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Palynology of the Baqueró Group (upper Aptian), Patagonia Argentina: An integrated study

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ABSTRACT

A palynological study on samples obtained from the Anfiteatro de Ticó and Punta del Barco formations (Baqueró Group, Macizo del Deseado area, Santa Cruz Province) is carried out. A total of 162 taxa are identified in this work, including the recognition of 59 not previously reported in the unit. Furthermore, 9 new species are proposed: *Coptospora santacrucensis* sp. nov., *Crybelosporites corrugatus* sp. nov., *Cycadopites grossus* sp. nov., *Cyclusphaera annularis* sp. nov., *Cyclusphaera punnulosa* sp. nov., *Densoisporites patagonicus* sp. nov., *Peromonolites globosum* sp. nov., *Retitriletes ornatus* sp. nov. and *Taurocusporites inaequalis* sp. nov. Continental algae, recovered from the Anfiteatro de Ticó Formation, are illustrated for the first time. Comparisons with other Lower Cretaceous palynological zones from regions located at similar paleolatitudes (e.g. Australia, India) and from the Potomac Group (USA) are carried out. Finally, changes in the floral composition across the Baqueró deposits are analyzed considering a context of progressive increase of volcanic activity that most certainly had some effect in the dynamics of the floristic community.

1. Introduction

The outcrops of the Baqueró Group (Patagonia, Argentina) comprise one of the most diverse and abundant Early Cretaceous floras in the Southern Hemisphere. The deposits of this unit record dramatic local environmental changes, were volcanic activity played a major role in the development of the ecosystem, and thus the study of the changes in the floristic composition across the sequence may reveal how the flora was affected by environmental stress. The Baqueró Group (composed by the Anfiteatro de Ticó, Bajo Tigre and Punta del Barco formations) is also one of the most important units regarding the study of the early diversification of angiosperms in South America, with well-preserved abundant and diverse macro and palynofloristic remains. Furthermore, this relevance is enhanced by the availability of absolute dates that constrain the age of deposition of the whole Baqueró Group to the late Aptian (Césari et al., 2011; Perez Loinaze et al., 2013; Passalia et al., 2016). The paleontological content of the Baqueró Group, mostly consisting of palynological and megafloristic remains, has been focus of study since 1960, and was summarized in several contributions presented by Archangelsky (2003), Del Fueyo et al. (2007) and Limarino et al. (2012). In spite of the numerous and detailed paleobotanical and palynological works done during more than fifty years in this unit, the outcrops of the Baqueró Group still continue to reveal new and interesting findings, such as the ones presented by Del Fueyo et al. (2012), Passalia et al. (2016), Carrizo et al. (2011), and Vera and Césari (2012, 2015), among others.

Limarino et al. (2012) performed a regional stratigraphic analysis of the Baqueró Group, and analyzed the environmental evolution of the basin. Thirteen fossiliferous levels, that yielded both mega and palynofloristic records, were identified and referred to a continuous stratigraphic scheme. The aim of this study is to present an exhaustive analysis of the palynological content of the Baqueró Group, based on the study of samples with precise stratigraphic location and referred to fossiliferous levels (sensu Limarino et al., 2012).

The number of species recorded in the Baqueró Group is increased with the recognition of taxa not previously reported in the unit, along with the description of 9 new species. In addition, reported algae from the Anfiteatro de Ticó Formation are illustrated for the first time. These results provide a detailed perspective on

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the floral composition across this unit during the Early Cretaceous. Changes in the floral composition are then considered in a context of a progressive increase in volcanic activity, which most certainly had some effect in the floristic community.

2. Geology

2.1. Stratigraphic framework

The Baqueró Group crops out in the south of Patagonia, in the Macizo del Deseado area, Santa Cruz Province, Argentina (Fig. 1). This unit comprises, from the base to top, the Anfiteatro de Ticó, Bajo Tigre and Punta del Barco formations (Cladera et al., 2002). The Baqueró Group was deposited in continental – mostly fluvial and lacustrine – environments and it is composed of sandstones, conglomerates, tuffs and mudstones, reaching 200 m in thickness (Limarino et al., 2012). The basement of the basin includes three major units: the Chon Aike, La Matilde and Bajo Grande formations (Panza et al., 1998). The Chon Aike Formation was dated by different methods (e.g. SHRIMP U–Pb zircon, Rb–Sr whole-rock, ^{40}Ar–^{39}Ar), and the ages obtained are indicative of a long period of acid eruptivity during the Middle–Late Jurassic (Pankhurst et al., 1998, 2000; De Barrio et al., 1999), being these ages consistent with the preserved fossil flora (De Barrio et al., 1982; Channing et al., 2007). The age of the La Matilde Formation is Bajocian–Callovian (late Middle Jurassic) on the base of faunal and floral fossil records (Stipanicic and Reig, 1956; Stipanicic and Bonetti, 1970). Finally, the Bajo Grande Formation is dated as Late Jurassic–Early Cretaceous, given its stratigraphic position (De Barrio et al., 1999).

The Baqueró Group is unconformably overlain by Paleogene and Neogene basalts (Panza et al., 1998) and/or the marine deposits of the Monte León Formation. This latter unit is dated as early Miocene, based on radiometric ages (Parras et al., 2012), as well as by its marine invertebrates and palynological content (Barreda and Palamarczuk, 2000).

The Anfiteatro de Ticó Formation consists mainly of shales and fine grained sandstones, and subordinated coarse-grained, gravelly sandstones and conglomerates deposited in a lacustrine and fluvial environment (Cladera et al., 2002). This unit has provided very well preserved and diverse palynological assemblages and megafloristic remains, summarized by Archangelsky (2003), Del Fueyo et al. (2007), and Limarino et al. (2012). Corbella (2001) dated this unit using the $^{40}Ar/^{39}Ar$ technique, and obtained an age of 118.56 ± 1.40 My. A few years later, the same author reported a new age for the unit, this time younger (111.8 ± 3.7 Ma), using fission track techniques (Corbella, 2006). Recently, Perez Loinaze et al. (2013) obtained a $^{206}Pb/^{238}U$ high precision age of 118.23 ± 0.09 Ma from tuffs obtained from the lower levels of Anfiteatro de Ticó Formation, using a modification of CA-TIMS procedures outlined in Mundil et al. (2004), Mattinson (2005) and Scoates and Friedman (2008). The discrepancy between the ages reported for the Anfiteatro de Ticó Formation is undoubtedly result of the different methodologies used. The age reported by Perez Loinaze et al. (2013) is considered more reliable, given that the used technique is one of the most accurate and precise methods of isotopic dating currently available (Parrish and Noble, 2003; Schmitz and Kuiper, 2013; Schoene, 2014). The middle Bajo Tigre Formation is composed by tuffs, muddy tuffs, tuffaceous sandstones and conglomerates deposited in a fluvial environment. Contrasting to the other two units of the Group, the paleontological record is scarce. To date, only few megafloristic remains were reported from this unit (Archangelsky, 2003), and palynofloras assemblages have not yet been found. Radiometric dating of this unit using $^{206}Pb/^{238}U$ on tuffs obtained at the Cerro Bayo locality yielded an age of 116.85 ± 0.26 Ma (Passalia et al., 2016).

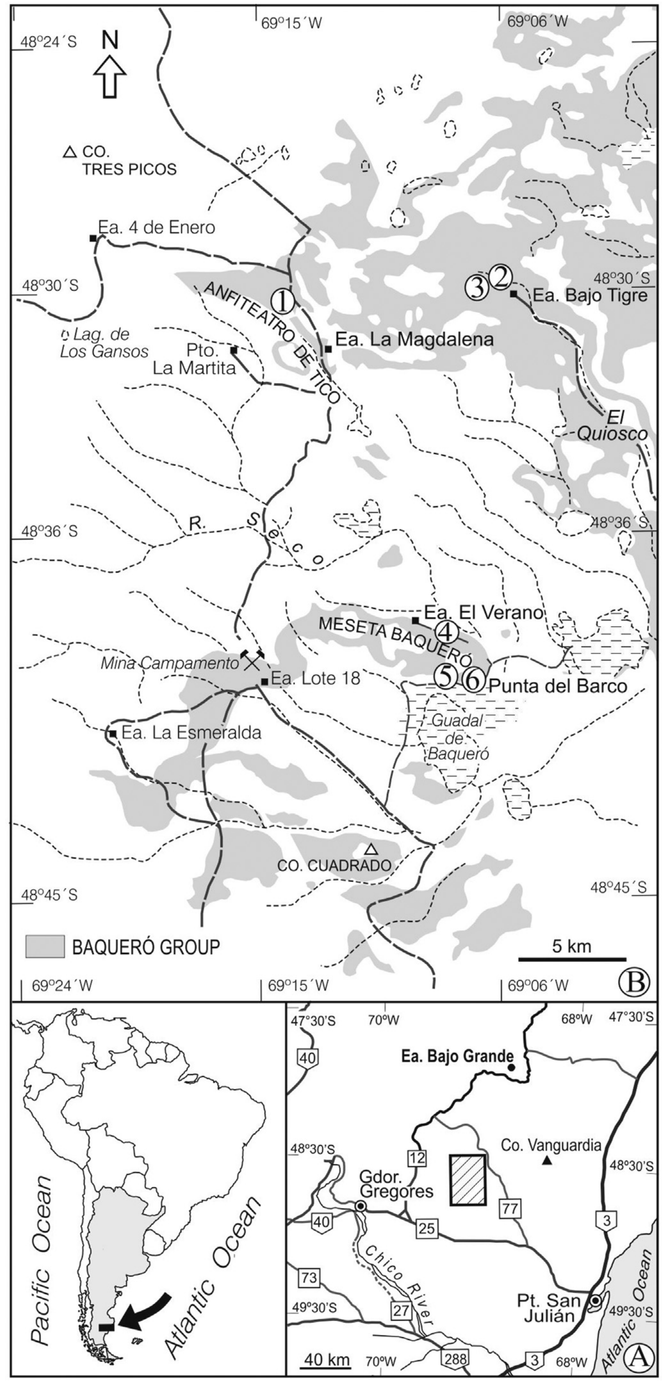

Fig. 1. (A) Location map of the study area in the Santa Cruz Province, Argentina. (B) Details of the area marked with a rectangle in A, showing the Baqueró Group outcrops (based on the geological survey of Panza et al., 1998). The studied localities are indicated with numbers as follows: 1, Anfiteatro de Ticó; 2, Estancia Bajo Tigre; 3, Cerro Testigo; 4, Estancia El Verano; 5, South flank of Meseta Baqueró; 6, Punta del Barco (modified from Limarino et al., 2012).

Finally, the youngest Punta del Barco Formation consist mostly of volcanoclastic sediments deposited in a fluvial environment, with alternation of syn-eruptive and inter-eruptive periods. The megafloristic remains of this unit have been studied since the beginning of last century (Berry, 1924; Herbst, 1960, 1962, 1966; Archangelsky et al., 1995; Cladera and Cúneo, 2002; Del Fueyo and Archangelsky, 2002, among others). On the other hand, the palynoflora of the unit was recently studied for the first time by

Llorens (2003, 2008a,b; 2012). The first radiometric ages for the unit were obtained by Corbella (2001) using the ^{40}Ar/^{39}Ar technique, resulting in 119.65 ± 0.45 Ma. More recently, Césari et al. (2011) reported a ^{206}Pb/^{238}U age of 114.67 ± 0.18 Ma, a result younger than the one originally presented by Corbella (2001). This age estimation indicates a latest Aptian age for the Punta del Barco Formation, an added to the ages of the Anfiteatro de Ticó Formation constrains the deposition of the Baqueró Group to the late Aptian.

2.2. Sedimentary environment

A detailed study of the depositional setting of the Baqueró Group was carried out Limarino et al. (2012), establishing an accurate sedimentary framework for the unit, which is here adopted.

The lowermost part of the Baqueró Group is composed of shales and fine-grained tuffs (Facies Association A of Limarino et al., 2012, Fig. 2), forming a monotonous sequence of shales, very fine-grained sandstones, massive mudstones and thin levels of intraformational breccias, and some conglomerates. Within the shales, centimetric intercalations of fine-grained tuffs occur, which represent the incipient onset of volcanic activity and its sedimentation into an environment of relatively deep part of a lake. Following, cross-bedded sandstones and conglomerates (Facies Association B of Limarino et al., 2012, Fig. 2), composed of fine-grained sandstones, coarse-grained and gravelly sandstones and fine- to medium-grained conglomerates, were deposited in more marginal areas of the lake. Coarse-grained sandstones and gravelly sandstones form thick beds, with three different kinds of geometries (tabular, lenticular and convex-up lenticular beds). The conglomerates comprise three principal types depending of the clast size and it clast/matrix ratios, and some of these clasts are sandstones, tuffs, volcanics and granites.

The next association of facies shows a limited regional distribution, encompassing marginal areas of the lacustrine basins, and composed of large-scale cross-bedded conglomerates (Facies Association C of Limarino et al., 2012, Fig. 2). Clast composition is dominated by different types of volcanic rocks, sandstones, tuffs and smaller amounts of granites and mudstones. This facies corresponds to a lacustrine environment under the effects of sporadic volcanic ash falls, showing an increasing in the eruptions frequency.

The overlying facies association consists of channelized conglomerates and coarse-grained sandstones were deposited, which laterally pass to fine-grained sandstones, mudstones and scarce thin levels of organic-rich mudstones (Facies Association D of Limarino et al., 2012, Fig. 2). The conglomerates are dominated by volcanic and sedimentary clasts, and pass vertically and laterally to coarse-grained cross-bedded sandstones. These rocks were mainly deposited in a platform deltaic environment that included distributary channel systems (the channelized deposits) and interdistributary areas (fine-grained sandstones and mudstones, including coal beds).

The following section consists of stacked tabular fining-upward cyclothems (Facies Association E of Limarino et al., 2012, Fig. 2), ranging in thickness from 2 to 4 m each. The sedimentary environment was probably a high sinuosity fluvial system under the active migration of channels.

The sedimentary conditions change in the next facies association towards a low-sinuosity multi-channelized fluvial system, where lenticular clast-supported conglomerates (Facies Association F of Limarino et al., 2012, Fig. 2) were deposited. The clasts are well-rounded, up to 9 cm in diameter, of tuffs, volcanics, sandstones and, rarely, granites.

These five facies associations are included in the Depositional Section 1 (DS1of Limarino et al., 2012), which represent different settings in lacustrine and fluvial environments, trending to a progressive shallowing of the lake system. The volcaniclastic input is moderate in this section, but its presence is recorded in almost all the facies associations. The DS1 is almost equivalent to the Anfiteatro de Ticó Formation of Cladera et al. (2002).

The overlying Bajo Tigre and Punta del Barco formations are more or less equivalent to DS2 and DS3 of Limarino et al., (2012), and consist of the alternation of Facies Associations G and H, where tuffs are the most abundant lithology (60% of the facies associations).

Facies Association G of Limarino et al. (2012) (Fig. 2) consist of tuffs, muddy tuffs and tuffaceous sandstones forming massive primary tuffs or partially reworked tuffs with horizontal lamination or small-scale cross-lamination, formed by fluvial regimes under syn-eruptive or brief inter-eruptive periods in wide floodplain areas.

Finally, there are recurrent levels of coarse-grained tuffaceous sandstones and conglomerates (Facies Association H of Limarino et al., 2012, Fig. 2), comprising channel-complex deposits, lenticular in shape, and corresponds to inter-eruptive periods long enough to allow fluvial channels to incise the syn-eruptive deposits of the facies association G.

In summary, the sedimentation of the entire analyzed section can be divided into two main scenarios. On the one hand, the lower Baqueró Group (DS1) was deposited in lacustrine and fluvial environments, with sporadic ash-fall input. The upper Baqueró Group is characterized by the disappearance of lacustrine systems and the presence of abundant ash fall deposits and volcanic breccias, with the alternation of syn-eruptive and inter-eruptive periods evidencing the increase of volcanic activity along the profile, with inputs of extrabasinal (Corbella, 2006) and intrabasinal volcanism in the Baqueró Basin (Limarino et al., 2012).

3. Material and methods

Nineteen samples (BA Pal 6214 to BA Pal 6232) were recovered from the Anfiteatro de Ticó Formation, and five (BA Pal 6233 to BA Pal 6236 and BA Pal 6238) from the Punta del Barco Formation (Fig. 2). In addition, palynological samples from the Punta del Barco Formation previously studied by Llorens (2003, 2008a,b, 2012; Llorens and Perez Loinaze, 2016), are incorporated to the analysis. Stratigraphic and geographic provenance of each sample is indicated in Fig. 3. The palynological samples were treated following standard techniques for extraction and concentration of palynomorphs (Phipps and Playford, 1984). Observations were made with an Olympus BX-51 microscope. Photographs were taken with a Nikon DS-Fi1 digital camera, and the coordinates of the illustrated specimens are given as England Finder references. The resulting slides are deposited in the Palynological Collection of the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (acronym BA Pal). To evaluate similarities among coeval Early Cretaceous palynofloras a multivariate analysis was carried out. Cluster diagrams (dendrograms) (Fig. 4) were calculated based on Raup–Crick dissimilarity matrices, using the single linkage and the Unweighted Pair Group Method with Arithmetic mean (UPGMA) methods. The data matrix was elaborated using previously published palynological data from the Lower Cretaceous of Argentina, from other gondwanan regions located at similar paleolatitudes during the Barremian-Albian interval (e.g., Australia, India), and from the Potomac Group (USA). The data matrix of analyzed assemblages is given in Appendix A.

4. Palynological results

Well-preserved palynomorphs were recovered and studied. A total of 107 spore species, 34 gymnosperm pollen grains, 10 angiosperm pollen grains and 11 algae taxa were identified,

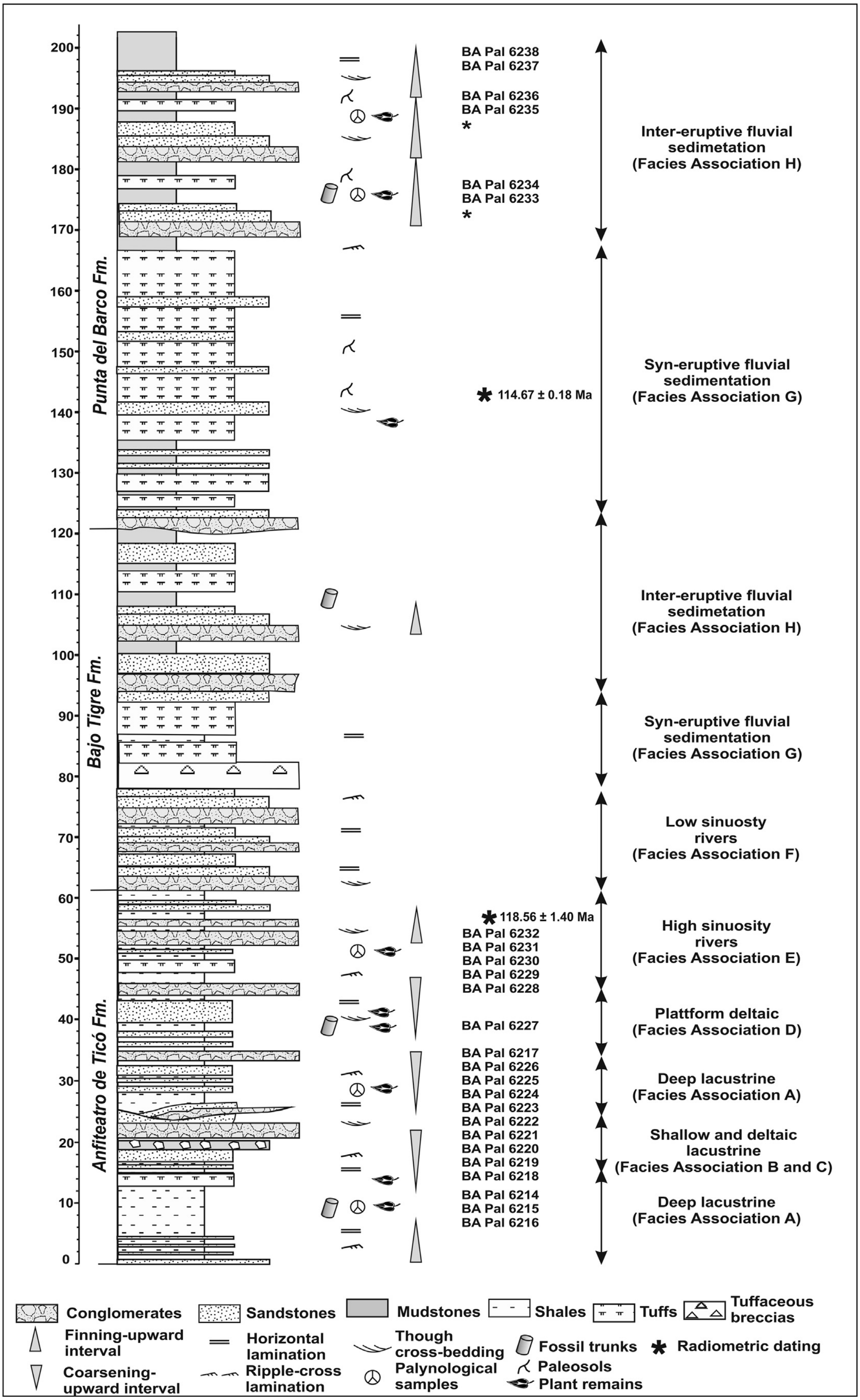

Fig. 2. Schematic stratigraphic section of the Baqueró Group showing the fossiliferous horizons (modified from Limarino et al., 2012).

Formation	Localitity	BA Pal	GPS coordinates
Punta del Barco	Ea. El Verano	6238	48°30.6′0.9″, 69°5.8′58″
	South flank of the Meseta Baqueró	6235, 36, ^	48°39'30"S, 69°07'18"W
	Punta del Barco	6234-33	48°39′24.78″S, 69°0.6′40.79″W
Anfiteatro de Ticó	Ea. Bajo Tigre	6228, 6230	48°30.6′0.9″, 69°5.8′58″
	Anfiteatro de Ticó	6217/19, 6222/27,6229, 6231/2	48°30'33"S, 69°14'11"W
	Cerro Testigo	6220/1	48°30.6'0.9"S, 69°5.8'58"W
	Ea. El Verano	6214/16	48°38'29.46"S, 69°08'5.11"W

Fig. 3. Provenance of the studied samples (^Reexamined samples).

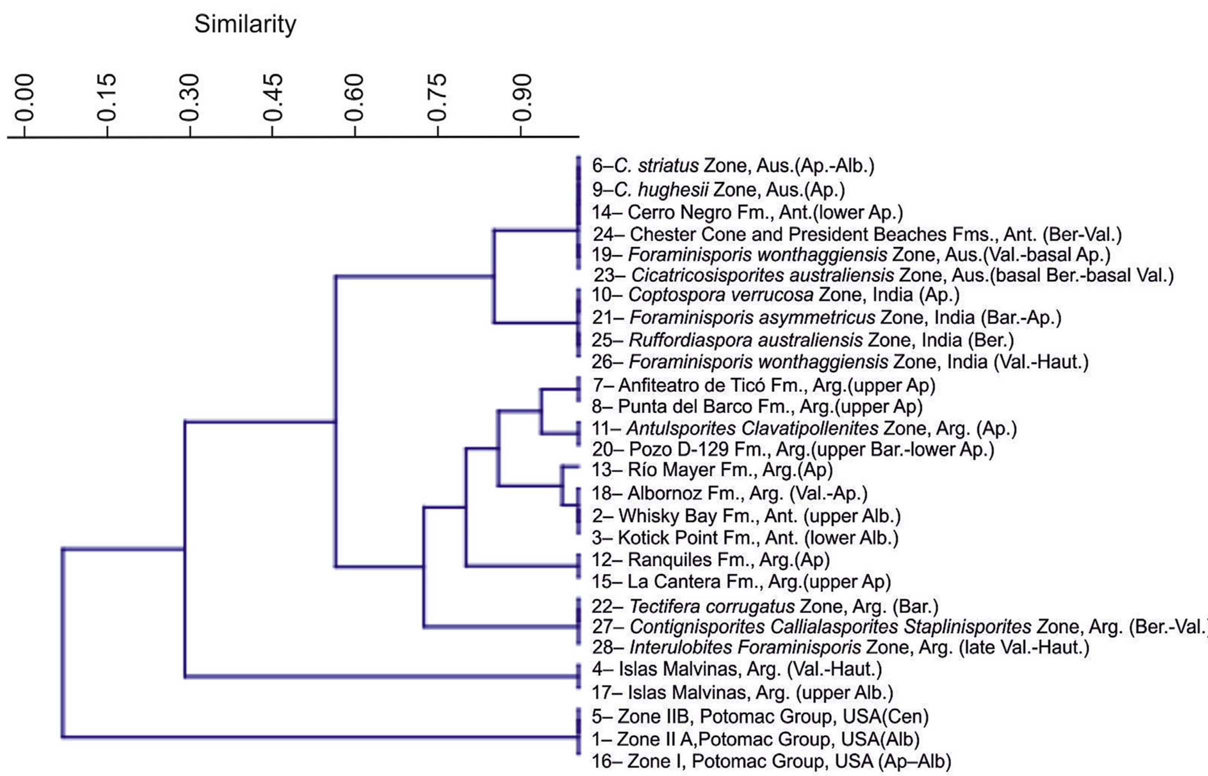

Fig. 4. Dendrogram showing the clustering of palynological assemblages from different formations and/or localities, based on Raup–Crick index, UPGMA technique (data matrix in Appendix B) and PAST programme. Reference: Berriasian: Ber.; Hauterivian: Haut.; Valanginian: Val.; Barremian: Bar; Aptian: Ap.; Albian: Alb.; Cenomanian: Cen.; Argentina: Arg.; Australia: Aus.; Antarctica: Ant.; 1-Zone IIA, Potomac Group, USA, lower Alb. (Brenner, 1963); 2-Whisky Bay Fm., Ant., upper Alb. (Dettmann and Thomson, 1987); 3-Kotick Point Fm., Ant., lower Alb. (Dettmann and Thomson, 1987); 4-Islas Malvinas, Arg., Val.-Haut. (Kotova, 1983); 5-Zone IIB, Potomac Group, USA, middle-upper Alb. (Brenner, 1963); 6-*Crybelosporites striatus* Zone, Aus., upper Ap.-lower Alb. (Helby et al., 1987); 7-Anfiteatro de Ticó Fm., Arg., upper Ap. (this work); 8-Punta del Barco Formation, Arg., upper Ap. (this work); 9-*Cyclogranisporites hughesii* Zone, Aus., Ap (Helby et al., 1987); 10-*Coptospora verrucosa* Zone, India, Ap. (Tripathi, 2008); 11-*Antulsporites clavatipoll*enites Zone, Arg., Ap. (Archangelsky et al., 1984); 12-Ranquiles Fm. = Quili Malal Member, Rayoso Fm., Arg., Ap. (Vallati, 1995); 13-Río Mayer Fm., Arg., upper Ap. (Pöthe de Baldis and Ramos, V., 1980; Medina et al., 2008; Perez Loinaze et al., 2012); 14-Cerro Negro Fm., Ant., lower Ap. (Hathway et al., 1999); 15-La Cantera Fm., Arg., upper Ap. (Prámparo, 1990, 1994); 16-Zone I, Potomac Group, USA, Ap. (Brenner, 1963); 17-Islas Malvinas, Arg., lower Alb. (Kotova, 1983); 18-Albornoz Fm., Arg., Val.-Ap. (Vallati, 1993); 19-*Foraminisporis wonthaggiensis* Zone, Aus., Val.-basal Ap. (Helby et al., 1987); 20-Pozo D-129 Fm., Arg., upper Bar.-lower Ap. (Vallati, 1996); 21-*Foraminisporis asymmetricus* Zone, India, Bar.-Ap. (Tripathi, 2008); 22-*Tectifera corrugatus* Zone, Arg., Bar. (Archangelsky et al., 1984); 23-*Cicatricosisporites austaliensis* Zone, Aus., basal Ber.-basal Val. (Helby et al., 1987); 24-Chester Cone and Presidente Beaches Fms., Ant., Ber-Val. (Duane, 1996); 25-*Ruffordiaspora australiensis* Zone, India, Ber. (Tripathi, 2008); 26-*Foraminisporis wonthaggiensis* Zone, India, Val.-Haut. (Tripathi, 2008); 27-*Contignisporites-Callialasporites-Staplinisporites* Zone, Arg., Ver.-Val. (Archangelsky et al., 1984); 28-*Interulobites-Foraminisporis* Zone, Arg., upper Val.-Haut. (Archangelsky et al., 1984).

constituting a total of 162 recognized taxa; 58 of them are reported for the first time in the Baqueró Group, and illustrated in Figs. 5–8. All identified taxa are listed in Appendix B, with their relative abundance and distribution in the units.

4.1. Systematic palynology

Nine new species are described in this section; six correspond to spores and three to gymnosperm pollen grains.

Genus *Coptospora* Dettmann, 1963
Type species. Coptospora striata Dettmann, 1963

Coptospora santacrucensis sp. nov.
Fig. 5K–M

Holotype. BA Pal 6219-10-2:Y35/3, Fig. 5L–M.
Derivation of name. In reference to the Patagonian Santa Cruz Province where the material comes from.
Type locality. Anfiteatro de Ticó, Santa Cruz Province, Argentina.

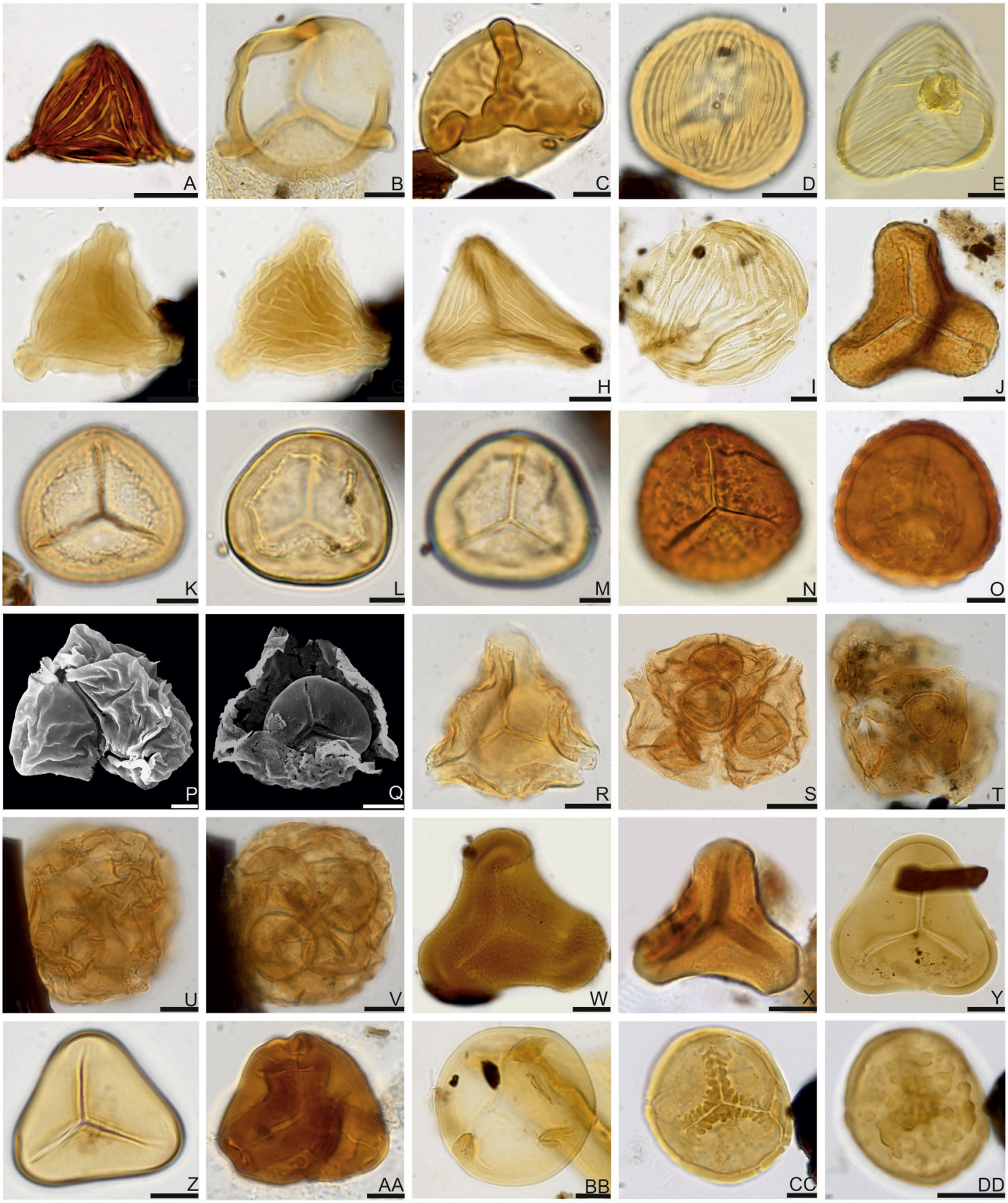

Fig. 5. A. *Appendicisporites unicus* BA Pal 6218-25-1:G56/0; B. *Biretisporites aegyptiaca* BA Pal 6220-25-1:V21/3; C. *Biretisporites* sp. cf. *B. crassilabratus* BA Pal 6220-10-2:W27/1; D. *Cicatricosisporites cuneiformis* Ba Pal 6220-25-2:P51/3; E. *Fisciniasporites potomacensis* BA Pal 6220-25-3:G48/2; F–G. *Cicatricosisporites* sp. BA Pal 6220-25-1:L33/3; H. *Cicatricosisporites abacus* BA Pal 6220-25-1:U30/1; I. *Cicatricosisporites* sp. cf. *C. spiralis* BA Pal 6227-25-1:G26/4; J. *Concavissimisporites crassatus* BA Pal 6224-10-2:P49/0; K–P. *Coptospora santacrucensis* sp. nov.; K. BA Pal 6225-25-2:U44/0; L–M. BA Pal 6219-10-2:Y35/3; N–O. *Coptospora* sp. BA Pal 6223-25-1:Q57/0; P–V. *Crybelosporites corrugatus* sp. nov.; P. BA Pal 6224, SEM; Q. BA Pal 6224, SEM; R. BA Pal 6225-25-1:Z47/2; S. BA Pal 6220-25-3:H44/0; BA Pal 6225-25-1:Z37/0; U–V. BA Pal 6225-25-1:H49/1; W. *Cyathidites asper* BA Pal 6220-25-1:H38/0; X. *Cyathidites concavus* BA Pal 6227-25-1:U25/1; Y. *Cyathidites patagonicus* BA Pal 6220-25-2:X25/0; Z. *Cyathidites rafaeli* BA Pal 6224-10-2:P47/4; AA. *Dictyophyllidites* sp. BA Pal 6214-10-1:R29/3; BB. *Divisisporites enormis* BA Pal 6220-25-3:Q47/0; CC–DD. *Interulobites pseudoreticulatus* BA Pal 6223-10-2:R52/2. Scale bar: 10 μm.

Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Spore radial hilate, exine psilate. Proximal face with a tetrad mark usually distinct, straight, accompanied by thin lips. Distal face with hilate exine ruptured.
Description. Spore radial hilate, amb subcircular. Exine 0.6(0.8) 0.9 μm thick, psilate. Proximal face with a tetrad mark usually distinct, straight, extending about ¾ to almost spore radius, accompanied by thin lips. Distal face with hilate exine ruptured. Hilum is irregular to subcircular in outline and 14(15.5)18 μm in diameter.
Dimensions. Equatorial diameter: 21(24.4)29 μm (47 specimens).
Comparison. Dettmann (1963) proposed the genus *Coptospora* for inaperturate or hilate spores. Although most of the species of this genus lack of a usually distinct tetrad mark, Dettmann (1963) noted that some specimens of *Coptospora paradoxa* present a faint tetrad mark. *Coptospora paradoxa* Dettmann 1963 differs from *Coptospora santacrucensis* sp. nov. by having scabrate thicker exine, larger diameter and distal polar exine with fractured hexagonal areas (5–9 in number) and only in some specimens the distal polar exine is ruptured (hilate).
Affinity. Spores of extant Sphaerocarpaceae, Ricciaceae and Riellaceae are similar to *Coptospora* (Dettmann, 1963).

Genus *Crybelosporites* Dettmann, 1963
Type species. Crybelosporites striatus (Cookson and Dettmann) Dettmann (1963)

Crybelosporites corrugatus sp. nov.
Fig. 5P–V

Holotype. BA Pal 6220-25-3:H44/0, Fig. 5S.
Derivation of name. Derives from the latin word *corrugis* (wrinkled), in reference to the sculpture of perispore.
Type locality. Cerro Testigo, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Perisporate spore. Exine of the spore body psilate to microfoveolate. Perisporium amb triangular, with three open blunt apices, loosely enveloping, psilate to microrugulate.
Description. Spore radial, trilete, perisporate, frequently united in tetrahedral tetrads. Spore body subcircular to a roundly subtriangular with slightly convex to straight sides and rounded apices, with exine in proximal and distal faces psilate to microfoveolate, 0.8(0.9)1 μm thick. Laesura straight, extending almost to equator, accompanied by lips. Perispore amb triangular with straight to slightly concave sides and three open blunt apices, loosely enveloping, psilate to microrugulate, 0.5(0.55)0.6 μm thick, often folded. Perispore is often broken in the trilete area (Fig. 5Q, R).
Dimensions. Diameter of a single spore: 35(44)53 μm, body diameter: 18(19)28.5 μm (57 specimens).
Comparison. Crybelosporites berberoides Burger 1976 resembles *Crybelosporites corrugatus* sp. nov. but differs in having a subcircular perispore amb with rounded apices and shorter laesura. *Crybelosporites striatus* (Cookson and Dettmann) Dettmann 1963 and *Crybelosporites punctatus* Dettmann 1963 possesses a gula-like projection in the polar region of the perispore. Furthermore, *Crybelosporites striatus* has proximally striated perispore, which is distally and equatorially reticulate. *Crybelosporites brenneri* Playford 1971 differs by having perispore with a gula-type projection over the proximal face, which is almost laevigate, Moreover, it has circular to subcircular spore body and perispore amb. *Crybelosporites stylosus* Dettmann 1963 differs by its circular amb, thicker exine, and finely spongeous in structure of the spore body (2–4 μm), also having reticulate perisporium with circular luminas (1–2 μm). *Crybelosporites australis* Archangelsky and Llorens 2005 is distinguishable by having very variable perine texture, ranging from fine and irregular reticulum (1–2 μm), microreticulate (less than 1 μm) to micropunctate.
Affinity. Related to Marsileaceae (Lupia et al., 2000).

Genus *Densoisporites* Weyland and Krieger emend. Dettmann, 1963
Type species. *Densoisporites velatus* Weyland and Krieger, 1953

Densoisporites patagonicus sp. nov.
Fig. 6A–G

Holotype. BA Pal 6218-10-1:Z34/0, Fig. 6C–D.
Derivation of name. In reference to Patagonia, the Argentinian region where the specimens were identified.
Type locality. Anfiteatro de Ticó, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Cavate spore. Endospore scabrate, exospore microrugulate and cingulated. Cingulum composed by radially elongated thickenings that converge at a continuous equatorial thickening.
Description. Spore radial, trilete. Amb roundly subtriangular. Laesura straight, extending almost to equador, accompanied by a margo, and occasionally lips. Exine two layered, cavate. Endospore scabrate, roundly subtriangular with slightly convex to straight sides and rounded apices, 0.5(0.6)0.75 μm thick. Exospore microrugulated and cingulated. Cingulum composed by radially elongated thickenings that converge at a continuous equatorial thickening 0.6(0.6)0.7 μm wide. Camera 3–7 μm wide in proximodistal view. Invariable concentric position of the endospore suggests the exinal layers are adpressed at the proximal face.
Dimensions. Overall equatorial diameter 21(26)35 μm, diameter of endospore: 16(20.6)24 μm (37 specimens).
Comparison. Lundbladispora, as described by Balme (1963), has an exospore with a spongy appearance. *Endoisporites* Wilson and Coe 1940 differs from *Densoisporites* by having smaller endospore and thinner exospore. *Densoisporites laevigatus* (Pocock) Waksmundzka 1992 differs from *D. patagonicus* sp. nov. by its larger diameter, nexine appressed to sexine and psilate exospore. *Densoisporites microrugulatus* Brenner 1963 differs by its microreticulate sculpture and by having its endospore appressed to the exospore.
Affinity. The genus *Densoisporites* has affinities with the Lycopsida (Balme, 1995).

Genus *Peromonolites* Couper, 1953
Type species. Peromonolites bowenii Couper, l953

Peromonolites globosum sp. nov.
Fig. 6N–S, U–W

Derivation of name. Derives from the latin word *globosum*, in reference to the globose aspect that the perispore confers
Holotype. BA Pal 6223-25-1:J36/3, Fig. 6R–S.
Type locality. Anfiteatro de Ticó, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Spore perisporate, cavate. Endospore and exospore psilate. Perispore ornamented with low rugulae and verrucae. Laesura with membranous lips. Three layers of spore wall only are attached at the proximal face, along the laesurae.
Description. Spore monolete, perisporate, cavate. Amb oval to elliptical with acute ends. Spore body elliptical to oval, endospore 0.4(0.5)0.6 μm thick and exospore psilate 0.45(0.6)0.8 μm thick, variably detached from endospore (Fig. 6U, V). Perispore ornamented with low rugulae and verrucae 0.6(0.7)0.9 μm thick, densely distributed. Laesurae straight, extending almost to the endospore equator, accompanied by membranous lips, up to 1.2 μm high (Fig. 6W).Three layers of spore wall only are attached at the proximal face, along the laesurae, forming a membranous apertural

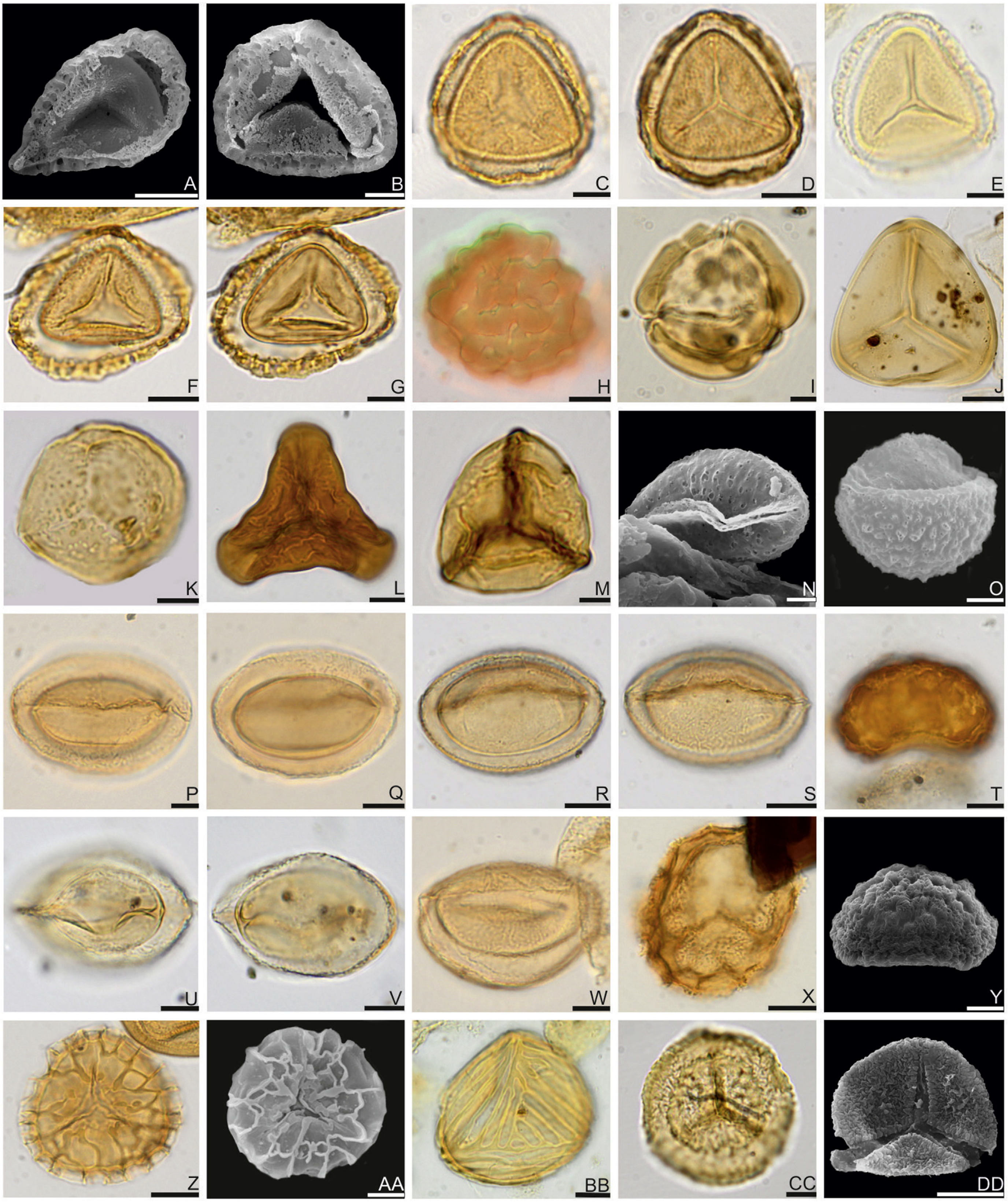

Fig. 6. A–G. *Densoisporites patagonicus* sp. nov. BA Pal; A. BA Pal 6218, SEM; B. BA Pal 6218, SEM; C–D. 6218-10-1:Z34/0; E. 6225-10-2:J20/0; F–G. 6224-25-1:V28/0; H. *Ischyosporites pachydictyus* BA Pal 6220-25-2:C30/1; I. *Leptolepidites crassibalteus* BA Pal 6220-10-1:P28/3; J. *Matonisporites* sp. BA Pal 6220-25-1:U49/2; K. *Nevessisporites simiscalaris* BA Pal 6223-25-1:E45/0; L. *Obtusisporis concavus* BA Pal 6224-10-2:T36/1; M. *Obtusisporis convexus* BA Pal 6224-10-1:N40/2; N–S, U–W. *Peromonolites globosum* sp. nov.; N. BA Pal 6218, SEM; O. BA Pal 6218, SEM; P–Q. BA Pal 6223-25-1:P35/0; R–S. 6223-25-1:J36/3; U–V. BA Pal 6223-25-1:F35/1; W. BA Pal 6223-25-1:Y45/0; T, Y. *Polypodiidites* sp. cf. *P. horridus*; T. BA Pal 6224-10-3:E38/2; Y. BA Pal 6218, SEM; X. *Retitriletes* sp. cf. *R. nodosus* BA Pal 6223-25-2:U49/2; Z, AA. *Retitriletes douglasii*; Z. BA Pal 6224-25-2:M53/2; AA. SEM; BB. *Cicatricosisporites hughesii* BA Pal 6227-25-1:G60/1; CC–DD. *Staplinisporites mathurii*; CC. BA Pal 6224-25-1:O49/0; DD. BA Pal 6223, SEM. Scale bar: 10 μm.

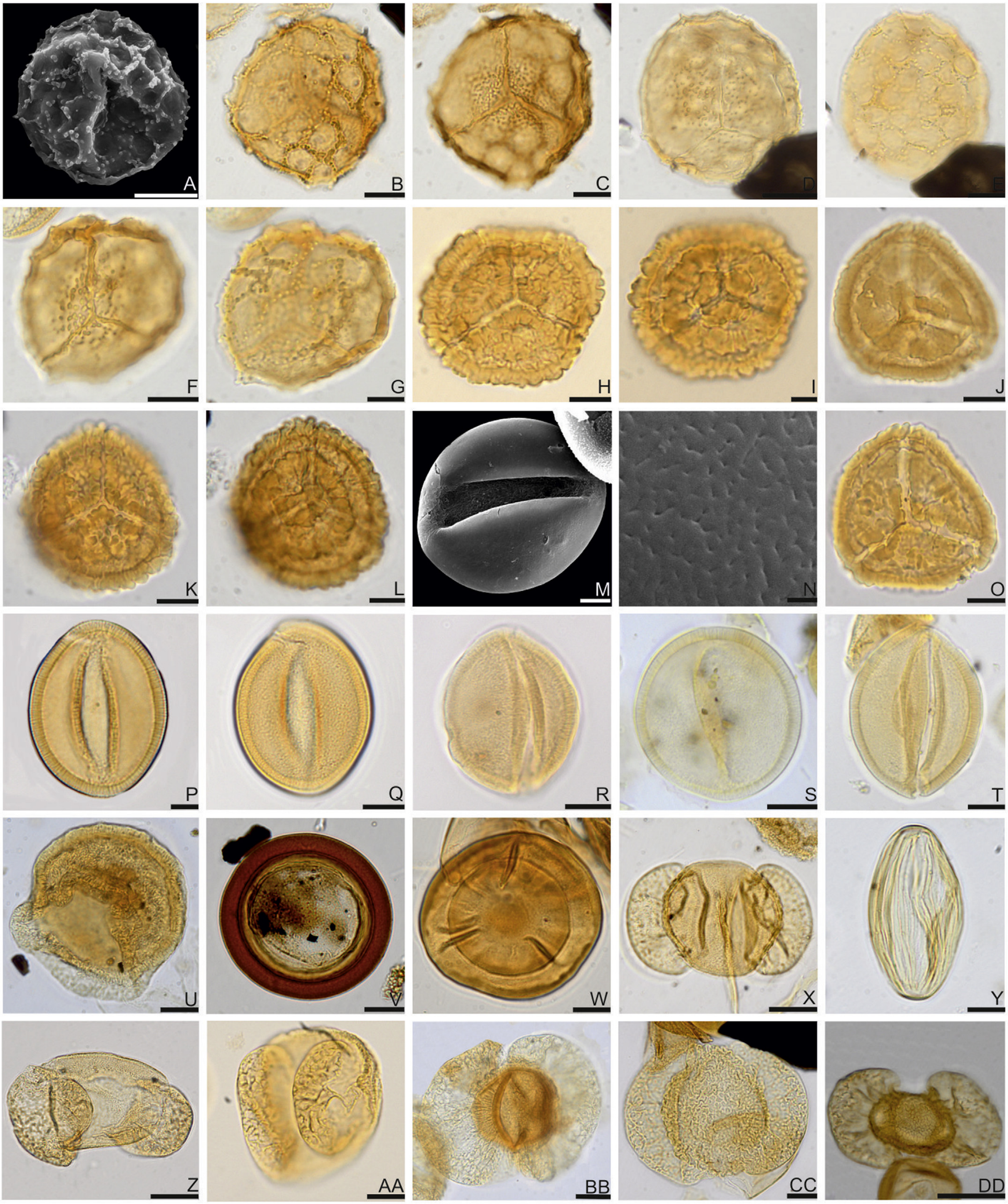

Fig. 7. A–G.*Retitriletes ornatus* sp. nov.; A. BA Pal 6223, SEM; B–C. BA Pal 6223-25-1:W26/2; D–E. BA Pal 6223-25-1:X36/2; F–G. BA Pal 6223-25-1:Q31/0; H–L, O. *Taurocusporites inaequalis* sp. nov.; H–I. BA Pal 6225-10-1:U36/1; K–L. BA Pal 6225-25-2:R43/2; J, O. BA Pal 6225-25-3:Q53/4; M–N, P–T., *Cycadopites grossus* sp. nov.; M. BA Pal 6218, SEM; N. Detail of exine sculpture, BA Pal 6218, SEM; P–Q. BA Pal 6224-10-2: R35/3, holotype; R. BA Pal 6218-1: X45/1; S. BA Pal 6218-10-1: M56/0; T. BA Pal 6218-10-1: X56/1; U. *Dacrydiumites praecupressinoides* BA Pal 6220-25-1:Z30/0; V. *Cyclusphaera patagonica* BA Pal 6224-25-2:Y44/2; W. *Cyclusphaera radiata* BA Pal 6224-10-1:F45/4; X. *Gamerroites* sp. cf. *G. psilasaccus* BA Pal 6223-25-1:Z29/0; Y. *Singhia multicostata* BA Pal 6223-10-2:L43/0; Z. *Podocarpidites herbstii* BA Pal 6218-25-1:Z44/0; AA. *Podocarpidites microreticuloidatus* BA Pal 6224-25-1:J35/1; BB. *Podocarpidites radiatus* BA Pal 6218-25-1:T56/4; CC. *Podocarpidites verrucosus* BA Pal 6224-25-2:S25/3; DD. *Podocarpidites granulatus* BA Pal 6224-25-1:T36/0. Scale bar: 10 μm.

ridge over the position of the laesurae, up to 4 μm high (Fig. 6N–P, S).
Dimensions. Overall equatorial diameter: 30(33)39 μm, body diameter: 23(26)29 μm (51 specimens).
Comparison. Peromonolites allenensis Brenner 1963 resembles *Peromonolites globosum* sp. nov. by having elliptical amb with acute ends, in addition to being also both perinate and cavate. However, the main difference is the presence of highly wrinkled perispore in the new taxon. *Palaeoisoetes* Nichols 2002 differs by having loosely attached perispore in the equatorial region.
Affinity. The genus *Peromonolites* has affinities with the Filicales (Brenner, 1963).

Genus *Retitriletes* Pierce, 1961
Type species. *Retitriletes globosus* Pierce, 1961.

Retitriletes ornatus sp. nov.
Fig. 7A–G

Holotype. BA Pal 6223-25-1:W26/2, Fig. 7B–C.
Derivation of name. Derives from the latin word *ōrnātus* (ornamented), in reference to the presence of ornamentation over muri.
Type locality. Anfiteatro de Ticó locality, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Proximal face ornamented by low verrucae densely distributed at the center of each contact area. Spherical distal surface ornamented by narrow muri, forming subpolygonal lumina, with laevigate inner surface and crests ornamented with grana and spines.
Description. Spore trilete, amb circular to subcircular. Laesura straight, extending almost to the equatorial margin, accompanied by lips, up to 1.7 μm high. Proximal face flat, ornamented by low verrucae, subcircular to elongated, densely distributed at the center of each contact area (0.5–1.5 μm width and 0.4–0.8 μm high). Spherical distal surface ornamented by narrow muri 2.4(2.7)3 μm high, forming subpolygonal lumina 5(7)10 μm in diameter. Crests distinctively ornamented with grana (0.7–0.9 μm in basal width and high) and spine (0.5–0.9 μm in basal width, 1–1.7 μm high), and laevigate lumina floors. Exine 0.5–1 μm thick.
Dimensions. Overall equatorial diameter: 35(42.8)50 μm (28 specimens).
Comparison. Retitriletes nodosus (Dettmann) Srivastava 1975 differs from the new taxon in having coarsely granulate exine all over the surface, shorter laesura and membranous muri. *Retitriletes baqueroense* Archangelsky and Villar de Seoane 1998 has irregularly developed lumina with laevigate muri.
Affinity. The genus *Retitriletes* has affinities with the Lycopodiales (Sajjadi and Playford, 2002).

Genus *Taurocusporites* Stover emend. Playford and Dettmann, 1965
Type species. *Taurocusporites segmentatus* Stover, 1962.

Taurocusporites inaequalis sp. nov.
Fig. 7H–L, O

Holotype. BA Pal 6225-10-1:U36/1, Fig. 7H–I.
Derivation of name. Derives from the latin word *inaequalis* (irregular), in reference to the irregular shape of verrucae.
Type locality. Anfiteatro de Ticó, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Laesura accompanied by a segmented margo formed by elongated verrucae with the major axis perpendicular to the trilete rays. Proximal face ornamented with densely distributed low, irregular to subpolygonal shaped verrucae. Distal face ornamented by two concentric irregular thickenings. Cingulum margin strongly crenated.
Description. Spore radial, trilete, amb circular to subcircular. Laesura straight, extending to the equatorial margin, accompanied by a segmented margo formed by elongated verrucae with varying degrees of fusion. Its major axis is perpendicular to the trilete rays. Proximal face ornamented with low, irregular to subpolygonal shaped verrucae densely distributed, 0.3–2 μm in basal width, 0.2(0.4)1.3 μm apart. Distal face ornamented by two concentric irregular thickening (21(22)28 μm) (Fig. 7I–J, L), formed by verrucae of varying size and fusion degree. In some specimens these two thickening are completely fused, forming a single core subcircular thickening (Fig. 7J). Sculptural elements form a cingulum about 2(3.1)3.9 μm thick, strongly crenated margin.
Dimensions. Equatorial diameter: 25(32.5)38 μm (48 specimens).
Comparison. Taurocusporites Stover emend. Playford and Dettmann 1965 accommodates trilete, cingulate spores with a ring-like subequatorial ridge on the distal face concentrically surrounding a distal polar thickening. *Polycingulatisporites* Simoncsics and Kedves 1961 is also cingulate and characterized by having two concentric irregular thickenings, but differs in having a laevigate proximal face. *Taurocusporites segmentatus* Stover 1962 shows some resemblance to *Taurocusporites inaequalis* sp. nov., but differs in having larger equatorial diameter, proximal face sculptured by irregular-shaped verrucae, which frequently are reduced in the equatorial area, and a less ornamented and segmented cingulum.
Affinity. The genus *Taurocusporites* has affinities with the Bryophyta *sensu lato* (e.g. Del Fueyo et al., 2007; Puebla et al., 2012).

Genus *Cyclusphaera* Elsik, 1966
Type species. *Cyclusphaera euribei* Elsik, 1966.

Affinity. The genus *Cyclusphaera* has affinities with the Araucariaceae. Pollen of *Cyclusphaera psilata* Volkheimer and Sepúlveda 1976 was found inside microsporangia of the Araucarian cone *Alkastrobus peltatus* (Del Fueyo and Archangelsky, 2005).

Cyclusphaera punnulosa sp. nov.
Fig. 8H–N, P–T, Fig. 9A–C

2008 *Cyclusphaera* sp. A in Medina et al., p. 280, pl. 5, fig. J,
2009 *Cyclusphaera* sp. cf. *C.? radiata* Archangelsky et al., in Archangelsky A. and Llorens, p. 227, pl. 1, fig. 10,
2012 *Cyclusphaera* sp. in Perez Loinaze et al., p. 168, pl. 4, fig. G
Holotype. BA Pal 6223-25-1:W55/3, Fig. 8P–S.
Derivation of name. Derives from the latin word *punnulis* (skirt), in reference to the aspect similar to a skirt due to the detachment of the exine layers.
Type locality. Anfiteatro de Ticó, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Pollen grain biaperturate, with the exine thickened at the equator, and thinner in both polar areas. Nexine attached to the sexine in one side, with an operculate-like structure in the other side. Both faces have rounded thickening in their central areas.
Description. Pollen grain biaperturated, amb subcircular to oval. Exine of variable thickness, thicker at equatorial belt and thinner in polar area, with two opposite apertures, one hilate, and the other one with a like operculum structure. Equatorial thickening 2.9(4.2) 4.7 μm thick. Exine sculptured with densely distributed tiny granules, frequently larger in the polar area. Nexine attached to sexine only in one side. In one of the apertural zones the hilum is sometimes visible as a tear in the exine. In the other side, having a circular, operculum-like, structure (33–42 μm in diameter). In some specimens it is possible to observe an evident slit along the border of the operculum-like structure (Fig. 8H–I, L), while in other grains this structure is entirely detached. Thus, some of these operculum-

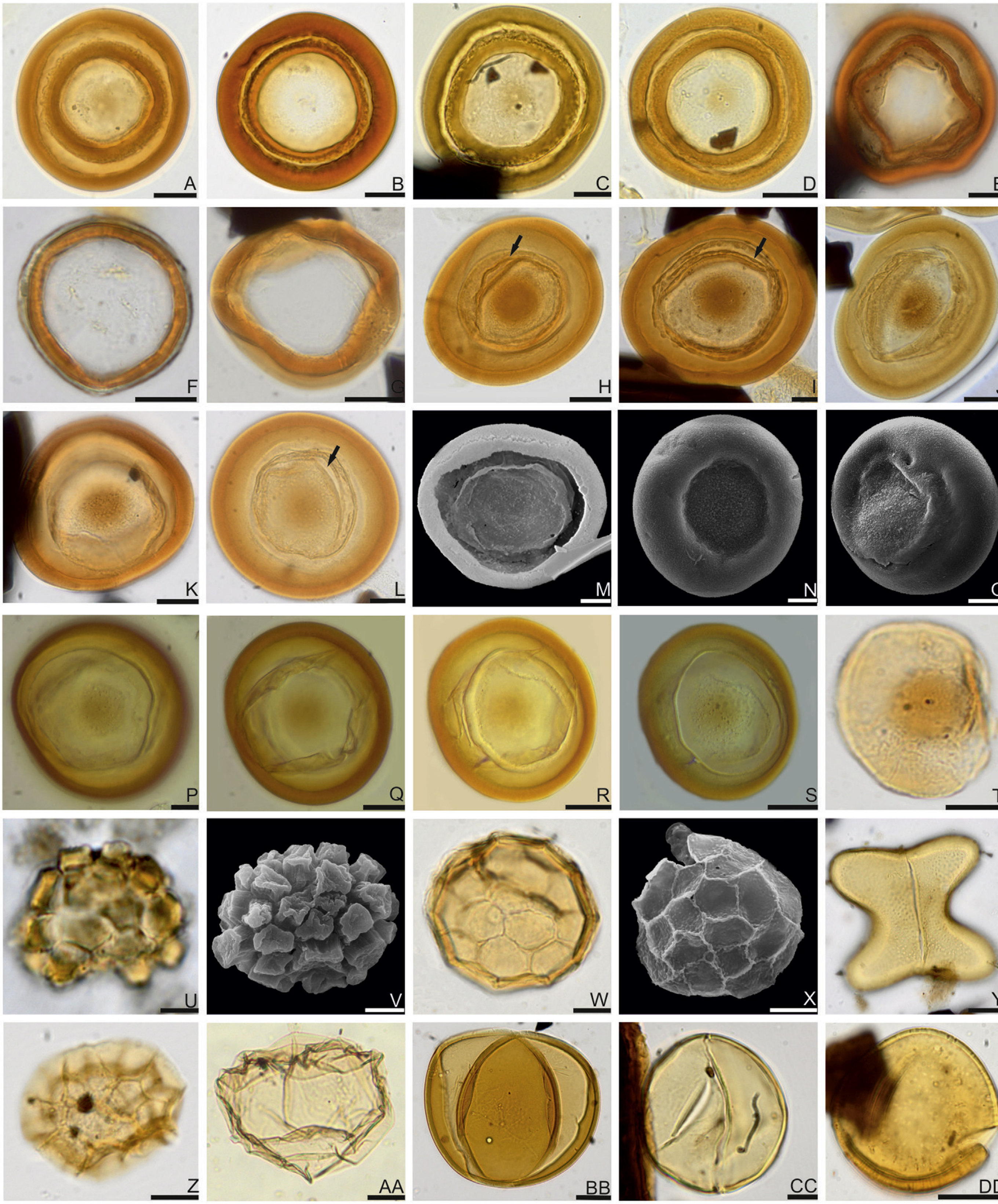

Fig. 8. A–G, O. *Cyclusphaera annulata* sp. nov. A. BA Pal 6231-25-1:Y33/0; B. BA Pal 6223-25-1:B20/0; C. BA Pal 6220-25-3:B37/4; D. BA Pal 6224-25-3:S28/3; E. BA Pal 6225-25-7:J34/2; F. BA Pal 6223-25-2:J41/1; G. BA Pal 6223-25-4:W57/1; O. BA Pal 6223, SEM; H–M, P–T. *Cyclusphaera punnulosa* sp. nov.; H. BA Pal 6224-25-2:U27/3; I. BA Pal 6223-25-2:J59/0; J. BA Pal 6224-25-3:U18/0; K. BA Pal 6225-25-6:Y20/2; L. BA Pal 6223-25-2:Z52/4; M. BA Pal 62XX, SEM; N. BA Pal 6218, SEM; P–S. BA Pal 6223-25-1:W55/3; T. BA Pal 6218-3:Q21/4; U–V. *Retirotundia pseudoreticulata*; U. BA Pal 6216-10-1S39/4; V. BA Pal 6218, SEM; W–X. *Cymatiosphaera* sp. 1; W. BA Pal 6223-10-2: X51/4; X. BA Pal 6220, SEM;Y. *Schizocystia rugosa* BA Pal 6214-10-4:M53/4; Z. *Cymatiosphaera* sp. 2 BA Pal 6223-10-2:Y52/4; AA. *Leiosphaeridia* sp. BA Pal 6223-80-1:S31/0; BB. C. *Ovoidites grandis* BA Pal 6223-80-1:T53/2; CC. *Ovoidites spriggii* BA Pal 6220-25-3:T28/0; DD. *Tasmanites* sp. BA Pal 6220-25-2:Y48/0. Scale bar: 10 μm.

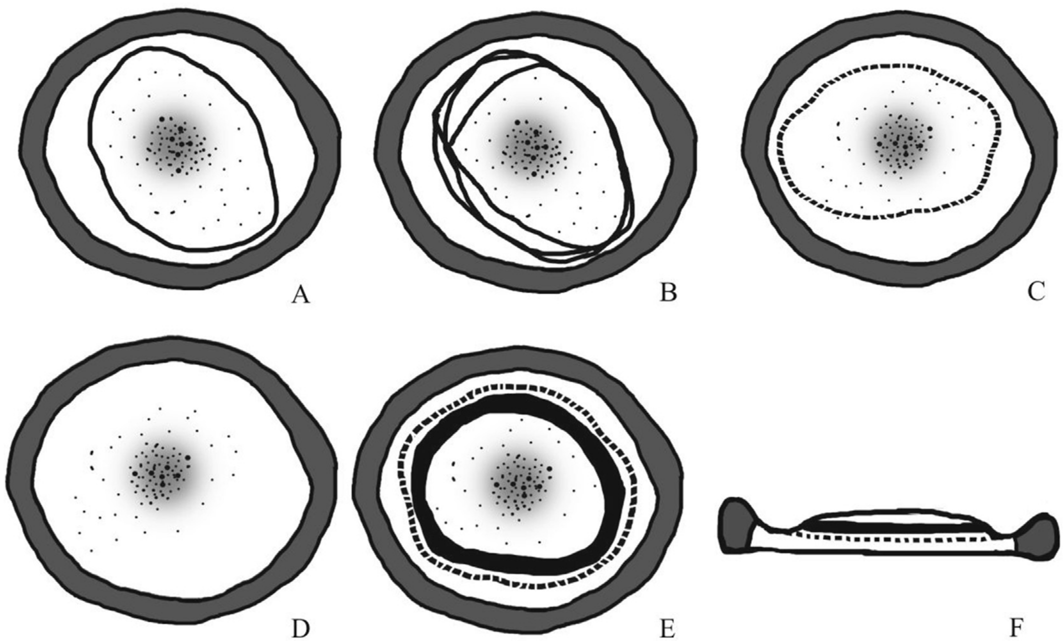

Fig. 9. A–C. Schematic drawings from photographs of *Cyclusphaera punnulosa* sp. nov. in polar view; A. Apertural zone of the hilum in one side (high focus), and nexine attached to sexine at this side (middle focus, B); C. Opposite apertural area showing an operculum-like structure, marked by a dotted line (low focus); D–F. Schematic drawings from photographs of *Cyclusphaera annulata* sp. nov.; D. Apertural zone of the hilum in one side (high focus, polar view); E. Opposite apertural area showing an operculum-like structure marked by a dotted line, with an annular internal thickening (low focus, polar view); F. Equatorial view, showing the operculum-like structure (marked by a dotted line) and the annular internal thickening.

like structures are found isolated in the palynological slide (Fig. 8T). In the central area of the both polar sides there is a radial thickening (11.5–17 μm in diameter).
Dimensions. Equatorial diameter: 49(56)65 μm (35 specimens).
Comparison. This species is assigned to the genus *Cyclusphaera* because it has two apertures. *Cyclusphaera radiata* Archangelsky emend. Del Fueyo et al., 2012 also has an operculum-like structure, but it in this structure is only a central circular thickening from where radial thickenings extend towards the equator (Del Fueyo et al., 2012, fig. 2.4). No other species included in this genus has a central operculum-like structure as *C. radiata. Cyclusphaera psilata* Volkheimer and Sepúlveda 1976 present a finely spinulate exine. *Cyclusphaera euribei* Elsik 1966 and *C. intacta* Venkatachala and Sharma 1974 differs by its greater diameter and psilate exine. *Cyclusphaera crassa* Archangelsky et al., 1983 and *C. patagonica* Archangelsky et al., 1983 are characterized by having a thicker equatorial thickening. *Cyclusphaera doubingeri* Salard-Cheboldaeff 1978 differs by its reticulate-perforate exine, and *C. scabrata* Jaramillo and Dilcher 2001 by its scabrate-verrucate exine.

Cyclusphaera annularis sp. nov.
Fig. 8A–G, O, D–F

Derivation of name. Derives from the Latin word *annularis* (ring shaped). In reference to the annular thickening at the polar zone.
Holotype. BA Pal 6223-25-1:B20/0, Fig. 8B
Type locality. Anfiteatro de Ticó, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Pollen grain biaperturate, with the exine thickened at the equator, and thinner in both polar areas. In one side there is an operculum-like structure with an internal annular thickening. Both faces have rounded thickening in their central areas.
Description. Pollen grain biaperturate, amb subcircular to oval. Exine with variable thickness, thicker at the equator, with two opposite hilate apertures. Equatorial thickening 2.8 (4.3) 6.2 μm thick. Exine sculptured with tiny granules, larger near the poles, narrowly distributed. In one of the apertural zones, the hilum is sometimes visible as a tear in the exine. In the other apertural zone, it has a circular operculum-like structure 28(33)42 μm in diameter, with an internal annular thickening of 2(3.2)5 μm thick. Some of these operculum-like structures are found isolated in the palynological slide (Fig. 8F, G).
Dimensions. Equatorial diameter: 41(49)58 μm (41 specimens).
Comparison. This species is assigned to the genus *Cyclusphaera* because it presents two apertures. *Cyclusphaera radiata* Archangelsky emend. Del Fueyo et al., 2012 and *Cyclusphaera punnulosa* sp. nov. are the only species that present an operculum-like structure. However, *Cyclusphaera radiata* shows some resemblance to *C. annularis* sp. nov. by having in one side an apertural membrane with an equatorial thickening, but differs in having three radial thickening in this apertural membrane, also being the operculum-like structure only a radial thickening (Del Fueyo et al., 2012, fig. 2.4). No other species of this genus has a central operculum-like structure, as is typical of this species. *Cyclusphaera punnulosa* sp. nov. presents an operculum-like structure, but lacks of the internal thickenings characteristic of *Cyclusphaera annularis* sp. nov.

Genus *Cycadopites* Wodehouse, 1933 ex Wilson and Webster, 1946
Type species. Cycadopites folliculus Wilson and Webster, 1946

Cycadopites grossus sp. nov.
Fig. 7.M–N, P–T

Holotype. BA Pal 6224-10-2: R35/3, Fig. 7P–Q.
Derivation of name. Derives from the Latin word *grossus* (thick). In reference to the thickness of the exine.
Type locality. Anfiteatro de Ticó, Santa Cruz Province, Argentina.
Stratigraphic horizon. Anfiteatro de Ticó Formation, Baqueró Group, upper Aptian.
Diagnosis. Monocolpate pollen grains. Exine microfoveolate, alveolar sexine, markedly thicker than nexine.

Description. Monocolpate pollen grains, elliptical to subspherical. Colpus extending along all (or almost all) the whole length of the grain. Regular, well defined margins, frequently folded. Exine microfoveolate of 1.8(2)2.6 μm thick, distinctly stratified, sexine alveolate (1–1.8 μm thick) bearing linear alveoli, markedly thicker than nexine (0.35–0.4 μm thick).
Dimensions. Longer equatorial axis: 27(30)34 μm, shorter equatorial axis: 19(22.6)26.5 μm (64 specimens).
Comparison. This new taxon differs from the many species assigned to this genus by the thickness of its exine. The alveolar features of the exine of *Cycadopites grossus*, typical of Cycadales (Audran and Masure, 1977a,b; Dehgan and Dehgan, 1988), can be observed under light microscopy and SEM. The linear alveoli in *Dioon* and other Zamioideae appear under light microscopy as fine, closely spaced radial lines in optical section, similar to what is observed in *Cycadopites grossus.* The thickness of the nexine and sexine, and its pitted surface (as observed at SEM), are typical of cycads.
Affinity. Many of the modern cycad pollen types are very similar in morphology, e.g., *Cycas*, *Zamia* and *Encephalartos* (e.g. Audran and Masure, 1977a,b).

4.2. Composition of palynomorph assemblages

The new palynological records here presented are analyzed in an integrated study, incorporating previously published data from the Punta del Barco Formation (Llorens, 2003, 2008a, 2012; Limarino et al., 2012; Llorens and Perez Loinaze, 2016), resulting in a more complete picture of the paleontological record across the unit. The variation observed in the distribution of the different palynomorph taxa here identified is in part a reflection of changes in the plant community that inhabited the region. However, other parameters, such as sea level, sedimentary environment, and climate changes also can influence changes in the vegetation (Abbink et al., 2004).

Samples BA Pal 6214 to 6216 (Figs. 2, 3) were obtained from the basal levels of the Anfiteatro de Ticó Formation at Estancia El Verano, from tabular levels with abundant shales with delicate lamination and carbonaceous mudstones, and wave-cross-laminated fine-grained sandstones. Limarino et al. (2012) interpreted these levels as deposited in a relatively deep part of the lake, that was deep enough to maintain non-oxidizing conditions. These samples have a moderate specific richness, represented by a total of 36 species, mainly consisting of trilete spores (Appendix B). These levels are dominated by *Gleicheniidites*, mostly represented by *G. senonicus* and *G.* sp. 3 in Llorens (2008a,b). Lycopodiaceae spores are also abundant, such as *Densoisporites velatus*, *D. corrugatus* and *Retitriletes douglasii*, together with bryophyta represented by *Taurocusporites inaequalis* sp. nov., Monilophyta *incertae sedis* as *Biretisporites* sp. cf. *B. potoniei* in Llorens 2008, and species of uncertain affinity, such as *Capsispora vulcanica* (Appendix B). Gymnosperm pollen grains are poorly represented, with only seven recorded species, being *Microcachrydites antarcticus* the only abundant species, the remaining being scarcely represented. Angiosperm pollen grains are rarely identified in this sample, and represented by *Clavatipollenites* sp. 2 in Archangelsky and Archangelsky (2013) and *Retimonocolpites* sp. A in Llorens (2003) (Appendix B). The algae are rare to common depending on the sample, and represented by *Botryococcus* sp., *Lecaniella foveata, Ovoidites parvus* and *Schizocystia rugosa* (Appendix B).

The middle part of Anfiteatro de Ticó Formation was deposited in lacustrine and deltaic environments, as interpreted by Limarino et al. (2012), showing a progressive shallowing of the lake system. Eleven palynological samples recovered (BA Pal 6217 to 6227, Figs. 2, 3) from the shallow lacustrine deposits have been obtained from the Anfiteatro de Ticó and Cerro Testigo localities. These palynofloras present a markedly greater specific richness in comparison with the lower levels of this unit, with 111 recognized spores, 33 gymnosperm pollen grains, 10 angiosperm pollen grains and 10 algae taxa (Appendix B). Among spores, abundance is high for non-vascular plants as *Coptospora santacrucensis* sp. nov., *Taurocusporites segmentatus* and *T. inaequalis* sp. nov. Among vascular plants, Selaginellaceae (such as *Ceratosporites equalis*), and Lycopodiaceae, represented by different species of *Densoisporites*, including *D. patagonicus* sp. nov., and by *Retitriletes douglasii.* Monilophyta are also very abundant, mostly represented by leptosporangiate ferns of the Schizaeaceae (*Ruffordiaspora* spp.*, Cicatricosisporites* spp.*, Trilobosporites* spp.), Gleicheniaceae (*Gleicheniidites senonicus,* among others), Marsileaceae (*Crybelosporites corrugatus* sp. nov.) and Dicksoniaceae (*Cibotiidites auriculatus*), are also very abundant.

Among gymnosperms, Araucariaceae pollen grains (*Cyclusphaera* spp.) are very abundant, along with Cheirolepidiaceae (*Classopollis* spp.), while Podocarpaceae are frequent or common, with the exception of *Podocarpidites marwickii* which is exceptionally abundant in sample BA Pal 6232 (Appendix B). A total of 10 species of angiosperm pollen grains are recognized in these levels, with a specific richness of up to six different taxa in a single sample (Appendix B). Relative abundance varies from rare to frequent, with the exception of *Jusinghipollis ticoensis*, abundant in the sample BA Pal 6227. Finally, algae are rare to frequent in this part of the unit (Appendix B).

Upper levels of the Anfiteatro de Ticó Formation consist of tabular beds of fining-upward cyclothems, deposited in high sinuosity fluvial systems under the active migration of channels (Limarino et al., 2012). The presence of fine-grained levels at the top of the cyclothems have been interpreted as flood-basin deposits (Limarino et al., 2012), and from these sediments five samples were recovered (BA Pal 6228 to 6232, Figs. 2, 3), obtained at Anfiteatro de Ticó and Ea. Bajo Tigre localities. Fourteen types of trilete spores were recognized, with the frequent presence of Schizaeaceae (*Plicatella baqueroensis*), and Gleicheniaceae (*Gleicheniidites senonicus*) (Appendix B). As in the underlying middle levels of the unit, conifers are abundant, represented by different species of *Cyclusphaera* and *Classopollis*. Angiosperm pollen grains range from abundant to frequent. Noteworthy, specific richness is lower than in the middle levels (Appendix B). Algae are scarce, and only represented by *Botryococcus* sp. and *Ovoidites parvus* (Appendix B).

As previously stated, the Bajo Tigre Formation overlies the Anfiteatro de Ticó Formation. Rock samples processed from the Bajo Tigre Formation resulted devoid of palynomorphs, and thus the next data in this “floristic sequence” comes from the lower levels of the Punta del Barco Formation. This unit was deposited in a fluvial environment, during syneruptive or brief inter-eruptive periods. Four palynological samples were obtained from these levels, cropping out at the southern flank of the Meseta Baqueró, and at Punta del Barco localities (BA Pal 6233 to 6236, Figs. 2, 3). Two samples originally studied by Llorens (2003, 2008a,b, 2012) were also reexamined (marked as ˆ in Fig. 3) and incorporated in the analysis. Taxa with higher abundance are the Selaginellaceae, represented by *Densoisporites corrugatus* and *D. velatus*, and the fern family Gleicheniaceae represented by different species, such as *Gleicheniidites senonicus*, *G.* sp. 2 in Llorens (2008) and *G.* sp. 3 in Llorens (2008) (Appendix B). Other spores of uncertain affinity, as *Capsispora vulcanica*, are also very abundant. *Foraminisporis dailyi*, related with hornworts, and *Taurocusporites inaequalis* sp. nov., related with Bryophyta, are common or abundant (Appendix B). Within gymnosperm pollen grains, the most abundant species are *Balmeiopsis limbatus* and *Cyclusphaera psilata* (both related to Araucariaceae), and different species of trisaccate pollen grains related to Podocarpaceae. Six angiosperm species are recognized in these levels, some of them very abundant, such as *Clavatipollenites* sp. 1 in Archangelsky and Archangelsky (2013) and *Clavatipollenites* sp. in Llorens and Perez Loinaze (2016) (Appendix B). Algae are abundant but moderately diverse, and represented by *Botryococcus* sp., *Ovoidites parvus, Retirotundia pseudoreticulata* and *Lecaniella foveata* (Appendix B).

Finally, the upper levels of the Punta del Barco Formation are composed of channel complexes laterally passing into tabular beds of mudstones and tuffaceous fine-grained sandstones, frequently bearing plant remains and roots. These deposits were interpreted as paleosoils developed in an inter-eruptive fluvial sedimentation (Limarino et al., 2012). From these levels, only one samples were recovered, from outcrops at Estancia Bajo Tigre (BA Pal 6238, Figs. 2, 3). The palynological content of these samples is notable by the low number of species identified, consisting only of *Gleicheniidites* spp., *Classopollis* sp. and *Botryococcus* sp. (Appendix B).

5. Discussion

5.1. Changes in the composition of palynomorph assemblages: phytogeographical and paleoenvironmental implications

Herngreen et al. (1996) recognizes a southern Gondwana palynological Province, namely Trisaccates for the Early Cretaceous, characterized by abundant bisaccate and trisaccate pollen grains, together with *Araucariacites, Callialasporites, Cycadopites*, and *Classopollis*. This province is also characterized by a high diversity of spores, such as *Cicatricosisporites*, *Gleicheniidites*, *Lycopodiumsporites* (*Retitriletes*), *Osmundacidites* and *Foraminisporis*. Volkheimer (1980) analyzed this Gondwanan assemblage, and concluded that a particular assemblage of the Trisaccates province was present in South America and Africa. As a result, he defined the *Cyclusphaera psilata-Classopollis* Subprovince, with a high abundance of *Cyclusphaera, Classopollis* and *Balmeiopsis*.

Llorens (2012) noted that the palynological assemblages of Punta del Barco Formation have poor representation of some taxa that characterize the Trisaccates province, such as *Classopollis, Callialasporites* and *Podocarpidites*. Noteworthy, the only abundant pollen grains related with Podocarpaceae are trisaccate. In the same way, some spores typical of this phytogeographic region are absent or are a minor component in the palynofloras of Punta del Barco Formation. The palynological samples from this unit are characterized also by the abundance of *Gleicheniidites* and perisporate spores, and the total absence of *Cyatheacidites tectifera* and spores related to Schizaeaceae. When the stratigraphic distribution of the recognized species is observed (Appendix B), the basal levels of the Anfiteatro de Ticó Formation reveal the same pattern, not only because of the absence of characteristic taxa, but also by the abundance of trisaccate pollen grains and perisporate spores. However, towards the middle to upper levels of the Anfiteatro de Ticó Formation, the vegetation changes, incorporating elements of a typical palynoflora of the *Cyclusphaera psilata-Classopollis* Subprovince (Appendix B). As previously noted, the lower levels of the Punta del Barco Formation show an increase in the volcanic activity, which is reflected in an impoverishment of the flora. In the middle levels of this unit, an inter-eruptive period is recorded. However, the vegetal community apparently wasn't able to recover, still showing a low number of taxa. Towards the top of the sequence a new pulse of volcanic activity is evidenced (Limarino et al., 2012), coincident with a decrease in the diversity in the only palynological sample recovered, composed exclusively by *Gleicheniidites* and colony-forming green algae (*Botryococcus* sp.). Gleicheniaceous ferns are opportunists which colonize open and disturbed grounds (Collinson, 1996, 2002; Van Konijnenberg-van Cittert, 2002). On the same way, several authors, such as Crabtree (1988), noted that gleicheniaceous ferns appear to be characteristic of ash deposits, indicating that they were important components of early successional (pioneer) vegetation. Similarly, Foster and Aforin (2005), when studying changes in carbon isotopic composition $\delta^{13}C_{org}$, noted that deposits with evidence of high volcanic activity also contain abundant algal remains (e.g. *Botryococcus*). This increase in the productivity was probably the result of the ash falls in the water bodies.

The different changes observed across the Anfiteatro de Ticó and Punta del Barco Formations can be explained, at least in part, by the effect of the environmental changes in the deposition area. The Baqueró flora developed under increasing volcanic activity, which produced recurrent and thick ash-fall deposits (Lesta and Ferello, 1972; Hechem and Homovc, 1987; De Barrio et al., 1999). The composition of the studied samples and its change across the Baqueró Group certainly reflect the ecological impact of this volcanism on the plant communities.

5.2. Palynostratigraphy

The Baqueró Group is a critical unit to reconstruct the Early Cretaceous vegetation from Patagonia, preserving abundant and diverse megafloristic and palynologic remains that record some of the oldest angiosperms of the region, along with other floristic elements that were part of these ancient ecosystems developed before flowering plants became a dominant group. Furthermore, this unit is relevant for correlating with other Cretaceous palynozones from Argentina and the rest of the world, because its age is precisely dated. Césari et al. (2011) and Perez Loinaze et al. (2013) presented radiometric ages of 114.67 ± 0.18 Ma for the Punta del Barco Formation, and 118.23 ± 0.09 Ma for the Anfiteatro de Ticó Formation respectively, allowing the referral of the whole Baqueró Group to the upper Aptian. Recently, Passalia et al. (2016) made a revision of the stratigraphy of the Cerro Bayo in the Bajo Grande area, and obtained a $^{206}Pb/^{238}U$ age of 116.85 ± 0.26 Ma for the Bajo Tigre Formation.

Based on palynological assemblages from the Austral Basin (Argentina), Archangelsky et al. (1984) proposed the *Antulsporites-Clavatipollenites* Zone for the Aptian (Fig. 10). Herein studied palynofloras also match with this palynozone by the presence of *Antulsporites baculatus* and *Clavatipollenites* spp. Other shared species are long ranging taxa, also present in the older *tectifera-corrugatus* interval Zone (Barremian) (Archangelsky et al., 1984). This zone is easily distinguishable from the Baqueró Group palynofloras by the absence of angiosperm pollen grains.

Palynological assemblages of the Aptian Río Mayer Formation (Austral Basin, Argentina) have been studied by Pöthe de Baldis and Ramos (1980, 1983, 1988), Medina et al. (2008) and Perez Loinaze et al. (2012). These palynofloras share many species with the Baqueró Group assemblages, such as *Ceratosporites equalis, Cyatheacidites tectifera, Densosisporites velatus, D. corrugatus, Cyclusphaera psilata, C. radiata, Foraminisporis asymmetricus, Staplinisporites caminus,* as well as the presence of angiosperm pollen referable to *Clavatipollenites*.

La Cantera Formation (San Luis Basin, Argentina), dated as late Aptian (Prámparo, 1990, 1994), present many species in common with the palynofloras here studied. Noteworthy, this unit yielded several angiosperm pollen taxa that are absent from the assemblages reported here, such as *Stellatopollis*, *Afropollis, Pennipollis peroreticulatus* and *Schrankipollis*. In the same way, Vallati (1995) recovered a rich palynoflora from the Aptian Ranquiles Formation (Neuquén Basin, Argentina), which shares many taxa with the palynological assemblages from the Baqueró Group, including *Clavatipollenites* spp. and *Retimonocolpites* spp. However, the palynoflora of the Ranquiles Formation also contains *Afropollis* spp. The

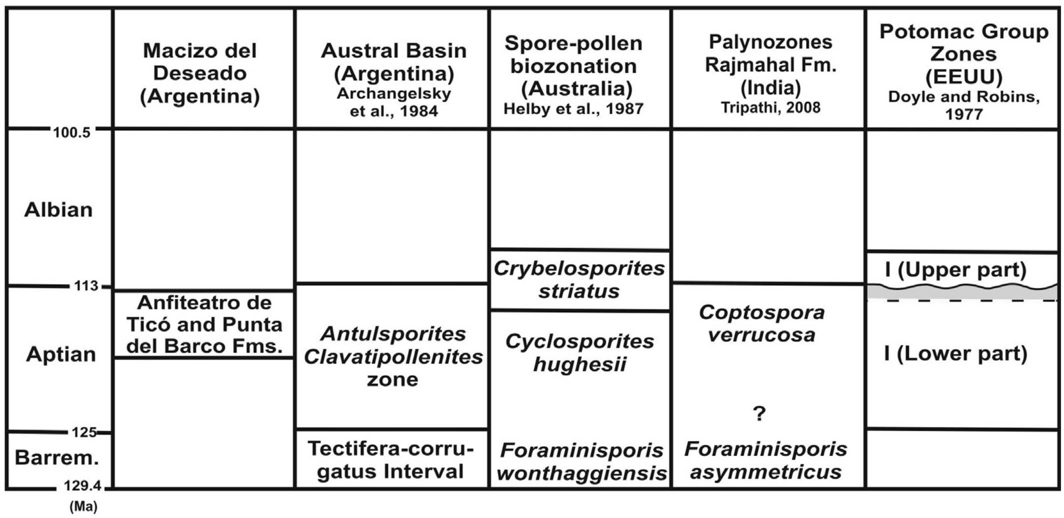

Fig. 10. Suggested correlation of the palynofloras of the Anfiteatro de Ticó and Punta del Barco Formations with different Aptian palynozones.

presence this genus in both units is explained by the location at lower latitudes of the Neuquén Basin, resulting in a mixture of species from Northern and Southern Gondwana palynological provinces (Herngreen et al., 1996).

Three palynological assemblages were recognized by Kotova (1983) from Upper Jurassic–Lower Cretaceous samples from core logs at Islas Malvinas. The Assemblage II, dated as Neocomian–Aptian shares some species with the palynofloras here studied, such as *Balmeiopsis limbatus*, *Cyclusphaera psilata*, and *Contignisporites cooksonii*, but are easily distinguishable by the absence of angiosperm pollen grains in the Assemblage II. The Assemblage III, dated as early Albian, only shares with the Baqueró palynofloras the presence of *Gleicheniidites* spp. and *Clavatipollenites* spp. The latter appearance of angiosperm pollen grains at the Islas Malvinas is probably the result of the location of this region at higher latitudes during the Aptian.

The palynofloras reported here can be compared with other coeval assemblages from Gondwana, and other regions of the word. Helby et al. (1987) provided a biostratigraphic scheme integrating all Mesozoic Australian basins. Recently, these zones were correlated with the Geological Time Scale of Gradstein et al. (2004), and numerical age estimates have been assigned to the zonal boundaries (Partridge, 2006). Aptian biozonation in Australia includes the *Cyclosporites hughesii* Zone and the lower part of *Crybelosporites striatus* Zone (Helby et al., 1987). The base of the *Cyclosporites hughesii* Zone is marked by the oldest occurrence of *Foraminisporis asymmetricus,* and the top by the oldest occurrence of *Crybelosporites striatus* (Helby et al., 1987). Using dinoflagellate cysts, Morgan (1980a,b) dated this zone as early to late Aptian. The younger *Crybelosporites striatus* Zone contains the oldest angiosperm pollen grains in Australia (Burger, 1993), and is dated as latest Aptian to early Albian (Morgan 1980a,b). The base of the *Crybelosporites striatus* Zone is characterized by the oldest occurrence of the homonym species, and its upper limit is defined by the oldest occurrence of *Coptospora paradoxa*, both species not recognized in the studied samples. The Baqueró palynofloras may be correlated with the *Cyclosporites hughesii* Zone, by the presence of *F. asymmetricus* and *Clavatipollenites* spp. (Fig. 10). Noteworthy, many species that have long ranging stratigraphic records in Argentina are more temporally restricted in the Australian assemblages.

The palynological samples here studied have some similarities with the *Foraminisporis asymmetricus* (Barremian to Aptian) and *Coptospora verrucosa* (Aptian) zones, proposed by Tripathi (2008) for the Rajmahal Basin (India). Some key taxa present in these two zones are also recorded in the Baqueró Group, such as *Ruffordiaspora australiensis, Aequitriradites verrucosus*, *Foraminisporis asymmetricus* and *F. wonthaggiensis*. The *Coptospora verrucosa* Zone is characterized by the presence of angiosperm pollen grains. Lower levels of this zone contain low angiosperm generic diversity, being recorded *Clavatipollenites* spp. and *Retimonocolpites* sp. Contrasting, the diversity of this group is increased towards the upper levels, where a more diverse array of angiosperm taxa was identified, including *Liliacidites* sp., *Stephanocolpites* sp., *Asteropollis* sp. and *Tricolpites* sp. (Tripathi, 2008). Comparatively, the assemblages of the Baqueró Group are similar to the ones recorded in the *Coptospora verrucosa* Zone, and more precisely to lower levels of this zone, and easily separable from the upper levels by the absence of some key angiosperm taxa (e.g. *Tricolpites*).

Duane (1996) carried out palynological studies on the marine Chester Cone and President Beaches formations (Byers Group), cropping out at Livingston Island (South Shetland Islands, Antarctica), identifying spores, gymnosperm pollen grains and dinoflagellate cysts, the latter taxa being used to propose a Berriasian age for the President Beaches Formation, and a latest Berriasian to middle Valanginian age for Chester Cone Formation. Angiosperm pollen grains were absent, and almost no differences can be identified among non-marine palynomorphs between both units, being the age differentiation only possible using dinoflagellate cysts Duane (1996). The younger Cerro Negro Formation, also included in the Byers Group, is a non-marine sequence that overlies the Chester Cone Formation, and is well known by its rich flora and diverse flora. Hathway (1997) and Hathway et al. (1999) reported radiometric ages for this unit, which indicate that Cerro Negro Formation was deposited during the early Aptian. The Baqueró palynoflora shares many species with the palynological assemblages reported by Hathway et al. (1999) for this Antarctic unit. However, angiosperm pollen grains, identified all along the Baqueró Group, are absent in the Cerro Negro Formation, probably due to its older age and its location at higher latitudes. The oldest reported angiosperm pollen grains from Antarctica are identified in the lower Albian Kutick Point Formation (Dettmann and Thomson, 1987; Riding and Crame, 2002).

The most widely used spore and pollen biostratigraphic scheme in New Zealand was originally proposed by Raine (1984), and later refined by the same author (Raine, 1990). This biostratigraphic system divides the Cretaceous into three microfloral assemblage zones, which are in turn subdivided into six subzones, resulting in a total of 18 subzones. The younger zone, named *Lycopodiacidites bullenensis*, dated as Berriasian to early Albian, shares a few number of species with the palynofloras here studied. Comparisons are difficult because the oldest records of angiosperms from New Zealand are from the upper Albian of the Clarence Series in the northeast of the South Island (Couper, 1953, 1960).

Within Africa, Early Cretaceous palynofloras from Egypt are undoubtedly among the better and more profusely studied (Schrank, 1983, 1992; Penny, 1986, 1988, 1989, 1991; Schrank and Ibrahim, 1995; Ibrahim and Schrank, 1996; Led and Lashin, 2016, among others). Along with other assemblages from northern Africa (Gübeli et al., 1984; Thusu et al., 1988), they are included in the *Dicheiropollis etruscus/Afropollis* Province (Berriasian-Aptian) of Herngreen et al. (1996). This province is mainly characterized by the presence of taxa as *Afropollis* spp., *Dicheiropollis etruscus* and *Tucanopollis crisolensis*, absent in the Baqueró palynofloras here studied.

Palynological studies from Madagascar are scarce. Chen (1978) studied palynological assemblages (including pollen, spores and dinoflagellates) recovered from the Ankanotra-1 well, northeastern Madagascar, whereas Herngreen et al. (1982) carried out a study on samples Albian to Danian in age recovered from the northwestern region of the island. Both studies reveal that angiosperm pollen grains have their first records in Albian sediments, contrasting with the Patagonian assemblages.

The lower part of Zone I of the classical Potomac Group (USA) is characterized by monocolpate angiosperm pollen grains. Tricolpate grains are also recorded, but its oldest records are found in the upper levels of the zone (Doyle and Robbins, 1977). Hochuli et al. (2006) suggested an Aptian age for the lower part of Zone I, and an early Albian age for the upper part, thus overlapping (at least partially) with the age of the Baqueró Group. Moreover, Ward et al. (1989) described *Lethomasites fossulatus* from the lower levels of the Potomac Group, and specimens closely matching the morphology of this species, only differing in having smaller size, are recognized in the palynological asemblages from the Anfiteatro de Ticó Formation (Llorens and Perez Loinaze, 2016). Similarly, Romero and Archangelsky (1986) noted that the angiosperm leaves of the Anfiteatro de Ticó Formation shared individual characteristics with specimens described for the Potomac Group (Doyle and Hickey, 1976). In agreement with this, great similarities between the Baqueró Group and the lower part of Zone I of the Potomac Group were found by Llorens and Perez Loinaze (2016) using multivariate statistic methods to compare Early Cretaceous angiosperm pollen assemblages.

When the Early Cretaceous palynofloras are compared using multivariate statistic methods (Fig. 4) the greatest similarities between the Punta del Barco and Anfiteatro de Ticó formations are found with the Argentinian Pozo D-129 Formation (upper Barremian–lower Aptian, Vallati, 1996), and the *Antulsporites-Clavatipollenites* Zone from Cuenca Austral, Argentina (Aptian, Archangelsky et al., 1984). Great similarities are also observed with the Ranquiles (Aptian, Vallati, 1995), and La Cantera (upper Aptian, Prámparo, 1990, 1994) formations from Argentina, as well as with the remaining three zones proposed for Cuenca Austral (Argentina) by Archangelsky et al. (1984). The four Zones proposed by Tripathi (2008) for India form a group of strong similarities. In the same way, the Australian zones proposed by Helby et al. (1987) form a group with strong similarities, together with the Cerro Negro Formation (lower Aptian, Hathway et al., 1999), Chester Cone (Berriasian, Duane, 1996) and President Beaches (uppermost Berriasian–lowermost Valanginian, Duane, 1996) formations from Antarctica. Marked similarities between the palynofloras from Australia and Antarctica were previously reported by other authors (Dettmann and Thomson, 1987; Dettmann, 1989, among others). The grouping of Indian and Australian zones show strong similarities between these asemblages, undoubtedly related to the close position of both regions during the Aptian. Another well defined grouping resulting from the analysis includes the different Zones recognized in the Potomac Group (USA). Noteworthy, when a statistical method is carried out including only angiosperm taxa, clear similarities are found between the assemblages of the southern region of South America and the Potomac Group, which is also reflected in the comparatively similar patterns of diversification and evolution of angiosperms that are observed in both region, which were located more or less at a similar distance to the Equators (Perez Loinaze et al., 2015; Llorens and Perez Loinaze, 2016). Nevertheless, when all recognized taxa of each assemblage are included, results are notoriously different. It is important to note that most major groupings coincide with palynozones from a single country, in spite of their different ages. These results are probably related to disparate ages of taxa in different areas, as well as the marked provincialism of some taxa, both issues often observed in non-marine palynomorphs. Furthermore, this could be enhanced by taxonomic and nomenclatural problems on the identification of the recorded taxa (e.g. Dettmann, 1986, 1989; Backhouse, 1988; Askin, 1989; Batten and Koppelhus, 1996; Truswell et al., 1999; Schrank, 2010).

6. Conclusions

The detailed study carried out on twenty four samples obtained from the continental deposits of the Baqueró Group allowed the recognition of 59 taxa not previously reported for the unit, as well as the definition of 9 new species. Samples were obtained from the Anfiteatro de Ticó and Punta del Barco formations, whereas the Bajo Tigre Formation did not provide fossiliferous palynological samples.

The middle to upper levels of the Anfiteatro de Ticó Formation yielded palynofloras that are typical of the *Cyclusphaera psilata-Classopollis* Subprovince of the Trisaccates phytoprovince. The taxonomic content of the Punta del Barco Formation is markedly different from the assemblage previously referred, with a notable poor representation of *Classopollis*, *Callialasporites* and *Podocarpidites*, and *Gleicheniidites* and perisporate spores standing out in abundance. Noteworthy, assemblages from the lower levels of the Anfiteatro de Ticó Formation (i.e., oldest assemblages of the Baqueró Group) also record a scarcely diverse palynoflora, closely comparable with the one recorded in the Punta del Barco Formation. In parallel, sedimentary evidence indicates the existence of volcanic activity across the whole Baqueró Group. It seems probable that plant communities were, at least partially, influenced by these periods of volcanism, with floristic replacements recording the establishment of pioneer vegetation, and posterior more mature assemblages, been again replaced by colonizing groups after a period of volcanic stress. The composition of the studied palynofloras would reflect the ecological impact of the volcanism on the plant communities.

When the palynological assemblages of the Baqueró Group are compared with other contemporary palynofloras, some similarities are found. The Baqueró assemblages can be correlated with the *Antulsporites-Clavatipollenites* Zone of the Austral Basin (Argentina), the *Cyclosporites hughesii* Zone from Australia, and with the *Coptospora verrucosa* Zone from the Rajmahal Basin (India). In addition, strong similarities are observed between the Baqueró Group and the lower part of Zone I of the Potomac Group, as previously suggested by other authors.

When the Early Cretaceous palynofloras are compared using multivariate statistics, the greatest similarities between the Punta del Barco and Anfiteatro de Ticó formations are found with the upper Barremian–lower Aptian Argentinian Pozo D-129 Formation and the Aptian *Antulsporites-Clavatipollenites* Zone from Cuenca Austral (Argentina). Great similarities are also observed with the Aptian Argentiniana Ranquiles and La Cantera as well as with the remaining three zones proposed for Cuenca Austral (Argentina). Other major groupings resulting in the analysis also coincide with palynozones of each country or region, in spite of having different ages. These results are probably related to disparate ages of taxa in different areas, as well as the marked provincialism of some taxa, both issues often observed in non-marine palynomorphs and taxonomic and nomenclatural problems on the identification of the recorded taxa. Noteworthy, when non-angiosperm taxa are excluded from the analysis, great similarities are found between the assemblages of the southern region of South America and the Potomac Group, which is also reflected in the comparatively similar patterns of diversification and evolution of angiosperms that are observed in both regions.

Without any doubt, the outcrops of the Baqueró Group represent a unique opportunity to characterize the plant communities that developed at mid-latitudes during the Early Cretaceous, mainly due to its exquisitely preserved and rich palynoflora. After more than 50 years, these Patagonian units still continue to provide important information of this particular period of time, critical to understanding not only the origin and early diversification of angiosperms, but also the shaping of the modern floristic communities.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.cretres.2018.02.004.