The avian remains from El Juyo, Lower Magdalenian Cantabrian Spain

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ABSTRACT

El Juyo is one of the Cantabrian sites of Iberia known from long ago for its important Lower Magdalenian sequence. The present study reports the results of the zooarchaeological and taphonomic analysis of the avian remains recovered at the site, which complements the archaeological and palaeoecological data already available. The remains recovered are limited, but they seem to indicate that humans were the main accumulating agent in the site, with sporadic presence of owls' activity. Additionally, humans could have used birds for other purposes than as a dietary resource, as suggested by cut marks observed on two wing bones.

1. Introduction

The use of avian resources by our prehistoric human ancestors is a subject of especial interest to the scientific community. Despite the current interest in these animals, their study is a relatively recent phenomenon. Avian remains have historically been excluded from exhaustive analyses, as they were considered to be a low-value resource from a nutritional point of view. Therefore, the analyses performed on bird bones were restricted to the taxonomical and anatomical determination of the remains to make paleoecological inferences (e.g., Carrera et al., 2018; Eastham, 1997; Núñez-Lahuerta et al., 2021; Sánchez, 1996; Sánchez Marco, 1999; Sánchez Marco and Sastre Páez, 2001; Tomek et al., 2012). No other systematic taphonomic analyses were performed on bird bones, as it was assumed that ancient human populations did not use them. This vision has changed during the last decades, as it has been shown that hominins exploited a wide diversity of resources –birds included– dating back to the Middle Pleistocene (Blasco et al., 2013, 2019; Morin et al., 2019). However, it is during the last phases of the Middle Palaeolithic (MIS 5-MIS 3), and especially from the Upper Palaeolithic onwards, that the use of birds and their products became a widespread phenomenon (e.g., Laroulandie, 2004; Peresani et al., 2011; Finlayson et al., 2012; Wertz et al., 2016; Gómez-Olivencia et al., 2018; Mourer-Chauviré, 2019; Goffette et al., 2020). In addition, their

exploitation does not seem to be limited to food purposes, but also to obtaining other non-edible products, such as bones, feathers, tendons, or claws (e.g., Costamagno and Laroulandie, 2004; Morin and Laroulandie, 2012; Romandini et al., 2014, 2016; García Benito et al., 2016; Blasco et al., 2019).

Still, it should be taken into account that, apart from humans, other predators can be accumulating avian remains and often occupy the same spaces as humans, including some small carnivorous mammals and birds of prey (e.g., Laroulandie, 2000, 2002; Bocheński 2005; Mallye et al., 2008; Bocheński et al., 2009; De Cupere et al., 2009; Monchot and Gendron, 2011; Lloveras et al., 2014; Rodríguez-Hidalgo et al., 2016; Alonso et al., 2020; Rufà and Laroulandie 2019, 2020; Wertz et al., 2021). For this reason, it is critical to determine the origin of an accumulation when studying an archaeological assemblage to understand more precisely the role of birds in these contexts.

El Juyo is an example of a cave site with an important Cantabrian Lower Magdalenian sequence. It is located approximately 8 km west of the city of Santander and 5 km south of the present-day coastline of the Cantabrian Sea (Barandiarán et al., 1987; Fig. 1), at approximately 60 m above sea level. The cave entrance is in a sinkhole in the local limestone topography and near the top of a hill, offering an excellent view of the surrounding terrain. During the last glacial maximum, the site was slightly further from the coastline (then, less than 15 km away). The site

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was similarly close to the montane region parallel to the north coast of Spain (the Cantabrian Cordillera). Except for traces of sporadic use, including the few artifacts left during the Bronze Age and a Visigothic burial in one of the back galleries of the cave, the deposits in El Juyo are only Cantabrian Lower Magdalenian (Barandiarán et al., 1987; Janssens and González Echegaray, 1958). These deposits in the cave's former vestibule were protected by the collapse of the main entrance around 14,000 B.P. and sealing by flowstone (Freeman et al., 1988:6). The site was tested archaeologically for the first time from 1955 to 1957 by Janssens and González Echegaray (1958). New excavations were begun in 1978 and 1979 under the joint direction of Barandiarán, Freeman, González Echegaray, and Klein, and in subsequent seasons (1982–83, and 1987–97) by Freeman and González Echegaray (Freeman et al., 1988, 1998; Klein et al., 1981; Barandiarán et al., 1987).

The excavations in the main vestibule covered an area over 40 m³, and the stratified deposits reach 3.5 m, with an estimated duration of Magdalenian occupation of around 1,000 years (Freeman et al., 1988). Levels 2 (Medieval) and 3 (Bronze Age) yielded only minor deposits. Levels 4 and 7 yielded radiocarbon dates on charcoal of 13,920+/-240 B.P. and 14,440+/-180 B.P., respectively (Freeman et al., 1988:12). Level 4 is the uppermost Lower Magdalenian deposit, a thin layer of occupation debris above the nearly sterile flowstone of Level 5. Level 4S (Sanctuary) intrudes into the lower deposits from Level 4 downward and consists of a complexly constructed series of mounds, walls, offering layers, and related features (Freeman and González Echegaray, 1981). Level 4R (Ramp) is an area of fill containing mixed deposits and may have accumulated during Level 4S construction. Levels 6–9 are the lowermost levels, that have been exposed over a wide area and contain much occupation debris, including faunal remains. Level 6 has yielded much worked and unworked antler and abundant red deer (Cervus elaphus) remains (Klein and Cruz-Uribe, 1987; Klein et al., 1981). Level 7 contained two basin-shaped hearths. Level 8 has yielded tens of thousands of shells, mainly limpets (Patella vulgata) and periwinkles (Littorina littorea) (Freeman et al., 1988; Krupa, 1994). Fish remains (primarily salmonids) are also abundant throughout the Magdalenian deposits (Pokines, 1998). Level 9 is similar to Level 8, although its mollusk content is less dense. Small exposures of Levels 10 through 12 have been made to date, and these lack the mollusk abundance of the previous two levels and contain dense concentrations of large faunal remains and (in the latter level) a large pit.

The mammalian microfauna from El Juyo was extensive, and its spatial, taxonomic composition, and taphonomic analysis is most consistent with accumulation by barn owls (Tyto alba) (Pokines, 1998). The total number of identified teeth (n = 7862) includes a sample (n = 376) identified in an earlier study of El Juyo by Castro Bernardez (1986). The taxa identified include Talpa sp., Sorex coronatus, S. minutus, Neomys fodiens, N. anomalus, Arvicola cf. terrestris, Microtus oeconomus, M. agrestis/M. arvalis, Microtus nivalis, Pitymys pyrenaicus, Pliomys lenki, Apodemus sylvaticus/A. flavicollis, and Mustela nivalis (Pokines, 1998). The proportions of these species are most consistent with an open, humid, meadow environment with some tree cover and some northern/alpine species extending their ranges to the coastal lowlands. Larger taxa identified include Equus caballus, Cervus elaphus, Capreolus capreolus,

Bison bonasus, Capra ibex, Sus scrofa, Panthera leo, P. pardus, Mustela putorius, Ursus arctos, Vulpes vulpes, Canis lupus, and Erinaceus europaeus (Freeman et al., 1988; Klein and Cruz-Uribe, 1987; Klein et al., 1981). Microfaunal remains that are most consistent with deposition by barn owls have their highest concentration toward the back of the vestibule area, although they are found throughout the deposits. Their distribution was likely affected by rolling and trampling, as no small concentrations of microfauna consistent with deposition as an individual owl pellet or masses of pellets were noted during the excavations.

Despite the paleoecological studies already published on microfaunal remains (Pokines, 1998, 2000a, 2000b, 2000c), no studies have been carried out on the bird remains recovered from the site to date. Thus, in the present work, the avifaunal remains from levels 4 to 12 have been studied with three main objectives: (1) to identify possible bird-accumulating agents in the assemblages, (2) to make paleoecological inferences concerning the period of occupation of the site, and (3) to better understand human subsistence strategies during the Lower Magdalenian in the site.

2. Methods

The whole bird bone assemblage (from levels 4 to 12) was revised and identified anatomically and taxonomically at the family, genus, or species level by using both osteological atlases (Bocheński and Tomek, 2009; Cohen and Serjeantson, 1996; Kraft, 1972; Tomek and Bocheński, 2000; Woelfle, 1967) and osteological bird collections. When detailed determination was not possible, the bones were classified by size (small, medium, or large). The distinction between adult and immature individuals was made based on the degree of ossification of the cortical tissue and the formation of the joint ends of the long bones (Hargrave, 1970; Lefèvre and Pasquet, 1994). After that, bones were quantified according to the Number of Identified Specimens (NISP), the Minimum Number of Elements (MNE), and the Minimum Number of Individuals (MNI). Due to the small number of remains in the assemblage, no other indices of skeletal survival or anatomical representation have been calculated, as the results would not be sufficiently robust.

In addition, bone completeness has been calculated. Likewise, when possible, long-bone fractures were classified by green, dry, and modern fractures. Green fractures are usually distinguished by the presence of oblique angles and smooth edges, while dry and modern fractures usually have rough and irregular edges. In addition, modern fractures can be identified, because the edges do not present other post-depositional modifications at the fracture points, and the fractures usually preserve the internal colouration of the bone (Sanchis, 2012; Steadman et al., 2002). All the ancient fractures were analysed looking for any evidence of anthropogenic activity, such as intentional breakage with associated peeling or superficial flaking (Laroulandie et al., 2008; Pedergnana and Blasco, 2016).

Once the quantification of the remains was completed, a detailed taphonomic analysis was conducted using a Euromex stereomicroscope (Nexius Zoom NZ 1902-P) with magnification up to 45x. This step consisted of observing the bone surfaces searching for characteristic traces of human and/or non-human activities (including mammalian
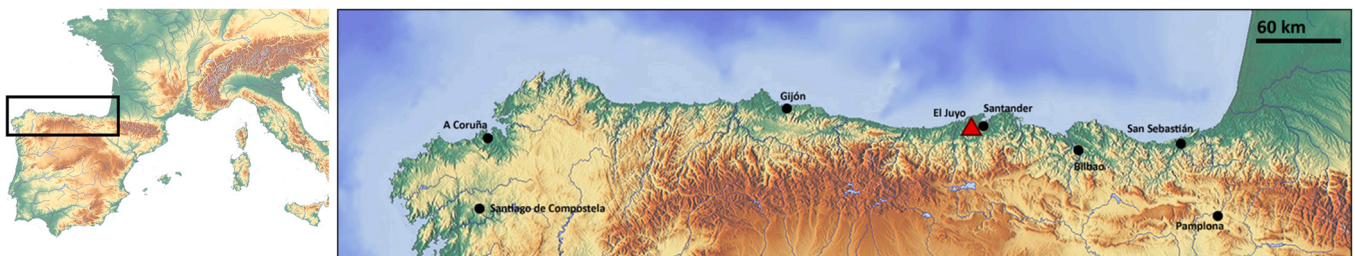

Fig. 1. Location of El Juyo site within the Iberian Peninsula and the Cantabrian coast.

carnivores and raptors). Several parameters were incorporated into the analysis, including the presence of cut marks, perforations and wrenching, tooth marks, and indicators of burning. Cut marks are the clearest evidence of human intervention on the remains (Shipman, 1981; Shipman and Rose, 1983; Laroulandie, 2001). Their location on the bone surface, as well as their distribution (isolated or grouped) and orientation concerning the longitudinal axis of the bone, were recorded. Nevertheless, due to their small size, birds are animals that can be easily processed without using tools, so that cut marks may be absent. Thus, the detection of other possible alterations that may be associated with human action was considered, such as perforations and wrenching associated with the overextension of the elbow joints (Laroulandie et al., 2008) as well as possible tooth marks, if their anthropic origin can be confirmed (Landt, 2007). Human tooth marks can morphologically differ from other predator tooth marks and can be diagnostic for their identification (Saladié et al., 2013). The presence of burnt bones, which could be related to the roasting of prey or other anthropogenic activities, was also documented and classified according to degree of staining/cremation (Stiner et al., 1995): 0 (no burning, no colour change), 1 (brown stains), 2 (brown, uniformly burnt), 3 (charred and black), 4 (grey/blue), and 5 (charred and white).

Mechanical modifications were registered in the database in the form of notches and crenulated edges. Chemical alterations produced by the ingestion of the bones were also documented, distinguishing among the five degrees of corrosion stated by Andrews (1990): 0 (no corrosion); 1 (light); 2 (moderate); 3 (strong); and 4 (extreme).

Post-depositional modifications were also recorded to reconstruct the taphonomic history of the accumulation. Some of the alterations were presented as fissures due to sediment pressure and/or weathering (Behrensmeyer, 1978). Trampling was also observed in the form of striae dispersed along the bone surface with no defined direction (e.g., Fernandez-Jalvo and Andrews, 2016). Chemical corrosion due to root action was documented in the form of pits with some surrounding dissolution. Finally, staining related to manganese oxides was recorded (Fernandez-Jalvo and Andrews, 2016).

3. Results

In the Magdalenian sequence of El Juyo, 97 avifaunal remains have been recovered and distributed among different archaeological levels (Fig. 2). Level 4 contains 49 specimens (50.5 % of the total number of avian remains); 14 specimens were recovered in the Ramp area (4R), 29 in the Sanctuary area (4S), and 6 are not associated with any of the mentioned sub-structures from level 4. However, as level 4 is considered as a whole entity, the number of elements recovered has been studied altogether. Level 4 is followed in number of remains by level 8 (n = 19; 19.6 %), 12 bones at level 6 (12.4 %), and 6 at level 9 (6.2 %). The rest of the levels have less than three remains and/or no clear stratigraphic attribution.

Some elements could be determined at the species level. This is the case of the Willow ptarmigan (*Lagopus lagopus*) and the Alpine chough (*Pyrrhocorax graculus*), which were present at various levels throughout the sequence. It should be noted that these species are the only ones represented within the phasianid and corvid families, respectively. Therefore, although some remains categorised within these groups could not be determined to species level, they likely belong to these taxa.

Although the assemblage presents a significant proportion of fragmentary elements, making taxonomic attribution difficult, it has been possible to identify some remains of anatids, ardeids, phasianids, and passerines, with corvids and small passerines being the best-represented taxa.

3.1. 3.1. Anatomical and taxonomical representation.

3.1.1. Level 4

The bird remains belonging to all components of level 4 total 49. Among them, small Passeriformes, corvids, and phasianids stand out (Table 1). There does not seem to be a particular distribution of species in the site plan. Species seem to be indistinctly present in both the Ramp zone (4R) and in the Sanctuary (4S). If the total MNI is considered, a minimum of 10 individuals composes the assemblage. Small-sized Passeriformes are the best represented, with five individuals: three adults and two young specimens. In addition, there is at least a large-
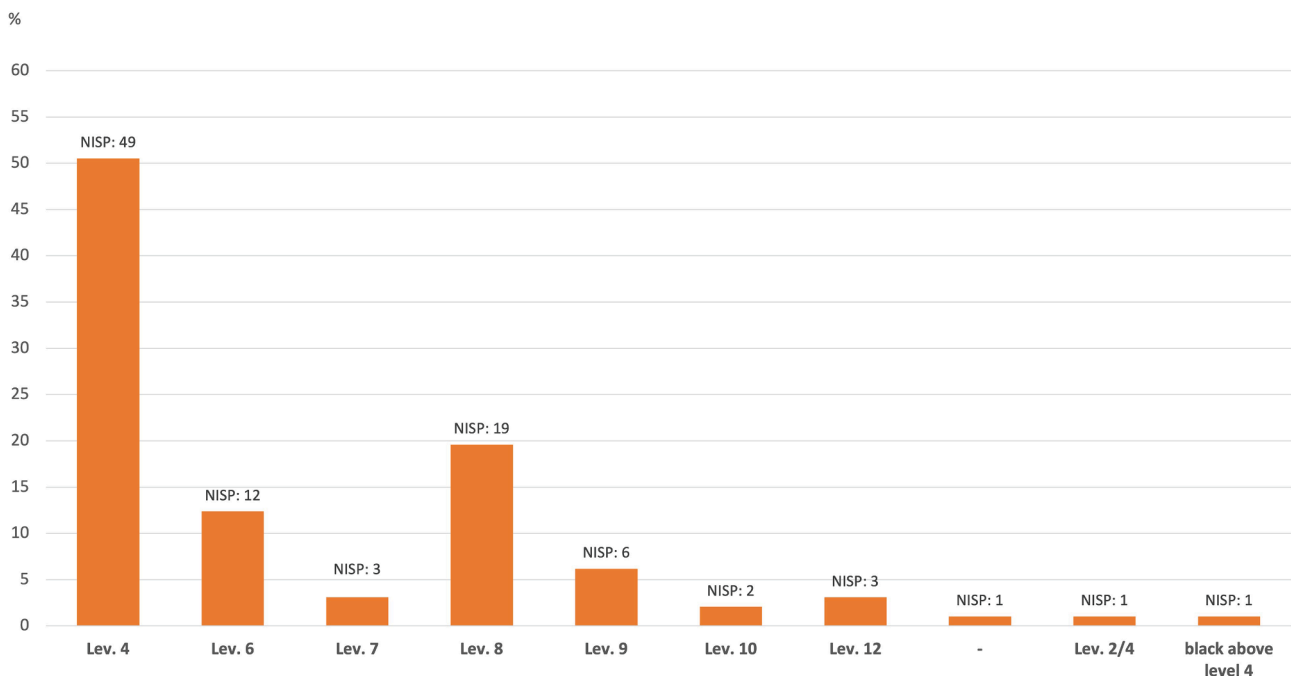

Fig. 2. Distribution of bird remains recovered at the different archaeological levels of El Juyo site. The "y" axis constitutes the percentage of specimens represented. The number of specimens (NISP) is also labelled above each level column. Remains with no clear level attribution ("-", "2/4", and "black above level 4") have been included separately.

Table 1
Number of avian remains recovered from level 4. The NISP and MNE normally coincide. Only when the number is different, the MNE is listed inside the parentheses (x). qua: quadratum; ver: vertebra; hum: humerus; uln: ulna; rad: radius; wph: wing phalanx; fem: femur; tib: tibiotarsus; tmt: tarsometatarsus; pph: posterior phalanx; tal: talon; long: long undetermined bone. Lsz: large size; msz: medium size; ssz: small size.

	Anatidae lsz	Ardeidae msz	*L. lagopus*	Phasianidae undet.	*P. graculus*	Corvidae undet.	Passeriformes msz	Passeriformes ssz	Aves lsz	Aves msz	Total
qua	1										1
ver									5	2	7
hum			1							1	2
uln						1	1		1	1	4
rad										2	2
wph										1	1
fem			1								1
tib	1	1		1				7 (5)	1		11 (10)
tmt		1			1	1		5			8
pph						6				2	8
tal						2					2
long										2	2
Total	**2**	**1**	**3**	**1**	**1**	**10**	**1**	**12 (10)**	**7**	**11**	**49**

sized anatid (Anatidae lsz), a Willow ptarmigan, an Alpine chough, and a medium-sized Passeriformes (Passeriformes msz). All are adult individuals. Apart from them, a medium-sized tibiotarsus diaphysis has been attributed to a member of the Ardeidae family. However, the absence of the proximal and distal ends of the element, as well as the lack of a properly complete osteological comparative collection, make its taxonomic attribution questionable.

Moreover, some remains of undetermined Phasianidae and Corvidae are present in the assemblage, and other elements attributed to large-sized (Aves lsz) and medium-sized (Aves msz) undetermined avifauna have been documented. All of them probably complement the elements already identified at the species level.

Considering the anatomical representation (Table 1), tibiotarsi are the most abundant elements in the assemblage (n = 11; 22.4 % of the remains), followed by tarsometatarsi (n = 8; 16.3 %), posterior phalanges (n = 8; 16.3 %), and vertebrae (n = 7; 14.3 %).

3.1.2. Level 6 and level 7
Level 6 has a total of 12 avian remains, all corresponding to

Table 2
Number of avian remains recovered from level 6. The NISP and MNE coincide. Ver: vertebra; cmc: carpometacarpus; mtt I: first metatarsus; wph: wing phalanx; pph: posterior phalanx. Lsz: large-sized; msz: medium-sized; ssz: small-sized.

	Aves lsz	Aves msz	Aves ssz	Total
ver			6	6
cmc	1			1
mtt I		1		1
wph		1		1
pph		3		3
Total	**1**	**5**	**6**	**12**

undetermined birds of different sizes. Six vertebrae of large-sized birds are the most abundant element. Apart from them, four phalanges (three posterior and a wing phalanx) and the first metatarsal of a medium-sized bird, as well as a small-sized bird carpometacarpus compose the assemblage (Table 2).

For level 7, only three bird remains were recovered: a phasianid humerus, a small-sized Passeriformes ulna, and an undetermined medium-sized bird wing phalanx.

3.1.3. Level 8
Level 8 contains 19 bird remains from different family groups (Table 3), counting a total MNI of five. Small Passeriformes are the best represented (40 % of the total MNI), with two individuals (one adult and one immature). However, the Willow ptarmigan, the Alpine chough, and a large undetermined anatid are also present with one adult individual each. Among the identified taxa, small Passeriformes present a higher number of remains (n = 4). However, there are some remains belonging to undetermined large-sized (n = 3) and medium-sized (n = 6) birds that could complement the above-mentioned family groups, increasing the number of skeletal elements represented.

In general, long bones are the best represented. Among them, radii stand out with six elements (31.6 % of the total elements represented).

3.1.4. Level 9
Six bird bones compose level 9. They correspond to a total MNI of three: a Willow ptarmigan, an Alpine chough, and a small-sized Passeriformes. Among them, the Willow ptarmigan is the one presenting a higher number of remains (n = 3), which represents 50 % of the level 9 assemblage (Table 4). Tarsometatarsi are the best-represented elements, but there are only two elements.

Table 3
Number of avian remains recovered from level 8. The NISP and MNE coincide. Sca: scapula; cor: coracoid; fur: furcula; ver: vertebra; uln: ulna; rad: radius; tib: tibiotarsus; tmt: tarsometatarsus; pph: posterior phalanx. Lsz: large-sized; msz: medium-sized; ssz: small-sized.

	Anatidae lsz	*L. lagopus*	Phasianidae undet.	*P. graculus*	Corvidae undet.	Passeriformes ssz	Aves lsz	Aves msz	Total
sca		1						1	2
cor		1							1
fur								1	1
ver							2		2
uln	1					1			2
rad			1		1	1		3	6
tib						1			1
tmt				1		1			2
pph							1	1	2
Total	**1**	**2**	**1**	**1**	**1**	**4**	**3**	**6**	**19**

Table 4

Number of avian remains recovered from level 9. The NISP and MNE coincide. cor: coracoides; hum: humerus; rad: radius; tmt: tarsometatarsus; pph: posterior phalanx. msz: medium-sized; ssz: small-sized.

	L. lagopus	P. graculus	Passeriformes ssz	Aves msz	Total
cor	1				1
hum	1				1
rad		1			1
tmt	1		1		2
pph				1	1
Total	**3**	**1**	**1**	**1**	**6**

3.1.5. Other levels

Two more elements were documented at level 10. They correspond to a tibiotarsus of a small Passeriformes and a posterior phalanx of an undetermined medium-sized bird.

At level 12, two humeri of Willow ptarmigan, assigned to two different individuals were identified, as well as a fibula of a large-sized bird. Apart from that, a large-sized bird radius fragment was recovered in the El Juyo assemblage, but no level attribution was assigned to it.

In addition, a tarsometatarsus of a small Passeriformes was discovered and assigned to level 2/4. A vertebra of a small-sized bird was also discovered in the black layer above level 4, with no clear attribution.

3.2. Bone surface modifications

3.2.1. Fragmentation

Considering the fragmentation of the bone assemblage, the percentage of complete bones varies depending on the level. Level 4 has only 34.7 % of the bones complete. The same happens at level 8, where complete bones represent 36.8 % of the assemblage. At levels 7 and 9 the completeness of the elements is low or non-existent (14.3 % and 0 %, respectively). Level 6 is the only exception, with 66.6 % complete elements. However, considering the low number of bones represented in this unit, as well as the fact that most of the complete elements are small and compact bones (e.g., vertebrae or phalanges), this percentage should be taken with caution, as bone fragmentation affects mainly long bones.

A significant percentage of long bones present modern fractures in all the levels, which hinders interpretation: more than 44.4 % of bones have recent postmortem fractures in level 8. This percentage reaches 72.2 % at level 4, which also has a high NISP (Fig. 2). For those long bones whose fracture edges could be analysed, green fractures only represent 15.6 % at level 4, 0 % at level 6, 41.7 % at level 8 and 33.3 % at level 9. Only one Passeriformes tibiotarsus from level 4 has a dry fracture edge. In addition, any fracture could be directly related to human activities, as peeling or superficial flaking have not been observed on the specimens.

3.2.2. Carnivore activity

Potential bird of prey action is only documented on four bones from level 4, all from the Sanctuary area, in the innermost area of the vestibule. One of these bones is a long bone of an undetermined medium-sized bird presenting a crenulated edge at the fracture level. The remaining three bones have slight gastric erosion and represent 6.1 % of the total level 4 avian assemblage. Two of these specimens correspond to a proximal and distal tibiotarsus of a small Passeriformes, probably belonging to the same individual. The third element is a shaft segment of an undetermined medium-sized bird.

3.2.3. Anthropogenic activity

Anthropogenic activity has been documented in the form of burning damage (7 bones) and cut marks (3 specimens) (Table 5). Neither perforations nor wrenching associated with overextension processes nor human tooth marks were noted. Burning damage is more extensive. Four

Table 5

Table summarizing the bone surface modifications produced by human and non-human predators in the site.

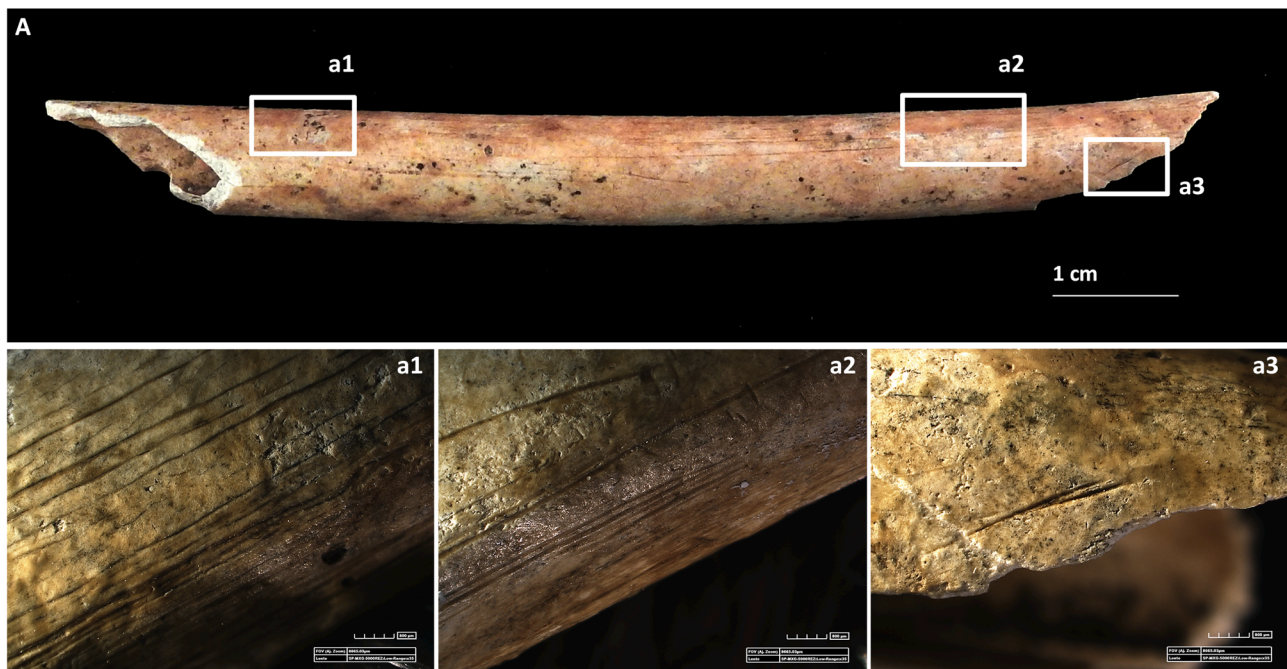| Modifications	Cut marks							Burning							Notches							Crenulated edges							Digestion						
Levels	4	6	7	8	9	10	12	4	6	7	8	9	10	12	4	6	7	8	9	10	12	4	6	7	8	9	10	12	4	6	7	8	9	10	12
Anatidae lsz				1														1																	
L. Lagopus					1				1																										
Corvidae msz										1																			2						
Passeriformes ssz								1																					1						
Aves msz				1				2			1	1										1													
Total				2	1			3	1	1	1	1						1				1							3						

Fig. 3. Large Anatidae ulna with scraping marks (a1, a2) and incisions on its surface (a3).

altered bones were found in the Sanctuary area of level 4 (8.2 % of the avian remains at this unit), corresponding to an ulna of a medium-sized corvid, a distal tibiotarsus of a small-sized Passeriformes, and a posterior phalanx and a humerus shaft of an undetermined medium-sized bird. All these bones present homogeneous colourations on the whole surface attributed to grade 2 of burning (Stiner et al., 1995), except for the humerus, which presents discontinuous thermal alterations on its surface (grade 1). At levels 6 and 8, respectively, one first metatarsal of an undetermined medium-sized bird (8.3 % of the level 6 assemblage) and a posterior phalanx of an undetermined medium-sized bird (5.3 % of the level 8 specimens) present homogeneous burning (grade 2). At level 9, a Willow ptarmigan coracoid has burning damage (grade 3) localised on its proximal end (5.3 % of the level 9 assemblage).

Cut marks are only present on three bones: two from level 8 and one from level 9. At level 8, a radius of a large undetermined bird presents a fine longitudinal scraping mark on the anterior shaft. The scraping is around 10.6 mm in length. In the same unit, the ulna of an undetermined

large anatid presents two groups of cut marks (Fig. 3). The first is an oblique incision of around 4 mm, close to one of the fracture edges of the bone (Fig. 3, picture a3). The second includes general longitudinal scraping along the whole bone shaft, suggesting that the bone was cleaned for an unknown purpose. This bone also has a notch on one of the fracture edges that might be of anthropogenic origin.

In level 9, the coracoid of a Willow ptarmigan presenting burning damage on its proximal end is associated with a group of three incisions on its *facies articularis humeralis* (ranging 1.5–3.1 mm in length) (Fig. 4).

3.2.4. Post-depositional modification

Post-depositional alterations are present at levels 4, 6, 8, 9 and 12 and affect 44.3 % of the assemblage (n = 43). The most extensive alterations are the coatings produced by manganese oxides (24 bones at level 4; one at level 6; ten at level 8; three at level 9 and one at level 12), which tend to spread arborescently throughout the bones, without covering them completely. Fissures are sporadically represented in levels 4 (n = 2), 8 (n = 3) and 9 (n = 2). Finally, trampling is rare and only present on one bone each from levels 4, 8 and 9. Chemical corrosion seems to be only present at level 8 (n = 3) and 9 (n = 1). None of the modifications described seem to affect bone surfaces to the point of hindering other possible interpretations on the site.

4. Discussion and conclusions

Although the number of bird specimens at El Juyo is limited, we have been able to obtain some interesting data. On the one hand, from a paleoecological perspective, the Willow ptarmigan is a species mainly found in subalpine and subarctic zones. This suggests habitats such as pine and birch forests, scrublands, tundra, and mountain slopes, where it finds ideal nesting conditions and sufficient food resources. The Alpine chough frequents high mountain meadows with cliff sides and rocky slopes. Both species are commonly found in the Cantabrian mountain range as it was during the Palaeolithic (Sánchez Marco, 2018; Blanco et al., 2021). The presence of anatids, and the possible presence of an ardeid bone in level 4, imply aquatic areas nearby. This description coincides with the previous studies concerning microfauna in the site, suggesting cold and open landscapes with some forest patches and grasslands, especially at levels 4 and 6 (Pokines, 1998, 2000a, 2000b,

Fig. 4. Willow ptarmigan coracoid with incisions on its proximal end (*facies articularis humeralis*). Burning damage can also be observed at the proximal part of the coracoid (see picture a1 on the right).

2000c).

On the other hand, the taphonomic analysis performed on the assemblage suggests that humans were the main accumulator agent on the site, at least for the anatids and phasianids. Those taxa present clear evidence of human activity on bones. In addition, they are not cave-dwelling birds, which suggests that they were brought to the cave by an external agent. However, the scarcity of avian remains recovered at El Juyo hinders further interpretation of both non-human and human activities carried out at the site. Despite some digestion traces being documented in level 4, their presence is minor, while burning damage and cut marks are more prevalent.

Digestive damage is only observed on small Passeriformes and an undetermined medium-sized bird bone. In addition, their level of digestion is light. Pokines (1998) suggested that the majority of the mammalian microfauna in the site could be related to the activity of barn owls. It is consistent with the results obtained from small birds (e. g., Laroulandie, 2002; Royer et al., 2019; Rufà and Laroulandie, 2019), which could indicate the sporadic consumption of birds by barn owls at the site. Those birds would have occupied an upper chamber suitable for roosting above the inner parts of the vestibule area, where carnivore damage is concentrated. However, the possibility that some birds may have died naturally on the site should not be completely ruled out. Some of the species documented, such as the Alpine chough or some Passeriformes, use caves and shelters for dwelling. Moreover, immature Passeriformes were found, especially at level 4 (23.1 % of the Passeriformes in the level), which could be compatible with chicks dying during the breeding season. Thus, even if no bones have been recovered in anatomical connection, the natural intrusion has to be taken into account for at least some species.

Human activity affecting the avian remains appears to have happened closer to the entrance. The presence of cut marks on a Willow ptarmigan coracoid suggests that this animal was processed by humans. Cut marks are located at the articulation of the humerus with the coracoid. Thus, the striae could be the result of separating the upper limb from the rest of the body to facilitate its consumption. This bone also shows localised burning. While burning damage can be accidental, the fact that it is localised at the proximal end suggests a roasting process related to the cooking and consumption of the prey.

Apart from the ptarmigan coracoid, the presence of two wing elements of large birds with scraping marks indicates that these avian bones were used for purposes other than food. Ulnae and radii are bones with little meat attached. Their dimensions and morphology make these bones ideal to be used as raw materials. There are many examples where bird bones could be used for that purpose. For example, Laroulandie (2016) observed similar traces on snowy owl remains during the Magdalenian in the Dordogne area, suggesting the cleaning of the bones to be used to make splinters. Goffette et al. (2020) also suggest the use of long bones of different bird species as raw materials at Trou de Chaleux (Belgium) during the late Magdalenian. Similarly, scraping marks on large bird ulnae have been recognised at the Upper Palaeolithic units (from Gravettian to the Magdalenian) of Isturitz (Buisson, 1990), and interpreted as cleaning marks to make flutes (García Benito et al., 2016). Thus, it is not surprising that similar uses could be reported in the case of El Juyo.

In summary, the avifaunal remains from El Juyo help us to understand the type of uses that Magdalenian societies could make of bird resources. Although the evidence is scarce, the type of striae observed on bones indicates uses that extend beyond the food itself and reflect the complexity of these past human groups. In addition, the involvement of other predators in the assemblage suggests that the cave was sporadically occupied by owls and other birds when humans were not using it (Pokines, 2000c).

CRediT authorship contribution statement

Anna Rufà: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Ruth Blasco:** Conceptualization, Funding acquisition, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – review & editing. **Melissa Menschel:** Data curation, Investigation, Supervision, Validation, Visualization, Writing – review & editing. **James T. Pokines:** Conceptualization, Data curation, Funding acquisition, Investigation, Project administration, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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