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Evaluating fish processing patterns in the lower stream of the Colorado River (eastern Pampa-Patagonian transition, Argentina): An experimental work

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ABSTRACT

Fish processing and consumption became an increasing part of the subsistence patterns in the lower stream of the Colorado River (Buenos Aires province, Eastern Pampa-Patagonian transition, Argentina) during the Middle and Late Holocene (ca. 6000–250 years BP). Freshwater and marine fish specimens recovered from the zooarchaeological assemblages of these periods exhibit processing cutmarks. Since cutmarks are unusual traits in this type of prey and actualistic research related to fish processing are not abundant, an experimental study was performed. The objective was to determine whether the activities related to fish butchering generate cutmarks and, in that case, if a pattern in the distribution of the marks is found in specific anatomic units. Results indicate that independently from the kind (Perciformes or Siluriformes) and size of fish, as well as the type of lithic raw materials used in the butchering process, cutmarks were consistently found on vertebrae. Despite two different methods of butchering employed for Perciformes and Siluriformes, the filleting stage produced the highest frequency of cutmarks. Nevertheless, results obtained in the experimental work show differences when comparing with archaeological assemblages. A combination of factors related to variations in butchering processes, the butchery skill, the employment of specific methods of cooking, and taphonomic factors, could be the causes of the differences.

1. Introduction

Experimental animal butchery has made an important contribution to the development of zooarchaeological studies, particularly those concerning large mammals (Binford, 1981; Buikstra and Swegle, 1989; Miotti, 1990–1992; Blumenschine, 1995; Lupo and Schmitt, 1997; Lupo, 1998; De Nigris, 2001; Mengoni Goñalons, 2001; Egeland, 2003). However, there have been few such studies on smaller vertebrates (Speth, 2000; Laroulandie, 2001; Lloveras et al., 2009; Escosteguy and Vigna, 2010; Medina et al., 2012) and fewer still concerning fish (Wheeler et al., 1989; Colley, 1990; Morin, 2004; Steffen and Mackie, 2005; Willis et al., 2008; Willis and Boehm, 2014, 2015; Archer and Braun, 2013; Svoboda and Moreno, 2014; Nurminen, 2015; Corbat et al., 2017).

Some ethnographic work on fish processing techniques has been undertaken (Stewart, 1991, 1994; Stewart and Gifford-Gonzalez, 1994; Zohar and Cooke, 1997; Gifford-Gonzalez et al., 1999) but less attention has been given to zooarchaeological evidence for fish processing. This is largely because cutmarks and other indicators of processing are rarely observed on archaeological fish remains, presumably because their small size means that they can usually be consumed either whole or without intensive processing (Wheeler et al., 1989; Colley, 1990; Juan-Muns i Plans et al., 1991; Willis et al., 2008; Zohar et al., 2018). Nevertheless, in different archaeological sites from the Pampas and Northern Patagonia several fish species with evidence of consumption have been observed (Quintana and Mazzanti, 2001; Martínez and Gutiérrez, 2004; Gonzalez, 2005; Prates, 2008; Musali, 2010; Bayon et al., 2012; Favier Dubois and Scartascini, 2012; Corbat, 2016; among others). Also, in the Eastern Pampa-Patagonian transition (the lower stream of the Colorado River), sizeable fish bone assemblages containing a variety of species have been recovered (e.g., sea catfish "*Genidens barbus*"; white croaker "*Micropogonias furnieri*"; perch "*Percichthys trucha*"; striped weakfish "*Cynoscion guatucupa*"). Within these assemblages there are specimens that exhibit evidence of processing and consumption (e.g., cutmarks and thermal alteration; Martínez et al., 2010; Stoessel, 2010, 2012a, 2012b, 2015). This situation and the lack of ethnographic or ethnohistorical evidence for these regions about fish procurement and processing techniques deserve the generation of frames of reference (Binford, 2001). Results can help interpret the mechanisms by which fish became incorporated into the archaeological

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record, as well as to understand patterns of fish processing, cooking and consumption. This paper represents a first step towards achieving this baseline dataset. To this end the aims of this paper are: a) to develop an experimental work[1] to observe if the activities related to fish butchering generates material correlates that can later be detected on bone surfaces; b) to determine which stages of the butchering sequence - from procurement to discarding-produce cutmarks, and to identify on which anatomical elements they occur; c) to compare these results to those from other experimental studies, and d) to compare the results obtained from the experimental work with the evidence provided by the ichthyoarchaeological record of the study area.

2. Biogeography of the Colorado River and the subsistence model

The lower stream of the Colorado River (38°–41° S; 62°–64° W), is located in the Pampa-Patagonian transition, within the so-called "Diagonal Árida", in southern South America (Abraham de Vázquez et al., 2000). The study area covers part of Villarino and Patagones districts, in the southern tip of the Buenos Aires province (Fig. 1). This area presents ecotonal characteristics from a faunal and floral point of view (Morello, 1958; Páez et al., 2001; Villamil and Scoffield, 2003). Given the purpose of this paper, ichthyofaunal aspects of the area are described in depth below.

Regarding fresh water fish species, the study area is located in the Andean Cuyan province (López et al., 2008), whose representative species include patagonian catfish (*Hatcheria macraei*), otuno (*Olivaichthys cuyanus*), perch (*Percichthys trucha*) and uruguay tetra (*Cheirodon interruptus*). This province shares species with the Aymaran, Patagonic and Great Rivers provinces (López et al., 2008). Almirón et al. (1997) pointed out that between the mouths of Colorado and Negro Rivers there are also species of the Austral and Brasílica subregions. The marine species are more abundant and present a larger diversity than the fresh water fish species. The marine sector, where the Colorado River delta is located, is included in the Rio Negro District, belonging to the Argentine province (Balech and Ehrlich, 2008). This province has significant fish heterogeneity due to the mixture of subtropical and subantarctic species. Some of these belong to families such as Sciaenidae (*Micropogonias furnieri*, *Cynoscion guatucupa*, *Macrodon ancylodon*, *Umbrina canosai*), Sparidae (*Pagrus pagrus*) and Cheilodactylidae (*Nemadactylus bergi*) (Balech and Ehrlich, 2008). Besides the Teleostei already mentioned, there are also Chondrichthyes species such as *Mustelus schmitti*, *Galeorhinus galeus*, Rajidae, Myliobatidae and Dasyatidae families (Cousseau and Perrotta, 2000). The largest richness of fish species is related to the Colorado River estuary, in which several euryhaline marine species such as white croaker (*Micropogonias furnieri*), black drum (*Pogonias cromis*), striped weakfish (*Cynoscion guatucupa*) and sea catfish (*Genidens barbus*) are present (Cousseau and Perrotta, 1998; Carozza et al., 2000; Macchi et al., 2002).

The knowledge generated about the subsistence of the hunter-gatherer groups that occupied the study area comes from the isotopic and zooarchaeological analyzes. On the one hand, information obtained from isotopic analysis ($\delta^{13}C$ and $\delta^{15}N$) of human remains from several sites (e.g., La Modesta, Paso Alsina 1, La Petrona and La Primavera; see Fig. 1) indicate that during the Middle Holocene diet was diverse, including marine, terrestrial, and fluvial resources. Towards the Late Holocene diet was relatively homogeneous and continental, characterized by the consumption of terrestrial herbivores and freshwater fish (Martínez et al., 2009; Flensborg et al., 2018). On the other hand, zooarchaeological analyses in Middle Holocene (ca. 6000–4100 years BP) inland sites indicate the exploitation of ungulates (specifically guanaco, *Lama guanicoe*) and smaller species such as large-sized rodents (nutria, *Myocastor coypus*), and possibly birds and armadillos (Alcaráz, 2017). In addition to these species, the presence of freshwater fish (*Percichthys* sp.) with evidence of consumption (cutmarks) is noteworthy (Stoessel, 2015). During the Late Holocene (3000–250 years BP) a diet based on the exploitation of large size species (guanaco, pampas deer-*Ozotoceros bezoarticus*, ñandú-*Rhea americana*), smaller-sized terrestrial species (e.g., rodents, armadillos), and inland fresh water prey species (e.g., anatids) was recorded. The simultaneous exploitation of fluvial and marine fish (e.g., sea catfish, white croaker, indeterminate sciaenidae) was recorded towards the Final Late Holocene (1000–250 years BP).

3. Fish exploitation and the archaeological record of the lower stream of the Colorado River

The information presented here comes from Site 1 of the San Antonio Archaeological Locality and from the La Modesta site. As described below, these sites are particularly useful case studies because both contain a large amount of fish remains (Stoessel, 2015; Alcaráz, 2017).

The San Antonio archaeological locality includes six sites located on low aeolian sand dunes, at ca. 4 km from the Atlantic coast (Fig. 1). The material comes mainly from stratigraphic contexts and involved piece-plotted artifacts recovered in the excavation units and specimens recovered by dry sieving with a 2 mm mesh size. The stratigraphic sequence at San Antonio 1 site is composed of extensive aeolian strata, which overlie ancient alluvial and marine deposits. The archaeological component – including fish remains – is exclusively located in the upper part of the sequence, more specifically in a buried "A" soil horizon dated ca. 1000–800 years BP (Martínez and Martínez, 2011), and falling within the Final Late Holocene. Given the geomorphological context described previously, the presence of fish bones is clearly the result of anthropic action, which is also indicated by evidence of cutmarks and thermal alterations (Martínez et al., 2010; Stoessel, 2010; Stoessel, 2012a, 2012b). These sites are interpreted as seasonal (spring and summer) residential bases used mainly for fish procurement, processing and consumption (Martínez et al., 2010). San Antonio 1 has the most fish remains of all sites in the locality ($N = 3693$), and its assemblage includes both marine and fluvial species. The marine species are present in higher frequencies ($n = 1586$), and among them the sea catfish fully dominates the assemblage (NISP = 1412; MNI = 133; Table 1). Taphonomic analyses of these assemblages indicate that 14.62% of the specimens were affected by root etching, 2.2% presented manganese staining, and evidence of chemical deterioration occurred in 0.03% of the sample (Stoessel, 2012a).

Among the sea catfish specimens at San Antonio 1 there are both cranial elements, in higher frequencies, and post-cranial elements (Table 2). Different regions that correspond to the skull, axial and appendicular skeleton are present. However, cutmarks were found in only two of those regions, and on only four specimens: two basioccipitals and two caudal vertebrae. While 19 cutmarks were identified in the former, only 4 were registered in the latter. In both cases the cutmarks are oriented transversely to the longitudinal axis of the bone (Fig. 2).

The La Modesta site is about 60 km from the Atlantic coast. It is located on a dune and the adjacent blowout distant ca. 1 km from an ancient paleochannel (Fig. 1). The majority of the material (lithic artifacts, faunal remains, and human remains, among others) appeared mainly on the surface of the blowout. These were recovered by means of 20 transects in which all materials were collected. Radiocarbon dates from faunal and human bones indicate Middle Holocene occupations (ca. 5900–5600 years BP; Martínez, 2017; Martínez and Flensborg, 2018). The site was characterized as a base camp where funerary practices were also performed. Among the faunal assemblage, a significant number of fish remains ($N = 2748$) was recovered, but only

[1] Experimental work understood as a part of actualistic studies implies reconstruction processes where certain variables are controlled. These procedures make it possible to observe the relationship between an agent's action and the physical results produced by those actions, as well as to established specific causal relations among them (Gifford-Gonzalez, 1991; Lyman, 1994).