

First occurrence of *Ellisonia*, *Gondolella* and *Ubinates* (Conodonts) in Itaituba Formation, Pennsylvanian of Amazonas Basin, Brazil

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ABSTRACT

This paper analyzes and describes a first occurrence of the conodonts *Ellisonia*, *Gondolella* and *Ubinates* in Amazonas Basin, North of Brazil. The recovered material comes from two outcrops along the Tapajós River and from a limestone quarry of Itaituba Formation, whose levels are included in the Itaituba Formation, with a Pennsylvanian age. Those conodonts are relevant paleoecological indicators of water depth, salinity and environmental energy and have implications in the Late Carboniferous to Triassic biostratigraphy. The fossil remains represent M and S conodont elements, associated to Pa elements of the *Idiognathodus*, *Idiognathoides*, *Neognathodus*, *Adetognathus*, *Hindeodus* and *Diplognathodus* genus.

Key words: conodonts, Amazonas Basin, Itaituba Formation, Pennsylvanian.

RESUMO

PRIMEIRA OCORRÊNCIA DOS GÊNEROS *ELLISONIA*, *GONDOLELLA* E *UBINATES* (CONODONTOS) PARA A FORMAÇÃO ITAITUBA, PENNSILVIANO DA BACIA DO AMAZONAS, BRASIL. Formas inéditas de conodontes dos gêneros *Ellisonia*, *Gondolella* e *Ubinates* são descritas para a Bacia do Amazonas, Brasil. O material amostrado é proveniente de dois afloramentos junto ao Rio Tapajós e de uma pedreira de calcário, cujos níveis foram atribuídos à Formação Itaituba, Pensilvaniano da Bacia do Amazonas. As formas de conodontes descritas são indicadores paleoambientais de profundidade da lâmina de água, salinidade e energia do ambiente e apresentam relevância bioestratigráfica mundial, principalmente entre o final do Carbonífero e Triássico. No material analisado, esses conodontes são representados por elementos M e S, associados a elementos plataformados dos gêneros *Idiognathodus*, *Idiognathoides*, *Neognathodus*, *Adetognathus*, *Hindeodus* e *Diplognathodus*.

Palavras-chave: conodontes, Bacia do Amazonas, Formação Itaituba, pensilvaniano.

INTRODUCTION

The record of conodonts in Brazil is known from the Paleozoic strata of Amazonas, Solimões, Parnaíba, Acre and

Paraná sedimentary basins. However, its main fossil occurrence is that registered in the Pennsylvanian marine deposits from the Itaituba Formation, Tapajós Group, at Amazonas Basin.

The first reference to conodonts in Brazil and Itaituba Formation was due to Fúlvaro (1965). Since then conodonts have proven relevant for biostratigraphic and paleoecologic

studies, as noted by Lemos and Medeiros (1996), Silva and Lemos (1996), Lemos and Scomazzon (2001), Nascimento *et al.* (2005) and Scomazzon and Lemos (2005).

The Itaituba Formation includes the thickest carbonate packages among the Tapajós Group, and the most abundant in conodonts. The conodont genera found there commonly include *Idiognathodus*, *Idiognathoides*, *Neognathodus*, *Adetognathus*, *Hindeodus*, *Diplognathodus*, *Idioproniodus* and, in recent addition to those, the herein presented *Ellisonia*, *Gondolella* and *Ubinates*. These associations are useful to the correlations with North American Pennsylvanian strata, mainly in the Midcontinent Region. In this paper it is furnished a first description of *Ellisonia*, *Gondolella* and *Ubinates* conodont genera in these deposits from Brazil.

LOCATION AND GEOLOGY

The intracratonic Amazonas Basin (Figure 1) has an area of 600.000 km², with sedimentary deposition from Cambrian to Tertiary forming a 6000 m thick sedimentary package. The Carboniferous-Permian sedimentary rocks, approximately 2000 m thick, relate to the trans-regressive marine and continental deposits of the

Tapajós Group (Caputo, 1984). The Itaituba Formation, estimated by conodonts an Atokan – early Desmoinesian age, includes mainly carbonates and evaporites with intercalated clastic deposits from tidal environments.

The study area is situated in the latitude 04°16'34", longitude 55°59' and comprises a limestone quarry (P2) owned by ITACIMPASA Cement Industry - located forty kilometers from the city of Itaituba and two outcrops along the Tapajós River (TAPCX and TAPTV), at the southern portion of the Amazonas Basin, Pará State, northern Brazil (Figure 2).

MATERIAL

Twenty five kilograms of sedimentary rock, consisting mainly of carbonates and shales, were processed using about 300g per each sample, and in accordance to Austin's (1987) methodology.

Ellisonia were recovered at TAPTV, TAPCX and P2. *Ubinates* and *Gondolella* were found at P2 (Table 1). The total of twelve elements studied herein is deposited at the Paleontology and Stratigraphy Department of the Geosciences Institute (UFRGS) under acronym MP.

SISTEMATIC PALEONTOLOGY

Order CONODONTOPHORIDA
Eichenberg, 1930

Family ELLISONIDAE Clark, 1972
Genus *Ellisonia* Müller, 1956

Ellisonia conflexa von Bitter and Merrill, 1983

(Figure 3A-3C)

Material. One *Sc* element.

Description. *Sc* element with prominent central cusp and pronounced curve, presenting spaces between cusp and nearest denticle. There are six denticles varying in size, some curved, and others straight, following the curvature of the *Sc* element. Shallow, elongated, sinuous basal cavity, having a strongly marked groove. *Ellisonia conflexa* retains most of its processes and denticula, besides presenting a well preserved basal cavity, relatively shallow and non-everted. The external structure of the element is similar to that of the neurodont conodonts (von Bitter and Merrill, 1983).

Ellisonia latilaminata von Bitter and Merrill, 1983
(Figure 3D-3F)

Material. Seven specimens of *S* elements.

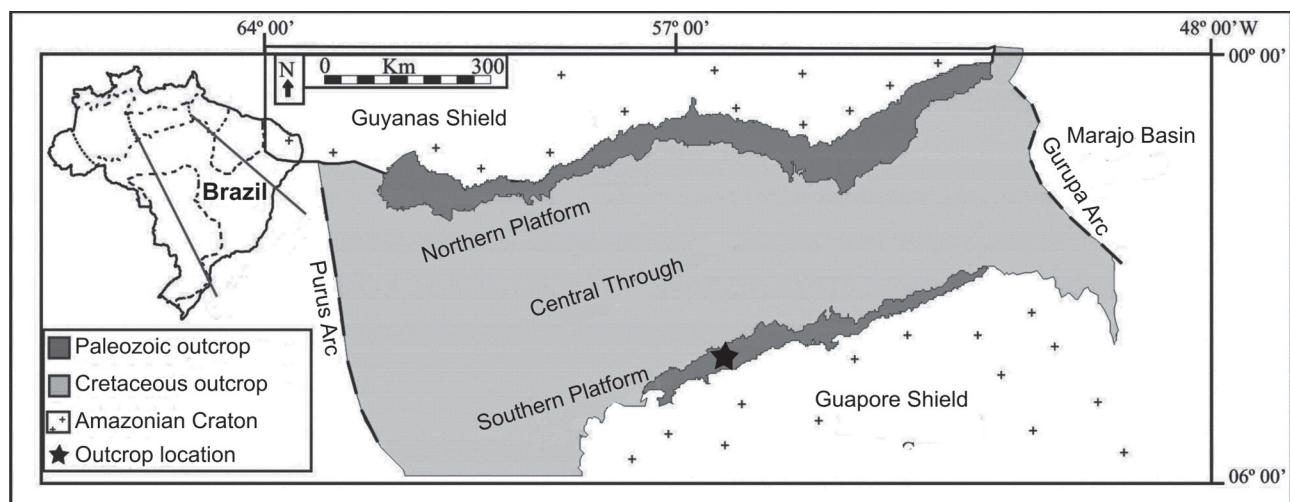


Figure 1. Location map of Amazonas Basin. The star indicates the studied area. Modified from Scomazzon (2004).

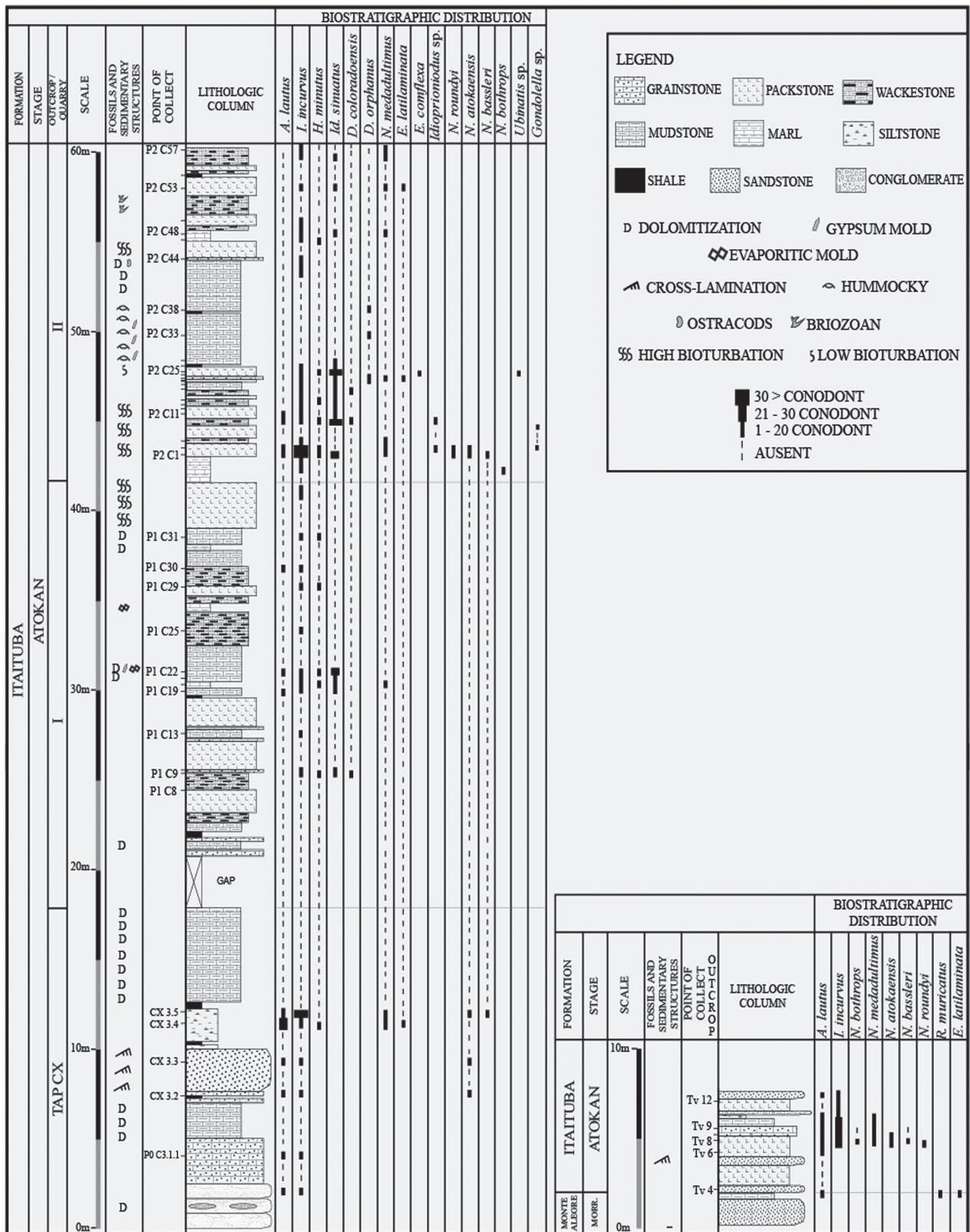


Figure 2. Stratigraphic section of the analyzed profile to the Itaituba Formation, located at south Pará State, Amazonas Basin, including TAPCX, TAPTIV and P2 outcrop sections.

Table 1. Conodonts distribution in TAPTIV, TAPCX and P2 studied outcrops.

Samples / conodonts	<i>Ellisonia latilaminata</i>	<i>Ellisonia conflexa</i>	<i>Ubinates</i> sp.	<i>Gondolella</i> sp.
P2C53	1			
P2C25	1	1	1	
P2 P2C24	1			
P2C9				1
P2C2				1
TAPCX3.4	3			
TAPTIV4	1	1		

Description. Extremely curved central cusp and everted basal cavity, with remains of a large denticle besides the cuspid. It was not possible to determine whether it is a Sc or a Sa element, due to its poor state of preservation. *Ellisonia latilaminata* does not present well preserved processes or denticles, having however everted portions of its basal cavity, which were helpful to its classification.

Discussion. *Ellisonia* was established by Müller (1956) based on bilaterally symmetrical conodont elements from the Early Triassic of the *Meekoceras* Zone, Nevada. Sweet (1970a, 1970b) reconstituted the apparatus of the type species *E. triassica* and included four types of elements in the apparatus of this species. Pennsylvanian species of *Ellisonia* are internally and externally similar to the neurodont conodonts, a group that was common during the Ordovician (von Bitter and Merrill, 1983). The first representatives of the Pennsylvanian Ellisonidae were interpreted by von Bitter and Merrill (1983) as two species of *Ellisonia* which appeared during the Atokan. The Pennsylvanian Ellisonidae, although rare, are of fundamental importance since they represent a lineage which survived the Early Permian crisis (Clark, 1972). The last occurrences of *Ellisonia* date from Late Triassic (Sweet, 1988).

Many *Ellisonia* spp. have eversion of the basal cavity as their main characteristic. *Ellisonia* has elements similar to those of *Idioproniodus*, making it difficult to reconstruct both apparatus, which leads to mistakes in classification. Nevertheless, *Ellisonia* differs from *Idioproniodus* in the

strength of its processes, the larger spaces between denticula and specific details in the basal cavity, since the *Idioproniodus* basal cavity is never everted.

In the architecture of their skeletal apparatuses, species of *Ellisonia* are similar to those species of *Idioproniodus*, from which they almost certainly developed (Sweet, 1988).

In North America *Ellisonia* spp. are most common in shallow-water biofacies. Von Bitter and Merrill (1985) provided two contrasting depositional hypotheses (one shallow, another deep) for *Idioproniodus*. Thus, in Illinois, Merrill (1980) interpreted *Idioproniodus* and *Gondolella* to be shallow water species, whereas von Bitter (1976) working further west in Kansas interpreted them to be deep water species. In the Ames Member (Conemaugh Group, Virgilian) in the Huntington area of West Virginia, the greatest number of species of *Ellisonia* occurs in the complex of barrier-lagoon-tidal-flat environments (Merrill, 1973). More recent consideration of Pennsylvanian conodont palaeoecology is discussed in Joachimski *et al.* (2006).

The two species of *Ellisonia* herein described, *Ellisonia conflexa* and *Ellisonia latilaminata* were classified by considering their external morphology, the shape of their basal cavity and existing processes. *Ellisonia conflexa* and *E. latilaminata* were distinguished from each other based in the fact that the former has a well-defined basal cavity and the latter exhibits a strongly everted basal cavity in individual elements, according to von Bitter and Merrill (1983).

Order CONODONTOPHORIDA
Eichenberg, 1930

Family GONDOLELLIDAE
Lindstrom, 1970

Genus *Gondolella* Stauffer
and Plummer, 1932

Gondolella sp.
(Figure 3G-3J)

Material. Two *M* elements.

Description. *M* element with carina and denticles well developed. Cuspid elongated and forwarded curved. Carina thin and well developed.

Discussion. *Gondolella* was defined by Stauffer and Plummer (1932) and it is known from Pennsylvanian to Triassic. This genus is the most restrict of Pennsylvanian, despite the fact that it normally occurs in abundance of elements, it is absent in the majority of world stratigraphic profiles. In general it is found in samples with an expressive amount of *Idioproniodus*, although not being found in samples in which *Ubinates* amount is higher than *Idioproniodus* (Merrill and King, 1971). *Gondolella* occurs in western North America (Youngquist *et al.*, 1951; Clark and Ethington, 1962; Rhodes, 1963), Greenland and Sicily (Bender and Stopel, 1965), China (Ching and Jin, 1960).

The *M* elements of *Gondolella* found in this study are similar to those of *Idioproniodus*, but they are also similar with the descriptions and illustrations of *M* elements of *Gondolella* of von Bitter (1976), Merrill (1980), and von Bitter and Merrill (1998). Then, after some discussions with these authors the herein specimens were established as *Gondolella M* elements.

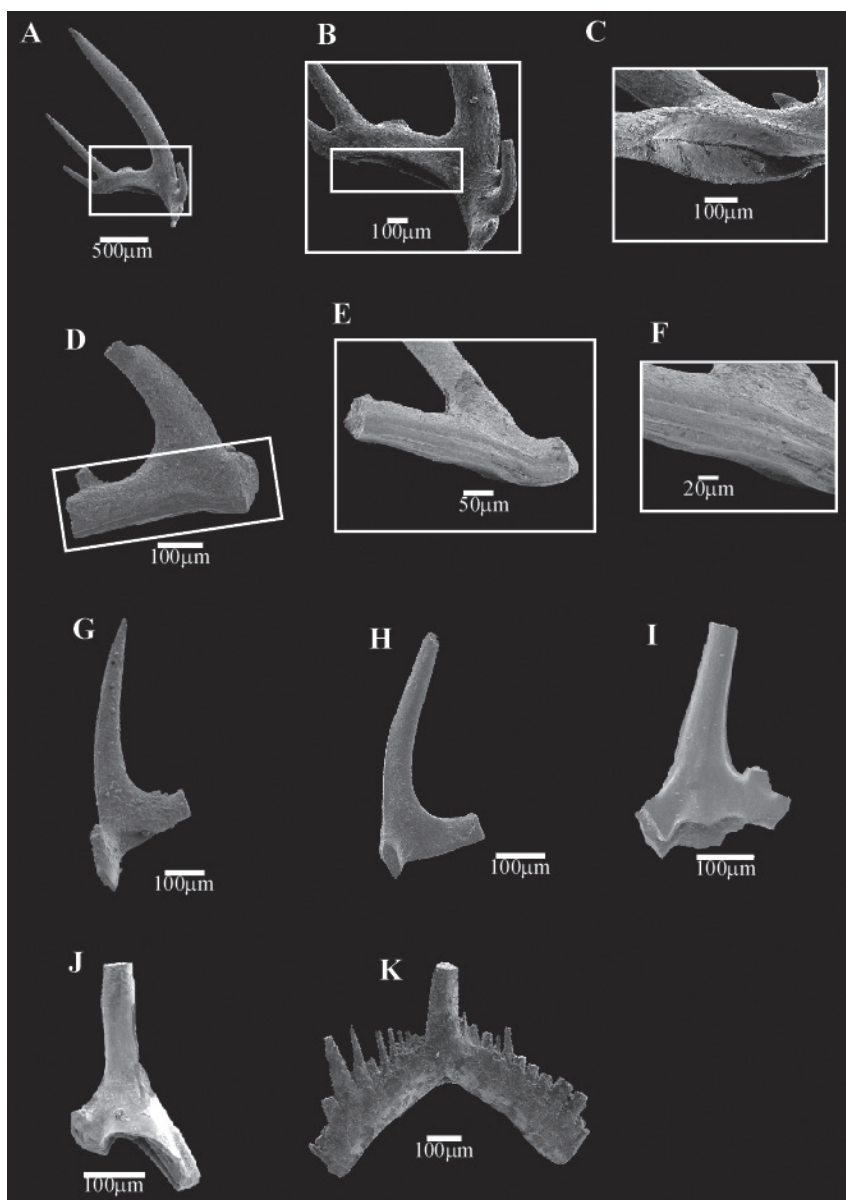


Figure 3. A-C *Ellisonia conflexa* MP-M 717; (A - 43X, B - 110X, C-140X); D-F *Ellisonia latilaminata* MP-M 718 (D-190X), (E-270X), (F-650X); G-H *Ellisonia latilaminata* MP-M 724 (160X), MP-M 719 (150X); I-J *Gondolella* sp. MP-M 725 (230X), *Gondolella* sp. MP-M 729 (250X) and K *Ubinates* sp. MP-M 726 (130X).

Genus *Ubinates* Baesemann and Purnell, 2000

Ubinates advena (Baesemann, 1973)
(Figure 3K)

Material. One *Sa* element.

Description. In lateral view, anterior process is laterally compressed, deflected downward denticles in the process, the second denticle from

the cusp is the largest. Pit expanded inward.

Discussion. The unique element recovered show features described by *Ubinates*. *Sa* element symmetric and well preserved Baesemann (1973) erected the genus *Aetbotaxis* to accommodate morphological distinctive conodont elements from the Pennsylvanian (Missourian) of northeaster Kansas.

The recent change in the name of *Aetbotaxis* to *Ubinates* is due to discovery of the previous use of the name by a notothenioid perciform fish *Aetbotaxis* Dewitt, 1962. Baesemann and Purnell (2000) proposed the name *Ubinates* which comes from latin *ubi*, meaning where (interrogative), and *nates* meaning rump; this refers to the fact that it is not known which, if any, of the elements presently assigned to species of *Ubinates* occupied the posterior positions in the apparatus. The type species of *Ubinates* is *U. advena* by original designation (Baesemann, 1973). Herein it was found only one specimen of *Sa* element showing the general aspects described by *Ubinates*.

Swade (1985) recognized that *Ubinates* is strongly restricted to carbonate lithotopes representing oxygenated conditions in the photic zone, and its occurrence in carbonate shales that separated limestone beds may suggested that it was somewhat more tolerant to turbid waters than *Hindeodus*, for example; conodont genera that generally appear to range farther onshore.

ENVIRONMENTAL DISTRIBUTION

Conodont associations in this study reflect a shallow shelf, marine environment of low to moderately energy. *Idiognathobodus* is the dominant genus throughout the interval studied. According to Merrill and von Bitter (1976), the *Idiognathobodus*-biofacies dominate most Pennsylvanian sedimentary rocks, and represents shallow open, normal marine offshore deposits.

According to Merrill and von Bitter (1984) *Ellisonia* is characteristic of restricted environments of low salinity and it occurs commonly in associations with *Adetognathus* elements.

Merrill and von Bitter (1976) suggested that *Ubinates* was inhabitant largely in clear water, shallow-water biofacies, normal to somewhat reduced salinity, generally high pH environments that commonly show evidence of high energy areas with open circulation above wave base that overlaps *Adetognathus* biofacies.

In the studied section the *M* elements of *Ellisonia* and *Sa* element of *Ubinates*

are in a succession of *packstone/grainstone* facies (P2C24, C25 and C53), indicators of relatively shallow waters associated with *Idiognathodus*, *Idiognathoides* and rare *Hindeodus* and *Neognathodus*.

Gondolella, in contrast, is typical of deeper waters and low energy (Merrill and von Bitter, 1976). This is considered environmentally the most restricted genus of Pennsylvanian, characterizing a relatively deep-water biofacies, low pH, overlapping the *Idioproniodus* one, in which this one is also very common (Sweet, 1988).

Herein the *M* specimens of *Gondolella* were found at P2C2 and P2C9 levels in association with *Idiognathodus*, *Neognathodus* and *Hindeodus* and rare *Adetognathus* (P2C2) and with *Idiognathodus*, *Idiognathoides*, *Idioproniodus*, *Neognathodus*, *Hindeodus* and rare *Adetognathus* and *Diplognathodus* (P2C9), in an environmental context of lower intertidal/infratidal *wackestones* suggested to these horizons.

CONCLUSIONS

The occurrence of *Ellisonia*, *Gondolella* and *Ubinates* in the Amazonas Basin is important to the correlations with strata from other locations, especially with those of the North American Midcontinent.

The taxonomic study of conodonts is based, in general, on individual elements and for biostratigraphic consideration, special to Carboniferous, in *Pa* elements, despite the diversity of other elements as *M* and *S* so far, in the conodont apparatus. However, the absence of *Pa* elements, in the studied herein genera, determined the use of ramiform *M* and *S* elements described.

One of the difficulties in the study of *Ellisonia* concerns to its scarcity in the Pennsylvanian, despite being of great importance as a surviving lineage from the Permian crisis and precursor of Triassic *Ellisonidae*. Seven specimens of *Ellisonia latilaminata* and one of *Ellisonia conflexa* were found in the shallow water deposits of P2, TAPTV and TAPCX localities in the Itaituba Formation, Pennsylvanian of

Amazonas Basin. *Ellisonia conflexa* has an external structure and its well preserved processes and denticles were essential to its classification. The totally everted basal cavity of *Ellisonia latilaminata* was the main characteristic used in its systematic classification.

Gondolella corresponds to deep water and black shales biofacies. Its scarcity with two specimens in the studied area reveals the shallow water conditions of these sedimentary deposits and also is reflect of its general scarcity in the world during the Pennsylvanian – Early Permian crisis; as well as *Ubinates* in which only one specimen was found in shallow and high energy water conditions in the analyzed section.

Finally, this paper brings information to corroborate biostratigraphic and mainly paleoecological information to the analyzed stratigraphic profile. The great importance of this paper though is in the recognition of the genera herein, for the first time, confirmed in a Paleozoic Brazilian basin despite of the difficulties to recognize their main characteristics.

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