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Paleogeographic Changes During the Middle Jurassic in the Southern Part of the Neuquén Basin, Argentina

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Abstract

Sedimentary facies and palynological content analysis have been carried out to estimate the paleogeographic changes during the Middle Jurassic of the southwestern Neuquén Basin. Outcrop sequence stratigraphy analysis allows to recognize in these deposits eight depositional sequences, with an internal organization in system tracts. Because these outcrops extend from mainly fluvial deposits in the east to coeval marine inner and outer shelf deposits in the west they provide an opportunity to analyze palynological contents related to both lateral and vertical paleoenvironmental changes. Two palynological transects were studied: north-south and east-west oriented. These studies comprise the localities of Cerro Chacaico-Estancia Charahuilla and Rincón del Aguila -Lohan Mahuida respectively. The ages of the studied deposits range from lowermost Bajocian to Middle Bathonian, dated by ammonoid faunas (Lower - Upper Bajocian) and regional correlation (Lower - Middle Bathonian). The average thickness of the studied exposures is about 500 m. showing a strong vertical progradational trend. In the west, the succession starts with marine outer shelf pelites followed by middle-inner shelf sandstones, ending with fine grained continental red beds. On the other hand, eastern outcrops start with shelf pelites, followed by medium to coarse grained alluvial deposits. The succession ends with fine grained continental red beds.

INTRODUCTION

During the Middle Jurassic in the study area (southwestern Neuquen Basin), Los Molles, Lajas, and Challacó formations of Cuyo Group, have been deposited corresponding to marine inner to shelf near-shore and fluvial deposits.

Outcrop sequence stratigraphy analysis allows to recognize eight depositional sequences, in these deposits with an internal organization in system tracts.

Two transects were studied: north-south and east-west oriented, taking into account their palynological content. The first comprises the localities of Cerro Chacaico - Estancia Charahuilla and the second Rincón del Aguila - Lohan Mahuida.

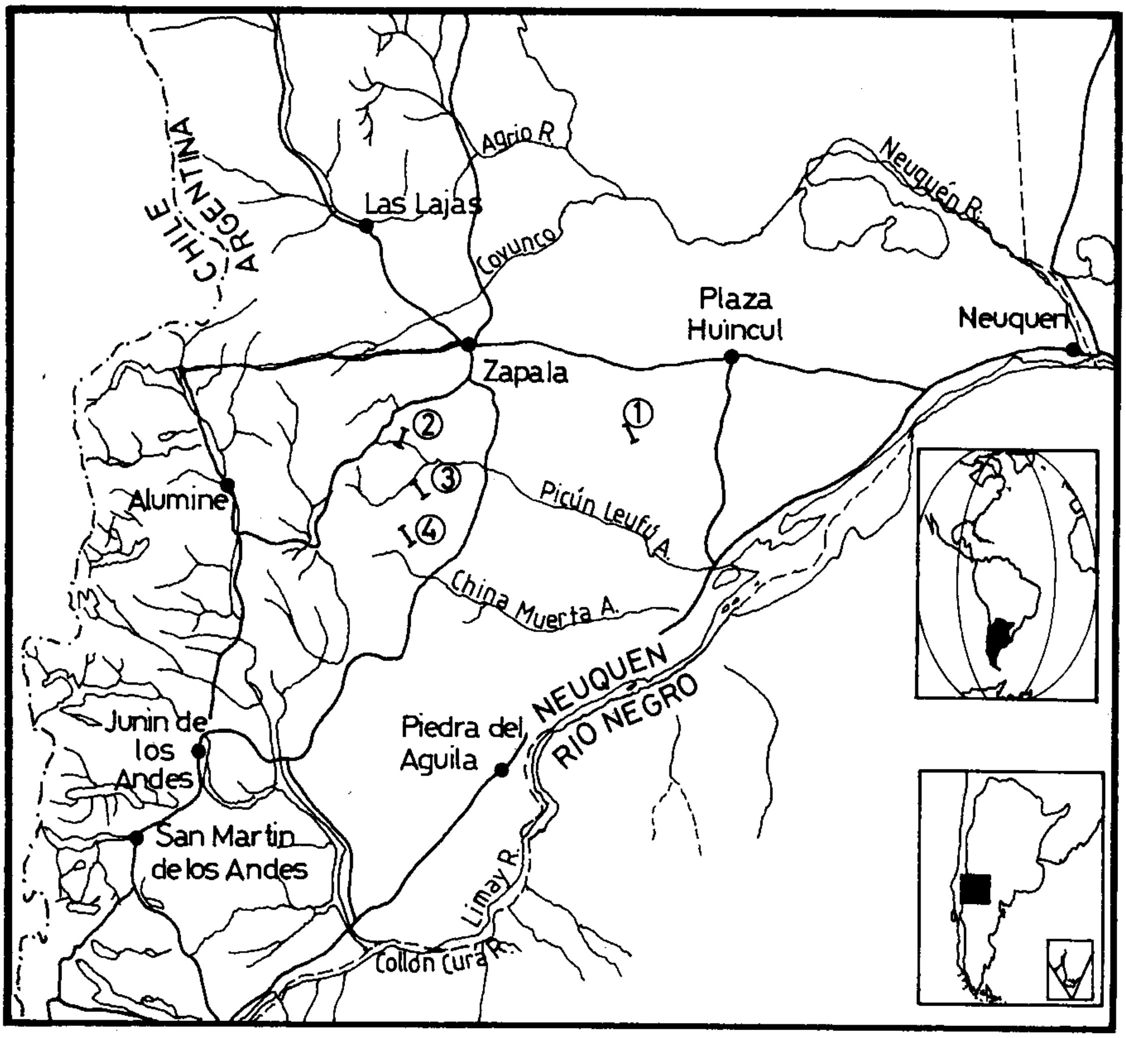
First a detailed account is given of the palynostratigraphy and age assessment of the Los Molles and Lajas formations. Challacó Formation was palynologically sterile.

In the second part palynofacies are described.

Palynofacies analysis includes structured organic matter (specially palynomorphs) and structureless organic matter.

In contrast to palynostratigraphic analysis which uses the palynomorph content of a rock sample to determine the age of the sample, palynofacies analysis deals with the total acid resistant organic residue.

In samples without palynomorphs, (JC4.1 and in some samples of JC5 sequence of Rincón del Aguila section) structured debris and structureless organic matter were considered, (organic matter is transported similarly to mineral matter, thus the results of a particulate organic matter study should correlate with the results of a sedimentary study, [1]).



REFERENCE

1. Rincón del Aguila Section
2. Lohan Mahuida Section
3. Cerro Chacaico Section
4. Charahuilla Section

Fig. 1: Location map.

These data were combined with sedimentological observations to develop an integrated paleoenvironmental interpretation.

Relations between relative sea level changes, inferred mainly from facies and sequence stratigraphic analysis, and paleoenvironmental conditions, provided by palynological studies, are used to reconstruct paleoclimatic changes.

This information has a well defined biostratigraphic framework, specially ammonite biostratigraphy.

GEOLOGICAL FRAMEWORK

The Neuquén Basin is a back-arc basin located in western central Argentina. It took place during uppermost Triassic and was an important area of sedimentation during the Jurassic and Lower Cretaceous .The study area is located in the southern part of the Neuquén Basin, almost 40 Km south of Zapala city. Facies and outcrop sequences allow to recognize four 3rd-order depositional sequences named JC4, JC5, JC6 and JC7, for the Cuyo Group (Middle Jurassic) in this area. The JC4 sequence is composed by 4th-order sequences: JC4.1, JC4.2, JC4.3, JC4.4 and JC4.5 (Zavala, this volume). In the present study JC4, JC5 and JC6 sequences are considered. (Fig. 2, 3, 4 and 5).

METHODOLOGY

Fieldwork included a palynological sampling of Charahuilla and Cerro de Chacaico in Sierra de Chacaico, Rincón del Aguila (Cerro Lotena) and Lohan Mahuida sections. The sections were described bank-by-bank and measured with Jacob's báculo.

Through facies analysis 17 facies were identified. These can be grouped in 12 sequences, each characterizing an equal number of sedimentary environments and subenvironments (Zavala, this volume).

In laboratory, physical and chemical extraction of the 44 stratigraphical levels were performed using [2], processing technique modified by Dr. W.A.S. Sarjeant, Laboratory, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Canadá.

The systematic study included 28 palynologically fertile levels (Microfloristic Associations).

Among 10 and 15 g of each sample were weighted and 2 tablets of *Lycopodium* sp. with 11267 spores each one were added.

For statistical purposes percentage and absolute pollen frequency (APF: number of pollen per gram sediment= grains .gm^{-1}), species diversity (number of species in each association) were considered.

The pollen percentages were calculated from the pollen sums between 150 and 200 grains of pollen, spores and plankton in each level. The foreign pollen was added to compute the absolute palynomorph frequency, (specimens g^{-1}, [3]).

For environment evaluation the spore/pollen taxa were compared with modern equivalents (Table 1).

Two major categories of organic matter under transmitted light are distinguished, [4]: Structured and Structureless materials.

Each paleomicrofloristic association was characterized using the following variables:

- The association of taxa in the microfloristic association that reflects vegetal paleocommunities. The evolution of these paleocommunities reflects paleoclimatic trends.
- The terrestrial components (sporomorphs, land debris, etc.) in an assemblage decrease, and the marine components (microplankton, foraminiferal, linings, etc.) increase with distance away from terrigenous influx [5].
- Maximum flooding surfaces in tidal flat, estuarine and lagoonal environments are more difficult to identify in the field, but can often be singled out by palynofacies analysis because they coincide with a significant increase in abundance and diversity of dinoflagellate cysts [6].
- Increasingly shallower water depths during late highstand deposits are often emphasized by a decrease in dinoflagellate cyst abundance and diversity [6].
- The palynological content of offshore facies reflects more accurately the average climatic conditions, because it is poorly influenced by local variations or sedimentary influx.
- The importance of the inland (long distant) influx (anemophilous) over the coastal forms, because it reflects the regional conditions more accurately.

-Presence of thermophilic spores and pollen versus temperate to cooler elements. The Cheirolepidiaceae producing *Classopollis* were thermophilic. Under conditions of warm and hot but relatively humid climate, the Araucariaceae could grow together with Cheirolepidiaceae, [7, 8], Schizaeaceae (*Ischyosporites)*, Cyatheaceae (*Deltoidospora*), Osmundaceae (*Todisporites)*, Dipteridaceae (*Dictyophyllidites*) and monocolpate (*Cycadopites*) are considered as subtropical, temperate and humid climate elements.elative percentages are used for paleoclimatic evaluation

- Absolute pollen frequencies (APF)are used for study of facies control over palynomorph presence.
- The relative abundance of inertinite (=Palynomaceral 4, [9]) and vitrinite (=Palynomaceral 1,2,3 [9]) may be used as an indicator of the energy/oxidation level. Large proportion of land plant tissues and cutinite versus inertinite and vitrinite indicate lower oxidizing conditions [10].
- Blade-shaped inertinite fragments have a better buoyancy than equidimensional fragments and their absolute frequency may be indicative of proximal-distal trends [9, 11].

TAXA	FAMILY/ORDER
Deltoidospora	Cyatheaceae-Dicksoniaceae
Todisporites	Osmundaceae
Biretisporites	"
Gleicheniidites	Gleicheniaceae
Dictyophyllidites	Dipteridaceae
Rugulatisporites	Osmundaceae
Osmundacidites	"
Punctatosporites	Marattiaceae
Granulatisporites	Dipteridaceae
Divisisporites	Gleicheniaceae
Ischyosporites	Schizaeaceae
Podocarpidites	Podocarpaceae
Microcachryidites	"
Callialasporites	"
Alisporites	"
Vitreisporites	Caytoniaceae
Inaperturopollenites	Araucariaceae
Araucariacites	"
Cycadopites	Cycadales/Bennettitales
Monosulcites	"
Classopollis	Cheirolepidiaceae
Gliscopollis	"

Table 1.Modern equivalents of some fossil taxa present in Los Molles and Lajas formations .

PALYNOSTRATIGRAPHY

The ranges of the studied sporomorphs are shown in Quattrocchio and Volkheimer (this volume) who divided the Jurassic of the Neuquén Basin into two palynozones and seven subzones. The studied interval corresponds to the *Callialasporites dampieri* Zone, *Callialasporites turbatus* Subzone (Upper Toarcian-Lower Bajocian) and *Ischyosporites marburgensis* Subzone (Upper Bajocian). They are correlated whith the ammonite zones [12]. (Table 2). A taxonomic list is also present (Appendix 1).

PALYNOFACIES (Figs. 2, 3, 4, 5)

Each sequence is characterized through its palynofacies content, specially palynomorphs. In platform facies of JC4.1 and graived meandering rivers facies of JC5 in Rincón del Aguila section, only structured debris and structureless organic matter are present.

SPECIES	*Emileia giebeli* Ass. Zone	*Megasphaeroceras rotundum* Ass. Zone
	LOWER BAJOCIAN	UPPER BAJOCIAN
Deltoidospora australis	----------	----------
Deltoidospora neddeni	----------	----------
Deltoidospora neddeni regularis		----------
Todisporites minor	----------	----------
Dictyophyllidites mortoni	----------	----------
Punctatosporites scabratus	----------	----------
Granulatosporites sp. A	----------	----------
Granulatosporites sp. B	----------	----------
Ischyosporites labiatus		----------
Ischyosporites cf. marburgensis	----------	----------
Podocarpidites ellipticus	----------	----------
Podocarpidites cf. otagoensis	----------	
Vitreisporites pallidus	----------	----------
Classopollis simplex	----------	----------
Classopollis cf. classoides	----------	----------
Gliscopollis tersus	----------	
Araucariacites fissus	----------	----------
Cycadopites punctatus	----------	----------
Alisporites robustus	----------	
Gleicheniidites argentinus		----------
Araucariacites australis	----------	----------
Araucariacites pergranulatus	----------	----------
Cycadopites nitidus	----------	----------
Monosulcites carpentieri	----------	
Monosulcites sp. A	----------	----------
Todisporites mayor	----------	----------
Callialasporites dampieri	----------	----------
Cycadopites granulatus	----------	----------
Callialasporites segmentatus	----------	----------
Concavisporites laticrassus	----------	
Concavisporites semiangulatus		----------
Alsophilidites cf. kerguelensis	----------	
Foveotriletes microfoveolatus	----------	
Inaperturopollenites turbatus	----------	----------
Apiculatisporites charahuillaensis	----------	
Ischyosporites pachydictyus		----------
Ischyosporites variegatus	----------	----------
Monosulcites aff. M. minimus	----------	----------
Asterisporites chlonovae	----------	
Verrucosisporites cf. walloonensis		----------
Uvaesporites minimus	----------	----------
Verrucosisporites cf. opimus		----------
Osmundacidites araucanus	----------	----------
Osmundacidites diazii		----------
Rugulatisporites neuquenensis	----------	----------
Podocarpidites cf. verrucosus	----------	----------
Callialasporites trilobatus	----------	----------
Microcachryidites antarcticus		----------
Microcachryidites cf. castellanosii	----------	
Baltisphaeridium debilispinum	----------	
Cymatiosphaera eupeplos	----------	
Escharisphaeridia pocockii	----------	----------
Micrhystridium fragile	----------	
Nannoceratopsis gracilis	----------	
Interulobites cf. variabilis	----------	----------

Table 2. Stratigraphic ranges of selected species from Los Molles and Lajas formations, Neuquén Basin.

DEPOSITIONAL SEQUENCE JC4
JC4.1 Sequence -HST- (High-Stand Systems Tract).

Age: lowermost Early Bajocian (Zavala, this volume).

Rincón del Aguila section, (Micr. Assoc. A) and Cerro Chacaico section (Micr. Assoc. A and B) and Charahuilla sections (Micr. Assoc. A) it includes off-shore claystones; upwards deltaic mouth bars of braid-deltas are registered. In Lohan Mahuida section (Micr. Assoc. A and B) it is integrated by offshore bars with tidal influence. (Fig. 6).

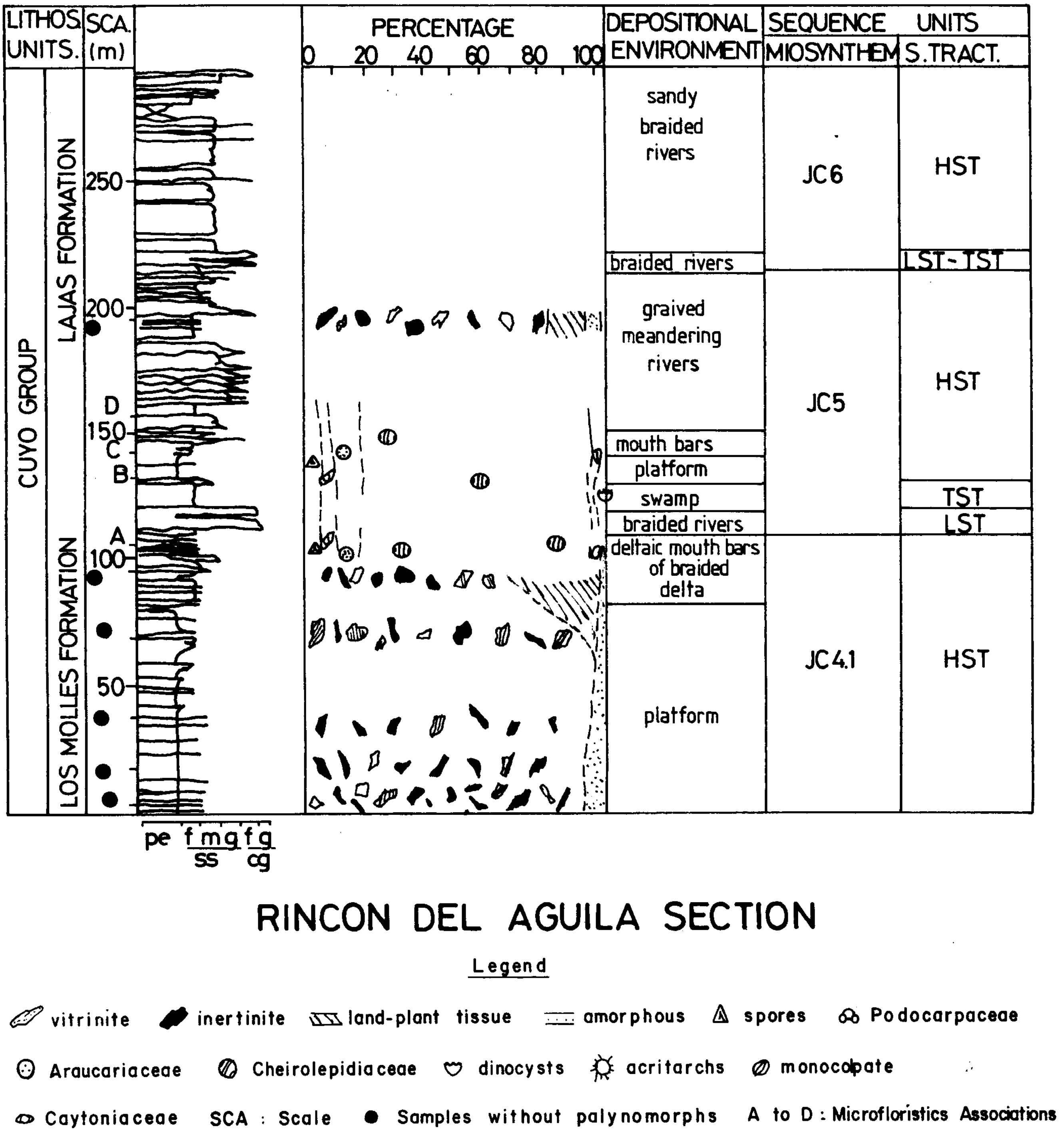


Fig. 2. Results of palynofacies analysis in the Lower to Upper Bajocian (Rincón del Aguila section). Neuquén Basin.

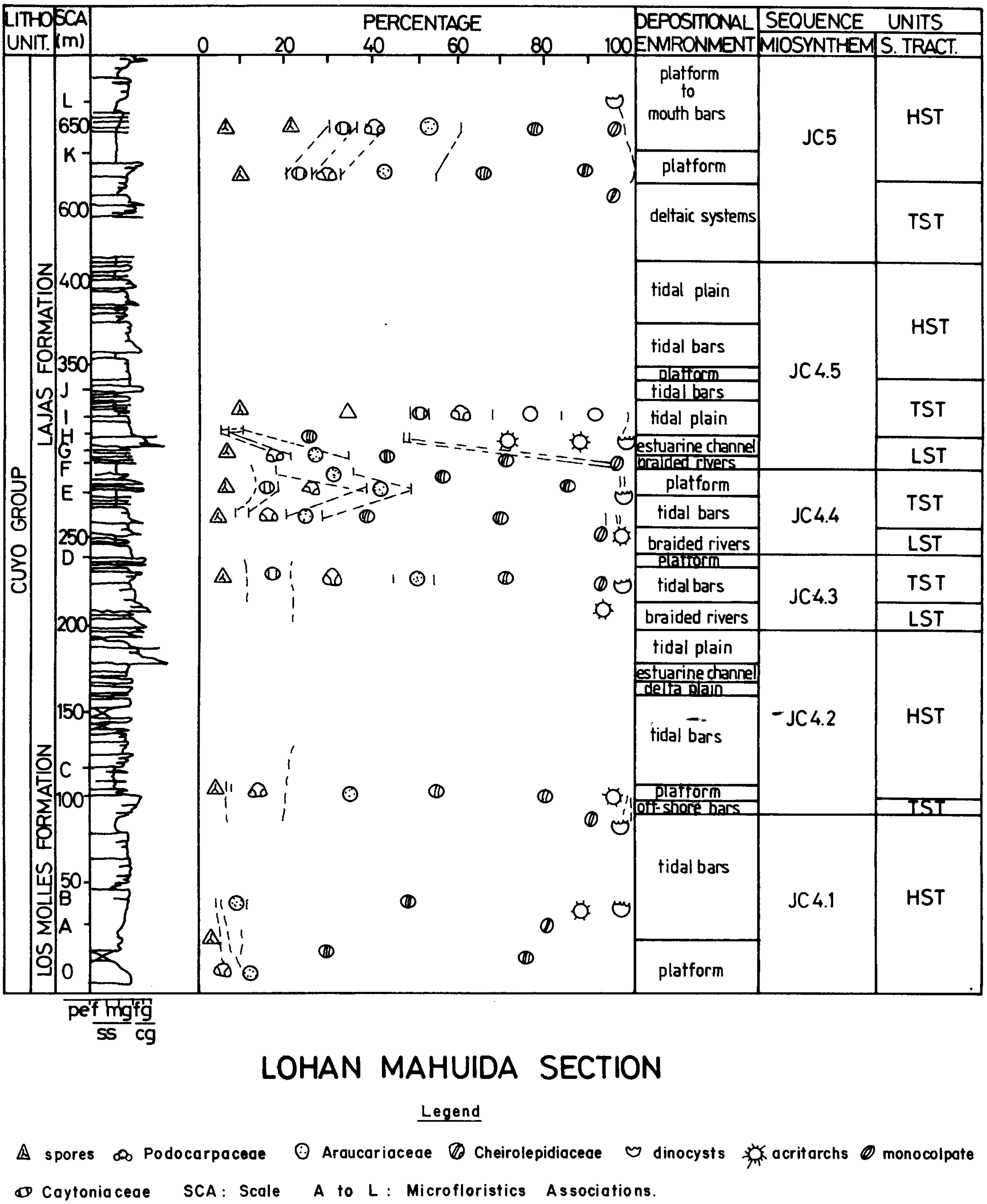


Fig. 3. Results of palynofacies analysis in the Lower to Upper Bajocian Lohan Mahuida sections Neuquén Basin.

Characteristic association:
- terrestrial: Cheirolepidiaceae-Araucariaceae.
- marine: *Escharisphaeridia pocockii* - *Baltisphaeridium* sp. - *Micrhystridium* sp.- *Cymatiosphaera* sp., in Lohan Mahuida and Charahuilla sections.

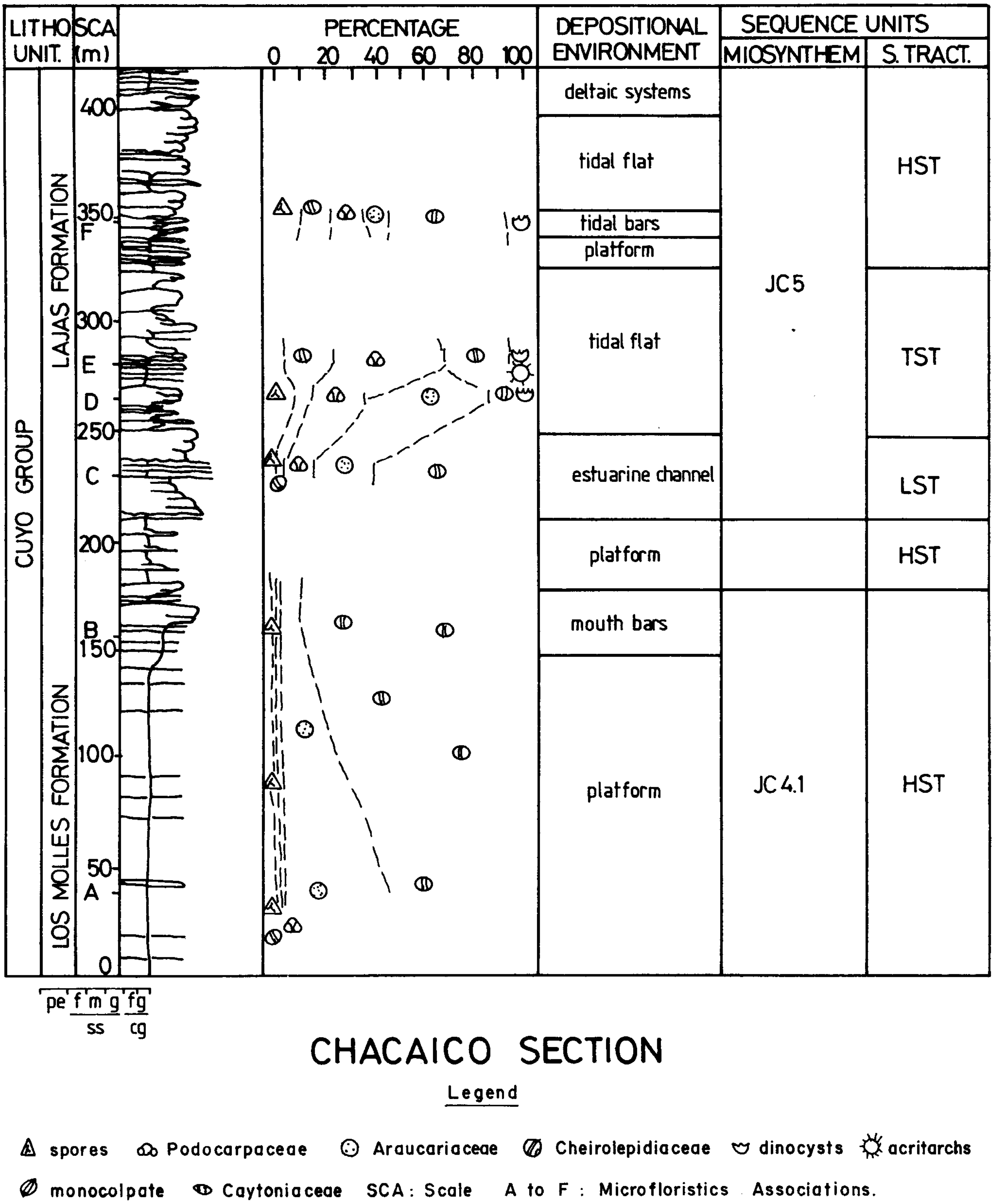


Fig.4. Results of palynofacies analysis in the Lower to Upper Bajocian Chacaico section. Neuquén Basin.

There is no register of paleomicroplancton in JC4.1 at Chacaico and Rincón del Aguila localities. In Lohan Mahuida section the acritarchs reach 582 grains . gm^{-1}, (15,4%) and dinoflagellates 100

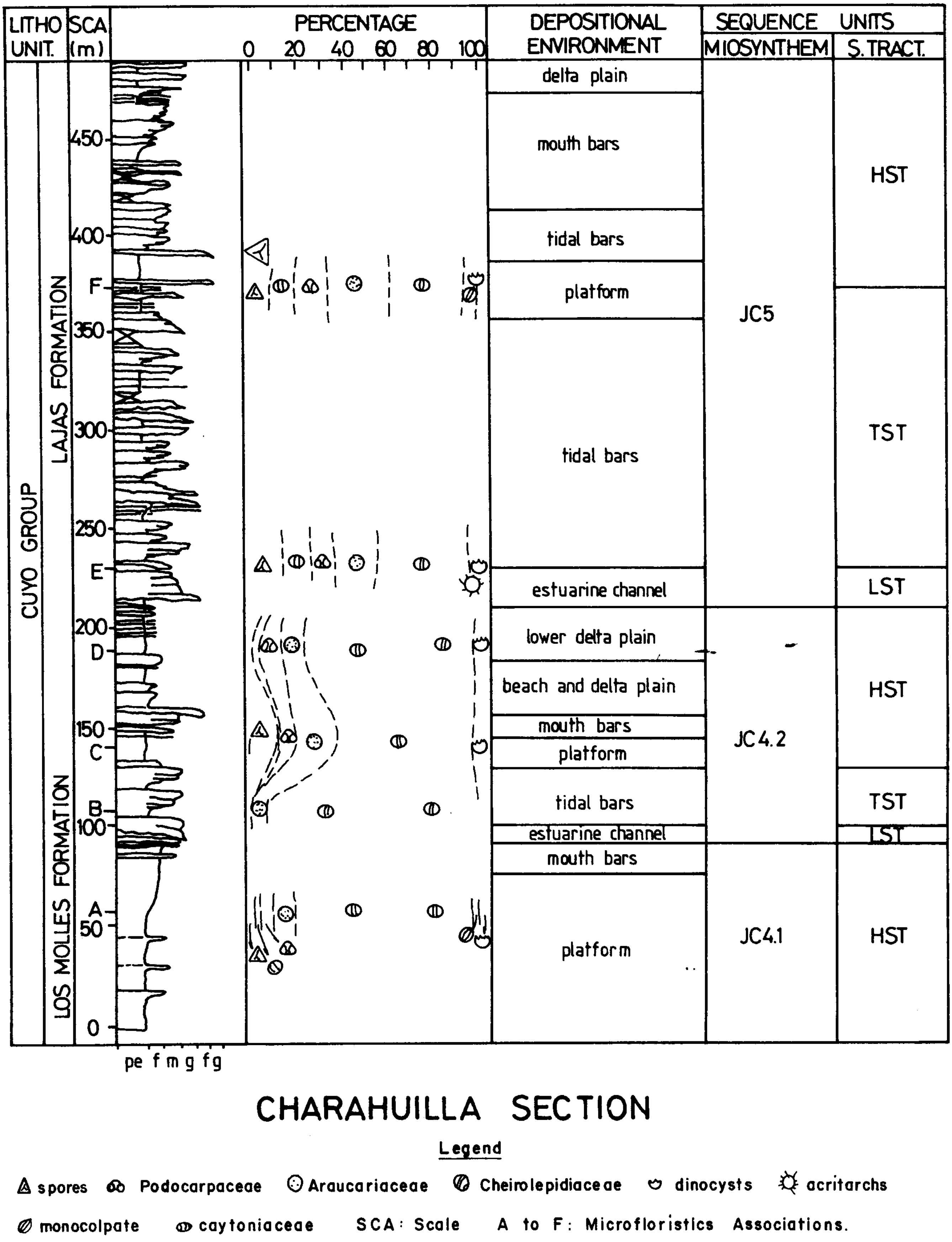


Fig. 5. Results of palynofacies analysis in the Lower to Upper Bajocian (Charahuilla section). Neuquén Basin.

grains . gm^{-1}, (4,6%) in Micr. Assoc. B.
The absolute frequency of *Classopollis* increases from the off- shore facies 4.600 grains . gm^{-1}, (91% Micr. Assoc. A) in Lohan Mahuida section to the deltaic mouth bars up to 91.600 grains . gm^{-1} (90%, Micr. Assoc. B) in Sierra de Chacaico.
The same behaviour present the Araucariaceae: 8.000 grains . gm^{-1} (26% Micr. Assoc. A) in Cerro Chacaico section; up to 10.365 grains . gm^{-1} (7,7 % Micr. Assoc. A) Rincón del Aguila section.
The lower part of JC4.1 at Rincón del Aguila section is dominated by bladeshaped inertinite and vitrinite and transparent organic matter (SOM), without palynomorphs.

JC4.2 Sequence -TST-(Transgressive Systems Tract) -HST-

Age: Middle Early Bajocian

Present in Charahuilla and Lohan Mahuida sections. At Lohan Mahuida the Micr. Assoc.C is associated to platform facies.
At Charahuilla section are recognized tidal bars (Micr. Assoc. B), platform (Micr. Assoc. C) and deltaic plain facies (Micr. Assoc. D). Presence of *Emileia* sp. of *Emileia Giebeli* Zone and fauna of *Emileia multiformis* Subzone [13].

Characteristic Association:
-terrestrial: Cheirolepidiaceae-Araucariaceae.
-marine: In deltaic plain facies: *Micrhystridium* sp. *Solisphaeridium* sp. In platform facies: *Escharisphaeridia pocockii* and *Micrhystridium* sp.

The Cheirolepidiaceae show a decrease of 27.637 grains . gm^{-1} (80% Micr. Assoc. D), from the deltaic plain to 16.522 grains . gm^{-1}, 58% (Micr. Assoc. C), in platform facies in Charahuilla section and 4.364 grains . gm^{-1}, (46,5% Micr. Assoc. C), in Lohan Mahuida section.
The Araucariaceae is the second dominant group with a maximum in platform facies, 6.258 grains . gm^{-1} (17,5 %, Micr. Assoc. C), in Charahuilla section. *Todisporites minor* , *T. mayor* and *Dictyophyllidites mortoni* present its maximum expression in platform facies 2.579 grains . gm^{-1}, (26%, Micr. Assoc. C) in Charahuilla section.
At Lohan Mahuida section the dinoflagellate present 227 grains . gm^{-1}, (3,6%) and acritarchs 170 grains . gm^{-1}, (2,4%) in Microfloristics Association C.

Sequences JC4.3, JC4.4 and JC4.5-LST-(Low-Stand Systems Tract) -TST-

Age: Early Bajocian

This sequence has only been recognized in Lohan Mahuida section.
JC4.3 and JC4.4 begin with thicker fluvial to estuarine channels (Micr. Assoc. D-E) followed by a fast transition to off-shore claystones (Micr. Assoc. F-G). JC4.5 sequence begin also with thicker fluvial channels (Micr. Assoc. H-I), followed by littoral to platform tidal facies (Micr. Assoc. J) with a retrogradational stacking pattern interpreted as TST deposits.
At JC4.5 presence of *Chondroceras cf. recticostatum* [12] de la Zona de *E. giebeli.*

Characteristic Association:
- terrestrial: Cheirolepidiaceae - Podocarpaceae, in JC4.3. Cheirolepidiaceae - Podocarpaceae-Araucariaceae in JC4.4
Cheirolepidiaceae - Araucariaceae-Podocarpaceae in JC4.5

- marine: *Escharisphaeridia pocockii - Micrhystridium* sp. in JC4.3 and JC4.5 sequences.
  Escharisphaeridia pocockii - Nannoceratopsis gracilis in JC4.4.

In JC4.3, the Cheirolepidiaceae represent 4.456 grains . gm^{-1} (37 %) of the total and the Podocarpaceae 2.240 grains . gm^{-1}, (24,6 %) in tidal bars (Micr. Assoc. D).

JC4.4 presents the highest absolute frequency of Cheirolepidiaceae : 81.859 grains . gm^{-1} gr. (66%); Podocarpaceae-Araucariaceae 12.391 grains . gm^{-1} (10%), spores (*Deltoidospora, Todisporites*) 9.387 grains . gm^{-1} (7,6%) and paleomicroplankton, (*Nannoceratopsis gracilis* and *Escharisphaeridia pocockii*) (2,4%) 2.253 grains . gm^{-1}, associated with tidal bars facies (Micr. Assoc. E). This Microfloristic Association E, presents the highest diversity (28 species of spores and pollen) of JC4.4 sequence. In platform facies the *Classopollis* represent 15.344 grains . gm^{-1} (48% Micr. Assoc. F) up to 24.637 grains . gm^{-1} (65 % Micr. Assoc. G). Microfloristic Association E, F and G are associated with Transgressive Systems Tract (TST).

In JC4.5 (LST) the Cheirolepidiaceae associated to fluvial channels facies (Micr. Assoc. H and I) have 26.521 grains . gm^{-1}, (61%) and indication a decrease of 3.242 grains . gm^{-1}, (37,7%) associated with the acritarchs 4.230 grains . gm^{-1}, (49,5%) in estuarine channels deposits. In Micr. Assoc. H the Araucariaceae present (6.760 grains . gm^{-1}, (15,6%), Podocarpaceae 3.120 grains . gm^{-1}, (7.2%) and *Cycadopites* 1.213 grains . gm^{-1}, (2,8%). In tidal flat facies (Micr. Assoc. J) the spores (*Ischyosporites marburgensis, I. labiatus, Deltoidospora australis D. neddeni, Todisporites minor, Rugulatisporites neuquenensis)* reach 2.699 grains . gm^{-1}, (47,3%).

DEPOSITIONAL SEQUENCE JC5

Age: Early to Late Bajocian

The depositional sequence JC5 was recognized in all sections.

Its basal boundary is the "Intrabajocian" unconformity for the study area (Zavala, this volume).

In Cerro Lotena (Rincón del Aguila) the sequence begins with braided river deposits which grade upward to off-shore marine claystone (Micr. Assoc. B and C) and mouth-bars (Micr. Assoc. D).

At Cerro Chacaico (Micr. Assoc. C, D and E), Charahuilla (Micr. Assoc. E) and Lohan Mahuida sections it begins with braided to estuarine channel deposits. A tidal sandwave environment with a retrogradational stacking pattern related to the TST is recognized upward. The HST begins with off-shore claystone, followed mainly by wave-dominated deltaic systems and delta plain sediment. At Cerro Lotena (Micr. Assoc. D), Charahuilla section (Micr. Assoc. F), Cerro Chacaico section (Micr. Assoc. F), and Lohan Mahuida section (Micr. Assoc. K and L).

Characteristic association:
- terrestrial: Cheirolepidiaceae-Araucariaceae
- marine: *Escharisphaeridia pocockii-Micrhystridium* sp.

In Chacaico section the spectrum is dominated by Cheirolepidiaceae (11.924 grains . gm^{-1}, (59,3%), Araucariaceae 4.788 grains . gm^{-1} (23,8%) in LST deposits, estuarine channels (Micr. Assoc. C).

In TST mouth-bar deposits (Micr. Assoc. D) in Chacaico section, the anemophilous pollen dominate the spectrum; the Araucariaceae 7.642 grains . gm^{-1}, (48 %), Podocarpaceae 12.617 grains . gm^{-1} (45 %), over the Cheirolepidiaceae 7.333 grains . gm^{-1} (25,5 %).

In HST deposits, (Micr. Assoc. D), Rincón del Aguila section, the Cheirolepidiaceae dominate the spectrum: 27.041 grains . gm^{-1} (88 %); the Araucariaceae are less frequent: 2.362 grains . gm^{-1}, (7,7%). In Lohan Mahuida (Micr. Assoc. L) the monocolpate reach 795 grains . gm^{-1}, (3,7%).

Associated with fluvial influence the microfloristic association shows a high diversity of terrestrial species (28). In meandering rivers (HST) inertinite and vitrinite whith a sligh proportion of tissue and land plant amorphous matter (SOM dark) dominate. Its organic content shows an environment distinguished by higher oxidizing conditions and rapid deposition, according with the fluvial facies.

DISCUSSION

- The distribution of palynomorphs are related to sedimentary facies. Thus, in the same sequence in different positions of the transect, the composition of the microfloristic assemblages changes in a lateral chronocorrelation. (Fig. 6 and Fig. 7).

Considerating the plant groups present in the studied sections we can infer that:

-During the deposition of JC4.1 and JC4.2, sequences (Lower Bajocian) the conditions may have been warm and relatively humid according with the following consideration [7, 8].

*The Cheirolepidiaceae producing *Classopollis* were thermophilic

*A low content (1-10%) of *Classopollis* suggests temperate climatic conditions, whereas a percentaje of 20-50% reveals warm subtropical ones. The climate was warmer and the humidity variant from 10 to 30-40 %.

*The highest content, attaining 60-75% and even 90%, testifies to an arid climate. In semiarid and arid hot climate the content of *Classopollis* is over 50 %. .

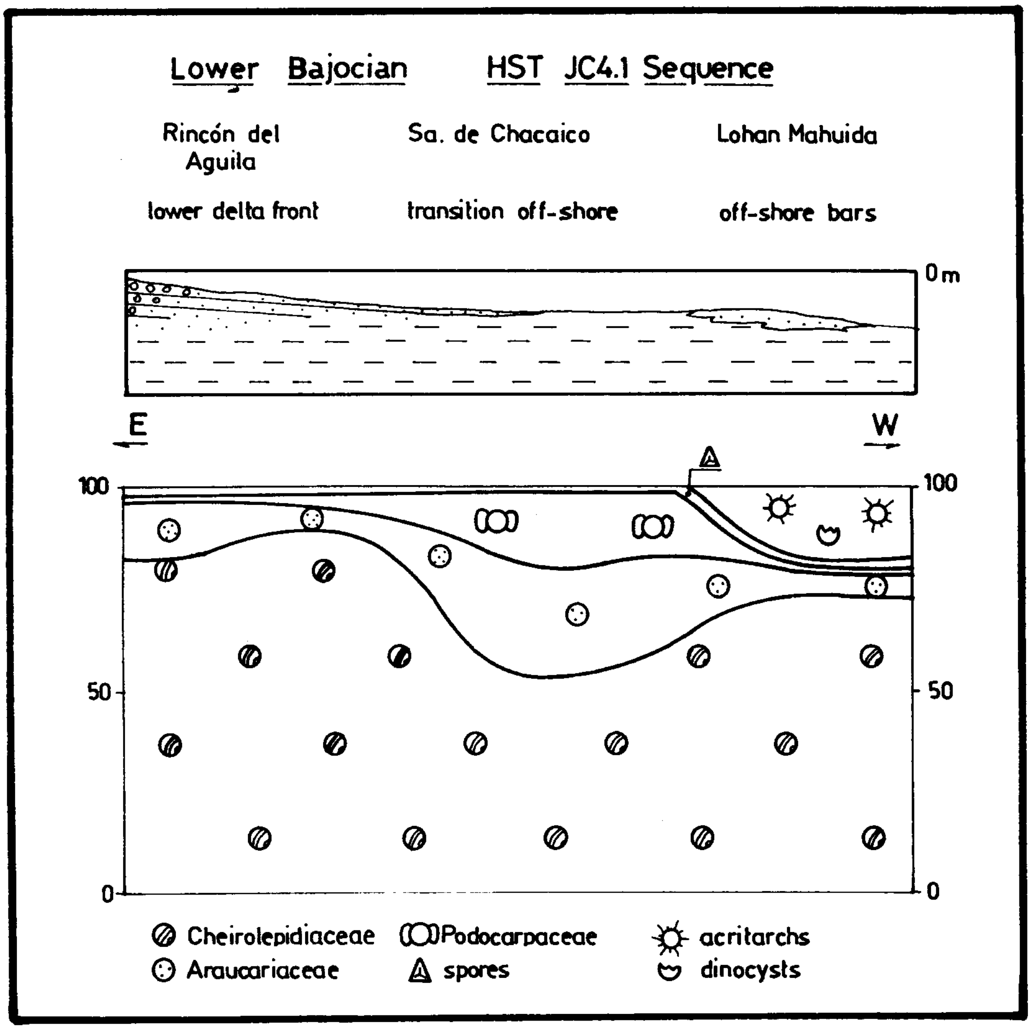


Fig. 6. Schematic distribution of palynofacies constituents across lower delta front to off-shore bars environments. JC4.1 Sequence.

-Under conditions of warm and hot but relatively humid climate, the Araucariaceae could grow together with Cheirolepidiaceae.

-The sequences JC4.3 and JC4.4 suggests the beginning of a relative climate deterioration, indicated by the increase of Podocarpaceae in relation with the lower sequences. The extensive representation of upland communities suggests a lowering of ecotones, bringing these communities into closer proximity to the lowland basin of deposition. This is consistent with the establishment of cooler temperatures.

-In JC4.5 and JC5, indicate that climate became warm and wet in agreement with the above mentioned consideration and also due to the higher representation of thermophilic spores (Schizaeaceae, Gleicheniaceae, Dipteridaceae, Marattiaceae, etc,) and pollen grains of *Cycadopites*. Cycadales and Bennettitales reached their maximum development under conditions of a humid subtropical to tropical climate, [8].

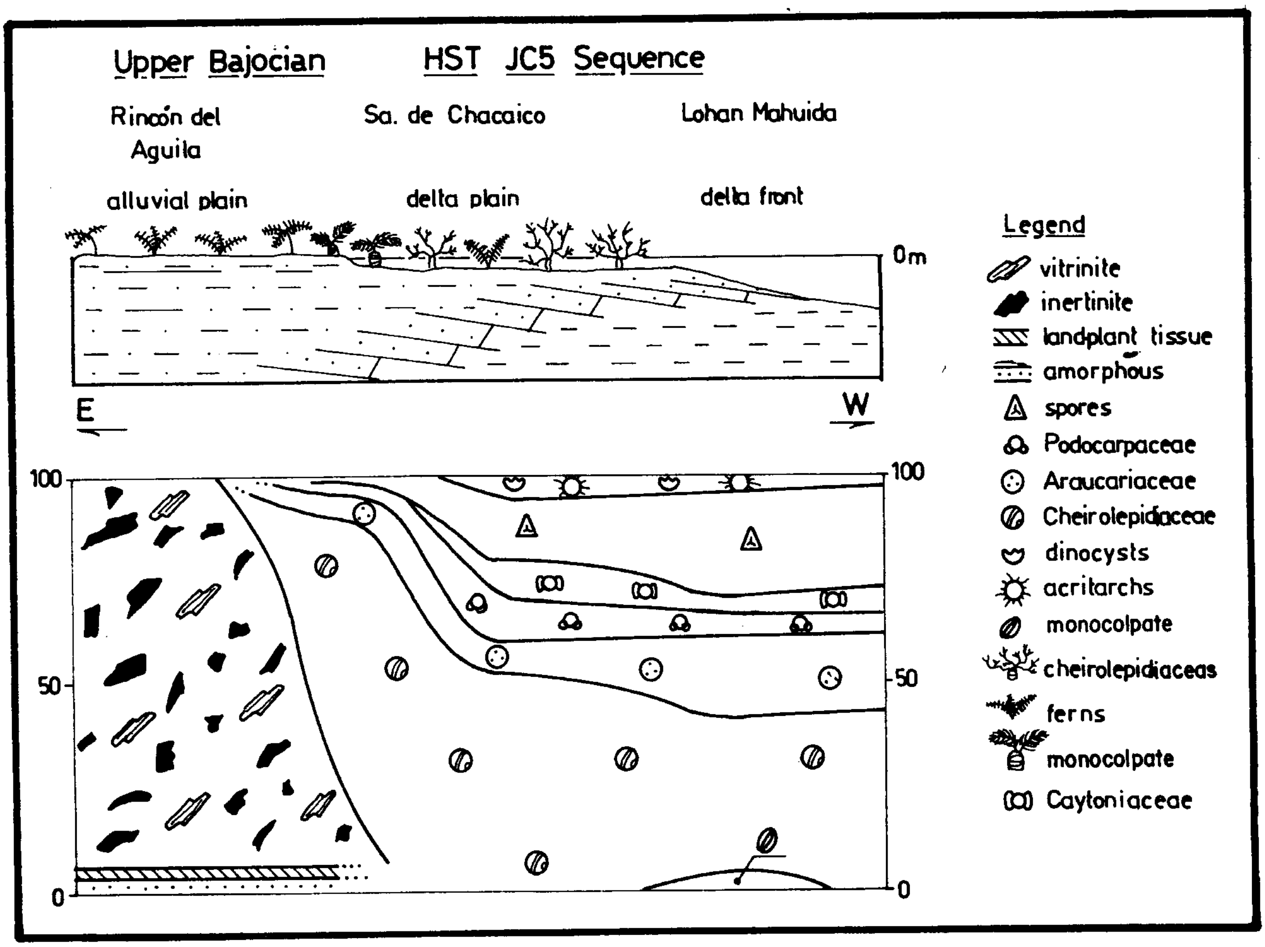
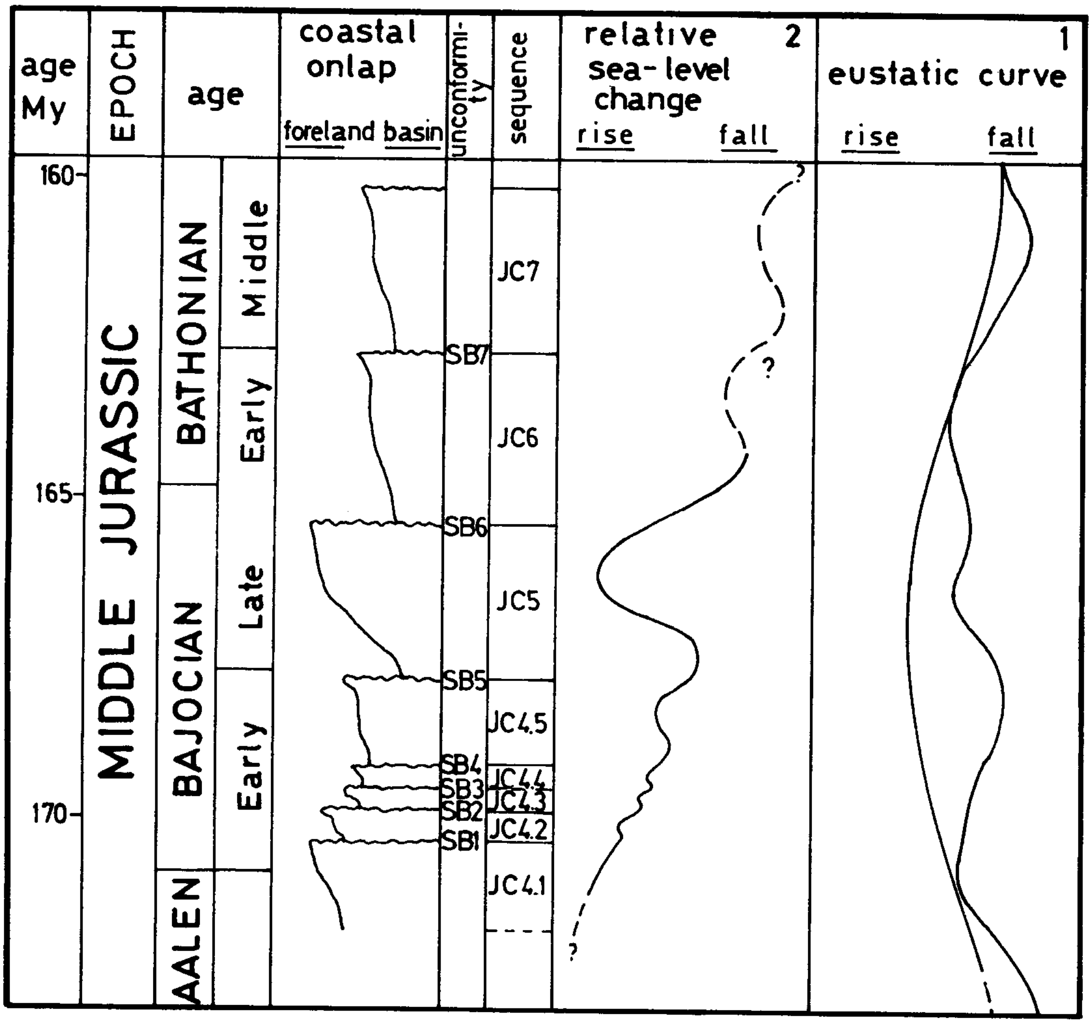


Fig. 7. Schematic distribution of palynofacies constituents across alluvian plain to delta front environments JC5 Sequence.

-From the analysis of the curve of relative sea level change (coastal onlap) for the Late Aalenian to Middle Bathonian in the study area (Zavala, this volume) and its comparison with the curve of eustatic variations of [14], a relatively high sea level in the lowermost Early Bajocian, followed by sequences of low sea level in the late Early Bajocian and a relative high sea level in the Late Bajocian [15], could be recognized. (Fig.8). The higher percentages and diversity of paleomicroplankton correspond to HST of JC4.1 sequence and HST of JC4.2 sequence associated with warm to relatively humid conditions in the continental areas.

- The deterioration suggested by the microfloras may correspond to the relative lower sea level of the Late Early Bajocian (JC4.3 and JC4.4 sequences). The highest sea level rise of the Late Bajocian is registered at late TST and HST of the JC5 sequence and suggests an amelioration of climatic conditions.



1. Haq, et al, 1987 . 2. Zavala, 1993 (for this study area)

Fig. 8: Curve of relative sea level change (coastal onlap) for the Late Aalenian to Middle Bathonian Neuquén Basin and its comparison with the curve of eustatic variations of [14, 15].

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Apendix 1. Taxonomic list of species.

Taxonomic list of species present in Cerro Chacaico, Charahuilla, Rincón del Aguila and Lohan Mahuida profiles.

Infraturma LAEVIGATI Bennie & Kidston emend. Potonié 1956
Deltoidospora australis (Couper) Pocock 1970
Deltoidospora neddeni Pflug 1953
Deltoidospora neddeni regularis (Pflug) Danzé Corsin & Levaine 1963
Todisporites cf. minor Couper 1958
Todisporites major Couper 1958
Alsophilidites cf. kerguelensis Cookson 1947
Divisisporites Thomson 1953
Dictyophyllidites mortoni (de Jersey 1959) Playford & Dettmann 1965
Concavisporites laticrassus Volkheimer 1972
Concavisporites semiangulatus Menéndez 1968

Infraturma APICULATI Bennie & Kidston emend. Potonié 1956
Apiculatisporites charahuillaensis Volkheimer 1972
Baculatisporites tenuis Volkheimer 1968
Granulatisporites sp. A Volkheimer 1968
Granulatisporites sp. B Volkheimer 1968
Osmundacidites cf. araucanus Volkheimer 1972
Osmundacidites diazii Volkheimer 1972
Rugulatisporites cf. neuquenensis Volkheimer 1972
Asterisporites chlonovae (Doring) Venkatachala at Rawat
Verrucosisporites cf. opimus Manum 1962
Verrucosisporites cf. walloonensis De Jersey 1959

Infraturma MURORNATI Potonié & Kremp 1954
Lycopodiumsporites cf. austroclavatidites (Cookson) Potonié 1956
Uvaesporites minimus Volkheimer 1968
Foveotriletes microfoveolatus Menéndez 1968

TRICRASSATI Dettmann 1963

Infraturma AURICULATI Schopf emend. Dettmann 1963
Gleicheniidites argentinus Volkheimer 1972
Ischyosporites cf. marburgensis de Jersey 1963
Ischyosporites labiatus Volkheimer 1968
Ischyosporites cf variegatus (Couper 1958) Schulz 1967
Ischyosporites pachydictyus Menéndez 1968

Infraturma CINGULATI Potonié & Klaus emend. Dettmann 1963
Interulobites cf. variabilis Volkheimer & Quattrocchio 1975

Turma MONOLETES Ibrahim 1933
Punctatosporites scabratus (Couper) Norris 1965
Peromonolites sp. (in Evitt 1963)

SACCITES Erdtman 1947
Callialasporites dampieri (Balmé) Dev. 1961
Callialasporites segmentatus (Balmé) Srivastava 1963
Callialasporites trilobatus (Balmé) Dev 1961
Vitreisporites pallidus (Reissinger) Nilsson 1958
Alisporites robustus Nilson 1958
Podocarpidites ellipticus Cookson 1947
Podocarpidites cf. verrucosus Volkheimer 1972
Podocarpidites cf. otagoensis Couper 1953
Microcachryidites antarcticus Cookson 1947
Microcachryidites cf. castellanosii Menéndez 1968

ALETES Ibrahim 1933
Inaperturopollenites turbatus (Balmé) Schulz 1957
Araucariacites australis Cookson 1947
Araucariacites pergranulatus Volkheimer 1968
Araucariacites fissus Reiser & Williams 1969

POROSES Naumova emend. Potonié 1960
Classopollis simplex (Danzé, Corsin & Laveine) Reisser & Williams 1969
Classopollis cf. classoides (Pflug) Pocock & Jansonius 1961
Classopollis intrareticulatus Volkheimer 1972
Gliscopollis tersus Norris 1965

PLICATES Naumova emend. Potonié 1960
Cycadopites nitidus (Balmé 1957) de Jersey 1964
Cycadopites granulatus Volkheimer 1968
Cycadopites punctatus Volkheimer 1968
Monosulcites aff. M. minimus Cookson 1947
Monosulcites carpentieri Delcourt & Sprumont 1955
Monosulcites sp. A. Volkheimer 1972

ACRITARCHS
Baltisphaeridium debilispinum Wall and Downie 1963
Baltisphaeridium sp.
Cymatiosphaera eupeplos (Valensi 1949) Deflandre 1954
Cymatiosphaera sp.
Comasphaeridium sp.
Micrhystridium fragile Deflandre 1947b
Micrhystridium sp.
Solisphaeridium sp.

DINOFLAGELLATE

Escharisphaeridia pocockii Erkmen & Sarjeant 1980
Nannoceratopsis gracilis Alberti 1961