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The spores of *Pteris cretica* complex (Pteridaceae-Pteridophyta) in America

OLGA G. MARTÍNEZ[1] & MARTA A. MORBELLI[2]

[1]*Cátedra de Plantas Vasculares, Facultad de Ciencias Naturales, Universidad Nacional de Salta, Salta, Argentina,*
[2]*Cátedra de Palinología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina*

Abstract
Spore morphology in the *Pteris cretica* complex, including *Pteris brasiliensis*, *P. ciliaris*, *P. cretica*, *P. denticulata* var. *denticulata*, *P. denticulata* var. *tristicula*, *P. ensiformis*, *P. multifida* and *P. mutilata* was examined using light and scanning electron microscope. The spores are trilete, triangular to circular in shape, with an equatorial thickening (= cingulum). Equatorial diameter ranges from 29 to 69 µm, and polar diameter from 18 to 53 µm. Exospore is proximally verrucate and distally rugate, with the exception of *Pteris ensiformis*, which has cones on both polar faces. Perispore is generally less than 1 µm thick, apparently single-layered in section, and translucent under light microscope. Spheroids were frequently observed on the surfaces of both perispore and exospore. Hyaline spores lacking cingulum were found in all specimens. *Pteris brasiliensis, P. cretica* and *P. denticulata* exhibit pronounced polymorphism and, in addition to trilete spores these taxa also produce atypical spores such as tetralete, monolete and intermediate types.

Keywords: Pteris, *spore morphology, polymorphism*

The genus *Pteris* L, with a pantropical distribution, includes approximately 250 species (Tryon et al., 1990), 60 of which occur in America (Mickel & Beitel, 1988). Tryon R. M. and Tryon A. F. (1982) classified the American species in six groups or complexes, *Pteris chilensis*, *P. cretica*, *P. deflexa*, *P. haenkeana*, *P. longifolia* and *P. quadriaurita,* based on the architecture of the lamina and the vein pattern.

The *Pteris cretica* complex has been characterised as a group of "small plants, usually with dimorphic fronds, laminae with a continuous and elongated terminal segment, and free or anastomosed veins" (Tryon, R. M. & Tryon, A. F., 1982), and includes the following species: *Pteris ciliaris* D.C. Eaton, *P. cretica* L., *P. denticulata* Sw., *P. ensiformis* Burm. f., *P. multifida* Poir. and *P. mutilata* L.

In the present study we follow the taxonomical changes proposed by Prado (1993) and Prado and Windisch (2000) including *Pteris brasiliensis* Raddi and the varieties of *P. denticulata* into the *P. cretica* complex. According to this grouping the complex thus comprises eight taxa, *Pteris brasiliensis*, *P. ciliaris*, *P. cretica*, *P. denticulata* Sw. var. *denticulata*, *P. denticulata* Sw. var. *tristicula* (Raddi) Prado, *P. ensiformis*, *P. multifida* and *P. mutilata*.

The members of the *P. cretica* complex occur in tropical America, from Florida and Nuevo León (Mexico) to northern Argentina and Chile, where they are particularly common in the Andes mountain range. They can be found in montane forests, the margins of clearings, and disturbed or artificial environments, such as the edges of roads or on humid walls.

Several authors have provided information on the spores of the *Pteris cretica*, *P. multifida* and *P. mutilata*. In general the spores can be characterised as triletes with a strong equatorial cingulum and ornamented of free or fused tubercules (Sladkov, 1962; Nayar et al., 1964; Nayar & Devi, 1966; Erdtman & Sorsa, 1971; Huang, 1981; Tryon, R. M. & Tryon, A. F.,

Correspondence: Olga G. Martínez, Cátedra de Planatas Vasculares, Facultad de Ciencias Naturales, Universidad Nacional de Salta, Av. Bolivia 5150, CP 144 00 Salta, Argentina. E-mail: *martinezog@gmail.com*

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1982; Ferrarini et al., 1986; Michelena, 1989; Large & Braggins, 1991; Arreguín-Sánchez et al., 1997). The spores of *Pteris ensiformis* have been described as formed of bacules (Nayar & Devi, 1966) or tubercles (Tryon & Lugardon, 1991).

Spore polymorphism and the presence of aborted spores have been mentioned for species of *Pteris* including *Pteris cretica* by Sladkov (1957), Nayar and Devi (1966) and Devi (1977).

Prado and Windisch (2000) proposed three types of spore morphology for the species of *Pteris* growing in Brazil: Type 1 – tetrahedral, rugose surface, roundish tubercles and equatorial flange with sooth surface; Type 2 – tetrahedral, rugose surface, prominent tubercles and subequatorial flange less differentiated; Type 3 – globose, reticulate surface, prominent reticule with a protuberance in the centre and equatorial flange weakly visible.

The perispore structure has been described as two-layered for *Pteris ensiformis* and *P. mutilata* by Tryon and Lugardon (1991).

No information was found about the spores of *Pteris ciliaris*.

As part of a systematic revision of the *Pteris cretica* complex for America, this work aims at providing the palynological charactristics for the complex.

Material and methods

This study was conducted on live material, which was subsequently deposited at the MCNS Herbarium and in the following institutions: BM, LP, MA, MCNS, NY, P, S. SI, SP, US and Z.

Spores were taken from each specimen and analysed under light microscope (LM) and scanning electron microscope (SEM).

For LM study, the spores were acetolyzed according to the technique proposed by Erdtman (1960), after treatment with heated 3% Na_2CO_3 solution for two minutes in order to preserve the perispore. The spores were then mounted in glycerine jelly and the slides sealed with paraffin. The slides were deposited at the Catedra de Palinología of the La Plata National University under the code MP+no and at the MCNS Herbarium at Salta National University under the code MPS+no. Quali-quantitative analysis was carried out using a Zeiss standard 16 binocular microscope with a 40x objective.

For SEM study, the spores were treated with heated 3% Na_2CO_3 solution for two minutes, then centrifuged with distilled water and suspended in absolute alcohol. They were then retrieved by means of a capillary tube and mounted on metal plates, to which they adhered due to surface tension. The material was studied using a Zeiss DSM 940A scanning electron microscope at the Darwinian Botanical Institute as well as a JEOL JSMT-100 scanning electron microscope, at the La Plata Museum of Natural Sciences.

Equatorial diameter (polar view) [E], polar axis (equatorial view) [P], length of laesura (an arm or branch), and width of equatorial cingulum were measured in microns for 20 spores in each sample. The minimum, maximum, and mean (in brackets) values are presented. Description of spores follows the terminology of Norem (1958), Nayar and Devi (1966), Lellinger and Taylor (1997) and Punt et al. (2007).

Specimens of *Pteris ensiformis* and *P. multifida* from outside the study area were considered for comparative purposes.

Results

Pteris brasiliensis *(Figure 1A–E)*

Spores trilete, triangular in polar view, with straight to concave sides and rounded corners; hemispheric-convex in equatorial view. Equatorial diameter, 39(51)58 µm; polar axis, 23(37)45 µm. Each laesura is 19(22)26.5 µm long. Leasura margin discontinuous. Cingulum variable in width 5(6)8 µm, narrower at the corners. The exospore is proximally verrucate and distally rugate with single or fused processes. The distal processes are fused forming ridges. The perispore is translucent when seen under LM, 40 nm, thick, verrucate, and apparently one-layered in section.

Comments: Spheroids fused to the spore surface are frequently observed. In all the specimens studied there are, apart from the trilete spores (66%), other atypical ones such as, tetralete (3%), intermediate (18%), monolete (4%) and hyaline spores (5%). The

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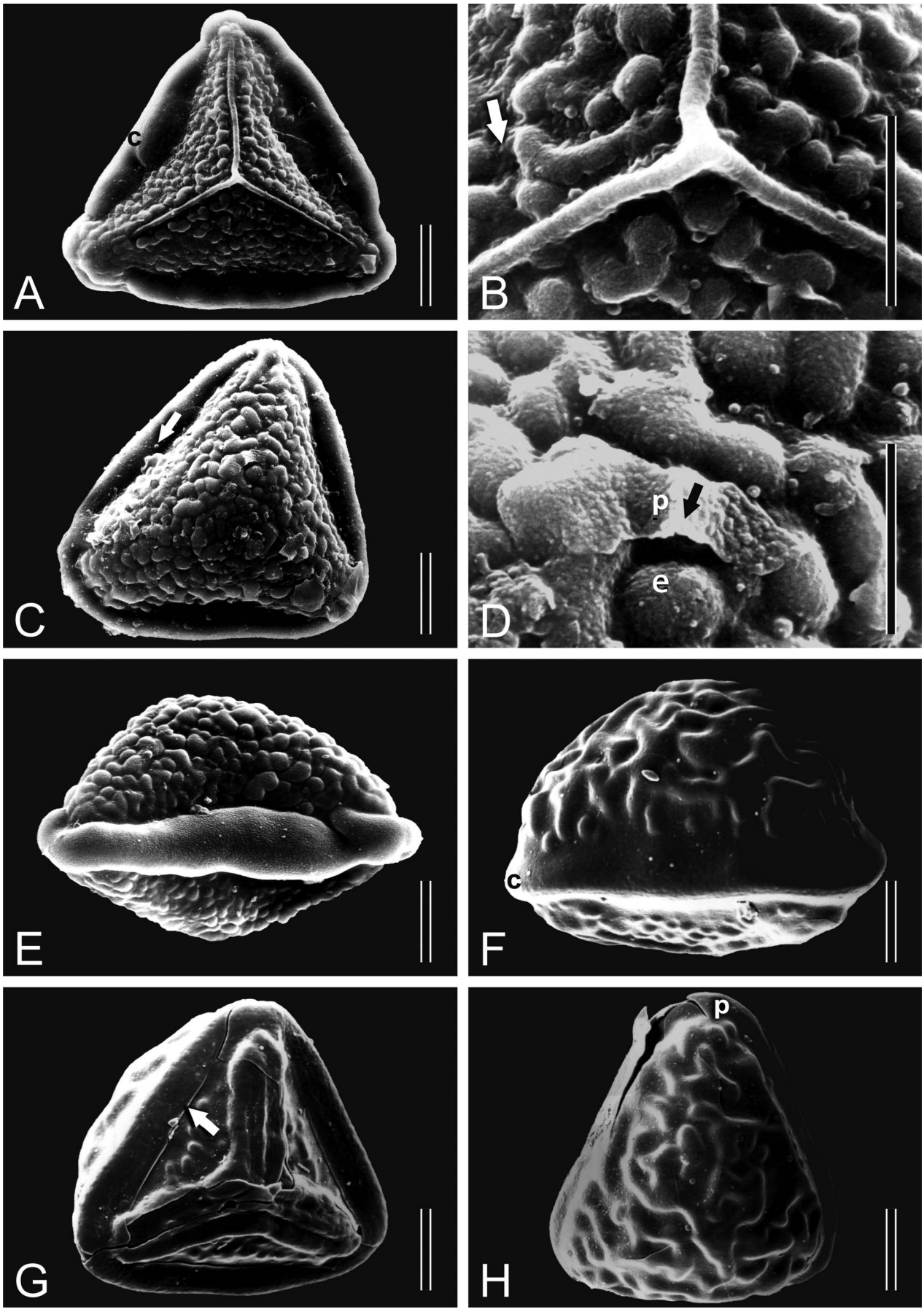
Figure 1. SEM micrographs of *Pteris brasiliensis*, Werner 405 (Z) [**A–E**] and *Pteris ciliaris* spores, Ekman 10403 (S) [**F–H**]. **A**. Proximal view, the ornamentation is verrucate; a prominent cingulum(*c*) is evident in the equator. **B**. Detail of the proximal face in the area where the three laesurae join; the laesurae margins are discontinuous (*arrow*). **C**. Distal view; the ornamentation is rugate; spheroids are fused to the surface (*arrow*); the equatorial cingulum is prominent and reduced at the corners. **D**. Magnified view of (**C**); arrow points a fracture of the perispore (*p*) surface which exposes the exospore (*e*); the perispore is verrucate with spheroids on the surface. **E**. Equatorial view showing a thick equatorial cingulum which is reduced at the corners. **F**. Equatorial view, with a continuous equatorial cingulum (*c*). **G**. Triangular proximal view showing a prominent and continuous laesural margin and fractured perispore (*arrow*). **H**. Distal view, with spheroids on the surface, fractured perispore (*p*). Scale bar – 10 µm (A, C & E–H); 5 µm (B, D).



latter are trilete, small, lack a cingulum, have a smooth exospore and are devoid of a perispore (4%).

Pteris ciliaris *(Figure 1F–H)*

Spores trilete, triangular to circular in polar view, with straight to convex sides and rounded corners; hemispheric-convex in equatorial view. Equatorial diameter, 32(38)69 µm; polar axis 18(34)41 µm. Each laesura is 15(18)23 µm long. Leasura margin thick and continuous. Cingulum variable in width, generally wider at the sides 4.5(7)8 µm and narrower at the corners. The exospore has different ornamentation on both polar faces. It is proximally verrucate and distally rugate. The proximal processes are more densely distributed at the sides of the laesurae margins. The perispore is 700 nm thick, verrucate, translucent when seen under LM, apparently single-layered in section.

Comments: Few spheroids were seen on the surface. Hyaline spores (5%) were found.

Pteris cretica *(Figures 2 & 4E, F)*

Spores trilete, triangular in polar view, with convex sides and rounded corners; hemispheric-convex in equatorial view. Equatorial diameter 50(59)66 µm; polar axis 38(45)53.5 µm. Each laesura is 18(23)26 µm long. Leasura margins discontinuous and irregularly thickened. Equatorial cingulum 4.5(6.5)8 µm wide, narrower at the corners. The exospore is proximally verrucate, with small and numerous processes and distally rugate. The rugae are fused and form ridges and areoli with central tubercles. The perispore is 600 nm thick, apparently single-layered in section, translucent when seen under LM, verrucate with few spaced perforations.

Comments: All spores have spheroids on their surfaces. Along with the typical trilete spores (25%) others were found, such as hyaline (10%), monolete (7%), tetralete (5%) and intermediate (53%) spores. The cingulum was also observed to be variable in thickness and straight to undulate.

Pteris denticulata *var.* denticulata *(Figure 3A, B)*

Spores trilete, triangular in polar view with straight to convex sides and rounded corners; hemispheric-convex in equatorial view. Equatorial diameter 31(39)55 µm; polar axis 23(34)46 µm. Each laesura is 17(21)24.5 µm long, sometimes with thick margins, formed by the fusion of small verrucae. The cingulum is 3(5)6 µm wide, narrow at the corners. The exospore is proximally verrucate, and distally rugate, with single or fused processes forming ridges or a reticulum. The perispore is 1 µm thick, smooth and translucent when seen under LM, apparently single-layered in section.

Comments: Numerous spheroids fused to the surface of the exospore were observed. Apart from the trilete spores (59%), other atypical ones such as tetralete (6%), intermediate (18%), monolete (8%), hyaline (9%), and atypical spores without cingulum, dyads, tetrads of trilete spores and tetrads of tetralete spores were also observed.

Pteris denticulata *var.* tristicula *(Figure 3C–G)*

Spores trilete, triangular in polar view, with straight to convex sides and rounded corners; hemispheric-convex in equatorial view. Equatorial diameter 29(36)52 µm; polar axis 24(29)34 µm. Each laesura is 18(22)24.5 µm long, with a continuous and thick margin. The cingulum is 3(4)4.5 µm wide, with an entire margin. It is narrow at the corners. The exospore is proximally verrucate and distally rugate. The proximal processes are small verrucae of different sizes, single or fused. The perispore is 180 nm thick, verrucate, translucent in under LM and is apparently single-layered in section.

Comments: Spheroids were frequently observed on the surface of the exospore. Along with the typical trilete (49%) spores, other atypical ones were found, such as hyaline trilete (6%), tetralete (4%), monolete (9%), intermediate between monolete and trilete (23%) and hyaline with straight walls (9%).

Pteris ensiformis *(Figure 4A–D)*

Spores trilete, triangular to circular in polar view, with straight to slightly convex sides and rounded corners; convex-plane in equatorial view. Equatorial diameter 44(49)61 µm; polar axis is 30(38)46 µm. Each laesura is 12(14)18 µm long. The cingulum is almost hyaline as seen under LM, variably

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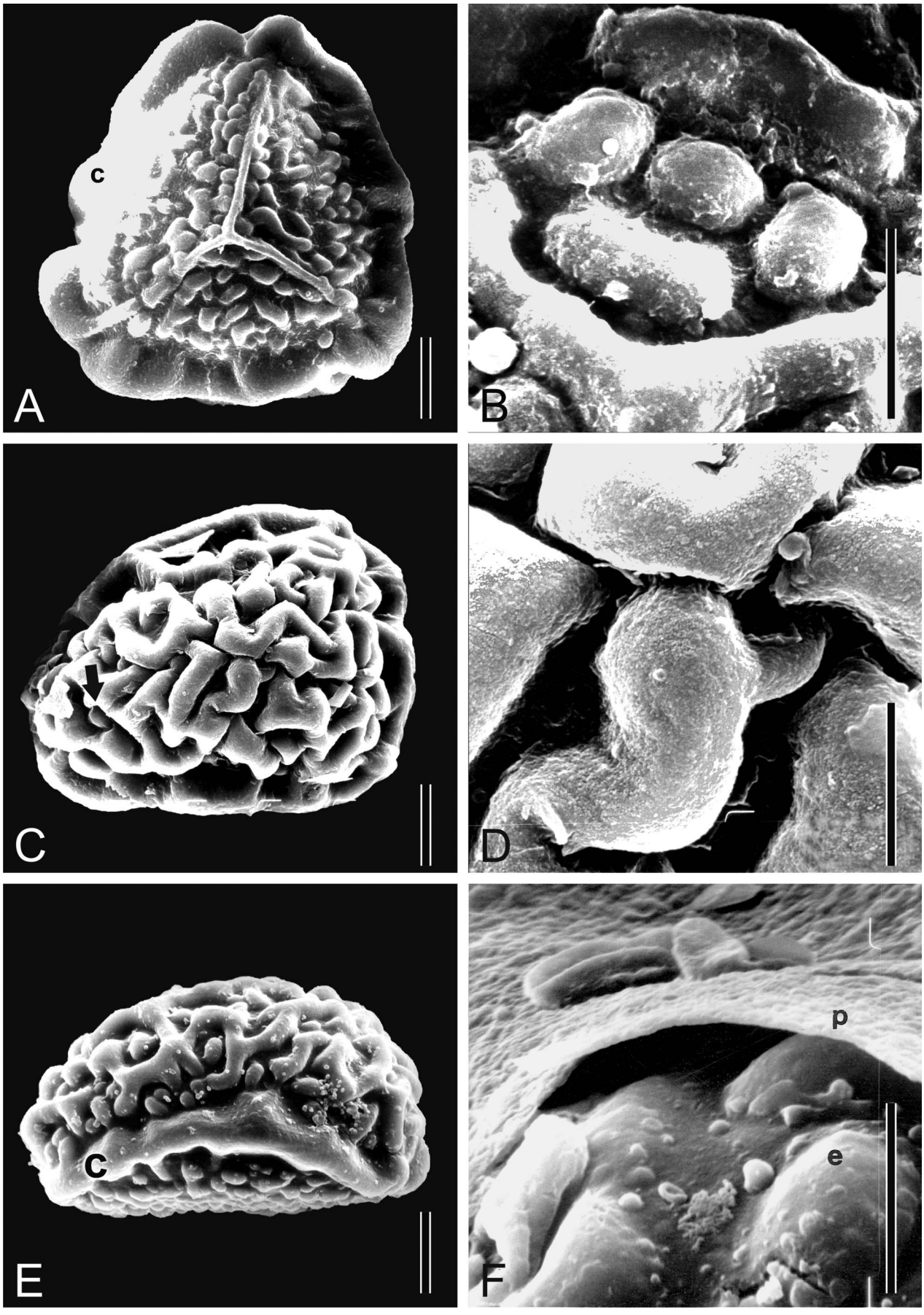
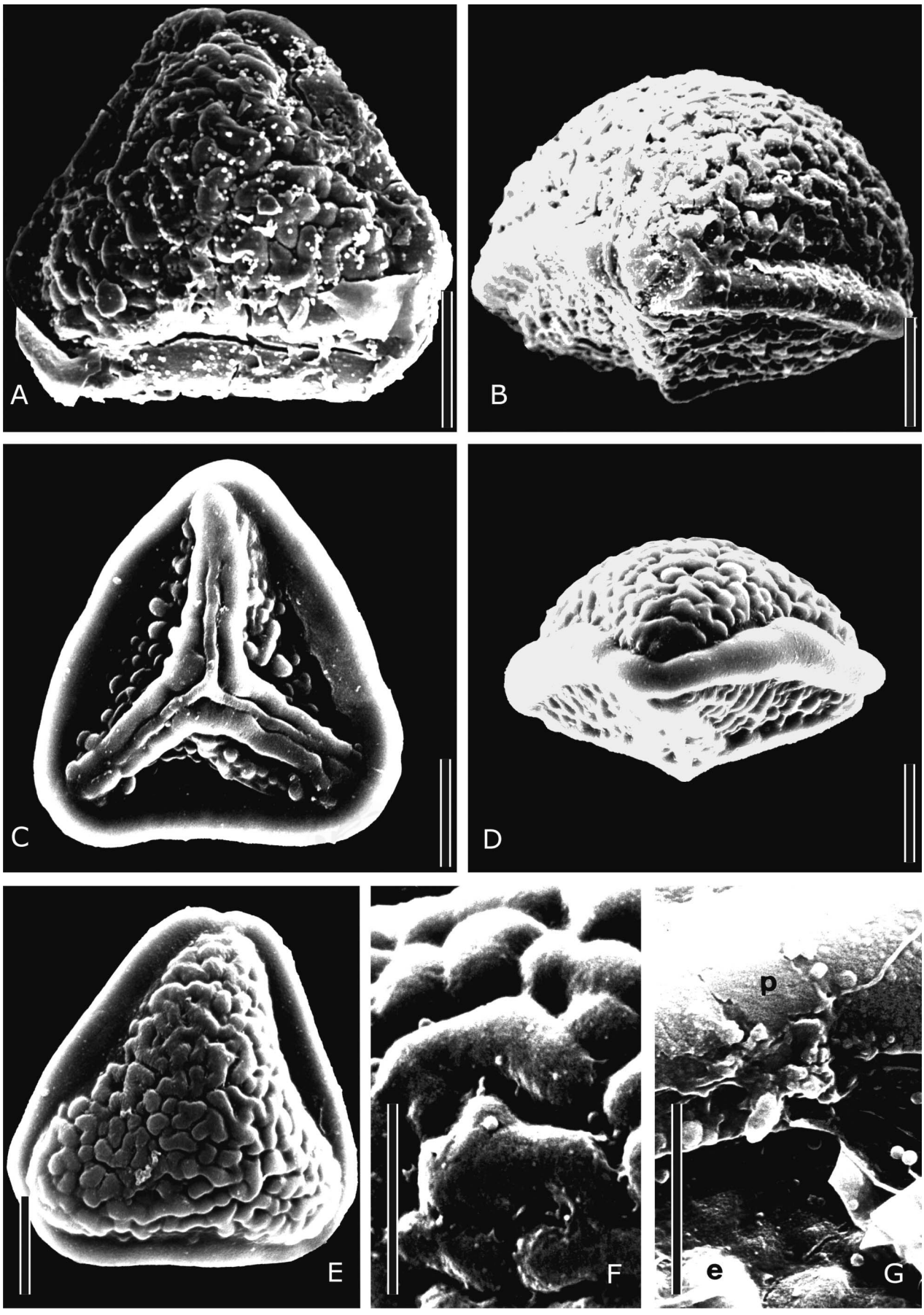
Figure 2. SEM micrographs of *Pteris cretica* spores, Martínez 820 (MCNS). **A**. Proximal view, the ornamentation is verrucate; the verrucae are single or fused. The equatorial cingulum (*c*) is prominent and its margin is irregular. **B**. Proximal face in detail which shows isolated verrucae. **C**. Distal view, the ornamentation is rugate with wide, numerous processes, partially fused, sometimes forming luminae with central verrucae (*arrow*). **D**. Distal face in detail with few fused spheroids, the perispore surface is verrucate. **E**. Equatorial view, hemispheric-convex; it has a prominent equatorial cingulum (*c*). **F**. A detail of a fractured perispore (*p*) which exposes the exospore (*e*) perispore surfaces, both walls have spheroids on their surfaces. Scale bar – 10 µm (A, C, E); 5 µm (B, D, F).





developed, 6(8)11 μm wide, barely reduced at the angles, and with a wavy margin. The exospore consists of cones on both polar faces. In some spores there are also spines. The distal cones are shorter near the equator. The proximal cones are centripetally distributed between the laesurae. The laesurae are bordered by cones, which are sometimes fused at their bases. The perispore is 1 μm thick, apparently verrucate, translucent or yellowish as seen under LM and apparently single-layered in section.

Comments: Trilete spores with diverse irregularities respect to the cingulum (lobulate, etc.), small trilete spores without a cingulum (9%) and hyaline spores (5%). Variations in size, including giant spores, were observed.

Pteris multifida *(Figure 5A–C)*

Spores trilete, triangular in polar view with straight to convex sides and rounded angles; hemispheric-plane in equatorial view. Equatorial diameter 40.5(46)67 μm; polar axis 31(36)40 μm. Laesurae tenuimarginate; each laesura is 15(19)24.5 μm long. The cingulum is 4.5(7)14 μm wide, with an entire or undulate margin, and is narrow at the angles. The exospore is distally rugate and proximally verrucate. The distal ridges may form a reticulum with small verrucae within the areoli. The proximal verrucae are single or fused. The perispore is ca. 210 nm thick, verrucate, transluscent or light yellow as seen under LM, apparently one-layered in section.

Comments: All the specimens studied produced hyaline spores (8%).

Pteris mutilata *(Figure 5D–F)*

Spores trilete, triangular in polar view, with straight to slightly concave sides and rounded angles; hemispheric-plane in equatorial view. Equatorial diameter 43(47)53.5 μm; polar axis 24(31)35 μm. Laesurae tenuimarginate; each laesura is 15(17)21 μm long. The cingulum is wider at the sides 4.5(5.5)6 μm at narrower at the angles and with a straight or undulate margin. The exospore is distally rugate and proximally verrucate with single or fused processes. Distal processes form areoles with scattered small processes. The perispore is 350 nm thick, verrucate; hyaline as seen under LM, apparently single-layered in section.

Comments: Hyaline spores (5%) were observed in all samples. Variations among specimens were observed in cingulum development and size and density of processes of the distal ornamentation.

Discussion and conclusions

Our study ascertains that the spores of the *Pteris cretica* complex are more variable in several morphological features than previously recorded.

Pteris brasiliensis and *P. denticulata* both have trilete, monolete, tetralete and intermediate spores with a proximally verrucate and distally rugate exospore. This corresponds to the ornamentation type 1 of the three ornamentation types identified by Prado and Windisch (2000) characterised by trilete spores with more or less fused tubercles.

Pteris ciliaris has trilete spores with a proximally verrucate and distally rugate exospore with processes fused at the laesura margin to form a continuous margin.

The spores of *Pteris cretica* are proximally verrucate and distally rugate with numerous small processes, isolated or fused at the distal pole. This ornamentation is different from that reported by Ferrarini et al. (1986), who described the ornamentation to be similar on both poles, although fainter on the proximal end. Our study also shows a high rate of atypic spores with 65% of of the specimens having monolete, tetralete and intermediate in addition to the trilete forms. The atypical forms are similar to those mentioned by Sladkov (1957), Wagner (1974) and Devi (1977). The dimensions reported by Nayar and Devi (1966) were lesser than those found here, which may be due to other aspects of variability, although Kanamori (1971) linked the wide variability in size between minimum and maximum, among other aspects, to the apogamy of this species.

The spores of *Pteris ensiformis* presented cones on both polar faces, and their dimensions varied. These results are generally in agreement with those reported by Nayar et al. (1964), Nayar and Devi (1966), Erdtman and Sorsa (1971), Tryon R. M. and Tryon A. F. (1982) and Tryon and Lugardon

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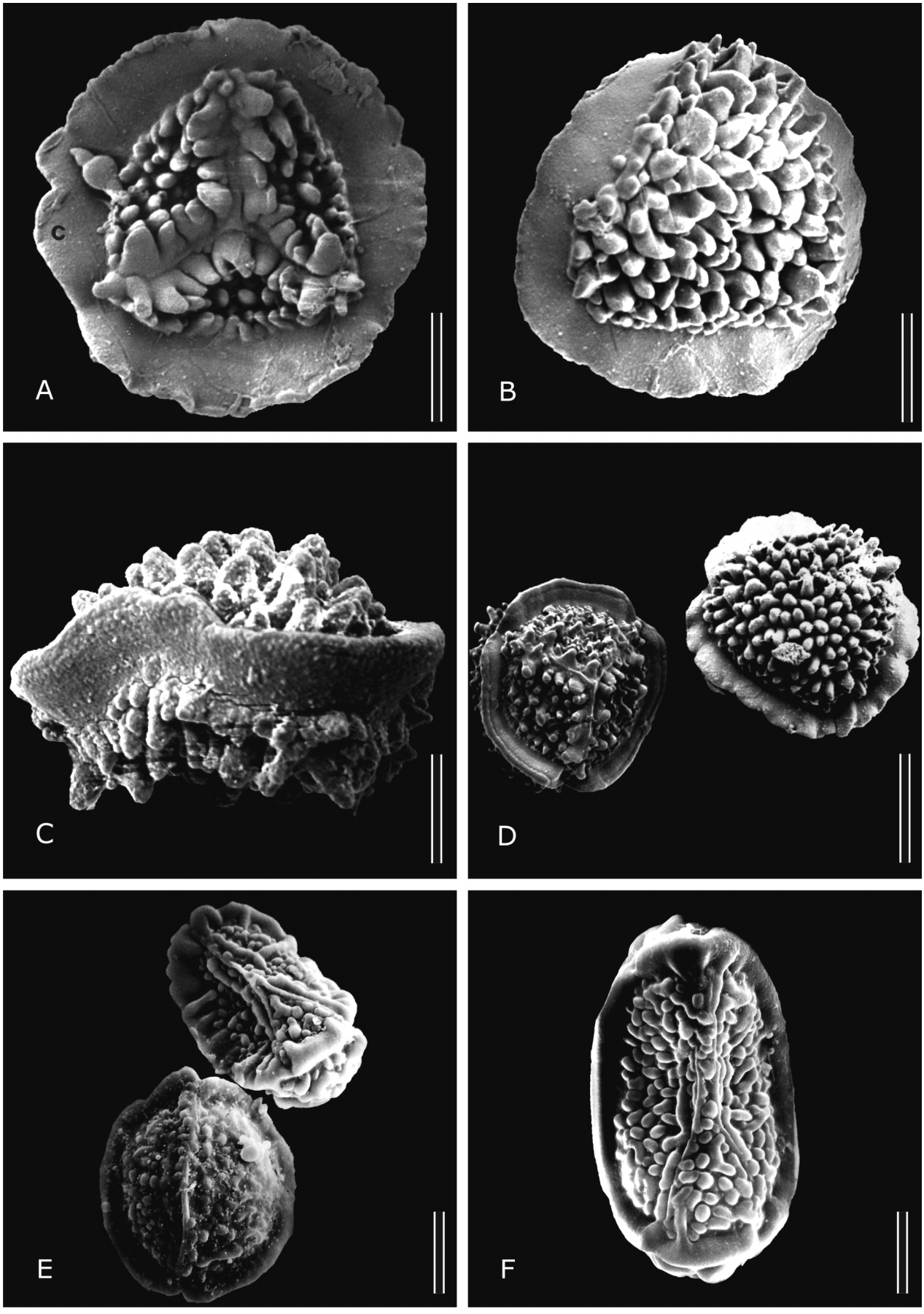
Figure 3. SEM micrographs of *Pteris denticulata* var. *denticulata*, Novara 9949 (MCNS) [**A, B**.] and *Pteris denticulata* var. *tristicula* Kuhlmann 206 (SP) [**C–G**]. **A**. Distal view, the ornamentation is rugate; there are numerous spheroids (*arrow*) on the surface; the cingulum has an entire margin and its width is reduced at the corners. **B**. Equatorial view, hemispheric-convex; the cingulum is prominent. **C**. Triangular proximal view, the ornamentation is verrucate with free or sometimes fused verrucae; the laesurae margins are thick and continuous; the cingulum has an entire margin, it is reduced at the corners. **D**. Equatorial view, hemispheric-convex; the equatorial cingulum is thick and reduced at the corners. **E**. Distal view, the ornamentation is rugate; there are spheroids on the perispore surface. **F**. Detail of the spore in (**E**), the perispore surface is slightly verrucate. **G**. Surface in detail showing a fractured perispore (*p*), allowing seeing the exospore (*e*) surface below, with spheroids on both exospore and perispore walls. Scale bar – 10 μm (A–E); 5 μm (F, G).



(1991). *Pteris ensiformis* is tetraploidic and this might account for the variability in dimension, as suggested by Walker (1962) and Kanamori (1974).

The spores of *Pteris multifida* are proximally verrucate and distally rugate, differing from the morphology described by Michelena (1989) for specimens from Argentina (Buenos Aires province). According to this author the proximal end is smooth with thickenings on both sides of the laesurae, and the distal end is verrucate.

For *Pteris mutilata* the spores were trilete, proximally verrucate and distally rugate. The fusion of sculptural elements on the exospore, particularly on the distal end, is akin to what Tryon R. M. and Tryon A. F. (1982) reported for the Haitian specimens.

The presence of a perispore is a constant feature for the spores of the *Pteris cretica* complex; under LM it appears translucent, and in SEM the fractures of the sporoderm appears to be single-layered. Nevertheless, Tryon and Lugardon (1991), who analysed the perispore with transmission electron microscope, reported the perispore to be composed of two layers.

The equatorial cingulum is a structure present in all taxa studied, in trilete as well as monolete, tetralete and intermediate spores. This feature was not mentioned by Arreguín-Sánchez et al. (1977) for *Pteris cretica*. The spores of *Pteris ensiformis* have a well developed equatorial cingulum with a wavy margin, whereas the cingulum in the remaining species is a continuous ridge with straight to slightly undulated margins, usually thinner at the angles.

In all specimens studied spheroids were observed on the exospore after acetolysis, particularly in *Pteris denticulata* var. *denticulata*; spheroids were also observed by Lugardon (1981) for other species, and homologised with the Ubisch bodies produced by the tapetum of the Embryophyta. Morbelli (1977) argued that the presence of these globules is a distinguishing trait of the spores of certain species, and might originated from a tapetum of singular characteristics, different from the plasmodial type described for the Filicopsidae.

Another aspect shared by the species comprising the *Pteris cretica* complex is the presence of hyaline spores (5–10%) without cellular content and lacking ornamentation and equatorial cingulum. This type of spores was linked to apogamy by Kanamori (1972). While apogamy has been described for *Pteris cretica* by Laird and Sheffield (1986) and for *Pteris multifida* by Kawakami et al. (1995) these authors do not refer to this type of spore.

No differences could be found between the American and Asian specimens of *Pteris ensiformis* and *P. multifida*.

We conclude that the species of the *Pteris cretica* complex generally produce trilete spores with equatorial cingulum and perispore. The ornamentation of the exospore is verrucate on the proximal face and rugate on the distal face, with the exception of *Pteris ensiformis*, which has cones on both faces. Features that are variable between species include the colour of spores in living specimens, the shape of the spores, the cingulum and the margin of the laesura.

The production of atypical spores in *Pteris brasiliensis*, *P. cretica*, *P. denticulata* var. *denticulata* and *P. denticulata* var. *tristicula*, is between 32–65%. This is likely due to apogamic processes, as proposed by Wagner (1974) for *Pteris cretica*, and on occasion to hibridation (Wagner et al., 1986). These anomalies were also observed by Nayar and Devi (1966) on *Pteris aspericaulis* Wall, *P. tripartita* Sw. and other Pteridaceae.

Biological processes such as hybridation, ploidy and apogamy are frequent in *Pteris*, and are likely causes for the presence of hyaline spores and the morphological variability of the spores of the group studied. Further research on the sporogenesis of these plants would help shed light on the issue.

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Specimens investigated

Pteris brasiliensis Raddi. ARGENTINA: Salta, Dpto. Santa Victoria, Río Lipeo. Mármol et al. 8725C. 28-10-1971 (LP)

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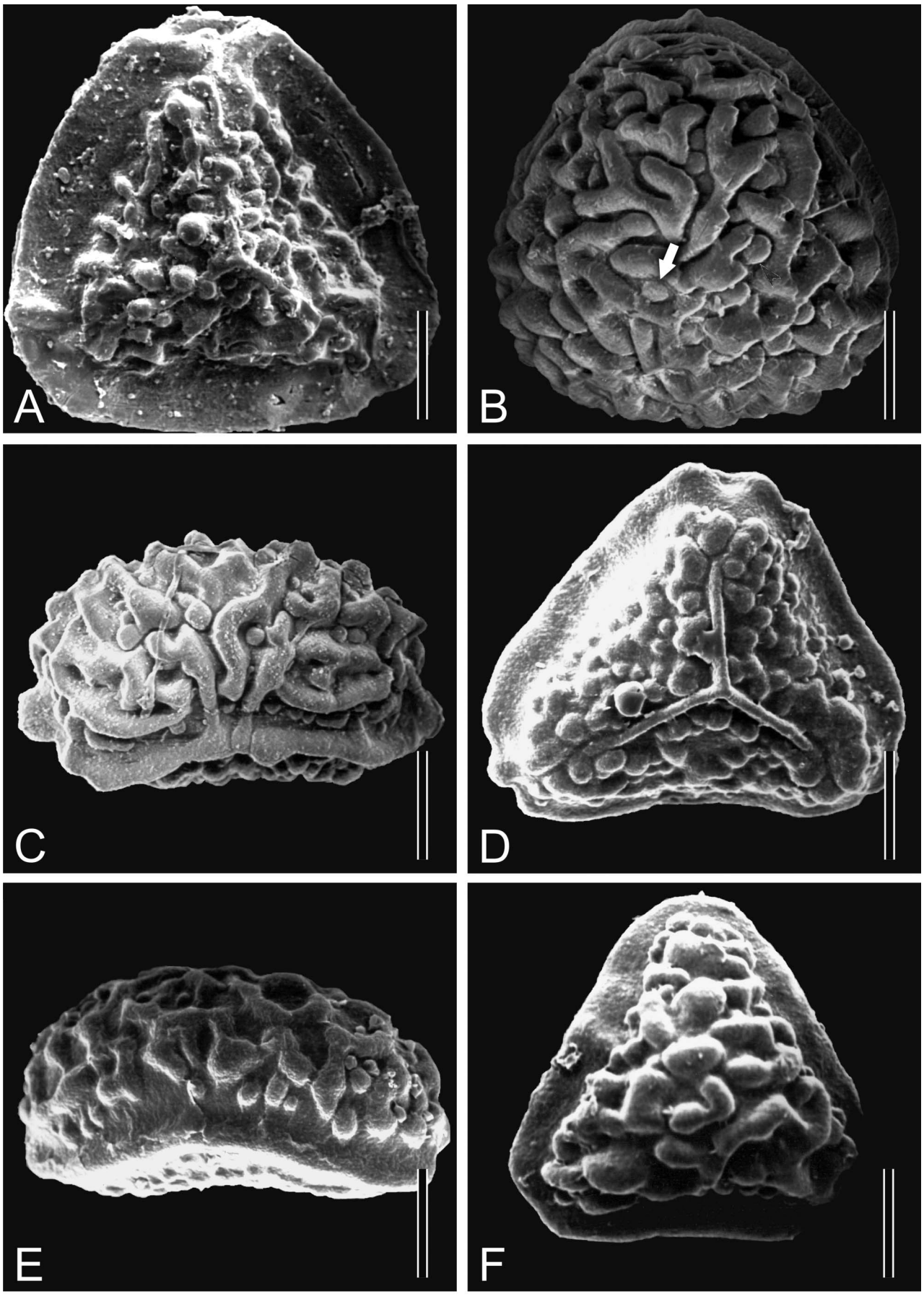
Figure 4. SEM micrographs of *Pteris ensiformis* spores, MA 228135 [**A–D**] and *Pteris cretica*, Martínez 820 (MCNS) [**E, F**]. **A**. Proximal view, ornamentation formed by cones; the equatorial cingulum (*c*) is wide and has regular margin. **B**. Distal view, the cones are higher at the pole and reduced towards the facet margins. **C**. Equatorial view, convex-plane; there are spheroids on the surface; the perispore is verrucate (evident on the cingulum surface). **D**. On the left there is one spore in proximal view and on the right there is one in distal view, both with wide cingulum of wavy margin, barely reduced at the corners. **E**. Two atypical spores, circular monolete in polar view, with numerous spheroids on the surface (*below*); and intermediate spore between monolete and trilete, with wide equatorial cingulum (*above*). **F**. Intermediate spore, with verrucate ornamentation on the proximal face, with free and fused verrugae. Scale bar – 10 μm (A–F).



(MP 2830). Lipeo, 1150 m s.m. Martínez 1525, 7-11-2007 (MCNS) (MPS 25). BRAZIL: Río Grande do Sul. Lindman A1027. 19-01-1893 (S) (MP 3930); Río de Janeiro. Werner 405. 10-1892 (Z) (MP 3931). Corcovado. Alston 5032. 15-10-1938 (BM) (MPS 11).

Pteris ciliaris D. C. Eaton. CUBA: Oriente. Ekman 5364. 9-04-1915 (S) (MPS 16). HAITI: Jérémie. Ekman 10403. 22-07-1928 (S) (MP 3929).

Pteris cretica L. ARGENTINA: Salta, Dpto. Capital, Quebrada de San Lorenzo. Martínez 913. 10-03-2002 (MCNS) (MPS 5); Martínez 138. 23-04-1994 (MCNS) (MP 3919); Quebrada Los Berros, Martínez 820. 10-03-2001 (MCNS) (MP 3934). UNITED STATES: California, Los Angeles. Hoshizaki s.n. 20-09-2002 (MCNS 1813) (MPS 3). GUATEMALA: Quiche, Nebaj, 4 km W. Contreras 4940. 11-06-1964 (S) (MPS 17). MEXICO: Veracruz, El Volcancillo. Theodore et al. 8576. 19-07-1978 (NY) (MPS 7).

Pteris denticulata Sw. var. *denticulata*. ARGENTINA: Salta, Dpto. Santa Victoria, Lipeo a Los Toldos. Martínez et al. 637. 5-07-1998 (LP, MCNS) (MP 3922); Baritú Nacional Park. Novara 9949. 15-09-1990 (MCNS) (MP 3923). BRAZIL: Rio Doce, Trilha da Campolina. Graçano 72. 25-01-1996 (SP) (MPS 9); Matto Grosso do Sul, Costa Rica, Rio Sucuruí. Nonato et al. 251. 19-02-1996 (SP) (MPS 10).

Pteris denticulata Sw. var. *tristicula* (Raddi) Prado. BRAZIL: São Paulo, Amparo, Monte Alegre. Kuhlmann 206. 15-06-1982 (SP) (MP 3927); Iguape. Lofgren s.n. 09-1894 (SP 21642) (MPS 8).

Pteris ensiformis Burm.f. UNITED STATES: California, Los Angeles. Hoshizaky s.n. 20-11-2002 (MCNS 1814) (MPS 6). PHILIPPINES: Neèlfes s.n. (MA 228135) (MP 3925). TAIWAN: Ta-jen Hsiang, Ansuo, 30 m s.m., Zogg & Gassner 6079. 16-10-1982 (Z) (MP 3928).

Pteris multifida Poir. LESSER ANTILLES: Leeward Island. Box 406. 04-1936 (BM) (MPS 14). URUGUAY: Punto Carreta, s.f., Filippone 4623 (SI) (MPS 3921). GERMANY: München, Nymphenburg, Botanischer Garten, sin col. 20-11-2001 (MCNS 1817) (MPS 2). JAPAN: Honschu, Kyoto, Arashiyama. Zogg & Gassner 11135. 1-09-1987 (Z) (MP 3926).

Pteris mutilata L. CUBA: no place named. 1849, Rugel 17. 1849 (BM) (MPS 12); Camaguey, Sierra Cubitas. Shafer 451. 19-02-1909 (BM) (MP 3933). Pinar del Río, León s.n. 19-08-1911 (P) (MP 3932). PUERTO RICO: Arecibo, Río Abajo. Acevedo-Rodríguez 10657. 4-06-1998 (US) (MP 3934).

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Figure 5. SEM micrograhs of *Pteris multifida*, Filippone 4623 (SI) [**A–C**] and *Pteris mutilata* spores, Acevedo-Rodríguez 10657 (US) [**D–F**]. **A**. Proximal view, the ornamentation is verrucate; it is formed by verrucae free or fused, laesurae tenuimarginate, cingulum reduced at the corners, surface with numerous spheroids. **B**. Distal view, ornamentation rugate, processes fuse forming muri leaving areoli with verrucae (*arrow*). **C**. Equatorial view, hemispheric-plane with spheroids on the surface. **D**. Triangular proximal view, ornamentation formed by free or fused verrucae, laesurae tenuimarginate, cingulum modified at the corners. **E**. Equatorial view, hemispheric-plane, cingulum of entire margin. **F**. Distal view, ornamentation rugate, with wide processes; there are spheroids on the surface. Scale bar – 10 μm (A–F).

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