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Ichthyoarcheological investigation at Los Bananos site, alluvial plain of Middle Paraná River (Goya, Corrientes, Argentina)

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ABSTRACT

This paper presents the analysis of the ichtyoarchaeological record from Los Bananos site (Goya, Corrientes, Argentine). The aim of this study is to render a first evaluation to the role played by fish in subsistence during subsequent occupations of the site. The site is located in the alluvial plain of Middle Paraná River, beside Paraná Miní creek, and it has provided new information about pottery and lithic technology, subsistence, chronology (^{14}C), site formation processes, etc. Bones from Los Bananos have been divided into three assemblages (LB1, LB2 and LB3), according to associated cultural materials. The pre-Hispanic populations that occupied this area by the end of the Late Holocene based their subsistence in hunting, gathering and fishing. Also, the makers of a distinctive ceramic ware associated with LB1 assemblage (related to Goya-Malabrigo entity -*lato sensu*-), relied on small-scale horticulture. Preceding materials of the other sets (LB2 and LB3) do not present necessary characteristics for cultural association as shown in LB1. The assemblages will be discussed in sequence of their deposition; and compared with results from other related sites. The results of zooarchaeological and taphonomic analysis of the faunal remains suggest that fish was an important resource in LB1. While from LB3 analysis, we will see that fish constituted a complementary resource in the diet. Thus, we can infer that, the role of animals in the diet of the site's prehistoric inhabitants changed during the time deposits were laid.

1. Introduction

Both, early general outlines involving Argentinean Northeastern region and more recent research work, agree on identifying an occupation dating from 2000 BC to the European Conquest in the Middle Paraná River. This occupation is assigned to the Goya-Malabrigo archaeological entity (Ceruti, 2003; Politis and Bonomo, 2012) having the following characteristics: a) a settlement pattern linked to raised and non-flooding landforms (caused by natural processes and/or anthropic activities) associated with water courses; b) an adapting pattern oriented to exploitation of river environments, with specialized associated technology (harpoons, nets, canoes), which implied hunting local mammals (river otters and marsh deer), fishing and horticulture (*i. e.* maize –*Zea mays*–, beans -*Phaseolus vulgaris*- and squashes -*Curcubita*-) (e.g. Acosta and Loponte, 2002–04; Bonomo et al., 2011); c) the presence of different technologies, such as pottery (characterized by zoomorphic appendages), lithic (grinding and chipping tools) and bone (especially antler points). Fishing played an important role for the subsistence of societies living in different areas in Northeastern Argentina (*i. e.* alluvial plain, Paraná River delta) (Pérez Jimeno, 2007; Musali, 2010; Politis and Leon, 2010).

Until the beginning of the present century, there was very little archaeological information available from alluvial plains in southeast Corrientes. Such findings describe ceramic material without taking into consideration the analysis of faunal remains and their relation to the subsistence of the groups which inhabited the area previous to the arrival of the first Europeans (Ambrosetti, 1894; Aparicio, 1948; Lafon, 1971; Rodríguez, 1998-1999, 2008).

Systematic research in southwest Corrientes Province began in 2007 and since then, there have been many contributions on different aspects of the societies who inhabited this area, such as pottery and lithic technology, subsistence, chronology, site formation processes, among others (Barboza et al., 2009; Barboza and Píccoli, 2011, 2013; Barboza, 2014; Barboza and Martín, 2014; Píccoli, 2014, etc.). In order to evaluate the importance of fish for the subsistence of societies who inhabited the alluvial plain of the

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middle part of Paraná River, this investigation shows the analysis results on the ichthyoarchaeological assemblage from Los Bananos site. Thus, general aspects of the archeofaunal record are described to render information referred to subsistence, with special emphasis on fish consumption. As well as taxonomic and anatomic identification and quantification, different taphonomical aspects were assessed.

2. Regional setting

Los Bananos site (LBS) lies on a low hill on the left bank of the alluvial plain of middle Paraná River. It belongs to the low terrace bordering Paraná Miní stream, which has a changing dynamics, directly related to Paraná River and its tributaries (Fig. 1). This terrace is characterized by a marked hydrophilic environment subjected to hydro-sedimentological pulses (*sensu* Neiff, 1990) of the local system (Aceñolaza, 2007; Ministerio de Obras Públicas, 2010). Hydrological excess is a characteristic resulting from wet weather established in the area during the late Holocene (*ca.* 3000 BP) (Orfeo, 2005).

The alluvial plain belongs to the Delta and Paraná Islands ecoregion (Burkart et al., 1999) and it is characterized by a wide range of biodiversity (Bó, 2005), appealing for human settlement. From the ichthyofaunal point of view, the area is located within the Paraná Domains (Ringuelet, 2004 [1975]). The large amount of ecological niches, typical of varied environments, is a home to an important variety of fish, mainly the Characiformes (*Leporinus obtusidens*, *Hoplias malabaricus malabaricus*, *Serrasalmus* sp., etc); and Siluriformes orders (catfish belonging to Pimelodidae, Doradidae, Loricadidae and Callichthyidae families, etc.).

3. Material and methods

Material analyzed in this work comes from a grid of 1 × 1 m (C2-C20) dug to the archeologically sterile level (~145 cm from the surface). Physical, physical–chemical and chemical determinations were performed to classify soil. Distribution, frequency and material association were also assessed in this grid. Values related to determinations to characterize soil are very similar up to 1.08 m deep (sandy-loam texture and slightly acid pH). Then, a sudden texture (sandy-clay-loam) and pH (from slightly acid to neutral) change was registered. This shows an edaphological formation from the surface to 1.08 m depth, which

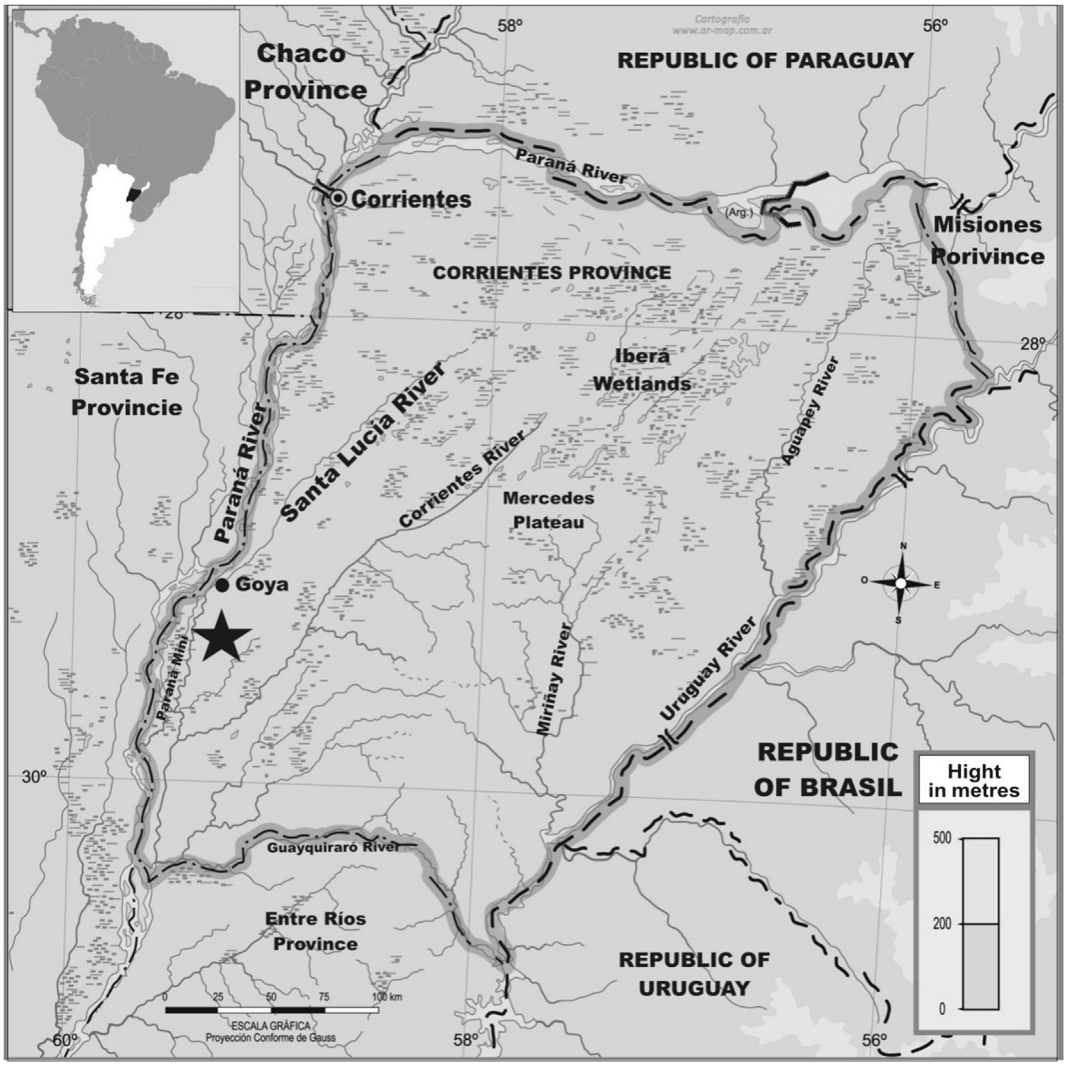

Fig. 1. Location of Los Bananos Site References. ★ Los Bananos site. Adapted map of IGN (2011).

corresponds to fluvial deposition. At 1.08 m depth from the surface, a second formation can be observed, a buried soil (Píccoli, 2014). This, together with distribution, frequency and association of recovered material assessment could suggest that the first centimeters dug (~45 cm deep -LB1-) would be related to a period of extended and/or recurring occupation. Faunal remains are associated with ceramic and lithic material in this layer. Such ceramic material is made up of fragments of vessels; most of them are smoothed, but fewer are coated and/or carved. The carved ones have zoomorphic appendages, especially psittacidae and gastropoda. Lithic material is represented by carving waste and grinding sandstone. Two samples of faunal remains assignable to this period showed the following results: 355 ± 43 BP (AA99790) and 488 ± 42 BP (AA97852) (Barboza and Píccoli, 2013; Píccoli, 2014).

Over a 30 cm thickness, only faunal remains were recovered (LB2). Finally, in the last 45 cm, a different archaeological concentration was identified (LB3), characterized by the existence of lithic material (sand stone carving waste and a reddish unidentified rock -2.5 YR 4/2 and 10R 4/3- with high siliceous content) together with faunal remains. It was not possible to obtain positive radiocarbon results in LB2 and LB3. However, it is considered that the last layer shows anthropic occupation different from the ones previously recorded (Barboza and Píccoli, 2013; Píccoli, 2014; Fig. 2). Considering the stratigraphic sequence characteristics, material was grouped according to origin (LB1, LB2 and LB3) for further analysis.

Reference collections and osteological guidelines were employed for a taxonomical identification and, whenever it was necessary, specialists were consulted. Material identified was quantified according to taxonomic (NISP and MNI) and anatomical (MNE) measurement (Mengoni Goñalons, 1988; Lyman, 1994).

Variables linked to taphonomic story of the set were macroscopically classified, with eventual help of a 20× magnifying glass. Fragmentation condition of the set was evaluated employing the whole percentage element (Lyman, 1994) and the ratio NISP/MNE. Degree of weathering (Svoboda and Moreno, 2014), presence of sediment abrasion, signs of roots, and carnivores and rodents (Butler and Schoeder, 1998; Gifford-Gonzalez et al., 1999; Erlandson and Moss, 2001) were recorded.

Chemical deposits were identified on the cortical surface: outer concretion of different morphology and tinction. The first ones were recorded from their reaction to acetic acid ($C_2H_4O_2$) to check if they were deposits of calcium carbonate ($CaCO_3$). Tinction was classified from isolated or grouped black or brownish stains, typical from manganese oxide and iron precipitation. These variables were recorded using five categories depending on the percentage found on the surface: 0 (absent); 1 (up to 25%), 2 (26–50%), 3 (51–75%) and 4 (76–100%) (Bárboza, 2014). To evaluate anthropic action on the faunal set, the degree of thermal alteration (Stiner et al., 1995), and cut and fracture signs on the bones in fresh state (Stewart and Gifford-Gonzalez, 1994; Gifford-Gonzalez et al., 1999; González, 2005) were recorded.

4. Results and discussion

The faunal record of the three LBS sets is shown in Table 1. The entire ichthyofaunal set is made up of blank 936 specimens, which means 79% of the total sample. However, there are differences in each subset according to their origin. LB3 presents the lowest frequency (n = 45; 38.5%) of fish and the highest amount of specimens assigned to mammals (58.1%; n = 68). Among the mammals identified, rodents (*i.e. M. coypus*) and cervidae stand out. Among fishes depicted, the categories included within the Siluriformes order are the most frequent (LB1: 44%, n = 270; LB2: 14%, n = 40; LB3: 60%, n = 27). However, as other authors have pointed out (Musali, 2010), this frequency might be over represented due to greater identifiability of elements corresponding to Siluriformes (*i.e.* skull and dorsal and pectoral spines) compared to Characiformes. Although Characiformes have elements liable to be identified, it is considered that their fragility could have affected the recovering frequency of the analyzed sets.

Regarding the description of bone parts in the three sets, some elements belonging to the skull were recovered (LB1: 31%; n = 184; LB2: 10%, n = 28; LB3: 48%, n = 21) and, more frequently, the post skull (LB1: 69%; n = 415; LB2: 90%, n = 248; LB3: 52%, n = 23). As shown in Tables 2a and b, the axial part of the post skull skeleton,

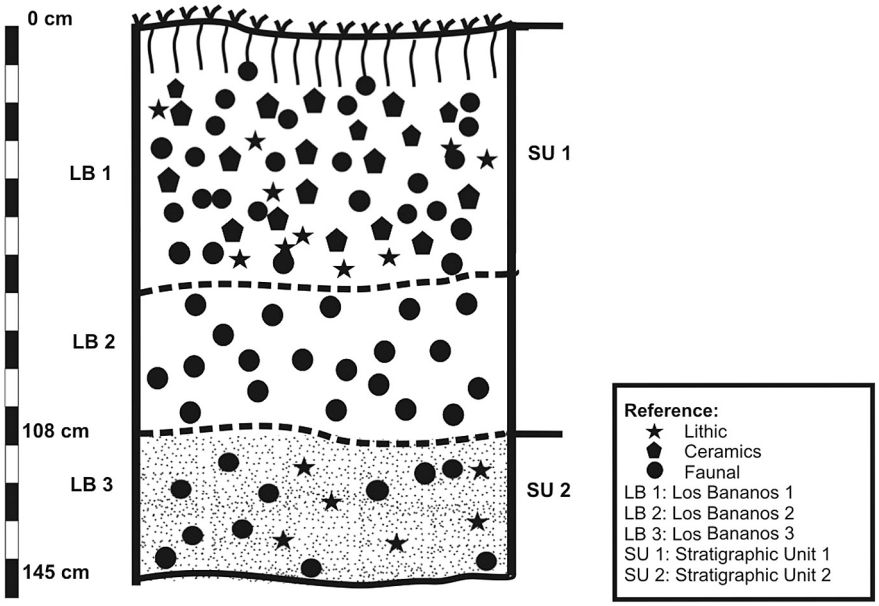

Fig. 2. Stratigraphic profile of Los Bananos Site.

Table 1
NISP and MNI represented for different identified taxonomic categories regarding origin.

Origin	LB1			LB2			LB3		
Taxa	NISP	NISP%	MNI	NISP	NISP%	MNI	NISP	NISP%	MNI
Mammalia	64	8.4%	1	7	2.2%		33	28.2%	
Cervidae	5	0.7%	1				1	0.9%	
Lagomorpha	1	0.1%		1	0.3%				
Rodentia	21	2.8%	1	7	2.2%	1	15	12.8%	1
Hydrochoerus hydrochaeris	1	0.1%					1	0.9%	
Myocastor coypus	19	2.5%	1	13	4.2%		16	13.7%	1
Ctenomys sp.	5	0.7%		3	1.0%		1	0.9%	
Dasypodidae	2	0.3%		1	0.3%		1	0.9%	
Dasypus hybridus	4	0.5%							
Birds	8	1.1%	1	1	0.3%		2	1.7%	
Actinopterygii	295	38.9%		227	72.5%		11	9.4%	
Siluriformes	250	33.0%	7	35	11.2%		23	19.7%	
Doradidae	10	1.3%					2	1.7%	1
Loricariidae	9	1.2%		4	1.3%		1	0.9%	
Paripemelodus valenciennis	1	0.1%							
Trachelyopterus sp.				1	0.3%	1	1	0.9%	
Characiformes	9	1.2%		1	0.3%		2	1.7%	
Leporinus obtusidens	18	2.4%		2	0.6%		5	4.3%	
Mylossoma paraguayensis	14	1.8%		5	1.6%				
Hoplias malabaricus	5	0.7%		3	1.0%				
Serrasalmus sp.	2	0.3%							
Teiidae	1	0.1%							
Caiman sp.	13	1.7%		1	0.3%		1	0.9%	
Anura				1	0.3%				
Bivalvia	1	0.1%					1	0.9%	
Total	758		12	313		2	117		3

represented by the vertebrae, belongs to the highest frequency of elements only assigned to class level in the three sets. This element could not be assigned to an anatomic origin.

The taphonomic variable with greater frequency in the three sets is the fragmentation of material. Although values in the relationship MNE/NISP (Table 3) show low or no fragmentation, when compared to the results of whole percentage elements, the frequency of fragmented specimens in dry state is always higher than 90% (LB1: 95%, n = 571; LB2: 97%, n = 266; LB3: 95%, n = 42). The set of complete items is exclusively made up of teeth in the three samples.

The second taphonomic variable in frequency is abrasion (LB1: 7%, n = 41; LB2: 12%, n = 32; LB3: 40%, n = 40). Some specimens (LB1: 2%, n = 11; LB2: 3%, n = 8; LB3: 7%; n = 3) show a colouring related to organic material impregnated with mineral oxides typical of sediments (manganese). That could be related to exposure to hydrological agents (Conti, 2000; Gutiérrez, 2004), such as humidity where the site is located. No other variables related to other natural agents have been found. Absence of weathering items could denote a sudden covering, which is compatible with hydro-sedimentation pulses which characterize the fluvial ecosystem functioning and structure where the place is located. The recorded abrasion at cortical level of the bone is not considered to be related to atmospheric conditions. Although different processes are able to erode bones (*i.e.* hydrological transportation), it is considered that, in this case, removal of cortical material is caused by the characteristic mechanical effect of contact with hard sedimentary particles, acting during or after covering (Mameli and Escalera, 2004). Thus, such variation can be understood in relation to flood stages.

Table 3
Relationship MNE/NISP by *taxa*, regarding origin.

Taxa	LB1	LB2	LB3
Actinopterygii	1.00	1.00	0.92
Siluriformes	0.96	1.00	0.93
Doradidae	1.00		1.00
Loricariidae	1.00	0.75	1.00
Paripemelodus valenciennis	1.00		
Trachelyopterus sp.		1.00	1.00
Characiformes	0.96	0.91	1.00
Leporinus obtusidens	1.00	1.00	1.00
Mylossoma paraguayensis	1.00	0.8	
Hoplias malabaricus	0.8	1.00	
Serrasalmus sp.	1.00		

Table 2a
Distribution of element frequency corresponding to Actinopterygii and Siluriformes by anatomic region, regarding origin.

Anatomical units			Actinopterygii			Siluriformes			Doradidae		Loricariidae			*P. valenciennis*	*Trachelyopterus* sp.	
			LB1	LB2	LB3	LB1	LB2	LB3	LB1	LB3	LB1	LB2	LB3	LB1	LB2	LB3
Axial Skeleton	Skull	Dental				1										
		Premaxilar				2				2						
		Indet. skull	1			133	17				1					1
	Vertebrae		278	223	8											
Apendicular Sk.		Cleithrum				6			1						1	
		Coracoideous				2	1									
		Pectoral spines				26		2		1						
		Dorsal spines				5								1		
		Indet. spines	15	4	3	67	17	1		3	2	1				
Other		Boneplates						7	1							
Total (MNE)			294	227	11	242	35	22	10	2	6	3	1	1	1	1

Table 2b
Distribution of element frequency corresponding to Characiformes by anatomic region, regarding origin.

Anatomical units		Characiformes			*Leporinus obtusidens*			*Serrasalmus* sp.	*Hoplias malabaricus*		*Mylossoma paraguayensis*	
		LB1	LB2	LB3	LB1	LB2	LB3	LB1	LB1	LB2		LB2
Skull	Dental							1				
	Opercular	1		1								
	Teeth	2	1		18	2	5	1	4	3	14	4
	Indet. skull	4		1								
Apend. Sk.	Indet. bones	1										
Total (MNE)		8	1	2	18	2	5	2	4	3	14	4

The settled bones would have been modified *in situ* by mechanical contact with an abrasive agent in suspension.

The representation of some endo skeleton elements could depend on different factors, such as bone fragility and size in these species, which could have accentuated fragmentation and, as a consequence, it could have biased recognition. This fact has been recorded by other research works which identified bone sets with different survival chances. A set made up of strong thick bones (*i.e.* pectoral and dorsal fish bones and cleithrum) could have more survival chances (Musali, 2010). Likewise, vertebrae have more chance of being recovered because of their higher quantity and greater thickness (being the MNE between 26 and 48 per individual). In contrast, gill skull elements, some neuro-skull ones in Siluriformes and the entire skull in Characiformes have fewer survival chances (Musali, 2010).

Among the variations related to anthropic action, thermal variation stands out (LB1: 17.8%, n = 109; LB2: 14.4%, n = 40; LB3: 64%, n = 29). In every case, most burned bones belong to the post skull (LB1: 58%, n = 63; LB2: 80%, n = 32; LB3: 66%, n = 19). No anthropic mark has been recorded in any of the three sets. Absence of this type of evidence has been mentioned in studies on small-medium size fish (Stewart and Gifford-González, 1994; Acosta, 2005). Anthropic fractures were recorded only in LB1 (2%; n = 12) and LB2 (1.4%; n = 4). They are slice marks in vertebrae (*sensu* Gifford-González et al., 1999). This type of fracture, related to preparation and consumption of fish, has been found in other sites of the region (Bárboza, 2014).

5. Conclusions

Formation processes of ichthyofaunal record of the three LBS sets share some characteristics similar to other archeo-faunal studied in the region. Although anthropic alterations are not abundant in the samples, it is considered that they are product of human action. In this sense, different studies consider the post skull part to be representative for cultural sets linked to settled occupation (Lyman, 1994; Stewart and Gifford-Gonzalez, 1994), which would coincide with what has been observed in at least two of the LBS sets (LB1 and LB3). The presence of thermal modified bones and intentional fractures, in smaller proportion, strengthens this statement. On the other hand, it is coherent with what has been established from other guidelines of archeological evidence, such as the ones belonging to data obtained from systematic survey of the low hills (*albardones*) in the area with no archeological occupation (*see* Píccoli, 2014). In this sense, in the sequence of a stratigraphic cut of low hills, made up of fluvial sedimentation mainly, material remains associated to past human settlements are not observed. However, in these places, concentrations of faunal remains which, in general, do not have either abundance or taxonomic and anatomic diversity, not even similar taphonomic profiles (Barboza, 2014; Píccoli, 2014), as the ones recovered in archaeological concentrations can be observed. Likewise, the information obtained shows a strong association between bone accumulation and cultural material, characterized in LB1 by a high frequency of pottery fragments with soot remains and carbonaceous adhesion, lumps of cooked clay, lithic material in smaller proportions (*i.e.* carving waste), the only resource recovered in LB3 together with fauna. LB2 should be differentiated from the other sets because, although faunal diversity and the presence -despite its low frequency- of specimens with anthropic modifications (*i.e.* thermal variations, marks and fractures) are recorded, they are not related to another cultural item. Thus, the evidence obtained does not reject the possibility that the set could have been created by anthropic action. Despite having an important presence in the three groups, LB3 could have had fish as a complementary resource in diets.

Through the information presented in LBS, it is possible to record a whole use of a wide range of taxa, with a highlighted exploitation of aquatic animals (Actinopterygii -especially Siluriformes-) together with some land animals with a certain grade of dependence to aquatic environment (rodents, cervidae and, eventually, birds), at least during the latest occupation of the site. Although river and land resources are available during the whole year in this alluvial plain, LB3 shows a subsistence based on a greater whole consumption of the second.

Besides the wealth and artefactual diversity, LBS also shows a faunal record not recorded previously. That is why this work should be considered to render novel information, to foster new questions on the adaptation strategies linked to the exploitation of resources by the groups who inhabited the left bank of the alluvial plain of Middle Paraná River, during the late Holocene.

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