60837, Q34/4.
4. A1-69, 1950', 27276, R41.
5. MG-1, 2315 m, 62781, O41/2.

6, 7. *Zonotriletes* sp. 5.

6. A1-69, 1483', 26995, U34/2
7. A1-69, 1483', 26994, R54/2.

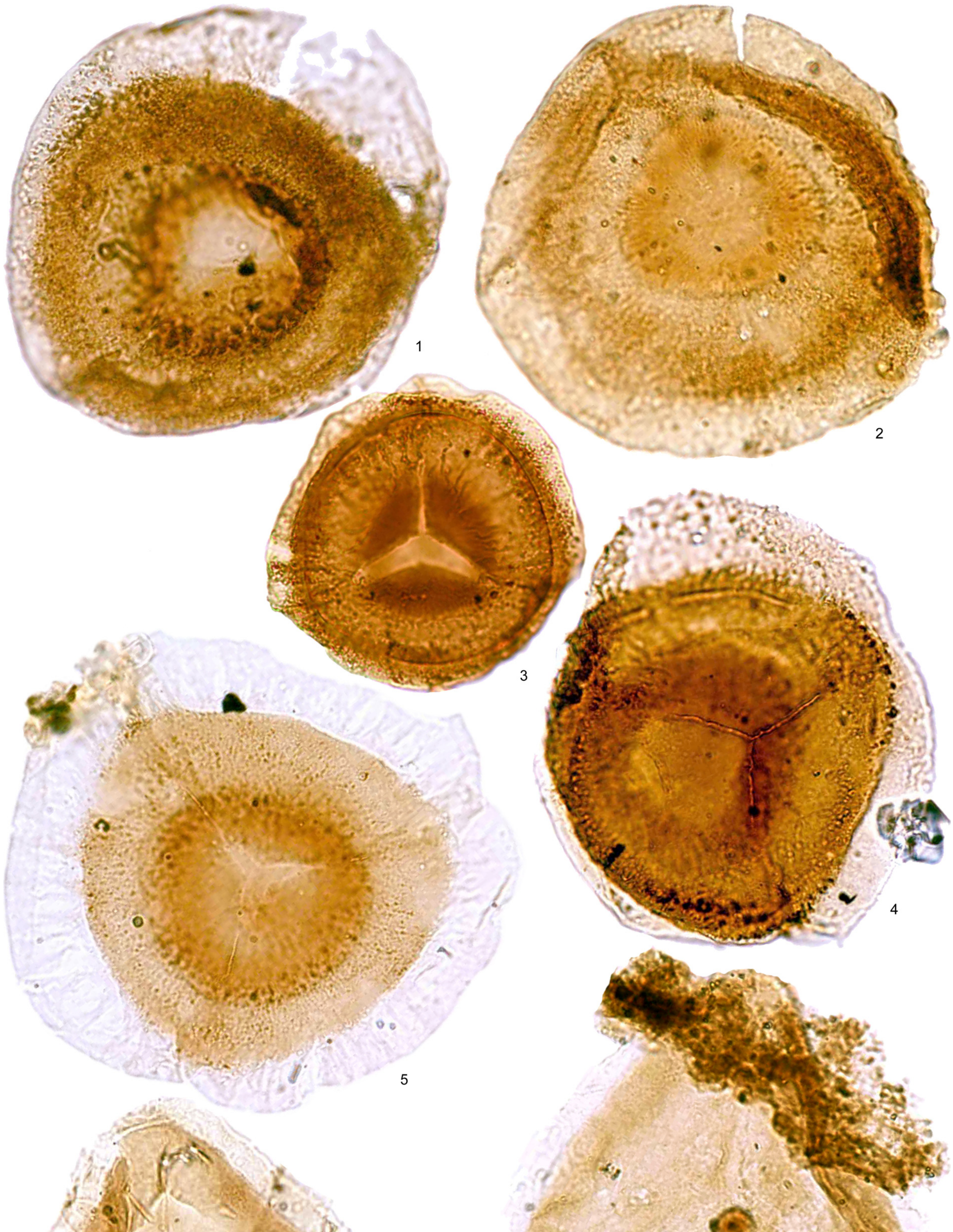

Plate 115

Plate 116.

1-3. *Zonotriletes* sp. 6.
1. JNDL-4, 448.6’, O34/2.
2. JNDL-4, 454.8’, H38/4.
3. BAQA1, 219.2’, 62236, N52/2.

4-9. Unidentified trilete spores.
4. A1-69, 1962’, 27277, G-H54.
5. BAQA-1, 345.5’, S38/2.
6. JNDL-1, 177.0’, R38.
7. MG-1, 2511 m, 62842, E44/3.
8. JNDL-1, 495.0’, 60855, P43/4.
9. JNDL-4, 182.5’, D27.

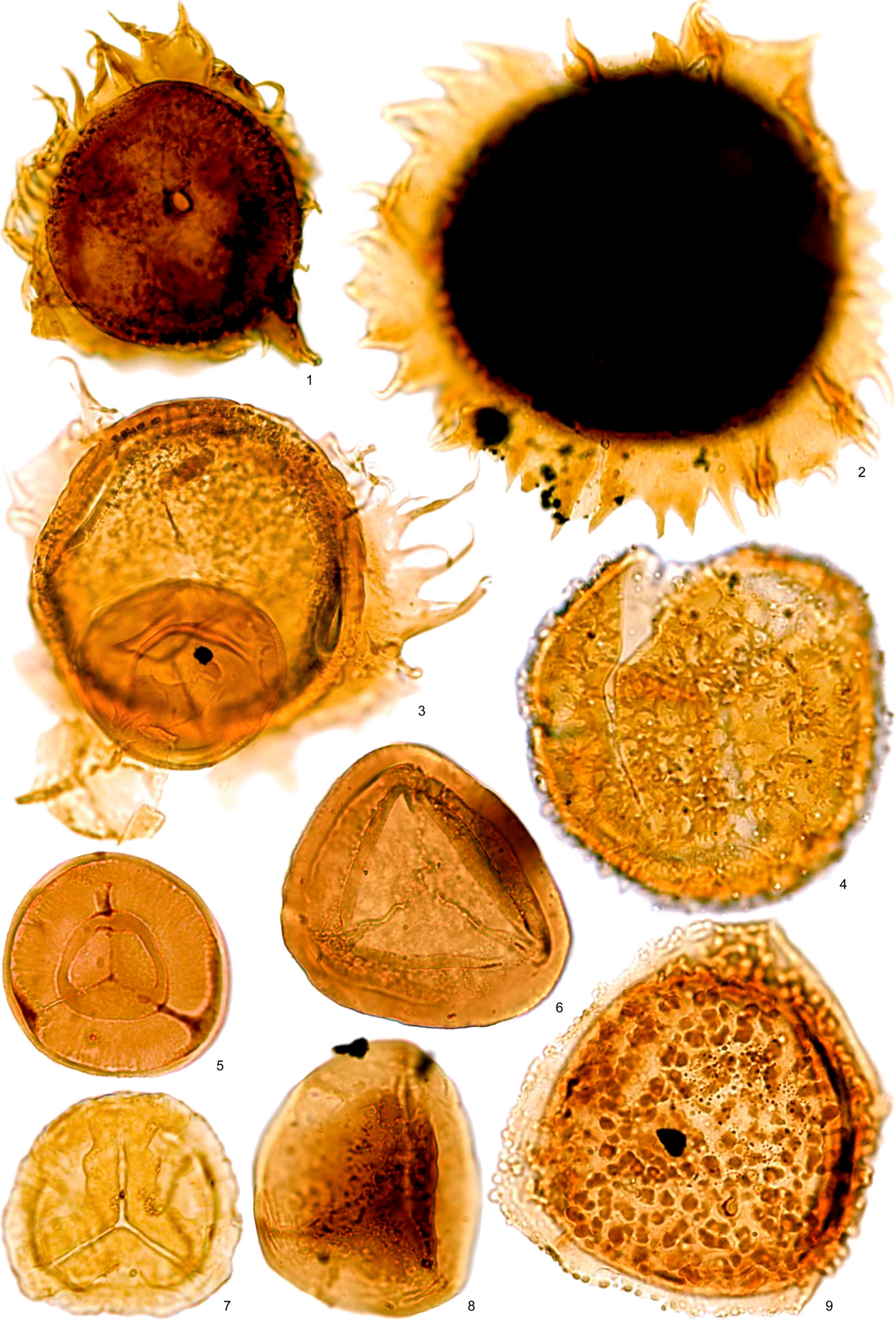

Plate 116

Plate 117.

1-13. Unidentified trilete spores.

1. Magnification x750. A1-69, 1277', 62635, M32/1.
2. UTMN-1830, 13738.5', 62322, S37/2.
3. MG-1, 2178 m, 62995, H42/1.
4. UTMN-1830, 13689.7', 62316, D34/2.
5. A1-69, 1540', 26987, D46.
6. JNDL-1, 156.0', 60839, E39/3.
7. JNDL-1, 156.0', 60839, J40/2.
8. S-462, 1760-1765', 63254, J28.
9. MG-1, 2270 m, 62849, Q44/1.
10. MG-1, 2520 m, 62594, R47/3.
11. MG-1, 2543 m, 62813, Q36.
12. JNDL-1, 155.6', 60838, D48.
13. S-462, 1710-1715', E48/4.

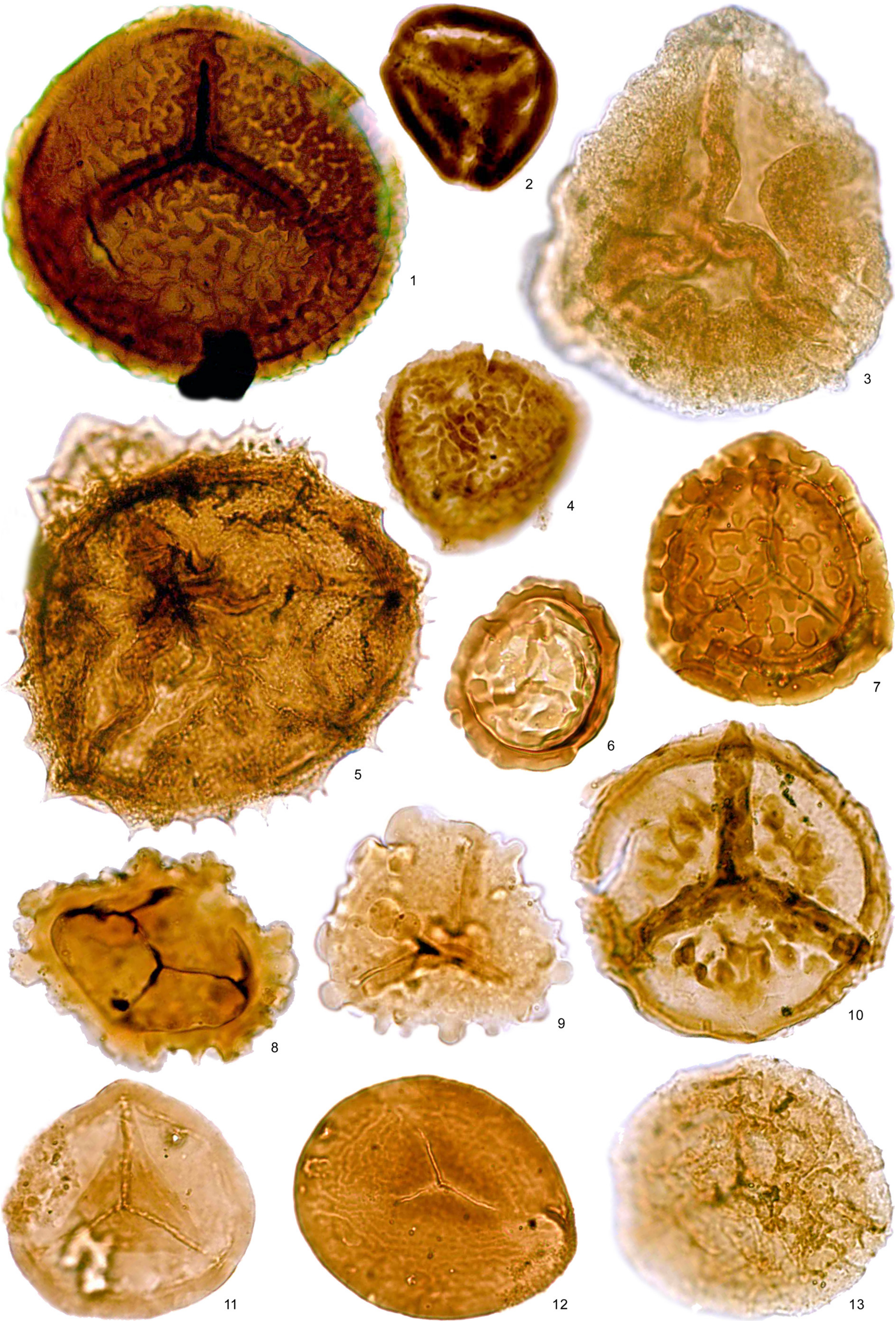

Plate 117

Plate 118.

1-3. *Contagisporites optivus* (Tchibrikova) Owens, 1971.
1. S-462, 2110-2115’, 63272, N40/1.
2. S-462, 2260-2265’, 63281, Q28/2.
3. S-462, 2110-2115’, 63272, O31.

4-6. *Corystisporites collaris* (Tiwari & Schaarschmidt, 1975).
4. A1-69, 1109’, 27274, O45/1.
5. S-462, 1760-1765’, 63255, P36/1.
6. A1-69, 971’, 62639, T32.

7-9. *Corystisporites multispinosus* Richardson, 1965.
7. A1-69, 1700’, 62632, R50.
8. A1-69, 1700’, 62633, T43/2.
9. A1-69, 1596’, 26989, T39.

10-15. *Corystisporites undulatus* Turnau, 1996.
10. A1-69, 1109’, 27273, E50/4.
11. A1-69, 971’, 62641, K46/2.
12. A1-69, 1277’, 62636, R29/2.
13. MG-1, 2205 m, 62595, G30/2.
14. MG-1, 2295 m, 63005, X51/3.
15. A1-69, 1277’, 62636, E35/3.

16-18. *Craspedispora ghadamisensis* Loboziak & Streel, 1989.
16. A1-69, 1322’, 27125, K54/2.
17. A1-69, 1596’, 26990, D44.
18. A1-69, 1700’, 62634, M37/2.

19-21. *Cristatisporites* sp. 1.
19. MG-1, 2713 m, 62811, H36.
20. MG-1, 2264 m, 62951, L42/3.
21. MG-1, 2285 m, 62846, L46.

22-24. *Cristatisporites* sp. 2.
22. MG-1, 2241 m, 62964, H44/3.
23. MG-1, 2270 m, 62849, R42/3.
24. MG-1, 2375 m, 62773, L33.

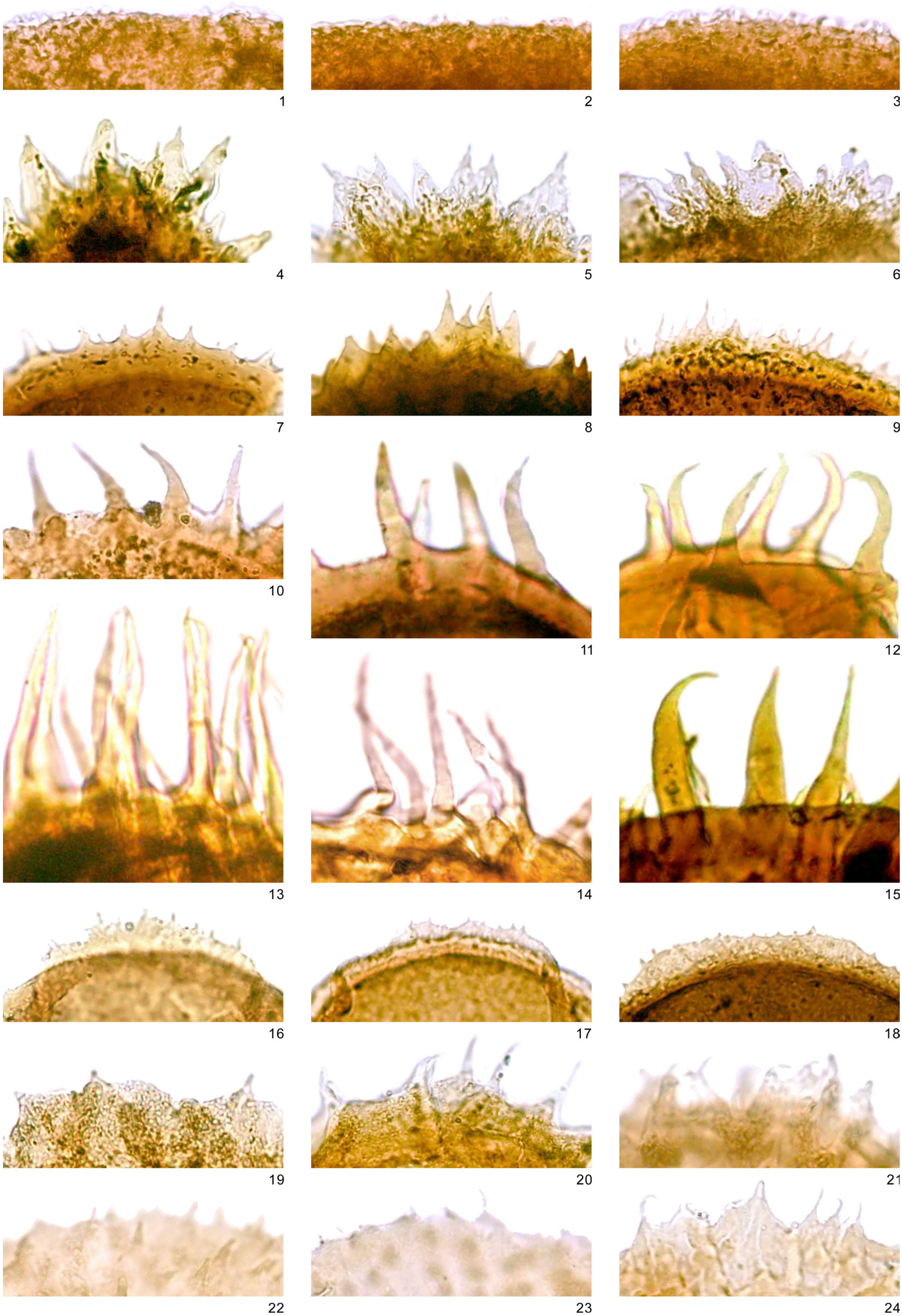

Plate 118

Plate 119.

1-3. *Cristatisporites* sp. 2.
1. MG-1, 2241 m, 62964, T30/1.
2. MG-1, 2285 m, 6285, J27.
3. A1-69, 1322', 27126, O37/1.

4-9. *Densosporites devonicus* Richardson, 1960.
4. MG-1, 2292 m, 63023, T29.
5. MG-1, 2483 m, 62802, C37/4.
6. MG-1, 2315 m, 62783, Q42.
7. MG-1, 2456 m, 62739, G44.
8. MG-1, 2295 m, 63007, E47/1.
9. MG-1, 2527 m, 63003, G34/2.

10-15. *Grandispora cassidea* (Owens) Massa & Moreau-Benoit, 1976.
10. MG-1, 2465 m, 62852, R43/2.
11. MG-1, 2518 m, 62805, N27/4.
12. MG-1, 2161.8 m, 62529, J49/1.
13. MG-1, 2536 m, 62740, L40.
14. MG-1, 2161.8 m, 62528, X52/2.
15. MG-1, 2639 m, 62778, T42.

16-24. *Grandispora douglastownense* McGregor, 1973.
16. A1-69, 1962', 27278, O39.
17. A1-69, 1962', 27278, P44/3.
18. A1-69, 1962', 27277, U54/3.
19. JNDL-1, 174.6', T32.
20. JNDL-1, 177.0', 60850, P45/4.
21. JNDL-1, 162.3', 60841, K44.
22. JNDL-1, 156.0', P36/3.
23. JNDL-1, 167.8', N37.
24. ABSF-29, 16327.6', E49.

25-27. *Grandispora fibrilabrata* Balme, 1988.
25. S-462, 1810-1815', 63257, R48.
26. S-462, 1860-1865', 63258, P27/1.
27. S-462, 2010-2015', 63266, S34.

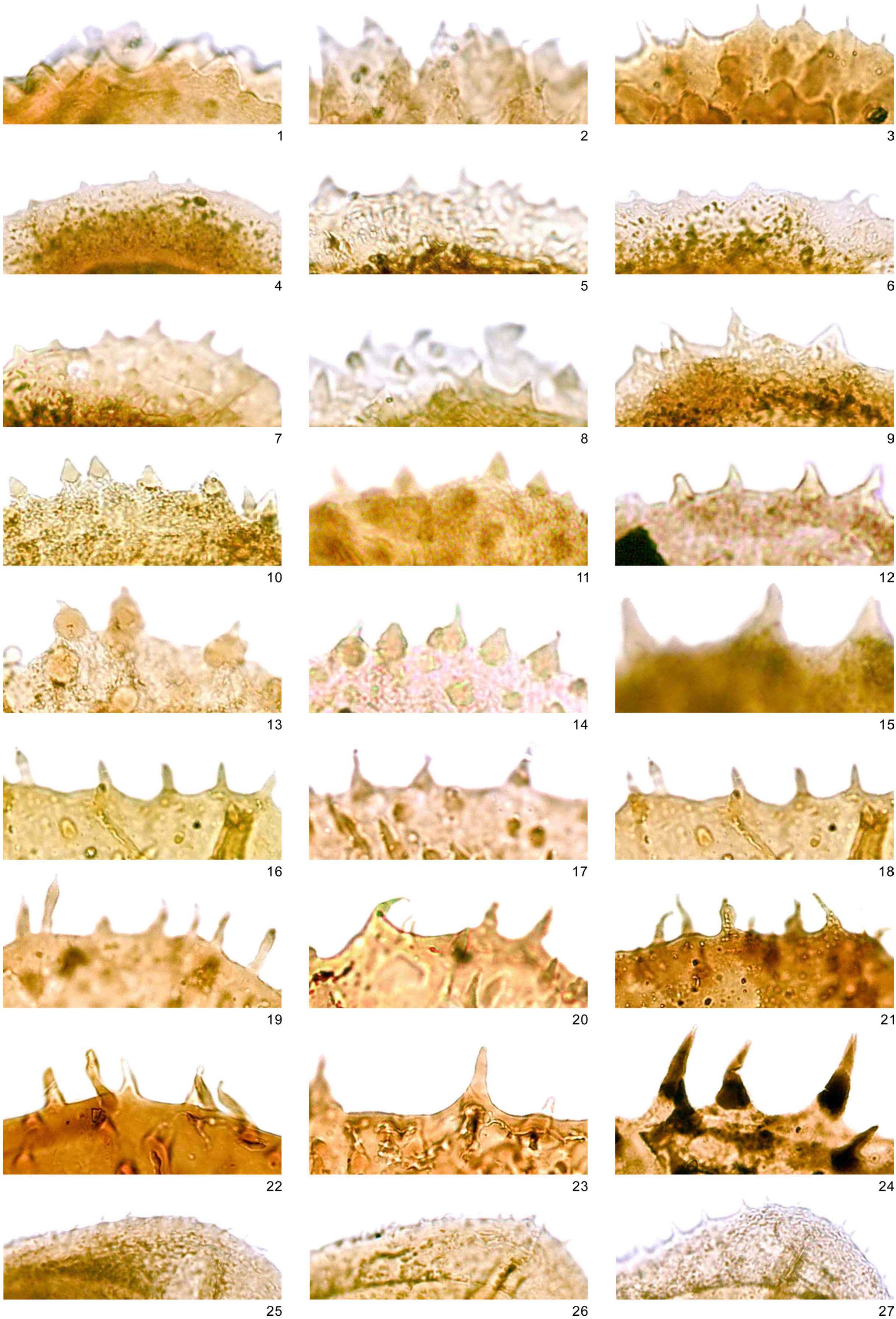

Plate 119

Plate 120.

1-3. *Grandispora gabesensis* Loboziak & Streel, 1989.

1. A1-69, 1596', 26990, P39/4.
2. A1-69, 1962', 27278, H51.
3. A1-69, 1483', 26994', S46/4.

4-12. *Grandispora incognita* (Kedo) McGregor & Camfield, 1976.

4. YBRN-1, 16684.3', 62427, D43.
5. A1-69, 1416', 26992, Q38/4.
6. A1-69, 1596', 26990, H36.
7. A1-69, 1540', 26988, Q37/2.
8. A1-69, 1540', 26988, N40/3.
9. A1-69, 1540', 26987, H37/1.
10. A1-69, 1277', 62636, K39.
11. A1-69, 1277', 62636, O41/4.
12. A1-69, 1277', 62636, M33.

13. *Grandispora inculta* Allen, 1965. S-462, 2060-2065', 63270, N30/3.

14-25. *Grandispora libyensis* Moreau-Benoit, 1980b.

14. A1-69, 1322', 27126, H36.
15. A1-69, 1277', 62635, Y31/2.
16. A1-69, 1416', 26993, G31/3.
17. A1-69, 1277', 62637, M31.
18. A1-69, 1416', 26993, R40.
19. A1-69, 1416', 26992, C37/2.
20. A1-69, 1416', 26993, S55/2.
21. A1-69, 1416', 26993, O43.
22. A1-69, 1277', 62636, O31/3.
23. A1-69, 1277', 62637, L51.
24. A1-69, 1174', 62673, O32/3.
25. A1-69, 1416', 26993, K31/3.

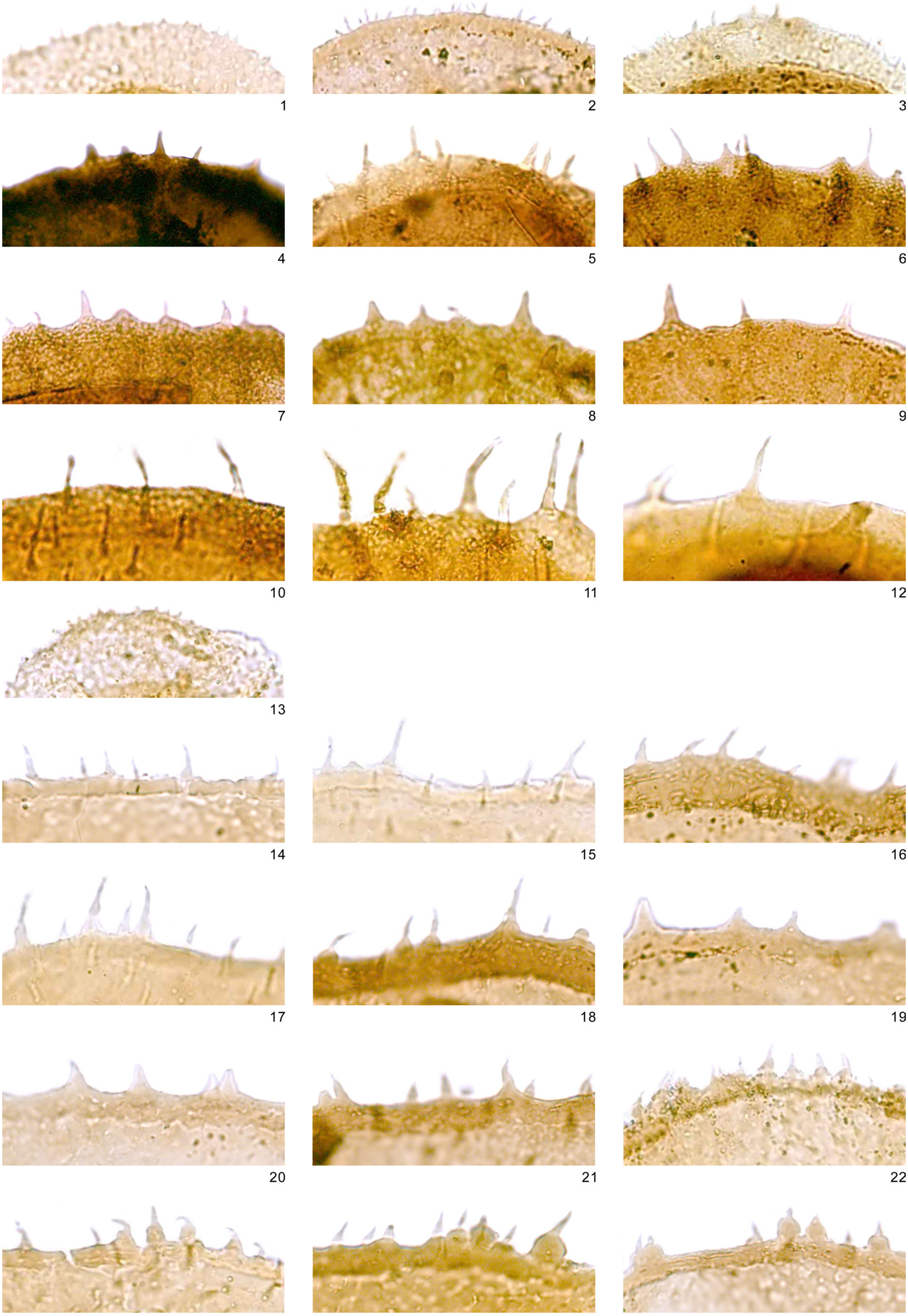

Plate 120

Plate 121.

1-9 *Grandispora libyensis* Moreau-Benoit, 1980b.
1. A1-69, 1174’, 62673, O32/3.
2. A1-69, 1334’, 27128, H39/4.
3. A1-69, 1334’, 27128, H39/4.
4. A1-69, 1296’, 62644, U29/1.
5. A1-69, 1296’, 62644, U29/1.
6. A1-69, 1296’, 62645, F36.
7. A1-69, 1296’, 62645, G47/2.
8. A1-69, 1296’, 62644, T35/1.
9. A1-69, 1296’, 62645, R43.

10-18. *Grandispora ?naumovii* (Kedo) McGregor, 1973.
10. S-462, 1710-1715’, 63222, G44/3.
11. S-462, 1710-1715’, 63222, V40.
12. S-462, 1710-1715’, 63224, F49-50.
13. S-462, 1660-1665’, 63219, L38/4.
14. S-462, 1760-1765’, 63254, J30.
15. S-462, 1470-1475’, 63213, J41/3.
16. A1-69, 1530’, 26984, J34/2.
17. A1-69, 1530’, 26984, J34/2.
18. A1-69, 1334’, 27127, O47.

19-24. *Grandispora permulta* (Daemon) Loboziak et al., 1999.
19. A1-69, 1277’, 62637, V49/1.
20. A1-69, 1322’, 27125, H39/4.
21. ABSF-29, 16358.5’, 61972, W31.
22. A1-69, 1277’, 62637, U47/1.
23. A1-69, 1483’, 26995, W43/3.
24. A1-69, 1296’, 62643, G34/1.

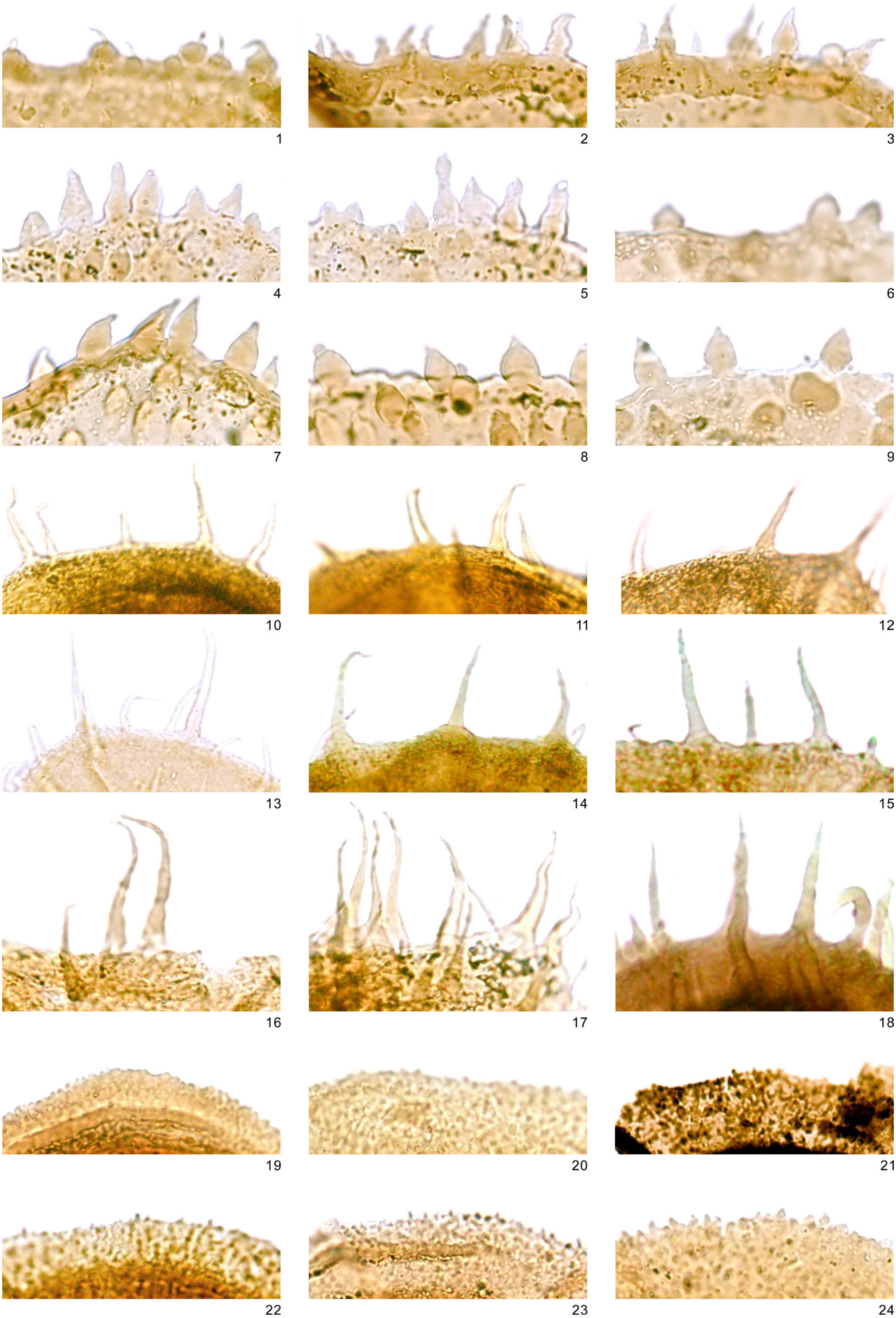

Plate 121

Plate 122.

1-3. *Grandispora permulta* (Daemon) Loboziak et al., 1999.
1. A1-69, 1596’, 26989, U46/3.
2. A1-69, 1530’, 26984, R46/4.
3. A1-69, 1596’, 26989, T43.

4-15. *Grandispora protea* (Naumova) Moreau-Benoit, 1980b.
4. JNDL-1, 495.0’, 60854, P51.
5. A1-69, 1962’, 27278, T36/3.
6. JNDL-1, 156.0’, 60840, Q32.
7. JNDL-1, 174.6’, 60848, P34.
8. JNDL-1, 174.6’, 60848, S43/4.
9. A1-69, 1530’, 26984, T54/1.
10. JNDL-1, 174.6’, Q39/4.
11. JNDL-1, 177.0’, 60849, L51/2.
12. A1-69, 1962’, 27278, T44/4.
13. JNDL-1, 172.7’, 60845, O40/2.
14. A1-69, 1962’, 27278, M49/1.
15. JNDL-177.0’, 60849, K51/1.

16-21. *Grandispora rarispinosa* Moreau-Benoit, 1980b.
16. S-462, 1710-1715, 63222, X40.
17. MG-1, 2182.4 m, 62527, Q32.
18. MG-1, 2285 m, 62845, L26/3.
19. MG-1, 2161.8 m, 62529, E50/4.
20. MG-1, 2413 m, 62776, R35/2.
21. MG-1, 2160.6 m, 62746, Q27/4.

22-24. *Grandispora stolidotus* (Balme) comb. nov.
22. A1-69, 1322’, 27126, Q39/3.
23. A1-69, 1322’, 27126, R42.
24. MG-1, 2465 m, 62852, L52/3.

25-30. *Grandispora velata* (Richardson) McGregor, 1973.
25. A1-69, 1416’, 26992, U47/2.
26. A1-69, 1540’, 26987, F41.
27. A1-69, 1530’, 26984, H40/1.
28. A1-69, 1867’, 26969, R53/4.
29. JNDL-1, 177.0’, 60849, F32/1.
30. A1-69, 1962’, 27277, F32/4.

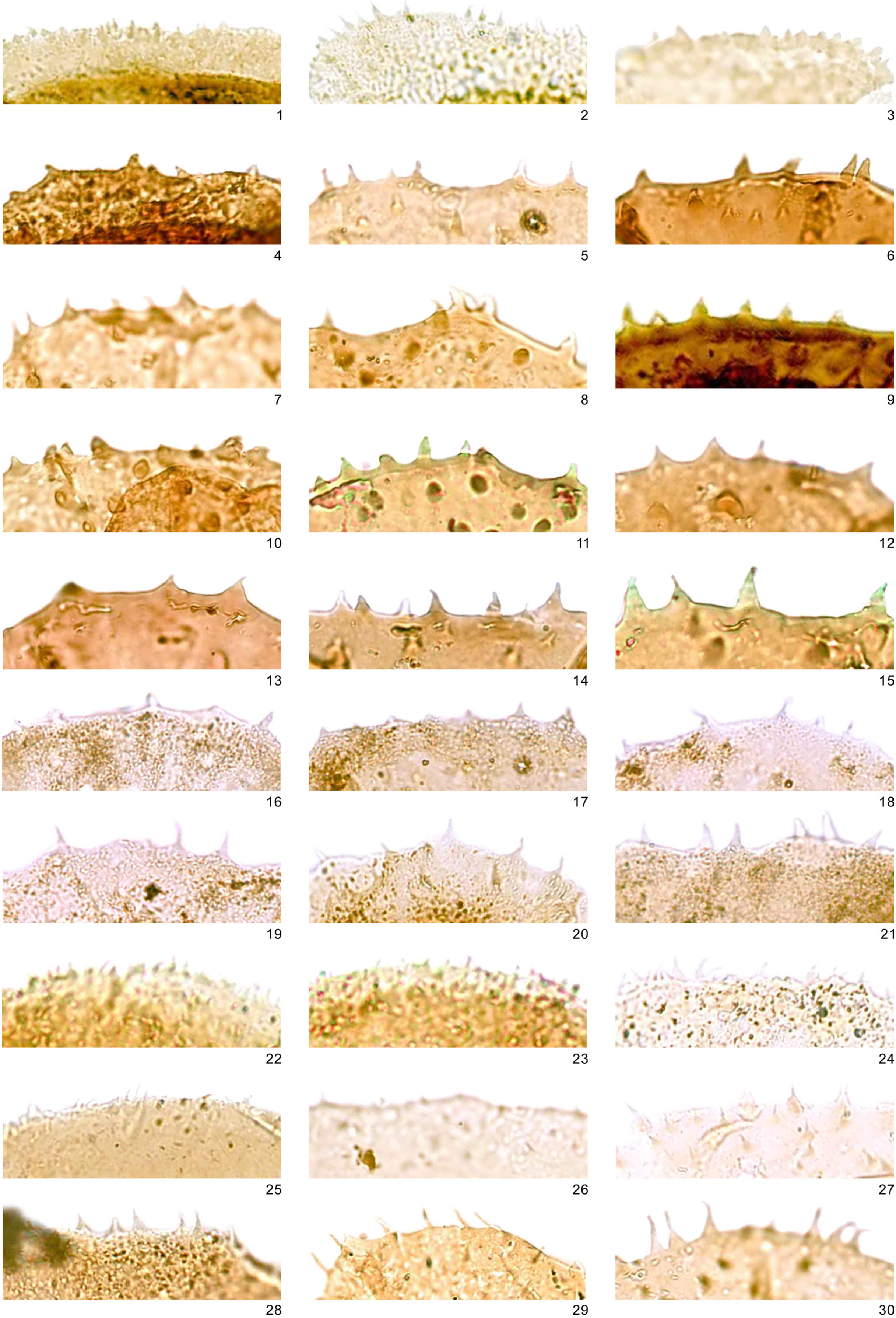
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Plate 122

Plate 123.

1-3. *Grandispora* sp. 1.
1. MG-1, 2241 m, 62966, S39/1.
2. MG-1, 2247 m, 62942, K37/3.
3. MG-1, 2465 m, 62852, H35.

4-6. *Hystricosporites* sp. 1.
4. MG-1, 2160.6 m, 62746, M49.
5. MG-1, 2161.8 m, 62528, Q44.
6. MG-1, 2160.6 m, 62727, E49.

7-9. *Hystricosporites* sp. 2.
7. MG-1, 2295 m, 63007, P37.
8. MG-1, 2375 m, 62772, H34/1.
9. MG-1, 2295 m, 63006, L52/3.

10-12. *Jhariatriletes emsiensis* (Moreau-Benoit) comb. nov.
10. A1-69, 1962', 27277, T45/4.
11. A1-69, 1962', 27278, J42.
12. A1-69, 1962', 27277, Q40.

13-15. *Samarisporites angulatus* (Tiwari & Schaarschmidt) Loboziak & Streel, 1989.
13. A1-69, 1596', 26990, K40/2.
14. A1-69, 1870', 26973, K41.
15. A1-69, 1867', 26969, D37.

16-18. *Samarisporites eximius* (Allen) Loboziak & Streel, 1989.
16. JNDL-1, 162.3', S45/3.
17. A1-69, 1334', 27127, N53/2.
18. JNDL-1, 177.0', 60849, O39.

19-21. *Samarisporites triangulatus* Allen, 1965.
19. A1-69, 1277', 62636, X31/1.
20. A1-69, 1277', 62637, T29/1.
21. MG-1, 2182.4 m, 62527, Q29/2.

22-24. *Samarisporites* sp. 1.
22. MG-1, 2741.4 m, 62611, L28/1.
23. MG-1, 2741.4 m, 62611, P39/2.
24. MG-1, 2741.4 m, 62611, K41.

25-27. *Samarisporites* sp. 2.
25. A1-69, 1334', 27127, K48.
26. MG-1, 2258 m, 62947, M39/2.
27. MG-1, 2258 m, 62947, M39/2.

28-30. *Samarisporites* sp. 4.
  28. A1-69, 1596’, 26989, G38/1.
  29. A1-69, 1596’, 26989, S55.
  30. A1-69, 1596’, 26990, N36.

31-33. *Verrucisporites ellesmerensis* (Chaloner) Chi & Hills, 1976.
  31. S-462, 1710-1715’, 63222, H31.
  32. S-462, 1860-1865’, 63258, N31/2.
  33. S-462, 1860-1865’, 63259, H38.

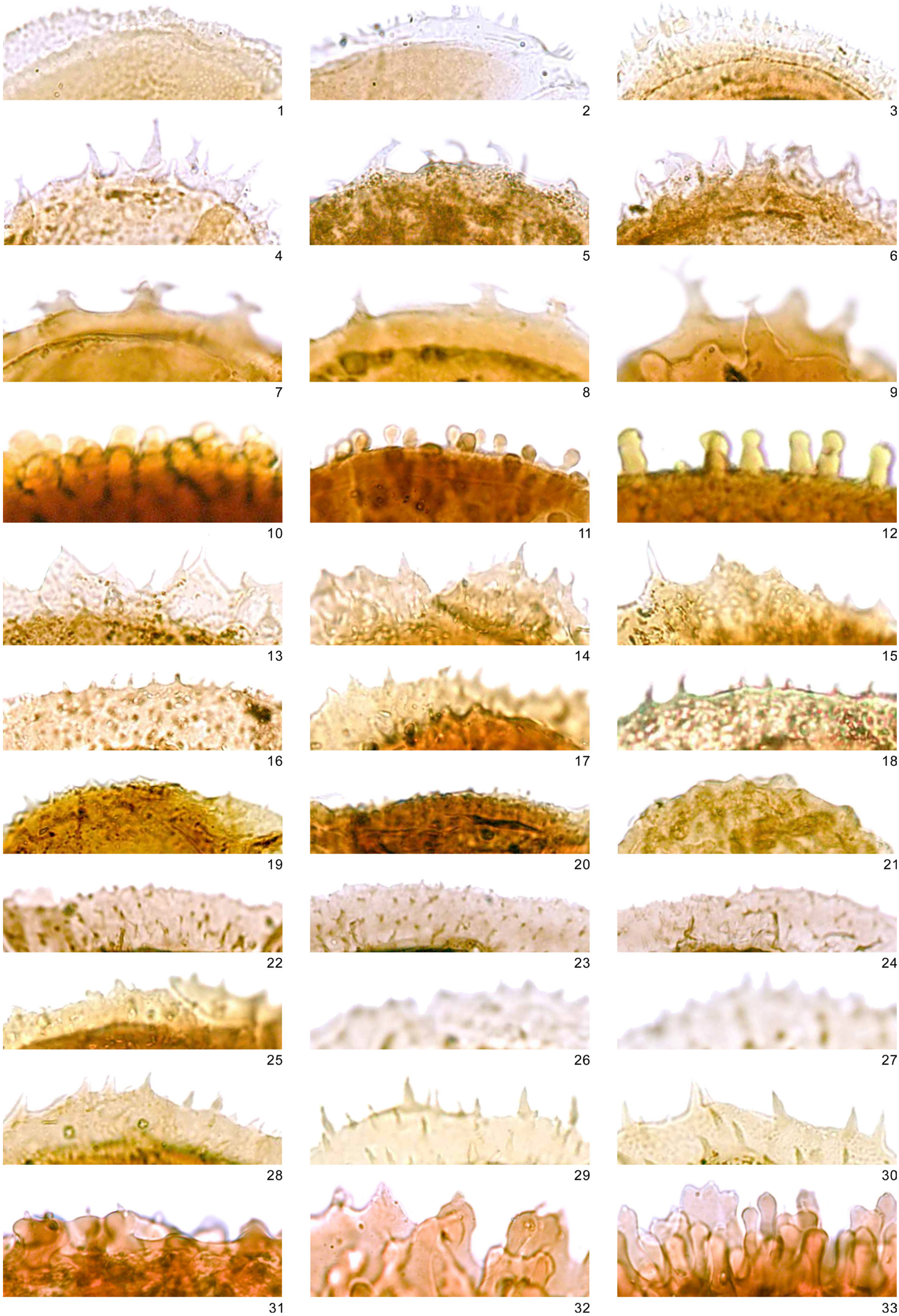

Plate 123

Plate 124.

1-10. Unidentified algae.

1. Magnification x500. JNDL-4, 221.8', P48/1.
2. Magnification x500. BAQA-2, 56.0', Q38.
3. Magnification x500. BAQA-2, 56.0', R45.
4. Magnification x500. JNDL-4, 221.8', M33/3.
5. JNDL-4, 112.0', L35/3.
6. JNDL-4, 118.0', M35/4.
7. Magnification x500. BAQA-1, 345.5', U41/2.
8. Magnification x500. BAQA-1, 345.5', T27/1.
9. Magnification x500. BAQA-1, 345.5', V27/2.
10. Magnification x500. BAQA-1, 345.5', X37/2.

Plate 124

Plate 125.

1-4. *Leisphaeridia jaufensis*.

1. JNDL-4, 177.7’, D37/4.
2. JNDL-4, 177.7’, J37.
3. JNDL-4, 177.7’, F38.
4. JNDL-4, 177.7’, P37/4.

5-26. Unidentified acritarchs.

5. ABSF-29, 16356.7’, 61967, L33/3.
6. ABSF-29, 16356.7’, 61967, D37/1.
7. ABSF-29, 16356.7’, 61967, D33/4.
8. ABSF-29, 16356.7’, 61967, H33.
9. KHRM-2, 16223.0’, 62807, W33/2.
10. KHRM-2, 16224.7’, 62090, R33/4.
11. BAQA-1, 406.0’, V42.
12. KHRM-2, 16223.0’, 62807, G34.
13. JNDL-3, 225.7’, S42/3.
14. JNDL-3, 225.7’, T31.
15. KHRM-2, 16316.6’, 62157, O32/1.
16. KHRM-2, 16316.6’, 62157, W35.
17. Magnification x500. MG-1, 2483 m, 62803, U41/2.
18. JNDL-3, 225.7’, Q47.
19. KHRM-2, 16224.7, 62091, G34.
20. JNDL-3, 421.8’, R40.
21. BAQA-1, 308.3’, B33/4.
22. BAQA-1, 395.2’, J22/4.
23. JNDL-3, 235.8’, T32/1.
24. JNDL-3, 235.8’, U26.
25. BAQA-1, 175.9’, P35/1.
26. UTMN-1830, 13613.2 m, 62370, M34/1.

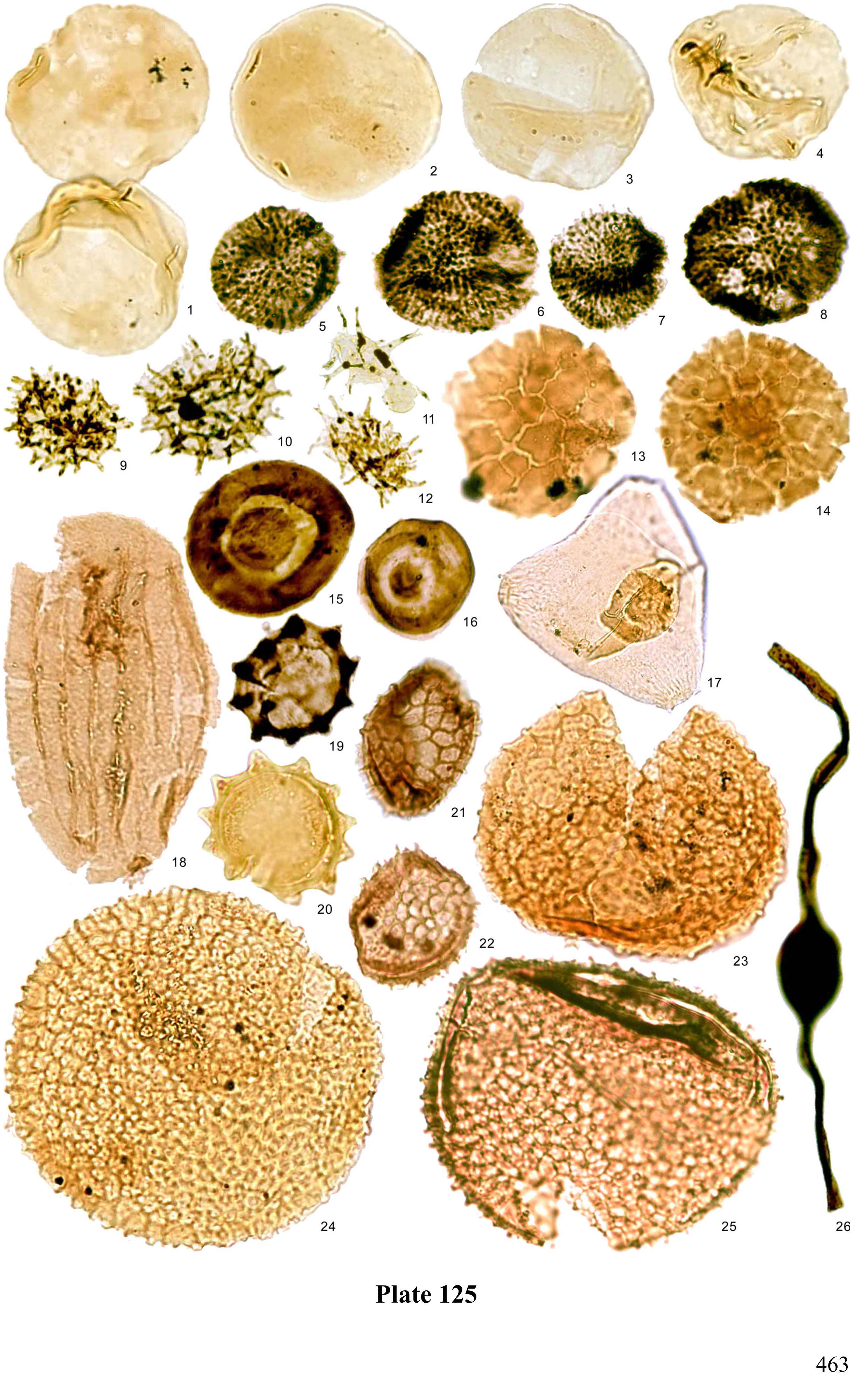

Plate 125

Plate 126.

1-8. Unidentified algae.

1. JNDL-3, 389.0’, V35/3.
2. JNDL-3, 225.7’, F32.
3. JNDL-1, 174.6’, 60848, W41/3.
4. UTMN-1830, 13738.5’, 62325, Q42/3.
5. UTMN-1830, 13738.5’, 62325, T31.
6. Magnification x500. JNDL-1, 155.6’, 60837, T49/3.
7. Magnification x500. JNDL-1, 156.0’, 60840, U30/1.
8. Magnification x500. JNDL-1, 156.0’, 60839, T26-27.

Plate 126

Plate 127.

1-9. Unidentified algae.

1. Magnification x500. JNDL-4, 221.8’, K27/1.
2. Magnification x500. JNDL-4, 221.8’, Q40.
3. JNDL-1, 153.8’, 60834, P39.
4. JNDL-1, 153.8’, 60834, Q50.
5. BAQA-2, 64.5’, S53.
6. JNDL-1, 154.5’, 60835, N38.
7. Magnification x500. A1-69, 1830’, 26962, R51.
8. Magnification x500. A1-69, 1830’, 26961, P35.
9. Magnification x500. A1-69, 1830’, 26962, D42.

10. *Coenobium* spp. UTMN-1830, 13670.8’, 62381, N48.

11-22. Unidentified algae.

11. JNDL-1, 156.0’, 60839, M42/2.
12. JNDL-1, 155.6’, 60838, K46/4.
13. JNDL-1, 167.8’, 60842, J35.
14. JNDL-1, 156.0’, 60839, C30/4.
15. KHRM-2, 16273.0’, 62120, P30/3.
16. JNDL-1, 156.0’, 60840, G40.
17. JNDL-3, 225.7’, W26/4.
18. JNDL-3, 225.7’, H26/1.
19. UTMN-1830, 13689.7’, 62317, F37.
20. UTMN-1830, 13738.5’, 62325, W37.
21. UTMN-1830, 13738.5’, 62325, D48.
22. UTMN-1830, 13738.5’, 62325, X30/2.

Plate 127

Plate 128.

1-20. *Quadrisporites spp.*

1. JNDL-3, 258.7’, G46.
2. A1-69, 2108/2111, 26912, G52.
3. KHRM-2, 16224.7’, 62090, D56.
4. JNDL-1, 155.6’, R39/4.
5. UTMN-1830’, 13614.1’, 62374, X26.
6. JNDL-1, 155.6’, W43.
7. UTMN-1830, 13738.5’, 62322, J39.
8. UTMN-1830, 13670.8’, 62381, S52.
9. UTMN-1830, 13738.5’, 62325, T40/2.
10. UTMN-1830, 13738.5’, 62324, O54/2.
11. UTMN-1830, 13738.5’, 62322, H33/3.
12. UTMN-1830, 13738.5’, 62325, X43/4.
13. UTMN-1830, 13738.5’, 62323, L49.
14. UTMN-1830, 13738.5’, 62323, Q33/4.
15. UTMN-1830, 13738.5’, 62324, G51.
16. JNDL-1, 153.8’, 60832, N27/3.
17. JNDL-3, 225.7’, C38/4.
18. KHRM-2, 16226.0’, 62093, U37/2.
19. UTMN-1830, 13614.6’, 62379, E46.
20. JNDL-4, 399.3’, T43.

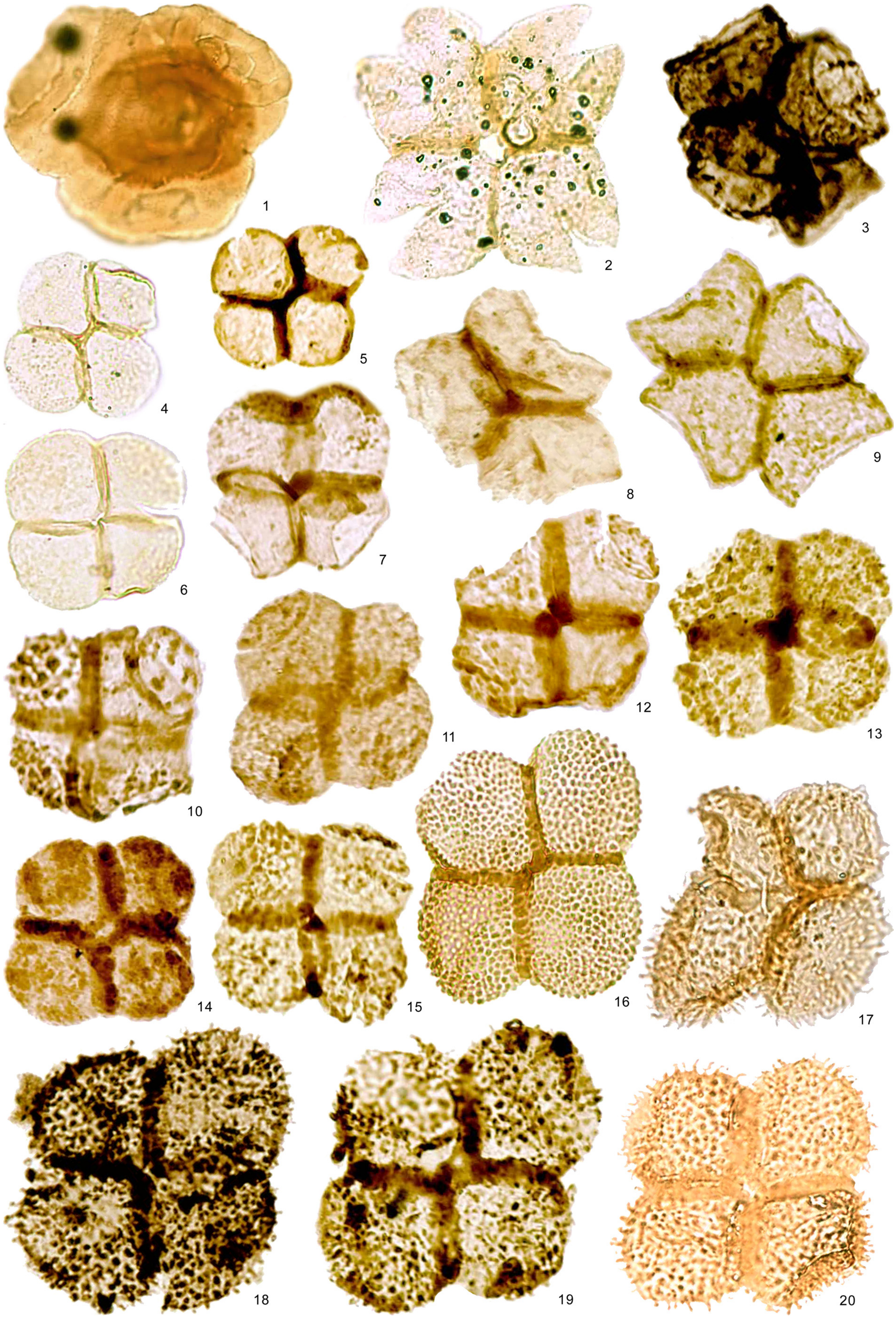

Plate 128

Plate 129.

1-8. Unidentified algae.

1. BAQA-1, 395.2', 62273, G32-33.
2. BAQA-1, 308.3', V23.
3. BAQA-1, 371.1', J33/3.
4. BAQA-2, 52.0', O36.
5. BAQA-2, 56.0', H33.
6. BAQA-2, 56.0', T50/2.
7. BAQA-2, 64.5', Q36/2.
8. BAQA-2, 64.5', H23/3.

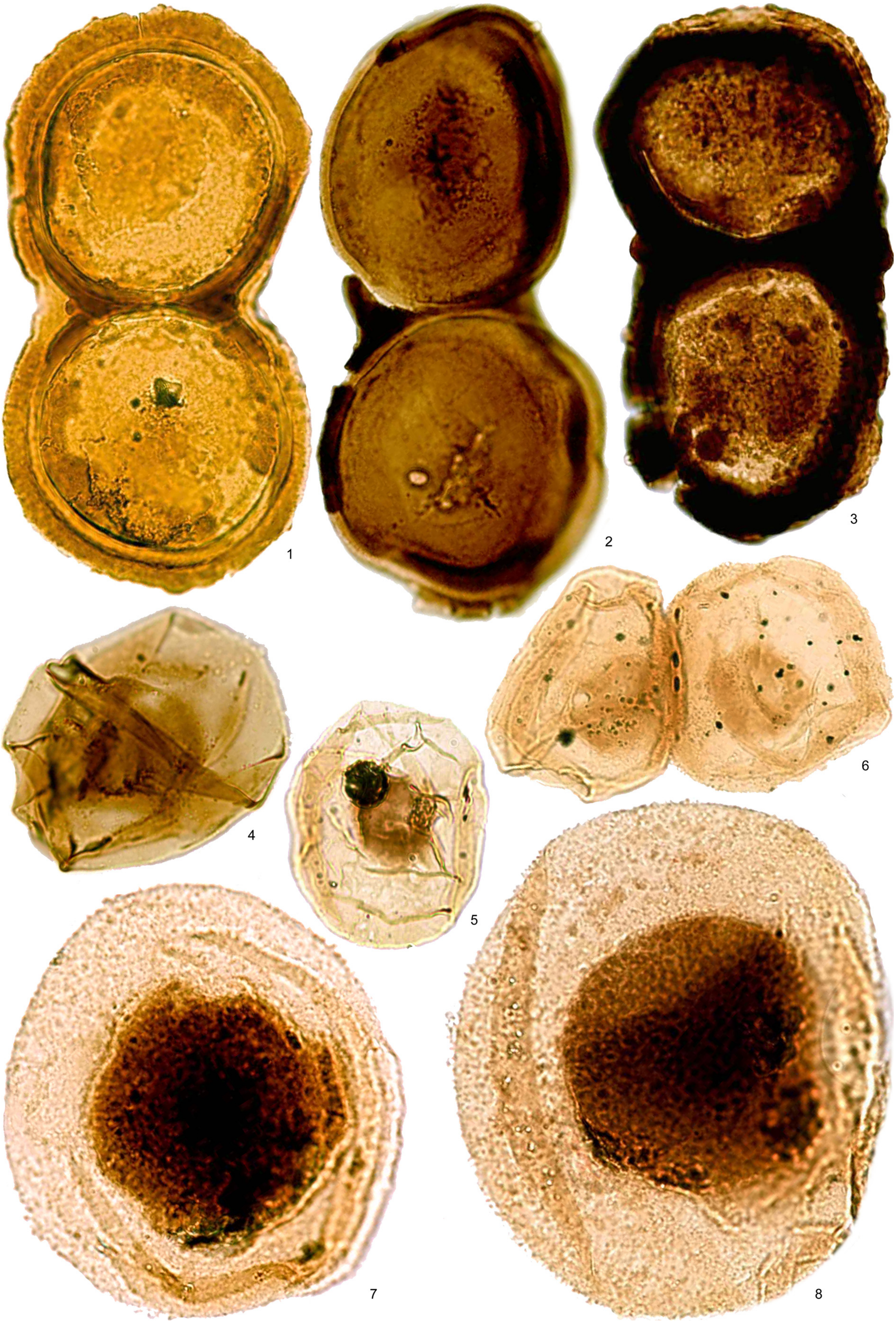

Plate 129

Plate 130.

1, 2. Unidentified scolecodonts. Magnification x500.
1. BAQA-2, 133.0’, X35/1.
2. BAQA-1, 376.4’, K46/3.

3, 4. Unidentified chitinozoans. Magnification x500.
3. A1-69, 1293’, 63067, H32/4.
4. JNDL-4, 163.7’, X46/3.

5-7. Unidentified fungal spores.
5. BAQA-1, 222.5’, V36/3.
6. KHRM-2, 16273.0’, 62121, U33.
7. ABSF-29, 16327.6’, V37.

8-10. Eurypterid fragments.
8. Magnification x250. JNDL-3, 368.8’, U35/3.
9. Magnification x500. BAQA-1, 205.8’, T49.
10. Magnification x500. BAQA-1, 205.8’, M41.

11-14. Copepod eggs (Arai, pers. comm., 2007). Magnification x500.
11. JNDL-3, 353.8’, T43/2.
12. JNDL-4, 48.1’, X39.
13. BAQA-1, 169.1’, M48/4.
14. JNDL-4, 185.0’, Q53.

15. ?*Arpylorus* spp. Magnification x500. JNDL-4, 221.8’, V45.

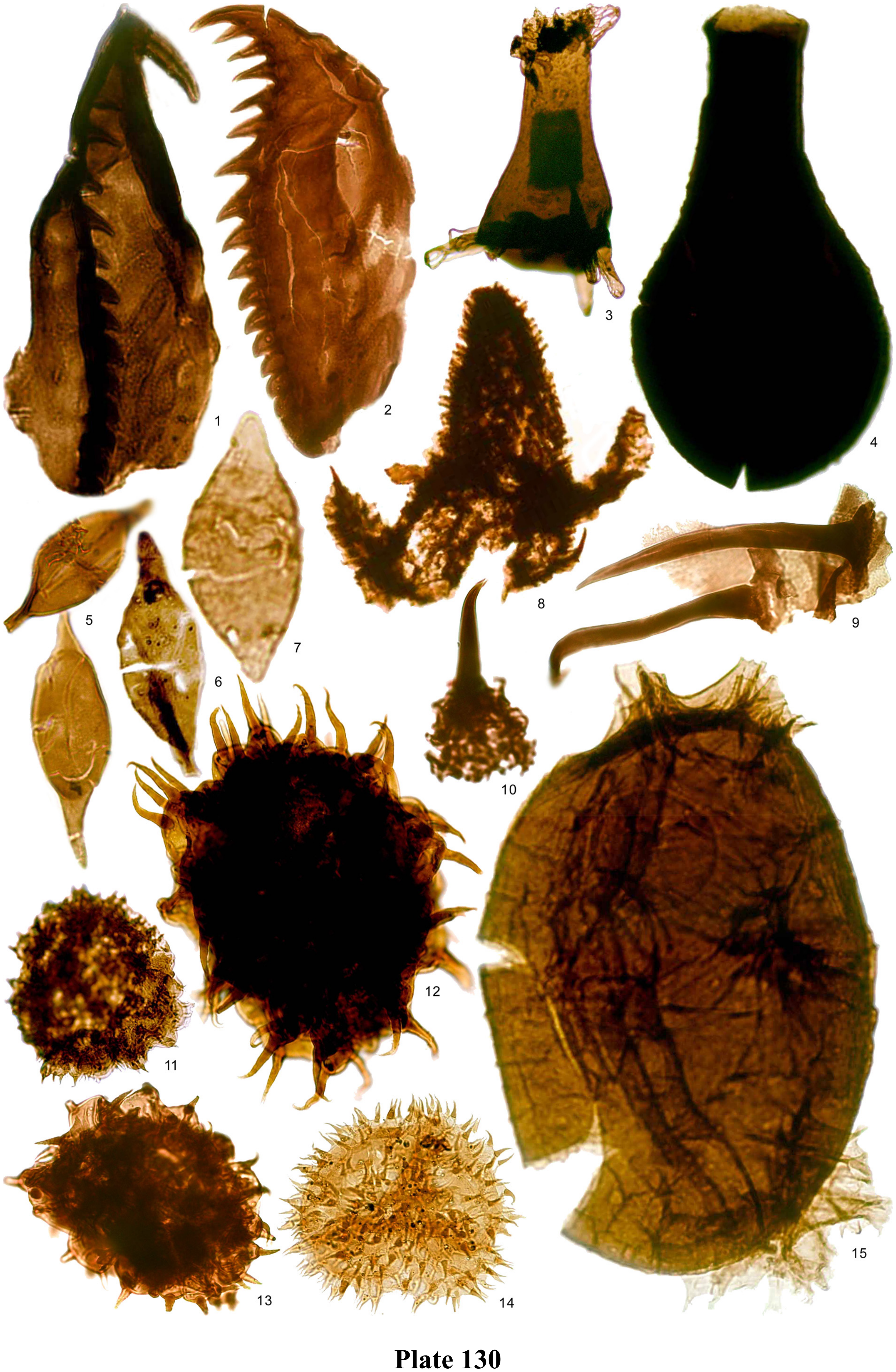

Plate 130