

Devonian palynological assemblages from the San Antonio x-1 Borehole, Tarija Basin, northwestern Argentina

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ABSTRACT

The palynological analysis of the 2548-3628 m interval of the San Antonio x-1 Borehole in northwestern Argentina is presented. The illustrated palynoflora is composed of 96 species represented by diverse palynological groups such as trilete spores and cryptospores (46 species), microplankton (39 species), chitinozoans (7 species), scolecodonts, and some remaining specimens in open nomenclature and as *incertae sedis*. One new species, *Retusotriletes ottonei*, is described. Thirty-four species are first records in the Argentinean Devonian. Three assemblages (SA1, SA2, and SA3) are defined based on the presence, absence, or abundance of groups of taxa. The presence of *Grandispora protea* and *Grandispora douglastownense* among others in the assemblage SA1 is indicative of a late Emsian to mid-Eifelian age. The concurrence of *Acinosporites macrospinosus* and *A. acanthomammillatus* in the assemblage SA2 is indicative of a late Eifelian-mid Givetian and is also supported by the appearance of several other species such as *Chomotriletes vedugensis*, *Dibolisporites farraginis* and *Biharisporites parviornatus*. An early Frasnian age is associated to the assemblage SA3 on the basis of the appearances of *Lunulidia micropunctata*, *Pseudolunulidia laevigata*, *Verrucosisporites bulliferus* and the abundance of *Maranhites*. The assemblages SA1 and SA2 reflect a nearshore, shallow marine depositional conditions, characterized by a high terrestrial input and variable marine influence, while the assemblage SA3 could represent a transgression during that time. The assemblages are composed of many cosmopolitan index species that support a partial correlation with Brazilian and Euramerican zonations resulting from the effects of paleolatitude and the configuration of land and sea for that time, with a narrow Rheic Ocean between northern Gondwana and Euramerica.

KEYWORDS | Palynofloras. Devonian. Los Monos Formation. Tarija Basin. Northwestern Argentina.

INTRODUCTION

Devonian deposits in the southern Tarija Basin crop out in certain areas of the western Subandean Range to the

eastern part of the Cordillera Oriental of Argentina (see Starck, 1999). In contrast, Devonian subsurface deposits are widely distributed in northern Argentina, Bolivia, and Paraguay, and contain paleontological evidences of having

been connected with other coeval close deposits in western Argentina, Brazil, Peru and Uruguay (Fig. 1A-B; Fig. 2), especially during transgressions (e.g., Melo, 1989; Starck, 1996; Grahn, 2005). The Subandean zone in this basin is a thin-skinned thrust belt with elongated anticlines that run North-Northeast–South-Southwest forming several continuous and parallel ranges (Echavarría et al., 2003, and references therein). One of them is named San Antonio, where the borehole San Antonio x-1 is located (see Fig. 1B). Even though many multidisciplinary works based on both subsurface and surface information have been carried out by different oil companies, published accounts are less numerous (e.g., Suárez Soruco 2000; Dalenz Farjat et al., 2002; Albariño et al., 2002; Álvarez et al., 2003; Vistalli et al., 2005). This detailed palynological survey, recovered from the 2548–3628m interval in the San Antonio x-1 borehole, is part of an important contribution (PhD thesis of the first author) to the recognized yet poorly understood biodiversity and succession of floristic events during the Devonian in northwestern Argentina. The stratigraphic distribution of the retrieved species (spores, cryptospores, chitinozoans and microplankton) is analyzed and compared with their global ranges to assess the age and correlation of the three assemblages defined in the interval. Palynofacies are also considered in order to better understand previous paleoenvironmental interpretations.

STRATIGRAPHICAL AND PALEONTOLOGICAL BACKGROUND

The stratigraphical units of the Late Silurian to Devonian rocks from northern Argentina and southern Bolivia have been assigned to supersequence hierarchies by Starck (1995, 1999) (Fig. 2). This includes a Silurian–Jurassic tectonic-stratigraphic interval that is divided into two units separated by a regional unconformity at the end of the Devonian. In the first Silurian–Devonian unit, the Cinco Picachos, Las Pavas and Aguaraquí Supersequences are characterized by stacked, kilometer scale, coarsening-upward shale and sandstone facies bounded by first order flooding surfaces. Under this scheme, the Huamampampa Formation is part of the upper Las Pavas Supersequence, conformably overlying the Icla Formation, and is transitional to the overlying Los Monos Formation. Lithologies in the Huamampampa Formation include sandstone layers interbedded with silty mudstones with variable thickness of 300–700m (Limachi et al., 1996). The Los Monos and Iquiri Formations are included in the last supersequence with a maximum thickness of 1000m. The former is mainly composed of grey and black mudstones interbedded with thin sandstones. In the latter, sandstones are more frequent and less represented in surface and subsurface of northern Argentina due to the Carboniferous erosive unconformity (see Starck, 1999). The Devonian/

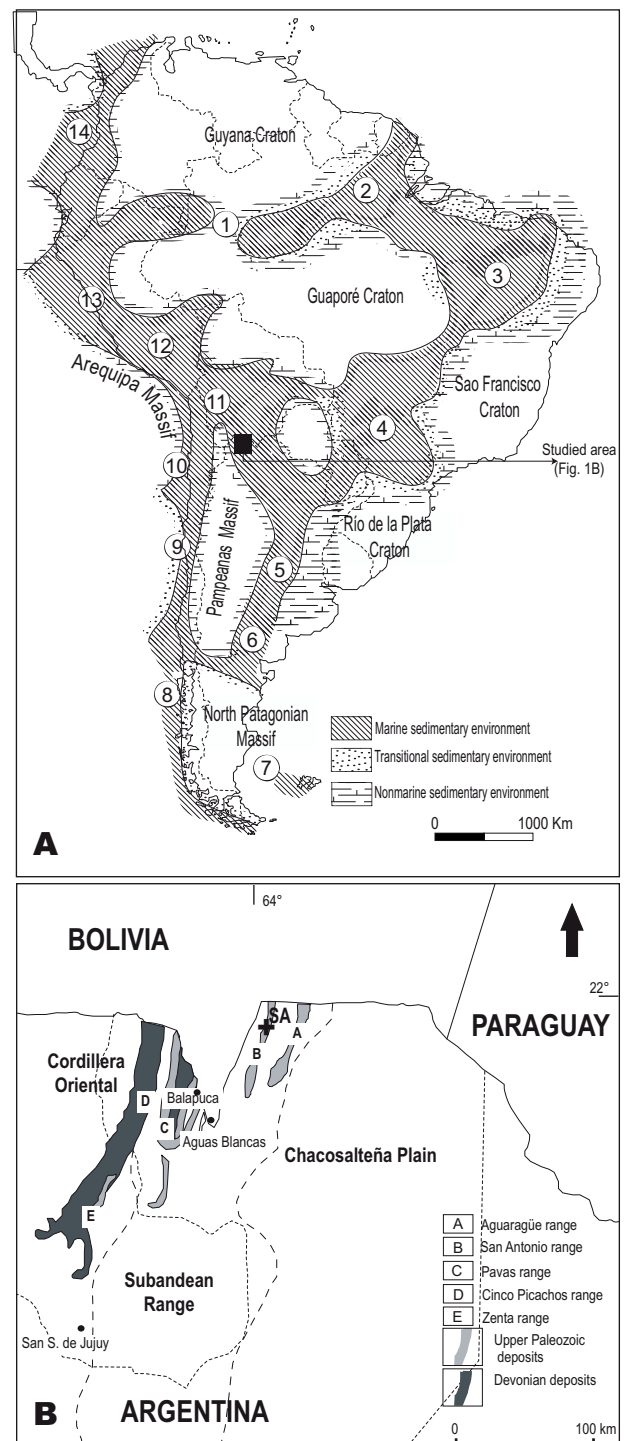


FIGURE 1 | A) South America, paleogeographical reconstruction, after di Pasquo et al. (2009). The rectangle indicates the studied area. References of basins: Brazil. 1: Solimões, 2: Amazon, 3: Parnaíba, 4: Paraná. Argentina. 5: Chaco-Paraná, 6: Sierras Australes, 7: Falkland Islands, 8: South Patagonian, 9: Cuyana or Precordillerana. Chile-Argentina. 10: Arizaro. Argentina-Bolivia-Paraguay. 11: Tarija. Bolivia-Perú. 12: Madre de Dios. Perú-Brazil. 13: Acre. Colombia. 14: Llanos Orientales. B) Distribution of Paleozoic surface deposits in the Geological Provinces of northern Argentina (see Starck, 1999), and location of the studied San Antonio x-1 Borehole.

Carboniferous boundary in this borehole was located by REPSOL-YPF around 2570m (see Fig. 3). The basal part of the column is conformed by a higher proportion of sandstones than mudstones, whilst the opposite occurs in the rest of the studied interval of the borehole (Fig. 3).

In Bolivia, the Huamampampa Formation has a maximum age span of late Emsian or early Eifelian through possibly earliest Givetian, whilst the Los Monos Formation, on the basis of previous palynological studies (see Melo, 2005a), is attributed to the late Eifelian or early Givetian through the early Frasnian. In northern Argentina, there are few publications on Devonian palynofloras containing systematic descriptions and illustrations of spores, acritarchs and chitinozoans, notably Volkheimer et al. (1986), Barreda (1986), Ottone (1996), Grahn and Gutiérrez (2001) and Grahn (2002). Menéndez and Pöthe de Baldis (1967) and Pöthe de Baldis (1974, 1979) described and illustrated palynomorphs found in the Picuiba borehole in northwestern Paraguay. In southern Bolivia, there are several stratigraphical, biostratigraphical and paleobiogeographical contributions, including Lobo Boneta (1975), Suárez Soruco and Lobo Boneta (1983), Kimyai (1983), McGregor (1984), Wood (1984, 1994, 1995), Pérez Leyton (1990, 1991), Racheboeuf et al. (1993), Bliciek et al. (1996), Grahn (2002, 2005), di Pasquo (2005, 2007a, b), whilst in northern Bolivia there are publications by Vavrdová et al. (1993, 1996), Ottone and Rossello (1996), Vavrdová and Isaacson (1999) and Díaz Martínez et al. (1999). Both Suárez Soruco and Lobo Boneta (1983) and Limachi et al. (1996) proposed biostratigraphical schemes for the Devonian based on unillustrated lists of

species. Melo (2005a) presented new palynostratigraphical results from some Devonian units in Bolivia but did not include lists or illustrations of palynomorphs. Although, many are compared in this paper, some of these works need to be reviewed in more detail in order to be applied with certainty to understanding the evolution of the Devonian microfloras in this region (see di Pasquo, 2007c).

MATERIAL AND METHODS

The San Antonio x-1 borehole was drilled to a total depth of 3600m (15700feet). A hundred and fifty seven cutting samples were collected, around each seven-meter depth along 1100m of the borehole. For a preliminary overview, twenty-three samples with an average distance of thirty-seven meters between each one were selected and processed, with results presented in Noetinger and di Pasquo (2007). An additional selection of samples was added to the previous study in order to complement and refine the information. Currently, the total count of samples is fifty-five, covering a depth from 2548 to 3628m, with an average distance of sixteen meters between each one (Fig. 3A-B). In order to track the Carboniferous-Devonian limit, which was indicated to occur at ca. 2504-02m by di Pasquo and Noetinger (2008), the samples, mainly from the top part of the column, span only two meters.

Standard palynological methods were performed to obtain organic residues from the samples. They were treated first with hydrochloric and then with hydrofluoric

Countries			ARGENTINA				BOLIVIA			BRAZIL			
Chronology Basin			Precordillera		Tarija		Madre de Dios		Paraná	Amazon	Parnaíba	Solimões	
			Central (1)	Western (1)	Subandean (S) (2)		Subandean (N) – Altiplano – Oriental (3)		(4)	(5)	(6)	(7)	
DEVONIAN	Upper	Frasnian	Punta Negra	Chinguillos Group	C:P: Las Pavas / Aguargüe Supersequences	Iquiri	Iquiri	Sica Sica	Tomachi	São Domingo	Barreirinha	Pimenteira	Uerê
	Middle	Givetian				Chigua	Los Monos			Los Monos	Ponta Grossa		
		Eifelian	Pescado	Huamampampa	Belén		Maecurú						
	Lower	Emsian		Talacasto		Pircas Negras	Porongal	Icla	Furnas	Manacapuru	Jaicós		
		Pragian	Baritú		Santa Rosa		Vila Vila						
		Lochkovian											

FIGURE 2 | Correlation of Devonian units of Argentina, Bolivia and Brazil. References: 1) Rubinstein (1999, 2000); 2) Starck (1996, 1999), Suárez Soruco (2000); 3) Díaz Martínez (1999), Suárez Soruco (2000); 4) Dino (1999); 5) Melo and Loboziak (2003), Grahn (2003); 6, 7) Grahn et al. (2003). Absolute time dates after Gradstein et al. (2004). Nevertheless, it must be noticed that there are relatively huge differences between this scale and the one proposed more recently by Menning et al. (2006), where the emsian-eifelian boundary is dated at 392Ma and the Givetian-Frasnian at 381Ma.

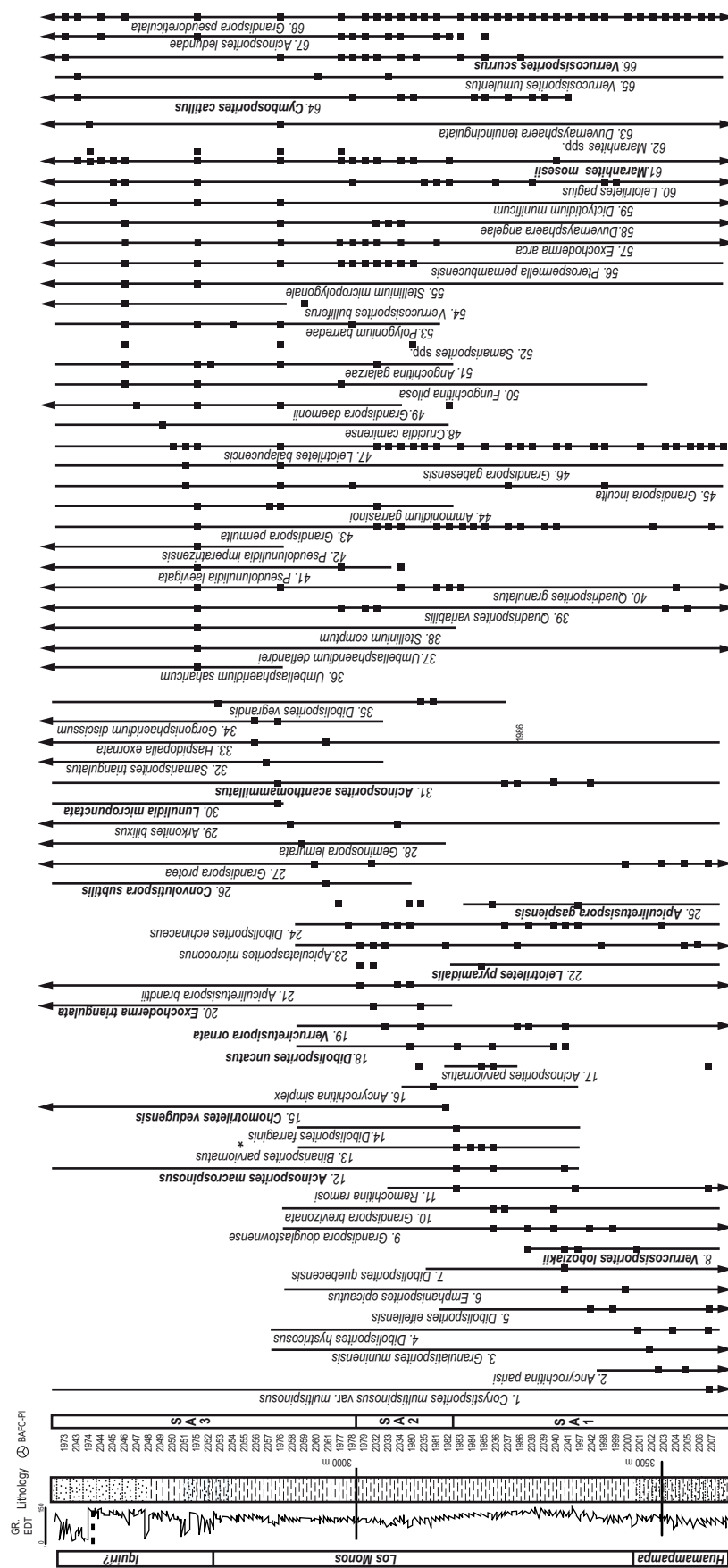


FIGURE 3 | A-B) Stratigraphic distribution of selected taxa (in last occurrence order) recorded in the San Antonio x-1 Borehole. The stratigraphic ranges (lines) are based on the selected literature: Marhoumi and Rausscher (1984), McGregor and Playford (1992), Turrau (1996), Quadros (1999), Vavrdová and Isaacson (1999), Marshall and Fletcher (2002), Grain (2005 and references therein), Hashemi and Playford (2005), di Pasquo (2007a, and references therein), Al-Ghazi (2007), Amenábar et al. (2006, 2007, and references therein), González (2009), di Pasquo et al. (2009, and references therein). (*) The occurrence point corresponds to *Dibolisporites* sp. cf. *D. farraginis*. The dashed line corresponds to the Devonian-Carboniferous boundary located by REFSOL-YPF.

acid to remove carbonate, silica and silicates, respectively, sieved with a 25µm mesh and finally mounted on slides with glycerine jelly.

The identification of palynomorphs was undertaken using both *Leitz Orthoplan* and *Nikon Eclipse 80i* trinocular transmitted light microscopes, with x1000 maximum magnification. The photomicrographs were obtained with *Motic* (2.0 megapixels) and *Pax-it* (3.1 megapixels) videocameras and the illustrations are labelled with BAFC-PI numbers followed by the England Finder reference. The studied samples are deposited at the Department of Geology of the School of Natural and Pure Sciences (University of Buenos Aires). Processing was undertaken at the Palynostratigraphy and Paleobotany Laboratory of the same institution. Detailed surface studies of the palynomorphs were illustrated under SEM photographed with a *Phillips serie XL model 30* at the Argentine Natural Sciences Museum “Bernardino Rivadavia” (MACN). The specimens were coated with a fine film of 200-300 Å Gold-Palladium using a sputter-coater “Termo VG Scientific SC 7620”. Coverslips bearing the isolated spores were then removed and mounted on slides with glycerine jelly to be re-illustrated under light microscope.

Even though C. Vistalli in “pers. comm.” has informed that the drilling of this borehole was well-maintained and that the stratigraphical distribution of the palynomorphs suggests that there was no contamination due to caving along the borehole (see Fig. 3A-B), because the studied material does not come from core samples it is impossible to be completely certain. Selected stratigraphical and geographical occurrences are presented in Fig. I in Appendix at www.geologica-acta.com, and quantitative information about major groups of palynomorphs is displayed in Fig. 4.

SYSTEMATICS

List of species

The identified palynomorph taxa are reported by major groups and alphabetical order in Table IA-B in Appendix at www.geologica-acta.com. Synonymies and remarks are included when necessary. Some specimens not illustrated are grouped at generic level due to their poor preservation preventing a more specific assignment. Nevertheless, they are included in the stratigraphical distribution of the assemblages, and some of them are figured together with the rest of the species as indicated in brackets (Figs. 5-6; II-VIII in Appendix at www.geologica-acta.com).

Systematic descriptions

Spores

Anteturma: Proximegerminantes POTONIÉ, 1970
Turma: Triletes Reinsch emend. DETTMANN, 1963
Suprasubturma: Acavatitriletes DETTMANN, 1963
Subturma: Azonotriletes LÜBER emend. DETTMANN, 1963
Infraturma: Retusotrileti STREEL *ex* BECKER, BLESS, STREEL and THOREZ, 1974

GENUS *Retusotriletes* NAUMOVA 1953 emend. STREEL, 1964

Type species: *Retusotriletes simplex* NAUMOVA, 1953.

Retusotriletes ottonei n. sp.

Figures 5N; III Q-S in Appendix.

1984 *Retusotriletes* sp. 3, Mc Gregor, 36, Figs. 2 (18), 5 (34).

1996 *Retusotriletes* sp., Ottone, 108, Fig. 1 (1).

Holotype. Fig. III. R in Appendix, BAFC-PI: 1977(1) W57/2.

Paratypes. Fig. III. S in Appendix, BAFC-PI: 1980(1) D30/4; Fig. 5. N; III. Q in Appendix, BAFC-PI: 1981(1) G55/4.

Description. Radial trilete spore; amb subcircular. Laesurae simple irregularly accompanied by straight to slightly sinuous lips extended $\frac{3}{4}$ the distance to the equator and connected with the other branches of the laesurae defining *curvaturae perfectae*. Exoexine laevigate, 1-2.5µm thick.

Dimensions. (10 specimens) 52- 80µm.

Derivatio nominis. Named after Dr. Guillermo Ottone.

Comparisons and remarks. *Retusotriletes paraguayensis* MENÉNDEZ and PÖTHE DE BALDIS has a thicker exoexine, straight lips and depressed contact areas. *R. distinctus* RICHARDSON comprises a much larger size range and has a very thick exoexine which forms an equatorial thickening. *R. dubiosus* MC GREGOR has a darkened triangular area at the apex of varied prominence. *R. albarinii* DI PASQUO and NOETINGER has irregularly

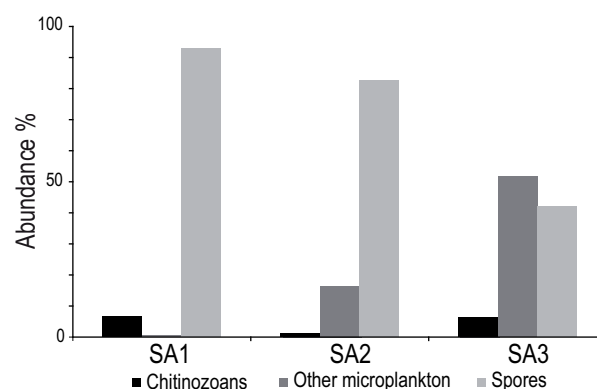


FIGURE 4 | Quantitative distribution of major groups of palynomorphs in the assemblages.

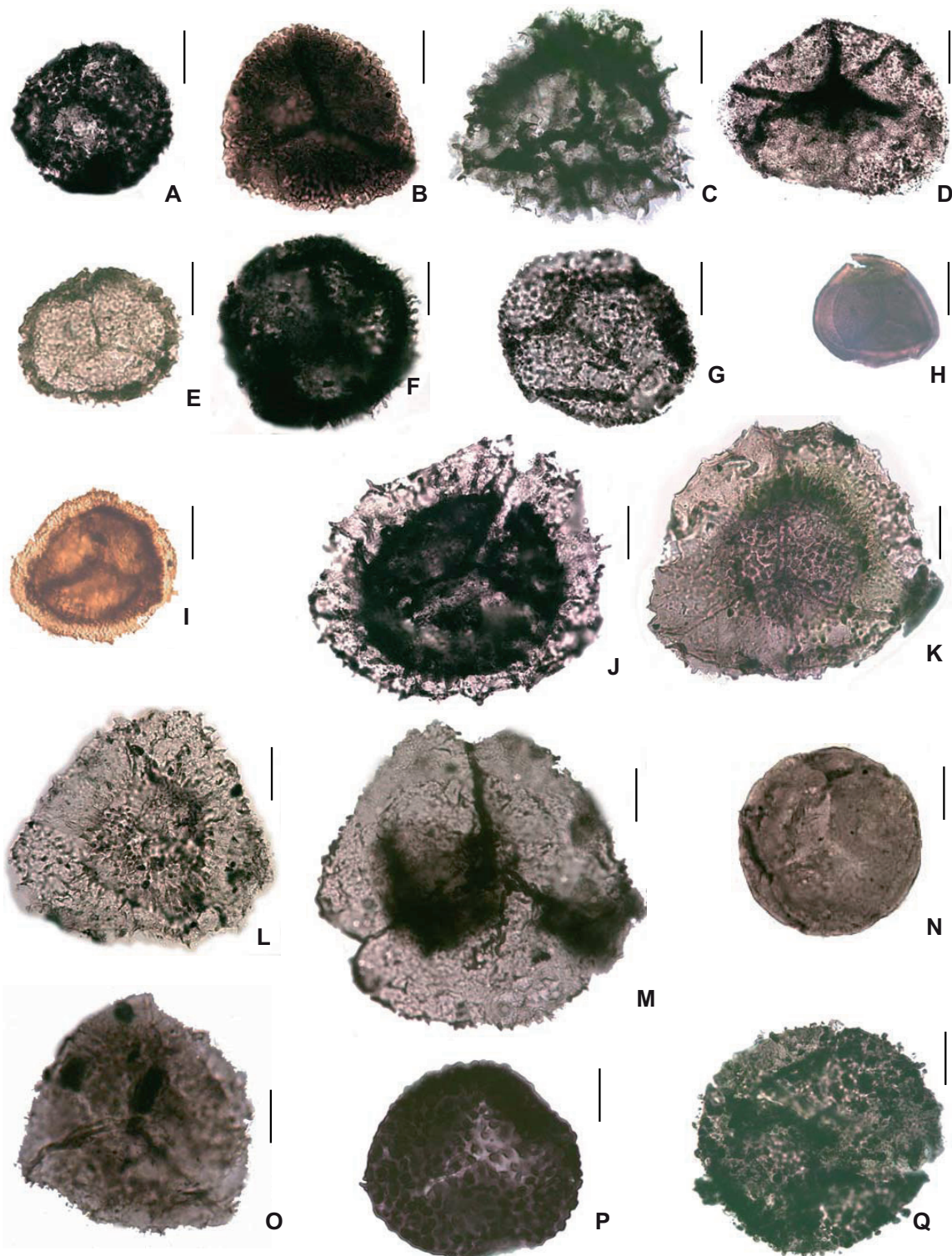


FIGURE 5 | Some of the biostratigraphical key species. A) *Acinosporites acanthomammillatus* RICHARDSON BAFC-PI: 1986(1) Y46/1. B) *Acinosporites ledundae* OTTONE BAFC-PI: 1978(1) M46. C) *Acinosporites macrospinosus* RICHARDSON BAFC-PI: 2041(1) H59/3. D) *Biharisporites parviornatus* RICHARDSON BAFC-PI: 1984(1) X51/3. E) *Cymbosporites catillus* ALLEN BAFC-PI: 2038(1) Q47. F) *Dibolisporites eifeliensis* (LANNINGER) MCGREGOR BAFC-PI: 1999(1) B41/1. G) *Dibolisporites hystricosus* HASHEMI and PLAYFORD BAFC-PI: 2007(1) V28. H) *Geminospira lemurata* BALME BAFC-PI: 2059(1) M33. I) *Grandispora daemonii* LOBOZIAK, STREEL and BURJACK BAFC-PI: 1982(1) M24. J) *Grandispora douglastownense* MCGREGOR BAFC-PI: 2006(1) U40/1. K) *Grandispora protea* (NAUMOVA) MOREAU-BENOÎT BAFC-PI: 2059(1) B41/4. L) *Grandispora pseudoreticulata* (MENÉNDEZ and PÖTHE DE BALDIS) OTTONE BAFC-PI: 1979(1) Y54. M) *Leiotriletes balapucencis* DI PASQUO BAFC-PI: 2001(1) Z59/3. N) *Retusotriletes ottonei* sp. nov. BAFC-PI: 1981(1) G55/4. O) *Samarisporites triangulatus* ALLEN BAFC-PI: 2057(1) F53/2. P) *Verrucosiporites bulliferus* (TAUGOURDEAU-LANTZ) RICHARDSON and MCGREGOR BAFC-PI: 2046(1) N56. Q) *Verrucosiporites loboziakii* MARSHALL and FLETCHER BAFC-PI: 2038(1) Q31/4. Scale bar: F-H, O-P=15µm; A-C, E, I-N, Q= 20µm; D= 35µm.



FIGURE 6 | Some of the biostratigraphical key species. A) Sp. A. BAFC-PI : 1975(2) Y36/3. B. Sp. B) BAFC-PI: 2007(2) C42/2. C) *Ammonidium garrasinoi* OTTONE BAFC-PI: 1975(2) D30/3. D) *Chomotriletes vedugensis* NAUMOVA BAFC-PI: 1982(1) P43/1. E) *Exochoderma triangulata* WICANDER and WOOD BAFC-PI: 2032(1) G38. F) *Lunulidia micropunctata* PÔTHE DE BALDIS BAFC-PI: 1976(1) W47. G-H) *Maranhites mosesii* (SOMMER) BRITO emend. GONZÁLEZ BAFC-PI: BAFC-PI: 2043(1) S52; BAFC-PI: 1977(1) V59/4. I) *Polyedrixium pharaonis* DEUNFF ex DEUNFF BAFC-PI: 1975(MEB) R42. J) *Umbellasphaeridium saharicum* JARDINÉ, COMBAZ, MAGLOIRE, PENIGUEL and VACHEY BAFC-PI: 1975(2) G58/2. K) *Ancyrochitina parisi* VOLKHEIMER, MELENDI and SALAS BAFC-PI : 2005(1) A29/4. L) *Ancyrochitina simplex* GRAHN, BERGAMASCHI and PEREIRA BAFC-PI: 1981(1) F33/3. M) *Angochitina galarzae* OTTONE BAFC-PI: 1975(1) C52. N) *Fungochitina pilosa* COLLINSON and SCOTT BAFC-PI: 1975(MEB2) H39/4. O) *Hercochitina* sp. BAFC-PI : 2007(2) C46. P) *Ramochitina ramosi* SOMMER and VAN BOEKEL BAFC-PI: 1983(1) F40/4. Scale bar: A-D, F, I = 15µm; E, G-H, J, P= 20µm; K-O= 30µm.

thickened the equatorial margin. *R. splendidus* CRAMER has a smaller size range. *R. pychovii* NAUMOVA is smaller and has darkened curvaturae. *R. politus* OWENS has a straight laesurae and a dark triangular area in the polar region. *R. punctimedianus* BALME has a much thicker exoexine and depressed contact areas.

Infraturma: Apiculati BENNIE and KIDSTON emend.
POTONÉ, 1956

Subinfraturma: Granulati DYBOVÁ and JACHOWICZ, 1957

GENUS *Dibolisporites* RICHARDSON emend. PLAYFORD, 1976

Type species: *D. echinaceus* (EISENACK) RICHARDSON, 1965.

Dibolisporites sp. cf. *D. farraginis* MCGREGOR and CAMFIELD, 1982

Fig. II T in Appendix.

1999 *Dibolisporites* sp. 1, Rubinstein, p. 17, Fig. 3H.

Description. Trilete miospore with subcircular amb Wall 3.5µm thick. Equatorial and distal regions bearing a mixture of spinae, coni, verrucae and bacula, of 1.5- 2µm base and 3- 4µm long, some of which could be surmounted by a hairlike process. Contact area with some widely scattered sculpture.

Dimensions. (1 specimen) 58µm.

Remarks. The lack of more and better-preserved specimens prevents a more accurate assignment.

Suprasubturma: Laminatitriletes SMITH and BUTTERWORTH, 1967

Subturma: Zonotriletes WALTZ in LÜBER and WALTZ, 1938

Infraturma: Cingulati (POTONÉ and KLAUS) DETTMANN, 1963

GENUS *Ambitisporites* HOFFMEISTER, 1959

Type species: *A. avitus* HOFFMEISTER, 1959.

Ambitisporites sp.

Fig. II E in Appendix.

Description. Spore radial, trilete, with thickened exinous equatorial band from 2 to 4µm width. Outline subcircular. Exoexine laevigate to finely infrapunctate. Trilete distinct straight and lips somewhat present, 1 to 3µm broad.

Dimensions. (6 specimens) 44 – 70µm.

Comparison and remarks. The species described herein is larger than *Ambitisporites avitus-dilutus* morphon STEEMANS et al. *A. warringtonii* (RICHARDSON and LISTER) RICHARDSON et al. differs in having a more triangular amb and a smaller diameter. *Retusotriletes albarinii* DI PASQUO and NOETINGER from the Lower Devonian Santa Rosa Formation of southern Bolivia is similar but differs in the

elevated lips that are a constant feature and the thickness of the equatorial margin that is not developed as a real cingulum.

Phytoplankton

Group: Acritarcha EVITT, 1963

?*Leiofusa* sp.

Fig. IV O in Appendix.

Description. Fusiform vesicle of laevigate wall. Polar spines and longitudinal folds not developed.

Dimensions. (2 specimens) Vesicle length: 170- 280µm. Width: 30- 70µm.

Remarks. Due to the lack of pointed processes and wall thickness, these specimens do not point to any reviewed species.

?*Micrhystridium* sp.

Fig. IV M in Appendix.

Description. Vesicle spherical, distinct from processes, psilate, 1- 1.5µm thick. Processes homomorphic, hollow, psilate and acuminate, free communicated with the vesicle cavity.

Dimensions. (2 specimens) Vesicle diameter: 29- 30µm; processes: 30- 41µm long.

Comparisons and remarks. These specimens closely resemble *Baltisphaerosum* sp. cf. *B. anfractum* in OTTONE (1996) by direct comparison, but the latter has semisolid processes which may or may not be connected with the vesicle cavity, and a relatively thick wall. Sarjeant and Stancliffe (1994) reviewed the genus *Baltisphaeridium* concluding that the absence of communication between process interior and central cavity is the main feature required for an assignment to the genus. *Polygonium* has a polygonal vesicle and, in general, more than eleven processes.

GENUS *Multiplicisphaeridium* STAPLIN emend. SARJEANT and VAJRDOVÁ, 1997.

Type species: *M. ramispinosum* STAPLIN emend. SARJEANT and VAJRDOVÁ, 1997.

Multiplicisphaeridium sp.

Fig. IV N in Appendix.

Description. Vesicle spherical, psilate. Numerous processes, hollow, laevigate as well, homomorphic to heteromorphic, with circular bases proximally contacting the vesicle and acuminate to branched distal extremities, free communicated with the vesicle.

Dimensions. (2 specimens). Vesicle diameter: 29- 42µm; processes 9- 11µm long.

Remarks. The poor preservation of the specimen, especially at the tips, does not allow a more accurate designation.

Chitinozoans

Group: Chitinozoa EISENACK, 1931

Order: Prosomatifera EISENACK, 1972

Family: Conochitinidae EISENACK emend. PARIS, 1981

Subfamily: Belonechitininae PARIS, 1981

GENUS *Hercochitina* JANSONIUS, 1964

Type species: *H. crickmayi* JANSONIUS, 1964

***Hercochitina* sp.**

Figs. 6 O; VII I, J in Appendix.

Description. Vesicle conical to claviform with a weakly developed flexure. Surface bearing free or connected spines of various lengths disposed in vertical rows.

Dimensions. (3 specimens). Vesicle 145- 209µm long, base 75- 93µm wide. Aperture 38- 54µm wide.

Remarks. The poor preservation of the few specimens encountered prevents a more precise designation.

Family: Lagenochitinidae EISENACK emend. PARIS, 1981

Subfamily: Angochitininae PARIS, 1981

GENUS *Angochitina* EISENACK, 1931

Type species: *A. echinata* EISENACK, 1931.

***Angochitina* sp.**

Fig. VII D in Appendix.

Description. Vesicle ovoid- cylindrical with the greatest width in the middle of the chamber. Convex basal end. Neck about ¼ of the total vesicle length. Aperture complete. Shoulder indistinct. Vesicle wall apparently sculptured with simple spines.

Dimensions. (1 specimen). Vesicle: 120µm long, 50µm wide. Aperture: 32µm wide.

Comparison and remarks. This specimen resembles *Angochitina* sp. C in GRAHN et al. (2002, p. 8, Fig. I in Appendix), from the São Domingos Formation (see Fig. 2), but *Angochitina* sp. is shorter.

GENUS *Fungochitina* TAUGOURDEAU, 1966

Type species: *Conochitina fungiformis* EISENACK, 1931

***Fungochitina pilosa* COLLINSON and SCOTT, 1958**

Figs. 6 N; VII F-H; VIII E, F in Appendix.

1996 *Fungochitina* sp. in Ottone, p. 143, pl. 12, figs. 1, 2, 4.

Description. Vesicle of Erlenmeyer- Flask shape. Chamber conical with a slightly convex base. Flexure

distinct, shoulder absent. Aperture entire. Vesicle surface sculptured with conical to spinose elements.

Dimensions. (5 specimens) Vesicle: 116- 157µm long, 77- 91µm wide. Aperture: 28- 47µm wide

Comparison and remarks. Like in Grahn and Melo (2002), the species is restricted to individuals with a vesicle shape similar to an Erlenmeyer flask, with simple spines and a neck slightly widened at the aperture.

Incertae sedis

Species A

Fig. 6 A; IV I in Appendix.

Description. Vesicle spherical conformed by a thin wall laevigate to scabrate. Five homomorphic processes are evenly distributed and are in free communication with the vesicle cavity. The processes have a cup shape where the rounded base has a diameter of 2-3µm and is slightly enlarged to its distal portion and where several digitiform projections with capitate tips emerge (around 5 or more of 4- 5µm in length). Excystment is by split of the vesicle.

Dimensions. (1 specimen). Vesicle diameter: 29µm; processes 10µm long.

Comparison and remarks. This species differs from *U. deflandrei* (MOREAU-BENOÎT) JARDINÉ et al. and *U. saharicum* JARDINÉ et al. by the digitiform endings at the infundibuliformes processes, and from *U. wicanderi* RICHARDS and MULLINS, from the Upper Silurian of England, by the number and form of the processes. The assignment to a new species is not advisable due to the fact that only one specimen was encountered.

Species B

Figs. 6 B; IV J- L in Appendix.

Description. Vesicle spherical, smooth that could appear granulate due to preservation. It bears a variable number of homomorphic, short conical processes having wide bases and acuminate distal terminations. The processes are solid and laevigate.

Dimensions. (4 specimens) Equatorial diameter (including processes): 75- 116µm; processes: 17- 21µm long.

Comparisons. This species resembles *Tornacia* sp. in LEGAULT (1973, pl.13, fig. 14), but the processes appear to be in a single plane. Moreover, the San Antonio specimens are larger. *Goniosphaeridium* sp. A. in LE HÉRISSE et al. (1995, pl.2, fig. 3) from the Silurian of Saudi Arabia has more processes.

PALYNOLOGICAL ASSEMBLAGES

Composition

The totality of microflora recovered along the

investigated interval of the San Antonio x-1 Borehole is composed of 96 relatively well preserved, species. They are represented by diverse palynological groups, such as trilete spores (45 species), cryptospores (1 species), microplankton, including several Prasinophycean and acritarch taxa together with Chlorophycean algae such as *Chomotriletes* and *Quadrisporites* (39 species), chitinozoans (7 species), scolecodonts, and some remaining specimens in open nomenclature and as *incertae sedis*. The thermal maturity (TAI) varies between 2 and 3 according to the scale of Utting et al. (in Utting and Wielens, 1992). Phytoclasts, such as tracheids and cuticular fragments, are frequent. Thirty-four species are first records in Argentina (Figs. 3A-B, 5, 6; Figs. I-VIII in Appendix). Three assemblages are defined based on the presence or absence of key taxa (see Fig. 3A-B) as well as abundances of different groups of taxa (Fig. 4) and palynofacies analysis.

Palynoassemblage SA1

Composed mostly of continental elements (93%). The biodiversity is relatively low. The general size of the spores is small in comparison to the general size in the other assemblages and the preservation is variable, from fairly good to quite poor, so that the identification of many palynomorphs was rather difficult. The palynofacies is characterized by a high concentration of cuticles. Some chitinozoan fragments begin to occur at the BAFC-PI 2040 (3150-3152m) and increase upwardly (see Fig. 3A-B).

Palynoassemblage SA2

Comprises predominantly continental elements (83%) while marine taxa are strongly subordinated (see Figs. 3A-B; 4;). Mainly cuticles compose the phytodebris. The biodiversity increases and the preservation is better in comparison to the underlying assemblages. Pseudosaccate spores of the genus *Grandispora* are dominant and especially *Grandispora pseudoreticulata*, endemic of the Middle to Late Devonian of South America (see di Pasquo et al., 2007, 2009), together with *Dibolisporites* spp. Scarce specimens of *Maranhites mosesii* are present. A few specimens of *Maranhites* and *Samarisporites* are recorded but are not assignable to any known species due to low frequency and poor preservation. The diversity and amount of phytoplankton is low.

Palynoassemblage SA3

Contains acritarchs and prasinophytes that represent in conjunction 52% of the total assemblage (see Fig. 4). Trilete spores are around 42%, while the chitinozoans are less frequent (6%). One single scolecodont was found (see Fig. V, U in Appendix). Many species appear within this assemblage such as *Verrucosisorites bulliferus*,

Umbellasphaeridium saharicum, *Pseudolunulidia imperatrizensis* and *Fungochitina pilosa*, among others. The preservation of the continental elements is very poor. It is also common to find sheared specimens (see Fig. VII, E in Appendix), which adds difficulty to the taxonomical determination. The proportion of pseudosaccate spores of *Grandispora* decreases from the assemblage 2 to be subordinated in this assemblage. Many palynomorphs especially microplankton species are well preserved with a low maturity spore colour (light yellow or TAI 2), though variable amounts of pyrite crystals on the exine are present. The phytoplankton seems to be dominated in the upper levels by acritarchs with processes such as *Veryhachium* spp., *Polygonium* spp. and *Multiplicisphaeridium* spp., while they are less conspicuous in the lower part of this interval where *Leiosphaeridia* spp. and Prasinophycean

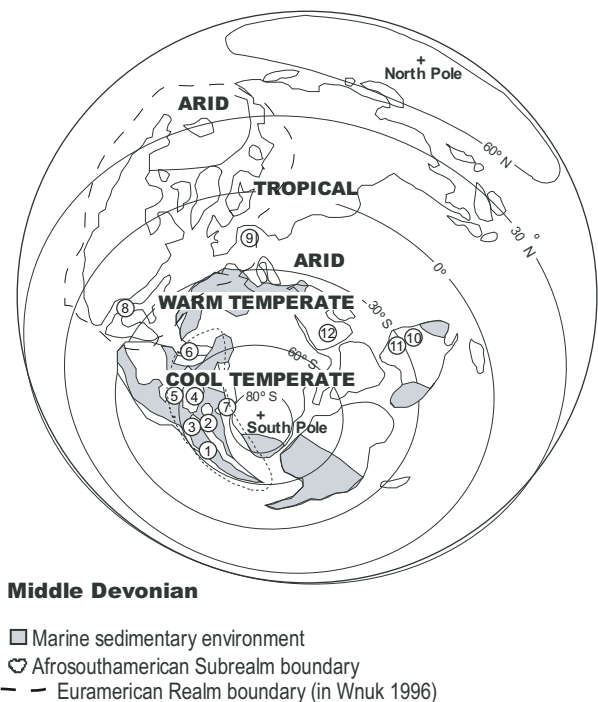


FIGURE 7 | Middle Devonian paleogeographical reconstruction (modified from di Pasquo et al., 2009) showing the marine deposits and the location of known, important, Middle Devonian palynological assemblages, which share species with the San Antonio associations. In dotted line the Afrosouthamerican Subrealm boundary and in dashed line the Euramerican Realm (Wnuk, 1996). Argentina: 1) Chigua Formation (Amenábar, 2009); Punta Negra Formation (Rubinstein, 1999, 2000). 2) Los Monos Formation (Barreda 1986; Ottone, 1996). Bolivia: 3) Los Monos Formation (di Pasquo, 2007a, b). 4) Limachi et al. (1996), Pérez Leyton (1991). 5) Tomachi Formation (Vavrdová et al. 1996). Brazil: 6) Maecurú, Ererê and Barreirinha formations (Melo and Loboziak, 2003); 7) Jandiataba and Urerê formations (Quadros, 1988); Ponta Grossa Formation (Dino, 1999; Quadros, 1999; Oliveira, 1997). Old Red Sandstone Continent: 8) Richardson and McGregor (1986). France: 9) Le Hérisse and Deunff (1988). Australia: 10) Hashemi and Playford (2005). 11) Colbath (1990), Playford and Dring (1981), Balme (1988). Saudi Arabia: 12) Loboziak (2000).

algae (e.g. *Maranhites* spp., *Dictyotidium* spp.) are more frequent. The chitinozoans are always in low frequency but are much more subordinated in the BAFC-PI 2060 (2598m) (Fig. 3 A-B).

DISCUSSION

Biostratigraphy and correlation

The three assemblages are characterized by species in common with palynofloras from South America and others selected from elsewhere (see Figs. 7, I in Appendix). Additionally, the restricted stratigraphic distributions of most species from the studied section of the borehole are in agreement with their global ranges (see Figs. 3 A-B; I in Appendix), making them reliable to assess the age of the studied interval as follows.

Assemblage SA1 (3124-3628m Interval)

In agreement with the biostratigraphical information provided by Grahn et al. (2000, 2002) and Grahn (2002, 2005 and references therein), the inception of *Ancyrochitina parisi* defines the late Emsian zone in Brazil, Bolivia and northern Argentina (see Fig. 8) and

extends upwards into the early Eifelian. Since *Ramochitina ramosi* also appears in this zone and follows up to the middle Givetian, the concurrence of both species could indicate a latest Emsian to early Eifelian for the lowest part of the studied section (3616-3584m). On the other hand, the presence of *Grandispora protea* and *Grandispora douglstownense* allow its correlation with the late Emsian – early Eifelian AP Zone of the Ardenne-Renish region (Streel and Loboziak, 1996), the *Grandispora douglstownense* – *Ancyrospora euryptera* Assemblage Zone of the Old Red Sandstone Continent (Richardson and McGregor, 1986), the *Grandispora/Samarisporites* spp. Interval Zone (GS) of the Amazon Basin (Melo and Loboziak, 2003) and the *Grandispora pseudoreticulata* Zone (Limachi et al., 1996) (see Fig. 8). Even though there are other species with restricted stratigraphical distribution such as *Verrucosporites loboziakii*, quoted for the Eifelian of the Orcadian Basin (Marshall and Fletcher, 2002), *Dibolisporites hystricosus*, characteristic of the early Eifelian-early Givetian of the Adavale Basin in Australia (Hashemi and Playford, 2005) and other taxa ranging since the early Eifelian to the late Eifelian or further (e.g., *Densosporites inaequus*, *Granulatisporites muninensis*, *Emphanisporites epicautus*, *Dibolisporites quebecensis*, *D. echinaceus*, *D. eifeliensis*, *Corystisporites multispinosus*, *Grandispora brevizonata*, *G. mammillata*

GEOCHRONOLOGY			REGION										
PERIOD	EPOCH	STAGE	Euramerica	Russia	Australia	Brazil	Bolivia			Argentina			
			A	B	C	D	E	F	G	H	I	J	
DEVONIAN	UPPER	FAMENNIAN	lepidophyta-nitidus	lepidophyta-explanatus PLE PM LM	R. lepidophyta	R. lepidophyta-V. vallatus	?						
			pusillites-lepidophyta	LV		R. lepidophyta							
			flexuosa-cornuta	VF C. varicornata L. immensus CZ VV	Microflora Brewer	V. hystricosus R. radiata							
		FRASNIAN	torquata-gracilis										
			ovalis-bulliferus	DE OG SD OK									
			C. optivus-C. triangulatus		Spinozonitrites sp. G. lemurata	R. bricei-D. mucronatus V. bulliferus-G. piliformis	Maranhites-Samarisporites	Lageno. avelinoi Fungo. pilosa					
	MIDDLE	GIVETIAN	lemurata-magnificus	G. extensa	Ancyrospora sp.	S. triangulatus	V. premnis-V. scurus	A. langei-F. pilosa	LM2		Fungochitina pilosa		SA 3
			devonicus-naumovii	R. langii	Aratrisporites sp. Hystricosporites sp. Brochozoniitrites	G. permulta	G. pseudoreticulata	A. taouratinensis	No information			Ch3	SA 2
		EIFELEIAN	velatus-langii	P. tortus									
	LOWER	EMSIAN	douglstownense-euryptera	D. inassueta		Grandispora-Samarisporites							
			annulatus-sextantii	R. clandestinus			Evitia sommerii-Emph. annulatus	R. ramosi A. parisi	LM1		A. parisi	Ch1	SA 1
		PRAGIAN	polygonalis-emsiensis										
breconensis-zavallatus						D. emsiensis		Ramochitina magnifica			Ramochitina magnifica		
LOCHKOVIAN		micronatus-newportensis				Schibocystia-Dictyoitrites	Eisenackitina cf. bohemica			Urochitina loboi			

FIGURE 8 | Correlation chart of the assemblages studied herein (J) and other biozones or assemblages of the Devonian Western Europe and North America (A), Russia (B), Australia (C), Brazil (D), Bolivia (E-G) and Argentina (H-J). References: A) Richardson and McGregor (1986), Streel et al. (1987); B) Avchimovitch et al. (1988, 1993), Byvsheva (1997); C) Playford (1985, 1991); Young (1996); D) Melo and Loboziak (2003); E) Suárez Soruco and Lobo Boneta (1983); Limachi et al. (1996); F, H: Grahn (2002, 2005); G) di Pasquo (2007a, b); I) Amenábar et al. (2006, 2007, 2009), Amenábar (2007). Abbreviations: (Euramerica) TS: *K. triradiatus-K. stephanophorus*, TC: *P. tessellatus-S. camptyopectera*, TK: *S. triangulus-R. knoxi*; BM: *V. bulliferus-L. media*, BJ: *V. bulliferus-C. jekhowskyi*, Tco: *S. triangulatus-C. concinna*, TA: *S. triangulatus-A. ancyrea*, AD: *A. acanthomammillatus-D. devonicus*, AP: *A. apiculatus-C. proteus*. (Russia) OK: *C. optivus-S. krestovnikovii*, SD: *G. semilucensa-P. donensis*, OG: *A. ovalis-V. grumosus*, DE: *C. deliquescens-V. evlanensis*, VV: *C. vimineus-V. evlanensis*, CZ: *C. cristifer-D. zadonica*, VF: *D. versabilis-G. famenensis*, LV: *R. lepydophyta-A. verrucosa*, LL: *R. lepydophyta-K. literatus*, LM: *R. lepydophyta-T. mirabilis*, PLE: *V. pusillites-R. lepydophyta-I. explanatus*, PM: *V. pusillites-T. malevkensis*, VG: *M. variomarginata-V. genuinus*.

and *Apiculiretusispora gaspiensis*), because the studied material comes from cutting samples, we define a broader range from the late Emsian to the mid Eifelian for this interval. Other partially coeval assemblages are known from the Precordillera of Argentina (Amenábar, 2009) and from southern Bolivia (di Pasquo, 2007a), which share several species with this assemblage (see Figs. 3A-B, 7, 8 and I in Appendix).

Assemblage SA2 (2690-3122m Interval)

This assemblage is characterized by important species such as *Chomotriletes vedugensis* from the late lower Givetian (Turnau and Racki, 1999), *Dibolisporites farraginis* and *Biharisporites parviornatus*. Other elements recognized below are *Densosporites inaequus*, *Grandispora douglastownense*, *G. brevizonata* and *Ramochitina ramosi*. The concurrence of *Acinosporites macrospinosus* and *A. acanthomammillatus* at the BAFC-PI 2037 (3112-3122m) is indicative of the late Eifelian-mid Givetian AD Zone of Streeel et al. (1987) in Euramerica (see Figs. 7, 8) and elsewhere (e.g., Loboziak, 2000) (see Fig. I in Appendix). The Givetian is reinforced by the occurrences within this interval of *Ancyrochitina simplex*, *Exochoderma triangulata*, *Apiculiretusispora brandtii*, *Arkonites bilixus*, *Ammonidium garrasinoi*, *Pterospermella pernambucensis*, *Duvernaysphaera angelae*, *Exochoderma arca*, *Angochitina galarzae*, *Verrucosporites tumultus* and *Grandispora daemonii*. Some long-ranging species appear within this interval, such as *Grandispora mammillata*, *Acinosporites parviornatus*, *Dibolisporites uncatius*, *Verruciretusispora ornata*, *Leiotriletes pyramidalis* and *Apiculatasporites microconus*.

The single records of *Geminospora lemurata* and *Samarisporites triangulatus* that appear later within the assemblage SA3 defined here (see Fig. 3A-B) are not interpreted as first appearances. It is also noted that species of *Chelinospora* and *Craspedispora* that are frequent in the *Geminospora lemurata*-*Chelinospora* ex gr. *ligurata* Interval Zone (LLi) and *Samarisporites triangulatus* Interval Zone (Trg) from Brazil (e.g., Melo and Loboziak, 2003) are absent here (see Figs. 3A-B; Fig. I in Appendix). However, a correlation with the Brazilian zonation (see Fig. 8) can be established based on the common pattern of frequencies of *Grandispora permulta* and several other large-sized spiny zonates and pseudosaccates of similar stratigraphic range in western Gondwana. Loboziak (1999) found that the frequency of this group rises through the Eifelian, attains peak values in the Givetian, and strongly decreases in the early Frasnian. These data allow the correlation of the association with several other regional palynofloras such as the early Givetian *Verrucosporites premnus*/*V. scurrus* Zone of Limachi et al. (1996), the late Eifelian and the mid-late Givetian assemblages 1 and 2 (LM1, LM2

in Fig. 8 of Los Monos Formation at Balapuca (di Pasquo, 2007a) from Bolivia, respectively, the assemblages 2 and 3 of Chigua Formation in Del Chaco and Don Agustín creeks (Amenábar, 2009), and partially with the palynoflora of the Los Monos Formation in the Galarza creek (Ottone, 1996) from Argentina (see Figs. 7; 8). On Eastern Gondwana, Hashemi and Playford (2005) described three palynoassociations (I, II, III) in the Adavale Basin (Australia) attributed to the Emsian to early Frasnian. Some of the shared species with the assemblage II (early Eifelian-early Givetian) are *Dibolisporites hystricosus*, *Grandispora inculta*, *Acinosporites acanthomammillatus* and *Verrucosporites scurrus* (see Figs. 3A-B, 7, I in Appendix).

Assemblage SA3 (2548-2600 m Interval)

The base of this assemblage is proposed between 2582 and 2600m where *Lunulidia micropunctata*, *Pseudolunulidia laevigata* and *Verrucosporites bulliferus*, appear and *Maranhites* is abundant. These species have been quoted in the early Frasnian (see Figs. 3A-B; I in Appendix) of northwestern Argentina (Ottone, 1996), Bolivia (Pérez Leyton, 1991; Vavrdová et al., 1996) and Brazil (Quadros, 1988, 1999; Oliveira, 1997). Other important species that are recorded in Frasnian assemblages appear within this interval, including *Umbellasphaeridium saharicum*, which has Frasnian occurrences in Algeria, Ghana, Brazil and Bolivia (see Fig. 3B), *Pseudolunulidia imperatrizensis*, *Fungochitina pilosa*, *Maranhites mosesii* and *Convolutispora subtilis* (see Fig. 3A-B). The profusion of *Maranhites* is typical from the Late Devonian assemblages in Bolivia, Brazil and Argentina (e.g., Ottone, 1996; Limachi et al., 1996; Quadros, 1999) and globally (e.g., Le Hérisse and Deunff, 1988; Colbath, 1990). *Grandispora gabesensis* is exclusive of this interval and has its last occurrence globally in the early Frasnian (see Figs. 3A-B, I in Appendix). Recently, Melo (2005b) has considered relevant to intra-Gondwanan (*) and intercontinental (**) correlations the following ranges for some selected species: Late early to late Givetian, FOD's of *Pseudolunulidia laevigata* / *P. micropunctata* (*) and *Samarisporites triangulatus* (**); early Frasnian, FOD's of *Lunulidia micropunctata* (*), *Maranhites insulatus* / *M. mosesii* (*), *Pseudolunulidia imperatrizensis* (*), *Umbellasphaeridium saharicum* (**), *Geminospora piliformis* (*), *Lophozonotriletes* spp. (**) and *Verrucosporites bulliferus* (**). Hence, an early Frasnian age for this assemblage is proposed. Similar assemblages including acritarchs and prasinophytes were also documented by Ottone (1996, and references therein) in the Los Monos Formation (northwestern Argentina) and Oliveira (1997) in the Ponta Grossa Formation and attributed to the Late Givetian – Early Frasnian. The presence of the key-taxa *Verrucosporites bulliferus* in this assemblage is important, supporting a correlation with the undifferentiated BJ–BM Opeel Zones of the Ardenne–

Rhenish zonal scheme (Streel et al., 1987), the *ovalis-bulliferus* Assemblage Zone of Richardson and McGregor (1986), and the *Verrucosisporites bulliferus*–*Geminospora piliformis* Interval Zone (BPi) of Melo and Loboziak (2003) (see Fig. 8). The latter zone is also correlated on the basis of the persistence of many species from the preceding Trg Zone (including *S. triangulatus*) and the remarkable decline and disappearance of several taxa introduced in the LLi, Per and GS Zones (see Melo and Loboziak, 2003). It is noted that *Geminospora piliformis* and species of *Lophozonotriletes* are not recorded in the Argentinian assemblage. The assemblage III of Hashemi and Playford (2005) attributed to the late Givetian-early Frasnian and the Frasnian microfloras documented by Balme (1988) and Playford and Dring (1981) for the Gneudna Formation in the Carnarvon Basin (Australia) share only the cosmopolitan age-diagnostic taxa such as *Geminospora lemurata*, *Samarisporites triangulatus*, *Verrucosisporites tumulentus*, *Gorgonisphaeridium discissum* (see Fig. I in Appendix).

Paleoenvironmental interpretation

The results from this study clearly show that Devonian miospores, acritarchs and chitinozoans are useful stratigraphic tools throughout South America and many are evidence of basin connections during this lapse as shown in Fig. 1A (see also Grahn, 2005; di Pasquo et al., 2009; and references therein). The concurrence of some Euramerican miospore species in these South-American assemblages could have been favored by these periods of low sea level where land masses could have connected both continents (di Pasquo et al., 2009) (Fig. 7). The Los Monos Formation was mainly interpreted to characterize offshore facies in Bolivia (Limachi et al., 1996). The palynofacies analysis and quantitative data displayed in Fig. 4 show paleoenvironmental changes during the deposition of the succession. It is likely that the low proportion of marine elements in SA1 and SA2 is evidence of shallow to littoral environments developed in this region. This is in agreement with a tendency of a drop in the sea level proposed by Albariño et al. (2002) registered in this region from the early Eifelian and it appears to have been maintained during the Givetian. Instead, in the early Frasnian assemblage (SA3), an increase of microplankton is recorded. In the lower part of this interval sphaeromorphs like *Leiosphaeridia* and Prasinophycean algae (e.g. *Maranhites* spp., *Dictyotidium* spp.) are more frequent than acanthomorphic acritarchs. Hence, it seems that this change was gradual from continental conditions still during the deposition of assemblage SA2 to shelf marine environments for the assemblage SA3. This is in agreement with the record of a new transgressive cycle in the latest Givetian-early Frasnian after Albariño et al. (2002).

CONCLUDING REMARKS

This study presents new palynological data on spores and microplankton for the San Antonio x-1 borehole. The stratigraphic distribution and abundance of species of trilete spores and cryptospores (46 species), microplankton including several prasinophycean and acritarch taxa together with chlorophycean algae (39 species), and chitinozoans (7 species), along the studied interval (between 2548-3628m), allows the definition of three palynoassemblages. Diagnostic markers present in these assemblages support a late Emsian to early Frasnian age to the whole interval.

Palynoassemblage SA1 ranges from the late Emsian to mid Eifelian and is interpreted as reflecting nearshore, shallow marine depositional conditions characterized by a high terrestrial input and variable marine influence, as well as the association SA2 of late Eifelian – mid Givetian age. The palynoassemblage SA3 suggest an early Frasnian accompanied by a high diversity and abundance of microplankton, which could represent a transgression.

According to the lithology and the age of the assemblages, the middle part of the section corresponds to the Los Monos Formation, whilst the base could be attributed to the upper Huamampampa Formation and the top to the Iquirí Formation.

The current analysis proves that the early Frasnian is still recorded up to 2548m, and is not coincident with the Devonian/Carboniferous boundary located by REPSOL-YPF (see Fig. 3).

The assemblages are composed of many cosmopolitan index species (e.g., *Chomotriletes vedugensis*, *Geminospora lemurata*, *Samarisporites triangulatus*, *Verrucosisporites bulliferus*, *Acinosporites macrospinosus*, *A. acanthomammillatus*) that support a partial correlation with Brazilian and Euramerican zonations (see Fig. 7, 8). This paleobiogeographical pattern could have resulted from the effects of paleolatitude and the configuration of land and sea for that time, with a narrow Rheic Ocean between northern Gondwana and Euramerica, which allowed the mixture of species in this region. However there are several other age-diagnostic taxa exclusively recorded in South America (e.g., *Grandispora pseudoreticulata*, *Grandispora brevizonata*, *Leiotriletes balapucensis*, *Acinosporites ledundae*, *Ancyrochitina parisi*, *Pseudolunulidia* spp., see Fig. I in Appendix) from the Mid-Devonian to Frasnian Afro-SouthAmerican Subrealm (di Pasquo et al., 2009) (Fig. 7), which imply that the construction of a regional biozonation would be totally viable, but for which more data points are necessary, particularly more reliable records like outcrops and core samples from the region.

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ELECTRONIC APPENDIX

TABLE I | A, B) List of species herein identified listed by major groups and alphabetical order. Remarks are included when necessary

Miospores and cryptospores

Species	Figure	Synonymies and remarks
<i>Acinosporites acanthomammillatus</i> Richardson	5 A; II A	<i>Synonymy</i> : 1999 Raistrickia sp. in Rubinstein, p. 17, Fig. 3, A. Remarks: From the illustration the specimen belongs to this taxon.
<i>Acinosporites ledundae</i> Ottone	5 B; II B	
<i>Acinosporites macrospinosus</i> Richardson	5 C; II C	
<i>Acinosporites parviornatus</i> Richardson	II D	
<i>Ambitisporites</i> sp.	II E	see "Systematic descriptions"
<i>Apiculatasporites microconus</i> (Richardson) McGregor and Camfield	II F	
<i>Apiculatisporis</i> sp. A in Amenábar, di Pasquo, Carrizo and Azcuy	II G	Remarks: Only a single specimen was found, so a more accurate designation is prevented.
<i>Apiculiretusispora brandtii</i> Strel	II H	
<i>Apiculiretusispora gaspiensis</i> McGregor	II I	
<i>Apiculiretusispora plicata</i> (Allen) Strel	II J	
<i>Biharisporites parviornatus</i> Richardson	5 D; II K	
<i>Convolutispora subtilis</i> Owens	II L	
<i>Corystisporites multispinosus</i> Richardson var. <i>multispinosus</i> McGregor and Camfield	II M	
<i>Cymbosporites catillus</i> Allen	5 E; II N	
<i>Densosporites inaequus</i> (McGregor) McGregor and Camfield	II O	
<i>Dibolisporites echinaceus</i> (Eisenack) Richardson	II P	
<i>Dibolisporites eifeliensis</i> (Lanninger) McGregor	5 F; II Q	
<i>Dibolisporites hystricosus</i> Hashemi and Playford	5 G; II R	
<i>Dibolisporites quebecensis</i> McGregor	II S	
<i>Dibolisporites</i> spp.		
<i>Dibolisporites</i> sp. cf. <i>D. Farraginis</i> McGregor and Camfield	II T	see "Systematic descriptions"
<i>Dibolisporites uncatus</i> (Naumova) McGregor and Camfield	II U	<i>Synonymy</i> : 1999 <i>Dibolisporites</i> sp. 2 in Rubinstein, p. 17, Fig. 3, C. Remarks: The illustrated specimen shows the characteristic ornamentation to be attributed to the taxon.
<i>Dibolisporites vegrandis</i> McGregor and Camfield	II V	
<i>Dyadospora murusattenuata</i> Morphon Ströther and Traverse <i>sensu</i> Steemans, Le Hérissé and Bozdogan	II W	Remarks: This morphon includes both species <i>D. murusattenuata</i> and <i>D. murusdensa</i> which have a long stratigraphical range and are widely distributed in Euramerica and Gondwana (see Rubinstein and Vaccari, 2004), somehow it is quoted until the lower Devonian and here it appears along the column from the Eifelian to the Frasnian.
<i>Emphanisporites epicautus</i> Richardson and Lister	III A	
<i>Emphanisporites rotatus</i> McGregor emend. McGregor	III B	
<i>Geminospora lemurata</i> Balme	5 H; III C	
<i>Grandispora brevizonata</i> (Menéndez and Pöthe de Baldis) di Pasquo	III D	
<i>Grandispora daemonii</i> Loboziak, Strel and Burjack	5 I; III E	
<i>Grandispora douglastownense</i> McGregor	5 J; III F	
<i>Grandispora gabesensis</i> Loboziak and Strel	III G	
<i>Grandispora inculta</i> Allen	III H	
<i>Grandispora mammillata</i> Owens	III I	
<i>Grandispora permulta</i> (Daemon) Loboziak, Strel and Melo	III J	
<i>Grandispora protea</i> (Naumova) Moreau-Benoît	5 K; III K	
<i>Grandispora pseudoreticulata</i> (Menéndez and Pöthe de Baldis) Ottone	5 L; III L	
<i>Grandispora</i> spp.		
<i>Granulatisporites muninensis</i> Allen	III M	
<i>Leiotriletes balapucencis</i> di Pasquo	III N	
<i>Leiotriletes pagius</i> Allen	5 M; III O	
<i>Leiotriletes pyramidalis</i> (Lüber) Allen	III P	
<i>Leiotriletes</i> spp.		
<i>Retusotriletes ottonei</i> n. sp.	5 N; III Q-S	see "Systematic descriptions"
<i>Retusotriletes simplex</i> Naumova	IV A	
<i>Retusotriletes</i> spp.		
<i>Samarisporites triangulatus</i> Allen	5 O; IV B,C	
<i>Samarisporites</i> spp.		
<i>Verruciretusispora ornata</i> (Menéndez and Pöthe de Baldis) Pérez Leyton ex di Pasquo	IV D	
<i>Verruciretusispora</i> spp.		
<i>Verrucosisporites bulliferus</i> (Taugourdeau-Lantz) Richardson and McGregor	5 P; IV E	
<i>Verrucosisporites loboziakii</i> Marshall and Fletcher	5 Q; IV F	
<i>Verrucosisporites scurrus</i> (Naumova) McGregor and Camfield	IV G	
<i>Verrucosisporites</i> spp.		
<i>Verrucosisporites tumultentus</i> Clayton and Graham	IV H	

TABLE I | Continued

Incertae sedis

? <i>Leiofusa</i> sp.	IV O	see "Systematic descriptions"
? <i>Micrhystridium</i> sp.	IV M	see "Systematic descriptions"
Species A	6 A; IV I	see "Systematic descriptions"
Species B	6 B; IV J-L	see "Systematic descriptions"

Phytoplankton

<i>Ammonidium garrasinoi</i> Ottone	6 C; V A; VIII A	
<i>Arkonites bilixus</i> Legault	V B	
<i>Chomotriletes vedugensis</i> Naumova	6 D; V C	
<i>Crucidia camirensis</i> (Lobo Boneta) Ottone	V D	
<i>Cymatiosphaera platoloma</i> Wicander and Loeblich	V E	
<i>Dictyotidium munificum</i> (Wicander and Wood) Amenábar, di Pasquo, Carrizo and Azcuy	V F; VIII B	
<i>Duvernaysphaera angelae</i> Deunff	V G	
<i>Duvernaysphaera stellata</i> Deunff	V H	
<i>Duvernaysphaera tenuicingulata</i> Staplin	V I	
<i>Exochoderma arca</i> Wicander and Wood	V J; VIII C	
<i>Exochoderma triangulata</i> Wicander and Wood	6 E; V K	
<i>Gorgonisphaeridium discissum</i> Playford in Playford and Dring	V L	
<i>Gorgonisphaeridium</i> spp.	VIII D	Remarks: It is notable the resemblance in between the specimen illustrated herein and those figured as <i>Gorgonisphaeridium</i> sp. by Ottone (1996, pl.7, figs. 2, 4) and <i>Gorgonisphaeridium</i> sp. 3 in Barreda (1986, pl. 4, figs. 1, 3, 12). Until the literature can be reviewed properly, we prevent a new designation.
<i>Haspidopalla exornata</i> (Deunff) Playford	V M	
<i>Hemiruptia legaultii</i> Ottone	V N	
<i>Leiofusa banderillae</i> Cramer	V O	
<i>Leiosphaeridia</i> spp.	V P	
<i>Lunulidia micropunctata</i> Pöthe de Baldis	6 F; V Q	
<i>Maranhites mosesii</i> (Sommer) Brito emend. González	6 G,H; V R-T	Remarks: The occurrence of equatorial pads in <i>M. mosesii</i> has biostratigraphic significance in Brazil, so the species is figured herein with these intraspecific variations.
<i>Maranhites</i> spp.		
<i>Multiplicisphaeridium ramispinosum</i> (Staplin) Sarjeant and Vavrdová	VI A; VIII G	
<i>Multiplicisphaeridium</i> sp.	IV M	see "Systematic descriptions"
<i>Navifusa bacilla</i> (Deunff) Playford	VI B	
<i>Polyedryxium pharaonis</i> Deunff ex Deunff	6 I; VI C; VIII H	
<i>Polyedryxium</i> sp. in Amenábar, di Pasquo, Carrizo and Azcuy	VI D	
<i>Polygonium barredae</i> Ottone	VI E	
<i>Polygonium</i> spp.		
<i>Pseudolunulidia imperatrizensis</i> (Brito and Santos) Brito and Quadros	VI F	
<i>Pseudolunulidia laevigata</i> Brito and Quadros	VI G	
<i>Pterospermella capitana</i> Wicander	VI H	
<i>Pterospermella pernambucensis</i> (Brito) Eisenack, Cramer and Diez Rodriguez	VI I	
<i>Pterospermella</i> spp.		
<i>Quadrisporites granulatus</i> (Cramer) Ströther	VI J	
<i>Quadrisporites variabilis</i> (Cramer) Ottone and Rossello	VI K	
<i>Stellinium comptum</i> Wicander and Loeblich	VI L	
<i>Stellinium micropolygonale</i> (Stockmans and Willière) Playford	VI M; VIII I	
<i>Tunisphaeridium caudatum</i> Deunff and Evitt	VI N	
<i>Umbellasphaeridium deflandrei</i> (Moreau-Benoît) Jardiné <i>et al.</i>	VI O; VIII K	
<i>Umbellasphaeridium saharicum</i> Jardiné, Combaz, Magloire, Peniguel and Vachey	6 J; VI P	
<i>Veryhachium (Tetraverhachium) longispinosum</i> (Jardiné <i>et al.</i>) Stancliffe and Sarjeant	VI Q	
<i>Veryhachium (Veryhachium) reductum</i> (Downie and Sarjeant) Stancliffe and Sarjeant	VI R	
<i>Veryhachium (Veryhachium) trispinosum</i> (Deunff) Stancliffe and Sarjeant	VI S; VIII L	
<i>Veryhachium</i> spp.		
<i>Villosacapsula colemanii</i> Playford	VI T	
<i>Chitinozoans</i>		
<i>Ancyrochitina parisi</i> Volkheimer, Melendi and Salas	6 K; VII A	
<i>Ancyrochitina simplex</i> Grahn, Bergamaschi and Pereira	6 L; VII B	Synonymy: 1999 <i>Ancyrochitina</i> sp. in Rubinstein, p. 15, Fig. 2D. Remarks: the original description of the species details a crown of 8 simple processes at the basal margin, but due to the preservation there are found less, as seen in Grahn <i>et al.</i> (2002) and in this paper.
<i>Angochitina galarzae</i> Ottone	6 M; VII C	
<i>Angochitina</i> sp.	VII D	see "Systematic descriptions"
<i>Fungochitina pilosa</i> Collinson and Scott	6 N; VII F-H; VIII E, F	see "Systematic descriptions"
<i>Hercochitina</i> sp.	6 O; VII I-J	see "Systematic descriptions"
<i>Ramochitina ramosi</i> Sommer and Van Boekel	6 P; VII K-M; VIII J	

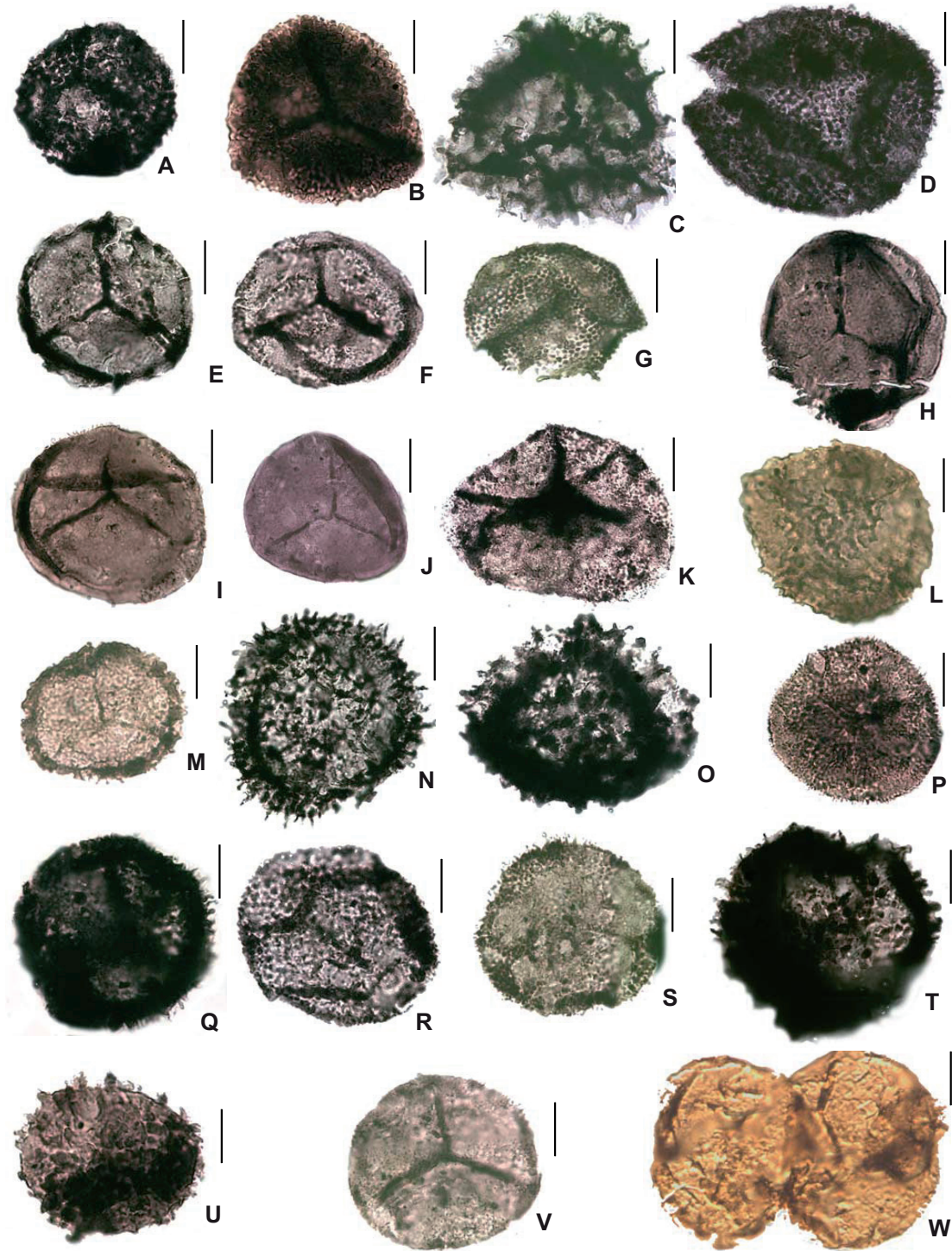


FIGURE II | A) *Acinosporites acanthomammillatus* RICHARDSON BAFC-PI: 1986(1) Y46/1. B) *Acinosporites ledundae* OTTONE BAFC-PI: 1978(1) M46. C) *Acinosporites macrospinosus* RICHARDSON BAFC-PI: 2041(1) H59/3. D) *Acinosporites parviornatus* RICHARDSON BAFC-PI: 2007(2) J33. E) *Ambitisporites* sp. BAFC-PI: 2003(1) C57/4. F) *Apiculatasporites microconus* (RICHARDSON) MCGREGOR and CAMFIELD BAFC-PI: 2006(1) F56/2. G) *Apiculatisporis* sp. A in AMENÁBAR, DI PASQUO, CARRIZO and AZCUY BAFC-PI: 2038(1) H34. H) *Apiculiretusispora brandtii* STREEL BAFC-PI: 1980(1) J54. I) *Apiculiretusispora gaspiensis* MCGREGOR BAFC-PI: 1980(1) P26/2. J) *Apiculiretusispora plicata* (ALLEN) STREEL BAFC-PI: 2049(1) K54. K) *Biharisporites parviornatus* RICHARDSON BAFC-PI: 1984(1) X51/3. L) *Convolutispora subtilis* OWENS BAFC-PI: 2061(1) O37/4. M) *Cymbosporites catillus* ALLEN BAFC-PI: 2038(1) Q47. N) *Corystisporites multispinosus* RICHARDSON var. *multispinosus* MCGREGOR and CAMFIELD BAFC-PI: 2007(1) J52/2. O) *Densosporites inaequus* (MCGREGOR) MCGREGOR and CAMFIELD BAFC-PI: 2002(1) H36. P) *Dibolisporites echinaceus* (EISENACK) RICHARDSON BAFC-PI: 1978(1) W36/2. Q) *Dibolisporites eifeliensis* (LANNINGER) MCGREGOR BAFC-PI: 1999(1) B41/1. R) *Dibolisporites hystricosus* HASHEMI and PLAYFORD BAFC-PI: 2007(1) V28. S) *Dibolisporites quebecensis* MCGREGOR BAFC-PI: 2041(1) T23/1. T) *Dibolisporites* sp. cf. *D. farraginis* MCGREGOR and CAMFIELD BAFC-PI: 1983(1) X43/3. U) *Dibolisporites uncatus* (NAUMOVA) MCGREGOR and CAMFIELD BAFC-PI: 1980(1) J60. V) *Dibolisporites vegrandis* HASHEMI and PLAYFORD BAFC-PI: 2036(1) P43. W) Morphon *Dyadospora murusattenuata* STRÖTHER and TRAVERSE *sensu* STEEMANS LE HÉRISSE and BOZDOGAN BAFC-PI: 1981(1) K22. Scale bar: E-J, L-U, W=15µm; A-D, V= 20µm; K= 35µm.

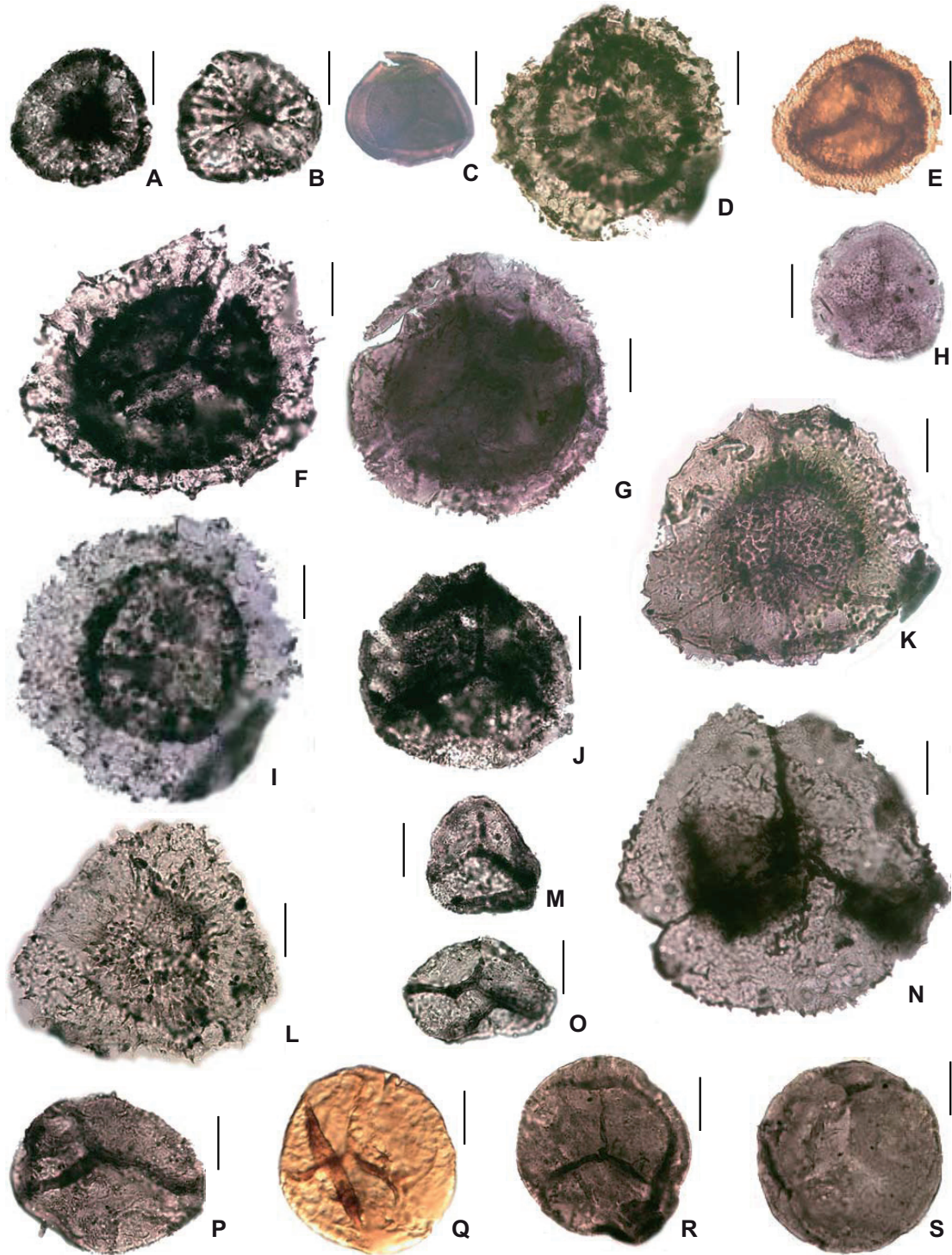


FIGURE III | A) *Emphanisporites epicautus* RICHARDSON and LISTER BAFC-PI: 2000(1) P29/2. B) *Emphanisporites rotatus* MCGREGOR emend. MCGREGOR BAFC-PI: 1998(1) 057. C) *Geminospora lemurata* BALME BAFC-PI: 2059(1) M33. D) *Grandispora brevizonata* (MENÉNDEZ and PÖTKE DE BALDIS) DI PASQUO BAFC-PI: 2041(1) Z35/4. E) *Grandispora daemonii* LOBOZIAK, STREEL and BURJACK BAFC-PI: 1982(1) M24. F) *Grandispora douglstownense* MCGREGOR BAFC-PI: 2006(1) U40/1. G) *Grandispora gabesensis* LOBOZIAK and STREEL BAFC-PI: 2051(1) 055. H) *Grandispora inculta* ALLEN BAFC-PI: 2051(1) V51. I) *Grandispora mamillata* OWENS BAFC-PI: 2038(1) L36. J) *Grandispora permulta* (DAEMON) LOBOZIAK, STREEL and MELO BAFC-PI: 2007(1) N30/4. K) *Grandispora protea* (NAUMOVA) MOREAU-BENOÏT BAFC-PI: 2059(1) B41/4. L) *Grandispora pseudoreticulata* (MENÉNDEZ and PÖTKE DE BALDIS) OTTONE BAFC-PI: 1979(1) Y54. M) *Granulatisporites muninensis* ALLEN BAFC-PI: 2002(1) G59/1. N) *Leiotriletes balapucencis* DI PASQUO BAFC-PI: 2001(1) Z59/3. O) *Leiotriletes pagius* ALLEN BAFC-PI: 1998(1) Z33/2. P) *Leiotriletes pyramidalis* (LÜBER) ALLEN BAFC-PI: 2005(1) T33/1. Q) *Retusotriletes ottonei* sp. nov. BAFC-PI: 1981(1) G55/4. R) *Retusotriletes ottonei* sp. nov. BAFC-PI: 1977(1) W57/2. S) *Retusotriletes ottonei* sp. nov. BAFC-PI: 1980(1) D30/4. Scale bar: B, C= 15µm; A, D-S= 20µm.

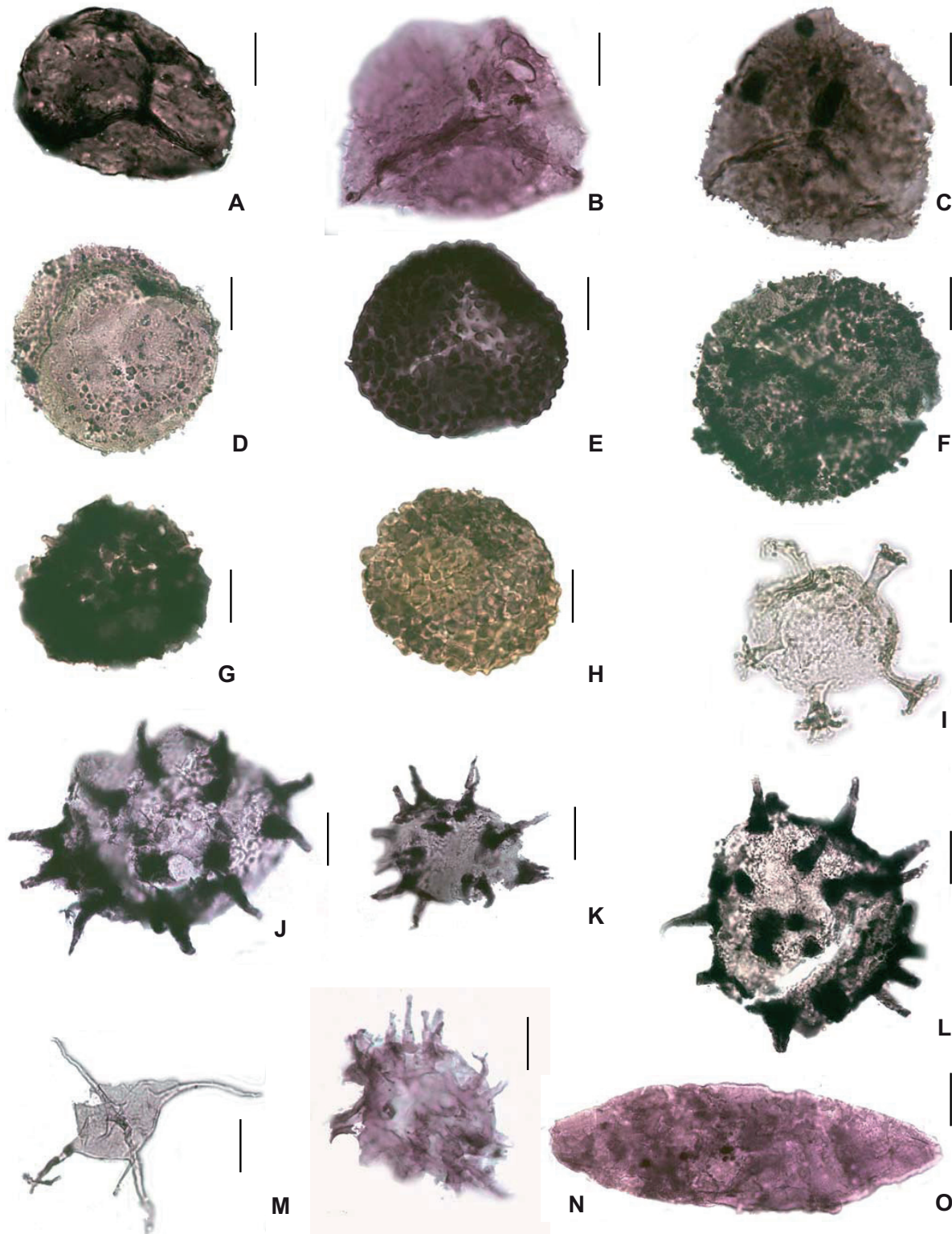


FIGURE IV | A) *Retusotriletes simplex* NAUMOVA BAFC-PI: 1984(1) G51/3. B) *Samarisporites triangulatus* ALLEN BAFC-PI: 1976(2) 057. C) *Samarisporites triangulatus* ALLEN BAFC-PI: 2057(1) F53/2. D) *Verruciretusispora ornata* (MENÉNDEZ and PÔTHE DE BALDIS 1967) PÉREZ LEYTON ex DI PASQUO BAFC-PI: 2041(2) G33/1. E) *Verrucosiporites bulliferus* (TAUGOURDEAU-LANTZ) RICHARDSON and MCGREGOR BAFC-PI: 2046(1) N56. F) *Verrucosiporites loboziakii* MARSHALL and FLETCHER BAFC-PI: 2038(1) Q31/4. G) *Verrucosiporites scurrus* (NAUMOVA) MCGREGOR and CAMFIELD BAFC-PI: 2041(1) H34/1. H) *Verrucosiporites tumulentus* CLAYTON and GRAHAM. BAFC-PI: 2033(1) Z40. I) Sp. A. BAFC-PI: 1975(2) Y36/3. J-L) Sp. B. BAFC-PI: 2007(1) C52/1; 2007(2) C42/2; 2007(2) C55/4. M) ?*Michystridium* sp. BAFC-PI: 1977(1) D38/2. N) *Multiplicisphaeridium* sp. BAFC-PI: 1975(2) Q36/4. O) ?*Leiofusa* sp. BAFC-PI: 1976(1) S48/4. Scale bar: N= 10 20µm; A-C, E, G-I, O= 15µm; D, F, J-L, M= 20µm.

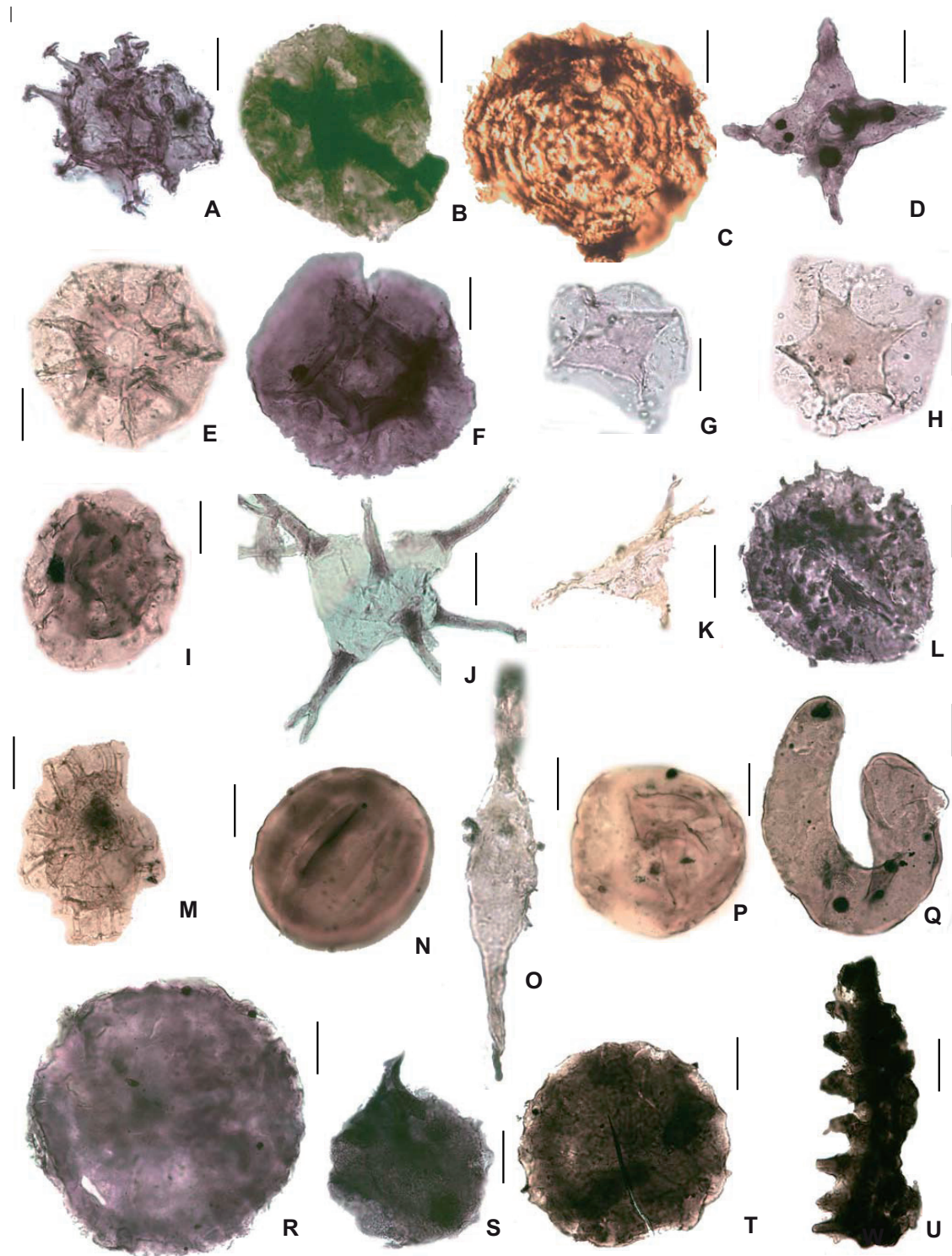


FIGURE V | A) *Ammonidium garrasinoi* OTTONE BAFC-PI: 1975(2) D30/3. B) *Arkonites bilixus* LEGAULT BAFC-PI: 2034(1) F43/3. C) *Chomotriletes vedugensis* NAUMOVA BAFC-PI: 1982(1) P43/1. D) *Crucidia camirensis* (LOBO BONETA) OTTONE BAFC-PI: 2049(1) T47/3. E) *Cymatiosphaera platoloma* WICANDER and LOEBLICH BAFC-PI: 1976(1) S33/1. F) *Dictyotidium munificum* (WICANDER and WOOD) AMENÁBAR, DI PASQUO, CARRIZO and AZCÚY BAFC-PI: 1975(2) B38/1. G) *Duvernaysphaera angelae* DEUNFF BAFC-PI: 1976(1) T32/2. H) *Duvernaysphaera stellata* DEUNFF BAFC-PI: 1977(1) Q45. I) *Duvernaysphaera tenuicingulata* STAPLIN BAFC-PI: 1976(1) U32. J) *Exochoderma arca* WICANDER and WOOD BAFC-PI: 1976(1) E58/1. K) *Exochoderma triangulata* WICANDER and WOOD BAFC-PI: 2032(1) G38. L) *Gorgonisphaeridium discissum* PLAYFORD in PLAYFORD and DRING BAFC-PI: 1976(1) B51/2. M) *Haspidopalla exornata* (DEUNFF) PLAYFORD BAFC-PI: 1975(1) T23/2. N) *Hemiruptia legaultii* OTTONE BAFC-PI: 1976(1) J27/4. O) *Leiofusa banderillae* CRAMER BAFC-PI: 2034(1) R29/4. P) *Leiosphaeridia* spp. BAFC-PI: 1975(1) H23. Q) *Lunulidia micropunctata* PÔTHE DE BALDIS BAFC-PI: 1976(1) W47. R-T) *Maranhites mosesii* (SOMMER) BRITO emend. GONZÁLEZ BAFC-PI: 2046(1) E46/3; BAFC-PI: 2043(1) S52; BAFC-PI: 1977(1) V59/4. U) Indetermined scolecodont BAFC-PI: 1978(1) T45. Scale bar: A-C, E-I, L-O, Q= 15µm; D, J-K, P, R-U= 20µm.

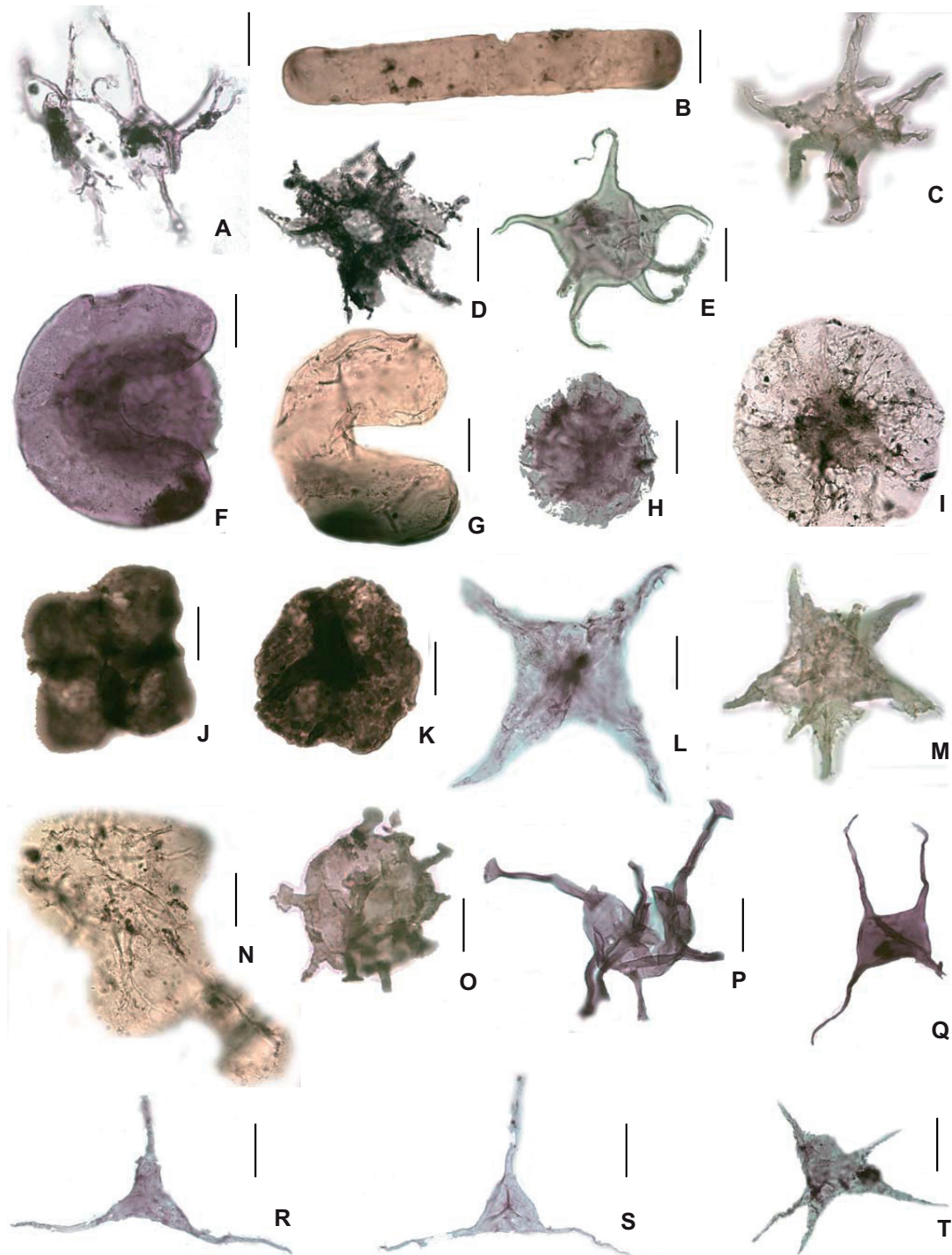


FIGURE VI | A) *Multiplicisphaeridium ramispinosum* (STAPLIN) SARJEANT and VAVRDOVA BAFC-PI: 1975(1) Q31/4. B) *Navifusa bacila* (DEUNFF) PLAYFORD BAFC-PI: 1975(1) Y29. C) *Polyedrixium pharaonis* DEUNFF ex DEUNFF BAFC-PI: 1975(MEB) R42. D) *Polyedrixium* sp. in AMENÁBAR, DI PASQUO, CARRIZO and AZCUY BAFC-PI: 2005(1) L30/4. E) *Polygonium barredae* OTTONE BAFC-PI: 2054(1) C52/4. F) *Pseudolunulidia imperatrizensis* BRITO and SANTOS BAFC-PI: 1975(2) H43/2. G) *Pseudolunulidia laevigata* BRITO and QUADROS BAFC-PI: 1975(1) F33/1. H) *Pterospermella capitana* WICANDER BAFC-PI: 2054(1) H50. I) *Pterospermella pernambucensis* (BRITO) EISENACK, CRAMER and DIEZ RODRÍGUEZ BAFC-PI: 1977(1) Q45/1. J) *Quadriscoprites granulatus* (CRAMER) STRÖTHER BAFC-PI: 1975(1) J24. K) *Quadriscoprites variabilis* (CRAMER) OTTONE and ROSSELLO BAFC-PI: 1975(1) Q48. L) *Stellinium comptum* WICANDER and LOEBLICH BAFC-PI: 1975(2) E45/1. M) *Stellinium micropolygonale* (STOCKMANS and WILLIÈRE) PLAYFORD BAFC-PI: 1975(MEB) V22/2. N) *Tunisphaeridium caudatum* DEUNFF and EVITT BAFC-PI: 1975(1) Q48/2. O) *Umbellasphaeridium deflandrei* (MOREAU-BENOÎT) JARDINÉ, COMBAZ, MAGLOIRE, PENIGUEL and VACHEY BAFC-PI: 1975(MEB) R43/3. P) *Umbellasphaeridium saharicum* JARDINÉ, COMBAZ, MAGLOIRE, PENIGUEL and VACHEY BAFC-PI: 1975(2) G58/2. Q) *Veryhachium* (*Tetraveryhachium*) *longispinosum* (JARDINÉ et al.) STANCLIFFE and SARJEANT BAFC-PI: 1976(2) K46N. R) *Veryhachium* (*Veryhachium*) *reductum* (DOWNE and SARJEANT) STANCLIFFE and SARJEANT BAFC-PI: 1975(2) A38/1. S) *Veryhachium* (*Veryhachiurn*) *trispinosum* (DEUNFF) STANCLIFFE and SARJEANT BAFC-PI: 1975(2) P30/2. T) *Villosacapsula colemanii* PLAYFORD BAFC-PI: 1980(1) D60/1. Scale bar: A, D-F, J, K, M, O, Q= 15µm; B, C, G-I, L, N, P, R-T= 20µm.

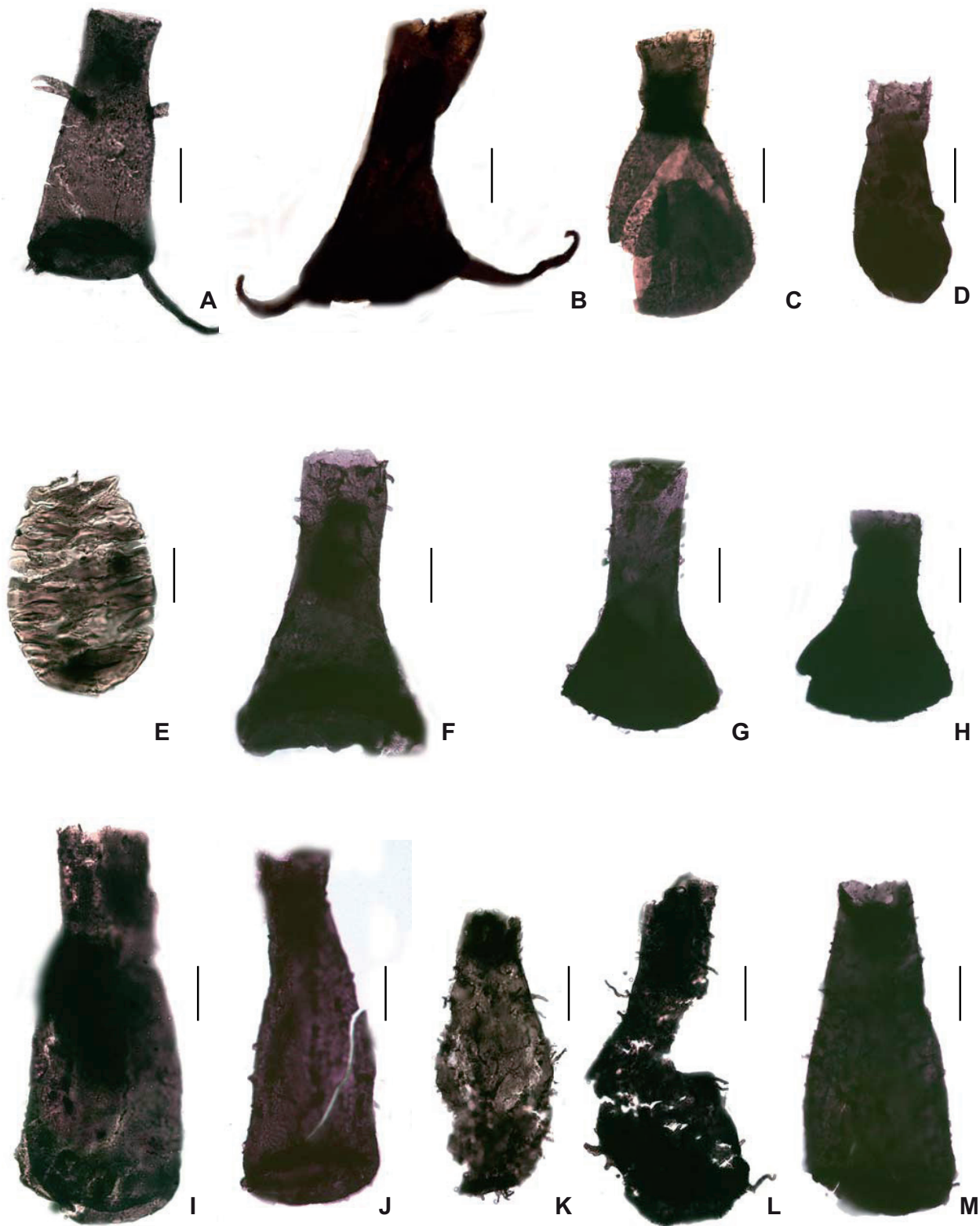


FIGURE VII | A) *Ancyrochitina parisi* VOLKHEIMER, MELENDI and SALAS BAFC-PI : 2005(1) A29/4. B) *Ancyrochitina simplex* GRAHN, BERGAMASCHI and PEREIRA BAFC-PI: 1981(1) F33/3. C) *Angochitina galarzae* OTTONE BAFC-PI: 1975(1) C52. D) *Angochitina* sp. BAFC-PI: 2052(1) P51. E) Indetermined chitinozoan BAFC-PI: 1978(1) U52. F-H) *Fungochitina pilosa* COLLINSON and SCOTT BAFC-PI: 2006(2) S22; 1975(MEB2) H39/4; 1975 (MEB2) F40/2. I-J) *Hercochitina* sp. BAFC-PI : 2007(1) M36/4; BAFC-PI: 2007(2) C46. K-M) *Ramochitina ramosi* SOMMER and VAN BOEKEL BAFC-PI: 1983(1) F40/4, 1997(1) Z49, 2007(MEB) M40/2G. Scale bar: E, K= 20µm; A-D, F-J, L-M= 30µm.

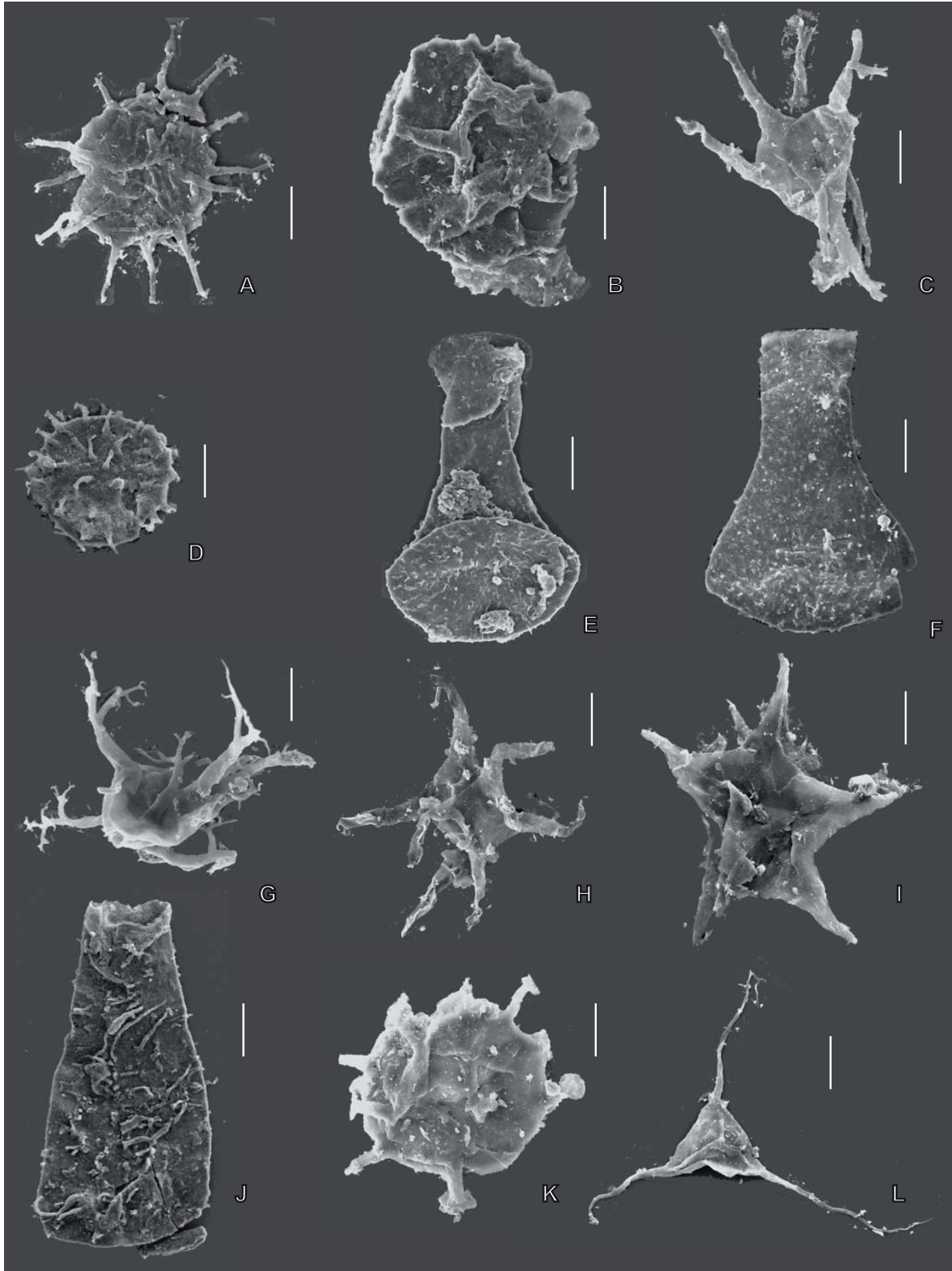


FIGURE VIII | **A)** *Ammonidium garrasinoi* OTTONE. Scale bar: 12 μ m. **B)** *Dictyotidium munificum* (WICANDER and WOOD) AMENÁBAR, DI PASQUO, CARRIZO and AZCÚY. Scale bar: 18 μ m. **C)** *Exochoderma arca* WICANDER and WOOD. Scale bar: 17 μ m. **D)** *Gorgonisphaeridium* sp. Scale bar: 19 μ m. **E-F)** *Fungochitina pilosa* COLLINSON and SCOTT. Scale bar: 25 μ m. **G)** *Multiplicisphaeridium ramispinosum* (STAPLIN) SARJEANT and VAVRDOVÁ. Scale bar: 10 μ m. **H)** *Polyedrixium pharaonis* DEUNFF ex DEUNFF. Scale bar: 18 μ m. **I)** *Stellinium micropolygonale* (STOCKMANS and WILLIÈRE) PLAYFORD. Scale bar: 10 μ m. **J)** *Ramochitina ramosi* SOMMER and VAN BOEKEL. Scale bar: 30 μ m. **K)** *Umbellasphaeridium deflandrei* (MOREAU-BENOÎT) JARDINÉ, COMBAZ, MAGLOIRE, PENIGUEL and VACHEY. Scale bar: 10 μ m. **L)** *Veryhachium* (*Veryhachium*) *trispinosum* (DEUNFF) S TANCLIFFE and SARJEANT. Scale bar: 16 μ m.