THE PALAEOBIOGEOGRAPHICAL SIGNIFICANCE OF THE SPORE *GRANDISPORA PSEUDORETICULATA* (MENÉNDEZ AND PÖTHE DE BALDIS) OTTONE IN THE MIDDLE TO LATE DEVONIAN OF GONDWANA

di Pasquo, M., Amenábar, C.R. and Noetinger, S.

CONICET. National Research Council of Argentina. UBA. Department of Geological Sciences. Faculty of Exact and Natural Sciences. University of Buenos Aires. Ciudad Universitaria. Pabellón II (1428). Capital Federal. E-mail: amenabar@gl.fcen.uba.ar; noetinger@gl.fcen.uba.ar; medipa@gl.fcen.uba.ar

Introduction

An update of the palaeogeographical and biostratigraphical distribution of *Grandispora pseudoreticulata*, based on new records coming from Devonian deposits of San Juan (Precordillera Argentina) and from the north of Argentina and the south of Bolivia (Tarija Basin) is presented. These recent studies show that this spore species is frequently very dominant is some levels where the palaeomicroplankton is scarce or is absent. The importance of the association of this taxon with plant remains attributed to "*Haplostigma" furquei* is also discussed (figures 1 A, B).

Palaeontological and biostratigraphical information

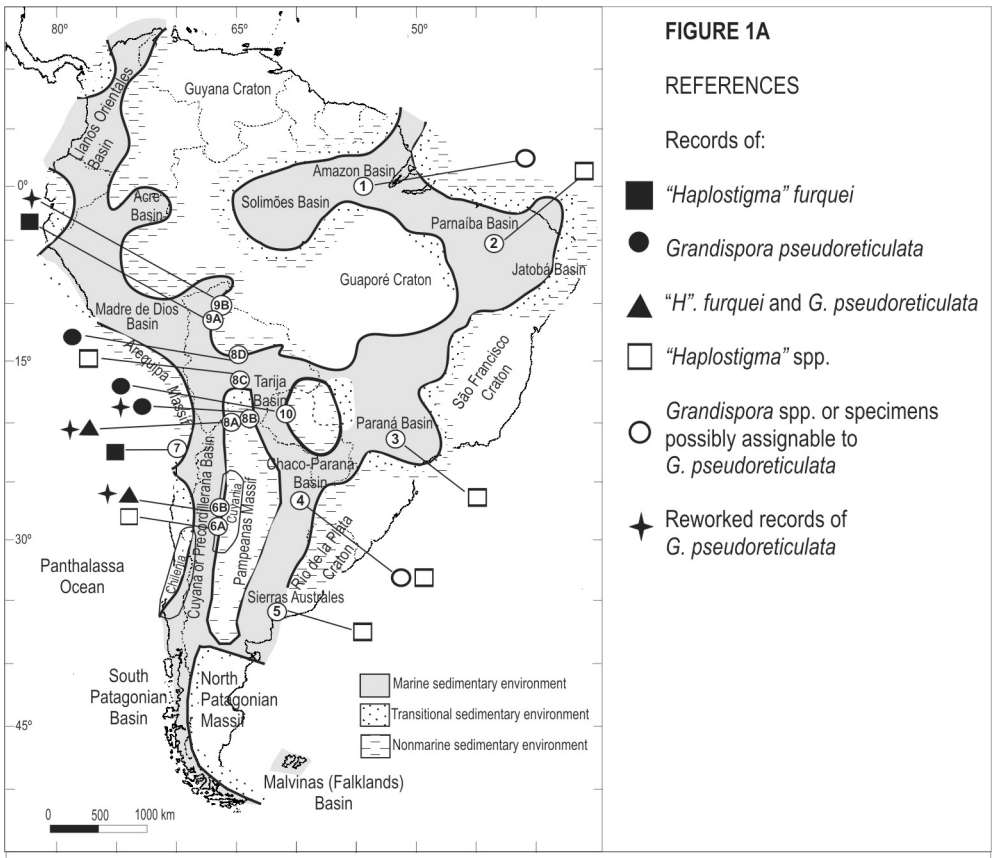
One of the studied palynoassemblages comes from the Chigua Formation (Chavela Member), in the Punilla and Del Volcán ranges, Precordillera, western Argentina (Amenábar *et al*., 2006). The fossiliferous samples were collected in the La Cortadera and Del Chaco creeks, eastern of the Blanco River (Figure 1, A). From the former, samples were obtained from shales which also contain trilobites; the microflora has the *Grandispora pseudoreticulata* and paleomicroplankton more or less in the same proportion. From the latter, samples were obtained from carbonaceous shales and has lycophyte remains with a microflora with dominantly continental elements. Based on the rest of the species that composed the assemblages, a Middle Devonian age (early Givetian) is proposed. The assemblages are comparable to *D. devonicus-G. naumovii* (DN) and *G. lemurata-C. magnificus* (LM) Richardson and McGregor (1986) and to the Interval zones GS, Per and LLi defined for Amazon basin (Melo and Loboziak, 2003). On the other hand, the other Devonian assemblages come from Los Monos Formation cropping out in the western flank of the Balapuca Anticline in the Las Pavas-San Telmo Range (Argentina and Bolivia respectively, Figure 1, A), where a rich microflora has been documented (di Pasquo, 2007 a). Two assemblages obtained mainly from shales and subordinated diamictites, were identified and they contain predominantly spores over paleomicroplankton species. In A1 hyolithes and trilobites and "*Haplostigma" furquei* are also recorded and in A2 only the plant species appeared. The A1 is attributed to the late Eifelian (A1) based mainly on the absence of *Geminospora lemurata* (Balme) Playford and other related species that first appear on the Givetian, and the other one represents the early late Givetian to base of the Frasnian (A2), due to the presence chiefly of *Samarisporites triangulatus* Allen and it is correlative to the *optivus-triangulatus* Biozone Richardson and McGregor (1986), and the *Trg* Zone Melo and Loboziak (2003). The assemblage of the Chavela Member of the Chigua Formation would be located between the mentioned A1 and A2 assemblages from the Los Monos Formation based on the presence of *Geminospora lemurata* and the absence of *Samarisporites triangulatus* in the studied microflora. In all of the assemblages mentioned above, *Grandispora pseudoreticulata* (along with other species of the genus) is noticeably abundant (see figure 2).

Other South American records of this taxon are included in the figure 1, B. From Paraná and Amazon Basins in Brazil, similar forms have been documented by Daemon *et al*. (1967; pl. 1, figs. 14, 15) and Melo and Loboziak (2003; pl. 1, fig. 6) that are here considered as likely records of *Grandispora pseudoreticulata*. A more extensive work with taxonomical treatment of this species and other related forms is in preparation. Thus, its stratigraphical range is well established as late Eifelian to early Famennian on the basis of the presence of Euramerican index species (see above). Moreover, it is used as a zonal index species in several biostratigraphical schemes proposed for the Tarija Basin (see di Pasquo, 2007 c). This species is

also recognized as reworked in the Early Carboniferous (early Visean) Malimán Formation (Rio Blanco Basin, Argentina; Amenábar, 2006), from the Itacua Formation at Balapuca (overlying the Los Monos Formation; di Pasquo, 2007 b), the Serpukhovian Kaka Formation (Madre de Dios Basin, Bolivia; Azcuy and Ottone, 1987), and in the Late Carboniferous Macharetí and Mandiyutí Groups from the Tarija Basin (di Pasquo and Azcuy, 1997; di Pasquo, 2003; see figures 1, A and 2). *Grandispora pseudoreticulata*, under the denomination of *Indotriradites variabilis* Pérez Loinaze (2005), is here interpreted as a reworked form. On the other hand, not all the deposits bearing the herbaceous lycophyte "*Haplostigma"* spp. have yielded palynofloras with *Grandispora* spp. except from the Balapuca section where both taxa come from the same levels. Records of "*Haplostigma" furquei* Frenguelli and other species of the genus (that still needs to be revised) are cited in figures 1, A-B. Unfortunately, up to now it is not possible to establish a narrower affinity between this spore species and the "*Haplostigma"* genus as its parental plant. However, the record of the megaflora remains is important since it indicates continental or at least transitional palaeoenvironments for the fossil-bearing deposits. Thus, on the basis of these data the Figure 1A presents a more accurately delimitation of the emergent areas (i.e., continental or at least transitional areas).

Palaeobiogeographical considerations and conclusions

Some previous palaeobiogeographical proposals for the Middle and Late Palaeozoic were summarised and updated by Wnuk (1996), who distinguished the Euramerican Realm and Gondwanan Realm, the latter including the South Gondwanan Temperate region. This author provided for the Middle and Late Devonian a briefly synthesis of previous palaeontological data into a paleobiogeographical scheme, but he indicated that an additional work on Middle and Late Devonian phytogeography is needed. The Gondwanan Realm encompasses the largest land area during the Palaeozoic and includes the South America, Antarctica, Africa, India and Australia continents with other regions such as Madagascar, Arabia, New Zealand, and the smaller, peripheral Tibetan, Iranian, and Turkish Plates (Li Xingxue, 1986; see figure 1, B). However, the floristic development of this realm is not well understood because of its poor fossil record (except during the Permian). At the same time, Streel and Loboziak (1996) defined the Western Gondwana-Southern Euramerica phytogeographical province, which includes the western Canada and the western of Europe, for the Middle-Late Devonian based on the resemblance of its palynoassemblages. Although most palynomorphs had a cosmopolitan distribution during the Devonian, Bär and Riegel (1974) had suggested that provincialism it would be recognized at the specific level for Gondwana. The frequent association of *Grandispora pseudoreticulata* with other endemic but stratigraphically important spore species (e.g., *Grandispora permulta* Loboziak *et al*., *Grandispora daemonii* Loboziak *et al*., *Leiotriletes balapucensis* di Pasquo, *Acinosporites ledundae* Ottone, *Apiculiretusispora laxa* Amenábar *et al*., *Apiculatisporis grandis* Menéndez and Pöthe de Baldis, *Retusotriletes paraguayensis* Menéndez and Pöthe de Baldis), as well with the *"Haplostigma" furquei* flora (Figures 1 A, B), elements absent in Euroamerica, demonstrates a certain degree of endemism of the floras mainly in South America and Africa and allows us to establish the **Afrosouthamerican Subrealm** into the mentioned phytogeographical province for the Middle to early Late Devonian. Then, this subrealm is defined up to now embracing Bolivia, Brazil, Paraguay, Uruguay and Ghana and it is characterized by *"Haplostigma" furquei*, *Grandispora pseudoreticulata* and other related endemic species recorded during the Middle to early Late Devonian that show a relative restricted palaeogeographical distribution. Based on the reconstruction of the palaeoclimatic zones here reproduced from Scotese in Cingolani et al. (2002; see figure 1B), these floras appear to have developed around 55° and 75° S palaeolatitude. Nevertheless, the occurrence of some Euramerican species in the assemblages of the cooler Afrosouthamerican subrealm can support the development of relatively similar climatical conditions (e.g., Streel and Loboziak, 1996), that are also evidenced by sharing the records of brachiopods such as *Tropidoleptus carinatus* (e.g., Fonseca and Melo, 1987) and several microplankton species (Quadros, 1999). Finally, more studies are needed to analyse the connection of this subrealm with other regions of Africa and Antarctica where other species of *Haplostigma* are recorded but palynology is still poorly known (see figure 1, B).



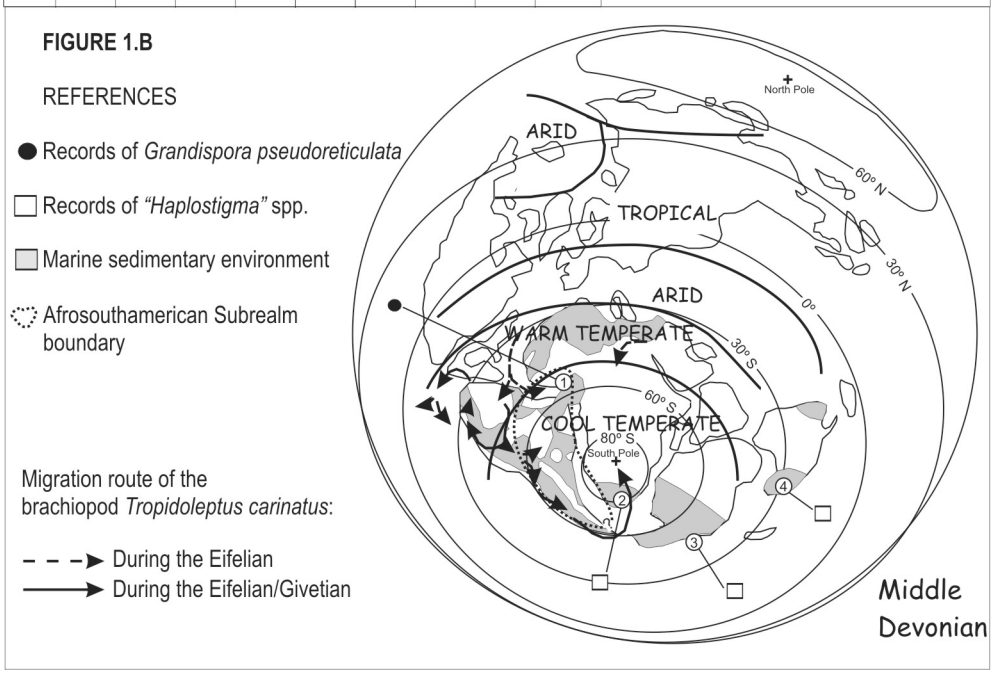


Figure 1.A. Location of known occurrences of ***Grandispora pseudoreticulata*** and ***"Haplostigma" furquei*** and other species of this genus in South America palaeogeographical reconstruction (based on Cuerda and Baldis, 1971; Melo, 1989). **1.** Amazon Basin (Melo and Loboziak, 2003). **2.** Parnaíba Basin, Pimenteira Formation (Suarez Riglos, 1975). **3.** Paraná Basin, Tibagi Member (Daemon *et al*. 1967). **4.** Chaco-Paraná Basin (Antonelli and Ottone, 2006). **5.** Sierras Australes, Lolén Formation (Cingolani *et al*., 2002). **6.** Cuyana or Precordillerana Basin, **6.A.** Punta Negra Formation (Baldis and Peralta, 2000), **6.B.** Chigua Formation (Gutiérrez, 1996; Amenábar *et al*., 2006) and Malimán Formation (Early Viséan; Amenábar, 2006) as a reworked form. **7.** El Toco Formation (Antofagasta region; Moisan and Niemeyer, 2005). **8.** Tarija Basin. **8.A.** Los Monos (Middle Devonian) and Itacua formations (Early Viséan) (Balapuca; di Pasquo, 2007 a, b), **8.B.** Los Monos Formation (Ottone, 1996) and Macharetí and Mandiyutí Goups (Late Carboniferous, see di Pasquo and Azcuy, 1997; di Pasquo, 2003), as a reworked form. **8.C.** Huamampampa, Los Monos, Iquirí formations (Campo Redondo, Suárez Riglos, 1975; Lajas, Wood, 1995). **8.D.** Los Monos, Iquirí formations (Bermejo River, Santa Cruz; Pérez Leyton, 1990). **9.**

Madre de Dios Basin. **9.A.** Pando and Manuripi boreholes (Vavrdová *et al*. 1996), **9.B.** Kaka Formation (Serpukhovian; Azcuy and Ottone, 1987), as a reworked form. **10.** Picuiba borehole (Menéndez and Pothe de Baldis, 1967). **Figure 1.B**. World's Middle Devonian palaeogeographic map with palaeoclimate zones (from Scotese in Cingolani *et al*., 2002) showing the marine deposits with the migration route of the brachiopod *Tropidoleptus carinatus* (after Fonseca and Melo, 1987) and the location of known occurrences of ***Grandispora pseuroreticulata*** and ***"Haplostigma"*** **spp**. in the rest of Gondwana. **1.** Ghana (Bär and Rieguel, 1974). **2.** Karro Basin, South Africa (Anderson and Anderson, 1985). **3.** Antarctica (McLoughlin and Long, 1994). **4.** Australia, New South Wales (McLoughlin and Long, 1994).

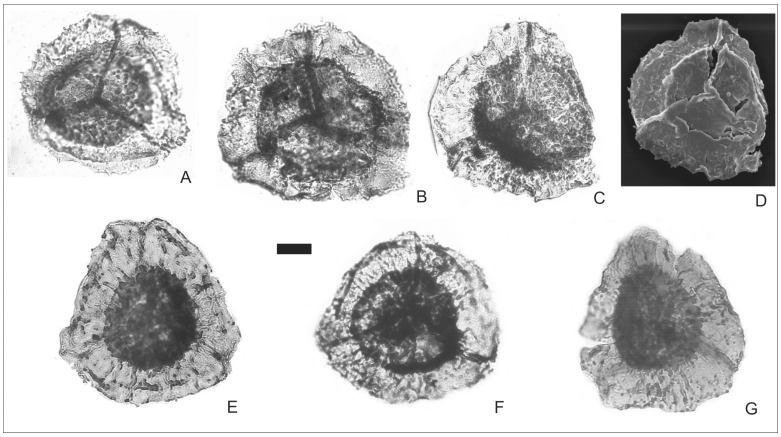


Figure 2. A-F. ***Grandispora pseudoreticulata*** (Menéndez and Pöthe de Bladis) Ottone. **A-D, F.** Indigenous specimens. **E, G.** Reworked specimens. **A, C-D.** Precordillera (Chigua Formation, La Cortadera creek) BAFC-Pl 1656 (1): H23. **C-D.** BAFC-Pl 1505. **B.** Precordillera (Chigua Formation, Del Chaco creek), BAFC-Pl 1780 (1): J25/4. **E.** Precordillera (Malimán Formation, La Cortadera creek), BAFC-Pl 1508 (4): P44. **F.** Los Monos Formation (Balpuca, San Telmo Range, Tarija department). BAFC-Pl 1269(1): Y35/2. **G.** Itacuamí Formation (Tuyunti creek, Salta), BAFC-Pl BAFC-Pl 1154 (1): Y39/4. Scale bar = 20 μm (x 500). The slides are housed with sample numbers BAFC-Pl from the Laboratory of Palynology (Department of Geology, Exact and Natural Sciences Faculty, University of Buenos Aires).

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