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LATE PALEOZOIC FAUNAL AND FLORAL SUCCESSIONS IN THE PARANÁ BASIN, SOUTHEASTERN BRAZIL*

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ABSTRACT

The stratigraphical distribution of the Late Paleozoic marine fauna and megaf flora is examined with respect to the available biostratigraphic framework for part of the Upper Paleozoic sequence of the Paraná Basin, Brazil (Tubarão Group) possibly spanning the Upper Carboniferous-Lower Permian interval.

Within this interval the megaf flora succession shows a transition from assemblages with incidence of northern forms to others in which the Glossopterids are more frequent and finally predominate.

The invertebrate megafauna (mollusks and brachiopods) succession shows a high frequency of cosmopolitan forms associated with Gondwanic forms in the early assemblages, followed later by more typical gondwanic faunal assemblages.

The evidence at hand for the correlation of the studied sequence with the Carboniferous-Permian boundary is discussed.

RESUMO

O presente trabalho inclui uma análise de distribuição e composição da megaf flora e megafauna marinha (moluscos e braquiópodes) do Grupo Tubarão, tendo em vista o arcabouço bioestratigráfico (palinológico) disponível para o Paleozóico Superior da Bacia do Paraná, Brasil. A sequência estratigráfica examinada abrange, possivelmente, o intervalo Neocarbonífero-Eopermiano.

A sucessão de megaf loras do Grupo Tubarão inicia-se com assembléias contendo formas "nórdicas", passando a outras em que as glossopterídeas são mais frequentes, ou mesmo predominantes, na parte superior da sequência investigada.

A megafauna de invertebrados marinhos, por sua vez, abrange, inicialmente, assembléias com proporção relativamente alta de formas cosmopolitas, associadas a gêneros gondvânicos, às quais se seguem assembléias de caráter mais tipicamente gondvânico.

Analisam-se, ainda, criticamente, as evidências disponíveis para o reconhecimento do limite Carbonífero-Permiano no Brasil e América do Sul.

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INTRODUCTION

Since it is not presently possible to establish the Carboniferous-Permian boundary with precision in the Paraná Basin as discussed below (p. 8), the approach used in this paper involves a synthetic description of the main Late Paleozoic faunal and floral features, according to their stratigraphic appearance in the Paraná Basin in sediments of the Tubarão Group (Itararé and Guatá Subgroups), which according to available evidence may span the Upper Carboniferous-Lower Permian interval (Fig. 1).

The stratigraphic framework adopted in the following discussion is based on the palynological biostratigraphical zonation (Daemon, Quadros, 1970), which is presently the only available scheme for intrabasinal correlation in the Paraná Basin of Brazil. Subsequent palynologic analysis of outcrop samples of diamictites or associated lithologies of the Itararé Subgroup (Kemp, 1973) yielded results generally consistent with the relative ages of parts of the section here analysed. Recent semi-detailed mapping of the Late Paleozoic sequence also added new important stratigraphic information (Andrade, Soares, 1971). The stratigraphic panel of Fig. 2 which will serve as a basis for this presentation, modified from Medeiros, Thomas Filho (1973), is greatly based on these new data.

Stratigraphical nomenclature of the Late Paleozoic beds treated below follows Rocha-Campos (1967). (See Rocha-Campos, 1970b, for a revised list of the marine fauna of the Tubarão Group). Although other vertebrates may occur in the Late Paleozoic beds treated only mollusks and brachiopods will be dealt with here.

The Itararé Subgroup faunal and floral assemblages are associated with diamictites of probable glacial origin (Leinz, 1937; Rocha-Campos, 1967; Frakes, Crowell, 1969). The Rio Bonito Formation assemblages (Guatá Subgroup) are included in the post-glacial sedimentary sequence of the Paraná Basin.

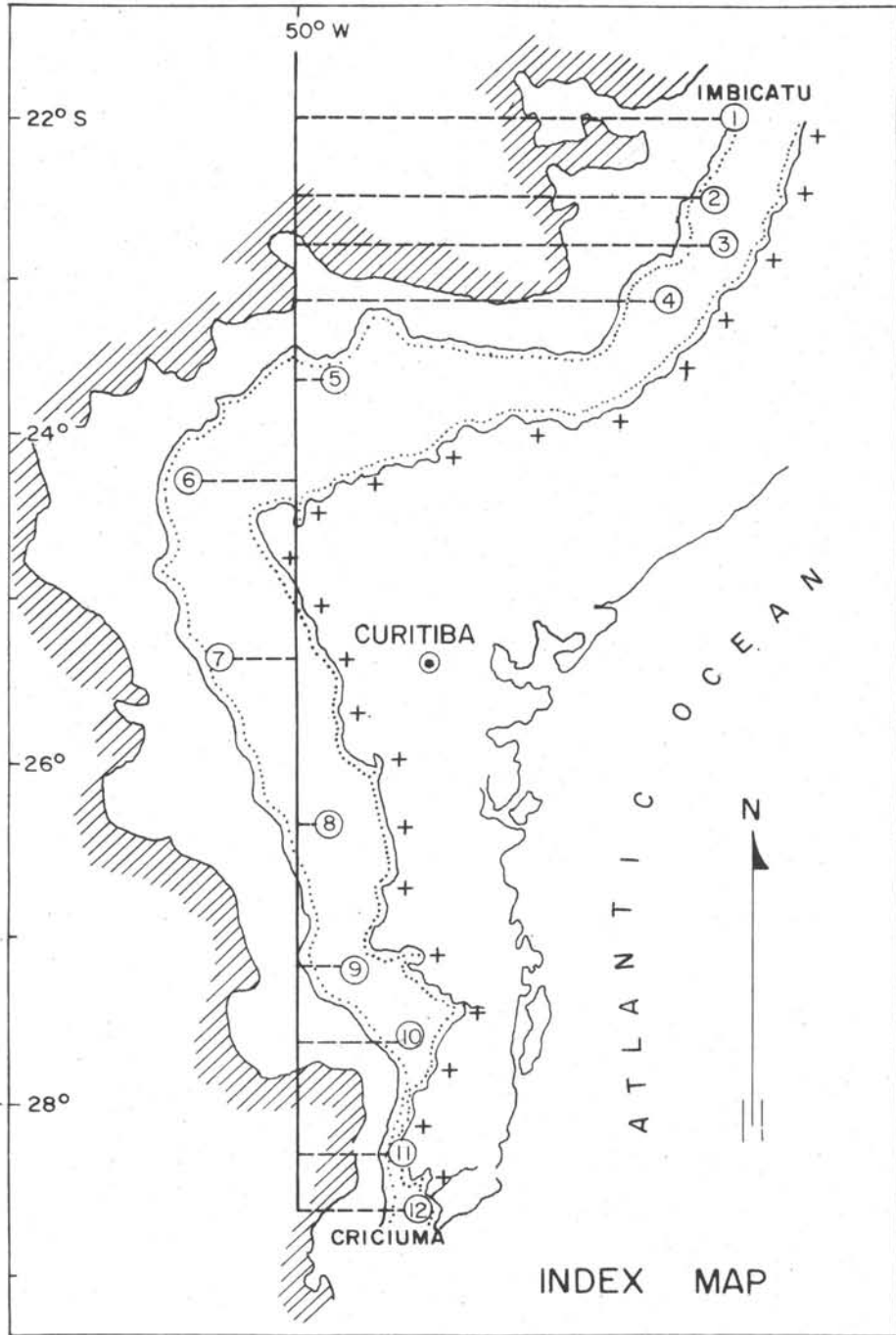
ITARARÉ SUBGROUP

FAUNA

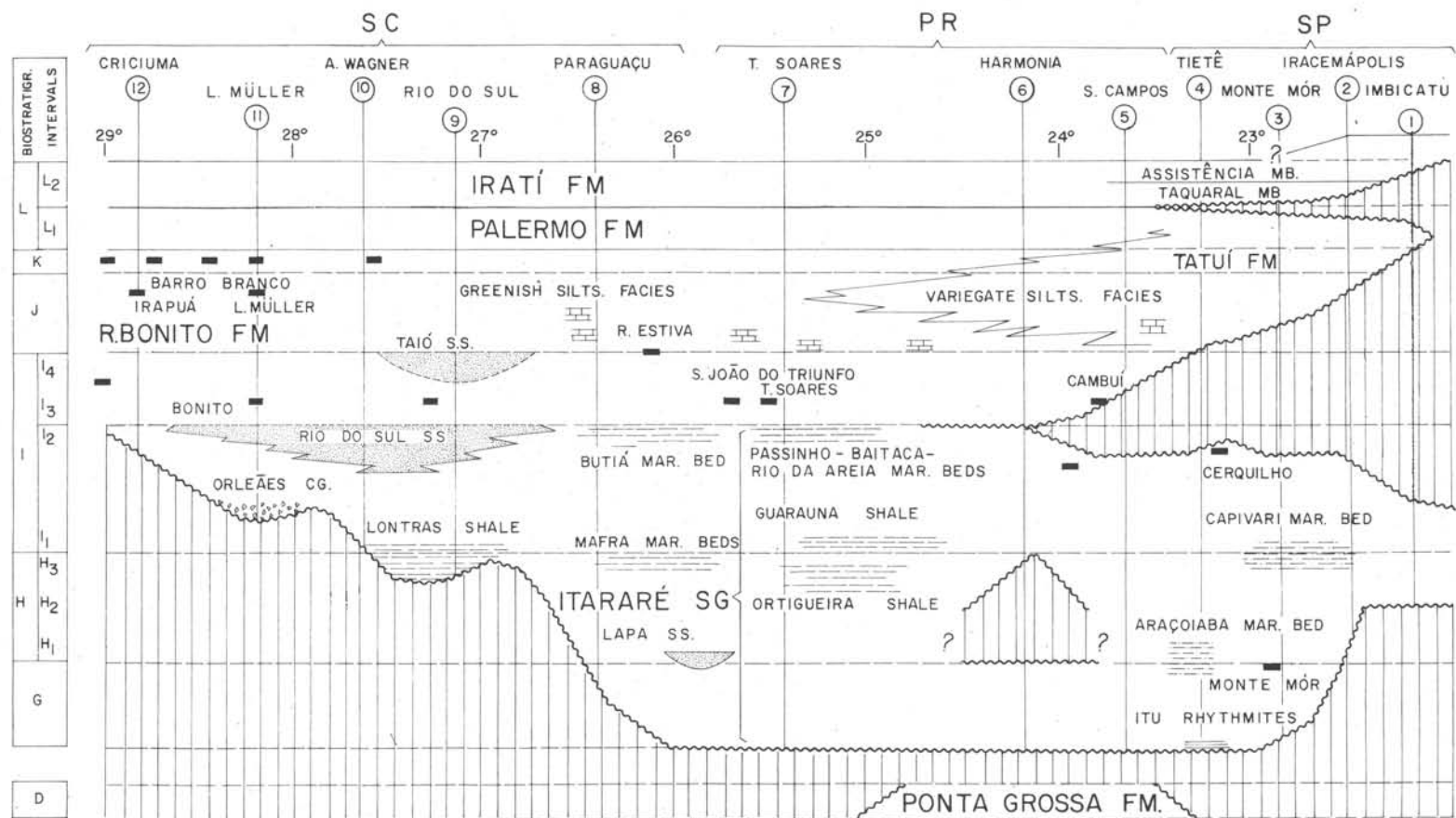
Araçoiaba assemblage. The lowermost marine intercalation in the Late Paleozoic strata of the Paraná Basin is documented by a small assemblage of arenaceous foraminifers (with *Hyperammina*, *Ammodiscus*, *Brunsiella*, *Textularia* and *Reophax*), associated with fish scales, spines and coprolites of the "enterospyron" type in concretions in mudstones (Lima et alii., 1976). (Fig. 2.) A similar assemblage was reported by McLachlan, Anderson (1973) from the Upper Dwyka shales of South Africa. In the Paraná Basin an associated microflora is characterized by a predominance of trilete spores together with monosaccate pollen, striated forms being rare. Lima et alii. (1976) correlated this with the palynological interval G-H1, which Daemon, Quadros (1970) interpreted as Stephanian C - Sakmarian. From the same locality, Kemp (1973) identified a microflora which she correlated with "Stage 2" of the eastern Australian scheme (Evans, 1967), of probable early Permian age (Asselian-Sakmarian). (Kemps 1976).

Capivari, Guaraúna - Ortigueira and Mafra assemblages. Though isolated geographically, these assemblages are all included at about the middle of the Itararé Subgroup (Fig. 2) and thus will be treated together. This however, does not imply their strict contemporaneity.

The most diversified assemblage occurs at Capivari, in central-eastern São Paulo State (Mendes, 1952; Rocha-Campos, 1966; 1970b), in marine siltstones underlain and overlain by glacial sediments. The most important components of the fauna are *Peruvispira delicata* and *Attenuatella* sp. nov. *Peruvispira delicata* was originally described from the Lower Permian (Wolfcampian) Copacabana Group of Peru and Bolivia (Chronic, 1953), but has also been reported in the northern hemisphere characteristically in beds of early Permian age. *Attenuatella* sp. nov. resembles



1. Late Paleozoic strata in eastern, Brazil. Explanation: dotted: Tubarão Group; crosses: Precambrian basement; open: younger Late Paleozoic strata; obliquely hatched: Mesozoic; number in circles refer to sections in Fig. 2; vertical (N-S) line is the projection plane of Fig. 2.



2. Chronostratigraphic diagram of the late Paleozoic sequence of eastern Paraná Basin (modified from Medeiros, Thomas Filho, 1973). Explanation: black rectangles: coal beds; SC: Santa Catarina State; PR:Paraná; SP:São Paulo.

species from the Lower Permian of New Zealand (Waterhouse, 1968). The affinities of these two elements are the only evidence for the ages of the assemblage which may be provisionally accepted as of early Permian. Other elements in the fauna are: *Limipecten capivariensis*, *Rhynchopora grossopunctata*, *Streblopteria* sp., *Phestia* sp., indeterminate bivalves and crinoid columnals. A probable extension of these beds northward, at Hortolândia, includes undescribed specimens of *Phestia*, *Nuculopsis*, *Edmondia* (?), indeterminate pholadomyid, etc.

From the Guaraúna shale Lange (1952) reported the lingulid *Langella imbituensis* and *Crurithyris roxoi* (= *Attenuatella roxoi*?, Rocha-Campos, 1970b). The Mafra assemblage in north Santa Catarina contains *Orbiculoidea guaraunensis*, *Langella imbituensis*, *Nuculana woodworthi* and arenaceous foraminifers (Rocha-Campos, 1970b). Recent mapping in central Paraná State (Andrade, Soares, 1971) showed that these strata are not equivalent to the Passinho Shale which occurs stratigraphically higher in the uppermost part of the Itararé Subgroup.

Passinho (plus Rio da Areia and Baitaca), Butiá and Budó assemblages. The most widespread marine intercalation in the Itararé Subgroup is probably represented by the Passinho Shale and associated strata (Baitaca and Rio da Areia beds) which have been mapped in the upper part of the Itararé in central and north Paraná State. Marine beds at the about the same stratigraphic level occur in north Santa Catarina, near Butiá (Rocha-Campos, 1966; 1970b).

In central Paraná, near Teixeira Soares, fine sandstone and siltstones below the Passinho contain *i.a.* the bivalves *Aviculopecten* cf. *A. multiscalptus*, *Aviculopecten* sp., *Limipecten* sp., *Permophorus*? sp., *Volsellina* sp., *Selenimyalina* sp., *Myalina* (*Myalinella*) sp., *Leiopteria* sp., *Streblopteria* sp., "*Allorisma*" *barringtoni*, associated with *Myonia* (or *Vacunella*?) sp., *Vacunella* cf. *V. etheridgei*, *Atomodesma* sp., the gastropods *Keeneia* sp., *Mour-*

loniopsis? sp., *Platyceras?* sp., *Retispira* sp., *Mourlonia* sp. and the spiriferid *Notospirifer* sp. (Lange, 1952; Rocha-Campos, 1970b).

Highly compressed specimens identified as *Myonia* (or *Vacunella*?) are similar to a specimen listed as *Myonia* (or *Vacunella*? *argentinensis* (= *Stuchburia argentinensis* Harrington, 1955) by Rocha-Campos (1970b), possibly conspecific with *Vacunella camacho* (Rocha-Campos, Carvalho, 1975) from the Bonete Formation assemblage ("*Eurydesma*" fauna) (Asselian-Sakmarian) in the Sierras Australes of Argentina. Specimens identified as *Vacunella* era close to *V. etheridgei* which is known from the Artinskian of eastern Australia (Runnegar, 1969). Other important elements are *Leiopteria* sp. which resembles *L.?* *carrandibiensis*, from the Lower Permian (Sakmarian) of Western Australia (Dickins, 1957), and *L.?* *dutoiti* from the "*Eurydesma*" fauna of Argentina. The fauna seems then to include cosmopolitan genera associated with other genera of gondwanic affinity (Runnegar, 1972) and a Lower Permian age may be preliminarily adopted for this assemblage.

The overlying dark, silty shales ("*Passinho Shale*", *s.s.*) contains an impoverished fauna with *Nuculana woodworthi*, *Anthraconeilo* sp. nov., *Chonetes rionegrensis*, *Crurithyris roxoi* (= *Attenuatella roxoi*), gastropods, lingulids (*Langella imbituensis*) and *Orbiculoidea guaraunensis* (Rocha-Campos, 1970b). Further south, siltstones overlying a diamictite at the Butiá Quarry, near Mafra, Santa Catarina also in the upper part of the Itararé Subgroup, yielded *Linoproductus* sp., *Cancrinella* sp., *Aviculopecten* sp., *Attenuatella* sp. and an indeterminate gastropod (Rocha-Campos, 1966, 1970b).

The Budó assemblage in Rio Grande do Sul (not shown in the diagram of Fig. 2) with *Aviculopecten cambahyensis*, *Langella imbituensis*, *Orbiculoidea maricaensis* may be a possible stratigraphic equivalent to the Passinho assemblage (Lange, 1954).

Again in this case, although the above assemblages occur in the upper part of the Itararé Subgroup, roughly at the same stratigraphic position their coevality is not yet established*

FLORA

Monte Mór assemblage. The lowermost floral assemblage yet recognized in the Itararé Subgroup (Taphoflora A of Rosler, 1973 and in press) was reported from Monte Mór in São Paulo State, associated with coal beds, in the lower part of this Subgroup. According to recent revisions by Millan (1972, 1974, 1975), it contains: *Lepidodendron pedroanum*, *Lycopodiopsis pedroanum*, *Lycopodiopsis pedroanus*, *L. derbyi*, *Rhacopteris* cf. *chubutiana*, *R.* cf. *ovata* (= *Pseudorhacopteris*), *Botrychiopsis* cf. *plantiana*, *Noeggerathiopsis hislopii*, *Paracalamites australis*, and several other forms. Rigby (1970) noted "torn leaves" of *Glossopteris* in this assemblage, but Millan (1975) does not include this genus in his list and thus, interprets it as a pre-*Glossopteris* assemblage of late Carboniferous age. Unfortunately, all taxa except *Lycopodiopsis pedroanus* and *Paracalamites australis* are represented by poorly preserved fragments. Therefore we consider that the absence of *Glossopterids* in this assemblage as not been completely demonstrated.

Cerquilha assemblage. The first well recorded *Glossopterids* in the Itararé Subgroup occur at Cerquilha, in strata belonging to the upper part of this Subgroup (= Transitional Taphoflora, Rosler, in press), less than 40 meters below the contact with the post-

-glacial Tatuí Formation (Rocha-Campos, 1967 = Guatá Subgroup). In a preliminary study Dolianiti, Millan (1972) listed *Glossopteris*, *Gangamopteris*, *Noeggerathiopsis*, and probable conifers of the *Paranocladus* type, but subsequent collecting at this locality failed to confirm the presence of *Glossopteris* in this assemblage. Thin coal beds are known from the same area probably at about the same stratigraphic position as the flora.

RIO BONITO FORMATION (GUATÁ SUBGROUP)

FAUNA

Taió assemblage. The only known marine assemblage of the post-glacial sequence of the Paraná Basin occurs in central Santa Catarina State in sandstones from the middle part of the Rio Bonito Formation at Taió. According to recent revision (Rocha-Campos, 1970a), the most common species in this fauna is *Heteropecten catharinae*. This peculiar aviculopectinid, with variably ornamented left valves, is reported to occur in the lower part of the Lyons Group of Western Australia (Dickins, 1963). Runnegar (1972) also refers to the possible presence of *Heteropecten* in the Mingenew Formation, Western Australia, on the basis of specimens figured by Etheridge, Dun (1906, Pl. 9, Figs. 3-9), which resembles specimens of *H. catharinae* from Taió. Dickins (1963) considers the age of the Mingenew Formation as equivalent to that of the Byro Group, interpreted by Glenister, Furnish (1961) as late Artinskian. Other aviculopectinids resembling *Heteropecten catharinae* may

* Outside the Brazilian portion of the Paraná Basin, Closs (1967, 1969) described the goniatite *Eoasianites (Glaphyrites) rionegrensis* and the orthoceratid *Sueroceras chubutense* from concretions at the base of the diamictite-bearing San Gregorio Formation (= Itararé Subgroup) in Uruguay. The first species was considered similar to Middle Pennsylvanian species from the U.S., thus indicating a Late Carboniferous age for the San Gregorio Formation. From the same concretions Marques-Toigo (1970, 1972) and Ybert, Marques-Toigo (1970) described a microflora with up to 20% of disaccate, striate pollen types, a lower percentage of mono-saccate types, and abundant trilete spore types, including diverse and frequent pollen of the *Vittatina* type. They interpreted this as indicative of an early Permian age for the flora; Kemp (1973) suggested its equivalence with "Stage 3" microflora of Australia (Lower Permian). This conflict in age determination is still unresolved.

occur at levels approximately equivalent to that mentioned above, at the base of the Snapper Point Formation (Conjola Subgroup) in the Sydney Basin of Eastern Australia (Runnegar, 1972).

Rocha-Campos (1970a) pointed out the striking similarity between *Oriocrassatella itajaiensis* from Taió and *O. queenslandica* from the Western Australian Artinskian. Runnegar (1972) suggested that a specimen referred to *Myonia tayoensis* from the Taió assemblage is the same as *Australomya sulcata* (Runnegar, 1969) from the early Artinskian of Queensland and New South Wales. Although very similar to the Australian material, the specimens from Taió seem to represent a new species. A probable Lower Permian (Artinskian) age is presently accepted for this assemblage.

FLORA

Teixeira Soares, São João do Triungo, Ibití, Cambuí assemblages. In Teixeira Soares and at other localities in Paraná State, the Passinho shale is conformably overlain by the predominantly sandy Rio Bonito Formation. The basal sandstones with thin coal beds at Teixeira Soares contain a flora with *Glossopteris orbicularis*, *G. communis*, *Paracalamites*, *Paranocladus? fallax* and *P. dusenii* (Rigby, 1970). Floras have been reported from equivalent beds at the basal part of the Rio Bonito Formation in several other places, in some of which the floras are also associated with coal seams: São João do Triunfo, Rio Carvãozinho, Ibití and Cambuí. At São João do Triunfo, the assemblage contains, besides the elements already mentioned above, species of *Annularia*, *Paracalamites*, *Asterotheca*, *Sphenopteris*, *Pecopteris* and *Lycopodiopsis pedroanus* (Rosler, 1972). In other localities, this flora is less but similarly diversified. These are all included in Taphoflora B of Rosler (1973, and in press).

Rio da Estiva assemblage. A recently found floral assemblage from the middle part of the Rio Bonito Formation in Rio da Estiva,

northern Santa Catarina, is characterized by the predominance of large impressions of *Glossopteris* leaves and fructifications (Rosler, 1975). It has been equated with Taphoflora C of Rosler (1973, and in press a).

Irapuá and Lauro Müller assemblages. From the Rio Bonito Formation in Southern Santa Catarina the Irapuá and Lauro Müller assemblages are characterized by the predominance of *Glossopteris* (Oliveira, 1969, Rigby, 1970, 1972). The main outcrop of the Irapuá assemblage is situated in Criciúma (Bainha outcrop) which is the type-locality of Taphoflora C (Rosler, 1973, and in press).

Rio Grande do Sul assemblages. In the Tubarão Group of Rio Grande do Sul State (not shown in Fig. 2) there are two groups of assemblages of Late Paleozoic age. The first group characterized mainly by "Gangamopteroid" leaves, is roughly similar to the Transitional Taphoflora, and occurs in the Itararé Subgroup. The second contains already a diversified Glossopterid flora roughly similar to Taphoflora C (Rosler, 1973, and in press) and occurs in the Itararé Subgroup and Rio Bonito Formation.

RECAPITULATION

The above description of stratigraphic succession of Late Paleozoic marine fauna and floral assemblages may be synthesized in the following manner:

- a) The poorly diversified marine invertebrate faunas intercalated in the glacial sequence (Itararé Subgroup) are mostly cosmopolitan in generic composition. They are preceded stratigraphically by a flora which the presence of Glossopterid elements has yet not been firmly established and which is provisionally interpreted as a pre-*Glossopteris* assemblage;
- b) The uppermost faunal assemblages of the Itararé Subgroup include a mixture of cosmopolitan elements having Tethyan

affinities, together with other typical Gondwana taxa. Floral assemblages with Glossopterids are also first recorded from beds in the upper part of the Itararé Subgroup, but are still overlain by diamictites;

c) The next younger Late Paleozoic floral assemblages, at the base of the Rio Bonito Formation (Guatá Subgroup), are already well diversified *Glossopteris* and *Gangamopteris* floras but are "mixed" with other elements of boreal affinities. They are stratigraphically succeeded by a typical Gondwana faunal assemblage;

d) Younger marine faunas are not yet known in the Paraná Basin; floral assemblages from the middle and upper part of the Rio Bonito are typical *Glossopteris* floras with this genus as the most common and diversified element.

PALEOCLIMATIC IMPLICATIONS

The stratigraphic distribution of faunal and floral assemblages and their probable approximate mutual lateral correspondence and relationships with coal beds and glacial sediments are suggestive of certain widespread paleoclimatic and tectono-sedimentary events in the Paraná Basin which will be mentioned only briefly here.

In the Itararé Subgroup of the eastern Paraná Basin the repetition of several diamictite beds separated by lithologies lacking evidence of glacial activity, some containing marine faunas, floras or even coal beds have been cited earlier as evidence for periods of deglaciation. The widespread reworking of diamictites constitute additional evidence for this concept (see Rocha-Campos, 1967; Frakes, Crowell, 1969 for a more thoroughly discussion).

Whether the above intervals correspond to interstadial or interglacial periods is yet difficult to establish. However, the presence of thicker non-glacial beds intercalated within the diamictites, the proliferation of floras and

most importantly coal seams indicate long periods of milder climate in the Paraná Basin during sedimentation of parts of the Itararé Subgroup.

The richer and more diversified flora of the post-glacial sequence and its apparent gradually higher stratigraphic appearance as one progresses southward may be related to translatitudinal migration of climatic conditions as pointed out by Rosler (1976).

CARBONIFEROUS-PERMIAN BOUNDARY

On the basis of the preceding discussion a few points can be made on the criteria presently available for positioning the Carboniferous-Permian boundary in the Late Paleozoic sequence of Gondwanic South America.

Megaflora. In accordance with the traditional Australian view the incoming of the Permian is conventionally fixed in South America at the lowest limit of the occurrence of the *Glossopteris* flora, or for practical purposes, the lowest occurrence of *Gangamopteris* (Archangelsky, 1971; Rosler, 1972, 1973). Studies of Late Paleozoic floral succession in Argentina (Archangelsky, 1971) have led to the establishment of a sequence of five floral "stages" (or perhaps more adequately, five assemblage-zones) for the probable Carboniferous and Permian. The megaflorestic modifications are thought to have chronological significance on the basis of evaluation of their evolutionary level; the ages assigned to the stages are also partially based on their relationship with marine invertebrates. The strata containing the floras do not occur in a continuous sequence, and thus succession is at least in part reconstructed by correlation. A parallel scheme has also been proposed for the eastern Paraná Basin of Brazil (Rosler, 1972, 1973, and in press) which can be roughly equated with that for Argentina.

The first Glossopterids in the Late Paleozoic of Argentina appear at the base of the Lubeckense A floral assemblage (Archangelsky, 1971) and in the Cerquilha assemblage

in the Paraná Basin of Brazil (= Transitional Taphoflora, Rosler, in press). The Sakmarian age attributed by Archangelsky (1971) to the Lubeckense A is partially based on its assumed stratigraphic position overlying the "Upper Tepuel" Group sediments in Southern Argentina which contains fossils of the *Canocrinella* cf. *C. farleyensis* zone considered to be early Permian in age (Amos, 1964; 1972, Amos et alii., 1973). Suero (1958) however, reports the presence of *Dielasma* and "*Productus*" associated with megaflores at Nueva Lubecka; *Dielasma* cf. *D. itaitubense* (Keidel, Harrington, 1938) is a characteristic component of the *Levipustula levis* zone in the Calingasta-Uspalata area of the Argentinian Precordillera considered as Westphalian in age (Amos, Roller, 1965; Amos et alii., 1973). (Table 2.)

In Argentina, assemblages with Glossopterids are preceded by megaflores containing *Pseudorhacopteris ovata* (Tupense assemblage) and *Botrychiopsis plantiana* (Trampeadense assemblage), the latter species coexisting in part with the Glossopterids (Archangelsky, 1971). A similar situation was described by Rigby (1973) for Queensland, eastern Australia, where *Pseudorhacopteris* and *Botrychiopsis* floras are succeeded by the typical Lower Gondwana flora with Glossopterids, in the Namurian - Lower Permian interval. "*Rhacopteris*" - like fronds (*Rhacopteris chubutiana* Archangelsky, Arrondo, 1966), however, were reported from Argentina associated with Glossopterids in the Lubeckense A assemblage (Archangelsky, 1971). In the Paraná Basin, Millan (1975) identified *Rhacopteris* cf. *ovata* (= *Pseudorhacopteris* cf. *ovata*) and "*Rhacopteris*" cf. *chubutiana* in the Monte Mór assemblage (Fig. 2). In this basin, the first recorded Glossopterids appear in the upper part of the Itararé Subgroup in northern Paraná Basin, elsewhere containing a possibly Lower Permian marine fauna (Passinho - Baitaca - Rio da Areia assemblages). The only place where *Botrychiopsis plantiana* has been reported in Brazil is in the Rio Bonito Formation of Rio Grande do Sul, where it is associated with *Glossopteris - Gangamopteris* (Rigby, 1970) at levels which Rosler (in press) de-

signantes as Transitional Taphoflora (= base of Lubeckense). (Table 1.)

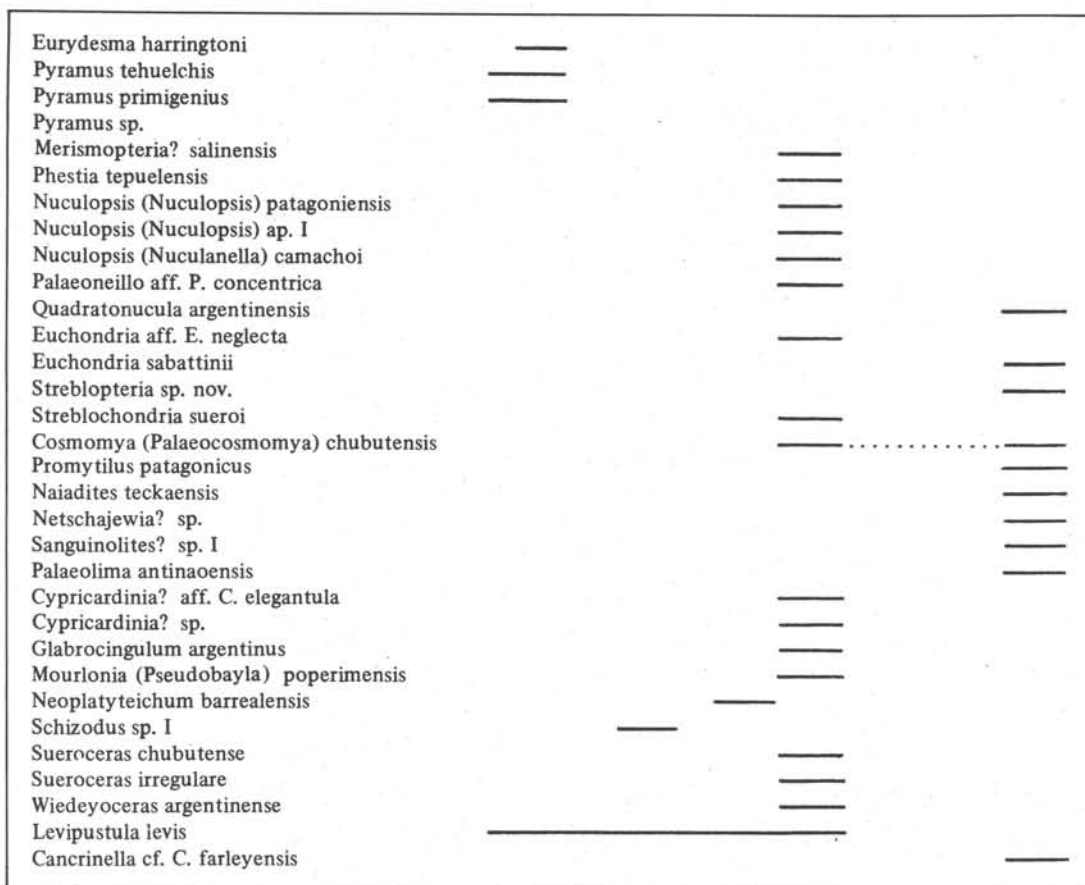
Megafauna. Other tentative age assignment of the South American Late Paleozoic sequence on the basis of a meager marine invertebrate fauna are clearly influenced by the Australian scheme, since on that continent faunas are relatively richer, better known, and more easily correlatable with the northern hemisphere on the basis of associated ammonoid faunas (Glenister, Furnish, 1961).

In the Precordillera and Central Patagonian basins of Argentina the occurrence of *Canocrinella* cf. *C. farleyensis* and its associated fossils (*Canocrinella* cf. *C. farleyensis* zone, Amos, Roller, 1965) is interpreted as indicating an early Permian age (Amos et alii., 1973). The most important species of these assemblages is *Canocrinella* cf. *C. farleyensis*, which resembles two eastern Australian species: *Canocrinella farleyensis* Dunn and also *Canocrinella levis* Maxwell. *C. farleyensis* was compared by Hill (1950) with *C. cancriniformis* and *C. cancrini* var. *lata* Netschajew both from the Sakmarian and Artinskian of Russia and with *C. phosphatica* from the early Permian of North America. Both Australian species are restricted to beds of Sakmarian age (Maxwell, 1964). (table 2).

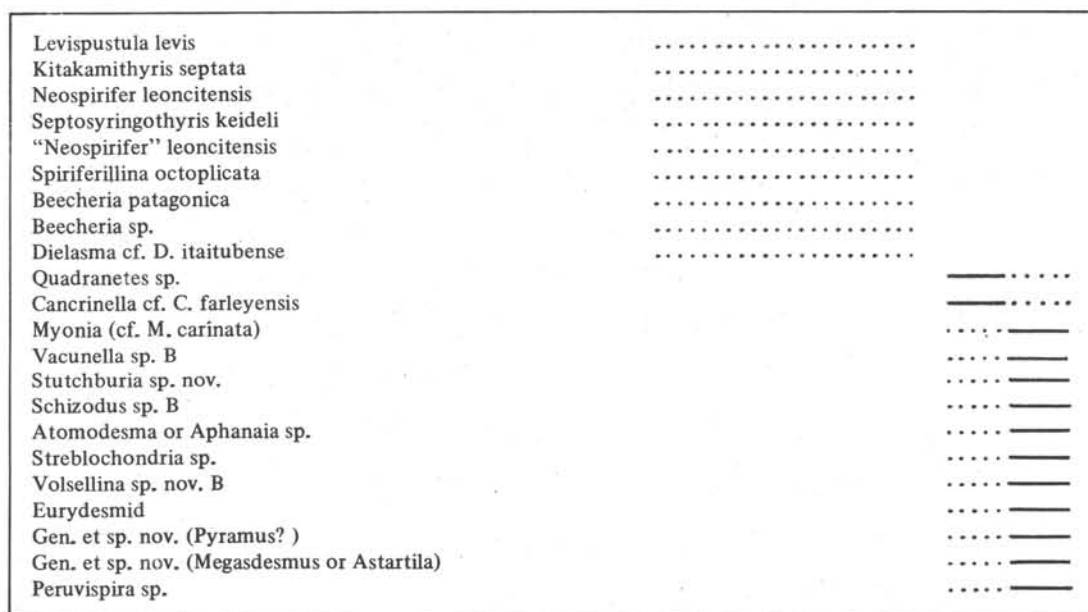
In the Central Patagonian Basin of Argentina *Canocrinella* cf. *C. farleyensis* occurs associated with bivalves which show a general affinity with Permian species from Australia (Gonzalez, 1972a, 1972b, 1972c, 1974). In Australia, as in Argentina, *Canocrinella farleyensis* occurs above the *Levipustula levis* zone which is considered as Westphalian (McKellar, 1965, McClung, 1975, Runnegar, 1972; Amos et alii., 1973). In contrast with Australia, *Eurydesma* or possibly its predecessor seems to appear early in the Late Paleozoic of Argentina in strata corresponding to the base of the *Levipustula levis* zone (Gonzales, 1972a), and possibly below the *Canocrinella* cf. *C. farleyensis* zone in the Precordillera of Mendoza (Rocha-Campos, 1970). A more

VISEAN	NAMUR	WESTPH.	STEPH.	L. PERM	Stand Scale	Local Subd.
	<u>Pseudorhacopteris</u> Flora		<u>Botrychiopsis</u> Flora	Lower Gondwana Flora		
<u>Pseudorhacopteris ovata</u>						EASTERN AUSTRALIA (Rigby, 1973)
<u>Botrychiopsis plantiana</u>						
Glossopteris & <u>Gangamopteris</u>						
	Stage 1			Stage 2	Polym. Subd.	
		Tupense	Trampeaderense	Lubeckense A B	Local Subd.	
<u>Pseudorhacopteris ovata</u>						ARGENTINA Archangelsky, 1971)
<u>Botrychiopsis plantiana</u>						
Glossopteris & <u>Gangamopteris</u>						
"Rhacopteris" <u>chubutiana</u>						
			Taphoflora A	Trans. Taph. B Taph. C	Local Subd.	
<u>Pseudorhacopteris</u>						BRAZIL (Röslér, in press a)
<u>Botrychiopsis cf. plantiana</u>						
<u>Gangamopteris</u>						
<u>Glossopteris</u>						
G/H1 → ← J					Polym. Subd.	

1. Comparison of distribution of key megaplant genera in the Late Paleozoic of Brazil, Argentina and eastern Australia. Correlation with standard scale at left denotes only local interpretation of age (data from Archangelsky, 1971; Rigby, Rosler, in press).



2a. Mutual stratigraphic distribution of some brachiopod and mollusk species in the Late Paleozoic of Argentina. (Central Patagonian Basin). Not to be taken as a range-chart.



2b. Mutual stratigraphic distribution of some brachiopod and mollusk species in the Late Paleozoic of Argentina (Precordillera).

typical but isolated *Eurydesma* fauna probably correlatable with the early Permian (Asselian) Allandale fauna of Eastern Australia (Runnegar, 1969, 1972) occurs in the Sierras Australes of Argentina.

On the basis of the evidence discussed, the Carboniferous-Permian boundary in Argentina may thus occur somewhere between the *Levipustula levis* and the *Canocrinella* cf. *C. farleyensis* zones. Unfortunately, none of the diagnostic zone fossils of the Argentinian Late Paleozoic have been found yet in the Paraná Basin, and thus correlation by means of the megafauna cannot be done at the moment.

Microflora. Daemon, Quadros (1970) subdivided the Late Paleozoic sequence of the Paraná Basin into six informal "biostratigraphic intervals" (G-H-I-J-K-L) based on individual form-species ranges and the appearance of important major spore and pollen groups. The "intervals" seem thus to correspond to assemblage zones. Intervals H, I and L were further subdivided into subintervals H₁ - H₃, I₁ - I₄ and L₁ - L₂, respectively.

In the Itararé Subgroup the lower microfloras already contain rare striate, bisaccate pollen associated with *Potoniesporites* and other typical spores and monosaccate pollen (intervals G-H₁) interpreted as Stephanian C - Sakmarian by Daemon, Quadros (1970). The greatest incidence of striated bisaccate

grains, including *Vittatina* and *Protospoxypinus*, appear at interval H₂ and especially at H₃. To these, an early Permian age was assigned by Daemon, Quadros (1970). The associated megaflores in the Paraná Basin are, respectively, a possible pre-*Glossopteris* flora in beds bearing microfloras of Intervals G-H₁, and a megaflores with *Glossopteris* in intervals higher than H₂ - H₃. This is in conflict with the situation in Australia where no striate bisaccate forms have been found in beds containing a pre-*Glossopteris* flora (Evans, 1967; Kemp, 1973).

In synthesis, it is obvious from the preceding discussion that there is no firm ground for establishing the C - P boundary within the Late Paleozoic sequence of the Paraná Basin of Brazil. From the meager evidence on hand, the boundary could lie within the Itararé Subgroup, somewhere between the Monte Mór and the Cerquillo floral assemblages and, possibly, below the Capivari marine assemblage. The palynological information however conflicts with this interpretation and on this basis the entire Itararé Subgroup could represent the Permian.

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