

The occurrence of Phacopida trilobites from Pimenteira Formation at João Costa, Piauí, Brazil

A ocorrência de trilobitas Phacopida da Formação Pimenteira em João Costa, Piauí, Brasil

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Abstract

The marine macroinvertebrate fossils from the Devonian of the Parnaíba Basin are among the most diverse of Paleozoic of Brazil. In recent years, most revisions on these fossils involved trilobites from the Pimenteira and Cabeças formations, in the region of Picos and Pimenteiras cities, in the Piauí State. This survey reports the occurrence of Devonian trilobites from the Pimenteira Formation cropping out at João Costa city, in the region of Serra da Capivara National Park, southeastern Piauí State, where two species were recognized: *Burmeisteria notica* Clarke, 1913 and *Metacryphaeus* cf. *australis* Clarke, 1913. The wide occurrence of these genera in the Malvinokaffric Realm shows that transgressive events during part of the Devonian favored the faunal communication between the Andean, Brazilian and South African provinces through the reduction of geographical barriers. Finally, although the still preliminary character of the studies on Pimenteira Formation trilobites, this unit is already providing new paleontological data that contribute to the understanding of these fossil assemblages.

Keywords: *Calmoniidae*; *Homalonotidae*; Devonian; Parnaíba Basin; Serra da Capivara National Park.

Resumo

Os fósseis de macroinvertebrados marinhos do Devoniano da Bacia do Parnaíba estão entre os mais diversos do Paleozoico do Brasil. Nos últimos anos, a maioria das revisões sobre esses fósseis envolveu trilobitas das formações Pimenteira e Cabeças, na região das cidades de Picos e Pimenteiras, no Estado do Piauí. Esta pesquisa relata a ocorrência de trilobitas devonianos da Formação Pimenteira, aflorante na cidade de João Costa, na região do Parque Nacional da Serra da Capivara, no sudeste do Piauí, onde duas espécies foram reconhecidas: *Burmeisteria notica* Clarke, 1913 e *Metacryphaeus* cf. *australis* Clarke, 1913. A ampla ocorrência destes gêneros no Domínio Malvinocáfrico mostra que eventos transgressivos durante parte do Devoniano favoreceu a comunicação entre as faunas das províncias Andina, Brasileira e Sul-africana, através da redução das barreiras geográficas. Finalmente, apesar do caráter ainda preliminar dos estudos sobre trilobitas da Formação Pimenteira, esta unidade continua fornecendo novos dados paleontológicos que contribuem para o entendimento destas assembleias fósseis.

Palavras-chave: *Calmoniidae*; *Homalonotidae*; Devoniano; Bacia do Parnaíba; Parque Nacional da Serra da Capivara.

INTRODUCTION

The marine macroinvertebrate fauna from the Devonian of the Parnaíba Basin is among the most diversified of Paleozoic of Brazil. It includes brachiopods, trilobites, ostracods, pelecypods, gastropods, hyolithids and tentaculitids preserved together with elasmobranchii fishes and plants in siliciclastics of Pimenteiras and Cabeças formations. The fauna in intermediate sections of the Pimenteiras Formation, cropping out at Piauí State, is dominated by the Chonetoida brachiopod *Montsenetes* cf. *boliviensis* Rachebouef, 1992 and also includes pelecypods, gastropods, trilobites and conularids (Castro, 1968; Melo, 1988; Carvalho, 1995; Siviero, 2002). Important revisions on this fauna have taken place in the last years, involving brachiopods (Fonseca, 2001, 2004; Gama Jr., 2008) and conularids (Siviero, 2002). Studies on trilobites from the Pimenteiras Formation back Caster (1948), who cited the occurrence of homalonotids and dalmanitids. The area between the cities of Picos and Pimenteiras, where this unit outcrops, was later visited by Kegel (1953), who collected fossils and described the occurrence of the genera *Homalonotus* König, 1825 and *Asteropyge* Hawle and Corda, 1847. These taxa were later reclassified by Castro (1968); the

former as *Burmeisteria notica* Clarke, 1913 and the latter, as *Metacryphaeus australis* Clarke, 1913. In general, Devonian trilobites of Parnaíba Basin were mainly treated as side subjects in stratigraphic (Kegel, 1953) and paleobiogeographic (Melo, 1985, 1988) studies. Nevertheless, more attention has been given to these fossils in the last twenty years, through detailed surveys on systematics and paleobiogeography (e.g. Carvalho, 1995; Carvalho et al., 1997).

The current survey reports the occurrence of trilobites from the Pimenteiras Formation at João Costa city (Figure 1), in the vicinities of Serra da Capivara National Park, southeastern Piauí State.

GEOLOGIC SETTING

The Pimenteiras Formation (Neoeifelian – Frasnian; Santos and Carvalho, 2004; Grahn et al., 2006) is located near the base of the Canindé Group, underlain by the Itaim Formation and overlain by the Cabeças Formation (Figure 2). Although in many works the unit is referred as “Pimenteiras Formation” as the formation’s name derives from the town of Pimenteiras, in the Piauí State

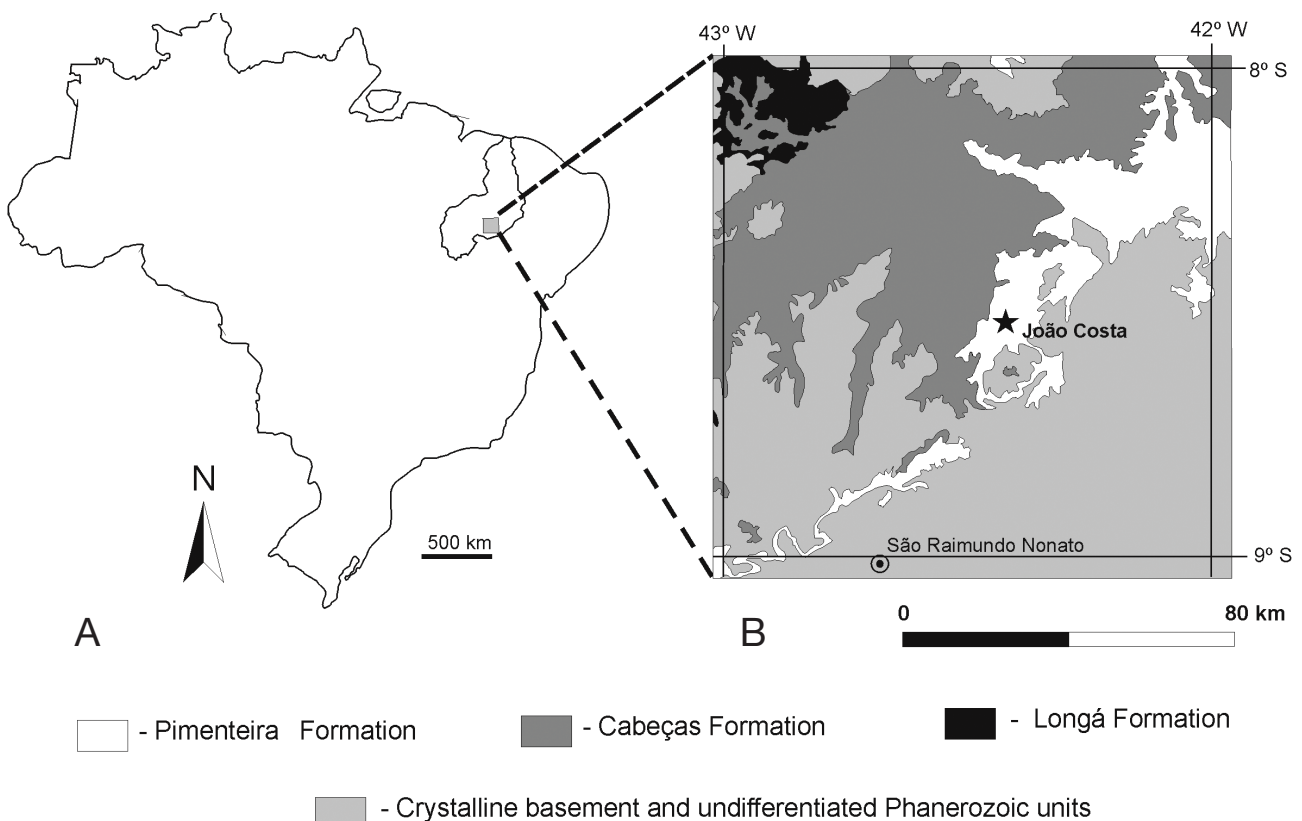


Figure 1. Geological map showing the city of João Costa in the Piauí State, Brazil. Note that the town is positioned within the Pimenteiras Formation. (B) modified from CPRM (2006).

(Small, 1914; Plummer et al., 1948) we rather use the term “Pimenteira Formation” following Carvalho (1995, 2006), Carvalho et al. (1997); Silva and Fonseca (2005). The unit marked the greatest marine transgression in the Parnaíba Basin, and consists on siderite and pyrite-rich dark (reddish when weathered) shales interbedded with siltstones and fine sandstones deposited in a storm-dominated shallow marine platform (Della Fávera, 1990; Góes and Feijó, 1994). The shales are often bioturbated, and contain iron oolites and phosphatic and hematitic concretions (Della Fávera, 1990). The fossils are often found as molds and casts in iron oxide concretions (Melo, 1988).

MATERIALS AND METHODS

Forty exemplars from outcrops of the Pimenteira Formation (Figure 2) at the localities of Morro do Ranulfo and Morro do Joaquim (23L UTM 9053313, 781243), in João Costa city, about 70 km from São Raimundo Nonato town, southeastern Piauí State were examined (Table 1). The fossils, preserved in ferruginous concretions, are deposited at the Fundação Museu do Homem Americano (FUNDHAM) scientific collection, in São Raimundo Nonato city. The preparation of the specimens followed the techniques used in the study of marine macrofossils mentioned in Feldmann et al. (1989) and Nobre and Carvalho (2010). The systematic identification and the morphologic terminologies for trilobites followed Eldredge and Branisa (1980), Lieberman et al. (1991), Lieberman (1993), Whittington et al. (1997) and Sandford (2005).

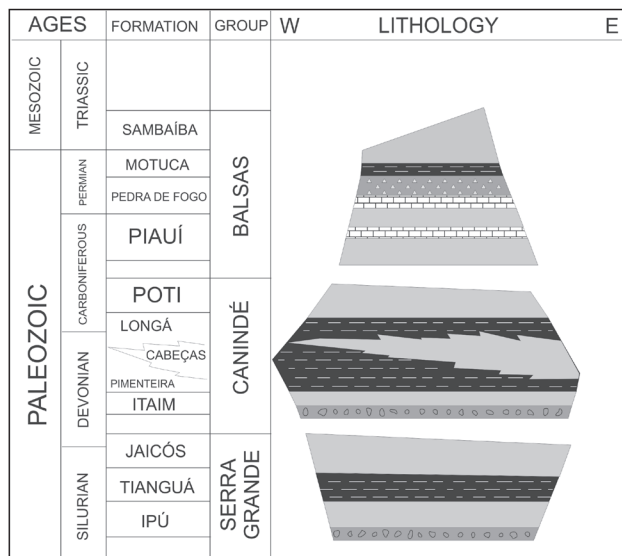


Figure 2. Stratigraphic section of the Paleozoic and early Mesozoic of the Parnaíba Basin. Modified from Góes (1995).

The fossils were analyzed with a Zeiss stereomicroscope and photographed with a Canon SX10 digital camera. These steps were carried out at the Laboratório de Estudos Paleobiológicos of the Instituto de Geociências da Universidade de São Paulo (IGc/USP).

RESULTS AND DISCUSSION

From the analyzed fossils, it was possible to discern two trilobite species: *Burmeisteria notica* and *Metacryphaeus cf. australis* (Figures 3A – 3G). The material also includes one specimen of *Rusophycus* Hall, 1852 (Figure 3H), already recognized in the area (Silva et al. 2011). Both trilobite species were described from the Pimenteira Formation in the region between Picos and Pimenteiras cities (Castro, 1968; Carvalho, 1995) and are also found in the Ponta Grossa Formation, Paraná Basin (Clarke, 1913; Carvalho et al., 1987). The occurrence of *Burmeisteria* Salter, 1865 and *Metacryphaeus* Reed, 1907 in João Costa town spreads the already wide distribution of these genera within the Malvinokaffric Realm, which also includes Bolivia (Icla, Bélen, Gamoneda, Sicasica and Catavi formations), Argentina (Lipéon Formation), South Africa (Gydo and Voorstehoeck formations), Falkland Islands (Fox Bay Formation) and Uruguay (Cordobés Formation) (Kozłowski, 1923; Reed, 1925; Branisa, 1965; Copper, 1977; Eldredge and Ormiston, 1979; Cooper, 1982; Lieberman, 1993; Carvalho, 1995, 2006; Carvalho et al., 1987; Carvalho et al., 1994).

Although the distribution of homalonotid trilobites extends to the Old World Realm, *Burmeisteria* consists on the most common genus in the Malvinokaffric Realm (Simões, et al., 2009). Contrarily, *Metacryphaeus* is considered an endemic genus for this paleobiogeographic province (Eldredge and Ormiston, 1979). The wide occurrence of *Burmeisteria* and *Metacryphaeus* in transgressive deposits within the Malvinokaffric context indicates that faunal interchanging between Andean, Brazilian and South African provinces took place during part of the Devonian, favored by the reduction of geographic barriers.

Table 1. Mode of preservation and number of samples of *B. notica* and *M. cf. australis*.

SPECIES/PRESERVATION	<i>B. notica</i>	<i>M. cf. australis</i>
Complete	9	-
Thorax-pygidium	3	3
Cephalon-thorax	7	-
Cephalon	2	-
Pygidium	9	1
Thorax	6	-
TOTAL	36	4

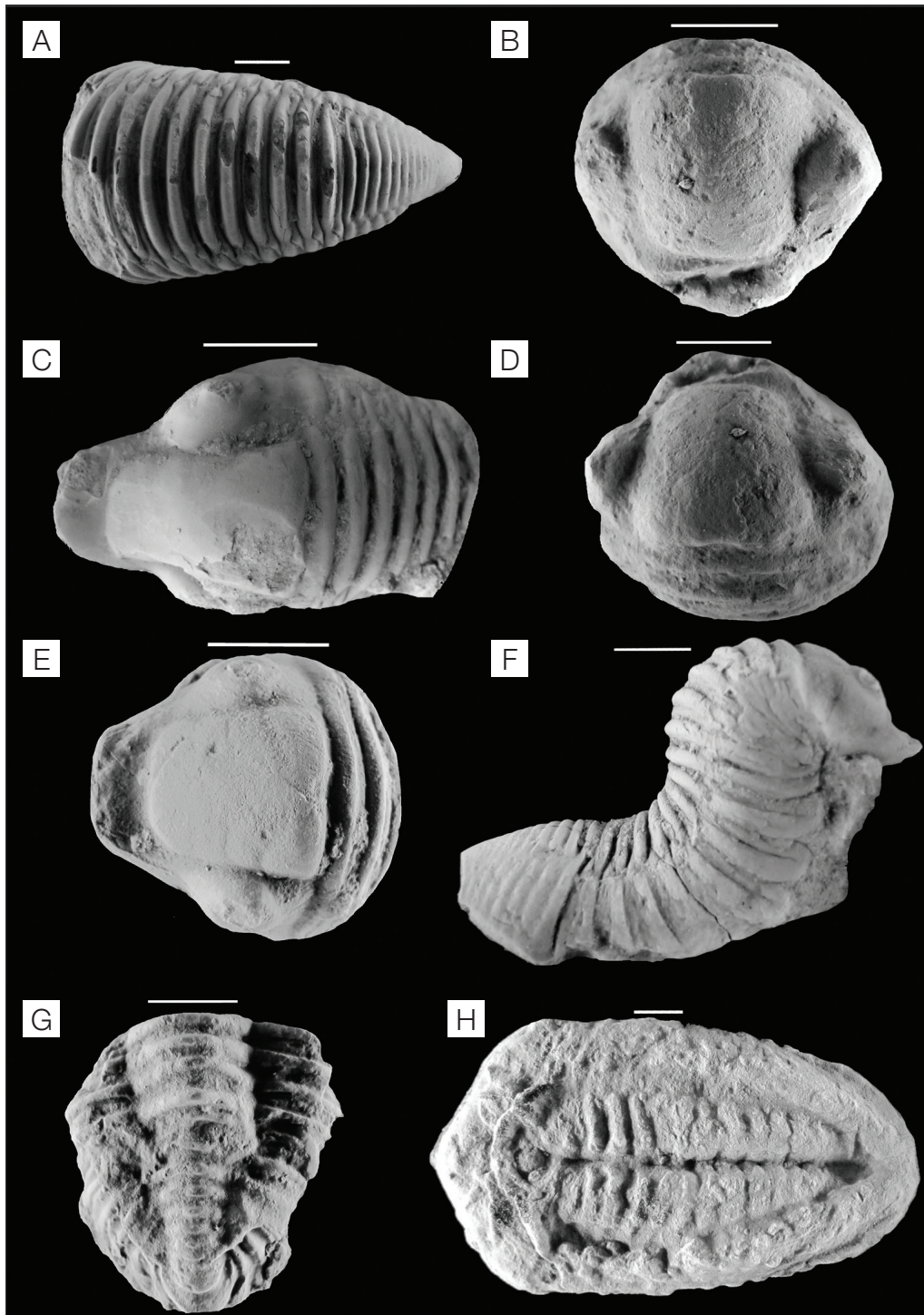


Figure 3. Specimens of *Burmeisteria notica* (A–F), *Metacryphaeus cf. australis* (G) and *Rusophycus* (H) from the Pimenteira Formation at João Costa city, southeastern Piauí State, and deposited at the Fundação Museu do Homem Americano scientific collection, under the numbers 169056 (A), 169045 (B, D and E), 169039 (C), 169044-1 (F), 169046 (G), and 872-113981 (H). Scale bars represent 1 cm.

FINAL CONSIDERATIONS

Though relatively recent, studies on trilobites from the Pimenteira Formation are already providing new paleontological, which allow a more precise comparison between fossil assemblages in this basin and those from other localities in the Malvinokaffric Realm.

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REFERENCES

- Branisa, L. (1965). Los fosiles guias de Bolivia. I. Paleozoico. *Servicio Geologico de Bolivia, Boletin*, 6, 1-282.
- Carvalho, M. G. P. (1995). *Trilobitas devonianos da Bacia do Parnaíba (Formações Pimenteira, Cabeças e Longá)*. Tese (Doutorado). Rio de Janeiro: Instituto de Geociências – UFRJ.
- Carvalho, M. G. P. (2006). Devonian trilobites from the Falkland Islands. *Palaeontology*, 49(1), 21-34.
- Carvalho, M. G. P., Edgecombe, G. D., Lieberman, B. S. (1997). Devonian Calmonioid trilobites from the Parnaíba Basin, Piauí State, Brazil. *American Museum Novitates*, 3192, 1-11.
- Carvalho, M. G. P., Melo, J. H. G., Quadros, L. P. (1987). Trilobitas devonianos do flanco noroeste da Bacia do Paraná. *X Congresso Brasileiro de Paleontologia*, v. 2, 545-565. Rio de Janeiro: SBP.
- Caster, K. E. (1948). Excursão Geológica ao Estado do Piauí. *Mineração e Metalurgia*, 12(72), 271-272.
- Castro, J. S. (1968). Trilobitas da Formação Pimenteiras, Devoniano do Estado do Piauí. *Anais da Academia Brasileira de Ciências*, 40(4), 481-489.
- Clarke, J. M. (1913). Fósseis devonianos do Paraná. *Monographia do Serviço Geológico e Mineralógico do Brasil*, 1, 1-353.
- CPRM. (2006). Serviço Geológico do Brasil. *Mapa geológico do Estado do Piauí: Sistema de Informações Geográficas - SIG*. 2ª versão. Teresina: 1 CD-ROM, Escala 1:1.000.000.
- Cooper, M. (1982). A revision of the Devonian (Emsian-Eifelian) trilobite from Bokkeveld Group of South Africa. *Annals of the South African Museum*, 89, 1-174.
- Copper, P. (1977). Paleolatitudes in the Devonian of Brazil and the Frasnian - Famennian mass extinction. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 21, 165-207.
- Della Fávera, J. C. (1990). *Tempestitos da Bacia do Parnaíba: um ensaio holístico*. Tese (Doutorado). Porto Alegre: Instituto de Geociências – UFRGS.
- Eldredge, N., Branisa, L. (1980). Calmonioid trilobites of the Lower *Scaphiocoelia* Zone of Bolivia, with remarks on related species. *Bulletin of the American Museum of Natural History*, 165(2), 185-289.
- Eldredge, N., Ormiston, A. R. (1979). Biogeography of Silurian and Devonian Trilobites of the Malvinokaffric Realm. In: A. J. Boucot, J. Gray (Eds.), *Historical biogeography, plate tectonics, and changing environment*. (147-167). Oregon State Univ. Press.
- Feldmann, R. M., Chapman, R. E., Hannibal, J. T. (1989). *Paleotechniques*. Knoxville: The Paleontological Society.
- Fonseca, V. M. M. (2001). *Brachiopoda (Stropheodontoidea, Chonetoida e Delthyridoidea) do Devoniano Médio das bacias do Amazonas e Parnaíba*. Tese (Doutorado). Rio de Janeiro: Instituto de Geociências – UFRJ.
- Fonseca, V. M. M. (2004). Chonetoidea (Brachiopoda, Strophomenata, Productida, Chonetidina) do Devoniano Médio das bacias do Amazonas e Parnaíba, Brasil. *Arquivos do Museu Nacional*, 62(2), 193-215.
- Gama Jr., J. M. (2008). *Braquiópodes da Formação Pimenteiras (Devoniano Médio/Superior), na região Sudoeste da Bacia do Parnaíba, Estado do Tocantins, Brasil*. Dissertação (Mestrado). Brasília: Instituto de Geociências – UnB.
- Góes, A. M. O. (1995). *A Formação Poti (Carbonífero Inferior) da Bacia do Parnaíba*. 1995. Tese (Doutorado). São Paulo: Instituto de Geociências – USP.
- Góes, A. M. O., Feijó, F. J. (1994). Bacia do Parnaíba. *Boletim de Geociências da Petrobrás*, 8, 57-67.

- Grahn, Y., Melo, J. H. G., Loboziak, S. (2006). Integrated Middle and Late Devonian miospore and chitinozoan zonation of the Parnaíba Basin, Brazil: an update. *Revista Brasileira de Paleontologia*, 9(3), 283-294.
- Kegel, W. (1953). Contribuição para o estudo do Devoniano da Bacia do Parnaíba. *Boletim da Divisão de Geologia e Mineralogia*, 141, 1-48.
- Kozłowski, R. (1923). Faune Dévonienne de Bolivie. *Annales de Paleontologie*, 12(1/2), 1-112.
- Lieberman, B. S. (1993). Systematics and biogeography of the “*Metacryphaeus* Group”, Calmoniidae (Trilobita, Devonian), with comments on adaptative radiations and the geological history of the Malvinokaffric Realm. *Journal of Paleontology*, 67(4), 549-570.
- Lieberman, B. S., Edgcombe, G. D., Eldredge, N. (1991). Systematics and biogeography of the “*Malvinella* Group”, Calmoniidae (Trilobita, Devonian). *Journal of Paleontology*, 65(5), 824-843.
- Melo, J. H. G. (1985). *A Província Malvinocáfrica no Devoniano do Brasil: estado atual dos conhecimentos*. 1985. Dissertação (Mestrado). Rio de Janeiro: Instituto de Geociências – UFRJ.
- Melo, J. H. G. (1988). The Malvinokaffric realm in the Devonian of Brazil. In: McMillan, N. J., Embry, A. F., Glass, D. J. (Eds.), *Devonian of the World*, (v.1, 669-703). Calgary: Canadian Society of Petroleum Geologists.
- Nobre, P. H., Carvalho, I. S. (2010). Fósseis: coleta e métodos de estudo. In: I.S. Carvalho (Ed.), *Paleontologia*, 3ª edição, (397-411). Rio de Janeiro: Interciência.
- Plummer, F. B., Price, L. I., Gomes, F. A. (1948). Estados do Maranhão e Piauí. *Conselho Nacional de Petróleo, Relatório 1946*, 87-134.
- Rachebouef, P. R. (1992). Los chonetáceos (brachiópodos) del Devónico boliviano: bioestratigrafía y datos taxonómicos complementarios. *Revista Española de Paleontología*, 7, 31-52.
- Reed, F. R. C. (1925). Revision of the Fauna of the Bokkeveld Beds. *Annals of the South African Museum*, 22, 27-225.
- Sandford, A. C. (2005). Homalonotid trilobites from the Silurian and Lower Devonian of south-eastern Australia and New Zealand (Arthropoda: Trilobita: Homalonotidae). *Memoirs of Museum Victoria*, 62(1), 1-66.
- Santos, M. E. C. M., Carvalho, M. S. S. (2004). Paleontologia das bacias Parnaíba, Grajaú e São Luís. *Programa Levantamentos Geológicos Básicos do Brasil, CPRM. Serviço Geológico do Brasil DIEDIG/DEPAT, Rio de Janeiro. Livro eletrônico em formato pdf, CD-Rom*.
- Silva, C. F., Fonseca, V. M. M. (2005). Hábitos de vida dos trilobitas das formações Maecuru e Ererê, Devoniano da Bacia do Amazonas, Brasil. *Revista Brasileira de Paleontologia*, 8(1), 73-82.
- Silva, R. C., Dominato, V. H., Fernandes, A. C. S. (2011). Novas considerações sobre icnofósseis devonianos da Formação Pimenteira, Bacia do Parnaíba, Brasil. *XXII Congresso Brasileiro de Paleontologia*, 483-485. Natal: SBP.
- Simões, M. G., Leme, J. M., Soares, S. P. (2009). Systematics, taphonomy and paleoecology of Homalonotid trilobites (Phacopida) from the Ponta Grossa Formation (Devonian), Paraná Basin, Brazil. *Revista Brasileira de Paleontologia*, 12(1), 27-42.
- Siviero, F. N. (2002). *Revisão sistemática das conulárias brasileiras*. 2002. Dissertação (Mestrado). Rio de Janeiro: Instituto de Geociências – UFRJ.
- Small, H. L. (1914). *Geologia e supprimento de água subterranea no Piauí e parte do Ceará*. Rio de Janeiro: Inspectoria de Obras Contra as Seccas.
- Whittington, H. B., Chatterton, B. D. E., Speyer, S. E., Fortey, R. A., Owens, R. M., Chang, W. T., Dean, W. T., Jell, P. A., Lawrie, J., Palmer, A. R., Repina, L. N., Rushton, A. W. A., Shergold, J. H., Clarkson, E. N. K., Wilmot, N. V., Kelly, S. R. A. (1997). *Treatise on Invertebrate Paleontology, Part O, Arthropoda 1, Trilobita*. Revised edition. Lawrence: Geological Society of America and the University of Kansas Press.