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Characterization of recent marks produced on fossil bone surface during sullegic and trephic processes and their influence on taphonomic studies

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ABSTRACT

Different taphonomic processes throughout the history of a fossil assemblage may preserve, modify or destroy, particular palaeobiological traits, but these processes always increase taphonomic information of the past. Similarly, fossils are affected during later stages of taphonomic history, i.e. excavation, preparation, study and storage of fossils, known as sullegic and trephic phases. Tools used during excavation and preparation of fossils can damage them and produce marks on their surface. Some of these recent marks highly mimic taphonomic marks produced before excavation. Both modern and fossil marks lead to misinterpretations and erroneous conclusions when similarities are not clearly detected. In order to distinguish recent from ancient marks, several diagnostic criteria resulting from experimental work are described in this paper.

1. Introduction

According to a large number of authors (Clark et al., 1967; Morlan, 1980; Fernández-López, 1984, 1988, 1989, 2000; Behrensmeyer and Kidwell, 1985; Hesse and Wapnish, 1985; Wilson, 1988; Seilacher, 1992; Dauphin et al., 1994; Fernández-Jalvo and Marin-Monfort, 2008; among others), the time setting for the taphonomic study spans from the production of the taphonomic entities (fossils) until the present time. Therefore, all processes and activities whose purpose is to extract, preserve or even analyze the fossils also belong to their taphonomic history.

Different factors and processes act upon the taphonomic entities since the time of production. Clark and Kietzke (1967) distinguish between thanatic processes related to production, equivalent to the death of the palaeobiological entity, perthotaxic, previous to the burial, taphic, which concern the burial process, anataxic, related to weathering and/or erosion after burial, sullegic, which include sampling activities, and trephic, concerning all post-sampling activities. Four of these factors act before digging/sampling and are influenced by habitat characteristics, population density, cause of the production, burial environment or differential decay amongst others (Clark and Kietzke, 1967). The last two factors include the most neglected taphonomic processes, which concern the fossil preservation and the loss of information, as well as the selection during sampling or extraction (sullegic processes) or during fossil preparation, storage, exhibition or study (trephic processes) (Clark and Kietzke, 1967).

Sullegic and trephic factors may introduce new alterations that cover, modify or even remove previous modifications, which may drive to misinterpretations of the taphonomic history of the fossil. An example concerning sullegic factors has been cited by Pesquero (2006) in her analysis of fossil collections from the Cerro de la Garita site (Concud, Teruel, Spain). She compared classic collections from different digging seasons that took place between the 1920s and 1984, and fossils issued from recent excavations carried out following detailed taphonomic methods. During the former historical seasons specimens smaller than 2 cm or specimens that disintegrate into a chalky substance when touching were neither recovered nor coordinated. A remarkable difference between the classic and the recent seasons is the proportion of specimens with digestion evidences (1 among 5320 in the classic collections and 52 among 4790 fossils from modern excavations). Most fossils with

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digestion evidences are unidentified small bone splinters that were discarded in the classic seasons, whose main objective was taxonomic identification. These small sized fossils also provided criteria to identify the type of water stream movements and environmental conditions, as well as to interpret the site formation and past ecosystems (Pesquero et al., 2013). In this respect, disaggregated fossils have provided criteria to interpret detailed environmental conditions of aridity and contemporaneous microorganisms related to the aquatic environment (Fernández-Jalvo et al., 2016).

An additional example, concerning trephic factors, is represented by several sites from Croatia, Italy and Belgium in which some marks were interpreted as signals of cannibalism among Neanderthals. Recent reviews of the recovered fossils led to the conclusion that those marks were neither cannibalism evidences nor the result of funerary rituals and corpse preparations, but alterations produced on fossils during the extraction, cleaning and preparation stages (Trinkaus, 1985; Russell, 1987; White and Toth, 1989, 1991).

Although they are still scarce, there is an increasing number of works taking into account the eventual removal of alterations that occurred before the excavation activities, or the introduction of new modifications (Bromage, 1984; Flessa et al., 1992; Landt, 2004, 2007; West and Hasiotis, 2007; Fernández-Jalvo and Marin-Monfort, 2008; Domingo, 2009; Marin-Monfort, 2015; among others). However, they did not describe valid characteristics to differentiate between them (Potts and Shipman, 1981).

Recent marks may mimic fossil marks produced before the excavation (Fig. 1). Brightness and colour are visual traits frequently used to distinguish between recent and old marks. Most frequently, recent marks are shinier and show a different colour than the rest of the fossil surface, whereas older marks are matt and show no colour difference. In addition, some old marks contain sediment or mineral infillings produced during fossilization processes (e.g. manganese stains) that usually are absent in recent marks (Shipman, 1981; Potts and Shipman, 1981). Distribution, arrangement and direction patterns can also be useful to distinguish between old and modern marks. Fossil cut marks for example occur close to the muscle/ligament insertion areas (Binford, 1981), whereas recent marks may randomly affect the fossil surface.

In order to identify excavation or preparation marks, chromatic criteria are not always valid, particularly with light colored fossils. This is the case of the Miocene fossil site of Batallones (Madrid, Spain), which yields mainly whitish fossils that make this task considerably difficult. In order to discern recent and fossil marks, Domingo (2009) carried out some experiments and analyzed the impressions produced by screwdrivers, metallic gravers and wooden tools, both on dry and humid fossils. Internal parallel micro-striation, hertzian cones and, sometimes, small fossil flakes inside the grooves, for example, are present in modern tool marks but absent in carnivore bite marks. These characteristic traits allowed the author to differentiate between recent and old marks in fossils of Batallones. Nevertheless, some marks produced during the excavation and preparation phases are highly similar to those induced by past hominins (absent in the Miocene site of Batallones).

Therefore, additional criteria are needed to properly distinguish recent marks (produced during the extraction and preparation activities) from any type of old fossil marks (including cut marks), and to be extrapolated to other fossil sites. The main goal of this work is to compare recent and fossil marks in order to obtain and characterize key diagnostic traits that allow us to distinguish them in fossil specimens.

2. Material and methods

A total of 22 unidentified non-coordinated fossil fragments from Pleistocene fossil sites were selected to perform this experiment (Table 1). Only diaphyseal fragments of similar compact bone thickness from adult medium size animals were used, thus avoiding morphological and structural differences related to the anatomic element.

Some fossils can show a certain degree of humidity, either transferred from the sediment during the excavation or due to humid laboratory treatments. In order to assess the eventual influence of humidity conditions, the fossil fragments were divided into two groups: one was left to dry in aerial conditions whereas the other one was immersed in water until the total saturation of the sample (Table 1).

Table 1
Tools, movement (impact/friction) and fossil condition (dry/wet) employed in the experiments.

		Dry		Wet	
		Impact	Friction	Impact	Friction
Metal tools	1. Small peak	X	–	X	–
	2. Chisel + Hammer	X	–	X	–
	3. Trowel	X	X	X	X
	4. Screwdriver	X	X	X	X
	5. Awl	X	X	X	X
	6. Scalpel	X	X	X	X
	7. Palette knife	X	X	X	X
	8. Flat tip probe	X	X	X	X
	9. Fine tip probe	X	X	X	X
Wooden tools	10. Skewer	–	X	–	X
Plastic tools	11. Surgical pick	–	X	–	X

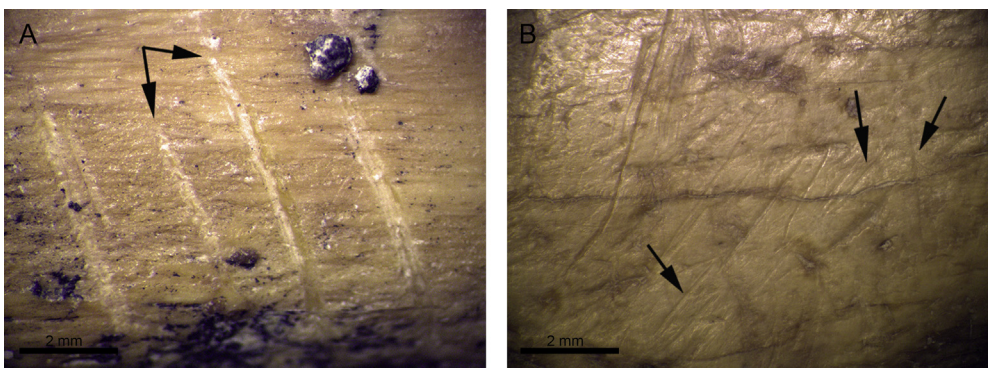

Fig. 1. A. Two recent marks made with a scalpel (arrows) between two ancient cut marks. Note that recent and ancient marks are almost indistinguishable; the latest covered by sediment and manganese stains. B. Fine-tipped probe recent marks (arrows) next to very similar trampling marks.

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