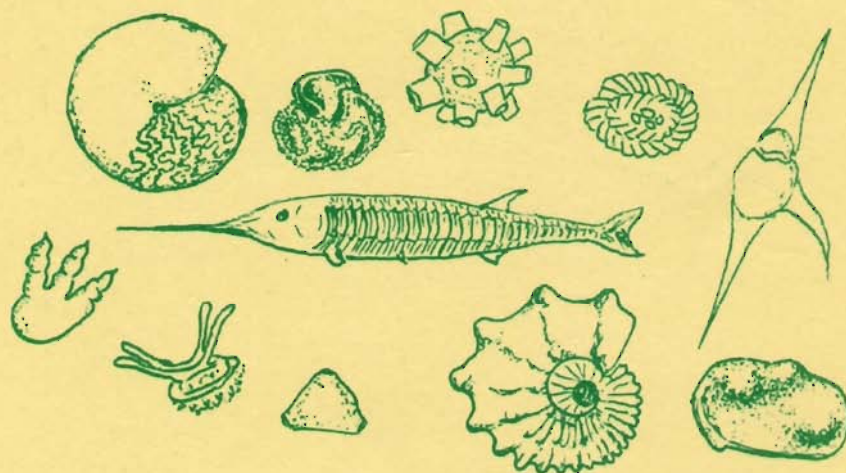


STRATIGRAPHIC RANGE OF CRETACEOUS MEGA- AND MICROFOSSILS OF BRAZIL

Edited by

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CHAPTER 4

RANGE CHARTS OF THE FOSSILS OF THE CRETACEOUS
INTERIOR BASINS

4.1. The São Francisco Basin

Ismar de S. CARVALHO (Coord., I), Luiz Carlos BERTOLINO (Coord., PR), Leonardo F. BORGHI (Coord., P), Lelia DUARTE (PR), Marise S.S. de CARVALHO (V), and Rita C.T. CASSAB (I)

(I)=Invertebrates; (P)=Palynomorphs; (PR)=Plant remains;
(V)=Vertebrates

This basin is bordered by two Precambrian geosynclines, Espinhaço (E) and Brasília (W). It exposes ca., 500,000 km² of Cretaceous sediments, which in its Northern portion probably interfinger with Cretaceous sediments of the Parnaíba Basin. The Alto Parnaíba structural arch, limits the São Francisco Basin to the south (Figure 1).

Lithostratigraphic units

According to the Brazilian Stratigraphic Lexic (Baptista et alii, 1984) there are three formal lithostratigraphic units in the São Francisco Basin (Figure 2):

1. Areado Formation

Abaeté Member: composed of conglomerates and yellowish coarse sandstones bearing small to large scale trough-cross-bedding.

Quiricó Member: fine sandstones with interfingering calciferous shales, carbonate lenses and bituminous shales with a varied flora and fauna. The sandstones have horizontal lamination, climbing ripples and ripple-marks.

Três Barras Member: medium to coarse reddish sandstones. Shaly and pebbly strata may also occur. The sandstones display large scale trough-cross-bedding.

2. Mata da Corda Formation

Patos Member: ultrabasic lavas and volcanoclastic sandstones. Volcanic agglomerates and welded tuffs may also occur.
Capacete Member: conglomerates, sandstones and shales. The source of the coarse-grained material is mainly volcanic.

3. Urucuia Formation: fine to medium, small scale trough-cross-bedded sandstones and subordinate conglomerates and shales.

Environmental overview

The environmental scenery of the São Francisco Basin in the Cretaceous, can be summarized as a depositional tract composed of aeolian, alluvial-fan, braided fluvial, lacustrine and marine systems. The resulting strata are possibly truncated by the extrusive igneous activity, which is thought to be related to the fragmentation of the Gondwana supercontinent.

A predominant arid climate is postulated by Suguio & Barcelos (1983), although a hot and humid climate is advocated by Lima (1979), Lima (1983) and Chateauneuf et alii (1981) based on palynological data.

The coarse-grained facies assemblage (conglomerates and coarse-grained sandstones) in the lowermost portion of the Areado Formation (Abaeté Member) would represent the proximal and median facies association of an alluvial-fan, which overlaps a complex of lacustrine sediments characterized by the sandy and muddy facies association (Quiricó Member).

The closure of the lacustrine environments and the loss of competence of the fans would have given rise to a cross-bedded sandy facies throughout the basin (Três Barras Member). This cross-bedded sandy facies was due to the physical dominance of an extensive alluvial braided plain, in which aeolian reworking produced extensive dune fields. Kattah (1991) suggest a subdivision of the upper Jurassic-lower cretaceous section into three facies units (A, B and C). The first one - Unit A comprises facies that register desertic, lacustrine and fluvio-deltaic depositional systems. Facies of Unit B were influenced by a transtensional tectonic context, and marginal lacustrine systems, alluvial and fandelta in arid conditions were the main depositional site of those facies. The last one - Unit C - consists of a fluvio-lacustrine system succeeded by a restricted marine shelf system.

The volcanic material (Patos Member) was reworked in an alluvial environment so ending the Cretaceous sequence in the basin (Capacete Member and Urucuia Formation).

Paleontology

The fossils of the São Francisco Basin come mainly from the Quiricó Member (Areado Formation).

Great palynological diversity is described in the literature (Lima, 1979; Chateauneuf et alii, 1981; von Freyberg, 1932 in Lima, 1979). Kattag & Koutsoukos (1992) recognized radiolarians. Some plant remains have been reported by Duarte (1969, 1985, 1991) and Grossi Sad et alii (1971).

Conchostraceans and ostracods are the most common invertebrate fossils (Cardoso, 1968, 1971; Ladeira & Brito, 1968; Grossi Sad et alii, 1971), and an *incertae sedis* crustacean named *Saucrolus silvai* (Santos, 1971), has also been recorded.

A small teleostean fish, *Dastilbe moraesii*, is the unique known vertebrate (Scorza & Santos, 1955).

Kattah (1993) identified dinosaur tracks on aeolian sediments of Areado Formation.

TAXONOMIC LIST OF IDENTIFIED SPECIES OF THE SÃO FRANCISCO BASIN

PALYNOMORPHS

- Applanopsis* cf. *A. dampieri* Döring, 1961 (5)
Araucariacites australis Cookson, 1957 (11)
Bennettitaepollenites sp. (11)
Caytonipollenites pallidus Couper, 1958 (5)
Cicatricosisporites sp. (5)
Cicatricosisporites morioides Delcourt & Sprumont, 1955 (5)
Circulina sp. (11)
Circulina parva Brenner, 1963 (11)
Classopollis classoides Pflug, 1953 (5, 11)
Classopollis torosus (Ressinger, 1950) Couper, 1958 (11)
Clavattipollenites sp. (11)
Cycadopites sp. 1 (11)
Cycadopites sp. 2 (11)
Deltoidospora sp. (11)
Dinogymnium cf. *D. acuminatum* Evitt, Clarke & Verdier, 1967 (5)
Elateroplicites africaenensis Herngreen, 1972 (5)
Ephedripites sp. (5)
Ephedripites aff. *E. fusiformis* (5)
Ephedripites aff. *E. multicostatus* Brenner, 1963 (5)
Ephedripites aff. *E. regularis* van Hoeken & Klinkenbergen, 1964 (5)
Ephedripites barghoonii Pocock, 1964 (5)
Ephedripites jansonii Pocock, 1964 (5)
Ephedripites torosus (5)
Ephedripites zaklinskaiae Azema & Boltenhagen, 1974 (5)
Exesipollenites tumulus Balme, 1957 (5, 11)
Eucommiidites minor Groot & Penny, 1960 (11)
Foveotriletes sp. 1 (5)
Foveotriletes sp. 2 (5)
Gnetaceaepollenites cf. *G. diversus* Stover, 1964 (5)
Gnetaceaepollenites oeradis Srivastava, 1968 (5)
Granulatisporites sp. (5)
Hexaporotricolpites emelianovi Boltenhagen, 1967 (5)
Inaperturopollenites sp. (11)
Inaperturopollenites crisopolensis Regali, Uesugui, Santos 1974 (11)
Klukisporites variegatus Couper, 1958 (5)
Longapertites chlonovae Boltenhagen, 1976 (5)
Lycopodiumsporites novamexicanum Drugg, 1967 (5)
Matonisporites sp. (5)
Monocolpopollenites sp. 1 (11)
Monocolpopollenites sp. 2 (11)
Oculopollis tropicus Boltenhagen, 1976 (5)
Perotriletes cf. *P. pannuceus* Brenner, 1963 (5)
Perotriletes pannuceus Brenner, 1963 (5)
Psilatricolpites hammenii Boltenhagen, 1976 (5)
Psilatricolpites psilatus Pierce (11)
Psilatricolporites sp. (5)
Psilatricolporites lehmanii Boltenhagen, 1976 (5)
Punctatosporites sp. (11)
Reticulate spores (5)
Retimonocolpites sp. (11)
Retitricolpites gageonnetii Boltenhagen, 1976 (5)

Retitricolpites heteroreticulatus Boltenhagen, 1976 (5)
Retitricolporites sp. 1 (5)
Retitricolporites sp. 2 (5)
Retitricolporites sp. 3 (5)
Retitricolporites sp. 4 (5)
Retitricolporites sp. 6 (5)
Retitricolporites sp. 7 (5)
Retitricolporites gabonensis Boltenhagen, 1976 (5)
Retitricolporites hispidus van der Hammen & Wynstriem, 1964 (5)
Schizea certa Bolkhovitina, 1956 (5)
Sergipea sp. (11)
Steevesipollenites cupuliformis Azema & Boltenhagen, 1974 (5)
Syncolporites incompus van Hoeken-Klinkenberg, 1964 (5)
Syncolporites cf. *S. incompus* van Hoeken-Klinkenberg, 1964 (5)
Tricolpites cf. *T. giganteus* Jardiné & Magloire, 1965 (5)
Triffosapollenites sp. 5 (5)
Triorites sp. (5)
Triorites africaensis Jardiné & Magloire, 1965 (5)
Vermiculate spores (5)
Verrutriteles sp. (5)

RADIOLARIANS

Indet. (15)

INVERTEBRATES

1. Ostracoda

Candonopsis sp. (2)
Darwinula sp. (2)
Eucyproides sp. (2)
Heterocypris sp. (2)

2. Conchostraca

Cyzicus (*Lioestheria*) *abaetensis* (Cardoso, 1971) = [*Pseudestheria abaetensis* Cardoso, 1971] (3,4,10,14)
Cyzicus (*Lioestheria*) cf. *C. barbosai* (Almeida, 1950) = [*Pseudograptia* cf. *P. barbosai* (Almeida, 1950)] (3,4,14) "*Estheria*" (1,2)
Palaeolimnadiopsis freybergi Cardoso, 1971 (3,4,10,14)
Palaeolimnadiopsis cf. *P. reali* (Teixeira, 1960) = [*Pteriograptia* cf. *P. reali* Teixeira, 1960] (3,4,14)

3. Incertae Sedis

Saucrolus silvai Santos, 1971 (12)

VERTEBRATES

1. Pisces

Dastilbe moraesi Santos, 1955 (1,9,13)

2. Reptilia

Dinosaur tracks (16)

PLANTS

- Araucarioxylon* sp. (1,9)
Brachyphyllum sp. (7)
Brachyphyllum obesum Heer, 1881 (8)
Leptaspis sp. (7)
Nymphaeites choffati (Sap.) Teixeira, 1947 (7,8)
Paraleptaspis vargensis Duarte, 1991 (8)
Podozamites sp. (6,7)
Podozamites lanceolatus (L. et H.) Schimper, 1870 (8)

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(Taxonomic list and range charts)

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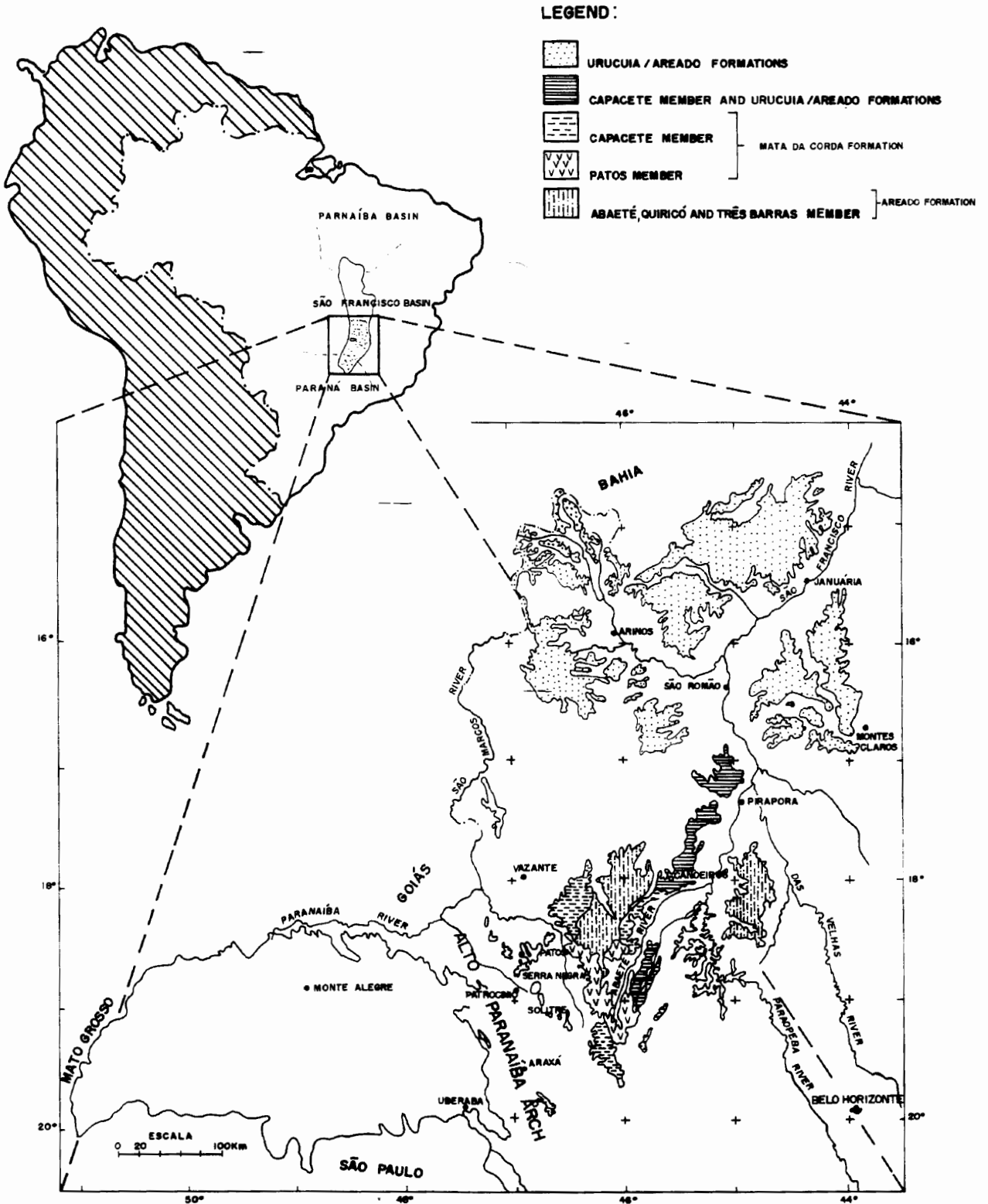


Figure 1 - Cretaceous lithostratigraphic units of São Francisco. (Modified from Sad et al., 1971).

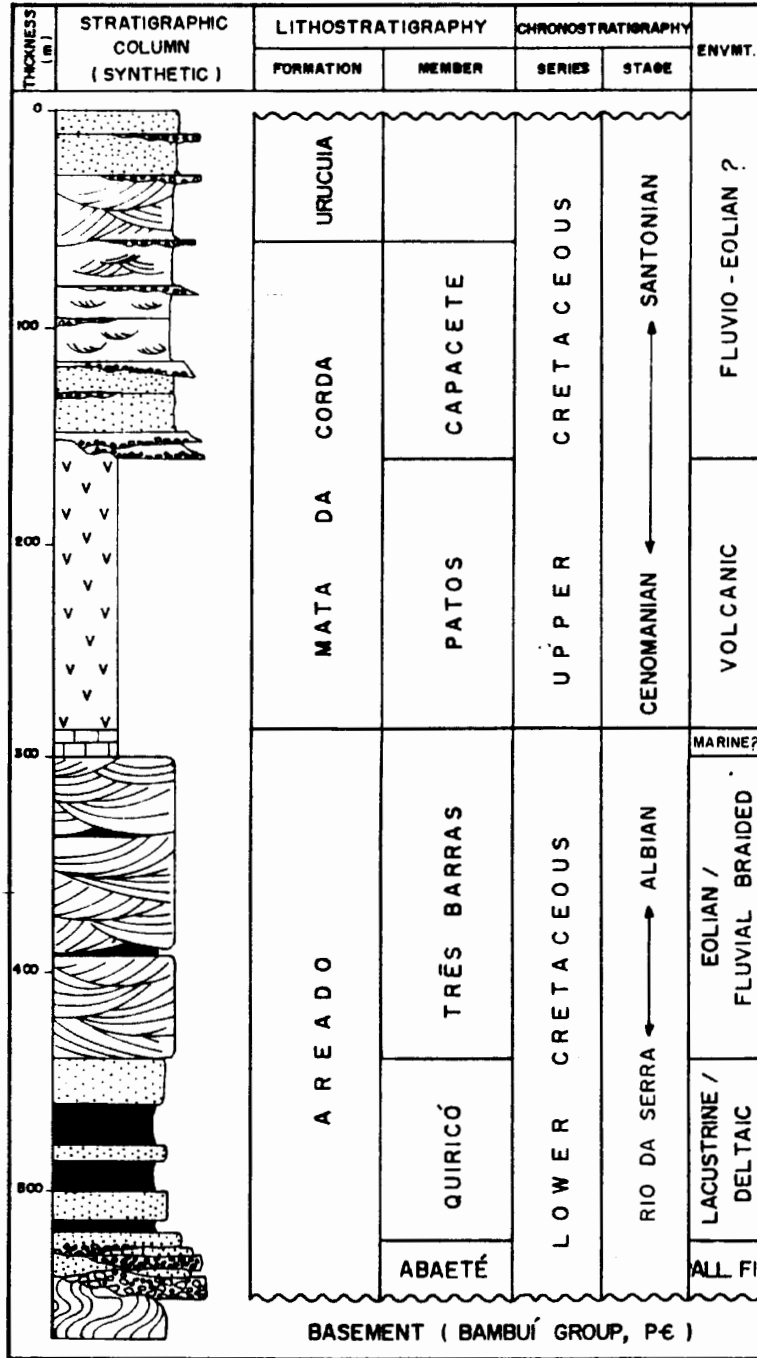


FIGURE 2
KEY TO THE STRATIGRAPHIC COLUMN

- v. COARSE SST. TO CONGLOMERATE
- MASSIVE SANDSTONE
- MUDSTONE
- LARGE SCALE CROSS-BEDDED SANDSTONE
- MEDIUM/SMALL SCALE CROSS-BEDDED SANDSTONE
- VOLCANIC LAVAS & TUFFS
- CARBONATE

Figure 2

EARLY CRETACEOUS TAXA PALYNOMORPHS SÃO FRANCISCO BASIN	NEOCOMIAN TO EARLIEST ALBIAN					ALBIAN (PARS)
	BRAZILIAN LOCAL STAGES					
	RIO DA SERRA	ARATU	BURACICA	JIQUIA	ALAGOAS	
<i>Applanopsis</i> cf. <i>A. dampieri</i> (5)						—
<i>Araucariacites australis</i> (11)				—		
<i>Bennettitaepollenites</i> sp. (11)				—		
<i>Caytonipollenites pallidus</i> (5)						—
<i>Cicatricosisporites</i> sp. (5)						—
<i>Cicatricosisporites morioides</i> (5)						—
<i>Circulina</i> sp. (11)				—		
<i>Circulina parva</i> (11)				—		
<i>Classopollis classoides</i> (5,11)				—		
<i>Classopollis torosus</i> (11)				—		
<i>Clavattipollenites</i> sp. (11)				—		
<i>Cycadopites</i> sp. (11)				—		
<i>Cycadopites</i> sp. 2 (11)				—		
<i>Deltoidospora</i> sp. (11)				—		
<i>Dinogymnium</i> cf. <i>D. acuminatum</i> (5)						—
<i>Elateroplicites africaenensis</i> (5)						—
<i>Ephedripites</i> sp. (5)						—
<i>Ephedripites</i> aff. <i>E. fusiformis</i> (5)						—
<i>Ephedripites</i> aff. <i>E. multicostatus</i> (5)						—
———— common						

EARLY CRETACEOUS TAXA PALYNOMORPHS SÃO FRANCISCO BASIN	NEOCOMIAN TO EARLIEST ALBIAN					ALBIAN (PARS)
	BRAZILIAN LOCAL STAGES					
	RIO DA SERRA	ARATU	BURACICA	JQUIÁ	ALAGOAS	
<i>Ephedripites</i> aff. <i>E. regularis</i> (5)						—
<i>Ephedripites barghoonii</i> (5)						—
<i>Ephedripites jansonii</i> (5)						—
<i>Ephedripites torosus</i> (5)						—
<i>Ephedripites zaklinskaiae</i> (5)						—
<i>Eucommiidites minor</i> (11)				—		
<i>Exesipollenites tumulus</i> (5,11)				—	—	—
<i>Foveotriletes</i> sp. 1 (5)						—
<i>Foveotriletes</i> sp. 2 (5)						—
<i>Gnetaceapollenites oeradis</i> (5)						—
<i>Gnetaceapollenites</i> cf. <i>G. diversus</i> (5)						—
<i>Granulatisporites</i> sp. (5)						—
<i>Hexaporo-tricolpites emelianovi</i> (5)						—
<i>Inaperturopollenites</i> sp. (11)				—		
<i>Inaperturopollenites crisopolensis</i> (11)				—		
<i>Klukisporites variegatus</i> (5)						—
<i>Longapertites chlonovae</i> (5)						—
<i>Lycopodiumsporites novamexicanum</i> (5)						—
<i>Matonisporites</i> sp. (5)						—
<p>———— common</p>						

EARLY CRETACEOUS TAXA PALYNOMORPHS SÃO FRANCISCO BASIN	NEOCOMIAN TO EARLIEST ALBIAN					ALBIAN (PARS)
	BRAZILIAN LOCAL STAGES					
	RIO DA SERRA	ARATU	BURACICA	JUIQUIÁ	ALAGOAS	
Monocolpopollenites sp. 1 (11)				—		
Monocolpopollenites sp. 2 (11)				—		
Oculopollis tropicus (5)						—
Perotriletes cf. P. pannuceus (5)						—
Perotriletes pannuceus (5)						—
Psilatricolporites sp. (5)						—
Psilatricolpites hammenii (5)						—
Psilatricolpites psilatus (11)				—		
Psilatricolporites lehmanii (5)						—
Punctatosporites sp. (11)				—		
Reticulate spores (5)						—
Retimonocolpites sp. (11)				—		
Retitricolpites gageonnetii (5)						—
Retitricolpites heteroreticulatus (5)						—
Retitricolporites sp. 1 (5)						—
Retitricolporites sp. 2 (5)						—
Retitricolporites sp. 3 (5)						—
Retitricolporites sp. 4 (5)						—
Retitricolporites sp. 6 (5)						—
————— common						

EARLY CRETACEOUS TAXA PALYNOMORPHS SÃO FRANCISCO BASIN	NEOCOMIAN TO EARLIEST ALBIAN					ALBIAN (PARS)
	BRAZILIAN LOCAL STAGES					
	RIO DA SERRA	ARATU	BURACICA	JQUIÁ	ALAGOAS	
Retitricolporites sp. 7 (5)						—
Retitricolporites gabonensis (5)						—
Retitricolporites hispidus (5)						—
Schizea certa (5)						—
Sergipea sp. (11)				—		
Steevesipollenites cupuliformis (5)						—
Syncolporites incompus (5)						—
Syncolporites cf. S. incompus (5)						—
Tricolpites cf. T. giganteus (5)						—
Triffosapollenites sp. 5 (5)						—
Triorites sp. (5)						—
Triorites africaensis (5)						—
Vermiculate spores (5)						—
Verrutriletes sp. (5)						—
<p>———— common</p>						

<p style="text-align: center;">LATE CRETACEOUS TAXA</p> <p style="text-align: center;">PALYNOMORPHS</p> <p style="text-align: center;">SÃO FRANCISCO BASIN</p>	CENOMANIAN	TURONIAN	CONIACIAN	SANTONIAN	CAMPANIAN	MAASTRICHTIAN
Applanopsis cf. <i>A. dampieri</i> (5)	—					
Caytonipollenites pallidus (5)	—					
Cicatricosisporites sp. (5)	—					
Cicatricosisporites morioides (5)	—					
Dinogymnium cf. <i>D. acuminatum</i> (5)	—					
Elateroplicites africaenensis (5)	—					
Ephedripites sp. (5)	—					
Ephedripites aff. <i>E. fusiformis</i> (5)	—					
Ephedripites aff. <i>E. multicostatus</i> (5)	—					
Ephedripites aff. <i>E. regularis</i> (5)	—					
Ephedripites barghoonii (5)	—					
Ephedripites jansonii (5)	—					
Ephedripites torosus (5)	—					
Ephedripites zaklinskaiae (5)	—					
Exesipollenites tumulus (5,11)	—					
Foveotriletes sp. 1 (5)	—					
Foveotriletes sp. 2 (5)	—					
Gnetaceaepollenites oeradis (5)	—					
Gnetaceaepollenites cf. <i>G. diversus</i> (5)	—					
Granulatisporites sp. (5)	—					
<p>————— common</p>						

<p style="text-align: center;">LATE CRETACEOUS TAXA</p> <p style="text-align: center;">PALYNOMORPHS SÃO FRANCISCO BASIN</p>	CENOMANIAN	TURONIAN	CONIACIAN	SANTONIAN	CAMPANIAN	MAASTRICHTIAN
Hexaporotricolpites emelianovi (5)	—					
Klukisporites variegatus (5)	—					
Longapertites chlonovae (5)	—					
Lycopodiumsporites novamexicanum (5)	—					
Matonisporites sp. (5)	—					
Oculopollis tropicus (5)	—					
Perotriletes cf. P. pannuceus (5)	—					
Perotriletes pannuceus (5)	—					
Psilatricolporites sp. (5)	—					
Psilatricolporites hammenii (5)	—					
Psilatricolporites lehmanii (5)	—					
Reticulate spores (5)	—					
Retitricolpites gageonnetii (5)	—					
Retitricolpites heteroreticulatus (5)	—					
Retitricolporites sp. 1 (5)	—					
Retitricolporites sp. 2 (5)	—					
Retitricolporites sp. 3 (5)	—					
Retitricolporites sp. 4 (5)	—					
Retitricolporites sp. 6 (5)	—					
Retitricolporites sp. 7 (5)	—					
<p>————— common</p>						

<p style="text-align: center;">LATE CRETACEOUS TAXA</p> <p style="text-align: center;">— PALYNOMORPHS</p> <p style="text-align: center;">SÃO FRANCISCO BASIN</p>	CENOMANIAN	TURONIAN	CONIACIAN	SANTONIAN	CAMPANIAN	MAASTRICHTIAN
Retitricolporites gabonensis (5)	—					
Retitricolporites hispidus (5)	—					
Schizea certa (5)	—					
Steevesipollenites cupuliformis (5)	—					
Syncolporites incompus (5)	—					
Syncolporites cf. S. incompus (5)	—					
Tricolpites cf. T. giganteus (5)	—					
Triffosapollenites sp. 5 (5)	—					
Triorites sp. (5)	—	—				
Triorites africaensis (5)	—					
Vermiculate spores (5)	—					
Verrutriletes sp. (5)	—					
<p style="text-align: center;">—— common</p>						

