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SPINICAUDATA DO TRIÁSSICO E JURÁSSICO DAS FORMAÇÕES SANTA MARIA E CATURRITA (BACIA DO PARANÁ): TAFONOMIA E PALEOAMBIENTES

São Leopoldo, 2017

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Sumário

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Resumo

Os conchostráceos, Spinicaudata, apresentam carapaça com composição quitino-fosfática, e, portanto, com baixo potencial de preservação, quando comparados a outros grupos de bivalves. Porém, estudos atualísticos demostraram sua alta resistência a processos físicos. Por conta desta característica enviesada, associada a sua ampla distribuição geográfica e curto tempo de vida, os conchostráceos tem sido utilizados como marcadores temporais bastante precisos. Sua boa resolução preservacional amplia seu potencial como indicadores temporais. Além disso, diante dessa característica tafonômica, os spinicaudatos podem ser úteis para melhor compreender os processos sedimentares dos ambientes deposicionais nos quais viviam. Este trabalho tem como objetivo uma análise paleoambiental e estratigráfica de conchostráceos (Spinicaudata) do intervalo Triássico-Jurássico da Bacia do Paraná (Formações Santa Maria e Caturrita). A metodologia consistiu nas análises de fácies e sistemas deposicionais, e tafonômicas das concentrações fossilíferas. A tafonomia evidenciou quatro associações fossilíferas, individualizadas por meio da gênese e das características intrínsecas e extrincecas das concentrações: 1a e 1b (fácies Fl) decantação de finos em planície de inundação; 2 (fácies Sr-Fl-Sh) extravasamento em planície de inundação; e, 3 (fácies Fl-Sm) barras de desembocadura. Nas associações tafonômicas 1a e 1b o alto grau de preservação está associado ao padrão autóctone dos conchostráceos, enquanto que nas associações tafonômicas 2 e 3, aos distintos padrões preservacionais podem ser considerados autóctones, para-autóctones até mesmo alóctones. Conclui-se aqui, que a qualidade preservacional desses organismos deve ter sido determinada pela duração do transporte, distância do sítio original de vida e magnitude do evento de soterramento final. Dentre as espécies identificadas, *Euestheria minuta* nos níveis do Arroio Passo das Tropas é mais um elemento no reconhecimento da uma idade entre o final do Triássico Médio e início do Triássico Superior para o Membro Passo das Tropas. A presença de uma nova forma relacionada a Fushunograptidae, por outro lado, constitui mais um elemento em apoio ao intervalo Jurássico, mais recentemente atribuída ao topo da Formação Caturrita por sua correlação com outras ocorrências mundiais.

Palavras-chave: Spinicaudata, conchostráceos, tafonomia, Triássico, Jurássico, Bacia do Paraná

Abstract

Due to the chitino-phosphatic nature of of Spinicaudata conchostracans, these organisms exhibit, as a rule, a low preservational potential when compared to other bivalve groups. Notwithstanding, recent studies point to their increased capacity to tolerate physical processes. Due to this biased characteristic, conchostracan have been utilized as precise temporal markers. Besides this, owing to this taphonomic particularity, spinicaudates can be also useful in the investigation of sedimentary processes and depositional environments in which these organisms inhabited in the past. The present work aims at providing a paleoenvironmental and stratigraphic analysis of conchostracans (Spinicaudata) from the Triassic-Jurassic of the Paraná Basin (Santa Maria and Caturrita formations). The adopted methodology consisted in the appraisal of facies, depositional systems and taphonomic signatures of the fossiliferous deposits. The results from the taphonomic study shows the presence of four distinct fossil assemblages, individualized based on the generation mechanism and intrinsic characteristics of the concentrations: 1a and 1b (facies Fl) is related to the decantation of fine grained sediments in floodplains; 2 (facies Sr-Fl-Sh) is related to overflow currents in floodplains; 3 (facies Fl-Sm) river mouth bars. In assemblages 1a and 1b, the high degree of preservation is associated to autochtony in the conchostracans, whereas the preservational condition of assemblages 2 and 3 point to authochthonoy, parautochthony and even allochthony. It is concluded, then, that the preservational quality of these organisms is probably related to transport duration, distance from original site of life and magnitude of the event of final burial. Within the observed species, the recognition of *Eustheria minuta* in the stratigraphic level of the Passo das Tropas creek corroborates an age for these deposits between the late Middle Triassic and early Upper Trisassic. The presence of a new form, likely related to the family Fushunograptidae, in sediments from the Caturrita Formation suggests a Jurassic age for these deposits.

Key word: Spinicaudata, conchostraceans, taphonomy, *Euestheria minuta*, Fushunograptidae, Paraná Basin.

Introdução

Os conchostráceos são pequenos crustáceos (Branchiopoda, Conchostraca) de água doce, cujo corpo está coberto por uma carapaça constituída por duas valvas de composição quitino-fosfática, com linhas de crescimento bem marcadas, consecutivas e acrescentadas na periferia durante o crescimento (Gallego, 1999a). Esse acréscimo depende de seu desenvolvimento variando de espécie para espécie, podendo ocorrer ecdise a cada 2 ou 3 dias (Tasch, 1975,1977), variando esse tempo conforme as etapas de desenvolvimento.

Seus pequenos ovos, resistentes à seca e às baixas temperaturas, dispersam-se facilmente pelo vento e pela água, eclodindo quando expostos a ambientes adequados (Webb, 1979). Esta característica, associada a um ciclo de vida curto, de cerca de 1-3 semanas, possibilita seu desenvolvimento em lagos ou em pequenos corpos d'água temporários desde o Devoniano até o presente (Tasch, 1987).

A aplicação de grupos fósseis com tais características paleobiológicas na resolução de problemas cronoestratigráficos e paleoambientais para depósitos continentais deve ser utilizada de forma cuidadosa. Um dos principais problemas é o desenvolvimento de faunas locais endêmicas em ambientes específicos limitando sua utilização na biocronoestratigrafia. Os paleoambientes aos quais os conchostráceos encontram-se associados, geralmente flúvio-lacustres, não apresentam taxas constantes de sedimentação. Ainda, conchostráceos são sensíveis às mudanças paleoambientais locais e regionais, bem como a eventos erosivos.

Os conchostráceos têm alto potencial de dispersão e curto tempo de vida, e por isso apresentam grande potencial para correlações biocronoestratigráficas (Gallego, 1999a). Diversos trabalhos, como os de Kozur e Weems (2007, 2010), realizaram estudos aplicando esse grupo fóssil na correlação de depósitos continentais do Triássico da Europa e América do Norte.

No intervalo Triássico-Jurássico do Rio Grande do Sul este grupo apresenta grande representatividade. Contudo, pela primeira vez é efetuado um trabalho de tafonomia de conchostráceos no Mesozoico da Bacia do Paraná. Nesse estudo se analisou as fácies com ocorrência de conchstráceos, e suas respectivas assinaturas tafonômicas com o intuito de realização de seu posicionamento estratigráfico e explicar a gênese dos acúmulos fossilíferos. A partir das características aqui observadas nos conchostráceos fósseis procurou-se uma aproximação das espécies já descritas e caracterização de um novo morfotipo com ocorrência até

então restrita aos estratos do Rio Grande do Sul. A parir dessa análise foi possível inferir uma distribuição paleogeográfica da fauna de conchostráceos aqui estudada.

As interpretações tafonômicas sugerem um alto grau de fidelidade. Isto ocorre devido ao fato dos indivíduos quitino-fosfáticos possuírem baixo grau de preservação, se comparados ao potencial de preservação de outros organismos de carapaça bivalve. O seu grau de fidelidade fica associado ao fato de que podem ser preservadas as valvas originais, valvas substituídas ou permineralizadas e ainda somente a impressão das valvas que permitem sua identificação. Além disso, este grupo mostra-se bastante resistente a ação processos físicos, fato este apoiado por meio de experimentos atualísticos publicados em diversos trabalhos (e.g. Orr *et al*., 2008; Astrop *et al.,* 2015). Estudos posteriores serão direcionados para uma maior análise sistemática e taxonômica dos espécimes para a realização de correlações estratigráficas entre bacias sul-americanas.

Este trabalho consiste na ampliação do registro da fauna de conchostráceos dos estratos do Triássico e Jurássico da Bacia do Paraná, estado do Rio Grande do Sul, e sua potencial aplicação à estratigrafia e na reconstituição dos paleoambientes.

Hipótese e objetivos

Esta pesquisa está baseada na hipótese de que conchostráceos podem ser bons biomarcadores estratigráficos e que a tafonomia deste grupo é útil para análises paleoambientais.

O objetivo geral deste trabalho é avaliar o potencial de conchostráceos Spinicaudata como marcadores estratigráficos e paleoambientais para os depósitos do Triássico e Jurássico da Bacia do Paraná no Rio Grande do Sul.

Objetivos específicos:

a) Interpretar e refinar os ambientes de sedimentação dos afloramentos estudados com base em análises das fácies e dos processos tafonômicos;

b) Identificar os morfotipos ocorrentes;

c) Descrever a ocorrência de novos morfotipos;

d) Posicionar os morfotipos ocorrentes no arcabouço estratigráfico regional;

e) Determinar as associações fossilíferas presentes nas distintas litofácies, buscando sua inserção e preservação nos distintos ambientes deposicionais;

Material e métodos

A metodologia deste estudo consistiu em etapa de campo para coleta de dados e amostras fossilíferas e trabalhos laboratoriais. Especificamente envolveu:

a) levantamento bibliográfico;

b) análise dos materiais depositados nas coleções do Laboratório (LaViGæa) do Museu de História Geologica do Rio Grande do Sul (MHGEO), do Programa de Pós-Graduação em Geologia da Universidade do Vale do Rio do Sinos (UNISINOS), do do Centro de Apoio à Pesquisa Paleontológica (CAPPA) da Universidade Federal de Santa Maria (UFSM) e da coleção do Núcleo de Estudos em Estratigrafia e Paleontologia (NEPALE), da Universidade Federal de Pelotas (UFPEL).;

c) coleta de fósseis em campo seguindo o protocolo tafonômico/paleoautoecológico de Simões e Ghilardi (2000);

d) levantamento de perfil estratigráfico na escala 1:50 e descrição das litofácies nos afloramentos com intuito de identificar os processos deposicionais;

e) análise dos aspectos tafonômicos segundo o modelo proposto por Kidwel *et al*., (1991), Speyer e Brett (1986, 1988);

f) identificação taxonômica dos conchostráceos seguindo a metodologia proposta por Scholze e Schneider (2015);

g) registro das formas de conchostráceos em microscópio eletrônico de varredura (MEV), para identificação dos padrões de ornamentação entre as linhas de crescimento.

Stratigraphic distribution, taphonomy and paleoenvironments of Spinicaudata in the Triassic and Jurassic of the Paraná Basin

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Abstract

Due to the chitino-phosphatic nature of Spinicaudata conchostracan exoskeletons, their carapaces exhibit a low preservational potential compared to other bivalve groups. However, the recent studies point towards the increased tolerance of the carapace against the physical processes. Due to this peculiar characteristic, conchostracan carapace have been utilized as precise temporal markers in estimating stratigraphic and taphonomic parameters. The same characteristic also makes the spinicaudatesuseful in evaluatingthedepositional processes and environments. The present work aims at providing a paleoenvironmental and stratigraphic analysis of

24   conchostracans (Spinicaudata) from the Triassic-Jurassic of the Paraná Basin (Santa Maria and

25   Caturrita formations) in terms of the sedimentary facies analysis, depositional system

26   characterization, and analysis of the taphonomic signatures of the fossiliferous horizons within

27   these formations. The results from the taphonomic study delineates the presence of 4distinct

28   fossil assemblages based on the causative mechanism and fundamental characteristics of the

29   fossil concentrations: 2 taphonomic assemblages in the laminated mudstone beds deposited from

30   the decantingfine-grained sediments in floodplains; the sandstone beds with plane parallel

31   laminations and dune- and ripple-cross-stratifications deposited from the flooding-related

32   overflow in the floodplains; and the association of laminated mudstone and massive sandstone

33   beds deposited as the river mouth bars. The results show that the taphonomic signatures, e.g.,

34   closed valves, may indicate the various patterns of autochthony and allochthony. In the fine-

35   grained floodplain assemblages, the high degree of preservation can be attributed to autochthony

36   in the conchostracans, whereas the preservational condition of floodplain sandstone sheet and

37   mouth bar assemblages point toward parautochthony and even allochthony. Therefore, the

38   preservational quality of conchostracan exoskeletons is likely a function of parameters, e.g.,the

39   transport duration, the distance from life position, and the magnitude of events causing their final

40   burial. Within the observed species, the recognition of *Eustheria minuta*in the stratigraphic level

41   of the Passo das Tropas creek corroborates an age for these deposits between the late Middle

42   Triassic and early Upper Triassic. The presence of a new form, likely related to the family

43   Fushunograptidae in sediments from the Caturrita Formation, suggests a Jurassic age for these

44   deposits.

45

46   **Keywords**: Spinicaudata, conchostracans, taphonomy, Triassic, Jurassic, Paraná Basin

47 **1. Introduction**

48 The conchostracans (Crustacea, Branchiopoda) have a soft body covered by a chitin-phosphate

49 bivalve carapace or shell(Orb et al., 2008) and a short life cycle. Their eggs, which areresistant to

50 drought and low temperatures, get dispersed by wind and water and hatch when exposed to

51 suitable environments (Webb 1979, Tasch 1987). Limnic environments, e.g., the ephemeral

52 water bodies, perennial lakes, and riverbanks of dense subaqueous vegetation capable of

53 providing protection against predators are the niches where conchostracans thrive (Webb, 1979;

54 Olsen, 1984; Tasch, 1987; Frank, 1988; Belk et al., 1995). They are suspensivores or filter

55 feeders, being capable of both burrowing into the sedimentary substrate and swimming (Webb,

56 1979; Olsen, 1984; Frank, 1988; Astrop et al., 2015). The development of conchostracan

57 carapaces is characterized by consecutive growth lines acquired during ontogenesis. The spacing

58 between growth bands can be variable, depending on local environmental conditions (Webb,

59 1979).In general, a body of water is occupied by a single population of conchostracan without

60 any coexistence of two or more species of the same genus(Kobayashi, 1954, Tasch, 1969, Webb,

61 1979; Gore, 1988; Gallego, 1999, Rohn *et al.,*1990).

62 The conchostracans can be considered as the good biostratigraphic markers due to their wide

63 geographic distribution and high reproduction rates(e.g., Gallego and Martins-Neto, 2006; Kozur

64 and Weems, 2010; Tassi *et al.*, 2015).Kozur and Weems (2010), for example, defined

65 approximately 30 species of conchostracans for the Triassic sedimentary basins in Germany.

66 These biozones are also recognized and correlated to the Newark Supergroup in eastern United

67 States (Kozur and Bachmann, 2008).In Brazil, Katoo (1971) conducted the first biostratigraphic

68 studies of the Mesozoic conchostracans from southern Brazil.

69   The conchostracans have the exclusively chitino-phosphatic carapaces of low preservational

70   potential, which is a common taphonomic phenomenon found amongst other invertebrate taxa of

71   similar characteristic (Kowalewski, 1996). This phenomenon does not necessarily imply a less

72   expressive or quantitative presence in their fossil record, although the quality of preservation of

73   conchostracan shells is variable both in space and time (Kowalewski and Flessa, 1996;

74   Behrensmeyer et al., 2005; Hendy, 2011). The high mechanical durability of conchostracan

75   valves was evidenced by Astrop *et al.* (2015) among the living and laboratory-cultivated

76   individuals. They also documented evidences that benthic forms turned to nektonic ethology

77   under turbulence while living and withstanding the stress caused by mechanical transport. Thus,

78   the taphonomy of this group is related to the association of facies and depositional settings,

79   reflecting the preservational paleoenvironments in which these faunae developed.

80   From a biostratigraphic standpoint, conchostracans are useful biomarkers due to their ample

81   geographic distribution and high rates of reproduction (e.g. Gallego and Martins-Neto, 2006;

82   Kozur and Weems, 2010; Tassi et al., 2015). Kozur and Weems (2010), for example, categorized

83   almost 30conchostracan biozones for the Triassic sedimentary basins of Germany. These

84   biozones were recognized and correlated to the Newark Supergroup, in southwestern U.S.

85   (Kozur and Bachmann, 2008). In Brazil, the first biostratigraphic contribution based on the study

86   of Mesozoic conchostracans from the south of Brazil was provided by Katoo (1971).

87   In the lower Mesozoic strata of Rio Grande do Sul state of Brazil, the group displays an abundant

88   record with the documented occurrences of the families Palaeolimnadiidae, Asmussiidae,

89   Estheriinidae, Vertexiidae, Palaeolimnadiopseidae, Eosestheriidae e Fushunograptidae (Pinto,

90   1956; Katoo, 1971; Tasch, 1987; Gallego, 1996, 1999b, 2001; Rohn et al., 2014). They are all

91   preserved in fluvio-lacustrine environments (Faccini 1989, 2000; Zerfass et al., 2003, 2004,

92 2007). In this work, three localities with occurrences of conchostracans and their respective

93 facies are described. The facies represent characteristics of the wide depositional dynamics of a

94 fluvio-lacustrine system. Associated with the levels with occurrence of conchostracans it can be

95 observed the presence of vertebrate taxa (Langer et al. 2007), remains of fossil plants (Barboni

96 and Dutra, 2013, 2015, Barboni et al., 2016), invertebrates (Corrêa, 2014), and trace fossils

97 (Silva et al., 2012).

98 Thus, this work intends to expand the Triassic and Jurassic faunal record of conchostracans of

99 the Paraná Basin. Moreover, the studyintends to evaluatethe taphonomic potential of the

100 conchostracan carapaces and the paleoenvironmental configuration. The detailed taphonomic and

101 sedimentological analysis of these new occurrences of fossilized conchostracans allows different

102 paleoenvironmental interpretations of the preservation of these faunae. Thus, the occurrence of

103 taxa with a wide paleobiogeographic distribution contributes to the refinement of the age of the

104 fluvio-lacustrine units that characterize the Triassic and Jurassic of the Paraná Basin in the south

105 of Brazil.

106

107 **2. Data and methods**

108 A total of 312 rock samples containing conchostracans are stored in the collections of the

109 Laboratório da História da Vida e da Terra (LaViGæa), at the Museum of Geological History of

110 Rio Grande do Sul (MHGEO), the Centro de Apoio a Pesquisa Paleontológica da Quarta Colônia

111 (CAPPA) of the Federal University of Santa Maria (UFSM), and the Nucleo de Estudos em

112 Paleontologia e Estratigrafia (NEPALE) of the Federal University of Pelotas (UFPEL). The

113 studied material was retrieved from three outcrops located in Santa Maria (Passo das Tropas

114 outcrop, 29°44'41.39"S; 53°47'35.32"W), São João do Polêsine (Piche outcrop, 29°39'13.84"S;

115   53°27'38.36"O), and Faxinal do Soturno (São Luis outcrop, 29°33'29.72"S; 53°26'52.56"O) at

116   the central part of the state of Rio Grande do Sul (Fig. 1).

117   The field work stage consisted in the construction of stratigraphic profiles (lithologs) at a 1:50

118   scale, facies descriptions, sample collection (according to the methodology as detailed in Barboni

119   *et al.*, 2008), and stratigraphic positioning (according to the taphonomic/paleo-auto-ecologic

120   protocol proposed by Simões and Ghilardi, 2000).

121   The collection of fossil material and acquisition of taphonomic data were preceded by the

122   demarcation of quadrants, with the purpose of vertical and lateral control of the fossils resulting

123   in a high resolution survey. The chosen areas were then analyzed for different taphonomic

124   attributes, e.g., bioclast packingand biofabrics, as defined by Kidwell et al., (1986) and Kidwell

125   and Holland (1991). The criteria for distinction between different fossil accumulations were the

126   depositional environments associated with biostratinomic aspects of taphonomic signature

127   groupings, e.g., responses to paleoenvironmental dynamics: articulation/isolation-scattering

128   degree of fragmentation, packing and biofabric (Speyer and Brett 1986, 1988).

129   In the lab, the samples were separated for definition and classification according to the

130   quantitative and qualitative parameters,as set out in Scholze and Schneider (2015), consisting of

131   a detailed investigation of the amount of separation between growth lines and verifying the

132   ornamentation patters at the surface of the valves. The technique aims at constraining the

133   changes in the ornamentation patterns and exploring their different physiognomic positions on

134   the surface of the valves, e.g., the earliest growth lines next to the umbo and along the anterior,

135   posterior, and ventral margins. The morphometric parameters utilized are length (L), height (H),

136   dorsal margin length (l), and curvature parameters (a, b, c, d). Besides individual parameter

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166   posterior, and ventral margins. The morphometric parameters utilized are length (L), height (H),

167   dorsal margin length (l), and curvature parameters (a, b, c, d). Besides individual parameter

168   values, relations among them are also commonly used, e.g., the height and length ratio (H/L), the

169   dorsal margin length and total valve length ratio (l/L), and the maximum curvature intensities at

170   the anterior (a/b) and posterior (c/d) margins of the carapace.

171   The material was photographically documented using a Nikon D3300 digital camera with the Af-

172   P Dx 18-55mm set of lenses, the illumination with a light surface inclined at 45° for better

173   contrast, and the detail recognition in the studied samples. The acquisition of morphometric

174   parameters was carried out by means of a Discovery V20 Zeiss stereomicroscope equipped with

175   Axio Vision system and MEJI TECNO (model FL-150 HIGH) optic fiber illuminator. The best

176   specimens were photographed and were further subjected to scanning electron microscopy

177   imaging (ZEISS EVOMA SEM), aiming at the detailed investigation of characteristic types of

178   ornamentation. The features proposed by Shen (1994), Stigall and Hartman (2008), Orlova and

179   Sadovnikov (2009), and Gallego (2010) were used as criteria for the taxonomic determination of

180   specimens.

181 **3. Geological Context**

182 The study area is located in the Paraná Basin where sedimentary rocks were deposited from the

183 Ordovician to the Cretaceous periods. The depositional pulses are intervened by erosional and

184 non-depositional unconformities. These so called "pulses" correspond to second order

185 depositional sequences based on changes of deposition styles (Milani, 1997).The studied interval

186 is consists of the units representing a continental depositional setting: viz., the Gondwana II

187 Supersequence (SG II) (Milani et al., 2007). The studied sedimentary succession possesses the

188 distinct depositional and fossiliferous features that are restricted only to the state of Rio Grande

189 do Sul. It corresponds to the strata representing important variations in their mode of deposition,

190 as well as embodying the main record of the Triassic Period in the basin (Faccini, 2000; Fig.1).

191 Faccini (2000), Zerfass et al., (2003, 2004), and Machado (2005), based on the structural and

192 sedimentological data, opined that the deposition during the Permo-Triassic was mainly

193 controlled by tectonism under a compressive regime related to the Gondwanides Orogeny. The

194 tectonic regime was reversed during the lower to middle Triassic to an extensional one, which

195 reflected the preliminary stages of Gondwana breakup and the uplift of Serra de La Ventana

196 (Barboni and Dutra, 2015). The Cape Fold Belt Orogeny also had an influence in the tectonic

197 scenario that characterized the Paraná Basin at this particular moment (Pángaro and Ramos,

198 2012).

199 The lithostratigraphic framework of the Triassic in the state of Rio Grande do Sul was initially

200 defined by Andreis et al., (1980) as Rosário do Sul Group, constituted from bottom to top by,

201 viz., Sanga do Cabral Formation, Santa Maria Formation (subdivided into Passo das Tropas and

202 Alemoa members) and Caturrita Formation. According to Faccini (1989; 2000), the Santa Maria

203 and Caturrita formations correspond to a second order depositional sequence called Middle-

204 Upper Triassic Sequence (Fig. 2).

205 FIGURE 1

206 Zerfass et al., (2003) proposed the subdivision of the Santa Maria Supersequence into three

207 distinct third order sequences: viz., Santa Maria 1, 2, and 3 (Fig. 2). According to Zerfass et al.,

208 (2005), these sequences were deposited during cycles of base-level variation in the order of 1 to

209 3 Ma. According to biostratigraphic data, these cycles can have the tectonicand/or climatic (i.e.,

210 allogenic) origin. The interval studied in the present work corresponds to the Santa Maria

211 1(Santa Maria Formation)and Santa Maria 2 (Caturrita Formation) sequences. According to

212 Bortoluzzi (1974), Santa Maria Formation consists of the Passo das Tropas Member,

213 predominantly sandy and with subordinate fine-grained layers, interpreted as a fluvial system

214 with associated flood plain, with discordant contact with the lower unit, Sanga do Cabral

215 Formation. Above this is the Alemoa Member, which is defined by siltstone and mudstones

216 deposited in flood plain deposits including small lakes, loess, and paleosols, with minor isolated

217 fluvial channels (ribbons) (Faccini, 2007).The interpretation of these deposits leads to define as a

218 fluvial system of low sinuosity and high energy (Zerfass et al, 2003), whereas Faccini (2000)

219 described the fluvial system to be perennial and braided. The top of the sequence studied is

220 defined by the Caturrita Formation. That consists of predominantly amalgamated sandstone

221 strata intercalated with siltstones strata with the lenticular, tabular, and sigmoidal geometries.

222 The geometry of the architectural elements and the stacking of facies units, characterize a change

223 in the fluvial style from the isolated sand deposition (sinuous/anastomosing) to the sheet-like

224 deposits of channels filled with the lateral accretion macroforms (Faccini, 2000). These

225 characteristics are typical of the point bars suggesting a meandering fluvial system (Zerfass et al.,

226 2003).

227 The predominance of sand grains in relation to clay grains, in the coarsening upward grain size

228 trend, possibly due to the channel migration and the progressive reworking of the flood

229 plains.(Faccini et al., 2003).

230

231 FIGURE 2

232

233 **4. Paleontological content**

234 The outcrops studied in the present effort are historically known for their vast fossiliferous

235 content, and accordingly, a synthesis of each can be found in Table 1

236

237 TABLE 1

238

239 **5. Results**

240 *5.1.* **Spinicaudata fauna**

241 At the stratigraphic level of the Passo das Tropas outcrop, the occurrences of *Eustheria*

242 *azambujai* Pinto, *Estheriina* sp. (Pinto, 1956) and *Palaeolimnadiopsis* sp. (Tasch, 1987) were

243 noted, which were originally described for the stratigraphic levels of the type section of Passo

244 das Tropas Member located approximately 500 m away from the studied outcrop(Bortoluzzi,

245 1974).In this locality there is still the presence the specimens Eustheria minuta Von Zieten

246 (1833) , were originally encountered at the Belvedere outcrop by Katoo(1971), besides

247 *Triasoglypta*Gallego(Gallego,1999b) defineds for a nivel below a diabase sill in the municipality

248 of Novos Cabrais. The recognition of *E. minuta* Von Zieten and *Triasoglypta* Gallego in the

249   present work carries important implications because these are the first occurrences of the genera

250   described for the Santa Maria Formation (Fig. 3).

251

252   TABLE 2

253

254   The occurrences of conchostracans at the level of the Piche outcrop were noticed by Jenisch et

255   al. (2016). In the present work, these will be treated as the morphotypes, mainly due to their

256   inferior quality of preservation, which makes the identification of diagnostic characteristics

257   difficult. However, these will be utilized for the taphonomic analysis and characterization of

258   paleoenvironment.

259   Rohn et al., (2014) described the occurrence of *Nothocarapacestheria soturnensis* and

260   *Australestheria* sp. in the intermediary portion of the São Luis outcrop. These were also

261   recognized and investigated in the present work (Fig. 3). At the top of the outcrop, three distinct

262   morphotypes were recognized, with *N. soturnensis* as one of the observed forms as recognized

263   by Rohn et al., (2014) in this same area. The second type is described below, however, due to

264   certain specific characteristics, it was possible to infer its taxonomic affinity as a possible

265   member of the family Fushunograptidae. Finally, the last observed form is simply treated here as

266   a morphotype.

267

268   FIGURE 3

269

270 **5.1.1. Description of a possible Fushunograptidae**

271 Among the samples containing conchostracans from the upper levels of the São Luis outcrop, the

272 occurrence of a morphotype raised interest due to its distinct morphology in relation to taxa

273 described up to this point in the Paraná Basin. The paleontological material described herein is

274 stored in the collections of the Museu de História Geológica do Rio Grande do Sul (MHGEO),

275 Unisinos University, São Leopoldo(RS, Brazil) under collection numbers ULGV 12021, ULGV

276 12022, and ULGV 12023. The descriptive features of this morphotype are medium-sized valves

277 (2.26 – 5.63 mm in length and 1.8 – 4.1 mm in height), oval to sub-circular outline, sub-central

278 and intramarginal umbo (Fig. 4 A, B and C). The number of growth lines varies from 15 to 25

279 with variable distance between them (0.3 to 0.12 mm) dependingon the part of the valve being

280 observed. It is also observed that there is a decrease in spacing between growth lines in the

281 direction of the ventral margin. The taxon displays smooth growth lines as well as a smooth band

282 in the beginning and end of each growth line.

283 The valve ornamentation is characterized by the radial striations, perpendicular to growth lines.

284 The growth lines close to the umbo exhibit irregular polygons separated by sinuous lines

285 characteristic of a reticulate pattern. At the valves central portion, the polygons are oriented,

286 thus, resulting in a more striated pattern(Fig. 4D). These striations are rather evident and well-

287 developed closer to the ventral margin, displaying a mean value of 40 to 50 striae per mm and a

288 maximum of 60 in the posterior ventral portion of the valve.

289 The pattern of ornamentation is composed of irregular polygons separated by sinuous grooves

290 and transverse the growth lines. This pattern stands for striae formed by irregular polygons that

291 join radially orienting themselves. The ornamentation of the carapace surface is predominantly

292 striated. This preliminary evidence suggests a tentative assignment of these specimens as part of

293   the Fushunograptidae Wang family (Hong et al., 1974). Among the described genera for this

294   family, the morphologic characteristics of the specimen corroborate its inclusion within the

295   genus *Wolfestheria* Monferran, Gallego andCabaleri, from the Cañadón Asfalto Formation from

296   the upper Jurassic of Argentina (Monferran et al., 2013).

297

298   FIGURE 4

299

300   **5.2. Facies and depositional systems**

301   The facies analysis was based in the attributes of geometry, texture, sedimentary structures,

302   paleocurrents, and fossil content, following the methodestablished in Miall (1978). In general,

303   the recognized facies (Table 2) are composed of fine to coarse sandstones, siltstones and

304   mudstones, with different contact relationships. The described sedimentary facies are presented

305   in Fig. 5, and can be similarly observed in the stratigraphic profiles of Fig. 6.

306

307   TABLE 3

308

309   FIGURE 5

310

311   FIGURE 6

312   At the Passo das Tropas outcrop (Fig. 7A and Table 2), the geometry of the deposits is

313   tabular/lenticular. The succession consists at the base of the facies St overlain by a level of facies

314   Sh with granules and mudstone intraclasts. Above facies Sh, the facies Fl is observed, displaying

315   restricted lateral distribution (7 m approximately), lenticular geometry, and abundant fossil

316   content. Occasionally, the cm-thick laminae of siltstone to very fine-grained sandstone are

317   intercalated with the non-fossiliferous beds. Towards the top of the section, facies St is again

318   observed. The lithologic characteristics and predominant architectural elements suggest

319   deposition related to the fluvial channel filling intercalated with the sediments deposited from a

320   lower energy. The thicker mudstone units are interpreted as the floodplain deposits located

321   adjacent to fluvial channels. The absence of desiccation cracks and wave ripples suggests

322   deposition in a perennially perched area protected from fluvial erosion due to the lateral

323   migration of channel. The intercalation of fine-grained sandstone stratawith thefossiliferous

324   intervals suggests that the paleoenvironment received regular sediment supply during the

325   flooding events.

326   The characteristics observed in this succession of facies assemblage allow its inclusion within

327   the Santa Maria Formation asits stratigraphically inferior Passo das Tropas Member (Bortoluzzi,

328   1974). According to Faccini (2000), the type of fluvial system characteristic of the Passo das

329   Tropas Member is represented by deposition in channels of low to moderate sinuosity with a

330   lesser contribution of fine-grained flood plain deposits.

331   The Piche outcrop (Fig. 7B and Table 2) possesses a facies association consisting of cm-thick,

332   tabular / lenticular beds of Sh, St and Sr intercalated with laminated siltstone units of facies Fl.

333   The dominance of facies Fl, and its intercalation with the facies Sm, Sh and Sr indicate a shallow

334   lacustrine environment. Additionally, the absence of any significant erosional surface suggests

335   deposition from the unconfined flows over flat surfaces within the water bodies. The thin beds of

336   facies Sh intercalated with facies Fl are interpreted to have been generated by the ephemeral

337   flows under turbulent regime over the lacustrine deposits. The deposition of facies St indicates

338   particle transportation by traction, whereas facies Sr by traction-suspension. These are most

339   likely related to the sporadic events of deposition in areas adjacent to the fluvial channels. This

340   association indicates the fluctuation sin energy and sediment supply that are typical of deposition

341   due to crevassing (CS).

342   The upper part of the outcrop displays St that are indentified identified as the channels with

343   smaller dimensions.. They are associated with or are cross cutting the siltstone-to-sandstone

344   lithofacies interpreted as the crevasse channels (CR). According to Zerfass *et al*., (2007),the

345   siltstone deposits correspond to the upper portion of the Santa Maria Formation (Alemoa

346   Member), which grades to the sandstone deposits of the Caturrita Formation (Bortoluzzi, 1974).

347   As a whole, these deposits are attributed to the overflowing larger channels and the breaching of

348   the levees, thereby, resulting in a sporadic deposition of the sheet-likesandstone layers over

349   floodplain areas (Faccini, 2000).

350   The São Luis outcrop (Fig. 7C and Table 3) is constituted, at its base, by facies Sh, Sr, and Sm

351   with the paleocurrents predominantly towards east and also with amalgamated layers reflecting

352   deposition within a meandering fluvial system. Above these levels, and displaying more

353   thickness, facies Sm is observed, which can be interpreted either as a product of the high-

354   concentration sediment-gravity flows or layers that have lost its sedimentary structures due to

355   fluidization in events post depositional. The top of these strata is marked by the presence of thick

356   rhizobioturbation as well as the *Taenidium barreti* bioturbation, which suggest the establishment

357   of larger-sized vegetation in a stable and subaerially exposed substrate in a paleoenvironment

358   favorable to biologic activity and, consequently, the preservation of ichnofossils.

359   Above these strata, facies Fl is observed, represented by deposition in a higher energy

360   environment. In these facies, which display 2.20 m thickness, the largest diversity of fossil fauna

361   from the São Luis can be found preserved in mudstones. In these levels, occasional input of silt

362 and very fine sand cause 2 intervals of ferriferous symmetrical ripples. This succession suggests

363 deposition in the shallow but perennial water bodies located in floodplains. Above these, a

364 heterolithic succession occursconsisting of the tabular, lenticular and occasionally sigmoidal

365 bedsof facies Sm, Sh, and St. It is common to observe facies Fl superposing these sandy facies,

366 which are mainly deposited by decantation processes. This facies association suggest

367 development of river mouth bars, formed as a consequence of the discharge of fluvial currents in

368 water bodies. The presence of roots and desiccation cracks at the top of individual layers indicate

369 the episodic subaerial exposures in tervened by the occasional depositional events.

370 FIGURE 7

371

372 **5.3. Taphonomy**

373 The fluvio-lacustrine environments are characterized by its dynamic traits. Sedimentary

374 deposition in these environments is complex, with a variety of micro-environments that are

375 subjected to different transport mechanisms of variable kinetic potential. This, in turn, has an

376 effect on the taphonomic characters of the accumulated skeletal remains. The taphonomy of the

377 conchostraceans analyzed in the present study was carried out taking into account the complexity

378 related to the quality of the fossil record. In this sense the results were generated from the

379 individualization of taphonomic classes according to the easy fossiliferous sedimentary. Thus the

380 analyzes are directly associated with the context of each depositional environment. Based on this

381 analysis it was possible to individually diagnose 4 distinct taphonomic assemblages:

382

383   **5.3.1. Assemblage 1a (facies F1, Fig. 8 A-C) – decantation of fine sediments in flood plain**

384   **(Passo das Tropas outcrop – Fig. 7A)**

385   Description: bioclasts weekly packedto disperse, supported by a muddy matrix. Poly modal

386   orientation, with bioclasts concordant to the bedding plane. In these levels, the bioclasts display

387   a high level of preservation. Approximately 90% of carapaces are scattered in the sedimentary

388   matrix. The remaining 10% correspond to concentrations of carapaces and angulous to rounded

389   fragments of valves. Taphonomic signatures such as bioerosion, encrustation, abrasion or

390   corrosion were not identified. The size of bioclasts varies from 4 to 7 mm, suggesting an absence

391   of hydraulic grain selection. In this interval, five distinct species of conchostracans were

392   identified: *Euestheria azambujai* (Pinto, 1956), *Estherites wianamattensis,Estheriina* sp.,

393   *Eustheria minua* (Katoo, 1971)*, Triasoglypta santamarianensis*(Gallego, 1999) and

394   *Palaeolimnadiopsis* sp. (Tasch, 1987).

395   Associated fossils: vegetative organs and reproductive structures (Barboni et al., 2015; Barboni

396   et al., 2016), fish scales, insect wings (Corrêa, 2014) and insect-plant interactions (Cenci et al.,

397   2013).

398

399   FIGURE 8

400

401   Stratigraphic position: seven levels recording conchostracan occurrences between the 2 and 4

402   meters mark at the Passo das Tropas profile (Fig. 6A), Passo das Tropas Mb. (Ladinian-

403   Carnian).

404   Interpretation: the taphonomy and paleoecology of conchostracan indicate an association

405   between autochthonous (articulated) and para-autochthonous (fragmented) organisms, pointing

406 to moments of high accumulation of sediments. The autochthonous organisms were possibly

407 surprised by a large inflow of sediments in suspension, brought about by episodic flooding

408 events. This process increases the turbidity of the environment, decreasing access to food and

409 implicating in the death of conchostracans. After the flood event, there is a decantation of fine

410 sediments, which will eventually bury the bioclasts and introduce it to the taphonomically inert

411 zone (TIZ). Bioclasts constituted of fragments are here interpreted as a result of two alternate

412 processes: (i) a post-mortem partial dissolution of the valves during its residence time in the

413 taphonomically active zone (TAZ); or (ii) fragmentation generated by mechanical processes

414 during its residence time in the TAZ. This physically driven processes (Astrop et al., 2015)

415 points to a perturbation in the environment during the income of flood waves, which cause valve

416 displacement and thus reflects a para-autochthonous pattern.

417

418 **5.3.2. Assemblage 1b (facies F1, Fig. 8 D-G) – decantation of fine sediments in flood plain**

419 **(São Luis outcrop – Fig. 7B)**

420 Description: this taphonomic assemblage is characterized by dispersing to weekly packed

421 bioclasts, with polymodal distribution in a muddy matrix. Valves are parallel in relation to the

422 bedding plane. They may occur grouped (10%) or isolated (90%). The fossils exhibit two size

423 classes, with valves varying from 6.4 to 8.5 mm (*Nothocarapacestheria soturnensis*) and 2.1 to

424 3.9 mm (*Australestheria* sp.), as described by Rohn et al., 2014. Taphonomic signatures such as

425 bioerosion, encrustation, abrasion or corrosion were not identified.

426 Associated fossils: Reproductive structures of Bennettitales (Barboni and Dutra, 2013), wood

427 (Pires and Guerra-Sommer, 2004, Wilberger et al., 2004, Pires et al., 2005), branches of

428 undetermined, fish scales (Perez and Malabara, 2002) and insect larvae (Corrêa et al., 2004).

429 Stratigraphic position: four occurrence levels between the 12 to 14 meters marks at the São Luis

430 profile (Fig. 6B), Caturrita Fm. (lower Jurassic).

431 Interpretation: In this interval, signatures of taphonomic damage from biostratinomic processes

432 were not identified, thus indicating an autochthonous character to this particular assemblage. The

433 taphonomic assemblage 1b differs from assemblage 1a due to the absence of accumulations of

434 fragmented bioclasts. These aspects, associated to facies interpretations indicate burial by

435 sediments derived from episodic flooding events, thus characterizing non-selective mortality.

436 These evidences suggest that bioclasts were exposed for short residence times to the TAZ.

437

438 **5.3.3. Assemblage 2 (facies Sr-Fl-Sh, Fig. 9) – overflow in flood plain (Piche outcrop – Fig.**

439 **7C)**

440 Description: Assemblage 2 is characterized by its occurrence in two distinct facies, Fl and Sh. In

441 faciesFl the bioclasts are dispersed (isolated), with polymodal geometry, parallel in relation to

442 bedding plane and with closed valves. These, however, occur both in the base (in the limit with

443 facies Sr) and intercalated within centimetric laminae of facies Fl. In facies Sh, the bioclasts

444 display polymodal distribution ,isolation/scattering/dispersal, close-packing, and parallel

445 orientation in relation to bedding planes, with convexity either pointing upwards or downwards,

446 with oblique orientations less frequent. Associated to these facies are also fragments of bioclasts.

447 Taphonomic signatures such as bioerosion, encrustation, abrasion or corrosion were not

448 identified. Three distinct conchostracans morphotypes were observed, with lengths varying from

449 1.9 to 6 mm (no hydraulic selection of bioclasts).

450 Associated fossils: fish scales in facies Fl (Perez and Malabara, 2002) and vertebrate bones in

451 facies Fh (Langer *et al.,* 2007).

452 Stratigraphic position: four occurrence levels between the interval from 5,50 to 6,50 m in the

453 profile of the Piche outcrop (Fig. 6B), Alemoa Mb. (Norian, upper Triassic).

454

455 FIGURE 9

456

457 Interpretation: the taphonomy, paleoecology and bioclast distribution in the matrix (constituted

458 by centimetric sand-silt intercalations) indicates both allochthonous (contact between faces Sr-Fl

459 and faces Sh) and autochthonous (articulated; Fl) patterns of preservation for the fragmented and

460 isolated fossiliferous accumulations. The episodic character reflected by the internal structure of

461 the layers evidences bioclast transport by means of traction (Sh), suspension (Fl) and traction-

462 suspension (Sr), related to sporadic events of deposition. The presence of fossil conchostracans

463 preserved in facies Fl, directly in contact with facies Sr, suggests bioclast decantation after

464 suspension enforced by erosive processes. However, due to higher density and size relatively to

465 mud sized particles, they tend to occur in the limit between facies. Conchostracan located in the

466 Fl laminae can be interpreted as autochthonous organisms that colonized the substrate during

467 temporary stabilization of the environment. In this environment, after the natural death of

468 organisms, these are buried by the decantation of fine grained sediment. In the case of

469 fragmented and isolated/scattered fossil conchostracans (with convexity oriented both upwards

470 and downwards) present in facies Sh, they are interpreted as the result of overflow events

471 generated by ephemeral flows under a turbulent flow regime, which remobilizes valves, thus

472 producing concentration, fragmentation, and at times an oblique disposition in relation to

473 bedding planes.

474

475 **5.3.4. Assemblage 3 (facies Fl-Sm, Fig. 10) – controlled by depositional processes in**

476 **rivermout bars (levels at the top of the São Luis outcrop – Fig 7C)**

477 Description: in facies Fl, bioclasts are disperse (isolated), with polymodal orientation, parallel in

478 relation to bedding planes and with closed valves. These make up 10% of the total concentration

479 of bioclasts. Intercalated or juxtaposed to these may be densely packed cluster (over 90%) in the

480 form of lenses, with polymodal orientation and parallel to bedding plane. From these 90%, circa

481 45% of the valves are closed, 10% open, and the other 45% consist of isolated/scattered valves.

482 These clusters can sometimes be individualized by size, according to variability between

483 morphotypes, but sometimes being mixed. In these levels, it was possible to identify the

484 occurrence of *Nothocarapacestheria soturnensis,* with valve length varying from 6.4 to 8.5 mm,

485 morphotypes related to Fushunograptidae (2.26 to 5.63 mm), and finally, an undetermined

486 morphotype with valve length of 2.2 to 3.5 mm. In facies Sm bioclasts are isolated, scattered and

487 fragmented, parallel to bedding surfaces. No facies exhibits evidence of bioerosion,

488 encrustation, abrasion or corrosion.

489 Associated fossils: vertebrate ichnofossils, footprint (Silva *et al*., 2012) in facies Sm,

490 rhizobioturbation in facies Fl.

491

492 FIGURE 10

493

494 Stratigraphic position: four levels of occurrence of facies Fl (between the 12 and 14 m marks)

495 and two occurrences in facies Sm, between the interval of 21,5 to 22.5 m, both in the São Luis

496 profile (Fig. 6), Caturrita Fm. (lower Jurassic).

497 Interpretation: the complex nature of this fossiliferous assemblage is attested by the ample

498   variation in taphonomic characteristics, which indicate an intercalation between bottom events

499   and moments of improved conditions and colonization. The internal structure of the layers

500   indicates deposition by means of traction and traction-suspension processes, related to sporadic

501   events of fluvial overflow. In general, the accumulations that display close packing (90%)

502   exhibit variety in bioclast size class, reflecting a lack of hydraulic selection taking place during

503   deposition of facies Fl. Such characteristic suggests a concentration of autochthonous (closed

504   valves) to allochtonous or parautochtonous (open valves or isolated/scattered valves). The

505   preservation of autochtonous bioclasts was possibly facilitated by the absence of bottom traction

506   after the last events of flooding.

507

508   **6. Discussion**

509   **6.1. Biostratinomic bias in the quality of the fossil record**

510   The distinct preservational patterns in a single deposit may be biased by sedimentation patterns

511   (definitive burial), variations in phreatic level and seasonal changes in climate. These interfere in

512   the dynamics of deposition in rivers, altering paleoenvironmental conditions, both in terms of

513   faunal development and taphonomic processes involved in paleoenvironments. Accordingly, if

514   certain facies may exhibit high preservational potential (closed valves), they may alternately

515   present parautochthonous and allochthonous patterns as a biostratinomic response to sedimentary

516   processes.

517   In crevasse and crevasse splaydeposits these patterns are most likely related to two factors: (i)

518   paleoenvironmental instability and consequent low biologic productivity; or, (ii) difference in

519   density and size of bioclasts. Paleoenvironmental instability may be related to the frequency,

520   intensity and intercalation of events of decantation of fine sediment arising as a consequence of

521 river overflow in flood plains.

522 The allochthonouspattern observed in bioclasts with closed valves in sandstone levels can be

523 explained by the high endurance of these organisms to transport. On the other hand, valves

524 preserved in mudstones indicate an autochthonous pattern. Isolated/scatteredvalves present in

525 sand/mud interface from assemblages 2 and 3 are the result of different hydraulic potential to

526 flow.

527 The high physical endurance of valves was explored by Astrop et al., (2015) with live

528 conchostracans in laboratory settings. The authors verified that these benthic organisms were

529 able to swim in moments of turbulence, and/or withstand still in life stress caused by transport.

530 Additionally, Orr et al., (2008) carried out a comparative taphonomic analysis of exceptionally

531 well-preservedconchostracans in the Carboniferous of Ireland. The experiments showed that

532 spinicaudate valves rapidly isolate/scatteredafter death, even in face of very slight disturbances

533 in the environment. In face of the actualisticbiostratinomic considerations mentioned above, it is

534 suggested herein that the preservational quality of these organisms is determined by duration of

535 transport time, distance from the original site of life and magnitude of the final event of burial.

536 These seem to be the conditions experienced by the conchostracans studied in the present work,

537 where, even when displaying allochthonous features, these may not have traveled long distances

538 away from the original environment inhabited.

539 Evidences of spatial mixture could be recognized due to the occurrence of clusters with different

540 morphotypes of distinct size classes. These likely correspond to populations that lived in

541 different environments or moments in time, which were sporadically remobilized by high energy

542 flows. The mixed sand-mud flows, as they arrive in bodies of water, can result in three possible

543 situations: (i) burial of conchostracans; (ii) putting valves in suspension, and (iii) carry valves to

544 more distal portions of the sedimentary environment. These events have the capacity of mixing

545 organisms from different sub-environment into the same horizon.

546 Assemblages 1a and 1b is characterized by the occurrence of fine grained facies and high

547 integrityindex in conchostracan carapaces, which suggests periods of energy stability. Both

548 *Nothocarapacestheria soturnensis*and *Australestheria* sp. display features indicative of adult

549 specimens, thus characterizing death by natural processes.The deaths of organisms present in

550 assemblages 2 and 3 are non-selective due to their association to high energy facies, where

551 tractive flows were brought about by episodic events of fluvial overflow.

552

553 **6.2. Paleoenvironmental and paleoecological inferences**

554 Conchostracan from the Passo das Tropas outcrop (Passo das Tropas Member) are preserved in

555 floodplain facies, which are characterized by perennial water bodies periodically affected by

556 flooding events due to fluvial channel overflows. An abundance of preserved fossils isfound in

557 these paleoenvironments, possibly caused by a decrease in oxygen due to a large amount of

558 organic matter present. Conchostracans are sensitive to limited availabilities of oxygen,

559 displaying low tolerance to hypoxia, which likely results in the development of response

560 mechanisms to these conditions, as discussed by Schmitz and Harrison (2004). In this outcrop,it

561 is observed the occurrence of tiny conchostracans leaflets, with smaller number of growth lines

562 (see table 2) and with smaller spacing between thems (Figure 3a,b,c,d,e). This pattern is possibly

563 caused by stressful conditions, which limits development at slower paces, thus being reflected in

564 the few number of growth lines (Rogers et al., 2012). Corroborating this inference is the fact that

565 the input of sediments in suspension in the environment by flooding events significantly

566 increases turbidity in the water column, rendering difficult the acquisition of food, since these

567 organisms select floating material (Vannier et al., 2003). If environmental conditions are only

568 favorable for short time periods, it is likely that individuals do not reach sexual maturity and

569 expire without reproducing (Cáceres and Tessier, 2003). These may by the conditions under

570 which some of the specimens were preserved, mainly due to the observed low numerical

571 occurrences.

572 The crevasse splaypaleoenvironment in which the conchostracan of the Piche outcrops (Alemoa

573 Member) are preserved are highly stressful due to periodic events of fluvial overflow. These

574 events caused deposition of large volumes of sand over floodplains, thus,filling thewater bodies

575 inhabited by the faunal elements. These characteristics are reflected in the diminutive sizes of

576 valves in the encountered specimens (Figure 9c, g). An evaluation of size and number of growth

577 lines in all 3identified morphotypes from the Piche outcrop (Fig. 4) indicates a more expressive

578 number of growth bands (Fig. 9c, g) which allows the inference of an accelerated sexual

579 maturation and release of eggs in the environment. This is a known survival strategy in the

580 ephemeral aquatic environments which allows the production of eggs to be in latency during the

581 dry season (Fryer, 1996). For many species, the eggs will not surpass the latency stage unless

582 completely dried and posteriorly rehydrated (Thiery, 1996). The incubation of laid eggs only

583 takes place in the following overflow event, when the flowing water rehydrates the eggs, thus,

584 causing their eclosion (Brendonck, 1996).

585 The conchostracan faunas documented in the intermediary portions of the São Luis

586 outcrop(Caturrita Formation), particularly the ones found in-between wavy ripple marks, are

587 characterized by the occurrence individuals of large dimensions and number of growth lines.

588 Rogers et al., (2007) carried out a study which shows that individuals obeying a varied and

589 nutrient rich diet display larger lengths, faster rate of maturation, larger number of better defined

590 growth lines, and larger egg clutches**.** Accordingly, it is, hereby, suggested that the larger

591 conchostracans in the São Luis outcrop developed under similar paleoenvironmental conditions.

592 In the stratigraphically higher levels of the São Luis outcrop, the individual clusters of

593 conchostracan with similar size and number of growth lines suggest similarity in their

594 ontogenetic stage. Therefore, it indicates that these organisms were incubated from eggs of a

595 single cohort (e.g., Vannier et al., 2003; Stigall and Hartmann, 2008). Still in these levels, the

596 documented occurrence of rest of individuals of different size classes in a same cluster may point

597 to selective transport mechanisms, which remobilizes valves from different locations, transported

598 and deposits it in a same accumulation.

599

600 **6.3. Stratigraphic distribution of conchostracans**

601 The present study allowed for a better positioning of conchostracans within the stratigraphic

602 framework of the Triassic and Jurassic intervalsof the Paraná Basin (particularly in the central

603 region of the state of Rio Grande do Sul), thereby, expanding its occurrence and distribution. It

604 was possible to confirm the occurrence of these organisms in the lower levels of the Santa Maria

605 Formation (the Passo das Tropas outcrop), which were originally recognized by Katoo (1971) in

606 the Belvedere outcrop. The species *Euestheria minuta* (Von Zieten) in Raymond (1946) was

607 originally described as *Posidonia minuta* Alberti (1832) and reinterpreted as *Estheria minuta*

608 (Jones, 1862) that displays ample geographic and temporal distribution. Jones (1862) recognized

609 its occurrences mainly in European (e.g. Germany, France, Italy, England and Scotland) and

610 South and North American sedimentary basins (Table 3). Kozur and Weems (2010) defined the

611 *E. minuta* Zone (the Ladinian) for Germany, China, Africa, Argentina, and Canada. Therefore,

612 the faunal and floral elements (table 1) encountered in the Passo das Tropas outcrop, particularly

613   in the presence of *E. minuta*, suggests a minimum Carnian age for these deposits (Table 4).

614

615   TABLE 4

616   The discovery of conchostracan in the Piche outcrop stratigraphic levels, yet not properly

617   classified under a family, broadens the occurrence of this group from the upper Triassic to strata

618   at the top of the Santa Maria Formation (Alemoa Member).

619   It was possible to confirm the occurrence of *Nothocarapacestheria soturnensis* and

620   *Australestheria* in the stratigraphic level of the Caturrita Formation, as was already observed in

621   intermediary levels of the São Luis outcrop by Rohn et al., (2014). The present work documents

622   new conchostracan occurrences in the top levels of this same outcrop. Rohn et al., (2014)

623   considers *N. soturnensis* and *Australestheria* as elements of the Jurassic period due to their

624   relationship with the coeval conchostracans derived from Antarctica and also from the Congo

625   Basin (*A. corneti*). The morphotypes described in the present work (see description section for a

626   possibly Fushunograptidae) did not display enough distinguishing characteristics to allow for

627   their assignment within any of the known genera of family Fushunograptidae. The family records

628   for South American rocks are restricted to records Monferran et al.,(2013), for Upper Jurassic

629   strata of Patagonia (Cañadón Asfalto Basin), happened by the registration made Tassi et

630   al.,(2015) in which they describe *Estheriellites zavattieriae* in Middle Triassic strata (Cerro de

631   Las Cabras Formation, Cuyo Basin). The material studied in the present work, however, reveals

632   a closer affinity to representatives of the family Fushunograptidae (*W. smekali*) from the upper

633   Jurassic intervals of Argentina (Monferran et al., 2013). Further detailed studies of these

634   specimens are necessary for a better taxonomic determination at the species level.

635

636 **7. Final considerations**

637 From this study It was possible to better constrain the environments and taphonomic processes

638 involved in the deposition of the studied stratigraphic intervals. This, in turn, allowed for the

639 verification that the taphonomic signatures present are fully associated to the paleoenvironments

640 inhabited by the conchostracan faunas, thus resulting in the identified taphonomic assemblages.

641 A new occurrence of *Eustheria minuta* was documented, reinforcing this biochronostratigraphic

642 referencefor the Santa Maria Formation strata (Passo das Tropas Member).

643 Additionally, the present effort resulted in the potential discovery of a new taxon in the

644 stratigraphic levels of the Caturrita Formation, pending upon more thorough analyses for the

645 proper taxonomic determination of the possible new genus.

646

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Figure and Table Captions

Figure 1. A. Location of the Paraná Basin in South America; B. Location of Mesozoic strata in the state of Rio Grande do Sul, with inidication of the lithostratigraphic units in C; C. Area of exposure of Santa Maria Fm. and Caturrita Fm. The star symbol indicates the location of investigated outcrops. Adapted from Faccini *et al.*, (2003).

Figure 2. Lithostratigraphic and sequence framework for the Permian-Cretaceous interval in the Paraná Basin, Brazil. Paleofloral cenozones from Barboni *et al.* (2016), litho- and chronostratigraphic units and models of systems tracts from Andreis (1980), Faccini (2000) e Zerfass *et al.*, (2003, 2004). The indication in red points to the location of conchostracans investigated in the present work.

Figure 3. Conchostracans from the Passo das Tropas and São Luis outcrops: A.*Euestheria azambujai* Pinto (NEP_I 110), superposed mould and counter-moulds; B. *Estheriina* sp., ovoid carapace (NEP _ I 133), superposition of external mould and rather complete counter-mould; ; C.

999 *Eustheria minuta* Von Zieten 1833 (ULVG 9625), external mould of valve. D. *Triasoglyptas*

1000 Gallego (NEP-I 114), external mould of valve; E. *Palaeolimnadiopsis* sp. (ULVG 9177), mould

1001 of valve exhibiting few ribs and associated to a *D. odontopteroides* pinnule (left); F.

1002 *Nothocarapacestheria soturnensis* gen. et sp. nov. Rohn, external mould of right valve in the

1003 intermediary levels of the São Luis outcrop (ULVG 11992); G. *Australestheria* Chen (Zhang *et*

1004 *al*., 1976), external mould of right valve (ULVG ; H. *Nothocarapacestheria soturnensis* gen. et

1005 sp. nov. Rohn in the upper levels of the São Luis outcrop.

1006

1007 Figure 4. New morphotype in the upper levels of the São Luis outcrop (Paraná Basin), displaying

1008 morphologic characteristics that suggests its affinity to the family Fushunograptidae. A. general

1009 view of the left valve`s external mould (ULVG 12023); B. C. General view of valve in SEM; D.

1010 Detail view of the striated ornamentation present in the medial dorsal portion of the valve, with

1011 tonality inversion permitting visualization of the original ornamentation present; E. Detail view

1012 of the striations present in the ventral portion of the valve, close to the last growth lines. Tonality

1013 inversion was also carried out in order to improve visualization of small details in the

1014 ornamentation.

1015

1016 Figure 5. Stratigraphic profiles of the investigated oucrops with indications of identified fossils.

1017 Black arrows with the letters AT indicate individualized conchostracan taphonomic assemblages.

1018 The wavy red line marcs sequence limits, as recognized by Zerfass et al., (2007) for the Piche

1019 outcrops. This limit was identified in the field, at the São Luis outcrop due to the occurrence of

1020 paleosoil containing ichnofossils that suggest a halt in the depositional system. Sx- Cobble; Gr –

1021   Gravel; Mg – very coarse sand; G – coarse sand; M – medium sand; F – fine sand; MF – very

1022   fine sand; S – silt; A- mud.

1023

1024   Figure 6. Described facies in the studied area (see Table 2): A. Sandstone with horizontal

1025   lamination (Sh), basal interval of the São Luis outcrop; B. laminated mudstone with fine siltstone

1026   (intercalations Fl), São Luis outcrop; C, Fine sandstone with cross lamination (Sr), São Luis

1027   outcrop; D. Massive sandstone (Sm), Piche outcrop; E. Fine sandstone with cross lamination

1028   (Srw), Piche outcrop; F. Fine to coarse sandstone with small to medium sized cross stratification

1029   (St). Pictures provided by Bruno Horn.

1030

1031   Figure 7. Images of the studied outcrops: A. Passo das Tropas outcrop, picture taken in activity

1032   carried out by team NEPALE – LAVIGEA; B. Piche outcrop; C. São Luis outcrop, picture

1033   provided by Tiers Wilberger (2012); Arrows indicating levels of the material investigated in this

1034   study.

1035

1036   Figure 8. Taphonomic assemblages 1a and 1b (A-C, Passo das Tropas outcrop, D-G, medium

1037   portion of the São Luis outcrop): A. mudstone levels intercalated to millimetric laminae of very

1038   fine sand; B. Isolated and fragmented valves (NEP_134); C. Accumulation of whole and

1039   fragmented valves (ULVG 9527); D. Detail in the lower and medium portion of the mudstone

1040   levels of the intermediary interval of the São Luis outcrop section. At the bottom of the image it

1041   is possible to observe horizons characterized by the presence of ferriferous *ripples*; E. Closed

1042   valves with superposition of internal mould to external mould (ULVG 9236); F. Concentration of

1043   closed valves with similar size and number of growth lines (ULVG 12015); G. External counter-

1044   mould of isolated, closed valves (ULVG 120007).

1045

1046   Figure 9. Taphonomic Assemblage 2 (Outcrop Piche). A. Detail of the levels with

1047   conchostracans of the association of facies of Outcrop Piche characteristic of environment of

1048   crevasse splay; B. Carapace accumulation at clayey levels; C. Carapace accumulation at clayey

1049   levels; D. Detail in hand sample of the levels of figure 10A, with the succession of facies

1050   characteristic of crevasse splay; E. Schematic model of accumulations of leaflet association in

1051   different facies; F. Significant taphonomic signatures lithosactic, closed closed articulated valves

1052   preserved in the facies Fl, oblique leaflets at the bedding plane, disjointed valves and angular

1053   fragments in the facies Sh, indicated successively by the arrows; G - I. Associations of skeletal

1054   remains in Sh facies: G. accumulations of disjointed valves; H. accumulations of angular

1055   fragments; I. Grouping of disjointed leaflets and angular fragments at sandy levels in the outcrop.

1056   J. Valves preserved in argillites buried by clay. K. Closed valves with minute size and numerous

1057   amounts of growth lines at the levels of Fl; L. Replica of the closed hinged valve.

1058

1059   Figure 10. Taphonomic Assemblage 3 (Outcrop São Luis, top). A. Upper section of the Sõa Luis

1060   outcrop and the four levels of occurrence of conchostracans indicated by the arrows; B.

1061   Accumulation of smaller valves; C. Accumulation of smaller cluster valves heavily packaged; D.

1062   Closed valves of the indetermined morphotype; E. Accumulation of leaflets and fragments with

1063   occurrence of the morphotype of the family Fushunograptidae; F. Valves of larger disarticulated

1064   and fragmented dimensions; G. Valves of different dimensions preserved at the same

1065   sedimentary level; H. Open valves ; I. densely packed accumulation of *N. soturnensis*; J. Detail

1066   image of *Nothocarapacestheria soturnensis* occurring both forming accumulations and isolated

1067   in the facies Fl; K. Valves with a class of distinct sizes preserved in the same accumulation; L

1068   Devastated and fragmented valves at the levels of Sm.

1069

1070   Table 1 – Integration of fossiliferous content data of the studied outcrops and their correlation.

1071

1072   Table 2 – Diagnostic characteristics of the different morphotypes recognized in this study

1073

1074   Table 3 –Sedimentary facies that occur in outcrops studies with characterization, fossiliferous

1075   content, location and interpretation.

1076

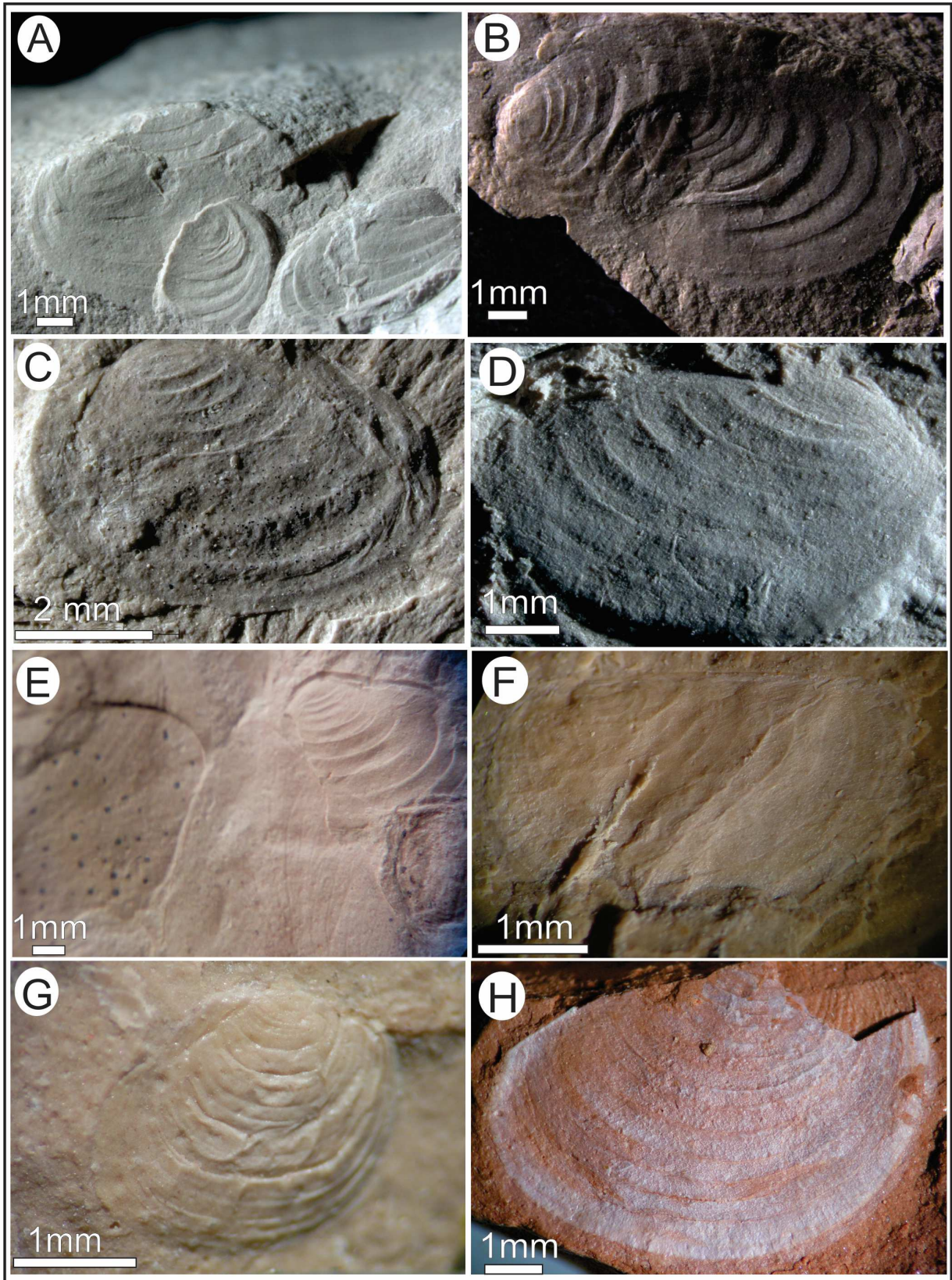1077   Table 4 – Stratigraphic distribution of *Euestheria minuta* anda related forms.
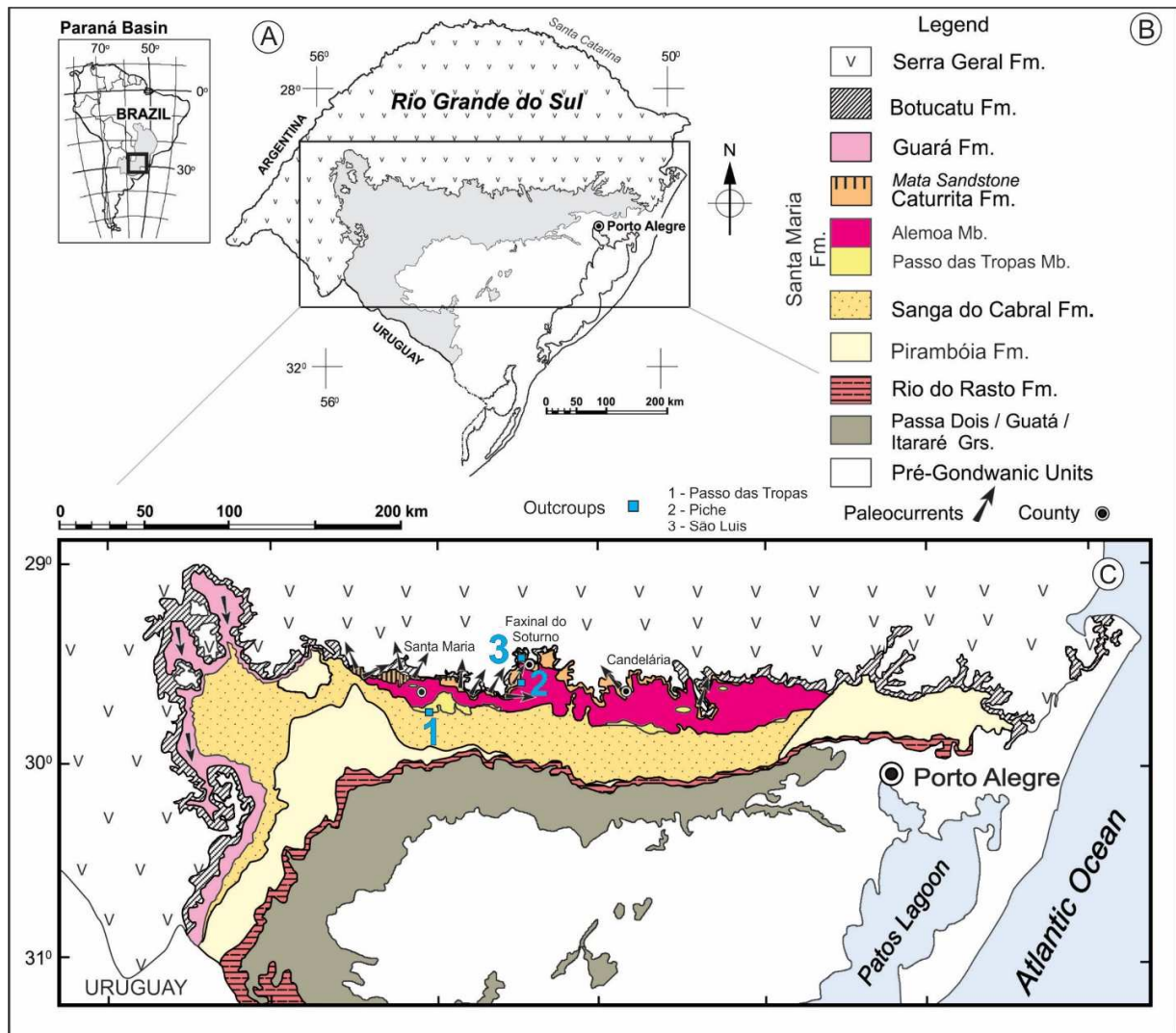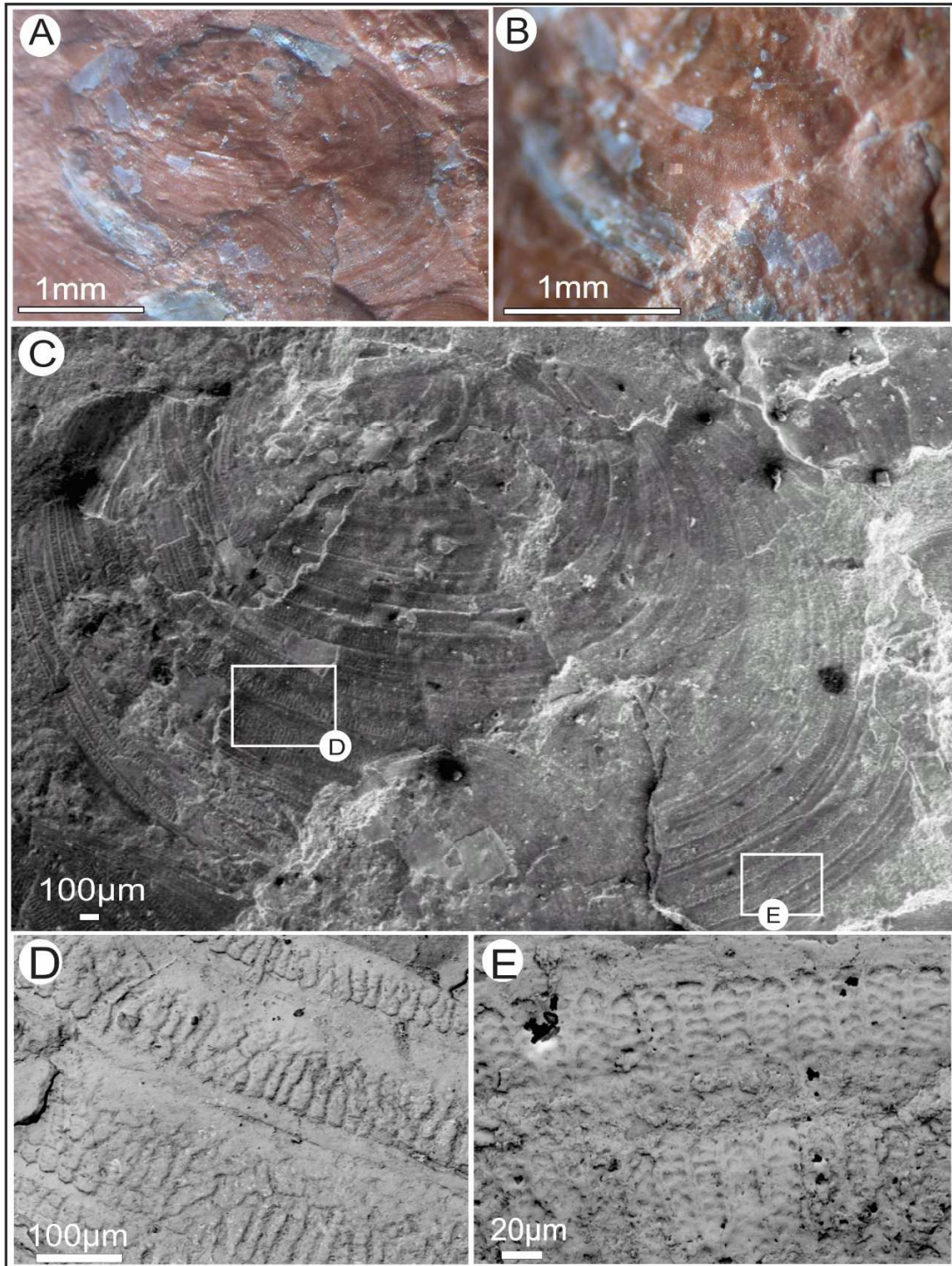
Figure 1
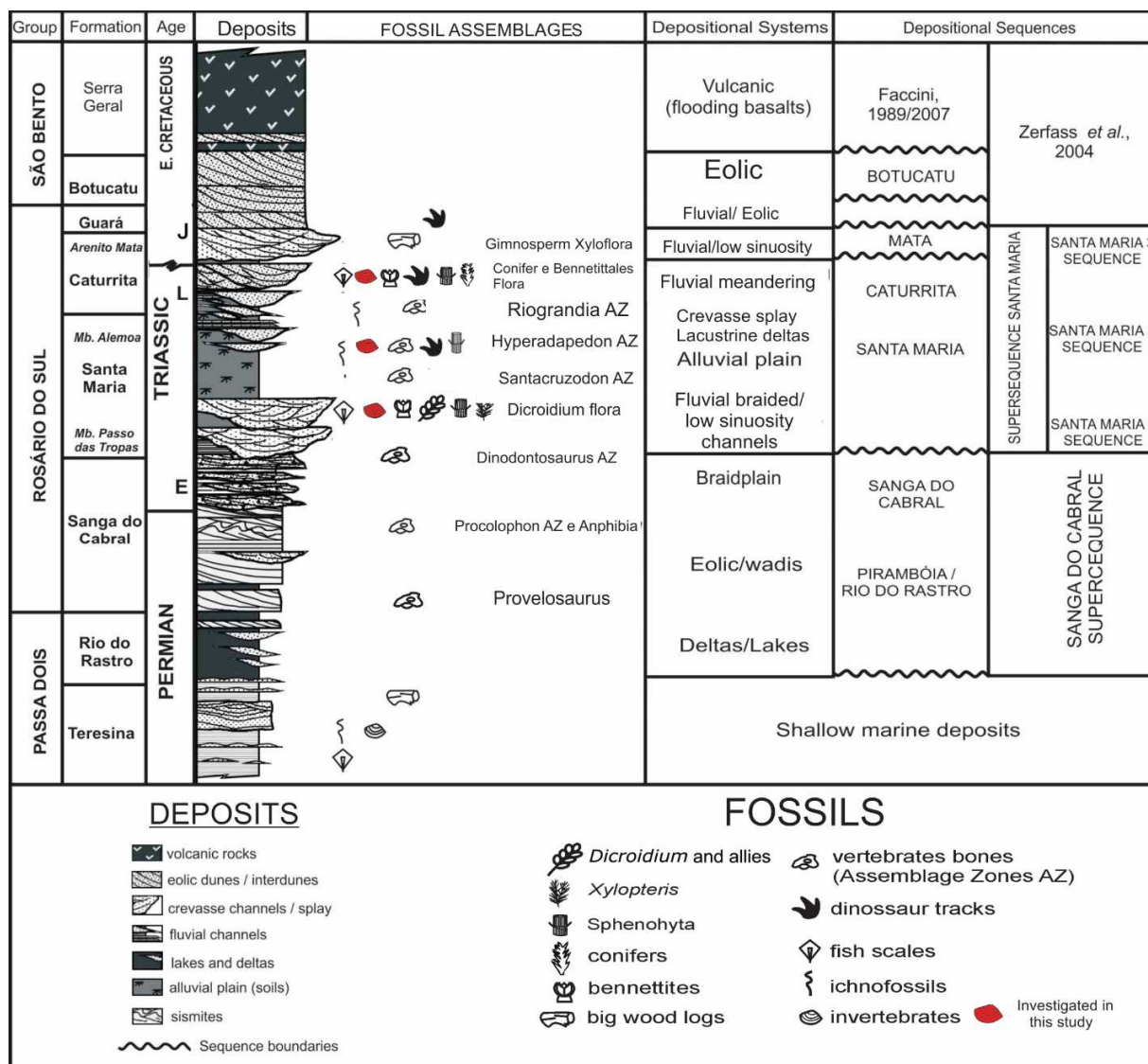
Figure 2

Figure 3

Figure 4
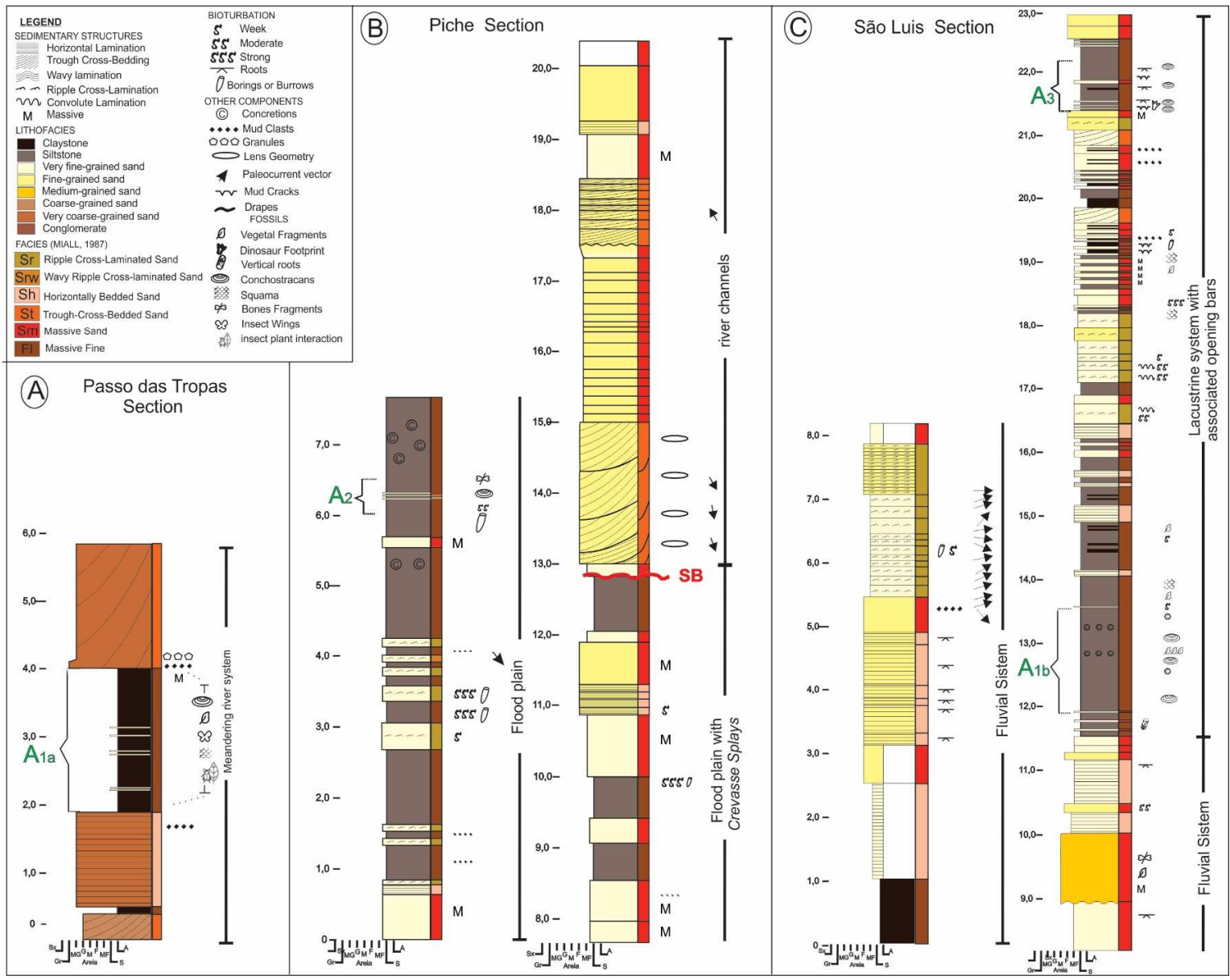
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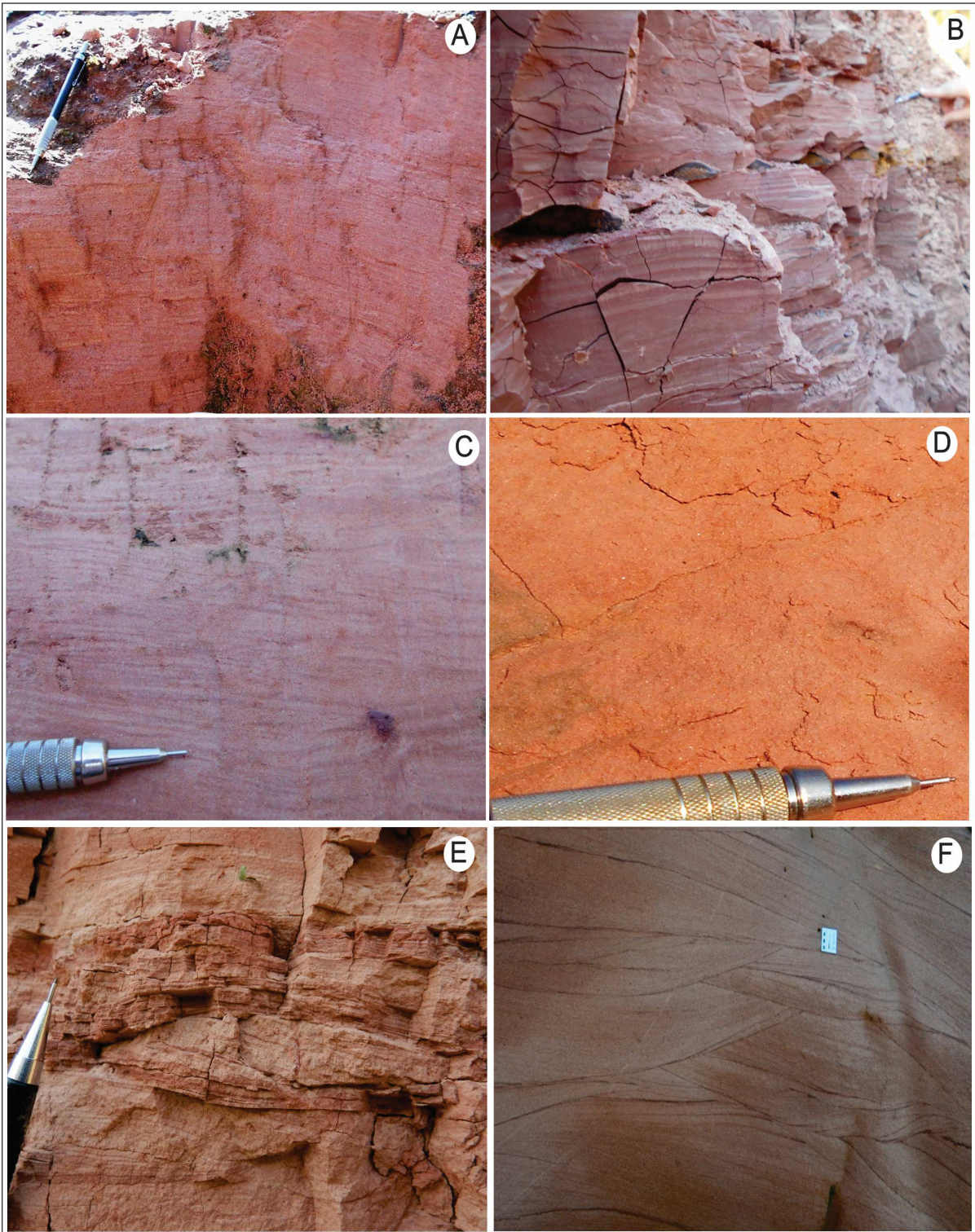
Figure 6
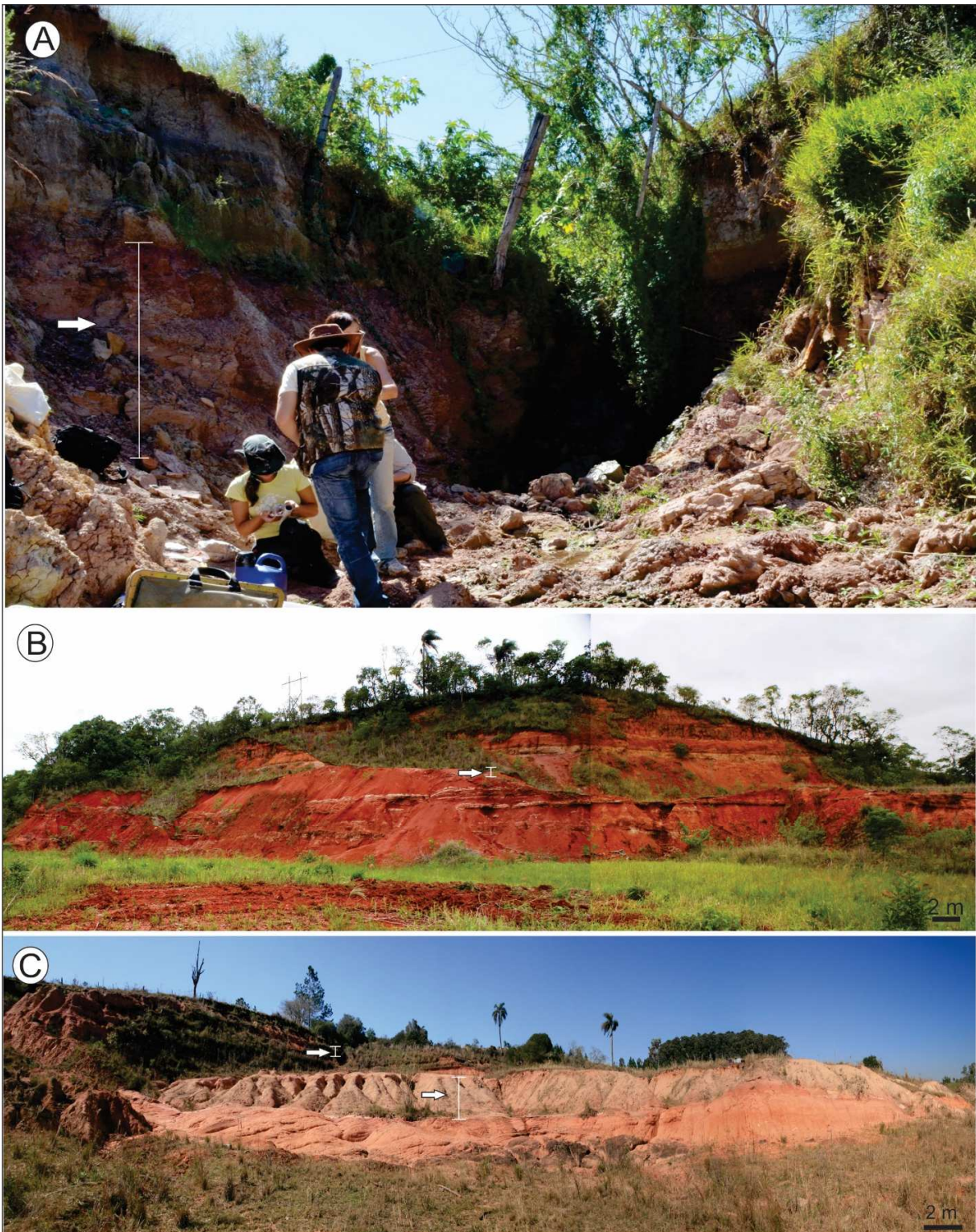
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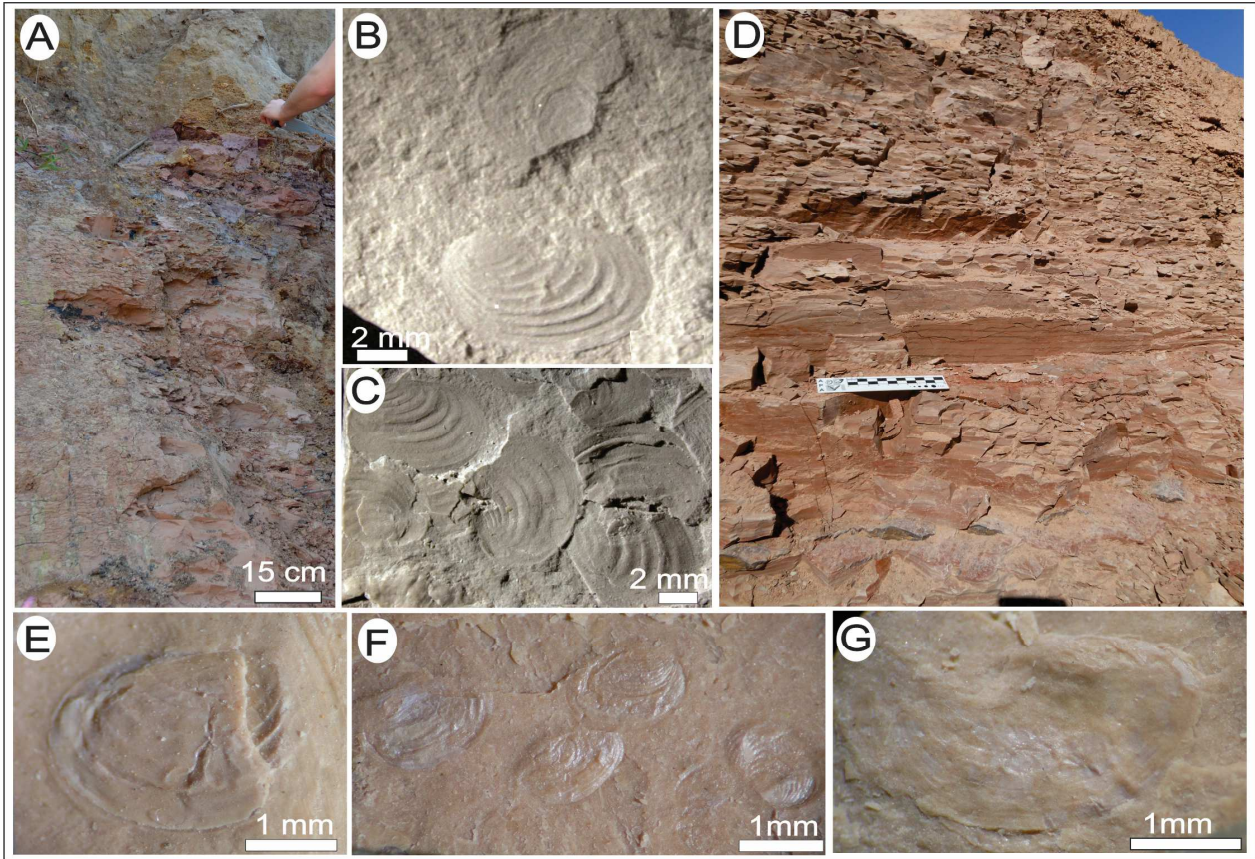
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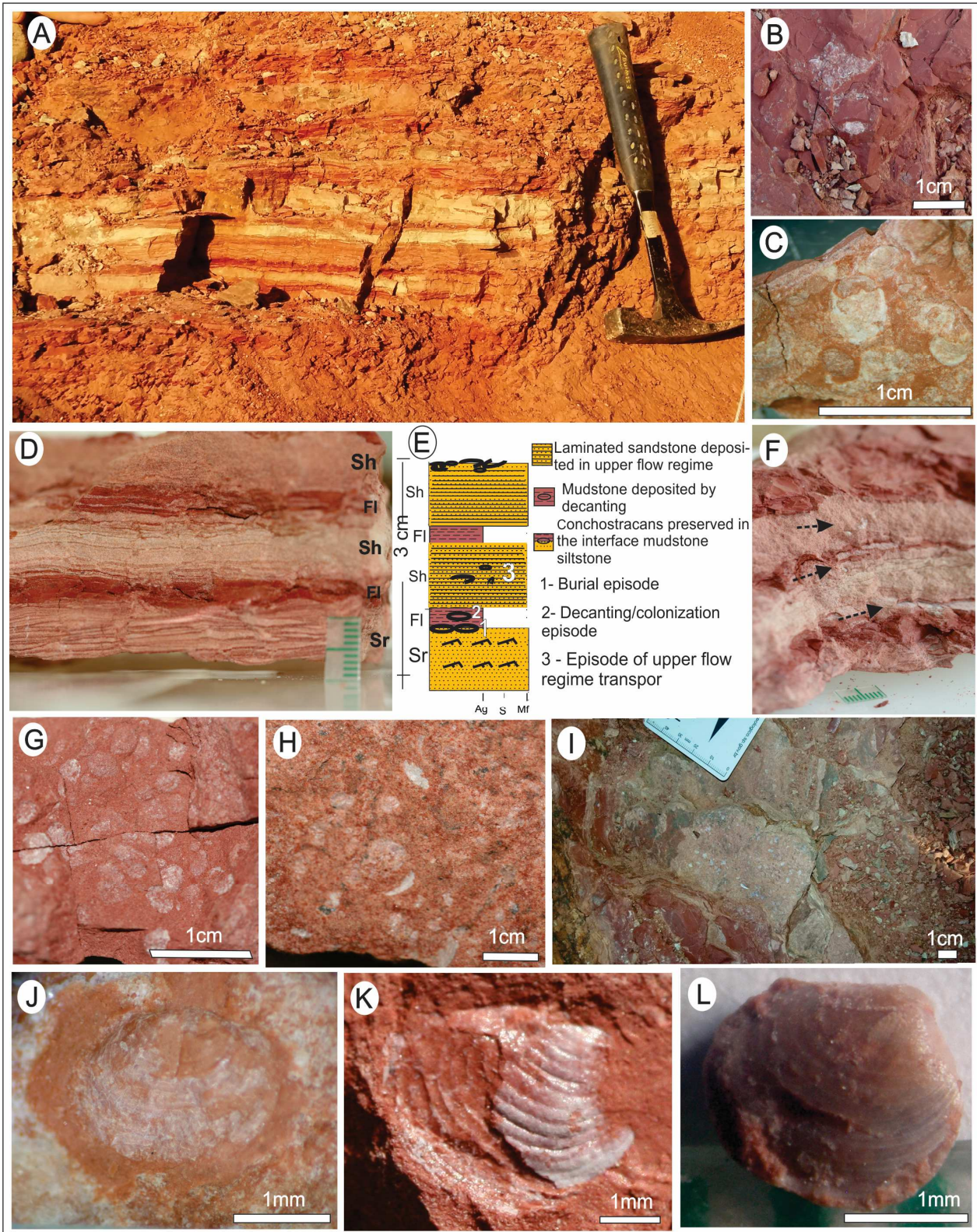
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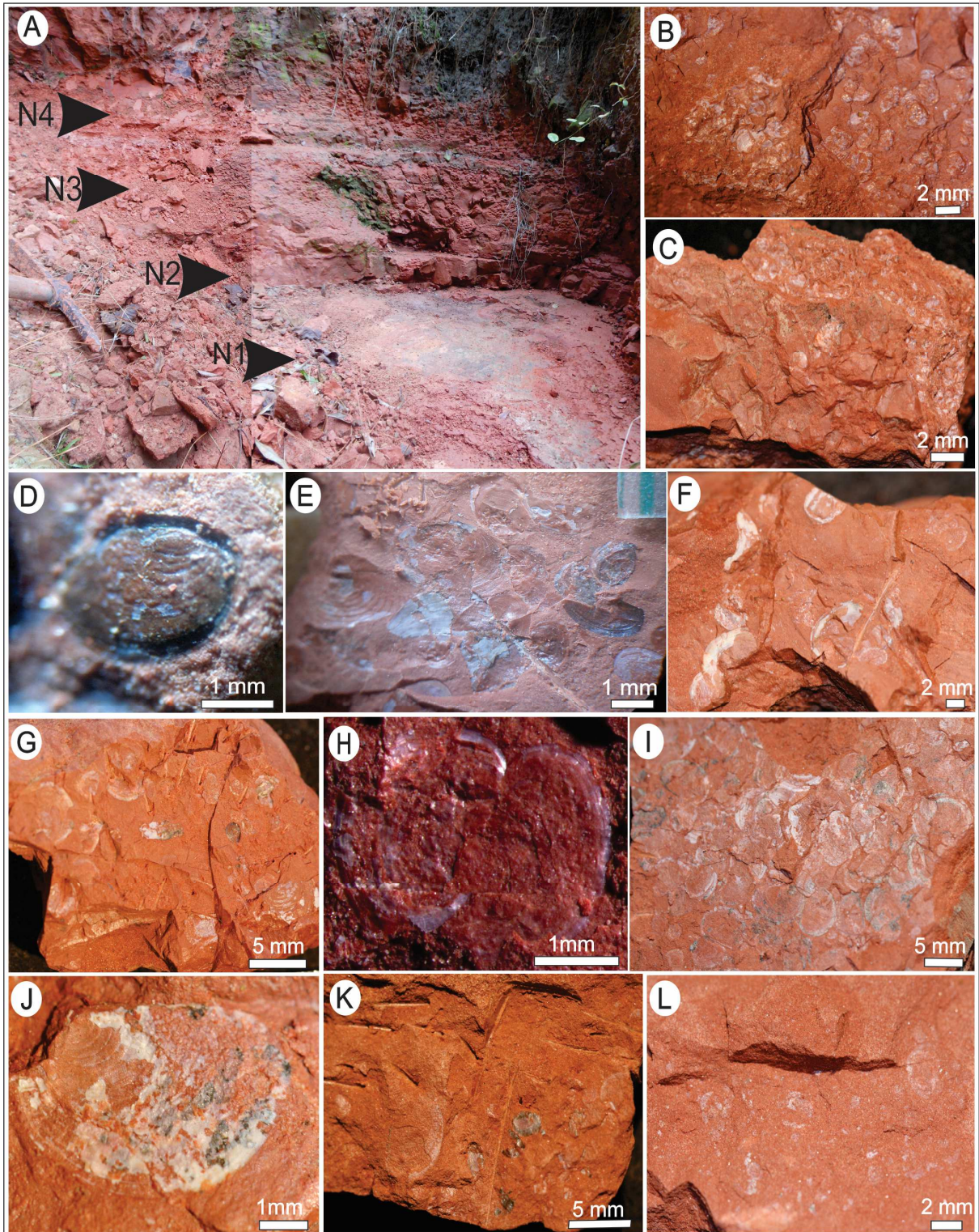
Figure 10

Table 1

Taxa	Location	Lithostratigraphic Unit	Age	Correlation	References
Equisetacea: *Neocalamites*	Passo das Tropas - Santa Maria/RS	Santa Maria Fm., Passo das TropasMb. (Andreis et al., 1980)	Triassic, Ladinian	Cerrode Las CabrasFm./ AR	Gordon and Brown, (1952); Bortoluzzi, et al., (1983); Barboni and Dutra (2015)
Fertile organs: *Hamshawvia, Stachyopitys, Pteruchus,*	Passo das Tropas - Santa Maria/RS	Santa Maria Fm., Passo das TropasMb. (Andreis et al., 1980)	Triassic, Ladinian – Carnian	Molteno Fm./ ZA	Pinto (1956); Barboni and Dutra (2015)
Leafs: *Dicroidium, Pachypteris, Zuberia, Thinnfeldia, Xylopteris, Schizoneura, Sewardia, Baiera, Sphenobaiera*	Passo das Tropas - Santa Maria/RS	Santa Maria Fm., Passo das TropasMb. (Andreis et al., 1980)	Triassic, Carnian	Los Rastros, Cortaderita, Potrerillos (AR), Molteno (SAfrica) Formations, Hawkesbury fluvial sandstone (AUS)	Retallack (1977); Guerra-Sommer et al., (1999); Barboni (2015); Barboni and Dutra (2015), Barboni et al., (2016)
Insects: Blattodea, Coleoptera, Orthoptera, Miomoptera, Grilloblattida, Odonata and Hemiptera	Passo das Tropas - Santa Maria/RS	Santa Maria Fm., Passo das TropasMb. (Andreis et al., 1980)	Triassic, Carnian	Los Rastros Fm (AR)	Pinto (1956); Martins-Netto & Gallego, (2003); Corrêa (2014)
Conchostracans: *Euestheria azambujai , Estherites wianamattensis Estheriina* sp., *Eustheria minua, Triasoglypta santamarianensis, Palaeolimnadiopsis* sp.	Passo das Tropas - Santa Maria/RS	Santa Maria Fm., Passo das TropasMb. (Andreis et al., 1980)	Triassic, Ladinian	German Basinsand Newark Supergroup/USA	Pinto, (1956); Katoo (1971), Tasch (1987); Gallego (1996 ,2001) ;Jenisch et al., (2013; 2015)

Vertebrates: *Actinopterygii indet. Rhynchosaurus, Hyperodapedon, Aetosaurus*	Piche - São João do Polêsine/RS	Santa Maria Fm., Alemoa Mb. (Andreis et al., 1980)	Triassico, Carnian	Ischigualasto Fm./AR	Perez e Malabarba (2002); Bonaparte (1982); Rogers et al., (1993); Furin et al., (2006), Langer et al., (2007); Martinez et al., (2011)
Fish remains : *Hybodontiformes* indet., paleoniscide teeth and scales	Piche - São João do Polêsine/RS	Santa Maria Fm., Alemoa Mb. (Andreis et al., 1980)	Triassic, Carnian	_____	Perez and Malabarba (2002)
Conchostracans	Piche - São João do Polêsine/RS	Santa Maria Fm., Alemoa Mb. (Andreis et al., 1980)	_____	_____	Jenisch et al., (2016)
Ichnofossils: *Skolithos, Taenidium, Paleophycus, Planolites, Arenicolites*	Piche - São João do Polêsine/RS	Santa Maria Fm., Alemoa Mb. (Andreis et al., 1980)	_____	_____	Godoy et al., (2012)
Reptiles: *Clevosaurus, Soturnia, Cargninia, Faxinalipterus, Guaibasaurus, Brasilodon, Brasilitherium, Minicynodon, Irajatherium, Riograndia*	São Luis – Faxinal do Soturno/RS	Caturrita Fm. (Andreis et al., 1980)	Triassic, Carnian – Norian	Ischigualasto Fm./AR	Bonaparte et al,. (1999, 2001, 2003, 2010a, 2010b); Ferigolo, (2000); Cisneros, (2000); Cisneros and Schultz et al., (2003); Martinelli et al., (2005); Bonaparte and Sues (2006); Arantes et al., (2009); Soares et al., (2011);
Fish: *Actinopteri indet.*	São Luis – Faxinal do Soturno/RS	Caturrita Fm. (Andreis et al., 1980)	Triassic	_____	Perez e Malabarba (2002)
Ichnofossils: footprint (*Eubrontes), Taenidium baretti, Planolithes, Paleophycus, Skolithos*	São Luis – Faxinal do Soturno/RS	Caturrita Fm. (Andreis et al., 1980)	Jurassic		Silva et al., (2012)
Reproductive structures: Bennettitales	São Luis – Faxinal do Soturno/RS	Caturrita Fm. (Andreis et al., 1980)	Lower Jurassic		Barboni et al., (2013)

Williamsonia potyporanae

Branches and leaves: *Brachyphyllum, Pagiophyllum, Pterophyllum?*	São Luis – Faxinal do Soturno/RS	Caturrita Fm. (Andreis et al., 1980)	Triassic / Jurassic		Herbst and Anzótegui (1968); Archangelsky (1970); Dutra and Crisafulli (2002); Bolzon et al., (2002), Bordy et al., (2004)
Undetermined conifers: *Agathoxylon africanum, Megaporoxylon kaokense* cf. *Chapmanoxylon jamuriense Kaokoxylon zalesskyi*	São Luis – Faxinal do Soturno/RS	Caturrita Fm. (Andreis et al., 1980)	Triassic		Crisafulli and Dutra (2009)
Conchostracans: *Nothocarapacestheria soturnensis; Australestheria* sp.	São Luis – Faxinal do Soturno/RS	Caturrita Fm. (Andreis et al., 1980)	Jurassic	Ferrar Group/ AQ Stanleyville group /CD	Rohn et al., (2014)

Table 2

Geologic units	Loca-lites	Outline/size (in mm)	Umbo	Dorsal margin	Ornamentation	Other	Taxa/Authors	Current taxonomic status
Santa Maria Fm. (Passo das Tropas Mb.)	Passo das Tropas	Irregulary ovoid, L:4,22 - 4,87; H:2,44 – 3,04	Poorly preserved	Straight, longer than half the length	Incipient formed by areolas	Number of growth lines 7 average	*Euestheria azanbujai* (Pinto 1956)	Family Lioestheriidae
	Passo das Tropas	Subeliptic L:4,76 – 7,84 H:3,31 – 5,79	Prominent, elongated, terminal	Features curved center inside	not observed	Number of growth lines 9 - 10	*Estheriina* sp. (Pinto 1956)	Family Palaeolimnadiidae
	Passo das Tropas	Subovoid L:5 – 6 H:3,5 – 4	Posterior, recurvature, proeminent terminal	Straight, elongated, curved at the junction with the posterior margin	Incipient formed by scores	Number of growth lines 9 - 10	*Palaeolimnadi opis* sp. (Tasch 1987)	Family Asmussidae
	Passo das Tropas	Ovoid L:4,92 – 5,49 H:3,58 – 4,18	Subterminal to prominent, supramarginal,subcentral	Medium short length, strongly curved	Incipient with areolar format	Number of growth lines 9 - 10	*Euestheria* cf. *minuta* V. Zieten (Katoo 1971)	Family Euestheriidae
	Passo das Tropas	Ovoid to eliptical L: 7 – 9,5 H: 4,73 – 6,4	Slightly convex and does not protrude sharply over the dorsal margin	Straight forming an anchor marked with a posterior margin	Areolar incipient, very poorly preserved	Approximately 9	*Triasoglypta* n. gen (Gallego 1999)	Family Loxomegaglyp-tidae

Caturrita Fm.	São Luis	Circular and dorsoventrally compressed; L: 2,1 – 3,9; H: 1,7 – 3,2	Subcentral, small, slightly elevated relative to the dorsal margin	Straight and short, close to half of length	Very finely serrated pattern on growth lines with fine scores tending to orthogonal alignment	Number of growth lines: 12 - 19	*Australestheria* sp. (Rohn et al., 2014)	Family Fushunogra-ptidae
	São Luis	Ovate; L: 6,4 – 8,5; H: 4,75 – 5,95	Very small sub-anterior	Slightly arched	Reticulated, isodiametric polygons elongated polygonal reticles sometimes forming striations in the distal portion	Number of growth lines: 18 - 27	*Nothocarapacestheria soturnensis* gen. et sp. nov. (Rohn et al., 2014)	Family Eosestheriidae

Table 3

Facies	Granulometry	Geometry/Structures	Thickness/Contact	Fossils	Location	Interpretation
Sh – sandstone with plane parallel lamination	Fine to coarse sand	Tabular Geomtry with horizontal, plane parallel lamination	10 – 60 cm, with plane inferior and superior contacts	Ichnofossilis (*skolithos* sp.)	Passo das Tropas, Piche and São Luis	Deposition under turbulent flow regime in floodplain.
St – sandstone with cross stratification	Fine to very coasre sand	Lenticular geometry with tangential cross stratification of small to medium size. Geometry sometimes sigmoidal; Paleocurrents indicate preferential flow towards SE.	15 – 100 cm in erosive contact with the subjacent river bottom	———	Passo das Tropas, Piche and São Luis	Longitudinal bars associated to river channels and rivermouth bars associated to floodplain
Sr – sandstone with cross lamination (ripple)	Fine to very fine sand	Tabular geometry with cross lamination. Paleocurrents indicate preferential flow towards E.	3 – 7 cm; abrupt contact with the subjacent layers	Ichnofossils (*Skolithos*, *Arenicolithes*, *Paleophycus*)	Piche and São Luis	Deposition under unidirectional laminar flow regime.
Srw – sandstone with wavy cross lamination	Fine to very fine sand	Tabular geometry with wavy cross lamination	3 – 7 cm; abrupt contact with the subjacent layers	———	Piche	Deposition under the action of bimodal currents
Sm – massive sandstone	Fine to medium sand	Tabuar geometry, massive or with indistinct lamination	30 – 100 cm ; abrupt contact with inferior and superior strata	Vertebrates, rhizobioturbation and ichnofossils (*Taenidium barreti*, *Paleophycus*)	Piche and São Luis	Deposition from high concentration gravitational flows, or absemce of sedimentary structures due to fluidization.
Fl – laminated mudstone	Very fine sand, silt and mud	Tabular geometry with fine laminations. Rarely massive. Presence of mudcracks in certain level.	10 – 200 cm ; abrupt contact with inferior and superior strata.	Plant remains, vertebrate bones, teeth, fish scales, insects, conchostracans, ichnofossils (*Skolithos*, *Taenidium*, *Paleophycus*, *Planolites*) and rhizobioturbation.	Passo das Tropas, Piche and São Luis	Deposition of fine grained particles in floodplain or in abandoned channels. Mudcracks point to subaerial exposure.

Table 4

Taxa	Author/year	Lithostratigraphic unit	Age	Location
Estheria minuta	Jones (1862)	Many Formations	Lower to Mid-Triassic	Europe (Germany and France)
Estheria (*Euestheria*) *minuta*	Defretin-Lefranc (1950)	Many Formations	Middle to Upper Triassic – Lower Jurassic	Europe (Germany and France)
Estheria (*Euestheria*) *minuta*	Defretin-Lefranc (1953)	Schist-sandstone series	Upper Triassic	South Africa
Euestheria minuta	Defretin-Lefranc (1969)	Cape Biot Formation	Upper Triassic	Greenland
Euestheria af. *E. minuta* (von Ziten) Raymond	Katoo (1971)	Santa Maria Foramtion (Passo das Tropas Member)	Middle Triassic	Brazil
Euestheria minuta	Chang *et al.*, (1976)	Badong and Xuanham Formations	Middle Triassic	China
Cyzicus (Euestheria) minuta	Tasch (1987)	Blizzard Heights Formation, Storm Peak	Lower Jurassic	Antartica
Euestheria) minuta	Tasch (1987)	Panchet Formation	Lower Triassic	India
Euestheria cf. *minuta*	Tasch (1987)	Blina Shale Formation	Lower Triassic	Australia
Cyzicus (Euestheria) minuta (Von Zieten) Tasch	Gallego (1992, 1999)	Potrerillos Formation	Mid- to Upper Triassic	Argentina

Cyzicus (Euestheria) minuta (Von Zieten) Tasch	Gallego (1992, 1999)	Santa Clara de Abajo Formation	Mid- to Upper Triassic	Argentina
Euestheria minuta	Gallego (1999)	Cacheuta Formation	Mid- to Upper Triassic	Argentina
Euestheria minuta	Kozur and Weens (2007)	Tuckahoe Formation	Mid- to Upper Triassic	United States
Euestheria minuta	Kozur and Weens (2010)	Wolfville Formation	Middle Triassic	Canada
Euestheria minuta	Tassi (2015)	Potrerillos Formation	Upper Triassic	Argentina

Highlights

- An integrated study between taphonomy and sedimentary geology is proposed for continental sub-aquatic macroinvertebrates from Paraná Basin.

- The data presented here show that taphonomic signatures may indicate different patterns of autochthony/allochthony.

- The stratigraphic positioning of the conchostracans showed a distribution from the Middle Triassic with possibillity to the Lower Jurassic.

Síntese final

Este trabalho traz uma abordagem baseada em um estudo integrado entre tafonomia e geologia sedimentar com o uso de macroinvertebrados sub-aquáticos continentais para os depósitos Mesozoicos Bacia do Paraná. Esta unificação é benéfica porque faz com que a resolução do registro fóssil se torne mais confiável para análises paleoambientais e estratigráficas, com posteriores correlações estratigráficas de superfície, muitas vezes podendo estar enviesadas devido aos problemas de amostragem, incompletude, misturas temporais e espaciais dos acúmulos fossilíferos ao longo do tempo e espaço. Esta é a missão da tafonomia como ciência paleontológica, ou seja, tentar minimizar os problemas relacionados aos vieses preservacionais que podem prejudicar as interpretações paleoambientais, mas principalmente as paleoecológicas por causa do problema da aloctonia.

Foi com esta visão integrada que o presente trabalho foi desenvolvido, utilizando uma associação de metodologias inéditas para os níveis com ocorrência de conchostráceos aqui estudados. Assim, este estudo apresenta uma nova abordagem, não somente para o intervalo Triássico/Jurássico sul-rio-grandense, mas para os ambientes continentais da Bacia do Paraná. Os afloramentos do intervalo Triássico-Jurássico desta bacia mostraram-se como bons exemplos para testar as hipóteses relacionadas à utilidade dos conchostráceos (Spinicaudata), como elementos para estudos sobre paleoambientes e sua confiabilidade e fidelidade em distribuições estratigráficas.

Os conchostráceos apresentam algumas contradições na literatura em relação à durabilidade de seu exoesqueleto. Se por um lado os organismos compostos por carapaças quitino-fosfáticas normalmente mostram um baixo potencial de preservação, estudos atualísticos evidenciam sua boa resistência aos agentes físicos, como distúrbios ambientais e energia no meio (transporte). Neste trabalho ficou evidenciado que, em algumas facies, ou, conjunto de facies, que estão relacionadas a processos de alta energia, os conchostráceos apresentam um bom grau de preservação, como pode ser observada nas associações tafonômicas 2 e 3, mas principalmente na 2, caracterizada por ambiente de *crevasse splay*. Foi possível confirmar que em locais de água mais clama, ocorrem formas mais bem preservadas principalmente devido a estabilidade desses ambientes.

Apesar de não ter sido possível precisar os componentes orgânicos das associações fósseis a um nível taxonômico mais específico, o grau de fidelidade

tafonômica para estudos bioestratigráficos e correlações, se demonstrou efetivo. Portanto, estudos futuros sobre a taxonomia e sistemática destes morfotipos, aparentemente inéditos para a bacia, devem ser incentivados daqui em diante.