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Differential anuran bone preservation in a taphocenotic sample of Barn owl pellets

Preservación diferencial de huesos de anuros en una muestra tafocenótica de egagrópilas de lechuza común

KEY WORDS: Anura, Taphonomy, Osteology, Archaeozoology, Quaternary.
PALABRAS CLAVE: Anura, Tafonomía, Osteología, Arqueozoología, Cuaternario.

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Zorretan gaude J. ALTUNA profesorearekin iberiar penintsulako faunaren historia ulertzeko bere etengabeko ikerlanak eskaintzen dizkigulako.

ABSTRACT

Remains derived from the predation of nocturnal prey birds are the most important taphocenotical origin for the fossil amphibians recovered in European Quaternary sites. We analyze a Recent deposit of Barn owl (*Tyto alba*) pellets, close to its taphocenotic destruction, found near Campos y Salave (Asturias, northern Spain). A total of 4973 anuran bones were recovered, that represent at least 140 individuals. The relative degree of conservation, ease for identification, and variation in the inference of the Minimum Number of Individuals, is calculated for each of the main bones of the skeleton in two of the species present (*Discoglossus galganoi* and *Rana temporaria*). There are no significant differences in preservation between bilateral elements, nor in the proportion of elements between species, but very large differences in the architectural strengh of each bone are detected, leading to differences in their capability to be recovered from the sediments. The ilium is ratified as the single element having the highest potential to be preserved and recovered, being a reliable basis for taxonomic identification.

RESUMEN

Los restos procedentes de la depredación de rapaces nocturnas son el componente tafocenótico más importante de los anfibios recuperados en yacimientos del Cuaternario europeo. En este trabajo se analiza un depósito actual de egagrópilas de Lechuza común (*Tyto alba*), próximo a su destrucción tafocenótica, procedente de Campos y Salave (Asturias). Se han recuperado 4973 huesos de anuros, pertenecientes a 140 individuos. Para dos de las especies presentes (*Discoglossus galganoi* y *Rana temporaria*), se calcula el grado de conservación, capacidad de identificación y variaciones en la inferencia del Número Mínimo de Individuos de cada uno de los elementos principales del esqueleto. No hay diferencias significativas de conservación entre elementos bilaterales, ni de proporción de elementos entre especies, detectándose en cambio grandes variaciones en resistencia estructural de cada hueso, y por ende en su facilidad para ser recuperados. El ílion se confima como el elemento individual que presenta la mayor capacidad de conservarse y ser recuperado, siendo una base firme para la identificación taxonómica.

LABURPENA

Gaueko hegazti harrapariek utzitako hondakinak dira Europako Kuaternarioko aztarnategietan berreskuratu diren anfibio-hondakin lurperatuen osagairik garrantzitsuenak. Lan honetan hontz zuriaren (*Tyto alba*) duela gutxiko egagropila-metaketa bat aztertzen da. Campos eta Salave-eko (Asturias) metaketa hori desegite tafozenotikotik gertu dago. Anuruen 4.973 hezur aurkitu dira, guztira 140 animalienak. Agertu diren bi espeziei dagokienez (*Discoglossus galganoi* eta *Rana temporaria*) kontserbatze maila eta identifikagarritasuna kalkulatu dira, hala nola eskeletoaren elementu garrantzitsu bakoitzetik ondoriozta diren gutxiengo ale kopuruan eman daitezkeen aldeak. Elementu bilateralen artean ez dago ezberdintasun nabarmenik kontserbatzeari dagokionez, ezta espezien arteko elementuen proportzioan ere ez dago ezberdintasun aipagarririk. Alabaina, hezur bakoitzean erresistentzia estrukturalari dagokionez alde handiak atzeman dira, eta ondorioz horiek aurkitzeko erraztasunean. Kontserbatzeko gaitasunik handiena duen hezurra iliona dela egiaztatu da; hezur hori da, beraz, identifikatze taxonomikorako oinarririk sendoena.

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INTRODUCTION

Most of the anuran palaeontological material recovered from European Pleistocene and Holocene sites is found in cave or shelter deposits (HOLMAN, 1998; SANCHIZ, 1998). The evidence of the micromammal composition of these Quaternary layers (FERNANDEZ-JALVO & ANDREWS, 1992; FERNANDEZ-JALVO, 1995), as well as the observations made in Present situations (e.g. ANDREWS, 1990; SANCHIZ, 1980), frequently indicate that the taphocenotic origin responsible for such microvertebrate assemblages is the accumulation of prey bird pellets. Remains derived from the predation of Barn owls (*Tyto alba*) are particularly interesting, because unlike other birds of prey they frequently maintain the same roosting places in shelters during generations, and the process of pellet formation results only in relatively slight bone alterations (FERNANDEZ-JALVO & ANDREWS, 1992; PINTO LLONA & ANDREWS, 1999). Furthermore, the Barn owl diet incorporates a small seasonal amphibian component, not always so clearly observed in the diet of other prey birds (e.g. UTTENDÖRFER, 1952; MARTIN & LOPEZ, 1990; REY *et al.*, 1994).

The amphibian elements recovered in a palaeontological or archaeological excavation in Quaternary deposits is the resultant of several natural processes, the general taphocenotic components, but also deeply modified by a potential bias derived from the technical procedures adopted by the excavation. Two of these components have never been subject to scrutiny, namely, the differential potential for preservation inherent to the architecture of each bone, and the facility by which their fragments can be identified during the sorting stage, when they are being selected among a large number of mixed and broken discarded mammalian bones. A large number of Recent anuran remains derived from Barn owl predation in one deposit in northwestern Spain, treated as an archaeozoological sample, has allowed us to provide the first preliminary quantitative data on the differential preservation and recognition capabilities of the main bone elements of the anuran skeleton. We consider these quantitative data relevant because they provide a confidence interval to the current zooarchaeological standards, and explore the possibility of future palaeobiological inquiries, beyond and not limited to the inference of the taxa and minimum number of individuals recovered.

MATERIAL AND TECHNICAL PROCEDURES

A sample of Barn owl (*Tyto alba*) pellets has been recovered (28th May, 2003) from an attic under the broken roof of an isolated and no longer used rural building about 1 km west of Campos y Salave (Asturias), placed at coordinates 29T PJ6925 in the Spanish geographical UTM reference grid. With a few exceptions that were used to identify the predator species, all the pellets were old and almost completely dissociated. Actually, the conditions of the deposit indicate that the material would surely have been destroyed within a few weeks. This situation thus matches the latest stage prior to burial of the bones in the taphocenotic development of a Quaternary shelter deposit.

The sample was first washed and screened in the laboratory using an 1.2 mm sieve. Flotation allowed to remove the large vegetal elements from the sample. The material was subsequently subject to water cleaning by ultrasounds (*Selecta Ultrasons 3000513*), followed by water screening using fine 0.5 mm meshes. In this way the bones were almost completely isolated. Once completely dry, all bones recognized as anuran ones were recovered under the binocular (magnification 2.6:1) by one of us (BS), having an experienced knowledge of the anuran morphology. The elements recovered at this stage are labelled as T1 in Table 1.

Afterwards, a second cycle of water ultrasound cleaning and screening (0.5 mm meshes) was performed. Once dried, the bones were free form most of the pellet's hair, and with the exception of mammal ribs and unidentifiable minute skull fragments, all the vertebrate bones were subsequently recovered. However, all the discarded material has also been kept at voucher. Again, one of us (BS) tried to exhaustively extract from this bone assemblage all the possible anuran elements, using binocular at higher magnification than before (4.1:1). The anuran material recovered at this stage is labelled as T2 in Table 1.

As a result of the whole process, a total of 4973 amphibian bones were recovered, not including in this figure the carpal, metacarpal, tarsal, metatarsal and phalanx elements, which were kept separately and are not considered in the present study. A total of 14 maxillary minute fragments could not be identified to species, and one centrum belonging to the Common or Grass frog could not be assigned to any vertebral rank, leaving 4958 remains completely identified to both

species and element, which are the basis for the present study. This material is stored in the Herpetological collection of the Museo Nacional de Ciencias Naturales, C.S.I.C. in Madrid, a collection that has also been used to provide the necessary compative material. Specimens MNCN 41080 (*Discoglossus galganoi*) and MNCN 14827 (*Rana temporaria*) have particularly been used as anatomical standards.

The minimum number of individuals (MNI) inferred on the available fragments is calculated after the number of each single element recovered, taking into account its side, sex (if possible), and the presence of a particular region of the bone (e.g. proximal, acetabular etc).

RESULTS

Three anuran species, representing at least 140 individuals, have been identified in the deposit: *Discoglossus galganoi, Hyla arborea, and Rana temporaria*. However, remains of the European Tree frog are merely limited to nine bones from 3 individuals, and cannot be quantitatively analyzed. From the remaining 4949 identified fragments, 91.4% belong to *D. galganoi* and 8.6% to *R. temporaria*, a minimum of 117 and 20 specimens respectively. Table 1 gives information on number of rests recovered in the two sorting stages, proportion of right side in bilateral elements, and minimun number of individuals inferred after each bone. The adult Barn owl normally swallows entire preys (e.g. MIKKOLA, 1983), and therefore it is expected that all the bones in the skeleton would be present. The results (Table 1) indicate the following patterns:

- As expected, the number of right elements does not significantly differ from the number of left ones, taking into account each sample size (χ^2.test, $p< 0.05$).

- The relative frequencies obtained in *D. galganoi* and *R. temporaria* for each bone are similar, with significant correlations ($r= 0.82$, $p< 0.05$) for both the number of rests and the minimum number of specimens inferred.

- Similarly in both species, the number of rests recovered in the first (T1) and second (T2) selection rounds seem related to the overall bone size. Our experience shows that the shape of a complete bone (or large part of it) is the first trait in which identification relies, this shape usually partially hidden by hair and dirt in T1.

- The number recovered of each element differs considerably within a species, all the elements being initially swallowed. Therefore, their underepresentation derives from two possible main sources. In the first place, the bones could be differentially altered (even destroyed) during the pellet formation in the avian gizzard, or afterwards in the sediment, becoming masked to such an extent that they are no longer easily identifiable. As a second possibility, the bones could not be recognized in the selection process just because of human error. We have tried to minimize the later aspect, but the selection of minute bones mixed among thousands of mammalian remains, in a reasonable time, is a difficult task. In any case, the figures in Table 1 give a realistic maximum potential probability of each element to be recovered in a fossil assemblage. Its differences with the much smaller proportions actually found are theoretically derived from: a) destruction during the period of burial in the sediments, variable according to site conditions; b) destruction or lost during the excavation washing and screening of sediments, sometimes using meshes >>1 mm; and c) lack of experience or adequate anatomical knowledge in the process of selection of the herpetological elements.

- The ilium is the single bone more frequently used in anuran palaeontology for taxonomic identification, being the preferred element to be considered holotype or paratype in the description of new fossil species (SANCHIZ, 1998). Table 1 confirms that the ilium is also a structurally robust element, actually the most frequently recovered in the combined assemblage and particularly in *D. galganoi,* only slightly behind distal humerus and central tibiofibular fragments in *R. temporaria*. This bone is thus ratified as the single element having the highest potential to be preserved and recovered, being both a reliable basis for taxonomic identification and abundance estimations.

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Element	part	Dga NRI T1	Dga NRI T2	Dga R %	Dga NRI	Dga MNI	Dga il P	Rte NRI T1	Rte NRI T2	Rte R %	Rte NRI	Rte MNI	Rte il P	Total NRI	Total NMI
Premaxilla	med	13	61	43,2	74	42	0,36	2	9	45,5	11	6	0,43	85	48
Maxilla	pos	163	52	46,0	215	79	0,68	13	6	47,4	19	6	0,43	234	85
Nasal	lat	17	25	52,4	42	20	0,17	0	0		0	0		42	20
Sphenethmoid	cen	67	5		72	72	0,62	6	2		8	8	0,57	80	80
Frontoparietal	pos	125	46	45,5	171	90	0,77	2	4	66,7	6	4	0,29	177	94
Prootic	ant	161	9	49,4	170	85	0,73	11	2	53,8	13	7	0,50	183	92
Exoccipital	pos	160	9	49,7	169	85	0,73	15	6	42,9	21	12	0,86	190	97
Pterygoid	cen	97	55	50,0	152	74	0,63	13	6	52,6	19	10	0,71	171	84
Squamosal	cen	58	68	53,2	126	67	0,57	4	1	20,0	5	4	0,29	131	71
Vomer	lat	3	9	33,3	12	7	0,06	0	0		0	0	0,00	12	7
Parasphenoid	pos	52	0		52	52	0,44	5	0		5	5	0,36	57	57
Quadrato-jugal	pos	2	45	51,1	47	24	0,21	1	0	100	1	1	0,07	48	25
Angulosplenial	pos	165	20	50,8	185	94	0,80	17	1	55,6	18	10	0,71	203	104
Dentary	ant	54	35	47,2	89	46	0,39	0	2	50,0	2	1	0,07	91	47
Thyroid		6	69	50,7	75	38	0,32	0	0		0	0	0,00	75	38
Atlas	ven	82	5		87	87	0,74	7	1		8	8	0,57	95	95
V2		69	14		83	83	0,71	9	3		12	12	0,86	95	95
Rib V2		1	8	44,4	9	5	0,04							9	5
V3		94	9		103	103	0,88	10	0		10	10	0,71	113	113
Rib V3		21	87	48,1	108	56	0,48							108	56
V4		78	12		90	89	0,76	3	1		4	3	0,21	94	92
Rib V4		4	4	50,0	8	4	0,03							8	4
V5		75	12		87	86	0,74							87	86
V5-V7								24	4		28	10	0,71	28	10
V6-V7		173	9		182	91	0,77							182	91
V8		69	16		85	85	0,73	7	1		8	8	0,57	93	93
Sacrum	ven	93	6		99	95	0,81	12	0		12	12	0,86	111	107
Urostyle	ant	105	6		111	110	0,94	12	2		14	13	0,93	125	123
Omosternum								0	5		5	5	0,36	5	5
Cleithrum	ant	116	30	49,3	146	71	0,61	5	0	60,0	5	3	0,21	151	74
Scapula	lat	133	34	53,3	167	88	0,75	16	4	55,0	20	11	0,79	187	99
Clavicle	lat	126	40	52,4	166	84	0,72	1	8	22,2	9	7	0,50	175	91
Coracoid	lat	153	28	47,5	181	93	0,79	21	2	43,5	23	13	0,93	204	106
Sternum								3	2		5	5	0,36	5	5
Humerus	dis	205	3	52,4	208	107	0,91	26	0	38,5	26	16	1,14	234	123
Radioulna	pro	196	12	49,0	208	106	0,91	24	0	37,5	24	14	1,00	232	120
Ilium	acet	232	2	50,4	234	117	1,00	24	0	58,3	24	14	1,00	258	131
Ischium	acet	75	5		80	80	0,68	9	1		10	10	0,71	90	90
Femur	pro	210	7	49,3	217	110	0,94	17	0	41,2	17	10	0,71	234	120
Tibiofibula	cen	209	6	48,8	215	110	0,94	32	0	37,5	32	20	1,43	247	130
TOTAL		**3662**	**863**		**4525**	**117**		**351**	**73**		**424**	**20**		**4949**	**137**

Table 1. Results of the taphocenotic analysis. Dga: *Discoglossus galganoi.* Rte: *Rana temporaria.*
NRI: Number of rests identified. NMI: Minimum number of individuals.
T1 and T2: first and second amphibian separation stages.
il-P: ratio of detection of NMI with relation to the ilium. Blank cells indicate non applicable possibilities.
acet: acetabulum lat: lateral
ant: anterior med: medial
cen: central pos: posterior
dis: distal pro: proximal
ven: ventral.

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