

Paleotropical pollen grains from the Neuquén Group, Patagonia, Argentina

Patricia VALLATI ¹

Abstract: This paper discusses the presence of elater-bearing pollen grains and other characteristic paleotropical palynomorphs in the mid to Late Cretaceous Neuquén Group at the El Zampal locality, south of Mendoza Province, Argentina.

The elaterates characterize the equatorial paleofloristic province in the Albian-Cenomanian. The species *Elateroplicites africaensis* is present in the pollen assemblage recovered from the lower section of the Huincul Formation, a basal unit of the studied Neuquén Group. It represents the first record of elater-bearing pollen grains in Argentina and marks their southernmost extension. Other conspicuous paleotropical elements recorded in different lithostratigraphic units of the Neuquén Group include gymnospermous polyplicate pollen grains and angiosperm pollen, including two species of the periporate pollen genus *Cretacaeiporites* and the triporate pollen species *Confossia vulgaris*. The paleobiogeographic and biostratigraphic significance of the paleotropical sporomorph record in the Cretaceous palynofloras of the Neuquén Group at El Zampal is herein discussed.

Key Words: Paleotropical palynomorphs; mid and Late Cretaceous; Neuquén Group; Patagonia; Argentina.

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Résumé : *Grains de pollen paléo-tropicaux dans le groupe de Neuquén, Patagonie, Argentine.*- Cette note discute la présence de grains de pollen à élatères et d'autres palynomorphes paléo-tropicaux caractéristiques dans le Groupe de Neuquén d'âge Crétacé moyen à supérieur de la localité d'El Zampal au Sud de la Province de Mendoza en Argentine.

Au cours de l'intervalle Albien-Cénomaniens, les élatères caractérisent la province paléofloristique équatoriale. L'espèce *Elateroplicites africaensis* est présente dans l'association de pollen extraite de la partie inférieure de la Formation Huincul, à la base du Groupe de Neuquén. C'est la première fois que des grains de pollen à élatères sont découverts en Argentine et cela correspond aussi à leur occurrence la plus méridionale. D'autres éléments paléo-tropicaux incontestables sont présents dans différentes unités lithostratigraphiques du Groupe de Neuquén : ce sont, par exemple, des grains de pollen polypliqués de gymnospermes et des grains d'angiospermes, incluant deux espèces à grains péripores du genre *Cretacaeisporites*, ainsi que l'espèce *Confossia vulgaris* à grains triporés. La signification paléogéographique et biostratigraphique de l'association de sporomorphes crétacés paléo-tropicaux extraite du Groupe de Neuquén à El Zampal est discutée.

Mots-Clefs : Palynomorphes paléo-tropicaux ; Crétacé moyen et supérieur ; Groupe de Neuquén ; Patagonie ; Argentine.

Introduction

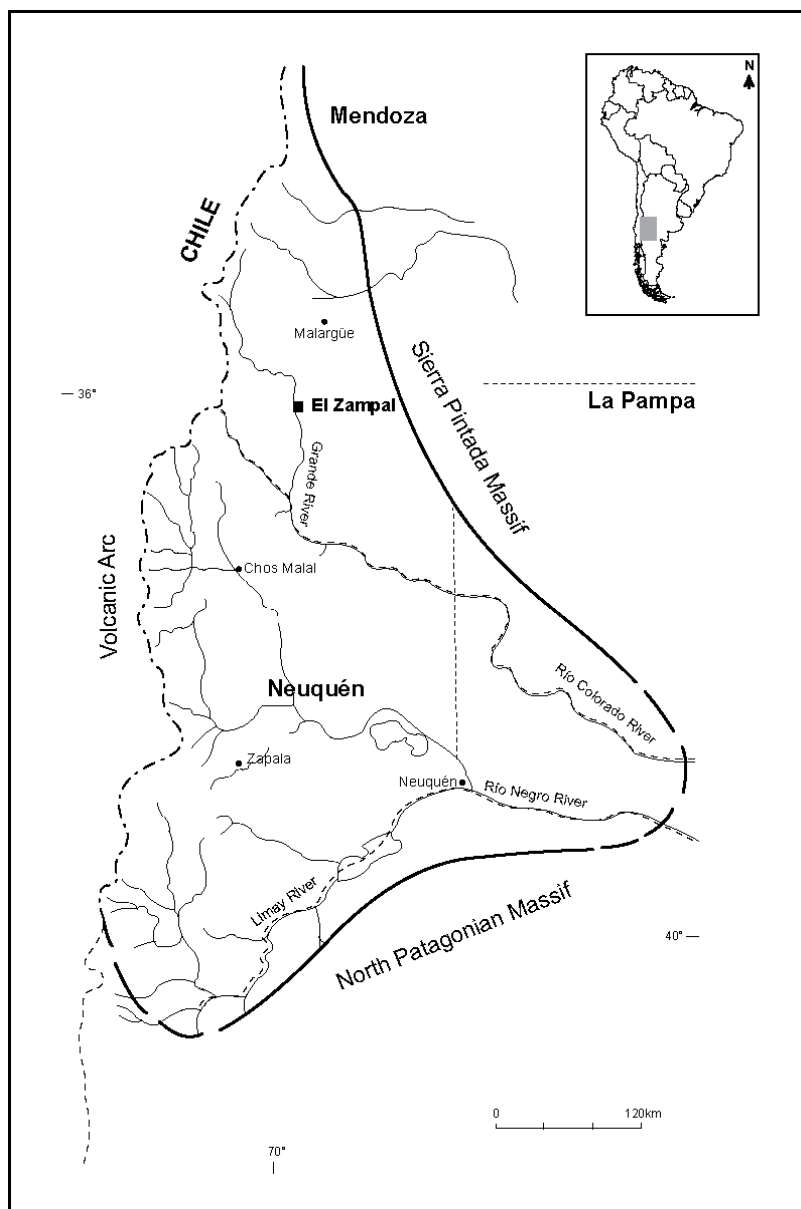
This contribution focuses on the paleotropical pollen recovered from different lithostratigraphic units of the Neuquén Group at the El Zampal section (approximately 36°32' S, 69°39' W), 115 km to the south of Malargüe, southern Mendoza Province (Fig. 1). At this

locality, the purple sandstones of the Candeleros Formation and the base of the Huincul Formation are not exposed (Fig. IIA). The Neuquén Group includes terrestrial post-orogenic deposits related to the main Miranic Orogeny (also known in the literature as the Patagonidic Orogeny) (STIPANICIC & RODRIGO, 1969; LEANZA, 2010).

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◀ **Figure 1:** Location map of the El Zampal section in the Neuquén Basin.

Rich remains of dinosaurs and other reptiles have been recovered from various levels of the Neuquén Group (see compilations by LEANZA *et al.*, 2004). Taking into account the micropaleontological record, calcareous microfossil assemblages including charophytes and ostracods have contributed to the chronology of these continental beds (MUSACCHIO, 2000, 2006, 2010).

Previous palynological studies of the Neuquén Group have yielded angiosperm pollen assemblages comprised of diversified pollen types. These include the *Fraxinoipollenites fragilis* assemblage (?Albian-Cenomanian) in the upper section of the Huincul Formation, the *Cretacaeiporites polygonalis* level in the Cerro Lisandro Formation (Cenomanian) and the *Confossia vulgaris*-*Cretacaeiporites scabratus* assemblage (Santonian-?Campanian) in the Bajo de la Carpa Formation (VALLATI, 2002,

2006, 2010). Typical paleotropical constituents such as *Elateroplicites africaensis*, *Cretacaeiporites polygonalis*, *Cretacaeiporites scabratus* and *Confossia vulgaris* were recorded in different stratigraphic units of the Neuquén Group (VALLATI, 2006, 2010, this contribution) (see Fig. II).

Paleotropical pollen grains have been reported from other Cretaceous palynofloras in Argentina, which also include endemic austral taxa, suggesting a mixed character for these assemblages (PRÁMPARO, 1990; VALLATI, 2002, 2006, 2010; BARREDA & ARCHANGELSKY, 2006).

In this contribution, the paleobiogeographic, paleoecological and biostratigraphic significance of the Cretaceous tropical pollen grains in Northern Patagonia is discussed, taking into account their restricted distribution in the Equatorial Region (HERNGREEN *et al.*, 1996).

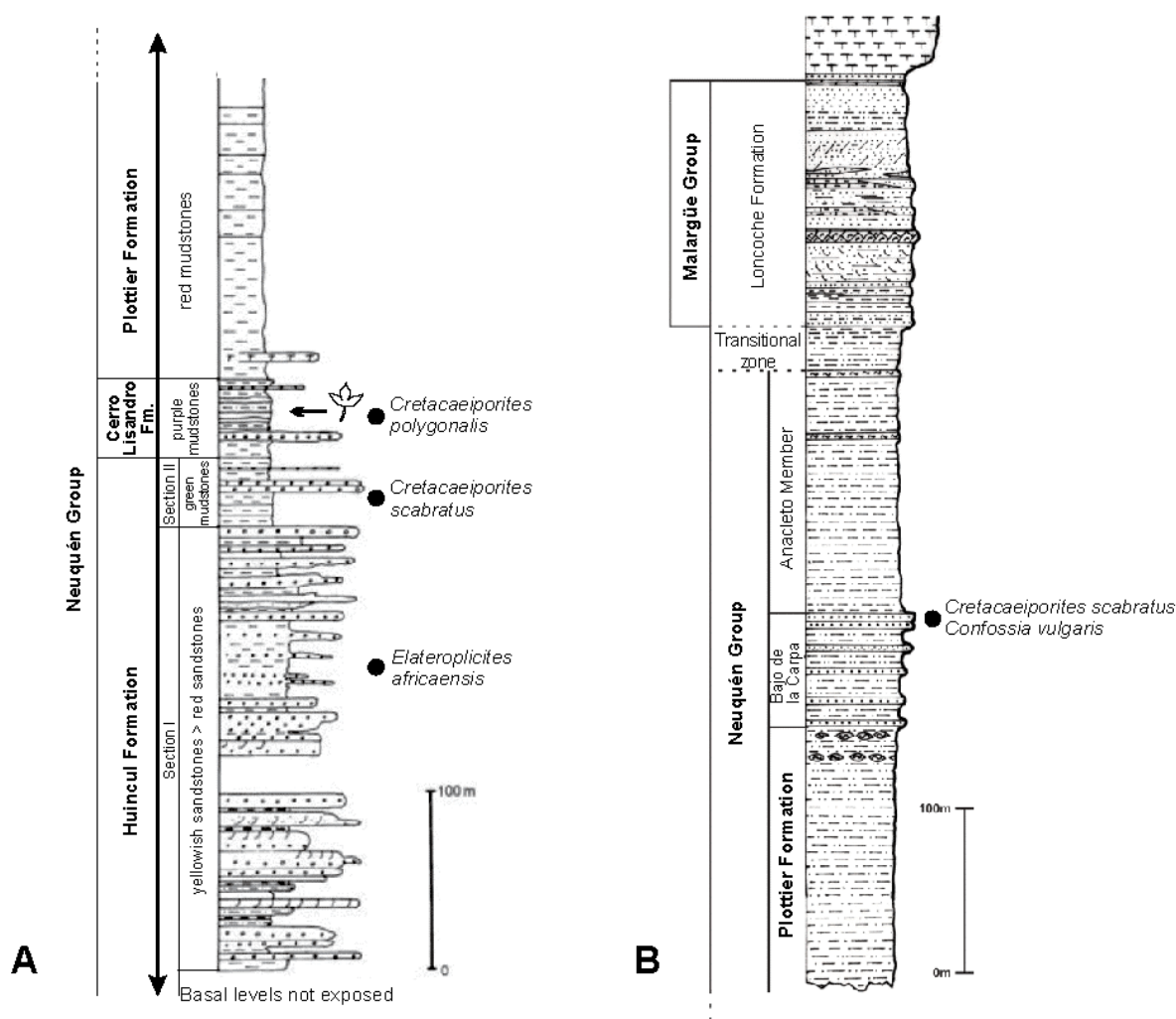


Figure II: Schematic section of the Neuquén Group at El Zampal (modified from ULIANA & MUSACCHIO, 1978). A: lower levels of the unit, B: upper levels of the unit.

Paleotropical representatives in Northern Patagonia

1. Elater-bearing pollen grains

The elaterate group includes several taxa of enigmatic pollen grains with protuberances from the Albian-Cenomanian Elaterates province, originally restricted to northern South America and northern Africa (HERNGREEN & CHLONOVA, 1981; HERNGREEN *et al.*, 1996). The protuberances that characterize this otherwise heterogeneous group of pollen grains, are only superficially compared to the elaters of the spores of extinct calamitaceans and of *Equisetum*, the unique extant genus representing the Sphenophyta.

The conspicuous tropical pollen grains, reported here, were mainly recovered from the Huincul Formation in the lower section of the unit (Fig. IIA, Section I). This section includes massive grey and yellowish brown sandstones, interbedded with mudstones, siltstones and purple sandstones. Within this interval, the dark

green mudstone beds yielded well preserved palynomorphs including the elater-bearing pollen grain *Elateroplicites africaensis* and a single specimen identified as *Galeacornea?* sp. (Fig. III, 8). The study of additional material is necessary in order to corroborate the presence of this last mentioned taxon in Patagonia.

1.1. Botanical affinity

In spite of the fact that the elater-bearing pollen grains have been intensely studied, their botanical affinity remains a matter of discussion among specialists. The morphological characteristics of these grains are unknown from extant pollen grains and up to now *in situ* specimens have not been found. A probable ephedroid affinity for the elaterates has been proposed by different authors (DINO *et al.*, 1999; SCHRANK, 2001). The elaterates are, otherwise, suggested to have been a group of extinct plants with sophisticated mechanisms of pollination, which developed and diversified in the paleotropics.

1.2. Biostratigraphic and paleoecological aspects

The elater-bearing grains have a restricted stratigraphic distribution. They appeared in the Lower Albian sediments of the low latitude region, diversified, became numerically important in the Upper Albian-Cenomanian stratigraphic interval and disappeared at the top of the Cenomanian during the rapid diversification and rise to dominance of the angiosperms (HERNGREEN & DUENAS JIMENEZ, 1990; HERNGREEN *et al.*, 1996). *Elateroplicites*, in particular, is restricted to the Middle Albian-Cenomanian interval (HERNGREEN *et al.*, 1996). The record of elater-bearing grains supports the previously suggested ?Albian-Cenomanian age for the Huincul palynoflora at El Zampal (VALLATI, 2006).

The paleotropical Elaterates Province represents warm arid or semi-arid conditions (HERNGREEN *et al.*, 1996; ZOBAA *et al.*, 2013). The presence of *Elateroplicites* at the latitude of Northern Patagonia suggests the southward migration of favorable conditions for the expansion of the elater-bearing grains. Its restricted stratigraphic distribution in the lower section of the Huincul Formation at El Zampal should be analyzed considering the probable fluctuating environmental conditions related to the main Miranic Orogeny. These tectonic movements were responsible for changing the regional slope from the Pacific to the Atlantic, and consequent physiographic changes. In this sense, it is stressed that the *Fraxinoipollenites fragilis* assemblage, previously recognized in the upper section of the unit (Fig. IIA, Section II), which is dominated by angiosperm pollen grains and has few *Classopollis* and polyplcate grains, suggests a humid climate (VALLATI, 2006).

2. Periporate pollen grains

The genus *Cretacaeiporites* includes Cretaceous spherical periporate pollen grains with a characteristic scabrate pore membrane.

Previous palynological studies of the Neuquén Group have highlighted the presence of this pollen type (VALLATI, 2006, 2010). *Cretacaeiporites polygonalis* was reported from the Cerro Lisandro Formation characterizing a palynological level (VALLATI, 2006). *Cretacaeiporites scabratus* was, in turn, reported from the Santonian-Campanian *Confossia vulgaris*-*Cretacaeiporites scabratus* assemblage in the younger Bajo de la Carpa Formation, in the upper levels of the Neuquén Group (VALLATI, 2010). In the present contribution, the species *C. scabratus* is also reported from the upper section of the Huincul Formation (Fig. IIA, Section II).

These records from the Neuquén Group suggest that the periporate pollen type was well diversified by the mid to Upper Cretaceous of Northern Patagonia.

2.1. Botanical affinity

HERNGREEN (1974) suggested that the species *Cretacaeiporites scabratus* had an affinity with the genera *Trimenia*, *Thalictrum* and *Alisma*. BOLTENHAGEN (1975) also noted the similarity of some species of *Cretacaeiporites* with pollen of the family Caryophyllaceae. More recently, FRIIS *et al.* (2011) considered the presence of *Cretacaeiporites scabratus* in the mid to Upper Cretaceous of Brazil and Africa, as the oldest potential record of the Trimenaceae.

2.2. Biostratigraphic interest

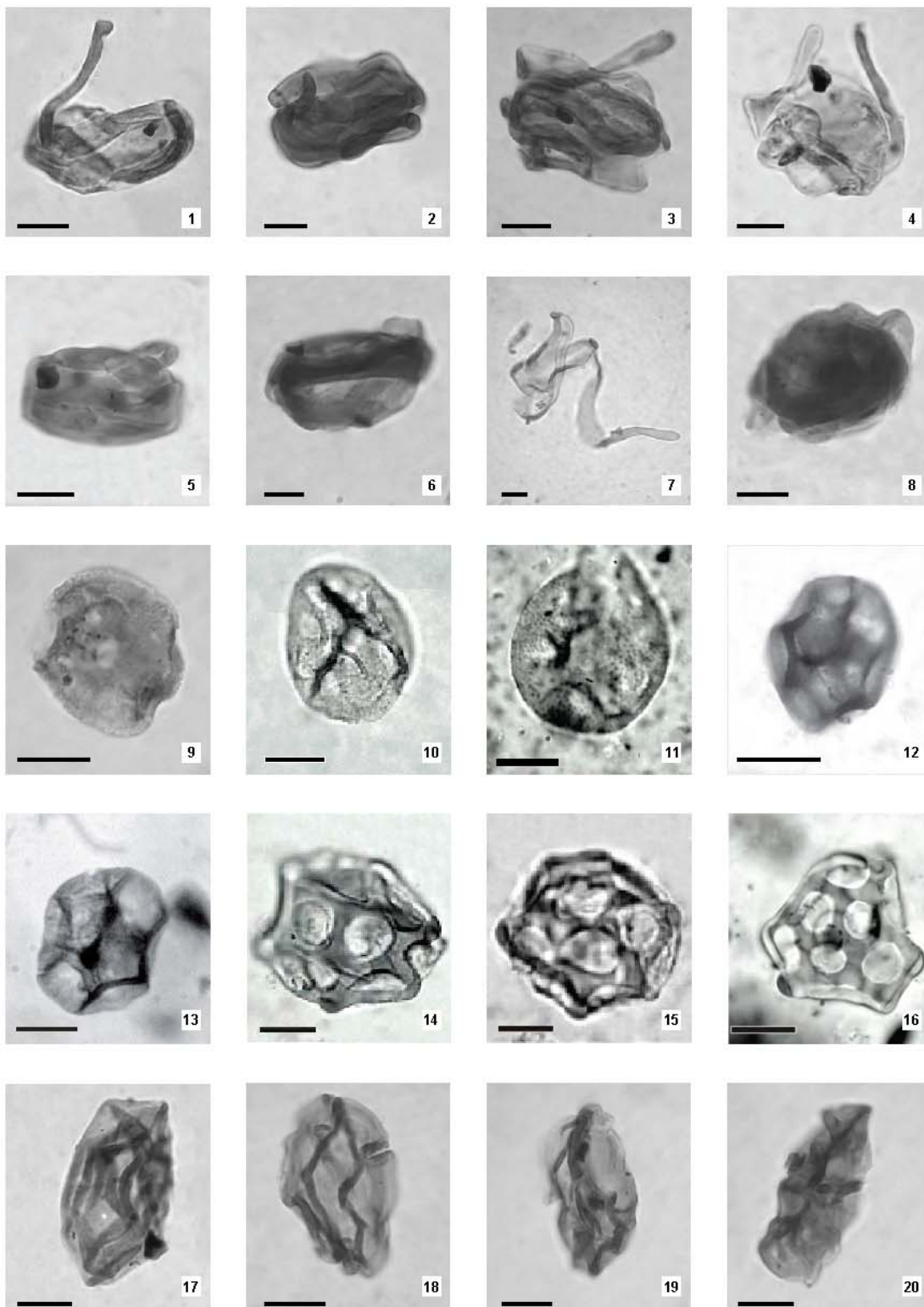
Cretacaeiporites scabratus is distributed in the Albian-Campanian of Brazil (see VALLATI, 2010) and the Upper Albian-Santonian of northern Africa (M.S. MAHMOUD & A.E. MAHMOUD, 2007). *Cretacaeiporites polygonalis* is a conspicuous element in paleotropical Middle Albian-Early Cenomanian assemblages of Brazil, África and Perú and decreases in abundance in the Upper Cenomanian, when the triporates are first recorded.

3. Triporate pollen grains

Confossia vulgaris is a triporate pollen grain of uncertain botanical affinity. It represents a pollen probably endemic to South America and is present in the Patagonian Austral and Neuquén basins (STOUGH, 1968; PÖTHE DE BALDIS, 1995; VALLATI, 2010) and in different Brazilian marginal basins, where it is distributed in the Santonian-Middle Campanian stratigraphic interval (REGALI *et al.*, 1974; REGALI, 1989).

► **Figure III:** Paleotropical grains recognized in different units of the Neuquén Group at El Zampal. In parenthesis slide numbers and coordinates in the microscope. Scale bars = 10 µm.

1. *Elateroplicites africaensis* (CR.P.CV 536 3 19/110)
2. *Elateroplicites africaensis* (CR.P.CV 536 2 23/100)
3. *Elateroplicites africaensis* (CR.P.CV 536 1 3/87)
4. *Elateroplicites africaensis* (CR.P.CV 536 1 20/90)
5. *Elateroplicites africaensis* (CR.P.CV 536 F 3.5/103)
6. *Elateroplicites africaensis* (CR.P.CV 536 1 20/96)
7. Loose elaters (CR.P.CV 536 4 23/97)
8. *Galeacornea* ? sp (CR.P.CV 536 1 11/86)
9. *Cretacaeiporites scabratus* (CR.P.CV 241 And 6/109)
10. *Cretacaeiporites scabratus* (CR.P.CV 543M 15/108)
11. *Cretacaeiporites scabratus* (CR.P.CV 543B 12/95)
12. *Cretacaeiporites polygonalis* (CR.P.CV 863 N2 10/112.5)
13. *Cretacaeiporites polygonalis* (CR.P.CV 863a 10/108.5)
14. *Confossia vulgaris* (CR.P.CV 543L 17/98)
15. *Confossia vulgaris* (CR.P.CV 54EZ30 17/90)
16. *Confossia vulgaris* (CR.P.CV 543L 10/91)
17. *Equisetosporites* sp. (CR.P.CV 536 5 23/94)
18. *Equisetosporites* sp. (CR.P.CV 536 6 15/105)
19. *Equisetosporites* sp. (CR.P.CV 536 3 21/95)
20. *Equisetosporites* sp. (CR.P.CV 536 1 25/96)



This angiosperm marker pollen characterizes the palynomorph assemblage *Confossia vulgaris-Cretacaeiporites scabratus* (Santonian-?Early Campanian) recovered from the Bajo de la Carpa Formation in the upper levels of the Neuquén Group at El Zampal (Fig. IIB).

4. Polyplicate pollen grains

Cretaceous assemblages of the Equatorial Region are characterized by the common distribution of gymnospermous pollen with straight or twisted ribs (HERNGREEN *et al.*, 1996).

Although not abundant, this pollen type is well diversified in palynological assemblages at different levels of the Neuquén Group. In particular, the liver-red colored siltstones and claystones of the Cerro Lisandro Formation and the Bajo de la Carpa Formation include several species of the genera *Equisetosporites*, *Steevesipollenites*, *Gnetaceapollenites* and *Singhia* (VALLATI, 2006, 2010).

New reports of polyplicate pollen grains are herein presented for the same samples including elaterates in the lower section of the Huincul Formation. Among others, *Equisetosporites* cf. *evidens* and some specimens with irregular and sinuous twisted ridges, included as *Equisetosporites* spp. are recognized (Fig. III, 17-20). *Equisetosporites irregularis* (HERNGREEN, 1973) LIMA, 1980 (Syn.: *Ephedripites irregularis* HERNGREEN, 1973), represented in the Aptian-Cenomanian stratigraphic interval in northeastern Brazilian basins and Africa, is a tropical species with twisted ribs and great morphological variability. The Patagonian specimens have thinner and more irregular ridges.

Conclusions

Distinctive paleotropical pollen taxa (*Elateroplicites africaensis*, *Cretacaeiporites* spp., *Confossia vulgaris*, polyplicate pollen grains) have been identified in the Neuquén Group at El Zampal, south of Mendoza Province.

The occurrence of these conspicuous paleotropical pollen grains in mid to Late Cretaceous Patagonian palynofloras suggests the southward migration of warm climatic conditions during this chronostratigraphic interval.

These pollen types represent significant palynological markers for the entirely terrestrial red beds of the Neuquén Group.

The presence of the paleotropical species *Cretacaeiporites polygonalis*, *Cretacaeiporites scabratus* and *Elateroplicites africaensis* in different units of this group is unique in Argentina.

The occurrence of elater-bearing pollen species in the Huincul Formation represents the southernmost known report of this pollen type. Its restricted presence in the lower section of the unit may be indicative of specific (drier?) environmental conditions.

The record of *Elateroplicites africaensis* in the Huincul Formation supports the ?Albian-Cenomanian age previously suggested for the *Fraxinopollenites fragilis* assemblage recognized in the upper section of the unit (VALLATI, 2002, 2006).

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Appendix

List of species illustrated or mentioned in the text

Gymnosperm pollen grains

- *Equisetosporites* sp. (Fig. III, 17-20)
- *Equisetosporites irregularis* (HERNGREEN, 1973) LIMA, 1980 (Syn.: *Ephedripites irregularis* HERNGREEN, 1973)
- *Equisetosporites* cf. *evidens* (BOLKHOVITINA) LIMA, 1980
- *Elateroplicites africaensis* HERNGREEN, 1973 (Fig. III, 1-6)
- *Galeacornea?* sp. (Fig. III, 8)

Angiosperm pollen grains

- *Confossia vulgaris* STOUGH, 1968 (Fig. III, 14-16)
- *Cretacaeiporites polygonalis* (JARDINÉ & MAGLOIRE) HERNGREEN, 1974 (Fig. III, 12-13)
- *Cretacaeiporites scabratus* (JARDINÉ & MAGLOIRE) HERNGREEN, 1974 (Fig. III, 9-11)
- *Fraxinopollenites fragillis* BURGER, 1993