The miospore genus *Lycospora* (Schopf et al.) Potonié & Kremp is one of the most abundant and most often recorded Carboniferous miospores (e.g. Smith 1962, Smith & Butterworth 1967, Somers et al. 1972, Bek 2012). The genus was established by Schopf et al. (1944) and emended by Potonié & Kremp (1954) and Somers et al. (1972). The first records of *Lycospora* concern its *in situ* occurrences from mono- and bisporangiate cones of the *Lepidostrobus* and *Flemingites*-types (Hooker 1848, Carruthers 1865, Schimper 1870). Also the stratigraphically oldest records of *Lycospora* from the Upper Devonian of China are *in situ* from cones of arboreal lycopsids (Wang et al. 2003a, b). The stratigraphically youngest occurrences of *Lycospora* are from Permian strata both as *in situ* (Rayner 1986) and dispersed spores (Brugman et al. 1985, Gao 1985, Görecka & Görecka-Nowak 1999, Lucas et al. 2006). The second emendation of the genus published by Somers et al. (1972) is important because several species were excluded from the genus. Many holotypes of *Lycospora* species were described, figured and synonymised to four main species, *Lycospora pusilla* (Ibrahim) Potonié & Kremp, *L. noctuina* Butterworth & Williams, *L. orbicula* (Potonié & Kremp) Smith & Butterworth and *L. rotunda* Bharadwaj. The latest research of *in situ* *Lycospora* had been published especially from the Pennsylvanian of the Czech Republic (Bek & Opluštil 1998, 2004, 2006; Opluštil & Bek 2009). Criteria for a new division of *Lycospora* were suggested by Bek (2012) who divided *Lycospora* into six morphological groups, reporting seventy-one *in situ* records of *Lycospora*, proposed twenty-nine valid species and excluded sixty-three species from the genus. The main aim of this paper is the separation of one group of non-cingulate pseudosaccate miospores with densely microspinose/spinate sculpture on the distal and proximal surfaces (except for contact area), which were produced by bisporangiate cones of the *Flemingites*-type.

**Material and methods**

Spores are classified according to the system of dispersed spores suggested by Potonié & Kremp (1954, 1955) and improved by Dettmann (1963) and Smith & Butterworth (1967). The terms used for the description of the morphology, including the sculptural elements follows the classification of Punt et al. (2007). The species determinations are based only on these original diagnoses, and not on the interpretations of subsequent authors. *In situ* miospores
macerated by the author and isolated from cones of the genus *Flemingites* Carruthers are stored in the Geological Institute, Academy of Sciences, v.v.i., Prague, Czech Republic. Dispersed miospores were macerated by J. Drábková from the Ovčín locality, Radnice Basin, Czech Republic are stored in the Czech Geological Survey, Prague, Czech Republic.

A NIKON Eclipse 80i microscope was used for the study of the spores. In situ spores were recovered by dissolving small portions (separated from the cone specimens with a mounted needle) of cones in nitric acid (40 per cent) for 24–48 hours and KOH (5 per cent) for 20 minutes. Most spores were mounted in glycerine jelly for direct microscopic examination. Some spores were sputter-coated with gold for examination with a Cameca SX100 SEM. Dispersed miospores were macerated using nitric acid (40 per cent) for 12–24 hours and neutralised by KOH (5 per cent) for 10 minutes. The specimen with cones of *Flemingites lycopoditis* Feistmantel (No. 3536) from the Krčelák locality, Lubná, Rako Mine, Kladno-Rakovník Basin (Bolsovian) is stored in the National Museum, Prague, Czech Republic.

**Systematic position of cingulate Lycospora**

*Lycospora* miospores have been described as having equatorial structure usually named as a flange. Some palynologists interpreted this term as cingulum, some others as cingulum and zona. Morphological heterogeneity of the genus was recognised by Bharadwaj (1957) and Piérart (1964) who distinguished four types of *Lycospora*, Rotunda, Bizońaria and Microcingulata for cingulizate and Lycospora for cingulate species. Smith & Butterworth (1967, pp. 245–247) recognised two morphological types of *Lycospora*, *L. pusilla* and *L. pellucida* (Wicher) Schopf et al., based on histograms of ratios of cingulum (and zona) width to spore radius. Also Thomas (1970), Thomas & Dytko (1980) and Brack-Hanes & Thomas (1983) recognised two main morphologically different types of *Lycospora*, cingulate and cingulizate based on studies of *in situ* spores.

Bek (2012) recognised two groups of cingulate and four groups of cingulizate *Lycospora* species. Cingulate *Lycospora* species were divided into morphologically different types that were produced by different parent cone and plant species (Bek & Opluštíl 2004, Opluštíl & Bek 2009, Bek 2012). The first type (*Lycospora micropapillata* Group) is represented by miospores with a microgranulate to microverrucate sculpture of both surfaces with a higher number of elements on the distal surface. Dispersed species of this group, *Lycospora parva* Kosanke, *L. rugosa* Schemel, *L. tripapillata* Ravn, *L. micropapillata*, *L. pusilla*, *L. rugulosa* Butterworth & Spinner and *L. granianellatus* Staplin were usually produced by the longest and most robust monosporangiate cones of *Lepidostrobus* Brongniart, which could be more than one meter long and about twenty centimeters wide (Bek & Opluštíl 2004, Bek 2012). The second morphological type of cingulate *Lycospora* (*Lycospora granulata* Group) is different, because this group is typical for its densely microspinate/spinate distal surface and laevigate, or sometimes microgranulate/microverrucate proximal surface. Only three dispersed species, *L. granulata* Kosanke, *L. orbicula* and *L. chaloneri* Scott & Hemsley were attributed to this group by Bek (2012). Miospores of the *Lycospora micropapillata* Group were produced by monosporangiate cones of the *Lepidostrobus*-type born on arborescent lycopsids of genera *Lepidodendron* Sternberg and *Lepidophloios* Sternberg, but spores of the *Lycospora granulata* Group were produced by bisporangiate *Flemingites* cones which belong to the arborescent lycopsid genus *Paralycopodites* (Morey & Morey) DiMichele.

Morphological differences and different parent cones and plants are the reason for erection of a new miospore genus *Microspinosporites* gen. nov. for pseudosaccate, distally and proximally (except for laevigate contact area) microspinate miospores produced by the cone genera *Flemingites* and probably *Moscovostrobus* Naugolnykh & Orlova (Bek 2012). Another morphological difference is the separation of an inner body, i.e. pseudosaccate character. Such a separation is not developed in all other species of *Lycospora*.

**Dispersed microspinate Lycospora**

The firstly erected dispersed species of this type, *Lycospora granulata* was established by Kosanke (1950, p. 45) for miospores with coarsely granulate exine and a small equatorial ridge. The diagnosis is poor (*e.g.* with no recognition of the sculpture of proximal and distal surfaces) and without mentioning the character and dimension of the equatorial structure. The holotype (Kosanke 1950, pl. 10, fig. 6) possesses a dark undulate ring delimiting the proximal surface. From the diagnosis, description and illustration is not clear if this structure is a cingulum or a prominent curvatureae, although it resembles a cingulum-like structure.

The second species of this group, *Lycospora orbicula* is described with (emendation given by Smith & Butterworth 1967, p. 249) an indistinct very narrow cingulum that is less than 1 μm in width and less than one-tenth of the radius. *L. orbicula* is not a typical species of the genus in that the cingulum is weakly developed. Potonié & Kremp (1955, p. 63, pl. 13, fig. 179) and Smith & Butterworth (1967, p. 249) defined *L. orbicula* for miospores with a denticulate margin, a finely granulate exine, and ornament lacking or reduced on the proximal surface. It is important,
In situ microspinate Lycospora

Lycospora-producing cones have been referred to the genera Lepidostrobus and Flemingites (Balme 1995). Some Lepidostrobus cones were mono-, some others bisporangiate. Brack-Hanes & Thomas (1983) studied the holotype of the type species, Lepidostrobus ornatus Brongnari, which yielded only cingulizinate Lycospora microspores. Therefore, the genus Lepidostrobus was re-defined for microsporangiate cones with cingulate and some of cingulate Lycospora microspores. Bisporangiate cones producing Lagenicula/Lagenoisporites megasporae and microspinate cingulate Lycospora microspores were assigned to the genus Flemingites by Brack-Hanes & Thomas (1983).

Hoskins & Cross (1940) mentioned the occurrence of microspores from bisporangiate cones of Lepidostrobus aristatus Hoskins & Cross and Flemingites bartletii (Arnold) Brack-Hanes & Thomas, but due to poor drawings (Hoskins & Cross 1940, H. C, figs 15–18) it is not possible to be sure about the precise classification of these microspores.

Moore (1946) described and illustrated microspores isolated from bisporangiate cones Lepidostrobus comosus Lindley & Hutton and L. cf. squarosus. The problem is, that Moore (1946) gave very poor descriptions and measurements of the spores, illustrated several hypothetic stages of maturity of microspores (combination of cingulate and cingulizinate forms with different sculptures) and therefore it is not possible to be sure about precise classification of these microspores.

Chaloner (1953) described microspores from bisporangiate cones Flemingites russelsianus (Binney) Brack-Hanes & Thomas, F. olryi (Zeiller) Brack-Hanes & Thomas and F. dubius Binney (synonymous to Flemingites gracilis Carruthers). All of them are very similar and Chaloner (1953) mentioned that an equatorial structure is not present, or only very slightly. It is possible to see on Chaloner’s illustrations (1953, text-figs 8, 17 and 23), that microspores of all the three cone species have prominent contact areas which only cover the majority of the proximal surface and that a cingulum is not developed.

Felix (1954) is probably the first, who published photomicrographs of in situ microspore microspores of this type isolated from bisporangiate cones Flemingites diversus (Felix) Brack-Hanes & Thomas and stressed their finely granulate (probably microspinate) sculpture. However the photomicrographs (Felix 1954, pl. 14, figs 14, 15; pl. 15, fig. 16) are very poor and it is difficult to be sure about the precise classification of these microspores.

The study published by Balbach (1966) is important as she macerated in situ microspores from coal-balls specimens of F. diversus, described the occurrence of an inner body as an internal membrane and (Balbach 1966, p. 337)

that in the diagnosis the cingulum is stated to be indistinct, very narrow and less than 1 μm in width. In the description of L. orbicula, Smith & Butterworth (1967, p. 249) described the cingulum as apparent only in slightly oblique compression and mentioned the occurrence of curvaturae. In fact, it is questionable if a cingulum can be less than 1 μm wide because the width of the cingulum is usually more than 2 μm (see Felix 1954; Willard 1989a, b; Bek & Opluštil 2004, 2006; Bek 2012). Microspinae are less than 1 μm long being of the same dimension as the equatorial structure.

The last dispersed species of this group, L. chaloneri, is known only in situ from cones Flemingites scottii (Jongmans) Brack-Hanes & Thomas. This species possesses an equatorial structure 2–4 μm wide. Scott & Hemsley (1993, p. 37) interpreted this structure as cingulum and zona. Specimens illustrated by Scott & Hemsley (1993, text-fig. 5B–G) and Hemsley et al. (1996, fig. 6; Fig. 1O herein) showing a prominent laevigate proximal contact area and microspinate/spinate remaining proximal portion and distal surface. It is important to realise that the proximal surface is sculptured except for contact area. We do not know any specimen of Lycospora with positive sculpture of cingulum or zona (Somers et al. 1972; Coquel 1972; Courvoisier & Phillips 1975; Brack-Hanes & Thomas 1983; Thomas 1988; Willard 1989a, b; Bek & Opluštil 1998, 2004, 2006; Bek 2012). Also the prominent microspinae/spinae (or other positive sculpture elements) visible on the margin of spores are not seen on the margins of other Lycospora species. The photomicrographs in light microscopy of Scott & Hemsley (1993, text-fig. 5C–F) are important in showing a narrow dark inner ring represented curvaturae, followed by narrow light middle ring and very narrow outer dark ring consists of microspinae/spinae. The contact area does not cover the whole proximal surface and no cingulum is seen. Hemsley et al. (1996, fig. 6; Fig. 1O herein) illustrated (SEM) the proximal surface of an in situ specimen of L. chaloneri where it is possible to see the sculptureless contact area, a sculptureless narrow inner ring (seen as a light middle ring using light microscopy) and a prominent outer ring of microspinae (seen as a dark sculptured outer ring on the margin).

Smith & Butterworth (1967) illustrated dispersed L. orbicula with prominent inner body (Smith & Butterworth 1967, pl. 20, fig. 19) and without cingulum (Smith & Butterworth 1967, pl. 20, figs 16–18). Ravn (1986, pl. 18, figs 3, 4; Fig. 1D herein) illustrated dispersed L. orbicula with a microspinate margin and a prominent inner body. A cingulum, however, is not seen. Lycospora granulata published by Ravn (1986, pl. 18, figs 12–14) probably has a cingulum. It seems, that these microspores have microgranulate proximal surfaces. The specimen on Ravn’s (1986) pl. 18, fig. 13 shows a relatively wide equatorial structure.
Genus Microspinosporites gen. nov.

Type species. – Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend.

Derivation of the name. – According to the typically densely microspinate sculpture of the distal and a part of the proximal surface.

Systematics

Anteturma Sporites H. Potonié, 1893
Turma Triletes (Reinsch) Dettmann, 1963
Suprasubturma Pseudosaccitrites Richardson, 1965
Infraturma Monospseudosaccitii Smith & Butterworth, 1967

Genus Microspinosporites gen. nov.

Type species. – Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend.
Diagnosis. – Trilete pseudosaccate miospores. Circular to subcircular amb. Rays of trilete mark equal to the diameter of the inner body. The equatorial margin finely microspinate to spinate. Proximal surface microspinate to spinate except for laevigate contact area. Distal surface densely microspinate to spinate. Inner body laevigate. Exine is thicker on the distal than on the proximal hemisphere.

**Microspinosporites chaloneri** (Scott & Hemsley) comb. nov. emend.
Figure 1B, O

1993 *Lycospora chaloneri* Scott & Hemsley, p. 37, text-fig. 5.

**Holotype.** – BMNH V. 63848, Natural History Museum, London, UK.

**Type locality.** – Pettycur Fife, Scotland, UK.

**Stratigraphic level.** – Asbian.

*Emended diagnosis.* – Pseudosaccate trilete miospores, 13.5–25 μm in diameter. Amb roundly triangular. Rays of trilete mark equal to the diameter of the inner body. Proximal surface microspinate and spinate except for laevigate contact area. Distal surface with spinæ and microspinae. Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend.

<table>
<thead>
<tr>
<th>Dispersed Microspinosporites</th>
<th>Diameter (μm)</th>
<th>Width of equatorial structure (μm)</th>
<th>Stratigraphic level of holotype</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Microspinosporites orbiculus</em></td>
<td>26 x 27</td>
<td>Not measured</td>
<td>Bolsovian</td>
</tr>
<tr>
<td><em>Microspinosporites chaloneri</em></td>
<td>13.5–25.5</td>
<td>2–4</td>
<td>Asbian</td>
</tr>
</tbody>
</table>

**In situ Microspinosporites**

<table>
<thead>
<tr>
<th>Parent plant</th>
<th>Diameter (μm)</th>
<th>Width of equatorial structure (μm)</th>
<th>Stratigraphic level</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Lepidostrobus diversus</em></td>
<td>17–27</td>
<td>Not measured</td>
<td>Asturian</td>
<td>Balbach (1966)</td>
</tr>
<tr>
<td><em>Lepidostrobus diversus</em></td>
<td>19–26</td>
<td>1.2</td>
<td>Asturian</td>
<td>Felix (1954)</td>
</tr>
<tr>
<td><em>Lepidostrobus oldhamius</em> (in part)</td>
<td>20–31</td>
<td>1.5</td>
<td>Carbondale</td>
<td>Courvoisier &amp; Phillips (1975)</td>
</tr>
<tr>
<td><em>Flemingites dabis</em></td>
<td>18–21</td>
<td>Not measured</td>
<td>Duckmantian</td>
<td>Chaloner (1953)</td>
</tr>
<tr>
<td><em>Flemingites olyri</em></td>
<td>19–34</td>
<td>Not measured</td>
<td>Duckmantian</td>
<td>Chaloner (1953)</td>
</tr>
<tr>
<td><em>Flemingites rasselianus</em></td>
<td>20–34</td>
<td>Not measured</td>
<td>Duckmantian</td>
<td>Chaloner (1953)</td>
</tr>
<tr>
<td><em>Lepidostrobus bartletti</em></td>
<td>20</td>
<td>Not measured</td>
<td>Asturian</td>
<td>Balbach (1966)</td>
</tr>
<tr>
<td><em>Flemingites schoptii</em></td>
<td>20–30</td>
<td>2</td>
<td>Langsettian</td>
<td>Brack (1970)</td>
</tr>
<tr>
<td><em>Lepidostrobus sp. U</em></td>
<td>Not measured</td>
<td>Not measured</td>
<td>Asturian</td>
<td>Balbach (1966)</td>
</tr>
<tr>
<td><em>Lepidostrobus comosus</em></td>
<td>20–40</td>
<td>Not measured</td>
<td>Asturian</td>
<td>Moore (1946)</td>
</tr>
<tr>
<td><em>Lepidostrobus cf. squarrosus</em></td>
<td>Not measured</td>
<td>Not measured</td>
<td>Asturian</td>
<td>Moore (1946)</td>
</tr>
<tr>
<td><em>Flemingites gracilis</em></td>
<td>18–21</td>
<td>2–3</td>
<td>Duckmantian</td>
<td>Brack-Hanes &amp; Thomas (1983)</td>
</tr>
<tr>
<td><em>Lepidostrobus aristatus</em></td>
<td>26–29</td>
<td>Not measured</td>
<td>Langsettian</td>
<td>Hoskins &amp; Cross (1940)</td>
</tr>
<tr>
<td><em>Flemingites cf. rasselianus</em></td>
<td>26–37</td>
<td>1–2</td>
<td>Westphalian</td>
<td>Opluštil &amp; Bek (2009)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dispersed Microspinosporites</th>
<th>Diameter (μm)</th>
<th>Width of equatorial structure (μm)</th>
<th>Stratigraphic level of holotype</th>
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</tr>
<tr>
<td><em>Microspinosporites chaloneri</em></td>
<td>13.5–25.5</td>
<td>2–4</td>
<td>Asbian</td>
</tr>
</tbody>
</table>

**Table 1.** Measurements of in situ and dispersed mio- and microspores of *Microspinosporites* gen. nov. and their stratigraphical ranges.

**Microspinosporites orbiculus** (Potonié & Kremp) comb. nov. emend.

Figure 1C–E, I, J, L, N

1955 *Cyclogranisporites orbiculus* Potonié & Kremp, p. 63, pl. 13, figs 179–183.


**Holotype.** – Potonié & Kremp, 1955, pl. 13, fig. 179. Preparation 607/2, KT 16.6 110.0.

**Type locality.** – Baldur Seam, Brassert Colliery, Ruhr Coalfield, Germany.
Stratigraphic level. – Lower Bolsovian.

Emended diagnosis. – Pseudosaccate trilete miospores, 20–35 μm in diameter. Amb circumb to oval, margin microspinate. Laesuriae simple, equal to the radius of the inner body, sometimes indistinct. Distal surface microspinate, proximal surface microspinate except for laevigate contact area. Distal exine thicker than exine of the proximal surface. Curvaturae sometimes developed. Contact area from three-quarters to the whole radius. Narrow folds commonly occur.

Remarks. – M. orbiculus is slightly larger (20–35 μm) than M. chaloneri (13.5–25 μm). Another difference is, that the contact area of M. chaloneri is more developed and more prominent. The sculpture elements of M. chaloneri are generally longer (microspinae and spineae) than those of M. orbiculus (only microspinae).

Conclusions

Microspinosporites belong to the group of pseudosaccate genera, especially with Grandispora (Hoffmeister et al.) McGregor, Geminospora (Balme) Playford, Leiozonotritiletes Hacquebard, Spelaetritiletes Neves & Owens. The suprasubturma Pseudosaccitritiletes was proposed for: “Trilete spores with a well-developed cavity separating any two layers of the exine and which do not have, in addition, a solid flange. The exine may have a sculpture, infrastructural...

Figure 1. A – diagrammatic polar section of Geminospora lemurata Balme which corresponds to a section of the genus Microspinosporites gen. nov. Legend: pp – proximal pole; dp – distal pole; i – intine; e – exoexine. From Playford (1983), fig. 5. • B – in situ Microspinosporites chaloneri (Scott & Hemsley) comb. nov. emend. isolated from Flemingites scotti Jongmans. Notice the prominent inner body and the absence of a cingulum. From Balbach (1966), pl. 2, fig. 2, × 1000. • C – microspinate distal surface of dispersed Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. from the Ovčín locality, Radnice Basin, Czech Republic, × 1000. • D – proximal view of dispersed Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. Notice the inner body and the microspinate outer margin. From Ravn (1986), pl. 18, fig. 4, × 1000. • E – microspinate distal surface of Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. from the Ovčín locality, Radnice Basin, Czech Republic. SEM, × 2000. • F – microspinate distal surface of Geminospora lemurata Balme. From Playford (1963), fig. 9B. SEM, × 1200. • G – Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. in situ microspores isolated from Flemingites lycopoditis Feistmantel (No. 3536). • H – semi-lateral view on dispersed Geminospora lemurata Balme. Notice the laevigate proximal surface (left) and the densely microspinate part of the distal hemisphere (right). From Playford (1963), fig. 6C. SEM, × 1000. • I – semi-lateral view of dispersed Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. from the Ovčín locality, Radnice Basin, Czech Republic. Notice the laevigate proximal surface (left) and the densely microspinate part of the distal hemisphere (right). SEM, × 2000. • J – semi-lateral view of dispersed Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. from the Ovčín locality, Radnice Basin, Czech Republic. Notice the laevigate proximal surface (upper) and the densely microspinate part of the distal hemisphere (lower). SEM, × 2000. • K – proximal surface on in situ Geminospora lemurata Balme, isolated from Bisporangiostrobus hamissi Chitaley & McGregor. Notice the laevigate proximal surface and the microspinate/spinate margin. SEM, × 1000. • L – proximal view of in situ Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. isolated from Flemingites lycopoditis Feistmantel (No. 3536). Krčelákovity locality, Lubná, Rako Mine, Kladno-Rakovník Basin (Bohovan). Notice the laevigate proximal surface and the densely microspinate part of the distal hemisphere. From Playford (1963), fig. 6F. SEM, × 1000. • N – semi-lateral view of in situ Microspinosporites orbiculus (Potonié & Kremp) comb. nov. emend. isolated from Flemingites lycopoditis Feistmantel (No. 3536). Krčelákovity locality, Lubná, Rako Mine, Kladno-Rakovník Basin (Bohovan). Notice the laevigate proximal surface and the densely microspinate part of the distal hemisphere. SEM, × 2000. • O – proximal surface of Microspinosporites chaloneri (Scott & Hemsley) comb. nov. emend. Notice the laevigate contact area, which makes about three-quarters of the radius, the developed labrum and the microspinate part of the proximal surface. From Hemsley et al. (1993), fig. 6. SEM, × 2000.
F. gracilis (Brack-Hanes & Thomas 1983), F. lycopoditis (Bek & Opluštil 1998) and F. cf. russelianus (Opluštil & Bek 2009) are pseudosaccate, with microspinate distal and proximal surfaces except for the contact area and have no cingulum. All of them correspond to the new miose spor genus Microspinosporites.

It seems, that some other pseudosaccate miose spor genera, e.g. Geminospora, Grandisspora and Leiozonotritiletes have similar morphology to Microspinosporites. Playford (1983, pp. 312–316) in emendation of generic diagnosis of Geminospora mentioned the occurrence of curvaturae, a contact area occupying most or the whole proximal surface. The same type of sculpture elements on the distal surface and the same sculpture on the proximal surface is developed and the inner body can occupy 60 to 98 per cent of spor cavity. Geminospora usually possesses a thicker exine and a larger diameter. Specimens of Geminospora show a more prominent dark ring on the margin due to the thickness of exine (from 1.5 to 7 μm), which may resemble a cingulum (e.g. Chitaley & McGregor 1989, pl. 10, figs 7–12), but, in fact, this represented a prominent curvaturae delimitating the contact area. SEM photomicrographs of dispersed (e.g. Playford 1983, figs 6–9; Fig. 1F, H, M) and in situ Geminospora (Chitaley & McGregor 1989, Fig. 1K herein) are morphologically very similar (sometimes even identical) to mio- and microspores of Microspinosporites. Distal surfaces of both genera (Fig. 1E, F) are the same, lateral views (Fig. 1H, I) are closely similar as well as proximal sculptures (Fig. 1G, J, K, M–O).

Microspinosporites-producing cones belong to the bisporangiate genera Flemingites and probably Moscovo strobus, born on arborescent lycopsids of the Paralycopodites-type.

Acknowledgement

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