

Palynology of the Chigua (Devonian) and Malimán (Carboniferous) formations in the Volcán Range, San Juan Province, Argentina. Part II. Cavate, pseudosaccate and cingulizionate spores



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Abstract. Palynological analysis of the Chigua and Malimán formations of Middle Devonian and Mississippian age respectively, is presented. They crop out in the Del Volcán Range at the Río Blanco Basin in western Argentina. In this second part, 40 indigenous species of cavate, pseudosaccate and cingulizionate spores from both units are illustrated. The species *Geminospora* sp. cf. *G. tuberculata* var. *tuberculata* McGregor is recorded in the Middle Devonian of South America for the first time. The following species are also recorded in the Mississippian of South America for the first time as *Crassispora invicta* Playford, *Densosporites asperus* Braman and Hills, *Densosporites gracilis* Smith and Butterworth, *Densosporites secundus* Playford and Satterthwait, *Densosporites* sp. cf. *D. triangularis* Kosanke, *Gorgonispora* sp. cf. *G. crassa* (Winslow) Higgs *et al.*, *Lophozonotriletes dentatus* Hughes and Playford, *Spelaotriletes echinatus* (Hacquebard) Utting, *Velamisporites perinatus* (Hughes and Playford) Playford. Some possibly reworked species (scolecodonts, paleomicroplankton and spores) from the Malimán Formation are illustrated and some of them are also described.

Resumen. PALINOLOGÍA DE LAS FORMACIONES CHIGUA (DEVÓNICO) Y MALIMÁN (CARBONÍFERO) EN LA SIERRA DEL VOLCÁN, PROVINCIA DE SAN JUAN, ARGENTINA. PARTE II. ESPORAS CAVADAS, PSEUDOSACADAS Y CINGULIZONADAS. Se presenta el análisis sistemático de las asociaciones palinológicas obtenidas de sedimentitas de las formaciones Chigua y Malimán, Devónico medio y Mississippiano respectivamente, aflorantes en la sierra del Volcán, cuenca Río Blanco, oeste de Argentina. En esta segunda parte se ilustran 40 especies de esporas cavadas, pseudosacadas y cingulizionadas presentes en ambas formaciones. La especie *Geminospora* sp. cf. *G. tuberculata* var. *tuberculata* McGregor es registrada por primera vez en el Devónico medio de América del Sur. Las siguientes especies también son registradas por primera vez para el Mississippiano de América del Sur, *Crassispora invicta* Playford, *Densosporites asperus* Braman y Hills, *Densosporites gracilis* Smith y Butterworth, *Densosporites secundus* Playford y Satterthwait, *Densosporites* sp. cf. *D. triangularis* Kosanke, *Gorgonispora* sp. cf. *G. crassa* (Winslow) Higgs *et al.*, *Lophozonotriletes dentatus* Hughes and Playford, *Spelaotriletes echinatus* (Hacquebard) Utting, *Velamisporites perinatus* (Hughes y Playford) Playford. Se ilustran y en algunos casos se describen algunas especies (escolecodontes, paleomicroplankton y esporas) posiblemente reabajadas presentes en la Formación Malimán.

Key words. Palynology. Chigua Formation. Malimán Formation. Middle Devonian. Mississippian. San Juan Province. Argentina.

Palabras clave. Palinología. Formación Chigua. Formación Malimán. Devónico medio. Mississippiano. Provincia de San Juan. Argentina.

Introduction

In this paper a palynological analysis of Devonian and Carboniferous sediments of the Río Blanco Basin in the western Argentina is presented. The Río Blanco Basin is one of the Late Palaeozoic basins

with the thickest Carboniferous deposits of Argentina, which overlies Devonian levels in angular unconformity. The palynomorphs studied herein come from samples obtained from the Chigua and Malimán formations that crop out at the La Cortadera creek in the western flank of the Volcán Range, Precordillera of San Juan. This analysis is presented in two parts. The paleomicroplankton from the Chigua Formation and acavate smooth and ornamented trilete spores from both units along with the geological setting, location of fertile samples in the outcrop scheme and material and methods were already presented in the first part (Amenábar *et al.*, 2006). This second part deals mainly with the systematic and the stratigraphic distribution of selected

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cavate, pseudosaccate and cingulizionate spores of both units. In addition, selected paleomicroplankton species either indigenous, recycled or of doubtful origin, obtained from the Malimán Formation, are illustrated in figure 1. Comparisons with other similar microfloras and the stratigraphic importance of both Devonian and Mississippian microfloras are subject of other contribution (in preparation).

Systematic palaeontology

Forty species of cavate, pseudosaccate and cingulizionate spores are presented in a parataxonomic scheme introduced by Potonié and Kremp (1954) modified by Potonié (1970) and others. The latest Spanish edition of the ICBN Code (Kiesling, 2002) is here adopted for the treatment of form taxa. Morphological terminology is mainly in accordance with the last glossary provided by Punt *et al.* (1994). Only species left in open nomenclature are described in detail whereas the main diagnostic features and/or remarks are given for previously known species that deserve a taxonomic and/or morphological discussion. Synonymy lists that have not been published yet are provided; otherwise they will be referred to where they were cited. The range and the worldwide geographic distribution of the species recognized in the Chigua and Malimán formations as shown in tables 1 and 2 are taken from selected systematic papers and others from illustrated lists of palynomorphs. Only the South American records are included in the text following the format presented in Part I. Selected palynologic works with illustrations are considered under the title Illustrated, while abstracts or non-illustrated works are mentioned as Listed. Illustrations of specimens are given in figures 4 to 7.

Finally, the figure 1 shows some species of scolecodonts, paleomicroplankton and spores found in the Malimán Formation. The specimens of the colonial algae *Botryococcus braunii* Kützing 1849 (figure 1.16) are here considered as indigenous. Other

species, such as *Maranhites brasiliensis* Brito *emend.* Burjack and Oliveira 1989 (figure 1.11), *Maranhites* sp. cf. *M. brasiliensis* Brito *emend.* Burjack and Oliveira 1989 (figure 1.10), *Hystricosporites* sp. cf. *H. gravis* Balme 1988 (figure 1.13), *Hystricosporites* sp. cf. *H. porrectus* (Balme and Hassell) Allen 1965 (figure 1.19), *Petaloferidium ancorum* (Wicander and Loeblich) Sarjeant and Vavrdová 1997 (figure 1.20), *Estiastra improcera* Loeblich 1970 (figure 1.21), *Synsphaeridium* sp. (figure 1.5), *Corystisporites* sp. (figure 1.14), are here interpreted as undoubted reworked forms. They are added to other reworked species registered in the unit and recently discussed and illustrated by Amenábar (2006). The remainder forms showed in the figure 7, *Tasmanites* sp. (figure 1.6), *Veryhachium* sp. cf. *V. trispinosum* (Eisenack) Deunff 1954 (figure 1.9), *Dictyotidium torosum* Playford in Playford and Dring 1981 (figure 1.12) and other species left in open nomenclature such as, scolecodonts (figures 1.1-1.4), and the paleomicroplankton *Dictyotidium* sp. (figures 1.7, 1.8), *Cymatiosphaera* sp. (figures 1.17, 1.18) and *Micrhystridium* sp. (figure 1.15), could be either indigenous (Carboniferous) or reworked forms. The latter species are described after the spores. A discussion about their stratigraphical value will be treated in other contribution.

The samples studied are housed in the repository of the Palynology Laboratory, Department of Geology, University of Buenos Aires. The slide number is denoted by the prefix BAFC-PI followed by the England Finder (EF) reference.

Spores

Anteturma PROXIMEGERMINANTES Potonié 1970
Turma TRILETES Reinsch *emend.* Dettmann 1963
Suprasubturma ACAVATITRILETES Dettmann 1963
Infraturma MURORNATI Potonié and Kremp 1954

Genus *Acinosporites* Richardson 1965

Type species. *Acinosporites acanthomammillatus* Richardson 1965.

Figure 1. Scolecodonts, palaeomicroplankton and spores from the Malimán Formation. Scale bar: 5, 12, 15, 20 = 10 µm (x 1000); 6-8, 17, 18, 21 = 15 µm (x 750); 1-4, 9-11, 13, 14, 16, 19 = 20 µm (x 500). Coordinates after EF (England Finder) graticule / scolecodontes, paleomicroplankton y esporas de la Formación Malimán. Escala gráfica: 5, 12, 15, 20 = 10 µm (x 1000); 6-8, 17, 18, 21 = 15 µm (x 750); 1-4, 9-11, 13, 14, 16, 19 = 20 µm (x 500). Las coordenadas corresponden a la reglilla EF (England Finder). **1-4**, Scolecodonts. **1**, BAFC-PI 1503 (2): L31; **2**, BAFC-PI 1501 (1): G28/4; **3**, BAFC-PI 1501 (1): V56/2; **4**, BAFC-PI 1501 (1): Y47/0-4. **5**, *Synsphaeridium* sp. Playford and Dring. BAFC-PI 1504 (1): X55/1. **6**, *Tasmanites* sp. BAFC-PI 1506 (4): V44. **7-8**, *Dictyotidium* sp. **7**, BAFC-PI 1506 (2): A22; **8**, BAFC-PI 1655 (2): G21/4. **9**, *Veryhachium* sp. cf. *V. trispinosum* (Eisenack) Deunff 1954. BAFC-PI 1506 (4): X55. **10**, *Maranhites* sp. cf. *M. brasiliensis* Brito *emend.* Burjack and Oliveira. BAFC-PI 1504 (2): Y42. **11**, *Maranhites brasiliensis* Brito *emend.* Burjack and Oliveira. BAFC-PI 1506 (2): R23/1-2. **12**, *Dictyotidium torosum* Playford in Playford and Dring. BAFC-PI 1504 (4): X60/2. **13**, *Hystricosporites* sp. cf. *H. gravis* Balme. BAFC-PI 1508 (4): P29/4. **14**, *Corystisporites* sp. BAFC-PI 1508 (4): A22/2. **15**, *Micrhystridium* sp. BAFC-PI 1504 (2): X55/1. **16**, *Botryococcus braunii* Kützing. BAFC-PI 1504 (3): S40/1. **17-18**, *Cymatiosphaera* sp. Q, BAFC-PI 1506 (2): V57; R, BAFC-PI 1506 (4): Z39/4. **19**, *Hystricosporites* sp. cf. *H. porrectus* (Balme and Hassell) Allen. BAFC-PI 1508 (4): V23/4. **20**, *Petaloferidium ancorum* (Wicander and Loeblich) Sarjeant and Vavrdová. BAFC-PI 1501 (1): K36/1. **21**, *Estiastra improcera* Loeblich. BAFC-PI 1506 (1): C32/3.

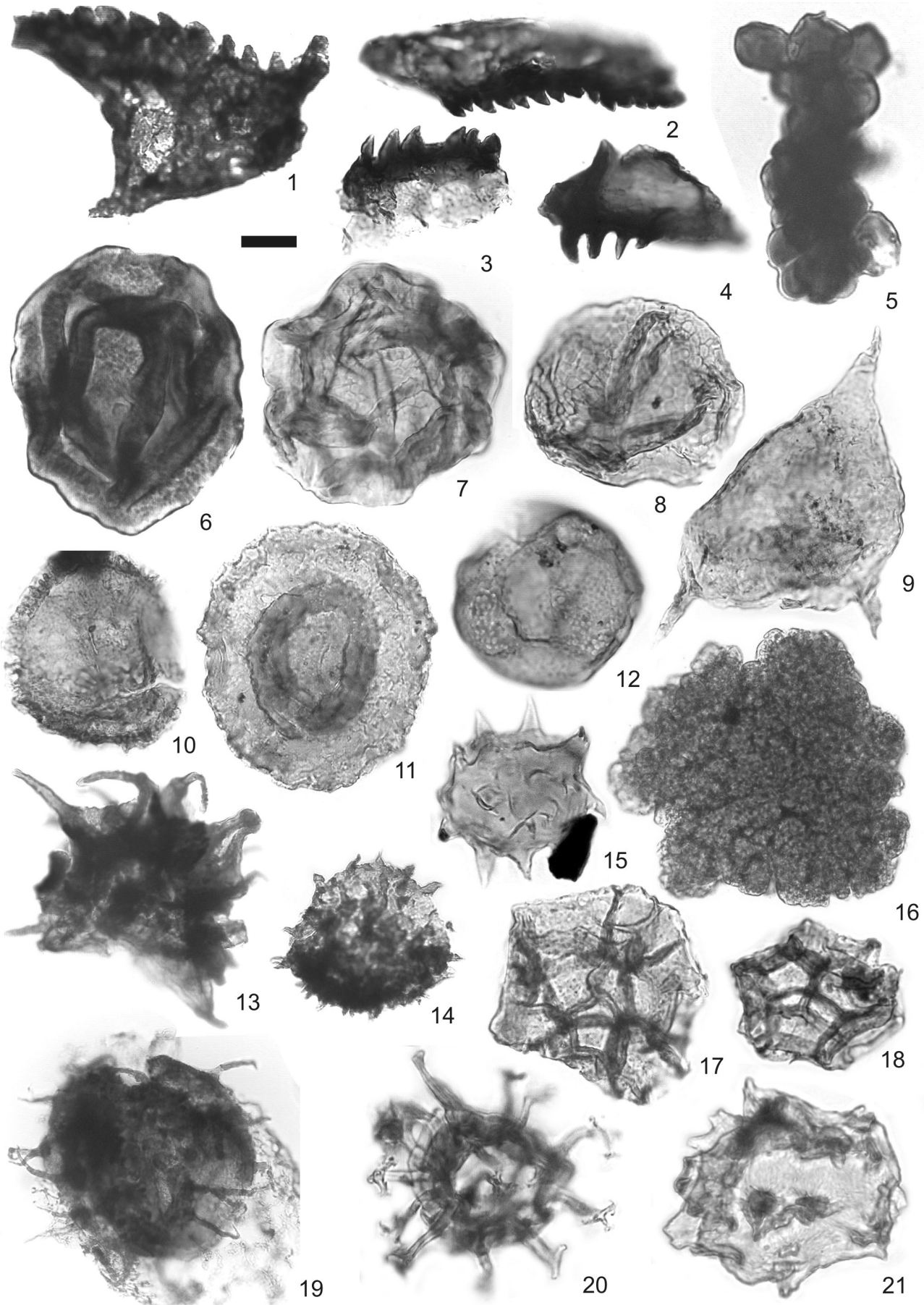


Table 1. Worldwide range and geographical distribution of selected species recognized in the Chigua Formation. Eurasia (E), South America (SA), North America (NA), Africa (Af), Australia (Au) / *distribución estratigráfica y geográfica mundial de las especies seleccionadas reconocidas en la Formación Chigua. Eurasia (E), Sud América (SA), Norte América (NA), África (Af), Australia (Au)*. References: for South American records see text and those for the rest of the world are mainly based on the following selected literature / *Referencias: los registros de América del Sur figuran en el texto y aquellos del resto del mundo se basan principalmente en la siguiente literatura seleccionada*: Allen, 1965; Richardson, 1965; Menéndez and Pöthe de Baldis, 1967; Owens, 1971; McGregor, 1973, 1977, 1979, 1984, 1996; McGregor and Canfield, 1976, 1982; Moreaut-Benoit, 1979, 1980; Loboziak and Strel, 1981; Paris *et al.*, 1985; Richardson and McGregor, 1986; Turnau, 1986, 1996; Burjack *et al.*, 1987; Balme, 1988; Loboziak *et al.*, 1988, 1991, 1992, 1997a, 1997b; Pérez Leyton, 1990, 1991; Braman and Hills, 1992; Avchimovitch *et al.*, 1993; Rodrigues *et al.*, 1995; Limachi *et al.*, 1996; Ottone, 1996; Ottone and Rossello, 1996; Vavrdová *et al.*, 1996; Dino, 1999; Turnau and Racki, 1999; Loboziak and Melo, 2000, 2002; Melo and Loboziak, 2003; Rubinstein *et al.*, 2005; di Pasquo, 2007a.

Chigua Formation	Selected species	Period														
		Early Devonian					Middle Devonian					Late Devonian				
		E	SA	NA	Af	Au	E	SA	NA	Af	Au	E	SA	NA	Af	Au
	<i>Acinosporites acanthomammillatus</i>	x				x	x	x	x			x	x	x		
	<i>Archaeozonotriletes chulus</i> var. <i>chulus</i>	x	x	x	x			x	x							
	<i>Cymbosporites catillus</i>		x				x	x						x		
	<i>Cymbosporites cyathus</i>		x				x	x						x		x
	<i>Geminospora lemurata</i>						x	x	x	x		x	x			x
	<i>Grandispora pseudoreticulata</i>							x								
	<i>Geminospor</i> sp. cf. <i>G. tuberculata</i> var. <i>tuberculata</i>						x	x	x			x				

Acinosporites acanthomammillatus Richardson
1965
Figures 2.1-2.2

Occurrence. (Illustrated): Middle Devonian, Bolivia (McGregor, 1984; di Pasquo, 2007a), Brazil (Burjack *et al.*, 1987). Late Devonian, Brazil (Loboziak *et al.*, 1988, 1992). (Listed): Middle-Late Devonian, Brazil (Dino, 1999), Bolivia (Pérez Leyton, 1991; Limachi *et al.*, 1996).

Subturma ZONOTRILETES Waltz *emend.* Potonié and Kremp 1954
Infraturma CINGULATI Potonié and Klaus *emend.* Dettmann 1963

Genus *Lophozonotriletes* Naumova *emend.* Potonié 1958

Type species. *Lophozonotriletes lebedianensis* Naumova 1953.

Lophozonotriletes dentatus Hughes and Playford
1961
Figure 3.1

Occurrence. First record for the Mississippian of South America.

Genus *Gorgonispora* Urban 1971

Type species. *Gorgonispora convoluta* (Butterworth and Spinner) Playford 1976.

Gorgonispora sp. cf. *G. crassa* (Winslow) Higgs, Clayton and Keegan 1988
Figure 3.2

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Studied material. BAFC-PI 1501 (1): M29/2.

Dimension (1 specimen). Equatorial diameter 57 µm.

Remarks. *Gorgonispora crassa* (Winslow) Higgs *et al.* 1988 presents slightly larger diameter 70-110 µm.

Occurrence. First record for the Mississippian of South America.

Genus *Knoxisporites* Potonié and Kremp *emend.* Neves 1961

Type species. *Knoxisporites hagenii* Potonié and Kremp 1954.

Knoxisporites sp.
Figure 3.3

Studied material. BAFC-PI 1506 (4): B30/2.

Description. Spore radial trilete, subcircular to triangular amb. Suture indistinct. Equatorial cingulum not clearly defined. Proximal surface laevigate, laesurae indistinct with broad labra up to 10 µm thickness. Distal surface laevigate bearing three muri arranged in a triangular pattern with the ends of the triangle joining the equator in the interradian positions. Muri 6-8 µm wide often slightly expanded at the equator or cingulum.

Dimension (1 specimen). Equatorial diameter 48.7 µm.

Comparison. *K. triangularis* Higgs *et al.* 1988 is very similar to *Knoxisporites* sp., but differs in having a larger diameter and a clearly defined cingulum.

Remarks. The poor preservation of the specimen does not allow an accurate taxonomic assignment.

Table 2. Worldwide range and geographical distribution of selected species recognized in the Malimán Formation. Eurasia (E), South America (SA), North America (NA), Africa (Af), Australia (Au) / *distribución estratigráfica y geográfica mundial de las especies seleccionadas reconocidas en la Formación Malimán. Eurasia (E), América del Sur (AS), América del Norte (AN), África (Af), Australia (Au)*. References: for South American records see text and those for the rest of the world are mainly based on the following selected literature / *Referencias: los registros de América del Sur figuran en el texto y aquellos del resto del mundo se basan principalmente en la siguiente literatura seleccionada*: Huges and Playford, 1961; Smith and Butterworth, 1967; Braman and Hills, 1977, 1992; Clayton *et al.*, 1978; Turnau, 1978; McGregor, 1979; Paris *et al.*, 1985; Richardson and McGregor, 1986; Azcuy and Ottone, 1987; Avchimovitch *et al.*, 1988, 1993; Higgs *et al.*, 1988; Playford, 1978, 1985, 1991; Utting, 1987; Playford and Satterthwait, 1988; Pérez Leyton, 1990, 1991; Loboziak *et al.*, 1991, 1992, 1997a, 1997b, 1998, 2000; Ravn, 1991; Vavrdová *et al.*, 1993, 1996; Césari and Limarino, 1995; Rubinstein *et al.*, 1996; Díaz Martínez *et al.*, 1999; Melo *et al.*, 1999; Niemeyer and Rubinstein, 2000; Jäger, 2002; Loboziak and Melo, 2002; Melo and Loboziak, 2000, 2003; Iannuzzi and Pfefferkorn, 2002; Utting and Giles, 2004; Fasolo *et al.*, 2006; Azcuy and di Pasquo, 2005, 2006; McLean *et al.*, 2005; di Pasquo, 2007b; Souza, 2006.

	Period	Late Famennian					Mississippian					Pennsylvanian/Cisuralian				
		E	SA	NA	Af	Au	E	SA	NA	Af	Au	E	SA	NA	Af	Au
Selected species																
<i>Auroraspora macra</i>		x	x		x	x	x	x	x	x	x					
<i>Auroraspora solisorta</i>		x	x		x		x	x	x		x					
<i>Bascaudaspora submarginata</i>		x					x	x	x							
<i>Colatisporites decorus</i>							x	x								
<i>Crassispora invicta</i>											x					
<i>Crassispora kosankei</i>							xcf.	x				x	x			
<i>Crassispora scrupulosa</i>								x			x					
<i>Crassispora trychera</i>							x	x	x							
<i>Cristatisporites indignabundus</i>								x	x			x	x	x		
<i>Cristatisporites indolatus</i>								xcf.			x					
<i>Cristatisporites matthewsii</i>		x	x				x									
<i>Cristatisporites peruvianus</i>								x								
<i>Densosporites anulatus</i>							x	x	x			x	x	x		
<i>Densosporites asperus</i>									x							
<i>Densosporites gracilis</i>												x				
<i>Densosporites regalis</i>							x	x	x							
<i>Densosporites secundus</i>											x					
<i>Densosporites</i> sp. cf. <i>D. triangularis</i>							x					x	x			
<i>Densosporites spinifer</i>							x		x			x		x		
<i>Gorgonispora</i> sp. cf. <i>G. crassa</i>		x					x									
<i>Grandispora debilis</i>								x			x					
<i>Grandispora notensis</i>			x		x			x			x					
<i>Grandispora spiculifera</i>			x					x			x					
<i>Kraeuselisporites</i> sp. cf. <i>K. mitratus</i>							x	x								
<i>Lophozonotriletes dentatus</i>							x									
<i>Spelaotriletes arenaceus</i>							x	x				x				
<i>Spelaotriletes echinatus</i>									x							
<i>Spelaotriletes obtusus</i>			x				x	x	x							
<i>Vallatisporites pusillites</i>		x	x	x	x		x	x	x	x						
<i>Velamispores perinatus</i>						x	x		x		x					

Suprasubturma LAMINATITRILETES Smith and Butterworth 1967

Subturma ZONOLAMINATITRILETES Smith and Butterworth 1967

Infraturma CRASSITI Bharadwaj and Venkatachala *emend.* Smith and Butterworth 1967

Genus *Crassispora* Bharadwaj *emend.* Keegan and Penney 1978

Type species. *Crassispora kosankei* (Potonié and Kremp) Bharadwaj 1957 *emend.* Smith and Butterworth 1967.

Crassispora invicta Playford 1971
Figure 3.9

Occurrence. First record for the Mississippian of South America.

Crassispora kosankei (Potonié and Kremp) Bharadwaj 1957 *emend.* Smith and Butterworth 1967
Figures 3.7-38

Remarks. The studied specimen shows the same
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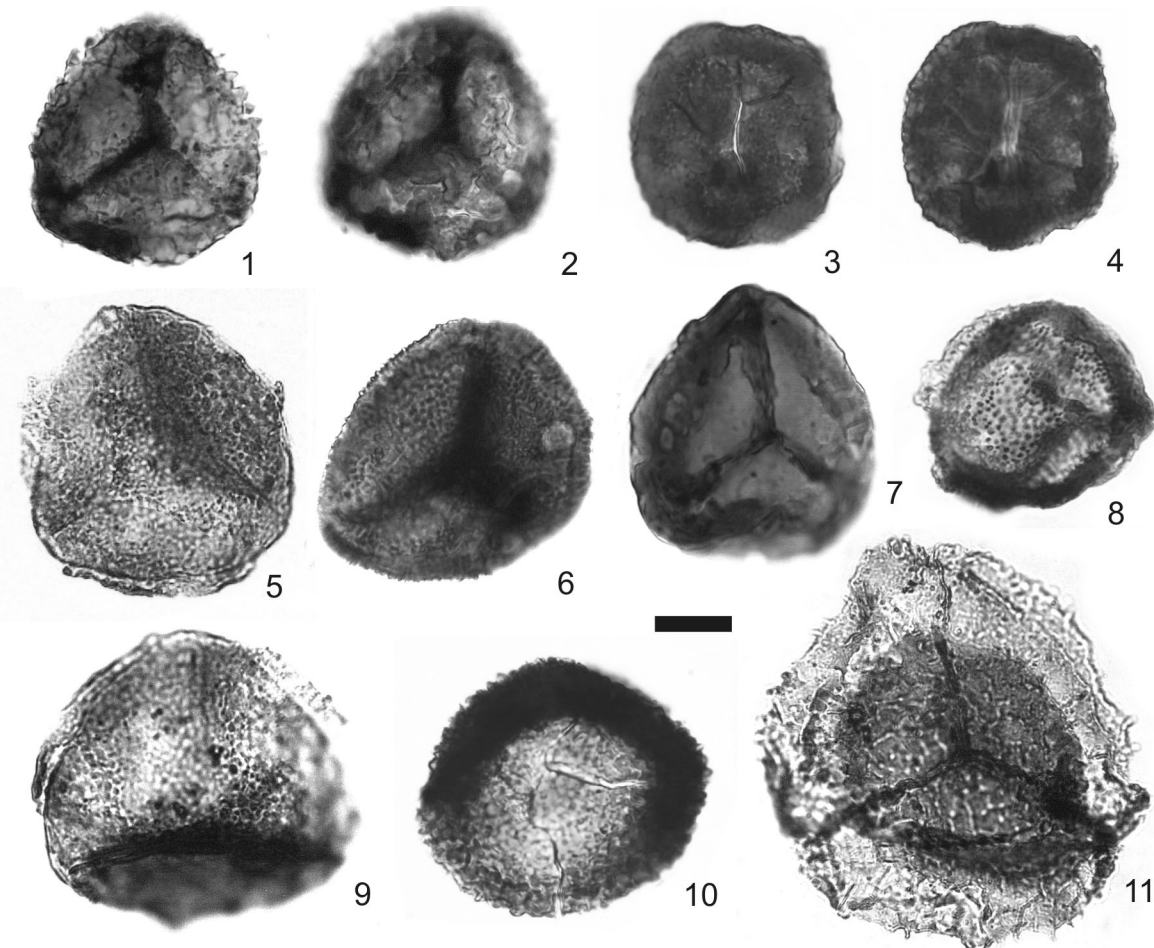


Figure 2. Cavate, pseudosaccate and cingulizonate spores from the Chigua Formation. Scale bar: 10, 11 = 20 μm (x 500), the rest = 15 μm (x 750). Coordinates after EF (England Finder) graticule / esporas cavadas, pseudosacadas y cingulizonadas de la Formación Chigua. Escala gráfica: 10, 11 = 20 μm (x 500), el resto = 15 μm (x 750). Las coordenadas corresponden a la reglilla EF (England Finder). **1-2**, *Acinosporites acanthomammillatus* Richardson. BAFC-PI 1656 (1): R35; **1**, proximal face showing a labiate trilete mark / cara proximal mostrando la marca trilete labiada; **2**, distal face showing the rugulae pattern / cara distal mostrando el patrón rugulado. **3-4**, *Cymbosporites catillus* Allen. BAFC-PI 1505 (2): G38/2. **5-6, 9**, *Geminospora lemurata* Balme 1962 emend. Playford. **5**, BAFC-PI 1505 (2): X34/2; **6**, BAFC-PI 1505 (5): D28/2; **9**, BAFC-PI 1505 (2): X35/1. **7**, *Archeozonotriletes chulus* var. *chulus* (Cramer) Richardson and Lister. BAFC-PI 1505 (5): X47. **8**, *Geminospora* sp. cf. *G. tuberculata* var. *tuberculata* McGregor. BAFC-PI 1505 (2): P52/4. **10**, *Cymbosporites cyathus* Allen. BAFC-PI 1505 (3): C37/3. **11**, *Grandispora pseudoreticulata* (Menéndez and Pöthe de Baldis) Ottone. BAFC-PI 1656 (1): F24/1.

sculpture like the Peruvian specimens illustrated by Azcuy and di Pasquo (2005).

Occurrence. (Illustrated): Viséan, Peru (Azcuy and di Pasquo, 2005, 2006), Bolivia (Fasolo *et al.*, 2006). For other records see Azcuy and di Pasquo (2006).

Crassispora scrupulosa Playford 1971 emend.
Playford and Satterthwait 1988
Figure 3.5

Occurrence. (Illustrated): Mississippian, Bolivia (di Pasquo, 2007b). (Listed): Mississippian, Argentina (Césari and Limarino, 1992), Bolivia (Vavrdová *et al.*, 1996).

Crassispora trychera Neves and Ioannides 1974
Figure 3.6

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Occurrence. (Illustrated): Tournaisian-Viséan, Brazil (Loboziak *et al.*, 1991; Melo and Loboziak, 2003). Viséan, Bolivia (di Pasquo, 2007b). (Listed): Mississippian, Brazil (Loboziak *et al.*, 1998).

Crassispora sp.
Figures 3.10-3.13

Studied material. BAFC-PI 1502 (1): K46, C32/1-2, W40/3; BAFC-PI 1655 (2): B26/3; BAFC-PI 1504 (1): E48.

Description. Spore radial trilete, subcircular to oval amb, irregular due to the folded exine. Laesurae indistinct, imperfect curvaturae observed in some specimens. Proximal face smooth to chagrinate when is present because is usually absent. Distal face orna-

mented with discrete conical spines, 0.6 µm high and wide, distributed randomly on the surface, bald areas frequently present. Equatorial crassitude narrow and irregular in thickness (cingulizone?) and wide varying from 2 to 3.5 µm.

Dimensions (5 specimens). Equatorial diameter 58-68 µm.

Comparison. *Crassispora trychera* Neves and Ioannides 1974 has a larger and more diverse ornamentation.

Infraturma CINGULATI (Potonié and Klaus)
Dettmann 1963

Genus *Bascaudaspora* Owens 1983

Type species. *Bascaudaspora canipa* Owens 1983.

Bascaudaspora submarginata (Playford) Higgs,
Clayton and Keegan 1988
Figure 3.4

Occurrence. (Illustrated): Late Tournaisian-Viséan, Colombia (Dueñas and Césari, 2006), Viséan, Peru (Azcuy and di Pasquo, 2005, 2006), Bolivia (Fasolo *et al.*, 2006), Brazil (Melo and Loboziak, 2000). (Listed): Mississippian, Brazil (Iannuzzi and Pfefferkorn, 2002). For other records see Azcuy and di Pasquo (2006).

Genus *Bellisporites* Artüz *emend.* Sullivan 1964

Type species. *Bellisporites nitidus* (Horst) Sullivan 1964.

Bellisporites sp.
Figures 3.14-3.16

Studied material. BAFC-PI 1508 (1): C30/1; BAFC-PI 1508 (2): Q28/1.

Description. Spore radial trilete. Amb triangular with straight or concave sides and rounded apices. Trilete mark distinct, simple, straight with rays that reached the spore margin. Proximal face smooth (?) and distal chagrinose to microgranulate-apiculate. Thickenings well defined on the distal surface, wart-like, with circular bases and slightly irregular margins, 5.8-8.12 µm wide. The radial thickenings do not continue to the equator, locating at the polar region leaving the apices free. Proximal subequatorial thickening (? kirtome) continuous bearing apiculate elements, undulate to crenulate margin, 4.5-7 µm in thickness.

Dimensions (2 specimens). Overall diameter 50-56 µm.

Comparisons. The conspecific species *Bellisporites bellus* Artüz 1957 and *Bellisporites nitidus* (Horst) Sullivan 1964 (in agreement with Smith and Butterworth

1967) have a laevigate distal face, radial thickenings that continue to the equator and punctuations, foveae and short grooves developed on the bands and in the inner boundary of the border. *Ahrensiporites* Potonié and Kremp 1954 has kirtomes curving toward the distal surface.

Remarks. The poorly preserved specimen illustrated in figure 3.16 shows much attenuated features respect to the one well preserved.

Genus *Densosporites* Berry *emend.* Butterworth,
Jansonius, Smith and Staplin in Staplin and
Jansonius 1964

Type species. *Densosporites covensis* Berry 1937.

Densosporites anulatus (Loose) Schopf, Wilson and
Bentall 1944
Figures 3.17-3.18

Occurrence. (Illustrated): Viséan, Peru (Azcuy and di Pasquo, 2005, 2006). (Listed): Mississippian, Bolivia (Fasolo *et al.*, 2006), Brazil (Iannuzzi and Pfefferkorn, 2002); Pennsylvanian, Brazil (Souza, 2006). For other records see Azcuy and di Pasquo (2006).

Densosporites asperus Braman and Hills 1977
Figures 4.1-4.2

Remarks. *Cristatisporites alpernii* Staplin and Jansonius 1964 differs from this species in having an apiculate sculpture with some setose tips on the distal surface and a trilete mark that extends up to the central body.

Occurrence. First record for the Mississippian of South America.

Densosporites gracilis Smith and Butterworth 1967
Figures 3.19-3.20

Remarks. The specimens agree with the original description, but exhibit a slightly narrower cingulum (9.3 µm wide that is about 15 % of total spore diameter). ?*Stenozonotriletes bracteolus* (Butterworth and Williams) Smith and Butterworth 1967 has a granular ornamentation.

Occurrence. First record for the Mississippian of South America.

Densosporites regalis (Bharadwaj and
Venkatachala) Smith and Butterworth 1967
Figures 4.7, 4.9

1984. *Densosporites spitsbergensis* Playford 1963; Higgs and Clayton, p. 24, pl. 2, fig. 17.

1988. *Densosporites spitsbergensis* Playford 1963; Higgs *et al.*, p. 78-79, pl.15, figs. 13-14.

1991. *Densosporites spitsbergensis* Playford 1963; Utting, p. 98, pl. 4.2, fig. 15.
 2000. *Densosporites spitsbergensis* Playford 1963; Melo and Loboziak, p. 153, pl. 2, fig. 11.
 2003. *Densosporites spitsbergensis* Playford 1963; Melo and Loboziak, p. 174, pl. 3, fig. 1.

Remarks. The specimens here illustrated as well as the above cited show the same intraspecific variation according to Smith and Butterworth, 1967.

Occurrence. (Illustrated): Viséan, Brazil (Melo and Loboziak, 2000, 2003). (Listed): Mississippian, Bolivia (Vavrdová *et al.*, 1996; Díaz Martínez *et al.*, 1999), Brazil (Iannuzzi and Pfefferkorn, 2002).

Densosporites secundus Playford and Satterthwait
 1988
 Figures 4.5-4.6

1960. *Spinozonotriletes ? exiguus* Staplin, p. 22, pl. 4, figs. 27-28.

Remarks. From the original diagnosis of this species given by Playford and Satterthwait (1988), some other features are evidenced here like the presence of some discrete biform elements between coni and spinae at the equatorial zone both may be coalescent in pairs or three elements.

Comparison. In agreement with Playford and Satterthwait (1988), *Densosporites aculeatus* Playford (1963) is distinguished from *Densosporites secundus* by having a wider cingulum (1/2 *vs.* 1/3 - 1/4 of central body) and the absence of labra.

Occurrence. First record for the Mississippian of South America.

Densosporites spinifer Hoffmeister, Staplin and Malloy 1955
 Figures 4.3-4.4, 4.8

Occurrence. (Listed): Mississippian, Peru (Iannuzzi and Pfefferkorn, 2002).

Densosporites sp. cf. *D. triangularis* Kosanke 1950
 Figures 4.10-4.12, 4.16

Studied material. BAFC-PI 1655 (1): L25/1; BAFC-PI 1655 (2): O28, F31/2, X28/2; BAFC-PI 1503 (1): B35/3; BAFC-PI 1506 (3): Z41; BAFC-PI 1506 (5): K23, G26/4, Y35/2, Q28/3, U31/1, D24/3, Y36/3, B40.

Description. Spore radial trilete, amb subtriangular to oval, often with one apex more pronounced than the other two. Margin smooth to serrate. Laesurae not visible. Central area granulate and vermiculate, 2.3-4.6 μm wide, some elements with fused bases forming short rugulae. Cingulum well defined with cuniculus somewhat visible, width 6-8 μm (aprox. 1/8 of spore diameter or 12% of the spore ratio) with coni and subordinate verrucate, 1.2-2.3 μm high and wide, some coalescent mainly in its inner portion. In some specimens the cingulum shows an irregular thickness decreasing to the amb.

Dimensions (14 specimens). Equatorial diameter 49-69 μm .

Remarks. In all specimens the proximal surface is not visible. Scarce forms (figure 4.16) show transitional features to *D. spinifer* Hoffmeister *et al.* 1955.

Comparison. *D. triangularis* Kosanke 1950 has a broader cingulum (more than 40% of the spore diameter) with foveolate dissections. *Cymbosporites cyathus* Allen 1965 has a lipped laesurae, inner border of the cingulum (or patina) less defined (cuniculus absent) and a dense ornamentation of verrucae, coni and rugulae outside the contact areas.

Occurrence. (Listed): Pennsylvanian, Brazil (Souza, 2006).

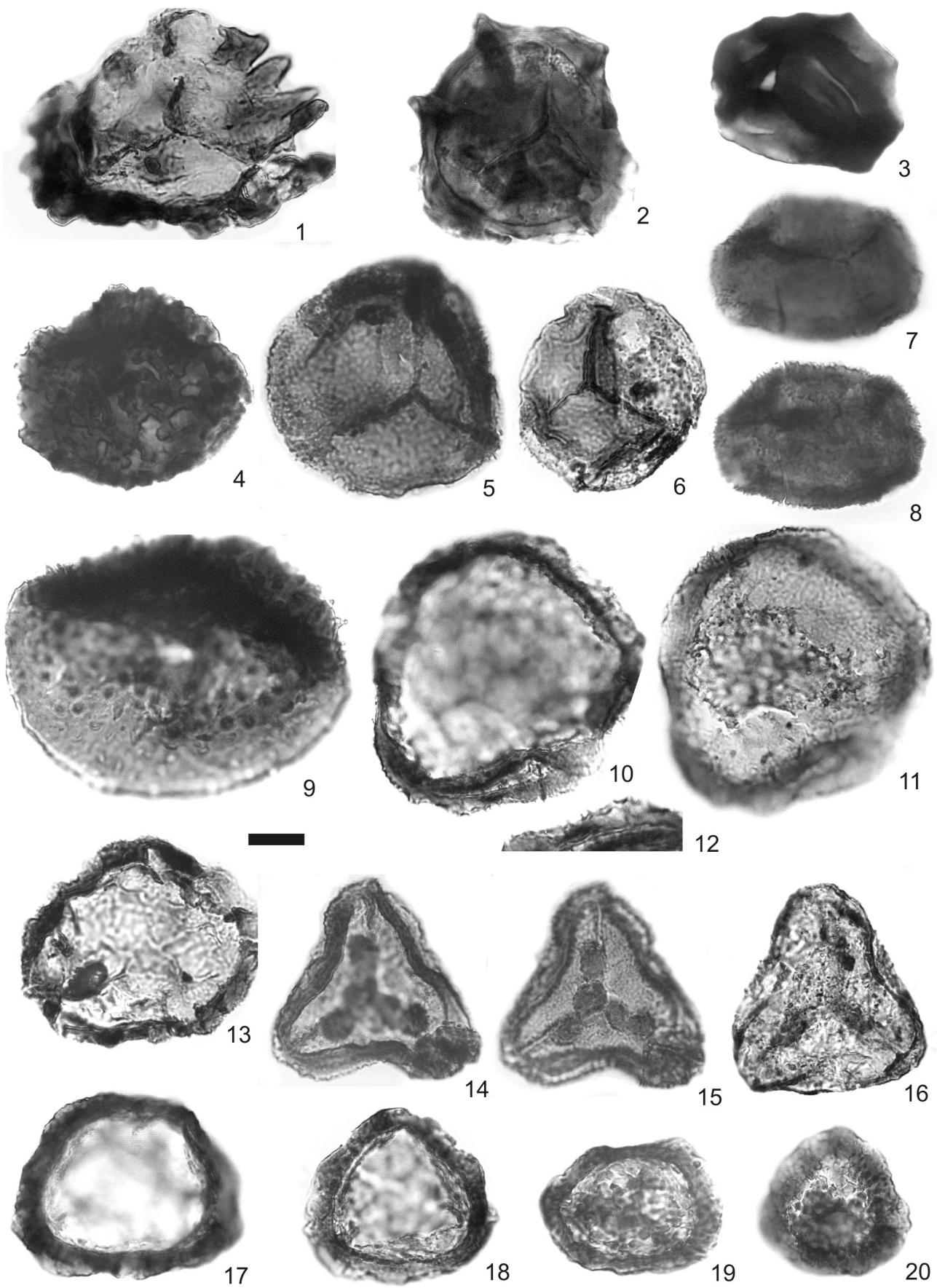
Genus *Cristatisporites* Potonié and Kremp 1954
emend. Butterworth, Jansonius, Smith and Staplin in
 Staplin and Jansonius, 1964

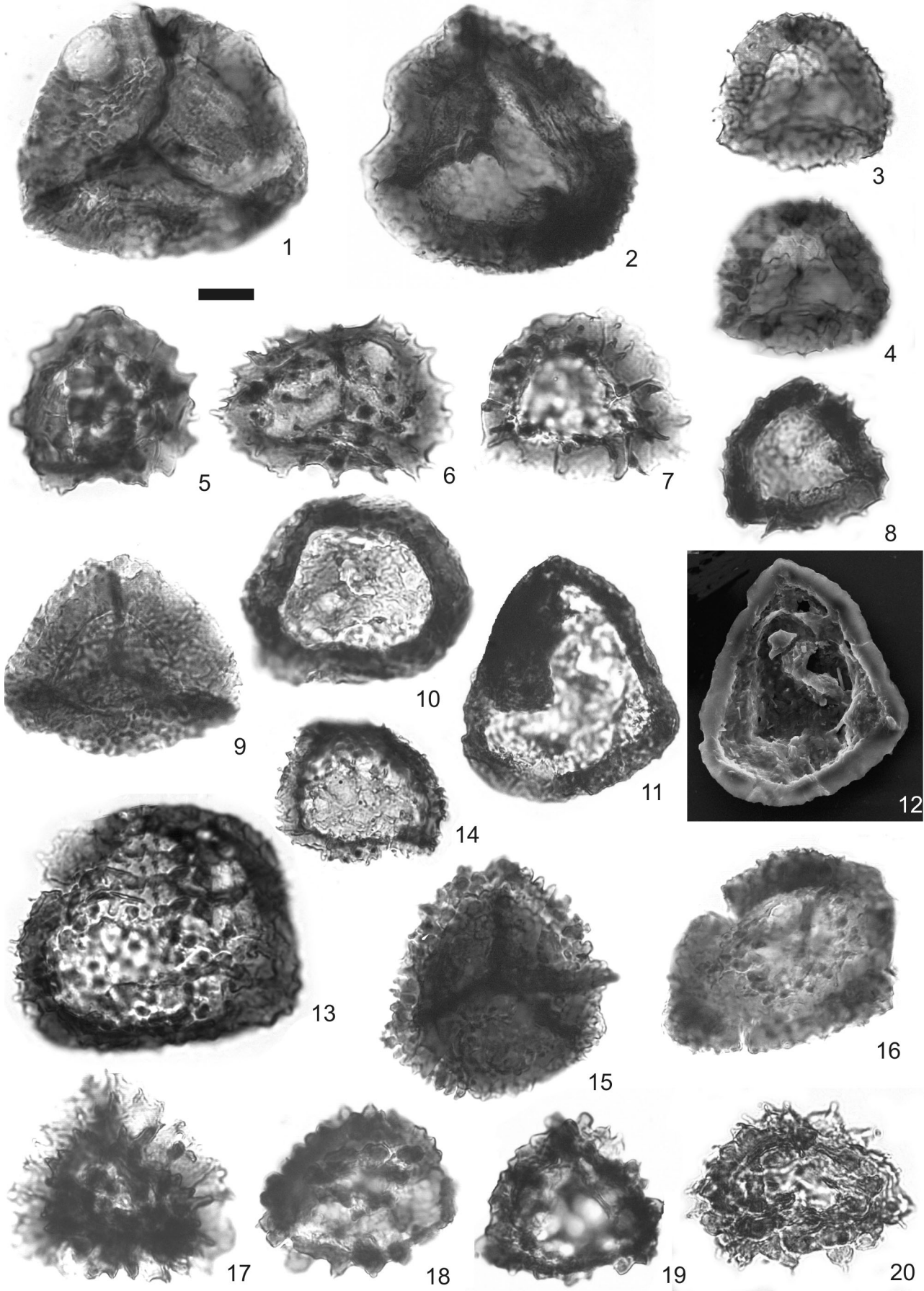
Type species. *Cristatisporites indignabundus* (Loose) Potonié and Kremp, 1954.

Cristatisporites indignabundus (Loose) Potonié and Kremp 1954
emend. Staplin and Jansonius 1964
 Figure 4.17

Occurrence. (Illustrated): Viséan, Peru (Azcuy and di

Figure 3. Cavate, pseudosaccate and cingulizionate spores from the Malimán Formation. Scale bar: all 15 μm (x 750), except 12: 10 μm (x 1000). Coordinates after EF (England Finder) graticule / *esporas cavadas, pseudosacadas y cingulizonadas de la Formación Malimán. Escala gráfica: todos 15 μm (x 750), excepto 12: 10 μm (x 1000). Las coordenadas corresponden a la reglilla EF (England Finder).* **1**, *Lophozonotriletes dentatus* Hughes and Playford. BAFC-PI 1655 (2): Y29. **2**, *Gorgonispora* sp. cf. *G. crassa* (Winslow) Higgs, Clayton and Keegan. BAFC-PI 1501 (1): M29/4. **3**, *Knoxisporites* sp. BAFC-PI 1506 (4): A30/4. **4**, *Bascaudaspora submarginata* (Playford) Higgs, Clayton and Keegan. BAFC-PI 1506 (4): A39/2. **5**, *Crassispora scrupulosa* Playford *emend.* Playford and Satterthwait. BAFC-PI 1508(4): F23/2-4. **6**, *Crassispora trychera* Neves and Ioannides. BAFC-PI 1508(2): F49/4. **7-8**, *Crassispora kosankei* (Potonié and Kremp) Bharadwaj *emend.* Smith and Butterworth. BAFC-PI 1504 (1): E30/3; **7**, Proximal focus / *foco proximal*; **8**, Distal focus / *foco distal*; **9**, *Crassispora invicta* Playford. BAFC-PI 1508 (1): W36. **10-13**, *Crassispora* sp.; **10-12**, BAFC-PI 1502 (1): K46; **12**, Detail of the ornamentation in the margin / *detalle de la ornamentación en el margen*; **13**, BAFC-PI 1655 (2): B26/3. **14-16**, *Bellisporites* sp.; **14-15**, BAFC-PI 1508 (1): C30/1; **14**, Proximal focus showing the kyrtome / *foco proximal mostrando el kirtoma*; **15**, Distal focus showing warts / *foco distal mostrando verrugas*; **16**, BAFC-PI 1508 (1): Q28/1. **17-18**, *Densosporites anulatus* (Loose) Schopf, Wilson and Bentall. **17**, BAFC-PI 1506 (3): Y48; **18**, BAFC-PI 1506 (1): C37/1. **19-20**, *Densosporites gracilis* Smith and Butterworth. **19**, BAFC-PI 1506 (1): H34; **20**, BAFC-PI 1506 (4): J56.





Pasquo, 2005, 2006), Bolivia (Fasolo *et al.*, 2006); Pennsylvanian, Brazil (Souza, 2006). For other records see Azcuy and di Pasquo (2006).

Cristatisporites indolatus Playford and Satterthwait 1988

Figure 4.15

1992. *Cristatisporites* sp. cf. *C. indolatus* Playford and Satterthwait 1988; Césari and Limarino, p. 47, pl. 1, fig. 6.

Occurrence. (Illustrated): Mississippian, Argentina (Césari and Limarino, 1992). (Listed): Mississippian, Argentina (Pérez Loinaze and Césari, 2003).

Cristatisporites matthewsii Higgs, Clayton and Keegan 1988

Figures 4.18-4.20

Occurrence. (Illustrated): Late Devonian, Brazil (Loboziak *et al.*, 1997a).

Cristatisporites peruvianus Azcuy and di Pasquo 2005

Figures 4.13-4.14

Occurrence. (Illustrated): Viséan, Peru (Azcuy and di Pasquo, 2005, 2006), Bolivia (di Pasquo, 2007b).

Genus ***Kraeuselisporites*** Leschik 1955 *emend.* Azcuy and di Pasquo 2005

Type species. *Kraeuselisporites dentatus* Leschik 1955.

Kraeuselisporites sp. cf. ***K. mitratus*** Higgs 1975
Figure 5.1

Studied material. BAFC-PI 1504(3): Z52.

Remarks. This species is comparable with *K. mitratus* Higgs 1975 but the absence of more specimens does not allow a more accurate assignment.

Occurrence. (Illustrated): Viséan, Peru (Azcuy and di Pasquo, 2005, 2006), Brazil (Melo and Loboziak,

2003). (Listed): Viséan, Bolivia (Fasolo *et al.*, 2006). For other records see Azcuy and di Pasquo (2006).

Genus ***Vallatisporites*** Hacquebard 1957

Type species. *Vallatisporites vallatus* Hacquebard 1957.

Vallatisporites pusillites (Kedo) Dolby and Neves 1970

Figure 5.2

Occurrence. (Listed): Mississippian, Bolivia (Vavrová *et al.*, 1996). Late Devonian, Brazil (Loboziak *et al.*, 1997a, 1997b; Limachi *et al.*, 1996).

Infraturma PATINATI Butterworth and Williams 1958

Genus ***Archaeozonotriletes*** (Naumova) Allen 1965

Type species. *Archaeozonotriletes variabilis* (Naumova) Allen 1965.

Archaeozonotriletes chulus var. ***chulus*** (Cramer) Richardson and Lister 1969

Figure 5.7

Remarks. These spores are attributed to *A. chulus* var. *chulus*, for its cingulate/patinate character, thin proximal exine and absence of ornamentation.

Occurrence. (Illustrated): Early-Middle Devonian, Brazil (Melo and Loboziak, 2003; Rubinstein *et al.*, 2005), Bolivia (McGregor, 1984).

Genus ***Cymbosporites*** Allen 1965

Type species. *Cymbosporites cyathus* Allen 1965.

Cymbosporites catillus Allen 1965

Figures 2.3-2.4

Occurrence. (Illustrated): Middle-Late Devonian, Argentina (Ottone, 1996), Brazil (Burjack *et al.*, 1987; Loboziak *et al.*, 1988, 1992, 1997a; Loboziak and Melo, 2000, 2002; Melo and Loboziak, 2003), Bolivia (Pérez Leyton, 1990; di Pasquo, 2007a). (Listed): Middle

Figure 4. Cavate, pseudosaccate and cingulizionate spores from the Malimán Formation. Scale bar: all 15 μm (x 750), except 3-4: 10 μm (x 1000). Coordinates after EF (England Finder) graticule / *esporas cavadas, pseudosacadas y cingulizionadas de la Formación Malimán. Escala gráfica: todos 15 μm (x 750), excepto 3-4: 10 μm (x 1000). Las coordenadas corresponden a la reglilla EF (England Finder).* **1-2, *Densosporites asperus*** Braman and Hills. **1**, BAFC-PI 1655(2): E39/3; **2**, BAFC-PI 1655(2): M36/1. **3-4, 8, *Densosporites spinifer*** Hoffmeister, Staplin and Malloy. **3-4**, BAFC-PI 1508 (3): S45; **8**, BAFC-PI 1506(3): W28/1. **5-6, *Densosporites secundus*** Playford and Satterthwait. **5**, BAFC-PI 1504(1): B42/3; **6**, BAFC-PI 1655(1): A31/3. **7, 9, *Densosporites regalis*** (Bharadwaj and Venkatachala) Smith and Butterworth. **7**, BAFC-PI 1504(2): M37/1; **9**, BAFC-PI 1655 (2): P53. **10-12, 16, *Densosporites*** sp. cf. ***D. triangularis*** Kosanke. **10**, BAFC-PI 1506(5): Y35/2; **11**, BAFC-PI 1506(5): E26/4; **12**, BAFC-PI 1655(1): SEM photo, the same specimen as 11 / *foto tomada con microscopio electrónico de barrido (MEB), el mismo ejemplar que 11*; **16**, BAFC-PI 1655(2): F31. **13-14, *Cristatisporites peruvianus*** Azcuy and di Pasquo. **13**, BAFC-PI 1506(4): Z50; **14**, BAFC-PI 1503(1): W28/1. **15, *Cristatisporites indolatus*** Playford and Satterthwait. BAFC-PI 1506(5): D50/1. **17, *Cristatisporites indignabundus*** (Loose) Potonié and Kremp *emend.* Staplin and Jansonius. BAFC-PI 1506 (2): K24/4. **18-20, *Cristatisporites matthewsii*** Higgs, Clayton and Keegan. **18**, BAFC-PI 1506 (5): G23; **19**, BAFC-PI 1506 (1): X21/1; **20**, BAFC-PI 1655 (2): B40/1.

Devonian, Brazil (Dino, 1999). Middle-Late Devonian, Bolivia (Pérez Leyton, 1991; Vavrdová *et al.*, 1996). Late Devonian, Chile (Rubinstein *et al.*, 1996).

Cymbosporites cyathus Allen 1965

Figure 2.10

Occurrence. (Illustrated): Middle-Late Devonian, Brazil (Burjack *et al.*, 1987; Loboziak *et al.*, 1988, 1992; Melo and Loboziak, 2003), Bolivia (Pérez Leyton, 1991; Vavrdová *et al.*, 1996; di Pasquo, 2007a). (Listed): Middle-Late Devonian, Brazil (Loboziak *et al.*, 1997a; Dino, 1999).

Suprasubturma PSEUDOSACCITRILETES Richardson
1965

Infraturma MONOPSEUDOSACCITI Smith and
Butterworth 1967

Genus *Auroraspora* Hoffmeister, Staplin and
Malloy 1955

Type species. *Auroraspora solisorta* Hoffmeister, Staplin and Malloy 1955.

Auroraspora macra Sullivan 1968

Figures 5.9, 5.14

Occurrence. (Illustrated): Late Tournaisian-Viséan, Colombia (Dueñas and Césari, 2006), Viséan, Peru (Azcuy and di Pasquo, 2005, 2006), Bolivia (di Pasquo, 2007b), Brazil (Loboziak *et al.*, 1992, 1997a; Melo and Loboziak, 2003). (Listed): Late Devonian, Brazil (Burjack *et al.*, 1987; Loboziak *et al.*, 1997b). Late Devonian- Mississippian, Bolivia (Pérez Leyton, 1991; Vavrdová *et al.*, 1996), Chile (Rubinstein *et al.*, 1996). Mississippian, Brazil and Bolivia (Iannuzzi and Pfefferkorn, 2002). For other records see Azcuy and di Pasquo (2006).

Auroraspora solisorta Hoffmeister, Staplin and
Malloy 1955
Figure 5.15

Occurrence. (Illustrated): Late Tournaisian-Viséan,

Colombia (Dueñas and Césari, 2006), Mississippian, Brazil (Loboziak *et al.*, 1992; Melo and Loboziak, 2003), Bolivia (di Pasquo, 2007b). (Listed): Late Devonian, Bolivia (Vavrdová *et al.*, 1996). Late Devonian- Mississippian, Chile (Rubinstein *et al.*, 1996). Mississippian, Brazil (Loboziak *et al.*, 1998; Iannuzzi and Pfefferkorn, 2002).

Genus *Geminospora* Balme 1962 *emend.* Playford
1983

Type species. *Geminospora lemurata* Balme 1962.

Geminospora lemurata Balme 1962 *emend.* Playford
1983

Figures 2.5-2.6, 2.9

Occurrence. (Illustrated): Middle-Late Devonian, Argentina (Ottone, 1996), Brazil (Burjack *et al.*, 1987; Loboziak *et al.*, 1988, 1992, 1997a; Rodrigues *et al.*, 1995; Dino, 1999; Loboziak and Melo, 2000, 2002; Melo and Loboziak, 2003), Bolivia (Ottone and Rosello, 1996; di Pasquo, 2007a). (Listed): Middle-Late Devonian, Bolivia (Pérez Leyton, 1991; Limachi *et al.*, 1996; Vavrdová *et al.*, 1996), Argentina (Rodríguez Amenábar *et al.*, 2003). Late Devonian, Brazil (Loboziak *et al.*, 1997b).

Geminospora sp. cf. *G. tuberculata* var. *tuberculata*
McGregor 1996

Figure 2.8

Studied material. BAFC-PI 1505 (2): P52/0-4.

Dimension (1 specimen). Equatorial diameter 45.2 μm .

Remarks. The lack of additional specimens does not allow a more precise assignment.

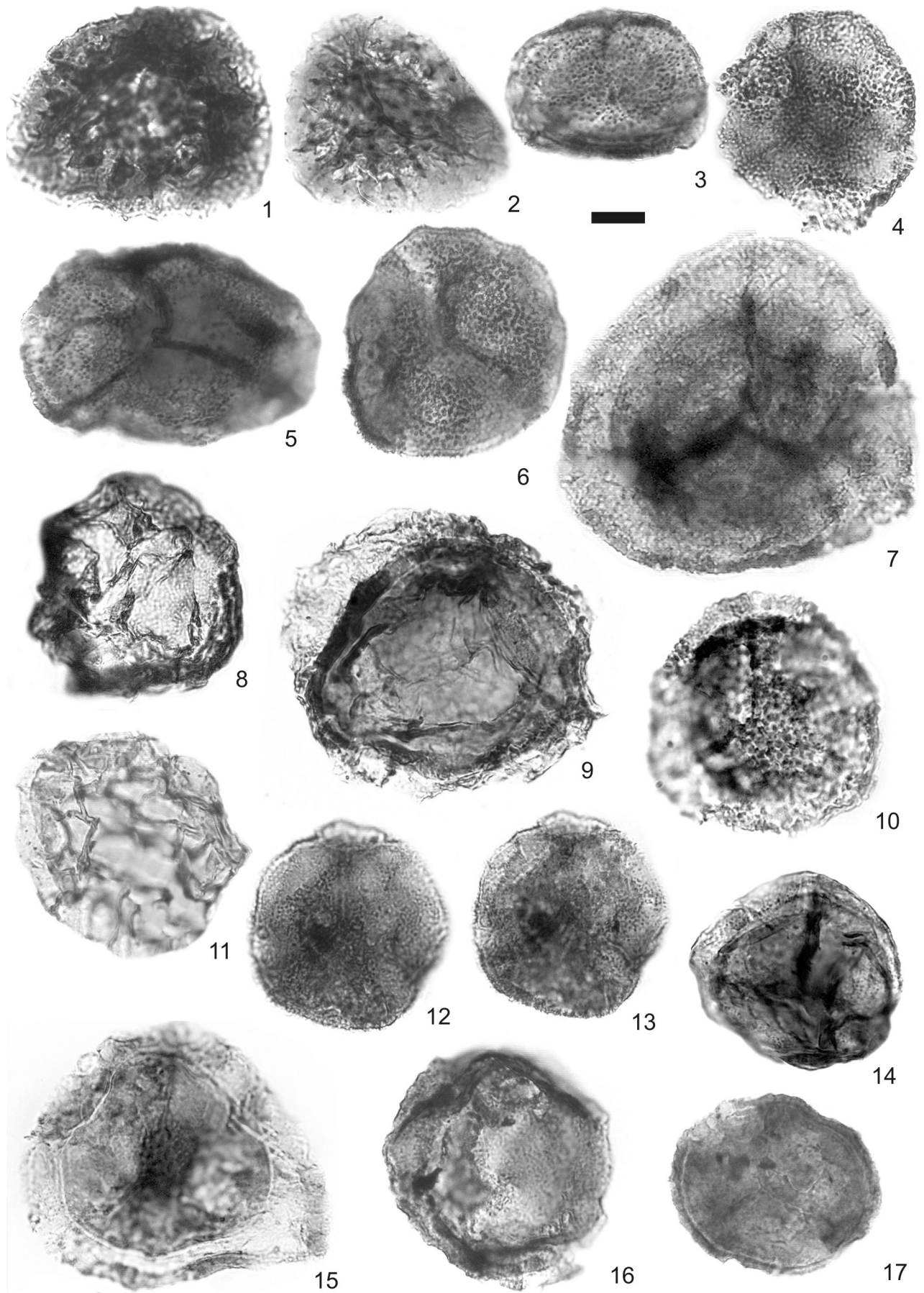
Occurrence. First record for the Middle Devonian of South America.

Genus *Grandispora* Hoffmeister, Staplin and
Malloy 1955

Type species. *Grandispora spinosa* Hoffmeister, Staplin and Malloy 1955.

Figure 5. Cavate, pseudosaccate and cingulizonate spores from the Malimán Formation. Scale bar: all 15 μm (x 750). Coordinates after EF (England Finder) graticule / *esporas cavadas, pseudosacadas y cingulizonadas de la Formación Malimán. Escala gráfica: todos 15 μm (x 750). Las coordenadas corresponden a la reglilla EF (England Finder).* **1**, *Kraeuselisporites* sp. cf. *K. mitratus* Higgs. BAFC-PI 1504 (3): Z52. **2**, *Vallatisporites pusillites* (Kedo) Dolby and Neves. BAFC-PI 1655(1): Z30/4. **3**, *Spelaeotriletes obtusus* Higgs. BAFC-PI 1501 (1): H33. **4-5**, *Spelaeotriletes arenaceus* Neves and Owens. **4**, BAFC-PI 1508 (5): E46; **5**, BAFC-PI 1655 (2): T57/1. **6**, *Spelaeotriletes echinatus* (Hacquebard) Utting. BAFC-PI 1501 (1): B26. **7**, *Grandispora debilis* Playford. BAFC-PI 1508 (3): K28/1. **8, 11**, *Velamisporites perinatus* (Hughes and Playford) Playford. **8**, BAFC-PI 1506 (3): U41/2; **11**, BAFC-PI 1501 (1): Q31/1. **9, 14**, *Auroraspora macra* Sullivan. **9**, BAFC-PI 1508 (1): J58/3; **14**, BAFC-PI 1504 (3): D33/1. **10**, *Grandispora notensis* Playford. BAFC-PI 1508 (4): Z51/1. **12-13**, *Grandispora spiculifera* Playford. BAFC-PI 1508 (1): Z27/3. **15**, *Auroraspora solisorta* Hoffmeister, Staplin and Malloy. BAFC-PI 1501 (2): V28/3. **16-17**, *Colatisporites decorus* (Bharadwaj and Venkatachala) Williams in Neves, Gueinn, Clayton, Ioannides, Neville and Kruszweska. **16**, BAFC-PI 1506 (1): X28; **17**, BAFC-PI 1501 (1): R38/3.

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Grandispora debilis Playford 1971

Figure 5.7

Remarks. The specimens here studied are slightly larger (81.2-87 µm) than the original material.

Occurrence. (Illustrated): Viséan, Peru (Azcuy and di Pasquo, 2005, 2006), Bolivia (Fasolo *et al.*, 2006). (Listed): Mississippian, Argentina (Sessarego and Césari, 1989; Césari and Limarino, 1992; Rodríguez Amenábar *et al.*, 2003; Pérez Loinaze and Césari, 2003). For other records see Azcuy and di Pasquo (2006).

Grandispora notensis Playford 1971

Figure 5.10

Occurrence. (Illustrated): Mississippian, Bolivia (di Pasquo, 2007b). (Listed): Late Devonian, Bolivia (Vavrdová *et al.*, 1996).

Grandispora pseudoreticulata (Menéndez and Pöthe de Baldis) Ottone 1996

Figure 2.11

Occurrence. (Illustrated): Middle Devonian, Paraguay (Menéndez and Pöthe de Baldis, 1967). Middle-Late Devonian, Argentina (Ottone, 1996), Bolivia (Ottone and Rosello, 1996; di Pasquo, 2007a). (Listed): Middle Devonian, Argentina (Rodríguez Amenábar *et al.*, 2003).

Grandispora spiculifera Playford 1976

Figures 5.12-5.13

Occurrence. (Illustrated): Late Tournaisian-Viséan, Colombia (Dueñas and Césari, 2006), Mississippian, Brazil (Loboziak *et al.*, 1991, 1992; Melo *et al.*, 1999; Melo and Loboziak, 2000, 2003). (Listed): Mississippian, Brazil (Loboziak *et al.*, 1998; Iannuzzi and Pfefferkorn, 2002), Argentina (Pérez Loinaze and Césari, 2003).

Genus *Spelaotriletes* Neves and Owens 1966

Type species. *Spelaotriletes triangulus* Neves and Owens 1966.

Spelaotriletes arenaceus Neves and Owens 1966

Figures 5.4-5.5

Remarks. The specimens here studied are smaller (54.5-75.4 µm) than the original material.

Occurrence. (Illustrated): Late Tournaisian-Pennsylvanian, Brazil (Loboziak *et al.*, 1991; Melo *et al.*, 1999; Melo and Loboziak, 2000, 2003). Mississippian, Bolivia (Azcuy and Ottone, 1987; Fasolo *et al.*, 2006). (Listed): Mississippian, Brazil (Loboziak *et al.*, 1998, 2000; Iannuzzi and Pfefferkorn, 2002).

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Spelaotriletes echinatus (Hacquebard) Utting 1987

Figure 5.6

Occurrence. First record for the Mississippian of South America.

Spelaotriletes obtusus Higgs 1975

Figure 5.3

Occurrence. (Illustrated): Late Famennian-Tournaisian, Brazil (Melo and Loboziak, 2003). (Listed): Late Devonian, Brazil (Loboziak *et al.*, 1997b). Mississippian, Bolivia (Vavrdová *et al.*, 1996).

Genus *Velamispurites* Bharadwaj and Venkatachala

1962

Type species. *Velamispurites rugosus* Bharadwaj and Venkatachala 1962.

Velamispurites perinatus (Hughes and Playford)

Playford 1971

Figures 5.8, 5.11

Occurrence. First record for the Mississippian of South America.

Genus *Colatispurites* Williams in Neves, Gueinn, Clayton, Ioannides, Neville and Kruszewska 1973

Type species. *Colatispurites decorus* (Bharadwaj and Venkatachala) Williams in Neves, Gueinn, Clayton, Ioannides, Neville and Kruszewska 1973.

Colatispurites decorus (Bharadwaj and

Venkatachala) Williams in Neves, Gueinn, Clayton, Ioannides, Neville and Kruszewska 1973

Figures 5.16-5.17

Occurrence. (Illustrated): Late Tournaisian-Viséan, Colombia (Dueñas and Césari, 2006), Viséan, Brazil (Melo and Loboziak, 2003), Bolivia (di Pasquo, 2007a), Peru (Azcuy and di Pasquo, 2005, 2006). (Listed): Mississippian, Brazil (Loboziak *et al.*, 1992, 1998, 2000; Iannuzzi and Pfefferkorn, 2002). For other records see Azcuy and di Pasquo (2006).

Paleomicroplankton*Micrhystridium* sp.

Figure 1.15

Description. Vesicle subcircular in outline, wall psilate and thin with at least fifteen discrete, heteromorphic processes with broad bases that sharply tapered to the end with simple apices or bearing a little spine.

Processes interior hollow and in free communication with the vesicle cavity. No excystment structure observed.

Dimensions (1 specimen). Overall diameter 35 µm, diameter of vesicle 27 µm, basal breadth of processes 2-3 µm, length of processes 4.6 - 7 µm.

Cymatiosphaera sp.

Figures 1.17-1.18

Description. Vesicle subspherical to polyhedral in outline. Vesicle surface granular, divided into around 12 polygonal fields, generally pentagonal; muri 2 to 3.5 µm height, luminae 7-15 µm in diameter.

Dimensions (2 specimens). Overall diameter 46-58 µm.

Comparison. *Cymatiosphaera apiaria* Ottone 1996 has larger fields with a fine reticulate sculpture inside.

Dictyotidium sp.

Figures 1.7-1.8

Description. Vesicle circular to subcircular in outline, deformed by frequent folds. Vesicle surface divided into polygonal to subcircular psilate fields that formed a well defined reticulum. Muri are psilate and narrow. No excystment structure is observed.

Dimensions (2 specimens). Overall diameter 55-63 µm, muri 1 µm height, fields 2.3-3.6 µm in diameter. Wall 1.2 µm thick.

Comparisons. *Dictyotidium* sp. is similar to *D. torosum* Playford in Playford and Dring 1981 but differs in having a thinner and folded wall. *D. prolatum* Playford in Playford and Dring 1981 is smaller, has a thinner wall and slightly sinuous muri.

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References

Allen, K.C. 1965 Lower and Middle Devonian spores of North and Central Vestspitsbergen. *Palaeontology* 8: 687-748.
 Amenábar, C.R. 2006. Significado estratigráfico de palinomorfos reabajados en la Formación Malimán (Viseano) en la Sierra del Volcán, Provincia de San Juan, Argentina. Resultados preliminares. *Revista Brasileira de Paleontología* 9: 21-32.
 Amenábar, C.R., di Pasquo, M.M., Carrizo, H. and Azcuy, C.L. 2006. Palynology of the Chigua (Devonian) and Malimán (Carboniferous) formations in the Volcán Range, San Juan Province, Argentina. Part I. Paleomicroplankton and aca-

vate smooth and ornamented spores. *Ameghiniana* 43: 339-375.
 Artüz, S. 1957. Die Spores dispersae der Türkischen Steinkohle vom Zonguldak-Gebiet. *Review Faculty of Sciences University of Istanbul* B 22: 239-263.
 Avchimovitch, V.I., Byvscheva, T.V., Higgs, K., Strel, M. and Umnova, V.T. 1988. Miospore systematics and stratigraphic correlation of Devonian-Carboniferous Boundary deposits in the European part of the USSR and Western Europe. *Courier Forschungs-Institut Senckenberg* 100: 169-191.
 Avchimovitch, V.I., Tchibrikova, E.V., Obukhovskaya, T.G., Nazarenko, A.M., Umnova, V.T., Raskatova, L.G., Mantsurova, V.N., Loboziak, S. and Strel, M., 1993. Middle and Upper Devonian miospore zonation of Eastern Europe. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine* 17: 79-147.
 Azcuy, C.L. and di Pasquo, M.M. 2005. Early Carboniferous palynoflora of the Ambo Formation, Pongo de Mainique, Peru. *Review of Palaeobotany and Palynology* 134: 153-184.
 Azcuy, C.L. and di Pasquo, M.M. 2006. Additional systematic information on the Early Carboniferous palynomorphs from the Ambo Formation, Pongo de Mainique, Peru. *Revista Brasileira de Paleontología* 9: 41-52.
 Azcuy, C.L. and Ottone, G. 1987. Datos palinológicos de la Formación Retama en la Encañada de Beu, Río Alto Beni (Bolivia). 4º Congreso Latinoamericano de Paleontología (Santa Cruz de la Sierra), *Actas* 1: 235-249.
 Balme, B.E. 1962. Upper Devonian (Frasnian) spores from the Carnarvon Basin, Western Australia. *The Palaeobotanist* 9: 1-10.
 Balme, B.E. 1988. Miospores from Late Devonian (early Frasnian) strata, Carnarvon Basin, Western Australia. *Palaeontographica* B 209: 109-166.
 Berry, W. 1937. Spores from the Pennington Coal, Rhea Country, Tennessee. *American Midland Naturalist* 18: 155-160.
 Bhardwaj, D.C. 1957. The spore flora of Velener Schichten (Lower Westphalian D) in the Ruhr Coal Measures. *Palaeontographica* B 102: 110-138.
 Bharadwaj, D.C. and Venkatachala, B.S. 1962. Spore assemblage out of a Lower Carboniferous shale from Spitsbergen. *The Palaeobotanist* 10: 17-47.
 Braman, D.R. and Hills, L.V. 1977. Palynology and Paleocology of the Mattson Formation, Northwest Canada. *Bulletin of Canadian Petroleum Geology* 25: 582-630.
 Braman, D.R. and Hills, L.V. 1992. Upper Devonian and Lower Carboniferous miospores, western District of Mackenzie and Yukon Territory, Canada. *Palaeontographica Canadiana* 8: 1-97.
 Burjack, M.I.A. and Oliveira, S.F. 1989. Contribuição ao conhecimento morfológico e sistemático do gênero *Maranites* Brito. *Boletim IG-USP (Instituto de Geociências-Universidade de São Paulo), Publicação Especial* 7: 45-67.
 Burjack, M.I.A., Loboziak, S. and Strel, M. 1987. Quelques données nouvelles sur les miospores dévoniennes du bassin du Paraná (Brésil). *Bulletin of Sciences Géologiques* 40: 381-391.
 Butterworth, M.A. and Williams, R.W. 1958. The small spore floras of coals in the Limestone Coal Group and Upper Limestone Group of the Lower Carboniferous of Scotland. *Transactions of the Royal Society of Edinburgh* 63: 352-392.
 Césari, S.N. and Limarino, C.O. 1992. Palinomorfos eocarboníferos en la Formación Cortaderas, Provincia de San Juan, Argentina. 8º Simposio Argentino de Paleobotánica y Palinología (Buenos Aires), *Publicación Especial* 2: 45-48.
 Césari, S.N. and Limarino, C.O. 1995. Primer registro palinológico de la Formación Malimán (Carbonífero Inferior), Cuenca Río Blanco, Argentina. 6º Congreso Argentino de Paleontología y Bioestratigrafía (Trelew), *Actas*: 77-83.
 Clayton, G., Higgs, K., Keegan, J.B. and Sevastopulo, G.D. 1978. Correlation of the palynological zonation of the Dinantian of the British Isles. *Palinología* 1: 137-147.
 Dettmann, M. 1963. Upper Mesozoic microfloras from south-eastern Australia. *Proceedings of the Royal Society of Victoria* 77: 1-148.

- Deunff, J. 1954. *Veryhachium*, genre nouveau d'Hystrichosphères du Primaire. *Comptes Rendus Sommaire des Séances de la Société géologique de France* 13: 305-306.
- di Pasquo, M.M., 2007a. Asociaciones palinológicas en las formaciones Los Monos (Devónico) e Itacua (Carbonífero Inferior) en Balapuca (cuenca Tarija), sur de Bolivia. Parte 1. Formación Los Monos. *Revista Geológica de Chile* 34: 97-137.
- di Pasquo, M.M., 2007b. Asociaciones palinológicas en las formaciones Los Monos (Devónico) e Itacua (Carbonífero Inferior) en Balapuca (cuenca Tarija), sur de Bolivia. Parte 2. Asociaciones de la Formación Itacua e interpretación estratigráfica y cronología de las formaciones Los Monos e Itacua. *Revista Geológica de Chile* 34: 163-198.
- Diaz Martínez, E., Vavrdová, M., Bek, J. and Isaacson, P.E. 1999. Late Devonian (Famennian) Glaciation in Western Gondwana: Evidence from the Central Andes. *Abhandlungen der Geologischen Bundesanstalt* B.A. 54: 213-237.
- Dino, R. 1999. Palynostratigraphy of the Silurian and Devonian sequence of the Paraná Basin, Brazil. In: M.A.C. Rodrigues and E. Pereira (eds.), *Ordovician-Devonian palynostratigraphy in Western Gondwana: update, problems and perspectives* (Rio de Janeiro). Faculdade de Geologia da Universidade Estadual do Rio de Janeiro, Resumos expandidos 27-61.
- Dolby, G. and Neves, R. 1970. Palynological evidence concerning the Devonian-Carboniferous boundary in the Mendips, England. 6° *Congrès International de la Stratigraphie et Géologie du Carbonifère* (Sheffield, 1967). *Comptes Rendus* 2: 631-646.
- Dueñas, H. and Césari, S.N. 2006. Palynological evidence of Early Carboniferous sedimentation in the Llanos Orientales Basin, Colombia. *Review of Palaeobotany and Palynology* 138: 31-42.
- Fasolo, Z., Vergel, M.M., Oller, J. and Azcuy, C. 2006. Nuevos datos palinológicos de la Formación Kaka (Viseano - Serpukhoviano) en la Encañada de Beu, Subandino Norte de Bolivia. *Revista Brasileira de Paleontología* 9: 53-62.
- Hacquebard, P.A. 1957. Plant spores in coal from the Horton Group (Mississippian) of Nova Scotia. *Micropaleontology* 3: 301-324.
- Higgs, K.T. 1975. Upper Devonian and Lower Carboniferous miopore assemblages from Hook Head, County Wexford, Ireland. *Micropaleontology* 21: 393-419.
- Higgs, K.T. and Clayton, G. 1984. Tournaisian miopore assemblages from Maesbury in the eastern Mendips, England. *Journal of Micropalaeontology* 3: 17-28.
- Higgs, K.T., Clayton, G. and Keegan, J.B. 1988. Stratigraphy and systematic palynology of the Tournaisian rocks of Ireland. *The Geological Survey of Ireland, Special Papers* 7: 1-93.
- Hoffmeister, W.S., Staplin, F.L. and Malloy, R.E. 1955. Mississippian plant spores from Hardinsburg Formation of Illinois and Kentucky. *Journal of Paleontology* 29: 372-399.
- Hughes, N.F. and Playford, G. 1961. Palynological reconnaissance of the Lower Carboniferous of Spitsbergen. *Micropaleontology* 7: 27-44.
- Iannuzzi, R. and Pfefferkorn, H.W. 2002. A pre-glacial warm-temperate floral belt in Gondwana (late Visean, Early Carboniferous). *Palaios* 17: 571-590.
- Jäger, H. 2002. Palynology of the Lower Carboniferous (Mississippian) Kammquartzite Formation in the Rhenohercynian Zone, Germany. *Senckenbergiana lethaea* 82: 609-637.
- Keegan, J.B. and Penney, S.R. 1978. Lower Carboniferous miopore assemblages from the Portlaw Area, County Waterford, Ireland. *Pollen et Spores* 20: 569-581.
- Kiesling, R. 2002. Código Internacional de Nomenclatura Botánica (Código de Saint Louis). *Instituto de Botánica Darwinion and Missouri Botanical Garden Press*, San Isidro, 181 pp.
- Kosanke, R.M. 1950. Pennsylvanian spores of Illinois and their use in correlation. *State Geological Survey of Illinois, Bulletin* 74: 1-128.
- Kützing, F.T. 1849. *Species algarum*. F.A. Brockhaus, Leipzig, 922 pp.
- Leschik, G. 1955. Die Keuperflora von Neuwelt bei Basel. II. Die Iso-Mikrosporen. *Palaeontographica* A 72: 1-70.
- Limachi, R., Goitia, V.H., Sarmiento, D., Arispe, O., Montecinos, R., Diaz Martínez, E., Dalenz Farjat, A., Liachenco, N., Pérez Leyton, M. and Aguilera, E. 1996. Estratigrafía, Geoquímica, Correlaciones, Ambientes Sedimentarios y Bioestratigrafía del Silúrico-Devónico de Bolivia. 12° *Congreso Geológico de Bolivia* (Tarija), *Memorias* 12: 183-197.
- Loboziak, S. and Melo, J.H.G. 2000. Miopore events from late Early to Late Devonian strata of Western Gondwana. *Geobios* 33: 399-407.
- Loboziak, S. and Melo, J.H.G. 2002. Devonian miopore successions of Western Gondwana: update and correlation with Southern Euroamerican miopore zones. *Review of Palaeobotany and Palynology* 121: 133-148.
- Loboziak, S. and Strel, M. 1981. Miopores in middle-upper Frasnian to Famennian sediments partly dated by conodonts (Boulonnais), France. *Review of Palaeobotany and Palynology* 34: 49-66.
- Loboziak, S., Strel, M. and Burjack, M.I.A. 1988. Miopores du Dévonien moyen et supérieur du Bassin du Paraná, Brésil: systématique et stratigraphie. *Sciences Géologiques Bulletin* 41: 351-377.
- Loboziak, S., Melo, J.H.G. and Strel, M. 1998. Reassessment of Viséan miopore biostratigraphy in the Amazon Basin, northern Brazil. *Review of Palaeobotany and Palynology* 104: 143-155.
- Loboziak, S., Melo, J.H.G. and Strel, M. 2000. Latest Devonian and Early Carboniferous palynostratigraphy of Northern Brazil and North Africa - a proposed integration of western European and Gondwanan miopore biozonations. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine* 22: 241-259.
- Loboziak, S., Melo, J.H.G., Matsuda, N.S. and Quadros, L.P. 1997a. Miopore biostratigraphy of the type Barreirinha Formation (Curuá Group, Upper Devonian) in the Tapajós River area, Amazon Basin, North Brazil. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine* 21: 187-205.
- Loboziak, S., Melo, J.H.G., Quadros, L.P. and Strel, M. 1997b. Palynological evaluation of the Famennian Protosalvinia (Foerstia) Zone in the Amazon Basin, Northern Brazil: a preliminary study. *Review of Palaeobotany and Palynology* 96: 31-45.
- Loboziak, S., Strel, M., Caputo M.V. and Melo, J.H.G. 1991. Evidence of West European-defined miopore zones in the uppermost Devonian and Lower Carboniferous of the Amazon Basin (Brazil). *Geobios* 24: 5-11.
- Loboziak, S., Strel, M., Caputo, M.V. and Melo, J.H.G. 1992. Middle Devonian to Lower Carboniferous miopore stratigraphy in the central Parnaíba Basin (Brazil). *Annales de la Société Géologique de Belgique* 115: 215-226.
- Loeblich, A.R. 1970. Morphology, Ultrastructure and Distribution of Paleozoic Acritarchs. *Proceedings of the North American Paleontological Convention*, Part G: 705-788.
- McGregor, D.C. 1973. Lower and Middle Devonian spores of eastern Gaspé, Canada. I. Systematics. *Palaeontographica* B 142:1-77.
- McGregor, D.C. 1977. Lower and Middle Devonian spores from Gaspé, Canada. 11. Biostratigraphy. *Palaeontographica* B 163: 111-142.
- McGregor, D.C. 1979. Devonian miopores of North America. *Palynology* 3: 31-52.
- McGregor, D.C. 1984. Late Silurian and Devonian spores from Bolivia. *Academia Nacional de Ciencias de Córdoba* (Córdoba). *Miscelánea* 69: 1-43.
- McGregor, D.C. 1996. Spores of the Escuminac Formation. In *Devonian fishes and plants of Miguasha, Quebec, Canada*. In: H.P. Schultze and R. Cloutier (eds.). *Verlag Dr. Friedrich Pfeil, München, Alemania*: 91-102.
- McGregor, D.C. and Canfield, M. 1976. Upper Silurian? To Middle Devonian spores of the Moose river basin, Ontario. *Geological Survey of Canada, Bulletin* 263: 1-63.
- McGregor, D.C. and Canfield, M. 1982. Middle Devonian miopores from the Cape de Bray, Weatherall, and Hecla Bay

- Formations of northeastern Melville Island, Canadian Arctic. *Geological Survey of Canada, Bulletin* 348: 1-105.
- McLean, D., Owens, B. and Neves, R. 2005. Carboniferous miospore biostratigraphy of the North Sea. In Carboniferous hydrocarbon geology: the southern North Sea and surrounding onshore areas. In: J.D. Collinson, D.J. Evans, D.W. Holliday and N.S. Jones (eds.). *Yorkshire Geological Society* 7: 13-24.
- Melo, J.H.G. and Loboziak, S. 2000. Viséan miospore biostratigraphy and correlation of the Poti Formation (Parnaíba Basin, northern Brazil). *Review of Palaeobotany and Palynology* 112: 147-165.
- Melo, J.H.G. and Loboziak, S. 2003. Devonian-Early Carboniferous miospore biostratigraphy of the Amazon Basin, Northern Brazil. *Review of Palaeobotany and Palynology* 124: 131-202.
- Melo, J.H.G., Loboziak, S. and Streel, M. 1999. Latest Devonian to early Late Carboniferous biostratigraphy of northern Brazil: an update. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine* 22: 13-33.
- Menéndez, C.A. and Pöthe de Baldis, E.D. 1967. Devonian Spores from Paraguay. *Review of Palaeobotany and Palynology* 1: 161-172.
- Moreau-Benoit, A. 1979. Les spores du Dévonien de Libye, 1ère partie. *Cahiers de Micropaléontologie, Centre National de la Recherche Scientifique*, Paris, 4: 3-58.
- Moreau-Benoit, A. 1980. Les spores du Dévonien de Libye, 2ème partie. *Cahiers de Micropaléontologie, Centre National de la Recherche Scientifique*, Paris, 1: 3-53.
- Naumova, S.N. 1953. Spore-pollen complexes of the Upper Devonian of the Russian Platform and their stratigraphic significance. *Transactions of the Institute of Geological Sciences, Academy of Science, SSSR*, 143 (Geol. Ser. 60): 1-200. [in Russian].
- Neves, R. 1961. Namurian plant spores from the southern Pennines, England. *Palaeontology* 4: 247-279.
- Neves, R. and Ioannides, N. 1974. Palynology of the Lower Carboniferous (Dinantian) of the Spilmersford Borehole, East Lothian, Scotland. *Bulletin of the Geological Survey of Great Britain* 45: 73-97.
- Neves, R. and Owens, B. 1966. Some Namurian camerate miospores from the English Pennines. *Pollen et Spores* 8: 337-360.
- Neves, R., Gueinn, K.J., Clayton, G., Ioannides, N., Neville, R.S. and Kruszewska, K. 1973. Palynological correlations within the Lower Carboniferous of Scotland and northern England. *Transactions of the Botanical Society of Edinburgh* 69: 23-70.
- Niemeyer, H. and Rubinstein, C.V. 2000. Stratigraphy and Palynology of the Devonian-Carboniferous boundary in the Zorritas Formation, Antofagasta region, northern Chile. 1º Congreso Ibérico de Paleontología. 16º Jornadas de la Sociedad Española de Paleontología. 8º International Meeting of IGCP 421 (Evora), *Libro de Resúmenes*: p. 260.
- Ottone, E.G. 1996. Devonian palynomorphs from the Los Monos Formation, Tarija Basin, Argentina. *Palynology* 20: 101-151.
- Ottone, E.G. and Rossello, E.A. 1996. Palynomorfos devónicos de la Formación Tequeje, Angosto del Beni, Bolivia. *Ameghiniana* 33: 443-452.
- Owens, B. 1971. Miospores from the Middle and Early Upper Devonian rocks of the Western Queen Elizabeth Islands, Arctic Archipiélago. *Geological Survey of Canada, Paper* 70-38: 1-157.
- Owens, B. 1983. *Bascaudaspora* gen. nov., a new reticulate miospore genus from the Namurian of Northern England. *Report of Institut of Geological Sciences* 83: 45-49.
- Paris, F., Richardson, J.B., Riegel, W. Streel, M. and Vanguetaine, M. 1985. Devonian (Emsian Famennian) palynomorphs. *Journal of Micropaleontology* 4: 49-82.
- Pérez Leyton, M. 1990. [Palynomorphes du Devonien Moyen et Supérieur de la Coupe de Bermejo-La Angostura (Sud-Est de la Bolivie). Master Dissertation, Faculté des Sciences, Université de Liège, Belgium, 156 pp. Unpublished.].
- Pérez Leyton, 1991. Miospores du Devonien Moyen et Supérieur de la coupe de Bermejo - La Angostura (Sud-Est de la Bolivie). *Annales de la Société Géologique de Belgique* 113: 373-389.
- Pérez Loínaze, V. and Césari, S. 2003. Revisión Palinológica de la Formación Cortaderas (Carbonífero), provincia de San Juan, Argentina. 3º Simposio Argentino del Paleozoico Superior. 2º Reunión del proyecto International Geological Correlation Program 471 (La Plata), *Resúmenes*: p. 22.
- Playford, G. 1963. Lower Carboniferous microfloras of Spitsbergen. Part two. *Palaeontology* 5: 619-678.
- Playford, G. 1971. Lower Carboniferous spores from the Bonaparte Gulf Basin, Western Australia and Northern Territory. *Bureau of Mineral Resources, Geology and Geophysics of Australia, Bulletin* 115: 1-105.
- Playford, G. 1976. Plant Microfossils from the Upper Devonian and Lower Carboniferous of the Canning Basin, Western Australia. *Palaeontographica* B 158: 1-71.
- Playford, G. 1978. Lower Carboniferous spores from the Ducabrook Formation, Drummond Basin, Queensland. *Palaeontographica* B 167: 105-160.
- Playford, G. 1983. The Devonian miospore genus *Geminospora* Balme 1962: a reappraisal based upon topotypic *G. lemurata* (type species). *Association of Australasian Palaeontologists, Memoir* 1: 311-325.
- Playford, G. 1985. Palynology of the Australian Lower Carboniferous: a review. 10º International Congress on Stratigraphy and Geology of Carboniferous (Madrid, 1983), *Comptes Rendus* 4: 247-265.
- Playford, G. 1991. Australian Lower Carboniferous miospores relevant to extra-Gondwanic correlations: an evaluation. *Courier Forschungsinstitut Senckenberg* 130: 85-125.
- Playford, G. and Dring, R.S. 1981. Late Devonian acritarchs from the Carnarvon Basin, Western Australia. *Palaeontological Association, Special Papers in Palaeontology* 27: 1-78.
- Playford, G. and Satterthwait, B. 1988. Lower Carboniferous (Viséan) spores of the Bonaparte Gulf Basin, Northwestern Australia: Part three. *Palaeontographica* B 208: 1-26.
- Potonié, R. 1958. Synopsis der Gattungen der Sporae dispersae, II. Teil: Sporites (Nachtrage), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates. *Beihefte zum Geologischen Jahrbuch* 31: 1-114.
- Potonié, R. 1970. Synopsis der Gattungen der Sporae dispersae, V. Teil: Nachtrage zu allen Gruppen (Turmae). *Beihefte zum Geologischen Jahrbuch* 87: 1-222.
- Potonié, R. and Kremp, G.O. 1954. Die Gattungen der Paläozoischen Sporae dispersae und ihre Stratigraphie. *Beihefte Geologischen Jahrbuch* 69: 111-194.
- Punt, W., Blackmore, S., Nilsson, S. and Le Thomas, A. 1994. Glossary of pollen and spore terminology. *Laboratory of Palaeobotany and Palynology Foundation, Contributions Series* 1: 1-71. World Wide Web: <http://www.bio.uu.nl/~palaeo/glossary/glos-p1.htm#Camera>.
- Ravn, R.L. 1991. Miospores of the Kekiktuk Formation (Lower Carboniferous), Endicott Field Area, Alaska North Slope. *American Association of Stratigraphic Palynologists Foundation, Contribution Series* 27: 1-173.
- Richardson, J.B. 1965. Middle Old Red Sandstone spore assemblages from the Orcadian Basin north-east Scotland. *Palaeontology* 7: 559-605.
- Richardson, J.B. and Lister, T.R. 1969. Upper Silurian and Lower Devonian spore assemblages from the Welsh Borderland and South Wales. *Palaeontology* 12: 201-252.
- Richardson, J.B. and McGregor, D.C. 1986. Silurian and Devonian spore zones of the Old Red Sandstone continent and adjacent regions. *Geological Survey of Canada, Bulletin* 364: 1-79.
- Rodrigues, R., Loboziak, S., Melo, J.H.G. and Alves, D.B. 1995. Geochemical characterization and miospore biostratigraphy of the Frasnian anoxic event in the Parnaíba Basin, northeast Brazil. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine* 19: 319-327.

- Rodríguez Amenábar, C., di Pasquo, M. M. and Carrizo, H.A. 2003. Datos palinológicos del límite Devónico/Carbonífero en la quebrada Cortaderas, provincia de San Juan, Argentina. 12° Simposio Argentino de Paleobotánica y Palinología (Buenos Aires), *Resúmenes*: 36-37.
- Rubinstein, C.V., Melo, J.H.G. and Steemans, P. 2005. Lochkovian (earliest Devonian) miospores from the Solimões Basin, north-western Brazil. *Review of Palaeobotany and Palynology* 133: 91-113.
- Rubinstein, C.V., Urzúa, F. and Niemeyer, H. 1996. Primeros resultados palinológicos en la Formación Zorritas, Devónico-Carbonífero de Sierra de Almeida, Región de Antofagasta, Chile. *Revista Geológica de Chile* 23: 81-95.
- Sarjeant, W.A.S. and Vavrdová, M. 1997. Taxonomic reconsideration of *Multiplicisphaeridium* Staplin 1961 and other acritarch genera with branching processes. *Geolines* 5: 1-51.
- Schopf, J.M., Wilson, L.R. and Bentall, R. 1944. An annotated synopsis of Palaeozoic fossil spores and the definition of generic groups. *Illinois State Geological Survey, Report Investigation* 91: 1-66.
- Sessarego, H.L. and Césari, S.N. 1989. An Early Carboniferous Flora from Argentina. Biostratigraphic implications. *Review of Palaeobotany and Palynology* 57: 247-264.
- Smith, A.H.V. and Butterworth, M.A., 1967. Miospores in the coal seams of the Carboniferous of Great Britain. *The Palaeontological Association, Special Paper in Palaeontology* 1: 1-324.
- Souza, P.A. 2006. Late Carboniferous palynostratigraphy of the Itararé Subgroup, northeastern Paraná Basin, Brazil. *Review of Palaeobotany and Palynology* 138: 9-29.
- Staplin, F.L. 1960. Upper Mississippian plant spores from the Golata Formation, Alberta, Canada. *Palaeontographica* B 107: 1-40.
- Staplin, F.L. and Jansonius, J. 1964. Elucidation of some Paleozoic Densosporae. *Palaeontographica* B 114: 95-117.
- Sullivan, H.J. 1964. Miospores from the Drybrook Sandstone and associated measures in the Forest of Dean Basin, Gloucestershire. *Palaeontology* 7: 351-392.
- Sullivan, H.J. 1968. A Tournaisian spore flora from the Cementstone Group of Ayreshire, Scotland. *Palaeontology* 11: 116-131.
- Turnau, E. 1978. Spore zonation of Uppermost Devonian and Lower Carboniferous deposits of western Pomerania. *Mededelingen rijks geologische dienst* 30: 1-35.
- Turnau, E. 1986. Miospore stratigraphy of Middle Devonian deposits from western Pomerania. *Review of Palaeobotany and Palynology* 93: 107-125.
- Turnau, E. 1996. Miospore stratigraphy of Middle Devonian deposits from Western Pomerania. *Review of Palaeobotany and Palynology* 93: 107-125.
- Turnau, E. and Racki, G. 1999. Givetian palynostratigraphy and palynofacies: new data from the Bodzentyn Syncline (Holy Cross Mountains, central Poland). *Review of Palaeobotany and Palynology* 106: 237-271.
- Urban, J.B. 1971. Palynology and the Independence Shale of Iowa. *Bulletins of American Paleontology* 60: 103-109.
- Utting, J. 1987. Palynology of the Lower Carboniferous Windsor Group and Windsor-Canso boundary beds of Nova Scotia, and their equivalents in Quebec, New Brunswick and Newfoundland. *Geological Survey of Canada, Bulletin* 374: 1-93.
- Utting, J. 1991. Lower Carboniferous miospore assemblages from the Hart River Formation, Northern Yukon Territory. *Geological Survey of Canada, Bulletin* 412: 81-99.
- Utting, J. and Giles, P.S. 2004. Biostratigraphical implications of new palynological data from the Mississippian of Newfoundland and Nova Scotia, Canada. *Association of Australasian Palaeontologists, Memoirs* 29: 115-160.
- Vavrdová, M., Bek, J., Dufka, P. and Isaacson, P.E. 1996. Palynology of the Devonian (Lochkovian to Tournaisian) sequence, Madre de Dios Basin, northern Bolivia. *Vestník Českého geologického ústavu* 71: 333-349.
- Vavrdová, M., Isaacson, P.E., Díaz Martínez, E. and Bek, J. 1993. Devonian - Carboniferous boundary at Lake Titikaka, Bolivia: preliminary palynological results. 12° *Congrès International de la Stratigraphie et Géologie du Carbonifère et Permien* (Buenos Aires, 1991), *Comptes Rendus* 1: 187-200.

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