

Evidences of an Early Cretaceous floristic change in Patagonia, Argentina

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Abstract. A new lithostratigraphic scheme has been proposed for the previous Baqueró Formation (Santa Cruz Province, Argentina), which is now considered to be a Group including three formations: Anfiteatro de Ticó the oldest, Bajo Tigre the middle and Punta del Barco the youngest. The distribution of plant fossils at several localities where these formations occur has shown that there are two different plant assemblages that are consistently present over a wide area. A detailed study of the distribution of all plant species known to be present in the Baqueró Group led to define two biozones, viz. *Ptilophyllum* (lower) and *Gleichenites* (upper). The main differences concern the disappearance of all Bennettites and most Cycads and Ginkgoales in the upper biozone, which in turn is clearly dominated by a gleicheniaceous fern assemblage. The latest Barremian to early Aptian age that has so far been accepted for this fossil flora, and the change of components in both biozones, suggests that this time interval may well correspond to the late Barremian to Early Aptian extinction event that has been proposed in other regions. This event was closely related to a strong volcanic activity that has also been recorded in the Baqueró Group. It is suggested that the vegetation during the time span represented by the Baqueró Group developed under stressful conditions that caused extinctions and a consequent change of the environmental scenario.

Key words. Argentina. Patagonia. Early Cretaceous. Paleobotany. Biostratigraphy.

Discussion

During the last four decades a substantial increase in the knowledge of the Early Cretaceous flora of central Santa Cruz Province, Patagonia, has allowed for the recognition of several plant bearing localities and has widened the geographical distribution of what was known as the Baqueró Formation. However, more recently detailed geological mapping of selected areas in which fossil plants are abundant has revealed that this unit is more complex than previously suspected. Therefore, a new lithostratigraphic scheme has been proposed in which three formations are defined, *i.e.* Anfiteatro de Ticó at the base, Bajo Tigre in the middle and Punta del Barco the topmost (Cladera *et al.*, 1999). All three formations have been united in the Baqueró Group.

Plotting the paleobotanical information available (tables 1-3) make it evident that the plant assemblages thus far described from several localities differ if considered in the context of this new stratigraphic scheme. The distribution of most paleobotanical taxa (including megaspores) are presented here in a chart in which fossil plants are grouped ac-

ording to their systematic affinity. Their presence is recorded in the three formations (A1, A2 and A3) and in several plant beds from different sites (SP). All species have a bibliographic citation and a number that is referred to in the Bibliography. To avoid a long list of references, a few key papers have been used as a main source of information, in which the fossiliferous beds have been noted and/or described.

The following data reveal:

1) There is a marked difference in the composition of plant assemblages found in the Anfiteatro de Ticó Formation and Punta del Barco Formation. There are exclusive taxa in the lower unit, *i.e.* Anfiteatro de Ticó Formation (megaspores are not taken into account).

a) Filicales: *Baqueroites padulae* Herbst, *Cladophlebis antarctica* Archangelsky, *C. cyathifolia* (Archangelsky) Villar de Seoane, and *C. tripinnata* Archangelsky.

b) Pteridosperms: *Ktalenia circularis* Archangelsky, *Pachypteris elegans* Archangelsky, *Ruflorentia papillosa* Villar de Seoane and *R. pilifera* Archangelsky.

c) Most Cycadales (85%).

d) All Bennettitales.

e) Most Ginkgoales (75%).

f) Conifers: *Apterocladus lanceolatus* Archangelsky, *Araucarites minimus* Archangelsky, *Athrotaxis ungeri* Archangelsky, *Morenoa fertilis* Del Fueyo *et al.*,

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Table 1. Distribution of species in Baqueró Group. Legend: A1 (Anfiteatro de Ticó Formation), A2 (Bajo Tigre Formation), A3 (Punta del Barco Formation). Location of plantiferous sections: SP 1 (Punta del Barco), SP 2 (Mina Caolín), SP 3 (Sierra Cuadrada), and SP 11 (Manantiales and Mercedes). References: (1) Archangelsky and Villar de Seoane (1990); (2) Archangelsky and Villar de Seoane (1991); (3) Taylor and Taylor (1988); (4) Archangelsky (1967); (5) Archangelsky and Villar de Seoane (1989); (6) Herbst (1966); (7) Villar de Seoane (1999a); (8) Villar de Seoane (2000); (9) Villar de Seoane (1997); (10) Archangelsky and Baldoni (1972a); (11) Archangelsky (1997); (12) A. Archangelsky *et al.* (1995); (13) Baldoni (1974); (14) Archangelsky and Baldoni (1972b); (15) Villar de Seoane (1999b); (16) Del Fueyo *et al.* (1990); (17) Del Fueyo (1991); (18) Archangelsky and Del Fueyo (1989); (19) Archangelsky and Taylor (1986); (20) Romero and Archangelsky (1986); (21) Martínez (1966).

UNITS TAXA	SP	A1					A2	A3					
		2	4	5	7	8	10	6	1	3	6	9	11
Lycophyta													
<i>Auriculozonospora spongiosa</i> (1)			○										
<i>Bacutriteles guttula</i> (2)			○										
<i>Bacutriteles triangulatus</i> (3)			○										
<i>Bacutriteles</i> sp. A (3)			○										
<i>Carbochonicus carbunculus</i> (2)			○										
<i>Erlansonisporites sparsis</i> (3)			○										
<i>Horstisporites feruglioi</i> (4)						○							
<i>Horstisporites iridodea</i> (3)			○										
<i>Hughesisporites patagonicus</i> (4)			○										
<i>Hughesisporites rugulatus</i> (2)			○										
<i>Minerisporites elegans</i> (5)			○										
<i>Minerisporites laceratus</i> (1)			○										
<i>Minerisporites patagonicus</i> (5)			○										
<i>Verrutriteles tomtaylori</i> (1)			○										
Equisetales													
<i>Equisetites</i> sp. (4)			○				○						
Filicales													
<i>Baqueroites padulae</i> (6)		○											
<i>Cladophlebis antarctica</i> (4)								○					
<i>Cladophlebis browniana</i> (4)									○				
<i>Cladophlebis cyathifolia</i> (7)									○				
<i>Cladophlebis haiburnensis</i> var. <i>rectimarginata</i> (6)													○
<i>Cladophlebis patagonica</i> (4)									○				○
<i>Cladophlebis tripinnata</i> (4)			○										
<i>Cladophlebis</i> sp. (4)						○						○	○
<i>Gleichenites argentinica</i> (4)										○	○		○
<i>Gleichenites feruglioi</i> (6)										○			○
<i>Gleichenites san-martinii</i> (4)									○	○		○	
<i>Gleichenites vegagrandis</i> (4)		○							○	○		○	
<i>Hausmannia papilio</i> (4)		○							○	○		○	
<i>Hausmannia patagonica</i> (4)									○	○		○	
<i>Ruffordia goepperti</i> (4)						○			○				○
Fronds (Morphogenera)													
<i>Sphenopteris</i> cf. <i>fittonii</i> (4)										○			
<i>Sphenopteris patagonica</i> (4)										○	○		
<i>Sphenopteris</i> (<i>Onychiopsis</i>) <i>psilotoides</i> (4)													○
<i>Sphenopteris</i> sp. (4)						○	○	○		○	○		○
Pteridospermales													
<i>Ktalenia circularis</i> (4)		○											
<i>Pachypteris elegans</i> (4)										○			
<i>Pachypteris?</i> <i>patagonica</i> (4)										○			
<i>Rufloflinia papillosa</i> (8)							○						
<i>Rufloflinia pilifera</i> (4)			○	○									
<i>Rufloflinia sierra</i> (4)			○	○			○			○			○
Leaves (Morphogenera)													
<i>Nilssonia clarkii</i> (4)										○	○		
<i>Taeniopteris</i> sp. (4)				○						○			○
Cycadales													
<i>Almargemia incrassata</i> (4)										○			
<i>Mesodescolea plicata</i> (4)			○					○			○		
<i>Mesosingeria coriacea</i> (4)				○							○		
<i>Mesosingeria herbstii</i> (4)			○	○									
<i>Mesosingeria mucronata</i> (4)				○									
<i>Mesosingeria?</i> <i>obtusata</i> (4)									○				
<i>Mesosingeria parva</i> (9)										○			
<i>Mesosingeria striata</i> (4)		○											

Nothopheuen brevis Archangelsky y Del Fueyo, *Squamastrobis tigrensis* Archangelsky y Del Fueyo, *Tarphyderma glabra* Archangelsky y Taylor, *Tomaxellia biforme* Archangelsky and *Trisacocladus tigrensis* Archangelsky.

2) Exclusive taxa for the upper unit, *i.e.* Punta del Barco Formation, are:

a) Filicales: *Cladophlebis browniana* (Dunk.) Sew., *C. haiburnensis* var. *rectimarginata* Herbst, *C. patagonica* Frenguelli, *Gleichenites argentinica* (Berry), *G. feruglioi* Herbst, *G. san-martinii* Halle, and *Hausmannia patagonica* Feruglio.

b) Pteridosperms: *Pachypteris? patagonica* Feruglio.

c) Morphogenera: *Sphenopteris* cf. *fittonii* Seward, *S. patagonica* Halle, and *Nilssonia clarki* Berry.

d) Cycadales: *Mesosingeria? obtusa* Archangelsky and *Pseudoctenis ornata* Archangelsky.

e) Conifers: *Podocarpus? palissyafolia* Berry.

3) Assemblages of the Anfiteatro de Ticó Formation are more varied taxonomically than those characterizing the Punta del Barco, upper flora. The difference between lower and upper assemblages, especially considering the absence of bennettitales and ginkgoales in the Punta del Barco Formation, implies an important vegetational change.

4) Angiosperms were already in existence during the deposition of the Anfiteatro de Ticó Formation, as determined by leaves (Romero and Archangelsky, 1986) and pollen (Archangelsky and Taylor, 1993).

Two biozones are here named and defined: *Ptilophyllum* (lower, Anfiteatro de Ticó being the type area and section) and *Gleichenites* (upper, Punta del Barco of Meseta Baqueró being the type area and section). They are characterized by the presence/absence of taxa noted above.

At present, the age of the Anfiteatro de Ticó Formation is considered to be late Barremian to early Aptian on palynological grounds and regional correlations. If so, the paleofloristic change may well correspond to the Aptian extinction event that is widely recognized (Hallam and Wignall, 1997). At that time extensive eruptions of the Ontong-Java Plateau took place in association with the strong volcanism registered in the Baqueró Group. Furthermore, the Early Cretaceous is a time of relatively low extinction rates and the only tentative evidence of such an event occurs in the Aptian (Hallam and Wignall, 1997). In this context it is possible to consider the abrupt extinction of two orders of gymnosperms within the Baqueroan time. Up to now there is no valid reference of Bennettitales or Ginkgoales during the Late Cretaceous in Patagonia, and the reasons for their extinction must have been quite dramatic. Perhaps the extensive volcanic activity was a principal cause. These stressful conditions may well have been a major cause for the extinctions, and the few plant records

from the Bajo Tigre Formation offer evidence for a survival epoch while the new vegetation that is found in the Punta del Barco Formation, growing under volcanic stress (Archangelsky *et al.*, 1995), suggests an epoch of recovery (Hallam and Wignall, 1997).

Based on this information it is possible to suggest a slightly younger age for the Bajo Tigre Formation (Aptian). Although some plant groups have disappeared during the deposition of Punta del Barco Formation, the presence of several common taxa with the underlying units constrain the age difference, that may be regarded as latest Aptian or Albian.

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