

Devonian macroinvertebrates from the State of Tocantins: occurrence history and new findings

Macroinvertebrados devonianos do estado de Tocantins: histórico de ocorrências e novos achados

Macroinvertebrados devónicos del estado de Tocantins: historia de ocurrencia y nuevos hallazgos

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Abstract: The state of Tocantins has been the subject of several paleontological researches in the past; however, the Devonian fossils have recently been poorly investigated. This paper expands the knowledge about Devonian in the state of Tocantins, presenting a bibliographic review and adding new fossiliferous discoveries. During fieldwork, brachiopods (*Australocoelia*, *Australospirifer*, *Derbyina*, infaunal lingulids, *Orbiculoidea*, *Tropidoleptus carinatus*, *Schuchertella*), cnidarians (*Conularia quichua*), crinoids (*Exaesiiodiscus dimerocrinosus*, *Laudonomphalus*, *Monstrocrinus*), mollusks (*Platyceras*, *Nuculites*, *Palaeoneilo*, *Sanguinolites*), and plants remains (*Spongiophyton lenticularis*) were found in different sedimentary facies of the Pimenteira Formation.

Keywords: Middle Devonian, South America, Parnaíba Basin, Fossil, Pimenteira Formation.

Resumo: O estado do Tocantins foi alvo de várias pesquisas paleontológicas no passado; no entanto, recentemente os fósseis do Devoniano foram pouco investigados. Este artigo amplia o conhecimento sobre o Devoniano no estado do Tocantins, apresentando uma revisão bibliográfica e agregando novas descobertas fossilíferas. Durante trabalhos de campo, braquiópodes (*Australocoelia*, *Australospirifer*, *Derbyina*, lingulídeos infaunais, *Orbiculoidea*, *Tropidoleptus carinatus*, *Schuchertella*), cnidários (*Conularia quichua*), crinoides (*Exaesiocrinus*, *Laudonomphalus*, *Monstrocrinus*), moluscos (*Platyceras*, *Nuculites*, *Palaeoneilo*, *Sanguinolites*) e restos de plantas (*Spongiophyton lenticularis*) foram encontrados em diferentes fácies sedimentares da Formação Pimenteira.

Palavras-chave: Devoniano Médio, América do Sul, Bacia do Parnaíba, Fóssil, Formação Pimenteira.

Resumen: El estado de Tocantins ha sido el objetivo de varias investigaciones paleontológicas en el pasado; sin embargo, los fósiles del Devónico se han investigado poco recientemente. Este artículo amplía el conocimiento sobre el Devónico en el estado de Tocantins, presentando una revisión bibliográfica y agregando nuevos descubrimientos fosilíferos. Durante el trabajo de campo, se encontraron braquiópodos (*Australocoelia*, *Australospirifer*, *Derbyina*, lingúlidos infaunales, *Orbiculoidea*, *Tropidoleptus carinatus*, *Schuchertella*), cnidarios (*Conularia quichua*), crinoideos (*Exaesiocrinus*, *Laudonomphalus*, *Monstrocrinus*), moluscos (*Platyceras*, *Nuculites*, *Palaeoneilo*, *Sanguinolites*) y restos vegetales (*Spongiophyton lenticularis*) en diferentes facies sedimentarias de la Formación Pimenteira.

Palabras clave: Devónico medio, América del Sur, Cuenca del Parnaíba, Fósil, Formación Pimenteira.

INTRODUCTION

The Parnaíba Basin is located in the northeast of South America in an area of approximately 600 thousand km², with rocks ranging from Silurian to Cretaceous (Góes & Feijó, 1994). Brazilian Devonian lithotypes are found only in the eastern and western borders of the basin, at Piauí and Tocantins states. Most of the paleontological studies are associated with the eastern portion while in the western margin studies are still scarce.

The Devonian fossils from Piauí are well represented by brachiopods, mollusks, arthropods, cnidarians, echinoderms, ichnofossils, tentaculitids, plants and fishes (Kegel, 1953; Barbosa, Ramos, Gomes & Helmbold, 1966; Ramos, 1967; Assis & Fernandes, 1980; Ferreira & Fernandes, 1983; Góes & Feijó, 1994; Santos & Carvalho, 2004; Vaz, Rezende, Wanderley Filho & Travassos, 2007; Queiroz, Gama Jr & Pires, 2013). On the other hand, in Tocantins state few studies mention brachiopods, tentaculitids, cnidarians, mollusks, echinoderms, and plants (Ramos, 1967; Melo, 1988; Gama Jr., 2008; Scheffler et al., 2011; Queiroz, Gama Jr & Pires, 2013), as well as palynomorphs, spores, chitinozoan, and acritarchs (Lima & Leite, 1978; Grahn, Melo, & Loboziak, 2006), microfitoplancton (Trindade & Carvalho, 2018) and ichnofossils (Assis & Fernandes, 1980; Ferreira & Fernandes, 1983).

Remarkably, few papers discuss the Devonian fossils in just over half a century of paleontological studies in Tocantins. To enhance the knowledge about Devonian

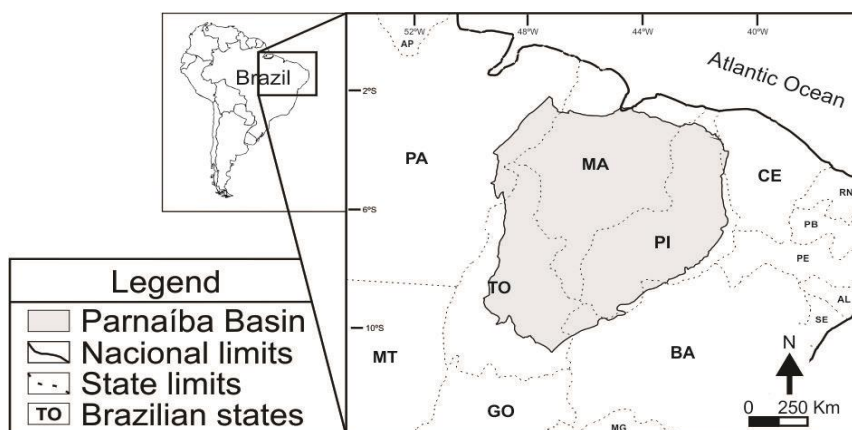
fossils from South America, our main goal is to present a bibliographic review and increase information about fossiliferous occurrences.

GEOLOGICAL BACKGROUND

The Parnaíba Basin is located on the South American platform and it has a basement composed of magmatic and metamorphic rocks. The sedimentary rocks were deposited during different geological events along the Silurian to the Cretaceous. However, events during the Triassic - Jurassic and early Cretaceous resulted in the occurrence of igneous rocks (Góes & Feijó, 1994). The outcrops are located in the states of Maranhão, Piauí, Tocantins, Pará, Ceará, and Bahia (Fig. 1).

The Devonian rocks were first described by Small (1914) in the surrounding areas of Pimenteiras, Piauí state. On that occasion, the rocks were individualized as reddish sandstones and schists, called Pimenteiras Formation. After that, Kegel (1953) attributed the Eifelian age to the basal rocks (Itaim Formation), overlapped by the Pimenteiras and Cabeças Formation, of Givetian age. Finally, Grahn, Melo & Loboziak (2006) performed microfossiliferous analyzes in the central and western Devonian of the Parnaíba basin, resulting in ages from the late Eifelian to late Frasnian for the Pimenteiras Formation. In general, the Pimenteiras Formation is characterized by rocks that were deposited during significant marine transgressions and regressions, covering marine platforms with strong storm influences (Santos & Carvalho, 2004).

Figure 1: Area of occurrence of the Parnaíba Basin.



Source: Adapted from Melo (1988).

PALEONTOLOGICAL BACKGROUND OF TOCANTINS STATE

The first Tocantins Devonian fossil were recorded by Barbosa et al. (1966). On the occasion, the authors mention brachiopods *Chonetoidea* Bronn, 1862, *Spiriferoidea* King, 1846, and *Australocoelia* Boucot & Gill, 1956, from the Pimenteiras Formation, on the right

bank of the Araguaia river. It was in the old village of Santo Antoninho, current city of Ananás (Santos & Carvalho, 2004). Later, Ramos (1967) recorded in the city of Tocantínia the genera *Spirifer* Sowerby, 1818, *Derbyina* Clarke, 1913, *Orbiculoidea* D'Orbigny, 1847, *Chonetes* Fischer de Waldheim, 1830, *Australocoelia* and *Lingula* Bruguière, 1797, the thallophyte *Spongiophyton* Kräusel, 1954, the cnidarian *Conularia* Sowerby, 1820, including tentaculitids.

Ramos & Barbosa (1967) reported the occurrence of *Spirifer* sp, *Derbyina* sp and *Orbiculoidea*? sp close to the Rio dos Mangues; *Tentaculites* sp, *Orbiculoidea* sp, Crinoids, and a bivalve in Tocantínia; *Orbiculoidea* sp, *Conularia* sp and *Australocoelia*? sp in Lajeado; and *Spongiophyton* sp on rocks from the Pimenteira Formation, in the state of Tocantins. Portela et al. (1976) also reported *Spongiophyton* sp in Tocantínia and Novo Acordo. Lima & Leite (1978) found acritarchs as *Maranhites brasiliensis* Brito, 1965, *Duvernaysphaera* sp, *Umbellaphaeridiune* sp, and *Veryachium* sp, also in the Pimenteira Formation, as well as *Ancyrospora* sp, *Nikintiosporites* sp, *Biharisporites* sp, and *Knoxiosporites* sp, with a predominance of *Hymenozotriletes* sp, and *Acarethotriletes* sp.

One of the first reports of ichnofossils in the state of Tocantins was made by Brito (1977). On the occasion, the author described *Asteriacites* sp as associated with ferruginous sandstones in Tocantínia. Assis & Fernandes (1980) and Ferreira & Fernandes (1983) also described ichnofossils (*Bifungites* sp, *Cruziana* sp, *Rusophycus* sp, *Guilielmites* sp, *Neonereites*? sp, *Palaeophycus* sp), and coprolites in black shales from Pimenteira Formation, next to the city of Miranorte.

After a long period without publications about the Devonian of Tocantins, Loboziak, Caputo & Melo (2000) improved the scientific information about Pimenteira Formation presenting a biostratigraphic analyses using miospore from different localities (Paraíso do Tocantins, Palmas, Miranorte, Miracema do Tocantins, Tocantínia, Pedro Afonso, Itacajá, Tupiratis, and Colinas do Tocantins). Later, Grahn, Melo & Loboziak (2006) presented biostratigraphic analyzes of chitinozoan from the Itaim and Pimenteira formations.

Corrêa, Agostinho, Fernandes & Vieira (2004) reviewed the ichnofossils previously published by Ferreira & Fernandes (1983), updating its systematic proposal. In this new perspective, the authors proposed the names *Bifungites* isp, *Nereites* cf. *N. missouriensis* Weller, 1899, *Rusophycus polonica* Seilacher, 1970, *Trichophycus* isp, and “*Guilielmites*” sp. So, Fernandes & Fonseca (2005) reclassified the ichnospecies described by Brito (1977) and the older *Asteriacites* isp became *Asteriacites stelliforme* Miller & Dyer, 1878.

Gama Jr. (2008) collected fossils near the city of Palmas (Estância Cantilena and Fazenda Encantada II), where he identified brachiopods as *Montsenetes carolinae* Fonseca, 2004, *Australocoelia palmata* Morris & Sharpe, 1846, *Delthyridoidea* Phillips, 1841, *Mucrospirifer pedroanus* Rathbun, 1874, *Amphigenia* cf. *A. elongate* Vanuxem, 1842, and *Tropidoleptus carinatus* Conrad, 1839, and crinoids, gastropods, *Conularia* and tentaculites in the Itaim and Pimenteira Formations. According to the author, this was the first occurrence of *M. carolinae*, *A. palmata*, and *M. pedroanus* in the lower part of the Pimenteira Formation.

Scheffler (2010) presented some crinoids from the Pimenteira Formation, such as *Monstrocrinus* sp B, *Exaesiocrinus* sp A, *E. sp B*, *Laudonomphalus* aff. *L. tuberosus*, *L. sp A*, *L. sp B*, *L. sp C*, *L. sp D* and *Marettocrinus*? sp A. A year later, Scheffler, Dias-Da-Silva, Gama

Júnior, Da Fonseca & Fernandes (2011) described for the first time crinoids in the western border of the Parnaíba Basin, in the surrounding area of Palmas. *Monstrocrinus incognitus* Scheffler et al., 2011, Rhodocrinitidae Roemer, 185), *Exaesiocrinus dimerocrinosus* Scheffler et al., 2011, Exaesiocrinidae Moore & Jeffords, 1968, and *Laudonomphalus* aff. *L. tuberosus* Yeltyshva, 1961. Flucticharacidae Moore & Jeffords, 1968 were found in the Estância Cantilena, and Fazenda Encantada II.

Queiroz, Gama Jr & Pires (2013) performed fieldworks on Rio das Balsas, Santa Teresa city, recording the first occurrence of brachiopods, crinoids, and bivalves in this region. In the locality were found *Australocoelia palmata*, *Australospirifer iheringi* Kayser, 1900, and *Tropidoleptus carinatus* in the Pimenteiras Formation. In the same year, the first brachiopod *Orthida* Schuchert & Cooper, 1932 was recorded by Silva & Candeiro (2013), in the central region of Tocantins, between the cities of Aparecida do Rio Negro and Palmas (Table 1).

The most recent papers have a palynological approach. Drilling holes were studied around the cities of Aparecida do Rio Negro, Novo Acordo, and Lagoa de Tocantins, to remake the paleoenvironment. The wells intersect the Itaim, Pimenteiras and Cabeças formations, where chitinozoan, prasinophytes, acritarchs and miospore were recorded, indicating ages from the limit Pragian-Emsian to Famennian (Trindade, Carvalho & Borghi, 2015; Trindade & Carvalho, 2018).

Table 1: Macrofossils of Devonian invertebrates and plants from Tocantins State.

PHYLUM / CLASS	TAXON	LOCATION	AUTHOR
Brachiopoda	<i>Australocoelia</i> sp	Santo Antoninho and Santa Teresa	Barbosa et al. (1966)
	<i>Australocoelia palmata</i>	Palmas	Gama Jr. (2008) Queiroz, Gama Jr & Pires (2013)
	<i>Montsenetes carolinae</i>	Palmas	Gama Jr. (2008)
	<i>Amphigenia</i> cf. <i>A. elongata</i>	Palmas	Gama Jr. (2008)
	<i>Mucrospirifer pedroanus</i>	Palmas	Gama Jr. (2008)
	<i>Australospirifer iheringi</i>	Santa Teresa	Queiroz, Gama Jr & Pires (2013)
	Centroneliidae	Palmas	Gama Jr. (2008)
	<i>Amphigenia</i> sp	Santo Antoninho	Barbosa et al. (1966), Ramos (1967), Gama Jr. (2008)
	Delthyridoidea g. A sp 1	Palmas	Gama Jr. (2008)
	<i>Derbyina</i> sp	Tocantínia	Ramos (1967)
	<i>Lingula</i> sp	Tocantínia	Ramos (1967)
	<i>Orbiculoidea</i> sp	Tocantínia	Ramos (1967)
	<i>Orthida</i> indet.	Aparecida do Rio Negro and Palmas	Silva & Candeiro (2013)
	<i>Tropidoleptus carinatus</i>	Palmas and Santa Teresa	Gama Jr. (2008) Queiroz, Gama Jr & Pires. (2013)
Cnidaria	Conulariidae	Tocantínia	Ramos (1967), Gama Jr. (2008)
Crinoidea	undetermined	Palmas	Gama Jr. (2008) Scheffler (2010)
	<i>Exaesiocrinus dimerocrinosus</i>	Palmas	Scheffler et al. (2011)
	<i>Laudonomphalus</i> aff. <i>L. tuberosus</i>	Palmas	Scheffler et al. (2011)
	<i>Monstrocrinus incognitus</i>	Palmas	Scheffler et al. (2011)

continua

conclusão

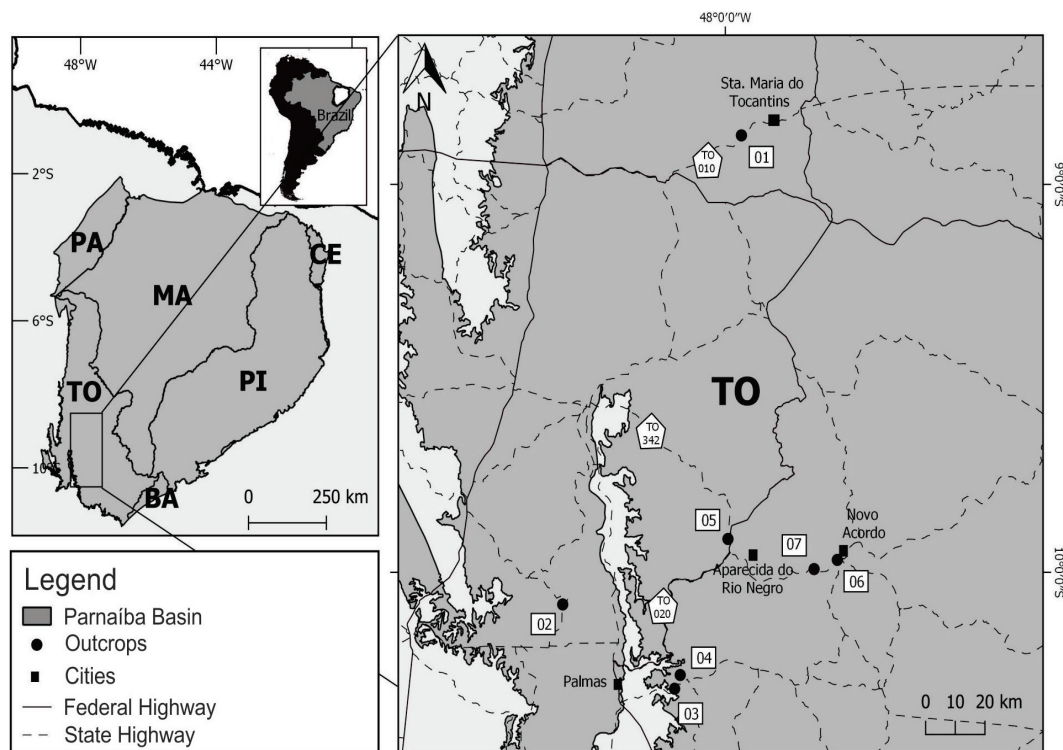
PHYLUM / CLASS	TAXON	LOCATION	AUTHOR
Gastropoda	Undetermined	Palmas	Gama Jr. (2008)
Bivalvia	undetermined	Tocantínia	Ramos & Barbosa (1967)
	undetermined	Santa Teresa	Queiroz, Gama Jr & Pires (2013)
<i>Incertae sedis</i> (Plantae)	<i>Spongiophyton</i> sp	Tocantínia and Novo Acordo	Ramos & Barbosa (1967)

VISITED OUTCROPS

According to the literature there are several fossiliferous outcrops in the state of Tocantins (Kegel, 1953; Barbosa et al., 1966; Ramos, 1967; Assis & Fernandes, 1980; Ferreira & Fernandes, 1983; Góes & Feijó, 1994; Santos & Carvalho, 2004; Vaz et al., 2007; Queiroz, Gama Jr & Pires, 2013). Those could be found in areas close to the cities of Aparecida do Rio Negro, Barrolândia, Bom Jesus do Tocantins, Miracema do Tocantins, Miranorte, Monte Carmo, Novo Acordo, Palmas, Pedro Afonso, and Taquaruçu do Porto.

We have found fossils in 15 outcrops during the fieldwork. Notes comprehended geographic coordinates, outcropping rocks description, and stratigraphic inferences as well as stratigraphic profiles. However, we present just seven outcrops (Fig. 2) once they had the most well-preserved fossils (Table 2).

Figure 2: Outcrop location map where the fossils were collected.



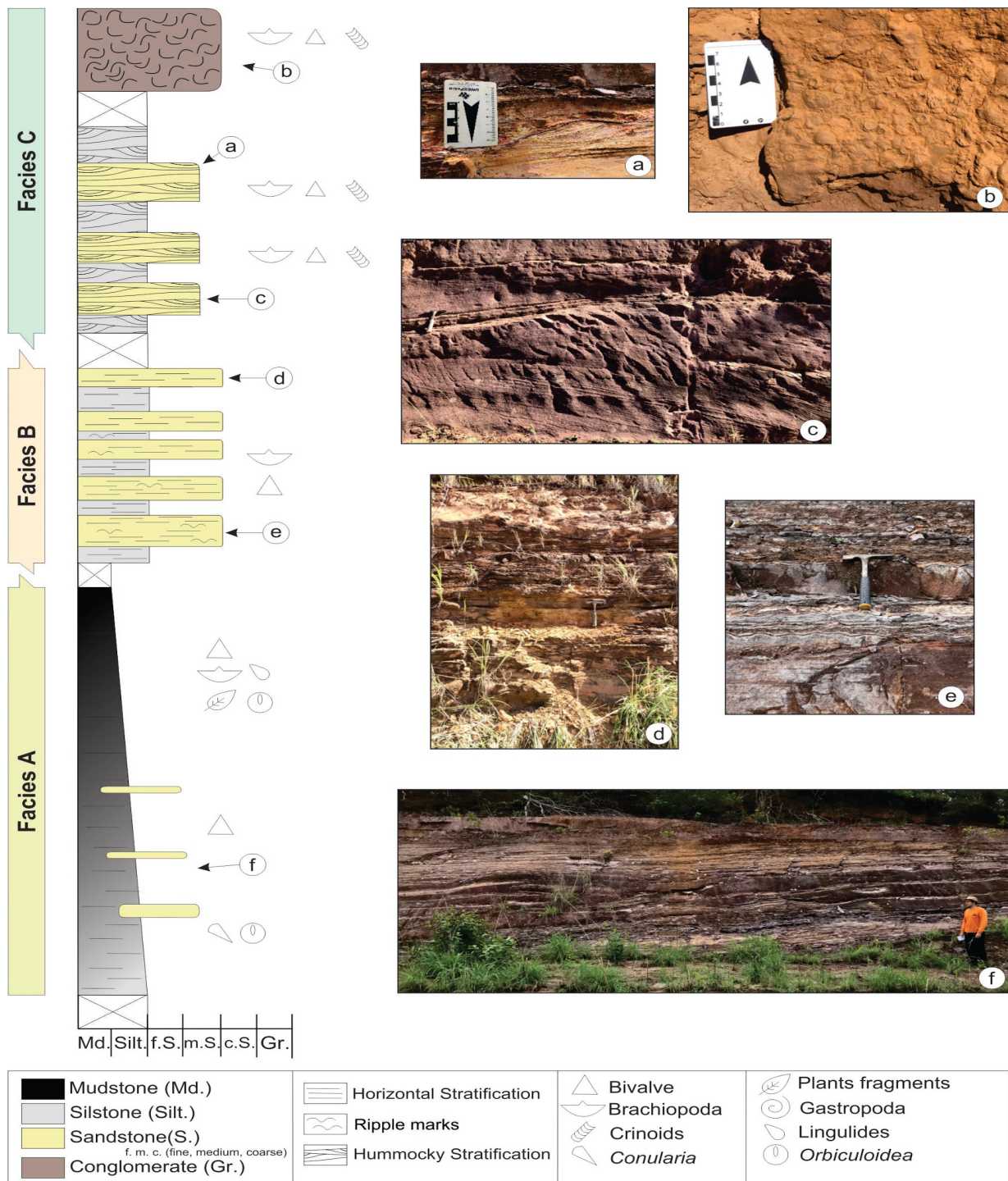
All fossils were collected in rocks of the Pimenteira Formation. This one is characterized as alternating sequences of reddish to yellowish sandstones, siltstones, and purplish to grayish sandstone with varying thickness. The sandstones granulometry range from medium to fine and sedimentary structures has wavy marks, hummocky, crossed stratifications, and incipient wavy marks. On the other hand, in the siltstones are common the plane-parallel stratifications, the wavy marks are rarely found, and the alterations with very fine yellowish sandstone are usually noticed.

Table 2: Outcrops with fossiliferous material presented in this paper.

SPOT	LATITUDE	LONGITUDE	LOCALITY
01	08°52'25,61''S	47°57'17,80''W	Margins of highway TO-010
02	10°04'58,80''S	48°27'15,80''W	Margins of highway TO-348
03	10°18'01,09''S	48°08'30,16''W	Mirante de Taquaruçu
04	10°15'53,50''S	48°07'33,50''W	Fazenda Encantada II
05	09°54'51,20''S	47°59'33,40''W	Margins of highway BR-010
06	09°58'05,20''S	47°41'13,10''W	Margins of highway TO-020
07	09°59'30,40''S	47°45'06,80''W	Margins of highway TO-020

The paleoenvironmental diagenetic processes of the Pimenteira Formation in the studied area present three facies associations. The first one (type A) includes rhythmic alternations of abundant siltstones, clayey, and very fine sandstones with plane-parallel stratifications, deposited by decantation in a low-energy marine environment. The second one (type B) combines finely laminated sandstones and siltstones, with parallel flat stratifications and wavy marks, deposited in a transitional environment. Finally, the third association of facies (type C) is characterized by sandstones with cross-layered hummocky stratifications, deposited by the influence of storm waves on a platform. The fieldwork, as well as the physiological distinctions, drove to a compound section for the Pimenteira Formation showed in Figure 3.

Figure 3: Composite section elaborated from the visited outcrops, where it is possible to notice the distinguished facies. Being a: hummocky cross-stratification; b: rocky pavement containing a great diversity of crinoids; c: large hummocky cross-bedding; d: alternation of siltstone and sandstones of facies B association; e: wavy marks and plane-parallel stratifications in sandstones and lutites; f: physiognomy of type A facies associations.

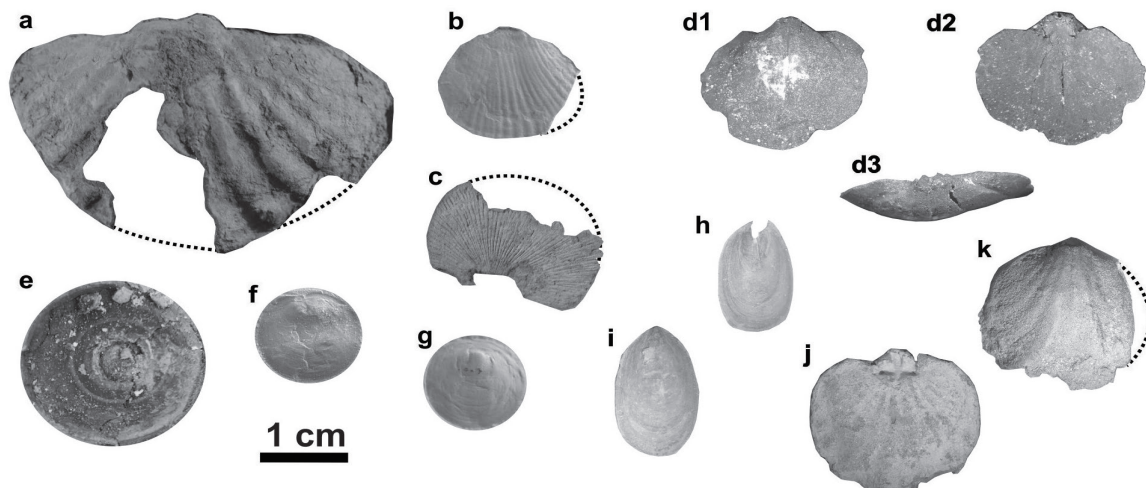


COLLECTED FOSSILS

Fossils collected in the most diverse localities were brachiopods, cnidarians, crinoids, mollusks, and fragments of plants.

Brachiopods could be identified as *Australocoelia* sp, *Australospirifer*? sp, *Schuchertella*? sp, *Derbyina*? sp, *Tropidoleptus carinatus*, infaunal lingulids, and *Orbiculoidea* sp (Fig. 4). It is worth mentioning that Barbosa et al. (1966), Gama Jr. (2008), and Queiroz, Gama Jr & Pires (2013) have already described some specimens of *Australocoelia* sp, *Australospirifer* sp, and *Tropidoleptus carinatus* in Tocantins. However, for the first time, the genus *Schuchertella*? was recorded in the western portion of the Basin.

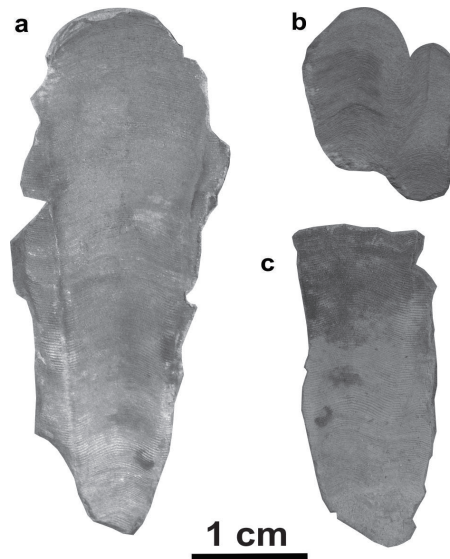
Figure 4: Brachiopods collected in Tocantins: a (peduncular valve of *Australospirifer*? sp, CCLP 1250); b (brachial valve of *Derbyina*? sp, CCLP 1239); c (brachial valve of *Schuchertella*? sp, CCLP 1251); d1 (front view, CCLP 1201.2), d2 (dorsal view, CCLP 1201.2), d3 (posterior view, CCLP 1201.2 of *Tropidoleptus carinatus*); e (photograph taken in the field); f (peduncular valve, CCLP 1240), g (brachial valve of *Orbiculoidea* sp, CCLP 1246); h (CCLP 1228), i (CCLP 1229, infaunal lingulids); j (brachial valve, CCLP 1195.3), k (peduncular valve of *Australocoelia* sp, CCLP 1256). Scale: 1 cm.



Considering the facies associated with the brachiopods, it is possible to notice that *Derbyina*? sp, *Orbiculoidea* sp, and the lingulids were found exclusive in type A facies, from a low-energy marine environment. Furthermore, *Tropidoleptus carinatus* and *Australocoelia* sp were identified in facies type C, whose disposition is related to storm waves on marine platforms. Finally, *Australospirifer*? sp and *Schuchertella*? sp were found in transitional facies B.

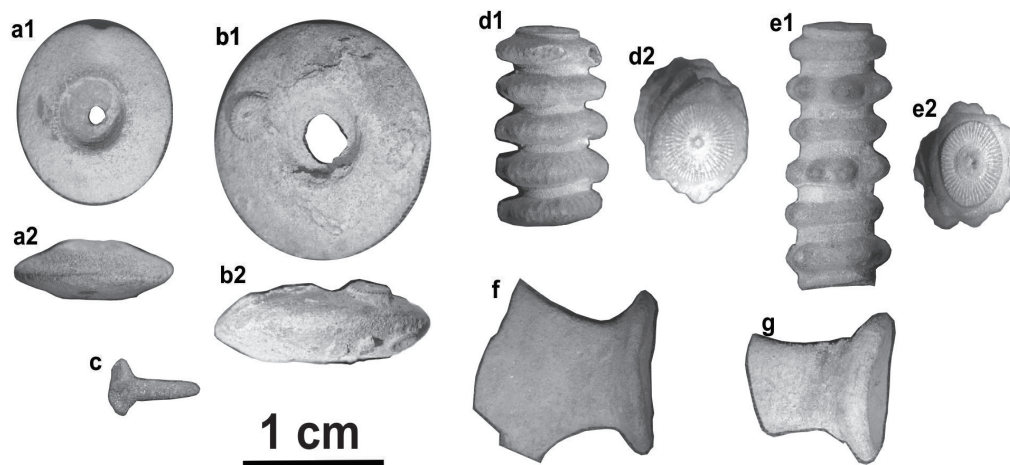
Ramos (1967) and Gama Jr. (2008) reported the first occurrence of conulariids in the Devonian of Tocantins, next to the city of Tocantínia, north of Palmas. Fossils of *Conularia quichua* Ulrich, 1890 (Fig. 5) were found between the cities of Pedro Afonso and Santa Maria do Tocantins, associated with type A facies.

Figure 5: *Conularia quichua*: a (theca with a full face, CCLP 1145); b (two faces of the opening region, CCLP 1138); c (faces with the middle and opening regions, CCLP 1143). Scale: 1 cm.



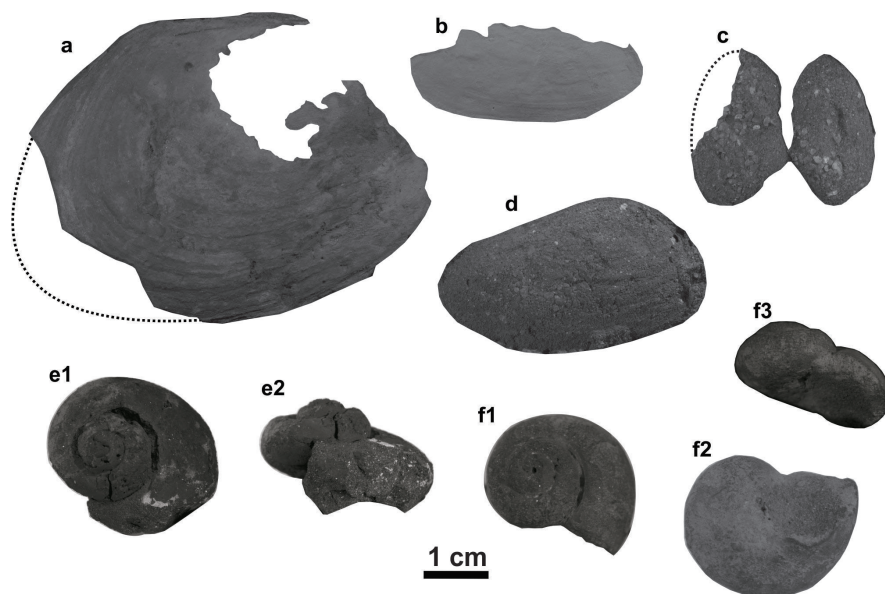
Crinoids were found in type C high energy facies, identified as *Exaesiocrinus dimerocrinosus*, *Laudonomphalus* sp A, *Laudonomphalus* sp C and *Monstrocrinus* sp (Fig. 6). A calycinal plaque with a thorn was also found, which resembles those of the genus *Acanthocrinus* Roemer, 1850. Gama Jr. (2008) had already identified some crinoids for the western portion of the Parnaíba Basin. However, Scheffler et al. (2011) identified and described these organisms taxonomically. Noteworthy is the presence of a column of another species of pedunculated echinoderm, which has not yet been described for formation. The specimen is anchored in the disjointed column of *E. dimerocrinosus*, which demonstrates the permanence of these columns on the seabed before the final burial, being used as a substrate for fixation.

Figure 6: Crinoids found during fieldworks: a1 (CCLP 1193.3), a2 (CCLP 1193.4), b1 (CCLP 1194.3), b2 (CCLP 1194.5, *Exaesiocrinus dimerocrinosus*); c (calycinal plaque with spine, similar to the genus *Acanthocrinus*, CCLP 1193.6); d1, d2 (*Laudonomphalus* sp A, CCLP 1194.1), e1, e2 (*Laudonomphalus* sp C, CCLP 1194.2); f (CCLP 1193.1) e g (*Monstrocrinus* sp, CCLP 1193.2). Scale: 1 cm



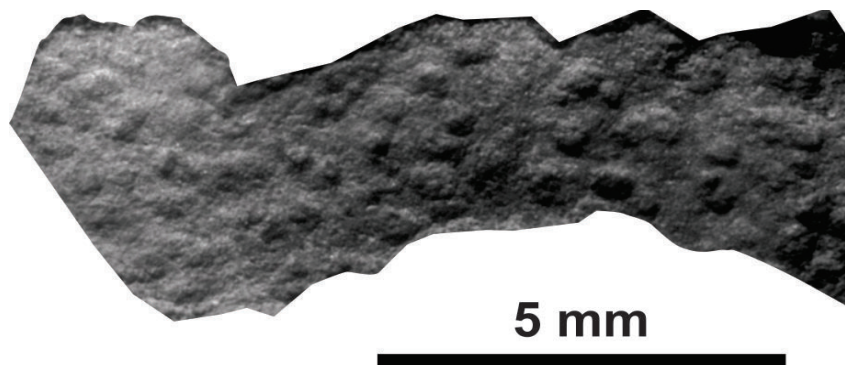
Few studies have addressed the occurrence of mollusks in Devonian rocks in the state of Tocantins. Bivalves were found in different localities and facies associations. In low energy facies (type A) were found *Nuculites?* Conrad, 1841 and *Sanguinolites* M'Coy, 1844, in addition to an unidentified bivalve. On the other hand, in type C facies, the gastropod *Platyceras* sp was found. Finally, a specimen of *Palaeoneilo* Hall & Whitfield, 1869 was found in type B facies (Fig. 7).

Figure 7: Mollusks found during fieldworks: a (right valve in lateral view of *Palaeoneilo* sp, CCLP 1253); b (right valve in lateral view of *Nuculites?* sp, CCLP 1247); c (articulated valves in a side view of unidentified bivalve, CCLP 1197); d (right valve in lateral view of *Sanguinolites* sp, CCLP 1196); e (e1 – dorsal view; e2 – side view of *Platyceras* sp, CCLP 1202); f (f1 – dorsal view; f2 – basal view; f3 – side view of *Platyceras* sp, CCLP 1255). Scale: 1 cm.



Some examples of Devonian plants were found in the vicinity of Tocantínia and Novo Acordo, where Ramos (1967) and Portela et al. (1976) indicated occurrences of *Spongiophyton* sp. The occurrence of this taxon was restricted to the species *Spongiophyton lenticularis* (Barbosa) Kräusel 1954, found in low energy facies (Fig.8).

Figure 8: Plant sampled, *Spongiophyton lenticularis*, CCLP 1173. Scale: 5,0 mm.



Among the fossils found in the Tocantins, *Australocoelia* sp was found in locality number 4, *Derbyina?* sp in the locality 7, *Australospirifer?* sp in 5, lingulids in locality 7, *Orbiculoidea* sp at 1, 6 and 7, *Tropidoleptus carinatus* at locality 4 and 5, and finally *Schuchertella?* sp at location number 5. Cnidaria, which at first were reported only in the vicinity of Tocantínia, were found in abundance at the locality named 1, identified as *Conularia quichua*. The crinoids (*Exaesiocrinus dimerocrinosus*, *Laudonomphalus* sp A, L. sp C, *Achantocrinus?* sp and *Monstrocrinus* sp) were only found in one location, named here number 4, associated with species of brachiopods and gastropods. Lastly, bivalves were found in different locations. *Nuculites?* sp in locality number 7, *Palaeoneilo* sp at number 5, *Sanguinolites* sp and unidentified molluscs in location 2. The plants (*Spongiophyton lenticularis*) were collected in locality number 3 and 7 (Table 3).

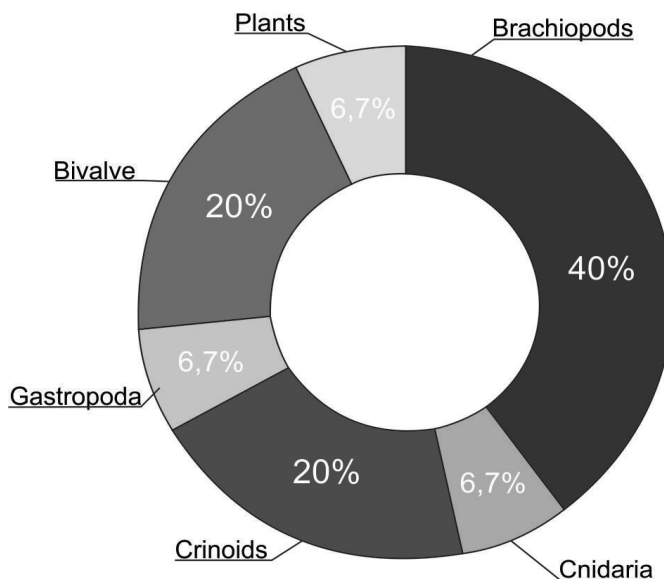
Table 3: Fossils collected during fieldworks and presented on this paper.

PHYLUM/ CLASS	TAXON	COLLECTED SPOT	FACIES
Brachiopoda	<i>Australocoelia</i> sp	4	C
	<i>Australospirifer?</i> sp	5	B
	<i>Derbyina?</i> sp	7	A
	infaunal lingulids	7	A
	<i>Orbiculoidea</i> sp	1	A
		6	A
		7	A
	<i>Tropidoleptus carinatus</i>	4	C
		5	C
	<i>Schuchertella?</i> sp	5	B
Cnidaria	<i>Conularia quichua</i>	1	A
Crinoidea	<i>Exaesiocrinus dimerocrinosus</i>	4	C
	<i>Laudonomphalus</i> sp A	4	C
	<i>Laudonomphalus</i> sp C	4	C
	<i>Monstrocrinus</i> sp	4	C
Gastropoda	<i>Platyceras</i> sp	4	C
Bivalvia	<i>Nuculites?</i> sp	7	A
	<i>Sanguinolites</i> sp	2	A
	<i>Palaeoneilo</i> sp	5	B
	Undetermined	2	A
<i>Incertae sedis</i> (Plantae)	<i>Spongiophyton lenticularis</i>	7	A

FINAL REMARKS

Among the several macrofossils presented in this paper, brachiopods have the highest taxonomic diversity - it compounds approximately 40% of fossils found during fieldworks in the state of Tocantins. Crinoids and bivalves correspond to 20% of taxonomic diversity each, followed by 6,7% of gastropoda, cnidaria, and plants (Fig. 9).

Figure 9: Taxonomic diversity of Devonian fossils from Tocantins.

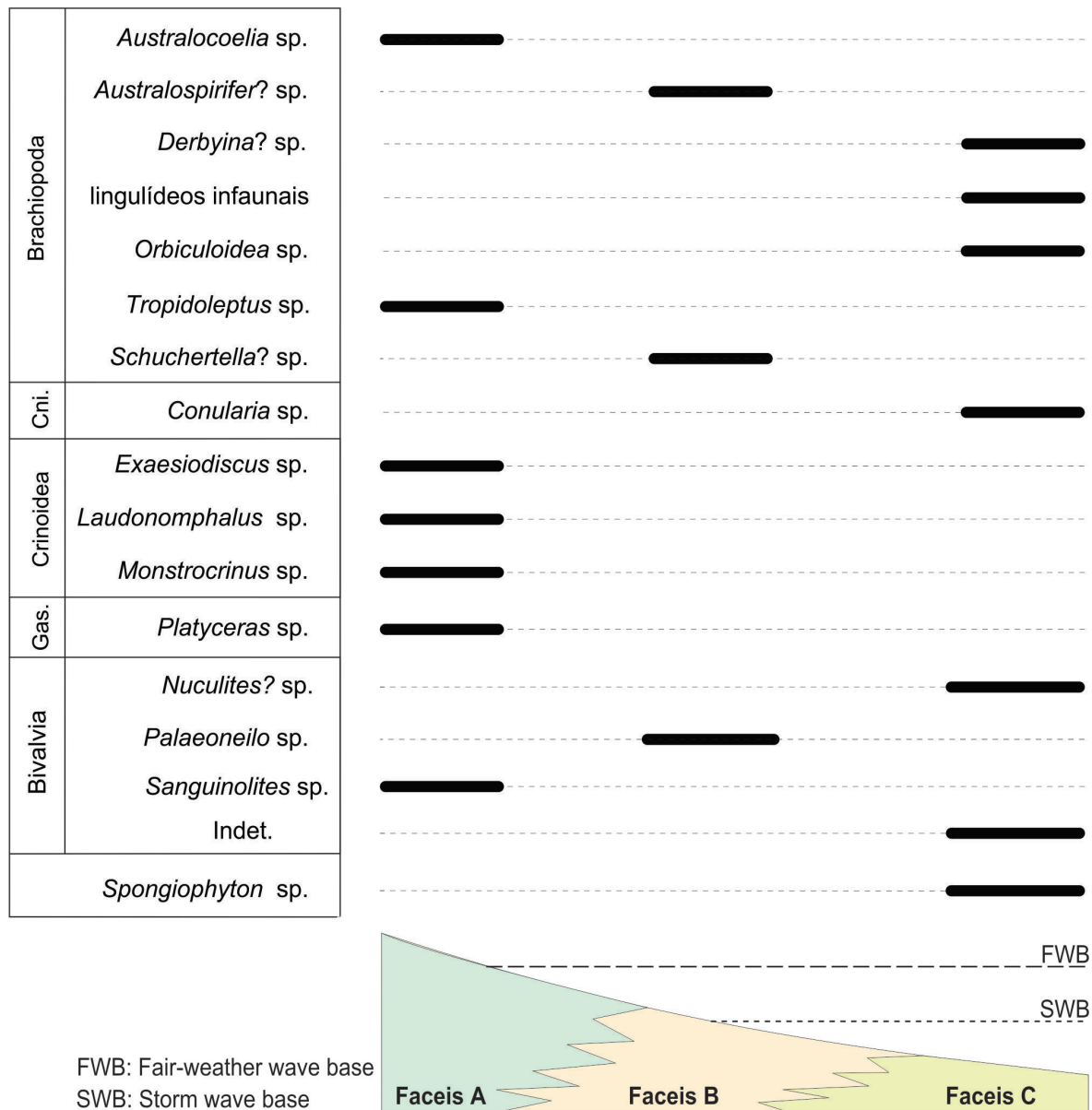


Paleontological studies about Devonian invertebrates in Brazil are less common when compared to other areas of Paleontology. This paper aims to gather more information about the South American Devonian fossils, as well as highlight the new fossiliferous occurrences in the western portion of the Parnaíba Basin. It is noticeable an increasing number of fossiliferous occurrences in the state of Tocantins, comparing to the previous taxonomic diversity data. The new occurrences of brachiopods (*Schuchertella?* sp), cnidaria (*Conularia quichua*), mollusks (*Platyceras* sp, *Nuculites?* sp, *Palaeoneilo* sp and *Sanguinolites* sp), and plants (*Spongiophyton lenticularis*) highlight the importance of the Parnaíba Basin for South American Devonian studies and point how poor the current knowledge of its western border is. In general, the Parnaíba Basin hosted great variety of fossils during the Devonian age, with great importance for the South American platform. The outcrops on the eastern edge of the basin have been explored since 1940, however, in the western side, just a little has been made. This work revives Devonian paleontological studies with macrofossils in the state of Tocantins, as well as enhancing the existing research in the region.

Taking into consideration the depositional facies (types A, B, and C), the taxa *Derbyina?*, infaunal lingulids, *Orbiculoidea*, *Conularia quichua*, *Sanguinolites*, *Nuculites?*, and *Spongiophyton* were found exclusively in facies with low energy, type A. The taxa *Australocoelia*, *Tropidoleptus carinatus*, *Exaesiocrinus dimerocrinosus*, *Laudonomphalus*, *Monstrocrinus*, and *Platyceras* were found in high energy depositional facies type C. Finally, taxa *Australospirifer?*, *Schuchertella?*, and *Palaeoneilo* were found in the transitional facies type B (Fig. 10).

The occurrences of *Tropidoleptus carinatus* in the Devonian of Tocantins can infer the Eifelian-Frasnian age. This Brachiopoda has its origin in the European basins during the Lochkovian, and just during the Middle Devonian, it gets a great widely paleogeographic distribution, because of Devonian climatic changes.

Figure 10: Facies association (A, B, and C) with their corresponded fossiliferous occurrences.



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