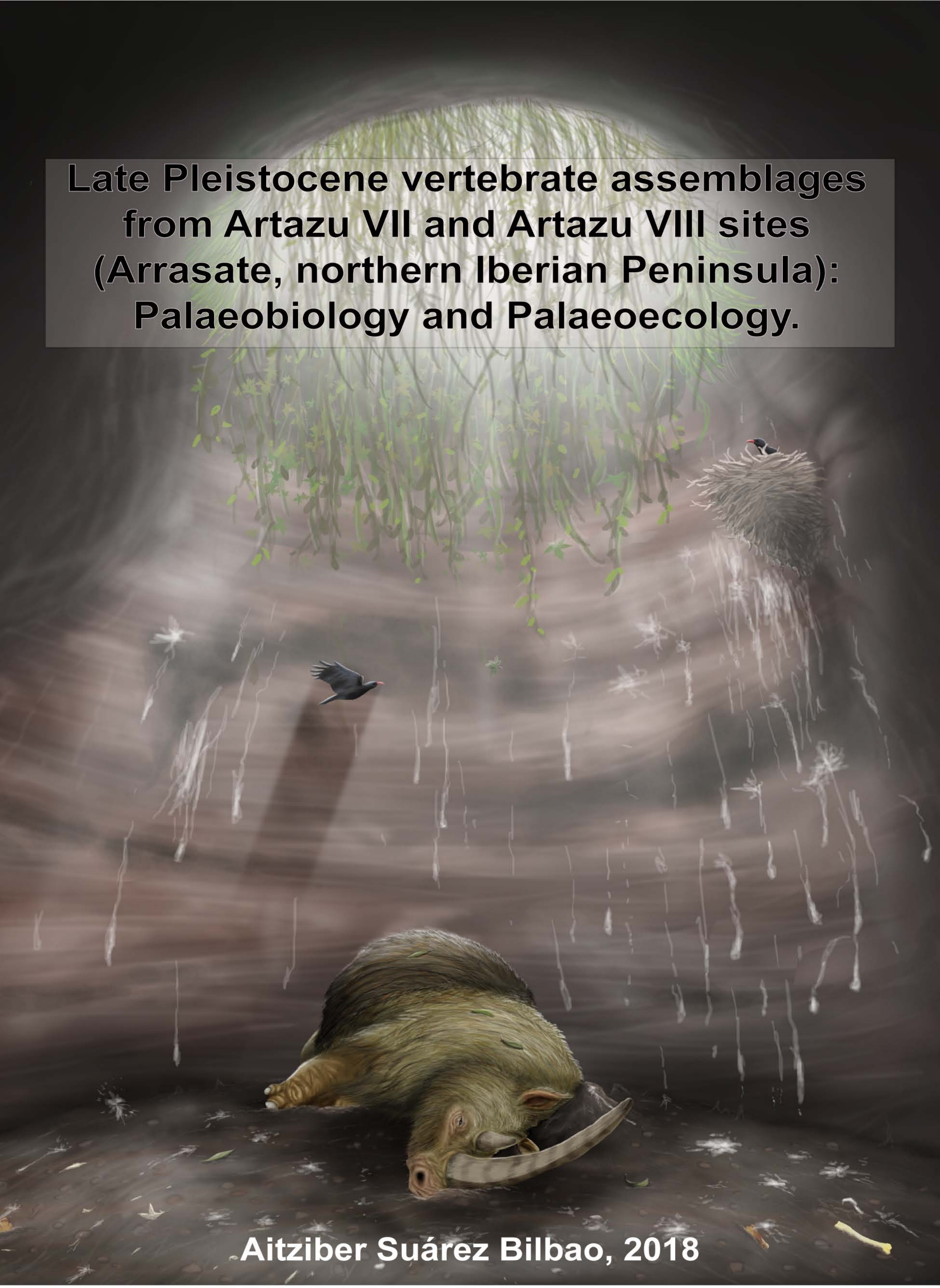

Late Pleistocene vertebrate assemblages from Artazu VII and Artazu VIII sites (Arrasate, northern Iberian Peninsula): Palaeobiology and Palaeoecology.

Aitziber Suárez Bilbao, 2018

eman ta zabal zazu

Universidad del País Vasco

Euskal Herriko Unibertsitatea

ZIENTZIA
ETA TEKNOLOGIA
FAKULTATEA
FACULTAD
DE CIENCIA
Y TECNOLOGÍA

TESIS DOCTORAL

La ilustración de la portada de esta memoria es creación original del Dr. Carlos de Miguel. La ilustración de los fondos del título de cada capítulo es creación original de la autora de esta memoria, Aitziber Suárez.

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UNIVERSIDAD DEL PAÍS VASCO (UPV-EHU)
FACULTAD DE CIENCIA Y TECNOLOGÍA
DEPARTAMENTO DE ESTRATIGRAFÍA Y PALEONTOLOGÍA

Late Pleistocene vertebrate assemblages from Artazu VII and Artazu VIII sites (Arrasate, northern Iberian Peninsula): Palaeobiology and Palaeoecology

TESIS DOCTORAL

Aitziber Suárez Bilbao

Bajo la dirección de los Drs.:

Xabier Murelaga Bereicua	Naroa Garcia Ibaibarriaga
Departamento de Estratigrafía y Paleontología	Departamento de Geografía, Prehistoria y Arqueología
Facultad de Ciencia y Tecnología	Facultad de Letras
Universidad del País Vasco (UPV-EHU)	Universidad del País Vasco (UPV-EHU)

Leioa, octubre de 2018

“No se trata de qué fuerte golpees, se trata de cuanto eres capaz de soportar ser golpeado y seguir moviéndote. Así es como se gana”

Sylvester Stallone

“Cada día sabemos más y entendemos menos”

Albert Einstein

GENERAL INDEX

Quiero dar comienzo al apartado de agradecimientos con unas palabras a alguien que siempre estuvo, está y estará a mi lado, y que a la vez hace mucho que dejó de estarlo. A alguien que se fue de mi vida demasiado pronto, tan pronto que ni si quiera me dio tiempo a crear un recuerdo de él, hablo de ti, aita. Este año hacen 25 años que te fuiste de mi vida, y casualidad es cuando termino de doctorarme. No te conocí, pero tú a mi sí. Aun así, es como si te hubiese conocido, ya que he oído y oigo mucho hablar de ti. Eras profesor de Historia y te llamaba mucho la atención "lo antiguo". Por esta razón, sé que estarías doblemente orgulloso de mí: por llegar donde he llegado y por el tema que elegí para hacerlo. Hubieras disfrutado y aprendido conmigo cada día. Desgraciadamente eso no ha sido posible, es por ello por lo que quiero dedicarte íntegramente esta tesis doctoral, esto va por ti.

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Jarraian nire zuzendariei eskertu nahi diet eman didaten aukera. Xabier Murelagari eskeiniko dizkiot lehenengo lerroak. Nire zuzendariaz gain nire irakaslea, laguna eta sostenguenetariko bat izan zara. 11 urte dira jada elkar ezagutu genuela eta hasieratik nigatik kezkatu izan zara. Eskerrik asko zurekin lan egiteko emandako aukera paregabe honengatik. Zuregandik asko ikasi dut; benetan landan lan egitea zer den ikasi dut (batzuetan gehiegi), ikerkuntzan orduak eta orduak sartzen ikasi dut, eskolak ematen ikasi ditut, dibulgatzen ikasi dut, eta baita bizitzarako hainbat lezio "*que los malos sean ellos*", "*hay que ser paleopolíticamente correcto*" e.a. Nahiz eta zure esaldirik gustokoena gorroto dudan "*lasai hartu*", kontua da azkenean pazientzia pixkat gehiago izatea lortu dudala. Eskerrik asko nigan izan duzun konfiantzagatik, nigan beti sinesteagatik, lan egiterako orduan emandako askatasunagatik eta emandako animo guztiengatik (batez ere azken hilabete hauetan). Badakit une asko egon direla ados egon ez garenak, eta non, nire jenio txarragatik, ez den erraza izan nirekin eztabaidatzea. Garrantzitsuena beti akordio batetara iritsi izan garela eta biok zerbait elkarrengandik ikasi dugula da (behin baino gehiagotan arrazoia eta guzti eman didazu!). Behin ere, mila esker!. Jarrian “*Sis*”, Naroa Garcia, eskertu nahi dut. Hasieran beste doktorego ikasle bat bezala ezagutu zintudan, geroago lankidea bihurtu zinen, ondoren laguna eta azken finean kozuzendaria. Honetaz gain, beti nire “*ahizpa nagusia*” izan zara, nire erreferentea hasi nintzenetik. Elkarren haserrealdiak pairatu izan ditugu (bai lanekoak zein lan kanpokoak) eta ehundaka aholku eman dizkiogu elkarri (batez ere zuk niri). Zenbat ordu pasa ote izan ditugu guztira telefonoz hitz egiten?. Beti hor egon zara, eta lau urteko bide honetan behar izan dudan beste sostenguenetariko bat izan zara. Zugandik ikasi dudana seriotasuna (zentzu onean) eta lan konstantzia izan dira, helburuak lortu arte borrokatzen. Baina batez ere eskerrak eman nahi dizkizut egindako zuzenketa guztiengatik (eta asko izan dira!), zure “*modo de corrector* ____ ____ *con cariño*”-rekin. Eskerrik asko bihotz-bihotzez!. Bukatzeko, Alvaro Arrizabalaga, nahiz eta nire kozuzendaritzan gauzak aldatu izan diren, benetan eskertu nahi dizut kozuzendariaren eginkizuna burutzeagatik ia bukaerararte. Zuri esker ikasi nuen industen, 2011. urtean Irikaitz aztarnategian. Bertan hasi nintzen ikerkuntzari buruz jakin-mina izaten. Gainera, ezagutu ninduzunetik beti nigan interesa erakutsi duzu. Oraindik gogoan daukat “*Aitziber, zuk Kuaternarioa eh*?”. Beraz, tesi hau nolabait zure insistentziari esker izan da. Eskerrik asko.

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ABSTRACT

The Late Pleistocene was a period characterized by numerous climatic fluctuations that occurred in millennial scale alternating cold and warm moments. Unfortunately, Late Pleistocene palaeontological sites without human intervention are limited in the Iberian Peninsula, and even more those with good state of preservation and rich taxa diversity. Thus, two new vertebrate fossiliferous localities are presented in this thesis: Artazu VII and Artazu VIII. Both sites were discovered after a blasting at Kobate Quarry (Arrasate, northern Iberian Peninsula). The good integrity and good state of preservation of large mammal bones, as well as the lack of anthropological or predator activity, discarded the possibility of an anthropogenic origin for both sites.

This thesis constitutes a compilation of different types of studies, all of them focused on the reconstruction and evolution of the environment during Late Pleistocene. The stratigraphic sequence has been correlated to Marine Isotopic Stages (MIS), taking into account Radiocarbon (AMS) and Amino Acid Racemization (AAR) datings and the palaeoenvironmental variations inferred from the small vertebrates community. In addition, we compare these results with the information available for the same periods at other sites in the Iberian Peninsula.

- Artazu VII site was discovered in 2012 and excavated in 2013 by an emergency excavation. There were no clear stratigraphic sequence or levels, and AMS and ARR datings situated the site in ~ 93 ka BP. The fossiliferous record (small mammals, amphibians, reptiles, ungulates, carnivores and birds) suggested the existence of large forested areas with some grassland and a water course nearby, within a notably warm and humid climate. Indeed, regarding woodland expansion and retraction, four climatic main phases were observed. These palaeoenvironmental conditions, combined with dating results, suggest that the deposit from Artazu VII would be located in the first half of the Late Pleistocene, in the MIS 5c.

- Artazu VIII site was found in 2013 and the excavation was carried out in the following two years. Based on sedimentological features, 12 levels were differentiated along the sequence. According to AMS and ARR datings, the sedimentary fill was a continuous succession that comprises, at least, 36 ka of the late Pleistocene. The small and large mammal assemblages and the preserved bird community, as well as the mineralogical and sedimentological studies, allowed the approach to the palaeoclimatic conditions and the evolution and sedimentary fill origin of this cave. Three palaeoenvironmental and palaeoclimatic stages were differentiated and correlated to NGRIP ^{18}O curve, from MIS 5c? to MIS 4.

LABURPENA

Goi Pleistozenoaren ezaugarri bereizgarriena milurteko eskalan emandako klima-aldaketa ugariak dira, garai epel eta hotzen txandakatzea emango zelarik. Zoritxarrez, ez dira ohikoak giza aztarnarik gabeko Goi Pleistozenoko aztarnategi paleontologikoak, are urriagoak direlarik hezurren kontserbazio ona eta ornodun taxoi kopuru handia duten metakinak. Tesi honetan, bi aztarnategi berriren ikerketaren emaitzak aurkezten dira: Artazu VII eta Artazu VIII. Bi metaketak Kobate Harrobian (Arrasate, Iberiar Penintsularen iparraldea) egindako leherketen ondorioz azaleratu ziren. Jatorri antropologikoaren aukera baztertu da bi aztarnategietarako, eta honen ordez tranpa natural bezala funtzionatu zutela proposatu da, non animaliak ustekabean eroriko ziren.

Tesi hau mota desberdinetako azterketen sintesia da, helburua garai horretako paisaia eta paleoklimaren berreraikuntza egitea izanik. Bi aztarnategiak Itsas Estadio Isotopikoekin (MIS) alderatu dira, kontuan izanik Radiokarbono (AMS) zein Amino Azido Razemizazio (AAR) bidezko datazioak eta mikroornodunen ikerketatik ondorioztatutako ingurunearen baldintzak. Gainera, Iberiar Penintsulako kronologia berdina duten beste aztarnategiekin konparatu dira.

- Artazu VII aztarnategia 2012. urtean aurkitu eta 2013. urtean industu zen, larrialdi-indusketa baten bitartez. Aztarnategi honek ez zuen estratigrafia argirik erakusten, hortaz, ez zen nibelen desberdinketarik egin. AMS eta ARR datazioen arabera aztarnategiak ~ 93 ka BP urteko antzinatasuna izango luke. Bertan mantendutako erregistro fosiletik (mikrougaztunak, anfibioak, narrastiak, ungulatuak, karniboroak eta hegaztiak) ondorioztatu da klima epela eta hezea izan zela, halaber, eremuan baso zein belardiak eta ur eremuak izan zirela nagusi. Hala ere, basoaren hedapen eta atzerapenen arabera lau fase klimatiko bereiztu dira paleoklima honen barnean. Antzemandako paleoingurumen baldintzak datazioekin parekatuta, Artazu VII aztarnategia MIS 5c-an kokatuta egongo litzateke.

- Artazu VIII aztarnategiaren aurkikuntza 2013. urtean gertatu zen, eta hurrengo bi urtetan industu zen. Ezaugarri sedimentologikoak kontuan izanik 12 nibel desberdindu ziren sekuentzian zehar. AMS eta ARR datazioen arabera sedimentazioa jarraia izan zela esan daiteke, gutxienez Goi Pleistozenoko 36 ka-ko denbora tartea barnean hartzen duelarik. Bertan kontserbatutako mikrougaztun, makroornodun eta hegazti elkartea aztertu eta analisi sedimentologiko eta mineralogikoak egin dira. Ondorioz, ezaugarri klimatikoen eta sedimentazioaren jatorria zein eboluzioa interpretatu dira. Ondorioztatutako baldintza klimatikoen arabera lau fase desberdindu dira haitzuloa aktibo egon zen bitartean. Bukatzeko, NGRIP ^{18}O kurbarekin konparatuz, Artazu VIII MIS 5c?-tik MIS 4-ra korrelazionatu da.

RESUMEN EXTENDIDO

El Pleistoceno Superior representa una fase crítica de la historia humana. En concreto, se caracteriza por englobar diversos cambios climáticos, tanto de escala global como regional, que afectan de manera directa a la biocenosis de ambientes muy diversos y al reemplazo de las especies presentes. Por lo tanto, resulta importante la obtención de datos paleoambientales y paleoclimáticos en medios continentales, puesto que, además de constituir el hábitat de nuestra especie, son zonas muy sensibles ante el cambio climático, con una evolución y una respuesta ambiental rápidas ante cualquier alteración del ecosistema. El empleo de bioindicadores precisos, cuyas asociaciones registran cualquier alteración climática de manera detallada, permite efectuar trabajos paleoecológicos y paleoambientales de alta resolución. Sin embargo, yacimientos exclusivamente paleontológicos de esta época y sin presencia de actividad humana son muy escasos en la Península Ibérica, y más aun los que han sido excavados de forma sistemática y en los que se haya realizado un estudio completo de los vertebrados. Así, esta tesis presenta un estudio integral (radiometría, sedimentología, estratigrafía, geoquímica, paleontología y climatología) de dos yacimientos, Artazu VII y Artazu VIII, descubiertos accidentalmente tras varias voladuras en la Cantera de Kobate (Arrasate, Gipuzkoa, norte de la Península Ibérica) en el 2012 y en el 2013, respectivamente. Ambos yacimientos se encontraban en el sistema kárstico del Valle del Deba, concretamente en el flanco suroeste del Monte Artazu. Sin embargo, Artazu VII estaría ubicado en el borde de la ladera de la montaña en un relieve abrupto y más deforestado, mientras que Artazu VIII se ubicaría hacia el interior de la montaña en una llanura con más vegetación.

Estos dos nuevos yacimientos poseían un carácter exclusivamente paleontológico, ya que no se detectó en ellos indicio alguno de actividad humana ni de depredación, y la mayoría de los restos se recuperaron enteros o con fracturas postdeposicionales. Así pues, se descartó el origen antrópico como causa de estas acumulaciones, proponiendo que funcionaron como trampas naturales en las que diversos animales cayeron accidentalmente. Por lo tanto, al tratarse de acumulaciones no generadas por ningún agente biológico, la biocenosis representada no se encuentra sesgada por las apetencias tróficas de ningún organismo. De esta manera, la asociación faunística recuperada refleja, de una manera más precisa, la fauna del entorno en el momento del relleno de las cavidades. Finalmente, en relación a la fauna preservada en ambos yacimientos, esta tesis representa algunas citas y hechos de gran relevancia.

Artazu VII

La mayor parte de la cavidad fue destruida con la voladura que dio lugar a su descubrimiento, preservándose únicamente una fracción del sedimento que la rellenaba adherida a la pared. Aunque lo reducido de la muestra ha supuesto un gran impedimento a la hora de reconstruir la cavidad, ha sido suficiente para un acercamiento. La secuencia estratigráfica no mostraba diferencias en el sedimento, por lo que la distinción de niveles no fue posible. Así pues, todo el enclave fue considerado como un único nivel, diferenciándose tres zonas de depósito. Las dataciones por Radiocarbono (AMS) y Racemización de Aminoácidos (AMS) realizadas en restos de macrofauna sitúan el yacimiento alrededor del ~ 93 ka BP.

Se han identificado un total de 24 taxones a nivel de género/especie entre los microvertebrados (micromamíferos, reptiles y anfibios), 14 en macrovertebrados (ungulados y carnívoros) y 12 en aves, destacando el gran número de carnívoros (29,1 % de la acumulación global). Esta asociación faunística incluye una de las colecciones más abundantes en restos de *Panthera pardus* (Leopardo) y *Lyrurus tetrix* (Gallo Lira) y la segunda cita fosilífera de *Buteo lagopus* (Ratonero Calzado) de la Península Ibérica, así como una de las mejores y más abundantes muestras de *Coturnix coturnix* (Codorniz Común) para el Pleistoceno Superior. Según estudios tafonómicos, parte de las aves residían en las grietas de la cavidad, al menos en la época de reproducción, y la otra parte fue acumulada por la acción de aves rapaces. Todos los análisis realizados apuntan a *Bubo bubo* (Búho Real) como posible depredador. Respecto a los microvertebrados, se ha concluido que una parte vivía allí, mientras que la otra parte se originó por la acción de los búhos y aves de presa diurnas.

Los resultados obtenidos del estudio de la asociación de vertebrados, así como del análisis geoquímico, son congruentes entre sí, apuntando hacia las mismas condiciones paleoambientales y un paisaje similar. Así, en general, las condiciones paleoambientales inferidas del estudio de los pequeños vertebrados muestran una mezcla de bosques y pastizales a lo largo de la secuencia estratigráfica con un cierto grado de humedad en el ambiente. De la misma manera, el conjunto de macromamíferos sugiere un entorno complejo, compuesto por un paisaje húmedo con bosques con espacios abiertos. Las fluctuaciones de los valores de $\delta^{13}C$ de los ungulados han sido atribuidos a un cambio en la dieta de los mismos y, por lo tanto, a la expansión o disminución de la masa forestal. Así, los valores más negativos de $\delta^{13}C$ muestran los momentos en los que abundaban en el paisaje las plantas C3 (arbustos), mientras que los valores más positivos corresponden a momentos con plantas C4 (hierba). Respecto a los valores $\delta^{15}N$, aunque en general los valores son consistentes con el nivel trófico en el que se encuentran los carnívoros y herbívoros, un individuo de *Vulpes vulpes* (Zorro Rojo) muestra valores inusuales. Este hecho ha sido vinculado con un cambio en el origen del animal o con una dieta omnívora por causa de una menor disponibilidad de los recursos cárnicos. Además, se ha identificado la presencia de dos individuos juveniles de *Rupicapra pyrenaica* (Rebeco) y *Cervus elaphus* (Ciervo Común). Finalmente, de acuerdo con las percepciones paleoambientales de las aves, el paisaje circundante a la cavidad correspondería, en el momento de la acumulación de los restos óseos, con el de una zona de montaña intermedia dominada por bosques, prados mixtos y un curso de agua cercano al yacimiento. Sin embargo, mientras que el análisis de pequeños vertebrados indica un ambiente relativamente cálido, el análisis de las aves apunta a una mezcla entre clima frío y templado. Esto podría explicarse por los movimientos de migración de aves marcados por la estacionalidad, desde latitudes altas hacia el sur. Si bien el desarrollo de biotopo forestal y, por lo tanto, el desplazamiento de los mamíferos estenoicos son procesos que llevan mucho tiempo, la migración de las aves ocurre en periodos cortos de tiempo.

Las dataciones realizadas sitúan el depósito de Artazu VII en la primera mitad del Pleistoceno Superior, en el MIS 5. Añadiendo a este hecho las condiciones paleoambientales inferidas para esa época, Artazu VII ha sido correlacionado con el subestadio MIS 5c. No obstante, de acuerdo a la tendencia de expansión/retracción del bosque inferido se han establecido cuatro fases. La Etapa 1 comienza con el momento de menor desarrollo forestal, expandiéndose progresivamente hasta alcanzar el máximo momento de desarrollo. Más tarde, en la Etapa 2, el biotopo forestal disminuye ligeramente. En la Etapa 3 la masa boscosa se expande de nuevo y, finalmente, en la Etapa 4, disminuye hasta alcanzar una extensión similar a la Etapa 1.

➢ Artazu VII

Pese a que una fracción del yacimiento fue pulverizado a causa de los trabajos de explotación, gran parte de su conjunto permaneció intacto. Así, la secuencia estratigráfica estudiada alcanzó los 5 m de relleno en los que se diferenciaron 12 niveles que fueron excavados de forma sistemática. Conforme a las dataciones de Radiocarbono (AMS) y Racemización de Aminoácidos (AMS) el yacimiento poseía una cronología de al menos 36 ka, desde aproximadamente 101 ka a 65 ka BP.

Para las estimaciones paleoambientales y variaciones climáticas se ha empleado el análisis de diversos proxies: micromamíferos, macromamíferos, aves, polen, mineralogía y sedimentología. Entre los micromamíferos han sido identificados 14 taxones, 11 en macromamíferos (ungulados y carnívoros) y cinco en aves. Entre estos restos puede encontrarse uno de los registros más antiguos para *Chionomys nivalis* (Topillo Nival) de toda la Península Ibérica, y una de las escasas citas fosilíferas en la misma de *Buteo lagopus* (Ratonero Calzado). Además, este yacimiento cuenta con el mayor número de restos de *Coelodonta antiquitatis* (Rinoceronte Lanudo) del Pleistoceno superior de la Península Ibérica.

Se ha realizado un estudio paleoambiental de los primeros 9 niveles de Artazu VIII. Además, los datos obtenidos mediante los distintos tipos de proxis coinciden en el tipo de paisaje y tendencias generales. Así, se han deducido fases relativamente tanto frías como atemperadas, con diferentes grados de humedad ambiental y una corriente de agua presente en las proximidades de la cueva. A pesar de que la asociación de mamíferos esté dominada por especies ubiquistas, se ha inferido la presencia de pastizales con zonas boscosas. Gracias a algunas especies, tanto de macro como de micromamíferos, cuya presencia está condicionada por frío relativo, se han concluido algunos momentos relativamente fríos. Respecto al estudio polínico, aunque los resultados no sean representativos por no ser suficientes las muestras conservadas, los taxones presentes son indicativos de vegetación tipo herbácea. Finalmente, y en relación a la avifauna, el ambiente reconstruido también coincide con el inferido por los anteriores. Por lo tanto, la comunidad de aves descrita indica áreas de montaña con espacios abiertos y áreas boscosas.

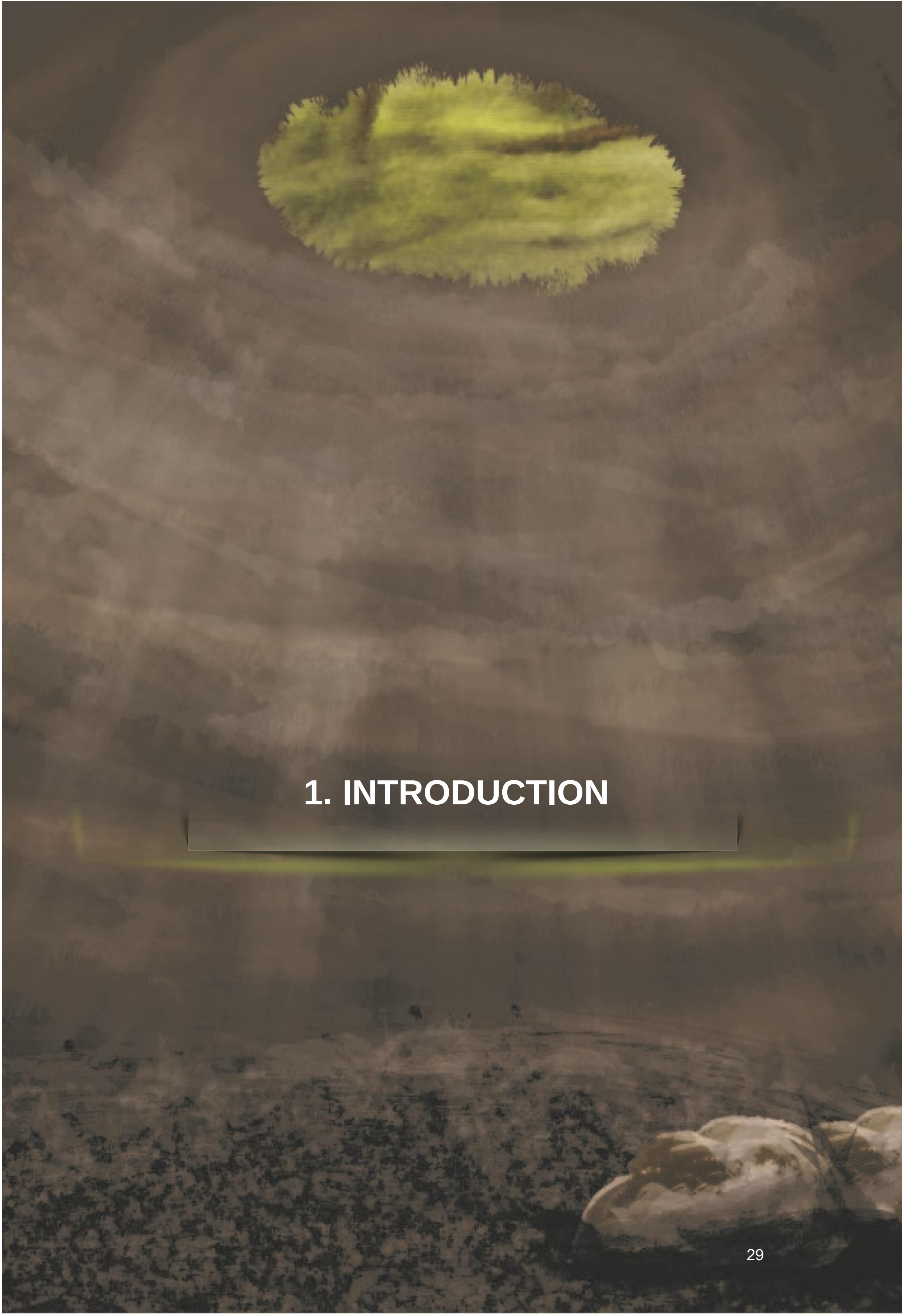
En general la expansión de la masa boscosa coincide con el aumento de la presencia de agua y el índice de diversidad de los micromamíferos. Aparte de esto, los análisis mineralógicos y sedimentológicos sugieren que en los momentos relativamente cálidos predominaban los procesos fluviokársticos y una sedimentación alóctona, mientras que en las épocas relativamente cálidas la sedimentación era mayoritariamente autóctona. De acuerdo a la variación y proporción de especies estenotérmicas y los análisis mineralógicos se han diferenciado un mínimo de tres fases climático-ambientales.

La secuencia comienza en la parte inferior del nivel 9 con una temperatura relativamente cálida y un desarrollo boscoso relativamente alto en comparación al de los niveles sucesivos. Para la parte superior de este nivel, Etapa 1/Sección 2, se ha interpretado un ambiente frío y seco debido a la disminución de especies forestales y al aumento de especies que habitan en biotopos fríos. Estas mismas condiciones también han sido inferidas del estudio mineralógico, debido a la alta proporción de illita. Además, la buena selección de los granos del sedimento indica un predominio de la actividad fluviokárstica y una gran abundancia de sedimentos alóctonos, atribuibles a la presencia de un río en la cueva. Estos hechos concuerdan con la presencia de especies ligadas al frío relativo como

Microtus (Alexandromys) oeconomus, Coelodonta antiquitatis o *Rangifer Tarandus*. Entre el Nivel 8 y 7b, según el índice de biodiversidad relativamente bajo y la proporción relativamente alta de illita, la segunda parte sería más fría. Posteriormente, en la Etapa 2/Sección 3, se ha inferido una mejora en las condiciones del medioambiente. Por un lado, las proporciones de especies indicativas de biotopo forestal aumentan, mientras que las especies que habitan en hábitats fríos desaparecen. Por otro lado, la proporción de illita disminuye. Todos estos hechos han sido atribuidos a momentos más cálidos y húmedos. Además, la coincidencia de la primera parte de esta Etapa 2/Sección 3 con la formación de espeleotemas, la menor selección granulométrica del sedimento y la abundancia de vermiculita, denotan una mayor infiltración de los suelos autóctonos y precipitación de carbonatos (que está relacionada con condiciones relativamente cálidas). Finalmente, el cambio Etapa 3/Sección 4 comienza con unas condiciones ambientales relativamente frías y húmedas. Sin embargo, posteriormente, se establece una nueva tendencia hacia un calentamiento climático y mayor humedad ambiental. En este momento las especies indicativas de un ambiente frío están ausentes y aquellas que indican la presencia de bosque aumentan considerablemente. Esta tendencia también ha sido inferida por la disminución de la illita y la presencia de espeleotemas y travertinos en los niveles 3 y 2.

Finalmente tras realizar la correlación con la curva NGRIP δ^{18}O se ha atribuido Etapa 1/Sección 2 al MIS 5b, la Etapa 2/Sección 3 al MIS 5a y la Etapa 3/Sección 4 al MIS 4, correspondiendo la fase cálida de este último al Interestadial Greenland 18.

Tras la correlación de Artazu VII y Artazu VIII con la curva NGRIP δ^{18}O, ambos yacimientos han sido comparados entre sí y con otros depósitos de la misma cronología de la Península Ibérica. Aunque ambos yacimientos se encuentran enmarcados en el Pleistoceno Superior Artazu VII, únicamente parecen coincidir con el interestadial MIS 5c y, por lo tanto, son cronológicamente complementarios en ese tramo. Así, Artazu VII se depositaría a la vez que la parte inferior de Artazu VIII, y posteriormente se acumularía el resto de Artazu VIII. Sin embargo, la información paleoambiental de la Península Ibérica respecto al MIS 5 y MIS 4 es menos abundante que otros estadios isotópicos debido a que los registros terrestres son imprecisos y fragmentarios. Además, la mayoría de yacimientos de la Península Ibérica que datan de MIS 5 están situados en el área mediterránea. De esta manera, los yacimientos estudiados en esta tesis han sido comparados con Lezetxiki II, Cueva del Camino, HAT, Cova del Rinoceront y Cueva de la Buena Pinta, suponiendo una aportación de gran relevancia y contribuyendo sustancialmente al conocimiento paleoambiental y faunístico del tercio norte ibérico para el Pleistoceno Superior.



1. INTRODUCTION

1. INTRODUCTION

1.1. The current climate in the Iberian Peninsula and Cantabrian region

The Iberian Peninsula is characterized by its heterogeneous physiography related to the high orographic and topographic gradients that give rise to diverse type of climates (Capel-Molina, 1981). It is located between the southern limit of the polar front, what implies great influence of wind depression, and the limit of the high tropical pressure areas, which brings the influence of hot and dry airs. Therefore, it is possible to distinguish two major areas in the Iberian Peninsula: the Atlantic and the Mediterranean region, separated by the Pyrenees and the Cantabrian mountain range. While the north of the Iberian Peninsula is more influenced by the cyclonic and depression systems, the south is under the effects of the tropical climate. Thus, the Atlantic region comprises the northern band of the Iberian Peninsula, and is controlled by the oceanic influence (Fig. 1A), resulting in high precipitation (more than 1500 mm/yr) and mean annual temperatures of 13-15 ºC (González-Sampériz et al., 2010). On the other hand, the Mediterranean region comprises the Iberian Peninsula fringe from the northeast to southwest (Fig. 1A), being drier and hotter, with an average temperature of 22 ºC. When a rainy front arrives to the Iberian Peninsula and flows through it, it causes heavy rainfalls until its encounter with any mountainous headwaters, creating Mountain climate (Fig. 1A) (López-Moreno et al., 2008). Apart from this, the Iberian System runs from the northwest to the southeast and marks the limit between river basins that flow to the Atlantic Ocean or to the Mediterranean Sea, creating strong thermic contrasts (from 6º C or lower temperatures in winter to more than 26º C in summer) (Continental climate) (Fig. 1A) (Carrión, 2002).

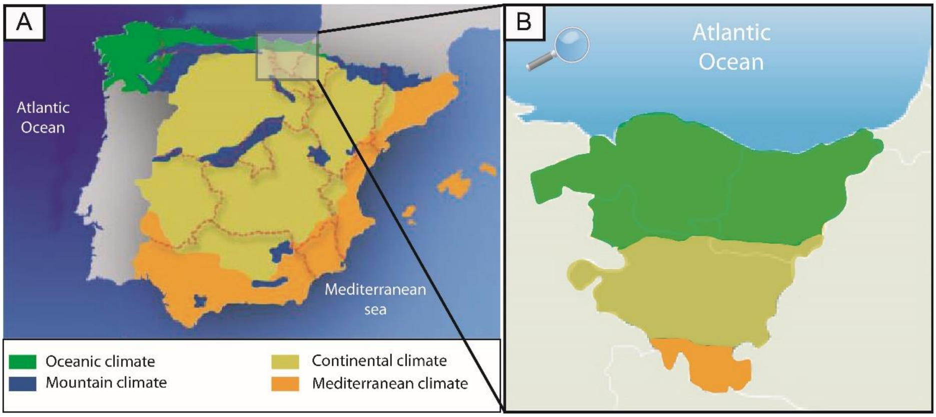


Figure 1. Climate zones. A: the Iberian Peninsula. B: in detail the Basque Country. A modified from Carrión (2002), B modified from Euskalmet (1990).

In the summer, the influence of the tropical pressures increases, bringing on warm and dry weather to the entire Iberian Peninsula. This temperature increase heats the air and makes it lighter, causing low atmospheric pressures (Martínez de Osés, 2003). The Cantabrian region lies outside the scope of these changes. In this area, the influence of the Atlantic fronts are higher than the tropical ones, so, the heavy rains are continuous.

The Basque Country is located on the northeast of the Cantabrian region, between latitudes 42º and 43.5º N. Therefore, it is near the subtropical area, with a mix of tropical marine winds and continental artic winds. This geographical feature is the determining factor regarding the climate in the Basque Country. Its latitude determinates the solar inclination, conditioning the amount of solar energy that fall upon the area in each season and the direction of the winds (Euskalmet, 1990). Thereby, the Gulf Streams and the winds of the Atlantic cause strong storms and heavy rains. The cold air masses coming from the north of America turn heated as they pass over the temperate Atlantic waters, so the airs arriving the European shores are relatively temperate. When these air masses cross the Iberian Peninsula in a SW-NE direction they dried, to be warmed substantially when they reach to the Cantabrian region. When they ascend again, they cooled and produce rainfall. By contrast, when the flows go in a NW direction, the relief of the Basque mountains acts as ascending ramp, creating strong winds and precipitations. Regarding ocean waters, when the surface waters are cooled they increased the density and they sink, being replaced by warmer waters from the Gulf Stream (Euskalmet, 1990). Similarly, the topography of the principal mountain ranges is oriented parallel to the current coastline, tempering the oceanic influence.

Three areas with different climate could be observed in the territory of the Basque Country, defined by two parallel ranges: the Atlantic watershed with oceanic climate, the Middle section with an intermediate climate and the South with Mediterranean climate (Fig. 1B) (Euskalmet, 1990):

- The Atlantic watershed is formed by numerous valleys and by short rivers with high angle of slope. Oceanic climate predominates, with wet environments, moderate temperatures and an average annual precipitations of 1600 mm.

- The Middle section is located between two mountain ranges, representing a transition between a continental and Mediterranean climate. Summers are warm and dry, while winters are cold and snowy.

- The south has a Mediterranean climate, being winters cold and dry and summers warm and dry, with mean annual rainfall below 50 mm.

1.2. Climatic cycles during the Late Pleistocene

The Late Pleistocene (128-11.7 ka BP) is part of the Quaternary period (2.6 Ma) which was a period of large climatic fluctuations that occurred in millennial scale, resulting in a temperature increase (interglacial) followed by a gradual relative cooling (glacial) conditions (Dansgaard, 1985; Sánchez-Goñi and D'Errico, 2005). While the interglacial periods are defined as minimal glacial ice covers, the glacial periods are intervals with significant continental ice sheets and the advance of glacial masses. This climatic oscillations are one of the main causes that sculpt landscapes, causes the sea level fluctuations, the advance or decrease of glaciers and vegetation and fauna changes, among others (Yokoyama et al., 2000; Gitay et al., 2001; Barnett et al., 2005; Bell et al., 2005; Candy et al., 2014). As a consequence, the instable climatic conditions during the Late Pleistocene strongly affected the living community, and in response, some species were forced to adapt, moving geographically or/and becoming extinct. So, faunal and vegetal changes could be correlated to palaeoenviromental and palaeoclimatic variations in this epoch (Pokines, 1998; Cuenca-Bescós, 2003). For this reason, this period has become an important research field for scientists from different areas of Geology, Palaeontology, Archaeology, Sedimentology and Palaeoclimatology.

The knowledge about how cold and warm period cycles occurred have increased a lot in the last years due to the study of $\delta^{18}O$ analysis extracted from the Greenland ice cores and foraminifera shells and continental records (pollen and small vertebrates proxies) analyses. These analysis provide data covering a long climate record differentiating alternative Marine Isotope Stages (MIS) of cold and temperate climates. To date, a total of 104 isotopic stages have been identified in the quaternary period, being the oldest MIS-104. These studies carried out in different proxies are of great value for a better understanding and determination of these palaeoenvironmental changes. Thus, several works conducted over the last two decades led us to reconstruct a high reliable climate models and the response of fauna and flora to these fluctuations (Sánchez-Goñi and D'Errico, 2005; Sánchez Goñi et al., 2008).

To classify the MIS some glacial-geologic-climate nomenclature is used. The glacial period is an interval where the global temperature decreases, resulting in the continental ice expansion and in the increase of the polar caps and the glaciers. On the contrary, interglacial period correspond to a global warming climatic interval, separating two glacial periods. Hence, MIS pair numbers are glacial periods and odd numbers are interglacial moments. They could also be defined the stadials and interstadials. The stadials are short and colder periods, while interstadials are periods of less cold climate during a glacial period. Thus, the Late Pleistocene initiated in the moment when the sea level displayed an upper position compared to the current situation, according to Chappell and Shackleton (1986) +6 m and to Bard et al. (1993) +7 m, and is divided in four Marine Isotope Stages, from MIS 5 to 2 (Lisiecki and Raymo, 2005).

MIS 5 interglacial was first defined as the last interglacial and interpreted as a single substage (Shackleton, 1969). However, the time range determination of MIS 5 has generated some controversies, with age variations depending on the authors. Thus, Emiliani (1955, 1971) defined MIS 5 between 132 and 103 ka BP, Ruddiman and McIntyre (1972) between 127 and 73 ka BP, Shackleton and Opdyke (1973) between 128 and 75 ka BP, and Martrat et al. (2007), Elias and Brigham-Grette (2007), Fletcher et al. (2010) and Mauz et al. (2012) between 130-125 and 75 ka BP. Furthermore, the climatic characteristics of the period have evolved with time. Firstly, it was described as a time when the western of Europe was covered by large broadleaf forests and areas free of ice increased in size with similar temperatures or even warmer than today (Harting, 1852). The investigations carried out in the recent years show that this stage was temperate and with a minimum ice volume, including two relatively cold episodes. Thereof, according to climatic fluctuations, MIS 5 was divided into five substages: as MIS 5.1-5.5 (Turon, 1984) and later as MIS 5e-a, (Shackleton, 1969)]. Three of the substages (MIS 5e, MIS 5c and MIS 5a) represent warm episodes characterized by major forested intervals , while the other two (MIS 5d and MIS 5b) are relative cold episodes (Shackleton, 1969; Sánchez-Goñi, 2007; Helmens, 2013) (Fig. 2):

- MIS 5e interstadial (between 130 and 115-112 ka BP) (Fig. 2) appears to had similar, or even warmer environmental conditions. According to Müller (1974), and based on lacrustine varve count, the duration of this substage was ~ 11.5 ka BP, although according to Behre (1989) it was~ 11-9 ka BP. During this period, the ice mass disappeared totally from Europe, causing a remarkable rise of the sea levels (López-García, 2008). In the northern Iberian Peninsula the maximum development of oak (deciduous *Quercus*) and hornbeam (*Carpinus betulus*) forest took place (Sánchez-Goñi and D'Errico, 2005).

- According to Dansgaard and Duplessy (1981), the step towards MIS 5d substage (between 115-112 and 105 ka BP) occurred rapidly, only within 10-5 millennia (Fig. 2). It is thought that in this glacial period the continental ice mass duplicated its volume and the sea level declined. In general, in the waters of the Atlantic Ocean foraminifera species that indicate cold environments prevailed (Drysdale et al., 2017). At temperate zones deciduous woods were replaced by boreal forest, while steppe-tundra and tundra dominated subarctic and high mountain biomes (Wohlfarth, 2013).

- MIS 5c (between 105 and 92 ka BP) was temperate interstadial that according to Guiot (1990) and Guiot et al. (1993) (Fig. 2), displayed less diverse deciduous arboreal development compared with MIS 5c. Thus, the deciduous trees survived the coldest glacials.

- During MIS 5b stadial (between 92 and 85 ka BP) (Fig. 2) a glaciation occurred, causing the drop of the sea-level and increase in continental ice sheet and glacier volumes. (Sánchez-Goñi and D'Errico, 2005).

- The MIS 5a interstadial (between 85 and 75-71 ka BP) was a relatively temperate period where, as MIS 5c presented less diverse deciduous forest development.

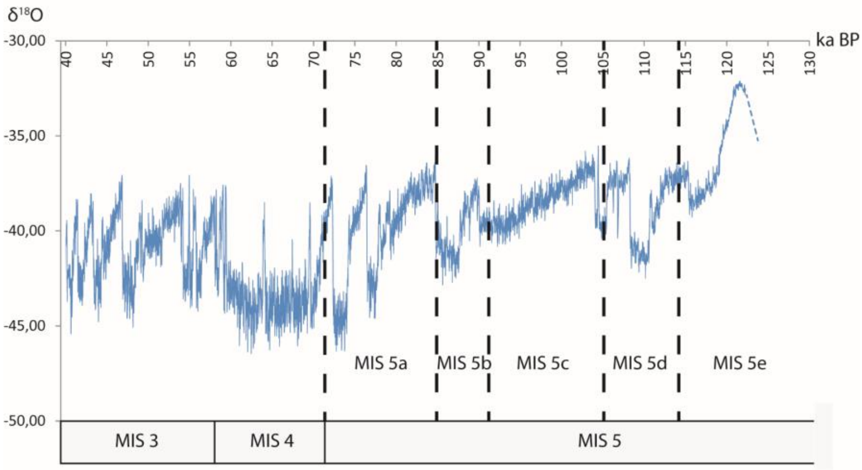


Figure 2. Greenland Ice Core Chronology 2005 (GICC05 modeltext) for NGRIP. Dating from 41.88 to 60 ka BP described in Svensson et al. (2007); from 60 ka BP to back towards in Wolff et al. (2010). Intervals from MIS 3 to MIS 5 according to Otvos (2015).

The transition from MIS 5a to MIS 4 (between 75-71 and 55-50 ka BP) (Fig. 2) occurred very fast, changing from an interglacial phase to a glacial. During this stage cold and dry conditions began to intensify accompanied by small ice expansion, although some small warm peaks interspersed (Sánchez-Goñi and D'Errico, 2005). In this period solar insolation was minimal, generating the maximum propagation of polar ice, which covers almost the totality of northern Europe (Sánchez-Goñi and D'Errico, 2005). According to pollen record from French lacrustine deposits in La Grande Pile and the Velay Maars (Sánchez-Goñi et al. 2008; Fletcher et al., 2010), a change occurred from a boreal forest to steppe-tundra vegetation.

The MIS 3 interglacial (between 55-50 and 30 ka BP) (Fig. 2) was colder than nowadays, even so, the general trend was a slight rise in average temperatures and a decrease in the volume of ice. Thus, woodland expansion and semi-arid development complex cycles were present in southern Europe (Sánchez-Goñi et al., 2008; Fletcher et al., 2010). This period is characterized by the advances and retreats of small glacials, prevailing the decrease of ice volume.

Finally, the MIS 2 glacial (between 29 and 14 ka BP) is dominated by intense cold and strong advance of glaciers, occurring the coldest climate conditions of the Late Pleistocene (Helmens, 2014).

Hence, the limit between the Late Pleistocene and the Holocene was marked by the last glacial (ca 11,700 years). Although climatic changes had a global extension, the lengths and the duration of glacial and interglacial units could vary according to the geographical area or the altitude above sea level (Otvos, 2015). In addition, marine and terrestrial fauna show different reaction time to confront these climatic changes (Otvos, 2015).

As a consequence of these climatic cycles, hydrochemical factors changed, being one of the basic agents that most affect the landscape. They remodeled it, creating crevices in rock structures and undergoing karst systems (Ford and Williams, 2007). These cavities are usually stuffed of sediments, so, it is not a coincidence that a majority of fossiliferous deposits of Quaternary age (archaeological and palaeolontological sites) have been preserved in caves, containing records of specific time range (Sasowsky, 1998 and 2007; White, 2007). The sediment trapped inside could have an allogenic or authigenic origin (Ford and Williams, 2007; White, 2007). The allogenic sediment could be integrated by infiltration soils or weathering rock. This is because the cave could function as giant sediment trap, accumulating clastic, chemical and organic sediments as alluvium, windblown material, animal feces (guano), fossil material and till among others (Sasowsky, 2007; White, 2007; Iacoviello and Martini, 2012).

Silts and clays are the principal clastic deposits, but their sources can be very diverse: eroded soils, reworked fluvial and lacustrine deposits, windborne dust and tephra or filtration from soils overhead (Ford and Williams, 2007). On the other hand, the authigenic sediments are accumulated by carbonate precipitation processes. These precipitations can appear in dense crystalline form with the shape of external morphology (speleothems and/or chemical flows), or sinter form (travertine) which are dense and compact and usually cover lands, walls and roofs (White, 2007). Depending on the environmental, climatic and geomorphological conditions, caves deposits fill change over time. Therefore, the constitution and grain-size of the sediments give powerful information about the origin of the fill. Precisely, and due to their environmental change sensitivity, small vertebrates (concretely small mammals, reptiles and amphibians) often are useful to infer palaeoenvironmental and palaeoclimatic variations during the time of their deposition. In addition, the small vertebrate accumulations are frequently originated by predation, and the represented biotic community can reflects the preferences of the biological accumulator agents (Andrews, 1990). Therefore, the study of the fossil bird fauna is a major issue to understand the small vertebrates bone accumulations and, eventually, to identify their bioaccumulation agents. For this reason, it is important to document both the small mammal association and bird assemblages.

1.3. Late Pleistocene palaeontological sites in the Iberian Peninsula

During the Pleistocene, the Iberian Peninsula played an important role in the distribution of some species due to its physiography complexity and its geographic position. The abundance of the mountain ranges of the Iberian Peninsula provided several microclimatic areas (Hewitt, 1996) and its location in the southwest of Europe, along with Mediterranean oceans influence, gave rise to glacial refuges for species providing warmer habitats (Hewitt, 1999; Hewitt and Ibrahim, 2001, Sánchez-Goñi and D'Errico, 2005; Fletcher et al., 2010; Tzedakis et al., 2013). This, together with its relatively low altitude, made it one of the few regions of Europe which was not covered by glacial ice during the Late Pleistocene.

According to palaeontological and palynological data, several temperate species have been recorded in the Iberian Peninsula also from stadial period deposits (Bennett et al., 1991). Furthermore, the high number of endemic animal and plant species present in the Iberian Peninsula suggests a long-term survival, differentiation and speciation (Ribera, 2000; Castroviejo, 2002; García-Barros et al., 2002; Sainz-Ollero and Moreno Saiz, 2002). Besides, evidences of some species from the northern latitudes in the Iberian Peninsula show that it functioned as a repository for the faunal from northern latitudes of Europe. As a result of the existence of the Pyrenees in the north, which functioned as biogeographical crossing obstacle, the dynamic of shelters evolved independently to the rest of Europe. During cold intervals, the species from cold biotopes migrated to west and south of Europe, being even able to cross Pyrenees and stablishing in the central Iberian Peninsula. Hence, it has been found one of the southwestern presence of *Microtus gregalis* in the Buena Pinta Cave (Pinilla del Valle, Madrid region) (Laplana et al., 2016) and the same for *Microtus oeconomus* in Abrigo del Monte (El Vellón, Madrid) and Peña de Estebanvela (Estebanvella-Ayllón, Segovia) (Sesé, 2006) in the Iberian Peninsula. Regarding Cantabrian region, we can find the typical mammal assemblages in the interglacial periods. Hence, when forest predominate, among the large mammals Cervidae, Bovinae and Equidae, and among the small mammals Gliridae and Muridae were more abundant (Altuna, 1992). In addition, certain characteristic animals of the Late Pleistocene made their appearance in this period, such as *Ursus spelaeus, Canis lupus*, and *Bison priscus* (Menéndez et al., 2012).

In the north of the Iberian Peninsula, Late Pleistocene sites that are exclusively palaeontological or that contain a palaeontological level are not common. Sites that acted as natural traps, thus reflecting the fauna in the surroundings at that time with greater verisimilitude, are even less frequent (Sesé, 2006). In addition, few palaeontological deposits have been excavated systematically or their vertebrate assemblages studied in detail. We can cite, in the western end of the region, the Galician sites of A Valiña (Fernández Rodríguez, 1989), Liñares (López, 2003) and Valdara 3 (Vaquero et al., 2018). In the central sector, known deposits are La Parte and Jou Puerta (Álvarez-Lao, 2014) in Asturias, and Peña Cabarga-Pico del Castillo (Castaños et al., 2012a) in Cantabria. In the eastern end, the deposits of Lezetxiki (Altuna, 1972), Punta Lucero (Castaños, 1988), Troskaeta (Torres Pérezhidalgo et al., 1991), Lezika (Castaños et al., 2009), and Kiputz IX (Castaños et al., 2012b) are located in the Basque Country. However, of all these, only few sites could be assigned to MIS 5; only La Parte and Peña Cabarga-Pico del Castillo have the same chronology as the sites studied in this PhD. In the Iberian Peninsula, there are few palaeontological deposits that can be attributed to MIS 5 period, and most of them are located in the Mediterranean region. Known sites are Hat (Panera et al., 2005) and Cueva del Camino (Laplana et al., 2013; Blain et al., 2014) in the centre of the Iberian Peninsula; Bolomor (Blasco et al., 2008), Cova Negra (Guillem-Calatayud, 2000, 2001), Cova del Rinoceront (Daura et al., 2015), Cova de les Teixoneres (Rosell et al., 2010) and Los Rincones (Sauqué et al., 2014) in the east of the Peninsula.

Regarding small vertebrates, only Valdavara 3 (Vaquero et al., 2018), Arlanpe (Garcia-Ibaibarriaga, 2015), Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a), Cueva del Camino (Laplana et al., 2013), HAT (Sesé et al., 2011) and Cova del Rinoceront (López-García et al., 2016) contain stratigraphic sequence dated to MIS 5. Finally, the only site correlated to MIS 5 with avian fossiliferous remains is Cueva de Valdegoba (Sánchez-Marco, 2004 and 2007).

1.4. Organization of thesis

This thesis is a compilation of multidisciplinary studies, where different scientific areas were approached, i.e. sedimentology (granulometries and micromorphological thin sections), stratigraphy, mineralogy (whole rock and clay mineralogy analyses), geochemistry and palaeontology (small mammals, large mammals, avifauna and palaeopalinology). For that purpose, the author of this thesis (Aitziber Suárez Bilbao) has counted with the collaboration of other specialists. All the stratigraphic descriptions and the reconstructions of the cavities were performed by this predoctoral researcher, as well as mineralogical studies. In addition, the PhD student was the responsible for the small vertebrate processing samples, and of their collecting, washing and separating phases. Once separation phase was performed, A. Suárez studied the remains of the small mammals and Dr. Naroa Garcia classified and quantified the herpetofauna. After the identification of the material, the predoctoral student analyzed all the results together. The study of the large mammals has been performed by Dr. Pedro Castaños and Dr. Jone Castaños. This predoctoral researcher collaborated during the excavation works, the sample washing phase, the collection number writing in the samples and the composition article. Apart from this, the avifauna study was carried out by Aitziber Suárez, with the assistence of the bird expert Mikelo Elorza to resolve doubts and in the event of difficulty when classifying. Dr. Maria Jose Iriarte performed the palaeopalinology study. In case of sedimentological analyses, the predoctoral student worked together with the sedimentologist Dr. Martin Arriolabengoa. Finally, for geochemistry study A. Suárez selected large mammal bones and prepared the samples together with the student Garbiñe Zamora, under the supervision of Dr. Luis Angel Ortega.

All the material here described is published or ready for publication. Consequently, this thesis has been used to correct some minor article errors. The writing has been structured in three blocks containing seven chapters. The first block is constituted from Chapter 1 to 3; the second block represents the body of this thesis, containing Chapter 4 and 5; and finally, the third block gives a brief summary of the main conclusions divided in Chapter 6, 7 and 8. The **Chapter 1** is the introduction, where both the current climate and the climatic cycles during the Late Pleistocene in the Iberian Peninsula are explained, with a particular emphasis in the MIS 5. Lined to this, and as a consequence of the climatic variations, also the role of the Iberian Peninsula for the fauna during this period is briefly mentioned. Finally, the organization of the thesis and the principal goals are explained. In the **Chapter 2** geographical and geological settings are described, as well as the description of the cavities and the stratigraphic sequences. Although these latest would be part of the results, we consider necessary their explanation at the beginning of the manuscript for the correct understanding of this thesis. The **Chapter 3** provides information about the materials and methodology, both in field techniques and laboratory techniques, which in turn are divided in some sections according to analyses type. The **Chapter 4** comprises all the fauna identified in both sites. Thereby, each taxon contains the taxonomic classification and the most characteristic features, how many remains have been recovered in each site and, as far as possible, their ecological preferences. The **Chapter 5** is divided in two parts due to the study of two sites. These, contains various subsections according to all performed analysis and proxies. Each subsection encompasses its results. Finally, the **Chapter 6** and **Chapter 7** discusses the main results and **Chapter 8** summarizes the most important contributions of this thesis.

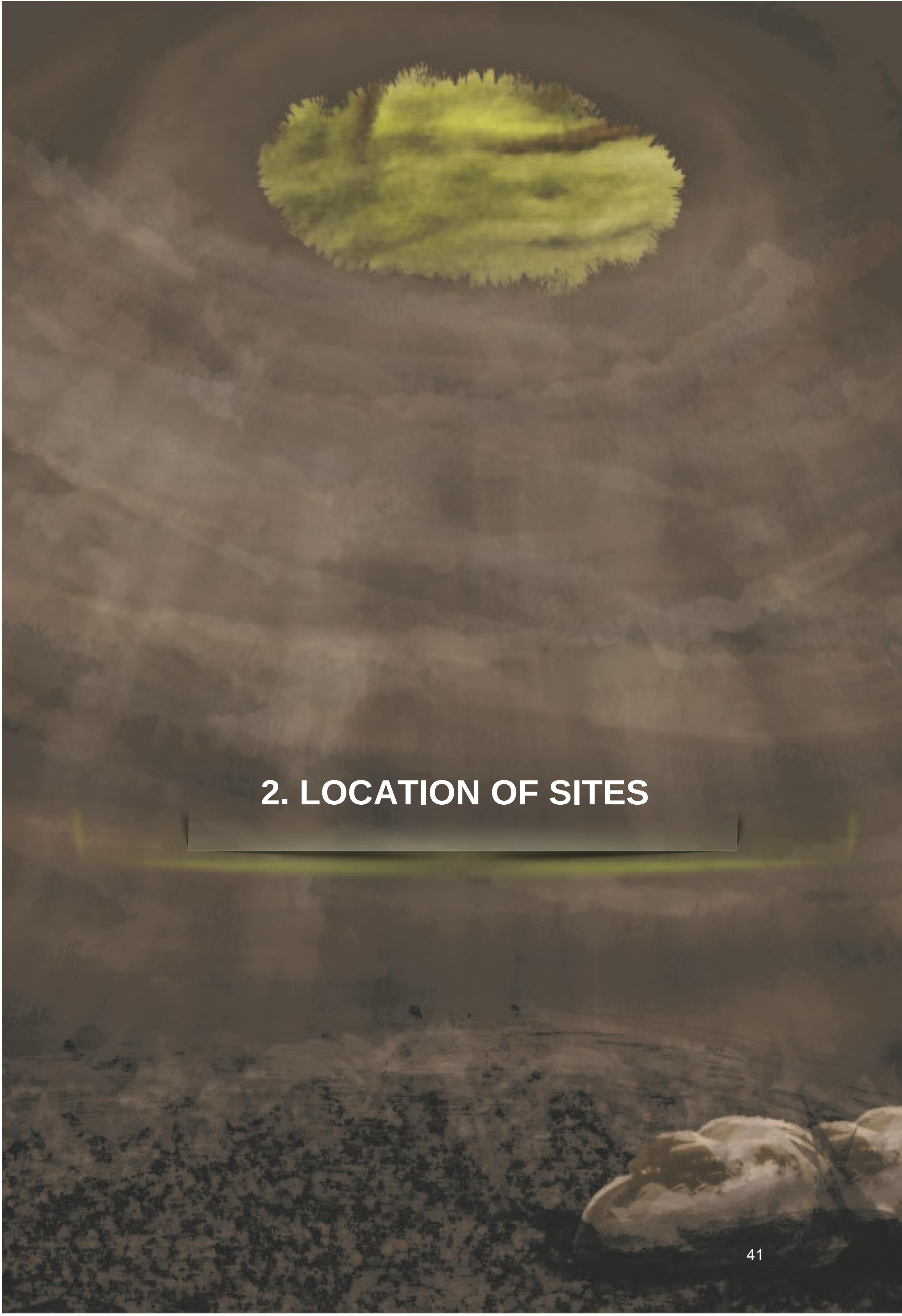
1.5. Principal goals

In this thesis, we present the study of two newfound sites: Artazu VII and Artazu VIII, The main objective of this thesis is to reconstruct the environment of both sites based on their palaeontological and sedimentological infilling. For that purpose, three major tasks were conducted:

1. Description of the sedimentary filling of both cavities identifying different levels and reconstructing the sedimentary deposits genesis using sedimentological and microstratigraphic studies. In addition, the chronology of the record inside the two cavities was established using radiometric dating by ^{14}C (AMS) in carbonate biogenic remains and Amino Acids Racemization (AAR).

2. Determinate the fossil assemblages for each level and based on them and in the taxa representation, reconstruct the biocenosis and perform a morphometric study (osteometric measurements) of some fossil remains.

3. Based on faunal association and in their ecological requirements, infer the palaeoenvironmental conditions for each level of both sites and compare between them. Try to correlate our data to NGRIP $\delta^{18}O$ curve in order to assign a concrete Marine Isotopic Stage (MIS), taking into account the dating and the stipulated palaeoenvironment conditions.



2. LOCATION OF SITES

2. LOCATION OF SITES

In this chapter, the geographic location and geologic context of Artazu VII and Artazu VIII sites, as well as administrative limits are described. Since they were located in the same area, both are explained in conjunction.

2.1. Geographical settings

The palaeontological sites of Artazu VII and Artazu VIII were located in the Cantabrian region, at the north of the Iberian Peninsula, in the Autonomous Community of the Basque Country (Fig. 3). In particular, the territory belongs to the province of Gipuzkoa, which adjoins with the Atlantic Pyrenees on the northeast, the Bay of Biscay on the north, and the provinces of Navarre on the east, Bizkaia on the west and Araba/Álava on the southwest (Fig. 3). More precisely, Artazu VII and Artazu VIII were discovered at Kobate Quarry, in the outskirts of Arrasate village, 70 km to the southwest of Donostia-San Sebastián (the capital of Gipuzkoa province) and 30 km to the north shore.

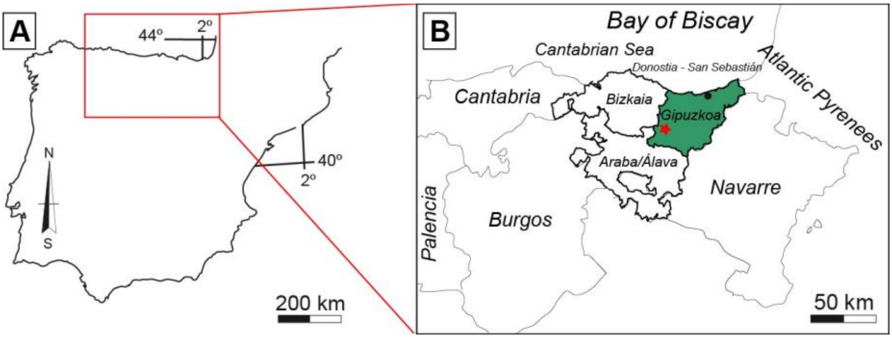


Figure 3. Geographical location of Artazu VII and Artazu VIII sites (Arrasate, northern Iberian Peninsula). A: position in the Iberian Peninsula. B: administrative limits, with red star position of both sites.

Both sites were situated in the south-western flank of Mount Artazu, in the upper course of the Deba Valley. This area is bounded by three mountain ranges: the first one is formed by the peaks of Udalaitz (1,090 m), Tellamendi (830 m) and Murugain (775 m); the second by Atzabal (1,168 m) and Karraskagain (400 m); and the third one by Anboto (1,268 m) and Kurtzebarri (1,155 m). Moreover, Artazu VII site was located on the edge of a steep slope on the hill, at 351 m above present sea level (UTM coordinates; X: 538241, Y: 4769155; datum WGS84 and Zone 30 T) and Artazu VIII at 367 m above present sea level (UTM coordinates; X: 538226, Y: 4769390; datum WGS84 and Zone 30T. Therefore, they were at a distance of approximately 15 m, being located Artazu VIII 16 m higher than Artazu VII.

2.2. Geological context

The Iberian Peninsula is located at the southwest of Europe, in the subtropical ridge, at latitude 43° 47′ N to 36° 01′ N and longitude 9° 30′ W to 3° 19′ E (Fig. 3) (Oliva et al., 2016). It includes seven principal mountain ranges, some of them exceeding 3,000 m of altitude: (1) the Pyrenees which crosses the isthmus at the northeast and connect the Iberian Peninsula with Europe, (2) the Cantabrian Mountains (at the north), (3) the Iberian Range (in the center), (4) the Iberian Central System (from central to west), (5) Sierra Morena (in the west of the south half), (6) the Catalan Coastal Range (on the east) and (7) the Betic Range (at the southeast) (Fig. 4A) (Vilá Valentí,1968; Menéndez Hevia, 2004).

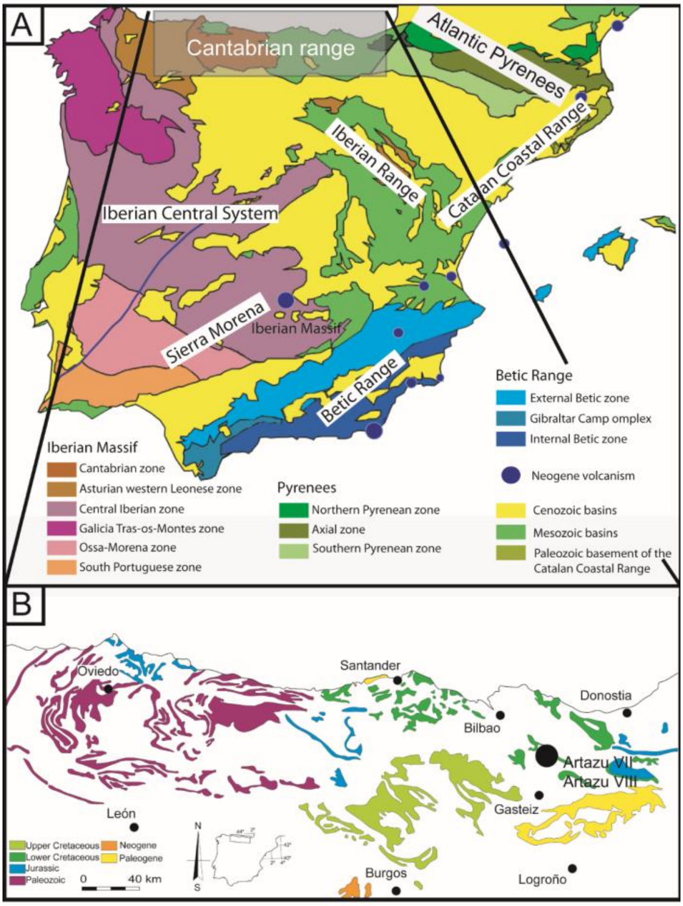


Figure 4. The geology of the Iberian Peninsula. A: major components. B: Basque-Cantabrian region map with carbonated rocks of different ages. A modified from Meléndez Hevia (2004) and B from Ayala et al. (1986).

Geologically the Basque-Cantabrian region is situated in the northern edge of the Iberian plate and comprises the west of the province of Navarre, the Basque Autonomous Community, the north of the provinces of Burgos and Palencia and a great part of the province of Cantabria. The sediments outcropping here belong to Paleozoic, Jurassic, Cretaceous, Paleogene and Neogene, and many present karst formations (Fig. 4B). This zone is an extension of the Pyrenees, and its landscape has been sculpt by the movements of Iberian plate facing European plate and numerous orogenic, volcanic, erosive and depositional processes.

Concretely, the Basque-Cantabrian region is located in the area of folds and thrust belts of the Pyrenees. The eastern sector is called Cantabrian region, and is divided into the Basque-Cantabrian zone (in the east) and the Asturian massif (in the west) (Fig. 5). The two sites studied in this thesis are located in the Basque-Cantabrian zone, which is delimited by the fault of Pamplona in the east, the Asturian massif in the west and the thrust belt fronts in the south (Fig. 5).

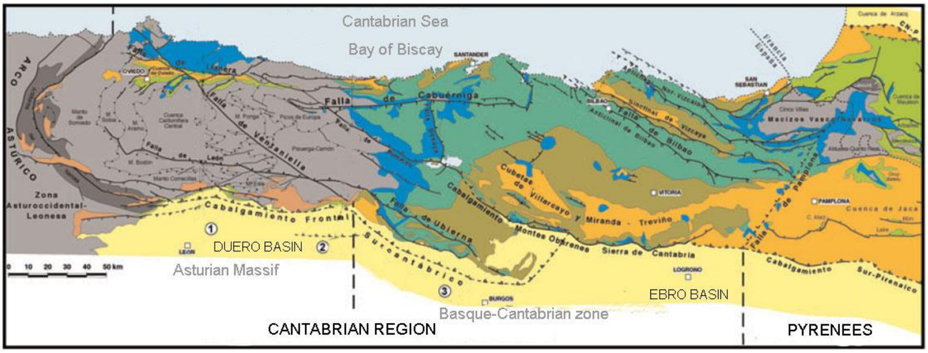


Figure 5. Cantabrian range part of the Basque-Cantabrian region divided in the sectors of Asturian massif and Basque-Cantabrian zone and delimited by the fault of Pamplona in the east, and the Narce Antiform in the west. Modified from https://www.entrecumbres.com/sistemas-montanosos/cordillera-cantabrica/.

The basin located in the Basque-Cantabrian zone is characterized by three principal factors: the substratum (mostly carbonated, alternating in some cases with mudstones), the Atlantic influence (which brings high rainfalls) and the relief limits (difference of more than 1000 m in altitude between the Pyrenees and the depression of the Ebro basin) (Bodego et al., 2014). In general, the orography is formed by mountains of cretaceous period showing abrupt reliefs and NW-SE orientation, as a result of the combination of geologic processes along the time.

Erosion caused by atmospheric agents in the carbonate rocks has created various karst systems along the upper Deba Valley, with numerous exokarst and endokarst land-forms and Quaternary fills. Thus, there are nowadays more than 5000 karst cavities catalogued in this area, with a development of more than 600 km (Dorado et al., 2013), including Artazu VII and Artazu VIII.

2.3. Description of the cavities

In the Basque-Cantabrian region, the majority of prehistoric sites are developed in karst cavities, which trap material indoors and provide relevant palaeontological, archaeological, palaeoenvironmental, sedimentological, mineralogical and geomorphological information (Sasowsky, 2007). Some of them were occupied by humans or by other predators in the past. Therefore, it is possible to find a variety of remains related with human activities, as lithic/osseous industry, fireplaces or animal remains.

2.3.1. Artazu VII cavity

In 2012, a cave filled by silt and clay sediment, limestone blocks and accumulations of fauna consisting on small vertebrate remains, large mammals, avifauna and malacofauna (Suárez-Bilbao et al., 2016) (Fig. 6) was accidentally discovered after a blasting in the Kobate Quarry (Arrasate, northern Iberian Peninsula). The majority of the cave disappeared, only preserving a small portion of sediment in the fissures of the cave wall. In 2013, an emergency excavation was carried out by María José Iriarte and Alvaro Arrizabalaga. No archaeological remains were found in the cave, so it was interpreted as a natural trap site.

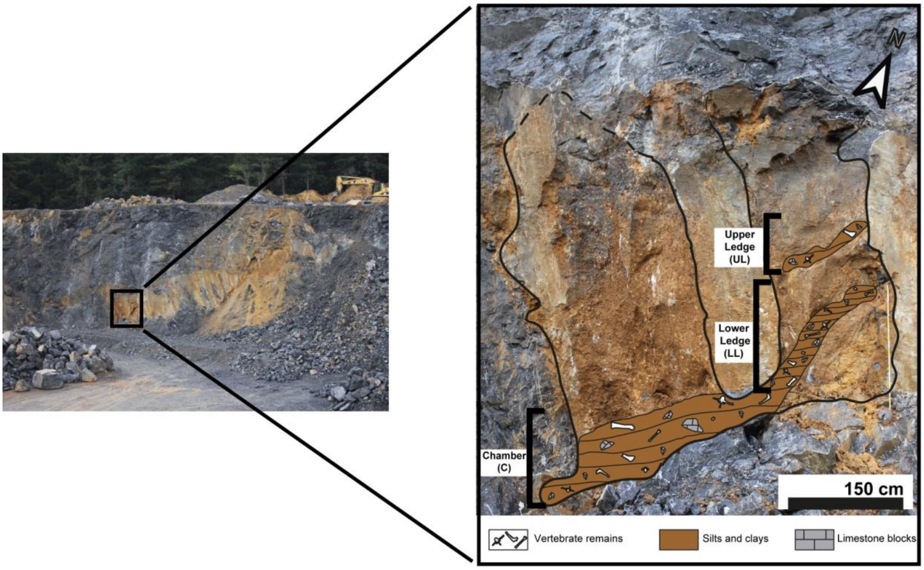


Figure 6. Artazu VII site (Arrasate, Gipuzkoa, northern Iberian Peninsula). At left the general view of mining front in Kobate quarry, with Artazu VII site inside the box. At right the stratigraphic sequence where three deposit zones can be observed: Upper Ledge (UL), Lower Ledge (LL) and Chamber (C). Suárez-Bilbao et al. (2016).

No levels were differentiated in the stratigraphic sequence of the site, but three fissures could be observed in the structure (Suárez-Bilbao et al., 2016). Thereby they were named in accordance with the shape of the fissures, from top to bottom: Upper Ledge (UL), Lower Ledge (LL) and Chamber (C) (Fig. 6). The UL was 1.5 m width and approximately 15 cm thick; the LL was 1.5 m width and thick; and the C was almost 2 m width and 1 m thick.

2.3.2. Artazu VIII cavity

The site of Artazu VIII was discovered in 2013 also after a blasting in Kobate Quarry. Consequently, much of the site was damaged and a fraction of its filling was scattered outside. Therefore, the excavation attempted to collect as many samples as possible. The cave of Artazu VIII was in the shape of an inverted funnel, with a shaft 4-5 m in diameter and 18 m deep connecting the entrance to the inner cave (Fig. 7). Filled by sediments, the cave was a maximum of 12 m in length and 1 to 5 m in width at the bottom of the site (Figs. 7B and 8).

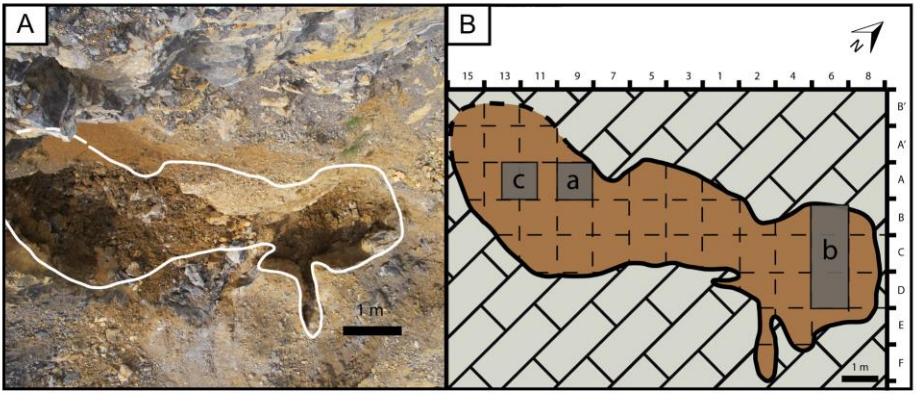


Figure 7. Aerial view of Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula) at the bottom of the site. A: real photograph. B: schematic drawing. The columns where sedimentological sampling was conducted are marked with a, b and c grey boxes.

As mentioned above, large part of the site was destroyed after blasting, so only part of sediment remained *in situ*. A stratigraphic fill of 5 m thick was studied, in which 12 levels were differentiated (Fig. 9). Breccias and limestone blocks form a large part of the Artazu VIII cave infilling, due to the collapse of cave bedrock walls and ceiling. This breakdown may be the result of freeze-thaw action. Fragments with a wide size range are appreciated in the breccia and limestone blocks, from few cm to metric size and mostly with angular morphology. In general, sands are fine-medium grained and organized in bed structures that reduce in thickness laterally, sometimes being tabular or flat (Fig. 9). Mudstones consist of fine parallel sediment that is slightly inclined.

The fossil material recovered from Artazu VIII consists of malacofauna, small vertebrates (small mammals, amphibians, reptiles, birds and fish) and large mammals (ungulates and carnivores). Owing to their abundance, with the exception of the small mammals, most of the taxonomical groups continue under study. All recovered material will be stored in Gordailua [Cultural Heritage Center of Gipuzkoa, Irun (Spain)].

Figure 8. Front view of Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula).

All the large mammal skeletal remains recovered from Artazu VIII display good integrity and a good state of preservation, without anthropological manipulation like cutmarks or skinning, or predator activity such as dismembering or bone fractures. However, although most of the anatomical elements were preserved, only some of them were found in anatomical connection. Apart from this, no evidences of a human presence, such as bones, lithic industry or bone tools, have been found. Therefore, the possibility of an anthropogenic origin has been discarded and we assume that the site would have functioned as a natural trap, which the large mammals fell into accidentally. Apparently, when the animals fell inside, their bodies lay on the sloping surface inside the cave and their bones became dismembered during the decomposition process.

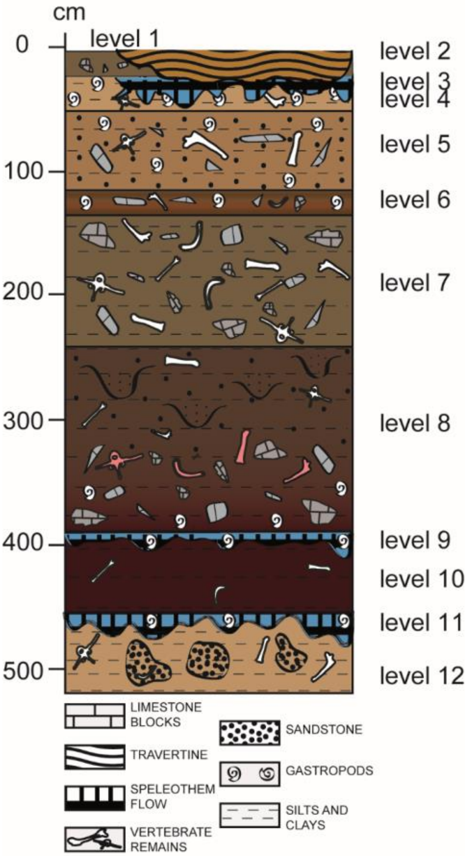


Figure 9. Stratigraphic sequence from Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula). 12 levels can be observed.

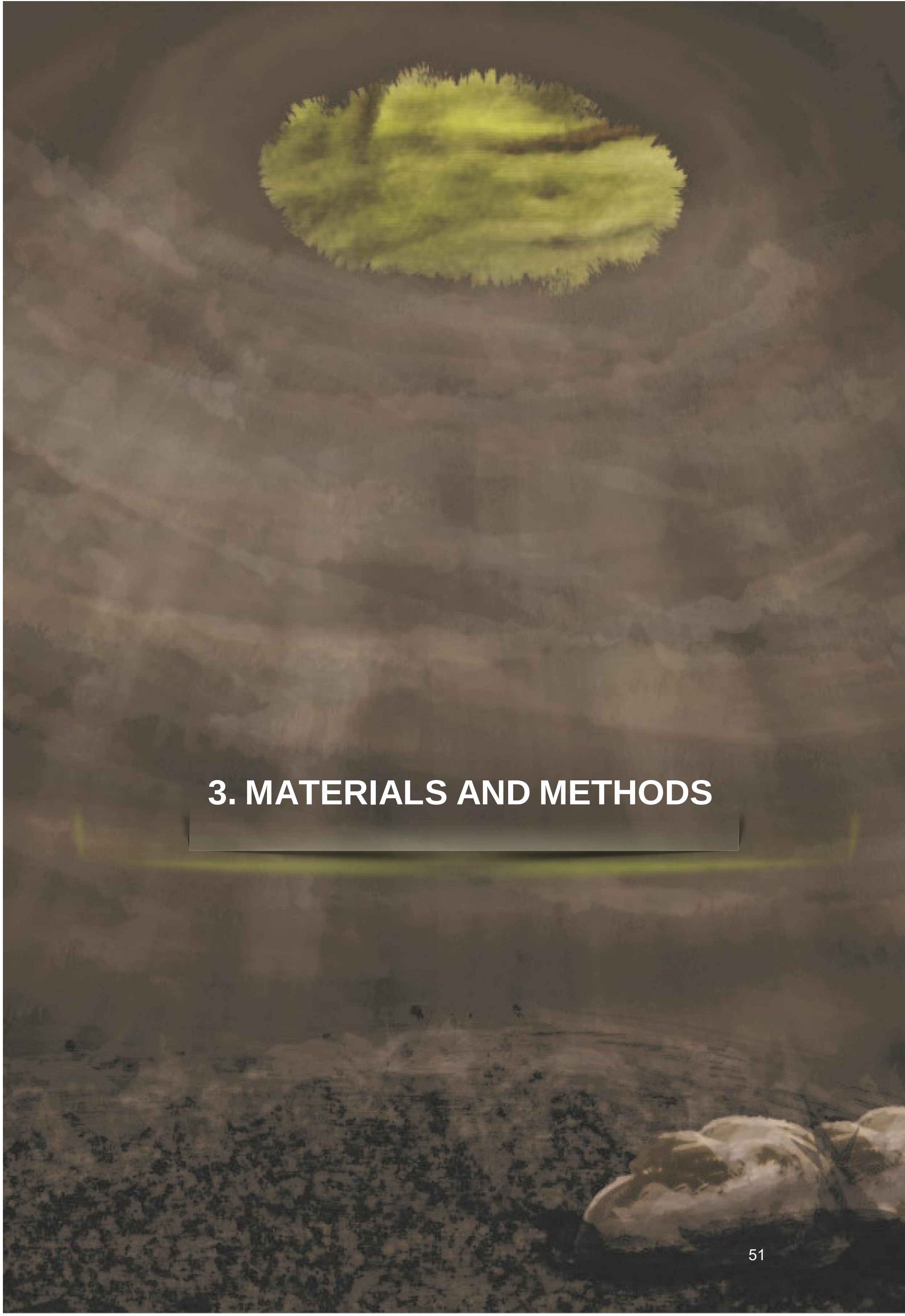
Three trenches in different zones but overlapping in places were studied to obtain a detailed spatial vision of the site. In the excavation horizontal view, the X axis was named by number (to the right of the 0.0 point with even numbers and to the left of the 0.0 point with odd numbers) and the Y axis was designed with letters (up from the 0.0 point with the prime symbol and down from the 0.0 point without symbol) (Fig. 7B). The first stratigraphic trench (a) was performed in Square A9 (Fig. 7B), the second stratigraphic trench (b) in Squares B6, C6 and D6 (Fig. 7B) and the third stratigraphic trench (c) was from the middle of Square 11A to the middle of 13A (Fig. 7B).

The different trenches of the excavation show various lithostratigraphic levels, which were sampled in order to obtain the lithostratigraphic sequence model and lithological description. Therefore, 12 lithostratigraphic levels, named using numbers, were described (Tab. 1). Thus, a succession of samples from Levels

12 to 7 have been taken from Trench a, complementing with samples from Trenches b (Levels 8 to 4) and Trench a (Levels 12 to 1 but with a width spacing between them).

Level	Lithology description
1	20 cm thick. Superficial breccias, especially limestone fragments.
2	Travertine and blocks with SW dip direction. Travertine stratum starts in Level 3 and sometimes overlaps Level 1 even causing the disappearance of it. Other times, in other zones, travertine is not present, so its thickness varies between 0 - 30 cm.
3	Speleothem flowstone with some breccia zones. Starts in the same level as 4 but not over the whole profile. The distribution of this crust is not continuous across the surface; its thickness varies between 0 - 25 cm.
4	Clay and silty matrix with many gastropods. This layer has the upper part encrusted and shows a lateral change. About 25 cm thick.
5	Clay matrix with sandstone and breccias 120 cm thick. At the top of level some gastropods and below more clasts and fewer gastropods. Altered gravel also appears throughout the whole level. Presence of speleothem crust fragments. In some points Level 5 is difficult to differentiate from Level 6 because of its similarity, so, occasionally, both levels have been merged and treated as if they were the same.
6	Clayey silt matrix 20 cm thick. Some gastropods and breccias are present. Strong coloring variation, from red, green to yellow. Presence of speleothem crust fragments.
7	Greyish clay soil. 110 m thick with angular limestone pebbles. Some bones are reddish in color.
8	Clay and silt matrix 160 cm thick subdivided into three sublevels. From top to bottom lithology changes with three sublevels, 8a, 8b and 8c, differentiated. 8a: sediment is greenish in color with a predominance of sandstone with microconglomerate particles. Some sediment canals can be observed, and some reddish bones. 8b: Unlike sublevel 8a, in this part appear breccias with a large limonite pebbles and reddish bones. This second part, laterally, goes from 50 cm thick to 10 cm. 8c: this final part contains a large accumulation of limestone blocks and just on the boundary between Levels 8 and 9 levels many gastropods and some iron oxides.
9	Speleothem flowstone with abundant gastropods (*Cepaea nemoralis*) in the lower part. On average 15 cm thick but laterally thickness declines and in some bands even disappears.
10	Red clays with breccias 50 cm thick. Both at the top and down it is limited by the crust. Even at the top, it joins with the crust from Level 9.
11	Crust flowstone with gastropods (*Cepaea nemoralis*) in the lower part. The thickness is changeable between 10–40 cm and laterally it even disappears completely in some bands.
12	Clay matrix combined with sandy patches and isolated rounded pebbles. 60 cm thick.

Table 1. Stratigraphic and geological description of Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula).



3. MATERIALS AND METHODS

3. MATERIALS AND METHODS

This is a multidisciplinary thesis that includes numerous studies of different scientific fields, carried out at both Artazu VII and Artazu VIII palaeontological sites (Arrasate, Gipuzkoa, northern Iberian Peninsula). While in Artazu VII the sediment only was preserved against the wall, in Artazu VIII a great part of the site left largely intact. After excavation works, description of the stratigraphic sequence and sampling, Radiocarbon Dating (AMS) and Amino Acid Racesimation (AAR) techniques were used to determinate the date of Artazu VII and Artazu VIII sites. In addition, the study of the small mammals, birds and large mammals (ungulates and carnivores) assemblages were conducted in both sites. However, they were carried out same studies in both sites due to the characteristic of each one. The analysis of the herpetofauna remains and geochemical study of the carnivores were only performed at Artazu VII. Conversely, sedimentological and mineralogical analyses, and palynological study only were performed in Artazu VIII due to its ordered and clear stratigraphy.

Considering that both sites were destined to be destroyed, the excavation and the collection of all the samples were very important works. Therefore, the recovery of samples was conducted meticulously and paying attention to every detail, registering and writing down all the steps. Here below each one is explained, divided into field and laboratory techniques.

Before starting, some terminology used in the text must be clarified. Due to the high size variability of birds (small and large vertebrates), they will tackle separately from microfauna and macrofauna, referring to them as avifauna.

3.1. Field techniques: excavation works and sample collection

Here are included those techniques performed to obtain the material, including the search and recovery of the material and its transportation.

3.1.1. Excavation works and palaeontological samples

The palaeontological material recovered from Artazu VII and Artazu VIII consists of small vertebrates, large mammals and avifauna remains, yielding a large number of remains and great taxonomical diversity (Suárez-Bilbao et al., 2016, 2017a, 2018; Castaños et al., 2017a). Whenever the same methodology was applied, it is explained further down in the text, referring to both sites ensemble. However, sampling peculiarities and some details of various proxies from each site are explained in the corresponding chapter (Chapter 6).

First, in order to recover small vertebrates and small bird remains, sediment samples were collected in sacks, ordered according to their provenance. All the sediment was exposed to open air and then soaked for some hours to disperse and deflocculate clays and silts (Fig. 10A). Afterwards, all the material was processed with the water-screening method (Fig. 10B) stablished by Daams and Freudenthal (1987). Two sieves were used for this process, differentiating thick (> 2 mm) and fine fractions (> 0.5 mm and < 2 mm) to make easier the following sift and identification of the material. Consequently, the great amount of sediment reduces and the fossil remains get concentrated. This work was possible thanks to the installations of “Aula Paleontológica de Cenicero” (La Rioja) and “Embalse del Ferial” from Bardenas Reales de Navarra (Navarre).

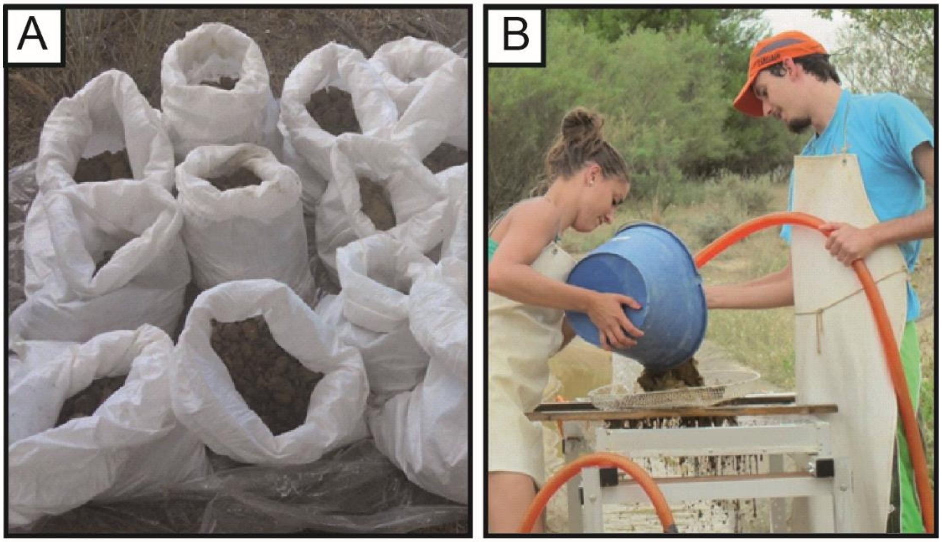


Figure 10. A: Collected sediment from Artazu VII left to dry. B: sediment water-screening process with sieves of 0.5 and 2 mm mesh size.

In contrast to Artazu VIII, the preserved sediment in Artazu VII did not allow the excavation by squares (Suárez-Bilbao et al., 2016). However, all the skeletal remains had a collecting number integrated in both sites (explained above). Depending sites stratigraphic sequence features in some cases the collecting number contained the spits of which they came from, or, in other cases, the location of square + band and level of where the remains were extracted. Most of the macrofaunal remains were found with postdepositional fractures and some parts of them were preserved in anatomical connection (Fig. 11). All the large mammal remains from both sites were recovered. In the cases of deteriorated or fragmented remains, actions were taken to protect the bones. This process was performed carefully *in situ*, using plastering method (Fig. 12). As a result of that process, many skeletal remains were recovered completely.

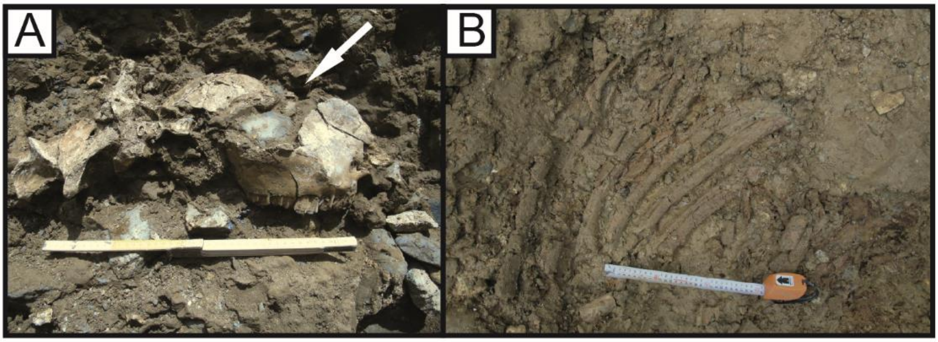


Figure 11. Some large mammal skeletal remains appearance during the excavation in Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). A: *Coelodonta antiquitatis* skull, the arrow indicates postdepositional fracture by failing rock. B*: Bison priscus* ribs in anatomical connection.

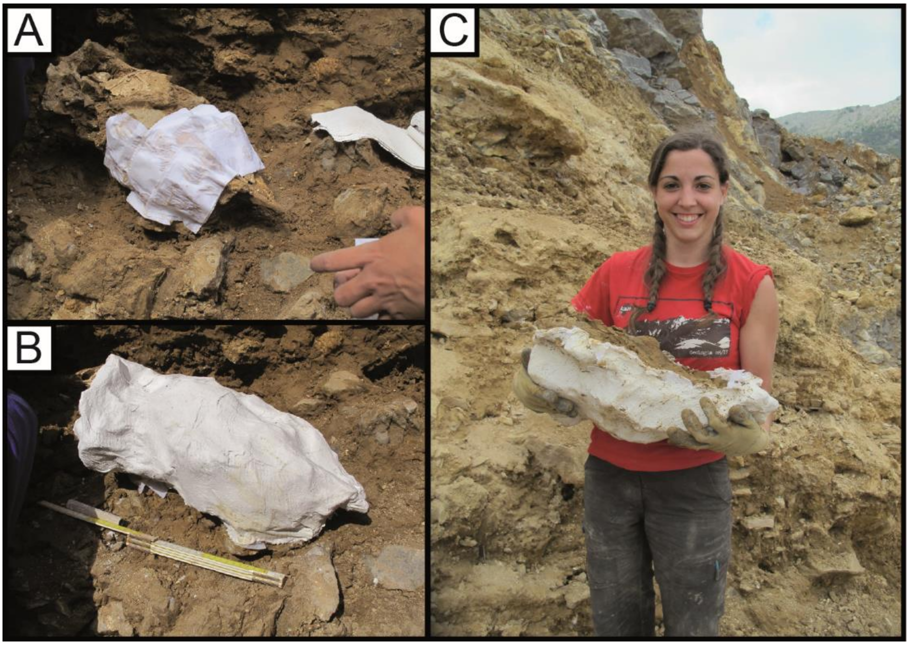


Figure 12. *Bison priscus* skull plastering process in Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). A: wrapping first stage. B: plastering drying. C: extraction of plastered skull.

A. Artazu VII

Since a large part of the site was destroyed during the blasting, all the remaining sedimentary fill of the fissures was recovered (Suárez-Bilbao et al., 2016). As commented in Chapter 2, three different areas were differentiated in the structure of the site, named from top to bottom, Upper Ledge (UL), Lower Ledge (LL) and Chamber (C). In total, nineteen 7–15 cm thick arbitrary spits were excavated (Suárez-Bilbao et al., 2018) (Fig. 13). These spits were designated in descending order from top to bottom, each one being allocated a depth, a letter or number. Thus, in the UL they were ordered by depth (from 0 to 15), in the LL alphabetically (from A to L) and in the C numerically (from 1 to 5) (Fig. 13). The fossil material recovered from Artazu VII consists of malacofauna, small vertebrates (small mammals, amphibians, reptiles and fish), avifauna and large mammals (ungulates and carnivores).

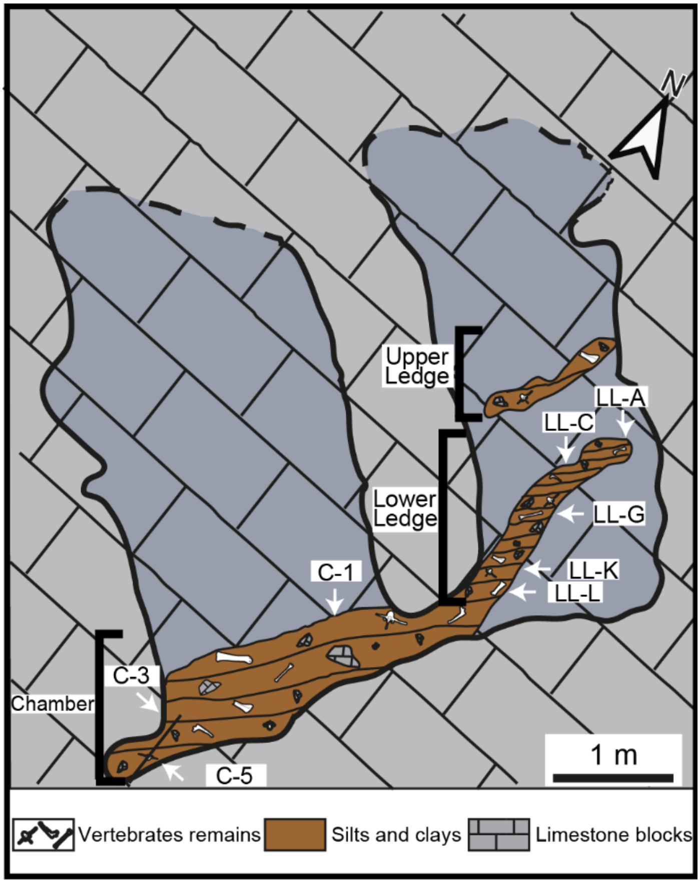


Figure 13. Three deposit zones can be observed: Upper Ledge (UL), Lower Ledge (LL) and Chamber (C) subdivided in 19 spits. Suárez-Bilbao et al. (2016).

Small vertebrates

For the study of the small vertebrates two samples were taken from the UL zone (total sediment volume: 2.5 l), twelve in the LL (total sediment volume: 156 l) and five in the C (total sediment volume: 82 l), amounting to an overall sediment volume of 240.5 l.

Large mammals

As Artazu VII was discovered after blasting in the quarry, a large proportion of the material was scattered into the air. However, all the large vertebrate remains, both in context (*in situ*) and out of context (*ex situ*), were collected. The samples collected *in situ* by excavation were called Storage 1, and those recovered *ex situ* from the pile of debris, Storage 2 (Castaños et al., 2017a). Most of the remains from Storage 1 were also disturbed, with species and individuals totally mixed, both horizontally and vertically; in some cases, the remains corresponding to a single individual were distributed among different areas of the cave. Therefore, no levels, square or sectors were stablished and the entire sample was considered as a single assemblage (Fig. 14).

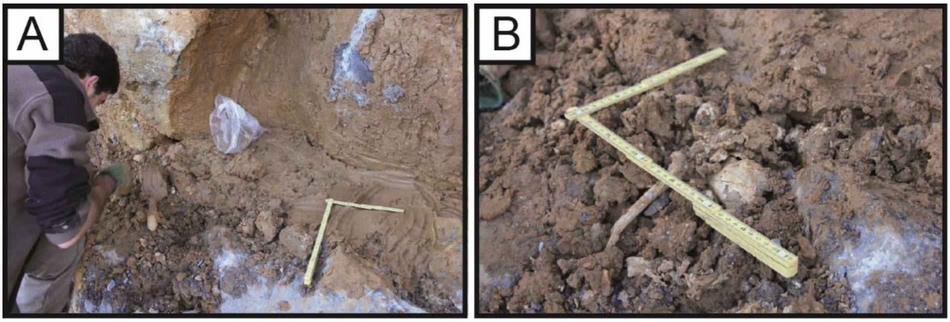


Figure 14. A: snapshot of excavation works in Artazu VII. B: example of the state of large mammal bones in situ, *Vulpes vulpes* skull could be observed.

Avifauna

Like the large mammal remains, all the vertebrate remains were collected, both *in situ* and *ex situ* (Suárez-Bilbao et al., 2018). Part of the bird remains that were in context come from the same samples used for the analysis of small vertebrates. In total, 19 samples were recovered. The avifauna has been analysed by maintaining the samples from the three different zones separate.

B. Artazu VIII

The fossil material recovered from Artazu VIII consists of malacofauna, small vertebrates (small mammals, amphibians, reptiles and fish), avifauna and large mammals (ungulates and carnivores). As mentioned in Chapter 2, a great part of the site was destroyed after blasting works, so, only a fraction remained *in situ* (Fig. 15). Moreover, of the preserved fraction the upper part presented a risk of rockfalls due to the abundance of limestone breccia (Fig. 15), and it was unsafe and dangerous to work there. In addition, no macrofauna remains were appreciated in this upper part. Therefore, taking into account the risk and the lack of large mammal remains, it was decided not to excavate this part, and consequently it only was possible to study the stratigraphic fill of 5 m thick.

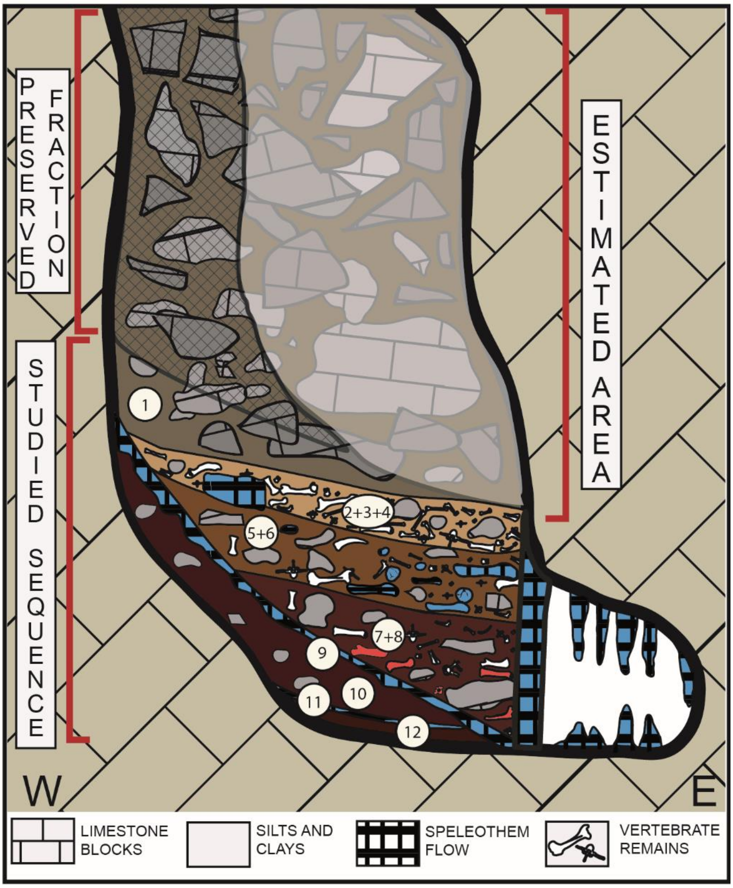


Figure. 15 Artazu VIII site schematic section performed in WE direction, without scale. Two parts could be observed: the studied sequence and the part with rockfalls risk.

Small vertebrates

The sampling was conducted in three areas of the site (named columns I, II and III) in order to cover the entire sequence, as well as to obtain a full picture with stratigraphic columns that could be correlated with each other. The first column (I) was performed between Squares 1 to 5 and Bands B and C (Fig. 16A), the second column (II) in Square 6 and Bands A to D (Fig. 16A) and the third column (III) was in Squares 9 to 13 and Band A (Fig. 16A). A total of 40 samples were collected with an average thickness of 10 cm. Each sample was 15 l in volume, representing a total volume of 600 l:

- -10 samples in column I from Levels 2 to 7 (named from I.1 to I.10, from the top to bottom),
- -15 samples in column II from Levels 1 to 7 with a hiatus in Levels 2 and 3 (named from II.1 to II.15, from the top to bottom)
- -15 samples in column III from Levels 7 to 12 (named from III.1 to III.15, from the top to bottom).

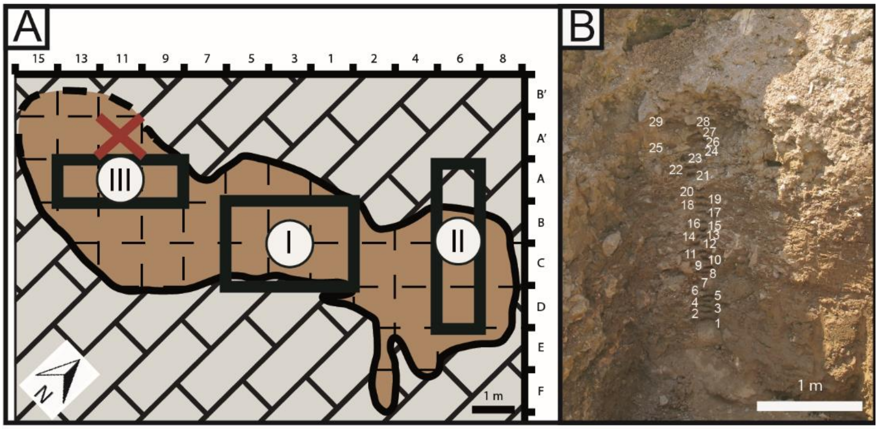


Figure. 16. A: Artazu VIII section performed at the bottom of the site, superficial plane. The columns where small vertebrates sampling were conducted are marked with a black boxes I, II and III. The palynology samples were collected in the square-band marked by X. B: pollen sampling in A'11 square numbered from the bottom to the top.

Large mammals

Unlike small vertebrate sampling, for the recovery of the large mammals the remaining sediment after blasting was divided in squares of 1x1 m (designated by numbers) and bands (designated by letters) (Figs. 16 and 17), following Cartesian coordinates (Laplace, 1971). In the excavation horizontal view, the X axis was named by number (to the right of the 0.0 point with even numbers and to the left of the 0.0 point with odd numbers) and the Y axis was designed with letters (up from the 0.0 point with the prime symbol and down from the 0.0 point without symbol) (Fig. 17A). The horizontal zero plane was placed at the top of the sediment filling, in the surface of Level 1.

An area of 36 m^2 was excavated during 2014 and 2015.The works were conducted following layers slope (from one end to other, differentiating the left, the middle and the right zones of the site), given the difficulties accessing the cave and the risk of a rockslide. The surface was mapped using a grid after excavation works.

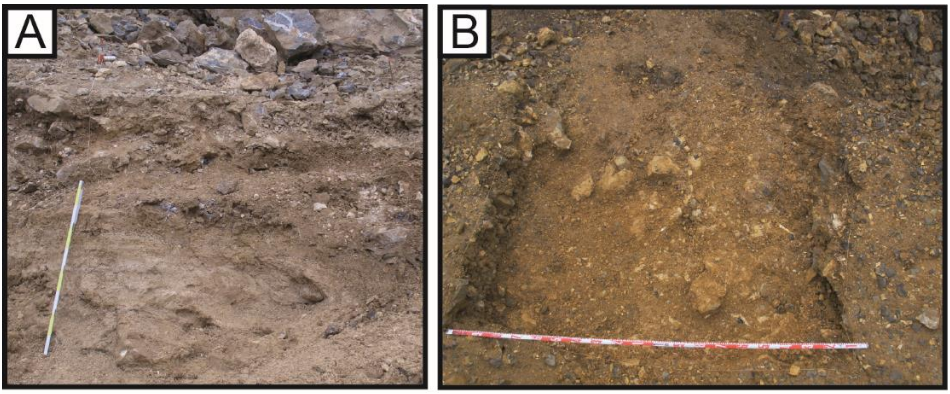


Figure 17. A and B detailed photographs of squares and bands from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) during excavation works.

Avifauna

The bird remains at Artazu VIII were extracted from the small vertebrate sampling conducted in Columns I, II and III (Fig. 16A). Therefore, avifauna fossil bones from 45 samples were studied.

Pollen

Pollen sampling is conditioned by sediment deposit type (López-Sáez et al. 2003). In Artazu VIII the “stratigraphic profile” or “continuous” method was selected in order to obtain a diachronic picture of vegetation change. To avoid sediment contamination, the stratigraphic profile of Artazu VIII was washed and the samples were collected from the bottom to the top. In order to obtain the most complete stratigraphic sequence the sampling was performed in Square A’11 (samples 1-29) and in Square B11 (samples 30-34) (Fig. 16). Thus, 34 samples of approximately 50 g of sediment were recovered from Level 4 to Level 8 (Tab. 2). The instrument was cleaned with distilled water each time the samples were taken and the sample containers were sterile.

Sample	Level	Depth (cm)
1	4	69
2	4	76
3	5	90
4	5	100
5	5	110
6	5	118
7	5	124
8	5	130
9	5	138
10	6	143
11	6	149
12	6	155
13	6	161
14	6	166
15	6	173
16	6	178
17	7	184
18	7	193
19	7	198
20	7	204
21	7	208
22	7	213
23	7	219
24	7	224
25	7	230
26	7	234
27	7	239
28	7	243
29	7	248
30	8	285
31	8	294
32	8	302
33	8	311
34	8	317

Table 2.Recovered samples from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). The shading cells indicate pollen studied samples

3.1.2. Sedimentological and mineralogical samples

Unlike in Artazu VII, in Artazu VIII it was possible to differentiate levels, 12 to be more precise. Therefore, here it was possible to perform sedimentological and mineralogical study. The studied site filling had 5 m of thickness, and 32 samples designated numerically in ascending order from bottom to top were collected in the three stratigraphic trenches. 12 samples were taken in Trench a, eight samples were collected in Trench b and the other 12 samples were sampled in Trench c (Fig. 7B).

3.1.3. Micromorphology samples

Three undisturbed samples of unconsolidated sediment were collected with Kubiena boxes in Artazu VIII (Fig. 18). The aim was to make thin sections and to study them under microscope to differentiate microfacies along the stratigraphy. This box had a lateral frame and two covers, which was carefully introduced in the profile helped by a knife. Samples were collected in Level 4, Level 5 and Level 8 (Fig. 9). Level 4 was selected due to the high abundance in small vertebrate bones and in malacofauna, Level 5 for being approximately the middle of the

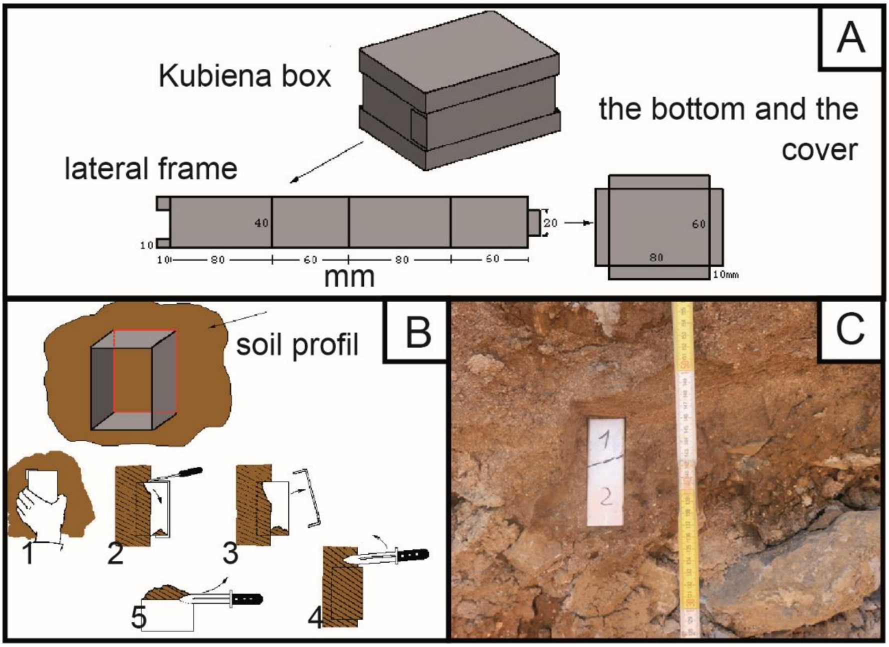


Figure 18. Micromorphology sample collection. A: Kubiena box in detail. B: the process of samples extraction. C: the appearance of Artazu VIII (Arrasate, northern Iberian Peninsula) profile during the extraction of micromorphology samples. Modified from http://edafologia.ugr.es/micropract/muestra.htm.

stratigraphic sequence and, finally, Level 8 because at first sight, much avifauna remains could be observe.

3.2. Laboratory techniques

This part refers to the techniques performed in the laboratory once all the material was recovered. Thereafter samples were selected to carry out different studies. Thus, this part was developed in various phases: selecting samples for dating, for palaeontological studies and for mineralogical and sedimentological analysis.

3.2.1. Dating techniques

The age of Artazu VII and Artazu VIII sites was calculated using Radiocarbon (AMS) and Amino Acid Racemisation dating (AAR) methods (Suárez-Bilbao et al., 2016). In addition, only in Artazu VIII was made an attempt of U/Th dating (Artazu VII lack speleothem crust). However, U/Th dating did not give reliable results.

- **Radicarbon Dating (AMS)**

Three bone samples were selected for an Accelerator Mass Spectrometry (AMS) radiocarbon determination to establish the exact age of the deposit, one at Artazu VII and two at Artazu VIII. In Artazu VII a *Rupricapra pyrenaica* metapodial was chosen from the UL zone, which a priori, was the most recent part of the deposit. On the contrary, in Artazu VIII a metapodial of *Coelodonta antiquitatis* and a rib of *Cervus elaphus* from Levels 7 and 2 were selected because of their consistency and good state of preservation. The samples, sent to Beta Analytic (Florida), yielded the minimum weight of 1 to 2 g collagen. However, the samples from both sites proved to be outside the maximum age limit of Radiocarbon dating (older than 43.5 ka), showing they were not at least referable to the later part of the late Pleistocene.

- **Amino Acid Racemisation (AAR)**

As it was not possible to date Artazu VII and Artazu VIII with Radiocarbon or either with the U/Th technique in case of Artazu VII (owing to the absence of speleothems), the method of Amino Acid Racemization was applied in both sites. This is one of the few dating methods that can be used in these chronologies, as at Las Callejuelas (Domingo et al., 2015). The dating of palaeontological and archaeological sites using AAR analysis has become a reliable method (Goodfriend, 1991; Kaufman and Manley, 1998; Torres et al., 2014), despite certain difficulties. As racemization is genus-dependent, the use of monogeneric samples reduces taxonomically-controlled variability in D/L ratios (Murray-

Wallace, 1995; Murray-Wallace and Goede, 1995). In order to reduce taxonomically-controlled variability in measured values, the remains of the most abundant taxon were selected and send to Biomolecular Stratigraphy Laboratory (LEB) in the Higher School o fMining Engineers in Madrid (E.T.S.I de Minas). The characteristics of each sample (information about the selected dental element) are shown in Table 3.

Samples of powdered dentine were obtained by drilling a hole 2 mm in diameter and 5-10 mm in depth with a thin diamond-headed device. Dentine collagen samples were obtained following the dialysis step (3.5 kDa) proposed by Lafont et al. (1984) and Marzin (1990), after de-mineralization of the dentine powder. Samples between 17.0 mg and 36.3 mg were subjected to amino acid analysis using a high performance liquid chromatograph (HPLC) in the Biomolecular Stratigraphy Laboratory, following the sample preparation protocol described by Kaufman and Manley (2000). This procedure involves hydrolysis, which was performed under N2 atmosphere in 20 µL/mg 7 M HCl for 20 h at 100ºC in the case of dentine samples (7 µL of 6 M HCl for ostracode valves). The hydrolysates were evaporated to dryness in vacuo and then rehydrated in 7 µL 0.01 M HCl with 1.5 mM sodium azide and 0.03 mM L-homo-arginine (internal standard). Samples were injected into an Agilent-1100 HPLC equipped with a fluorescence detector. Excitation and emission wavelengths were programmed at 230 and 445 nm, respectively. A Hypersil BDS C18 reverse-phase column (5 µm; 250 x 4 mm i.d.) was used for the analysis

A. Artazu VII

Two *Panthera pardus* dental elements were selected (Tab. 3) (Suárez-Bilbao et al., 2016). The first sample of panther was an upper left canine from LL-L (LEB-14069) and the second was a lower left first molar from LL-K (LEB-14070). Moreover, this technique was also tested in 16 gastropods belonging to two genera (eight to *Clausilia* sp. and eight to *Xerosecta* sp.). Analyzed gastropods were extracted from LL (spits A, C, G, K and L) and from C (spits 1, 3 and 5), collecting the same two genera for each spit. Thus, it was possible to contrast two datings for each level.

B. Artazu VIII

With respect to AAR, this method was applied in eight dental elements of *Bison priscus* and two *Coelodonta antiquitatis*. Analysed *B. priscus* samples were extracted due to was the most abundant taxon and was the most presented at all levels. Thus, in Level 1 were extracted two elements belonging to the same individual and from Level 3 to 8 were chosen one sample for each Level. In the case of *C. antiquitatis,* both samples were recovered from Level 8 and they also belonged to the same individual. Although the dated teeth in each species always belonged to the same taxon, the same dental element was not present in all levels, so the dental elements which had better preservation were selected in each case. The samples from Level 1 were a third upper and lower molar (LEB-14060 and LEB-14061), from Level 3 to 5 were third lower molars (designated consecutively with numbers from LEB-14062 to LEB-14064), from Level 6 was a first/second lower molar (LEB-14065), Levels 7 and 8 (LEB-14066 and LEB-14067) were first/second upper molars, and, finally, the remaining samples from Level 8 (LEB-14071 and LEB-14072) were M1(Tab. 3). All samples corresponded to *B. priscus* with the exception of the last two.

Site	**Provenance**	**Lab Code**	**Sample**	
Artazu VII	Lower Ledge L	LEB-14069	C of *Panthera pardus*	
	Lower Ledge K	LEB-14070	M1 of *Panthera pardus*	
Artazu VIII	Level 1	LEB-14060	M3	*Bison priscus*
	Level 1	LEB-14061	m3	
	Level 3	LEB-14062	m3 of *Bison priscus*	
	Level 4	LEB-14063	m3 of *Bison priscus*	
	Level 5	LEB-14064	m3 of *Bison priscus*	
	Level 6	LEB-14065	m1-2 of *Bison priscus*	
	Level 7	LEB-14066	M1-2 of *Bison priscus*	
	Level 8	LEB-14067	M1-2 of *Bison priscus*	
	Level 8	LEB-14071	Left M1	*Coelodonta antiquitatis*
	Level 8	LEB-14072	Right M1	

Table 3. Amino acid racemization ages from Artazu VII and Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula).

- **Uranium/Thorium (U/Th)**

U/Th dating of a speleothem crust collected from Level 9 from Artazu VIII (No. 2016070 AAV) was also attempted. The sample was sent to CENIEH Laboratory (Centro Nacional de Investigación sobre la Evolución Humana) (Burgos, Spain) and was processed following Cheng et al. (2013). It provided a ^{230}Th age of 40,914 ± 214 BP. However, this result is not valid since the samples dated by

AMS were above the speleothem crust in the stratigraphy and therefore they are chronologically more recent. The age was not consistent with the AAR datings either. The high proportion of $^{232}Th/^{230}Th$ ($46 \pm 4 \times 10^{-6}$) and the presence of organic material and detritus could be responsible for the deficient reliability of the U/Th date.

3.2.2. Palaeontological samples

No DNA analyses were performed and no DNA criteria were taken into consideration for the identification of species. A common laboratory methodology was applied for both sites, as it is explained together below. For the skeletal remains, some abbreviations are used (Tab. 4).

	DENTAL ELEMENTS	
A: upper antemolar	a: lower antemolar	
I: upper incisive	i: lower incisive	(N): order number of dental element.
C. upper canine	c: lower canine	
D: upper deciduous	d: lower deciduous	
M+(N): upper molar	m+(N): lower molar	e.g: m3 (third lower molar)
P+(N): upper premolar	p+(N): lower premolar	

	SKELETAL ELEMENTS	
Ang: Angular	Ili:Ilium	Rad: Radius
Ast: Astragalus	Mall: Malleolar	Rib: Ribs
Atl: Atlas	Man: Mandibula	Sac: Sacrum
Axi: Axis	Max: Maxillar	Sca: Scapula
Cal: Calcaneum	Mtc: Metacarpal	Scag: Scapular girdle
Car: Carpal	Mtp: Metapode	Ses: Sesamoid
Caver: Caudal vertebrae	Mtt: Metatarsal	Spm: Sphenethmoid
Caver+r: Caudal vertebrae with	Ost: Osteroderm	Ssca: Suprascapulae
Cever: Cervical vertebrae	Par: Parietal	Skll: Skull
Cla: Clavicle	Pat: Patella	Str: Sternum
Cmc: Carpometacarpus	Pe: Peak	Sqm: Squamosale
Cor: Coracoideum	Pel: Pelvis	Sver: Sacral vertebrae
Cr: Cranium	Pha: Phalange	Tal: Talus
Cta: Centrotarsal	Prmx: Premaxillar	Tbt: Tibiotarsus
Dver: Dorsal vertebrae	Prm: Phalange distalis digit I	Tib: Tibia
Fem: Femur	Prs: Parasphenoid	Tmt: Tarsometatarsus
Fibula: Fib	Psver: Postsacara vertebrae	Tth: Teeth
Fro. Frontal	Ptr: Pterygoid	Tib: Tibia
Frp: Frontoparietal	Pyg: Pygostylus	Tver. Trunk vertebrae
Fur: Furcula	Pham: Premaxilla	Uln: Ulna
H. Cor: Horn core	Pr-ex: prootic-exocipitale	Uro: Urostyle
Hum: Humerus	Qut: Quadratum	Ver: Vertebrae
Hyo: Hyoid		

Table 4. Summary table of skeletal and dental elements of all taxa identified in Artazu VII and Artazu VIII sites (Arrasate, Gipuzkoa, northern Iberian Peninsula) with its abbreviation.

The International Code of Zoological Nomenclature (ICZN) does not legislate in its regulations the use of subgenus. Therefore, the genus is only completely written the first time that the species is mentioned, in order to facilitate the reading of scientific names. Hence, they are only written in full in summary tables and in the taxonomic classification in the corresponding section in Systematic (Chapter 5). Moreover, the Binomial Nomenclature System usually complicates the science reading. For this reason, in this thesis we opted for the use of abbreviations, shortening the genus name and using only the first letter, displayed below in the correspondence paragraph. However, the detailed data from each site is developed in the corresponding chapter (Chapters 6).

Small vertebrates

After water-screening, a selection from all recovered samples was made, choosing some of them for analysis. In certain cases the sample was even quartered in portions.

Once the samples had been selected, the next step was to separate the fossil material from the inorganic remains under the microscope. To make the process easier, the sediment was divided into two fractions. The coarse fraction consisted of the particles with a diameter larger than 2 mm, whereas the fine fraction were particles that had a diameter between 2 and 0.5 mm. Thereby the small vertebrate bones, bird remains and gastropods were separated by tweezers and fine brushes under the stereoscopic microscope (Fig. 19A). Subsequently, for the small vertebrates study, amphibians, reptiles and mammals were saved in different boxes and separated by anatomical elements (Fig. 19B).

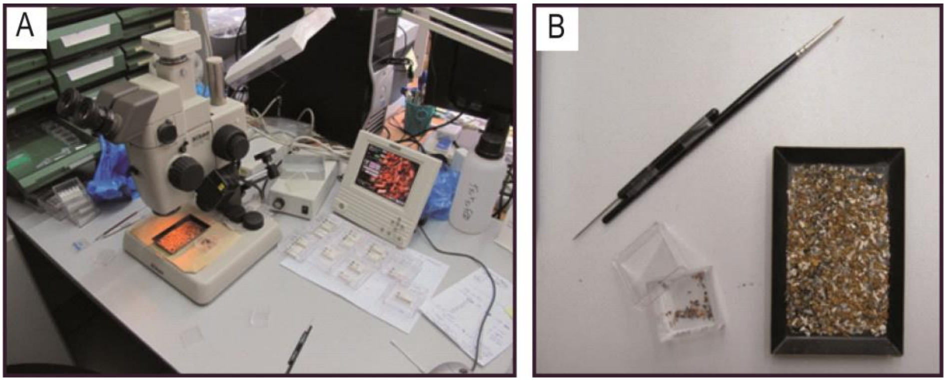


Figure 19. Steps of the small vertebrate separating processes. A: stereoscopic loupe with camera and monitored screen connected. B: at right a plate with sample that is being separated with a brush and at left a box that contains small mammal remains. Suarez-Hernando (2017).

The abbreviation summary list used for small vertebrates is displayed in Table 5. The photography was carried out using a Nikon SMZ 1500 stereomicroscope at 10 × magnification, connected to a DS-5m camera and monitored DS-L1 screen. All these steps were performed in the Stratigraphy and Palaeontology Department of the University of the Basque Country (UPV-EHU). The specimens studied here will be housed at Gordailua (Cultural Heritage Center of Gipuzkoa, Irun, Spain).

	Taxa	**Abbreviation**	**Common name**
ORDER RODENTIA	*Arvicola amphibius*	*A. amphibius*	European Water Vole
	Arvicola sapidus	*A. sapidus*	Southwestern Water Vole
	Microtus (Microtus) agrestis	*M. agrestis*	Field Vole
	Microtus (Microtus) arvalis	*M. arvalis*	Common Vole
	Microtus (Terricola) sp.	*M. Terricola sp.*	Vole
	Microtus (Alexandromys) oeconomus	*M. (A.) oeconomus*	Tundra Vole
	Chionomys nivalis	*C. nivalis*	Snow Vole
	Pliomys lenki	*P. lenki*	Extinct
	Apodemus sylvaticus	*A. sylvaticus*	Wood Mouse
	Apodemus flavicollis	*A. flavicollis*	Yellow-necked Field Mouse
ORDER EULIPOTYPHLA	*Erinaceus europaeus*	*E. europaeus*	Western Headgehog
	Sorex (Sorex) araneus	*S. (S.) araneus*	Common Shrew
	Sorex (Sorex) coronatus	*S. (S.). coronatus*	Millet's Shrew
	Sorex (Sorex) minutus	*S. (S.) minutus*	Eurasian Pygmy Shrew
	Neomys sp.	*Neomys* sp.	Water Shrew
	Talpa sp.	*Talpa* sp.	Mole
ORDER CAUDATA	*Salamandra salamandra*	*S. salamandra*	Fire Salamander
	Triturus sp.	*Triturus* sp.	Newt
ORDER ANURA	*Alytes obstreticans*	*A. obstreticans*	Midwife Toad
	Discoglossus sp.	*Discoglossus* sp.	Frog
	Bufo bufo	*B. bufo*	Common Toad
	Hyla arborea	*H. arborea*	European Tree Frog
	Rana temporaria	*R. temporaria*	European Common Frog
	Rana iberica	*R. iberica*	Iberian Frog
ORDER SQUAMATA	Lacertidae indet.	Lacertidae indet.	Lizard
	Anguis fragilis	*A. fragilis*	Slow Worm
	Coronella girondica	*C. girondica*	Southern Smooth Snake
	Vipera sp.	*Vipera* sp.	Viper

Table 5. Summary table of all small vertebrate taxa identified in Artazu VII and Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) with its abbreviation and common name.

The sampling at Artazu VIII was conducted in three areas of the site in order to cover the 12 levels of the entire sequence. The correlation of the trenches was performed based on the sedimentological differences and in the presence/lack of each taxa and in their proportion, in particular of those that are environmentally more significant, such as *A. sylvaticus-flavicollis* or *M. (A). oeconomus*. The correlations are summarized in an explanatory scheme in Table 6.

Level	Column I	Column II	Column III
1		II.1	
		II.2	
		II.3	
		II.4	
		II.5	
		II.6	
2	I.1		
3	I.2		
	I.3		
4	I.4	II.7	
	I.5		
	I.6		
5	I.7	II.8	
	I.8		
6	I.9	II.9	
7a		II.10	
	I.10	II.11	
		II.12	
		II.13	
7b		II.14	III.1
		II.15	III.2
			III.3
			III.4
8			III.5
			III.6
			III.7
			III.8
			III.9
9			III.10
			III.11
10			III.12
12			III.13
			III.14
			III.15

Table 6. Samples analysed for the small mamal study at Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). In grey the samples that containsavifauna remains.

- ***Identification of the material***

Once the small vertebrate remains had been separated into mammals, reptiles and amphibians, bones were grouped according to anatomic criteria to classify them taxonomically. Firstly, the remains were identified using osteological literature and then, in some cases, they were verified using anatomical reference collections. Thereby, the compared anatomy collection of the Muséum national d´Histoire naturelle (MNHN) in Paris (France), the reference collection of small vertebrate remains of the National Natural Science Museum (MNCN) in Madrid and our own compared collection (which is in the process of being created) were used. The taxonomy of the small mammals follows Wilson and Reeder (2005), while Speybroeck et al. (2010) is followed for amphibians and reptiles. Additionally, the vertebrate remains were identified following the criteria established in: Van der Meulen (1973), Pasquier (1974), López-Martínez (1989), Heinrich (1982), and Berto (2013), for rodents; Reumer (1984) and Furió Bruno (2007), for eulipotyphlans; Sevilla (1988) for Chiroptera; and Szyndlar (1984), Bailon (1991, 1999) and Blain (2009) for amphibians and reptiles. Specific attributions were made mainly for the most diagnostic cranial and/or postcranial elements for each case:

- the lack or presence of roots and cement, dental enamel thickness and morphology of teeth for rodents (first lower molars for Arvicolidae, and any molar for Muridae) (Figs. 20 and 21).

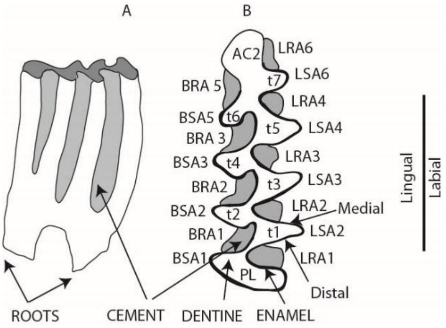


Figure 20. Example of Arvicolinae tooth. A: Features of the side view of a lower left third molar. B: Occlusal view of the lower left first molar based on Van der Meulen (1973) and Heinrich (1978). t = triangle, the number indicates the order of counting. Abbreviations: BRA, buccal entering angle; BSA, buccal salient angle; LRA, lingual entering angle; LSA, lingual salient angle; AC2, anterior complex; PL, posterior lobe.

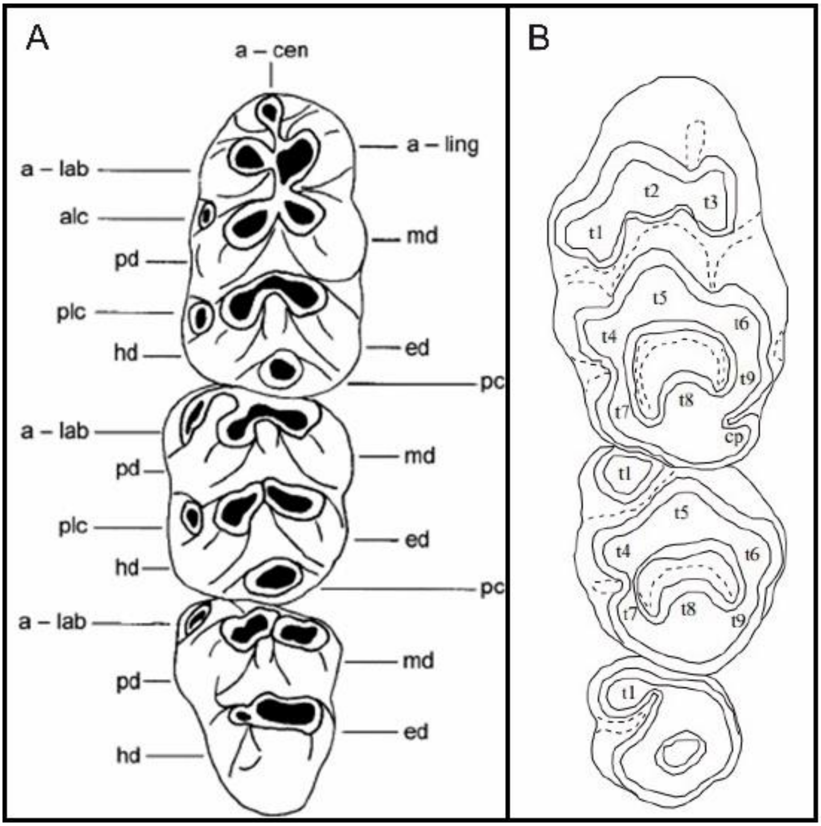


Figure 21. Murinae dental nomenclature in occlusal surface. A: Lower left teeth row. Abbrevations: a-cen, anterocentral cusp; a-lab, anterolabial cusp; a-ling, anterolingual cusp; pd, protoconid; hd, hypoconid; md, metaconid; ed, entoconid; pc, posterior cingulum; alc, anterior labial cusplet; plc, posterior labial cusplet. B: Upper left teeth row. t1-t3 and t6, tubercles; t4, paracone; t5, protocone; t7, metacone; t8, pseudohipocone ; cp, posteroloph. Modified from Musser and Newcomb (1983).

-mandibles, maxillae and isolated teeth for Erinaceidae (Fig. 22) and Soricidae (Fig. 23).

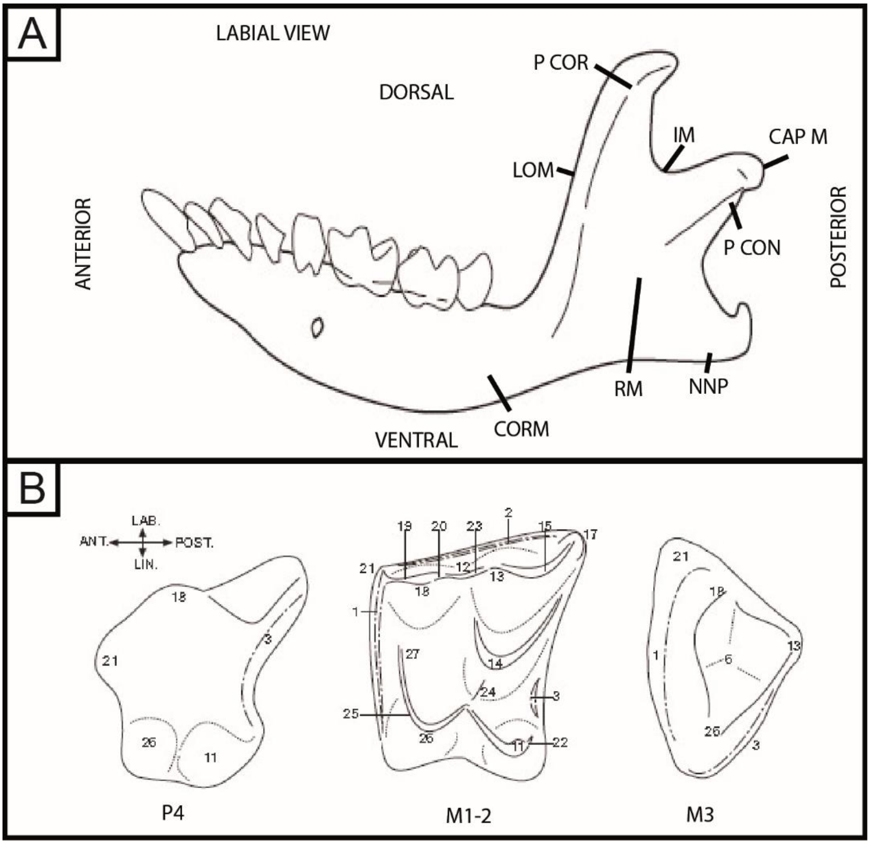


Figure 22. *Erinaceus* cranial elements nomenclature based on Corbet (1988). A: lower left mandible. LOM, linea oblique mandibulae; RM, ramus mandibulae; CORM, corpus mandibulae; P CON, processus condylaris (condyloideus); IM, incisura mandibulae; P COR, processus coronoideus; CAP M, caput mandibulae; NNP, nom nominates processus; COLM, collum mandibulae, B: dental upper left elements. 1, anterior cingulum; 2, labial cingulum; 3, posterior cingulum; 4, hipocone crest; 5, accessory cuspid; 6, trigone depression; 7, ectolophe; 8, posterior emargination; 9, endolophe; 10, hipocone flank; 11, hipocone; 12, mesostyle; 13, metacone; 14, meraconule; 15, metacrest; 16, metalophe; 17, metastyle; 18, paracone; 19, paracrrest; 20, paramesocrest; 21, parastyle; 22, posthipocrest; 23, postmesocrest; 24, postprotocrest; 25, preprotocrest; 26, protocone; 17, protoconule. Modified from Furió Bruno (2007).

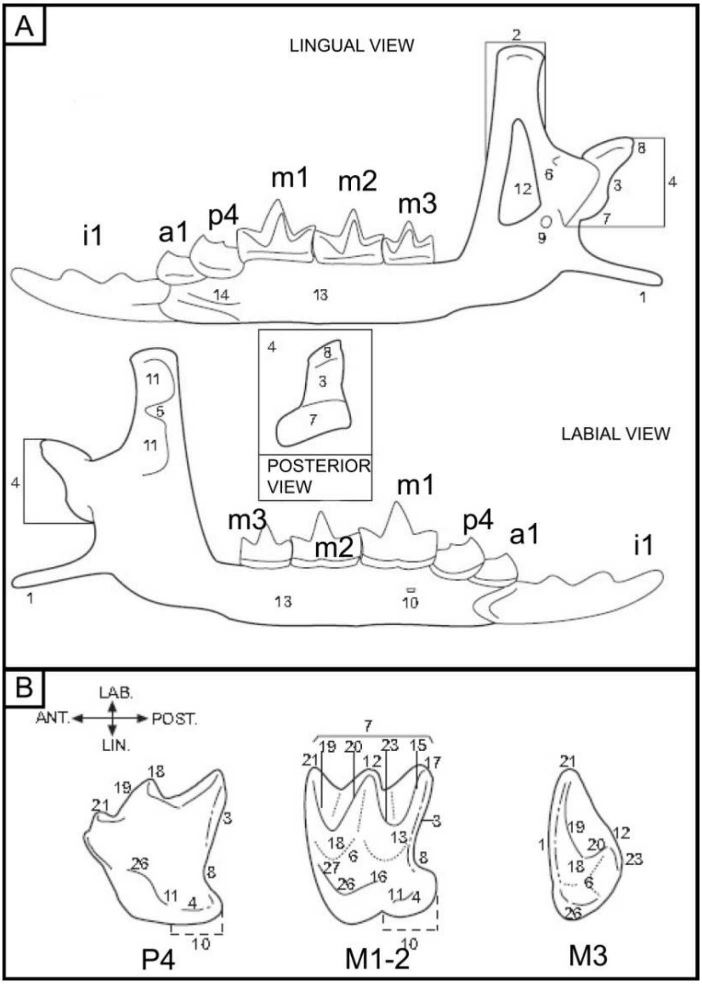


Figure 23. Soricidae cranial elements nomenclature based on Reumer (1984). A: right mandible. 1, apophysis or angular process; 2, apophysus or coronoid process; 3, interarticular area; 4, articular condile; 5, coronoid spicule; 6, pterigoid spicule; 7, inferior articular facet; 8, superior articular facet; 9, mandible foramen; 10, mentionian foramen; 11, external temporal fossa; 12, internal temporal fossa; 13, mandible/horizontal ramus; 14, mandible symphisis. B: dental upper left elements. 1, anterior cingulum; 2, labial cingulum; 3, posterior cingulum; 4, hipocone crest; 5, accessory cuspid; 6, trigone depression; 7, ectolophe; 8, posterior emargination; 9, endolophe; 10, hipocone flank; 11, hipocone; 12, mesostyle; 13, metacone; 14, meraconule; 15, metacrest; 16, metalophe; 17, metastyle; 18, paracone; 19, paracrest; 20, paramesocrest; 21, parastyle; 22, posthipocrest; 23, postmesocrest; 24, postprotocrest; 25, preprotocrest; 26, protocone; 17, protoconule. Modified from Furió Bruno (2007).

-mandibles, maxillae, isolated teeth, radius, humerus and phalanges for Talpidae (Fig. 24).

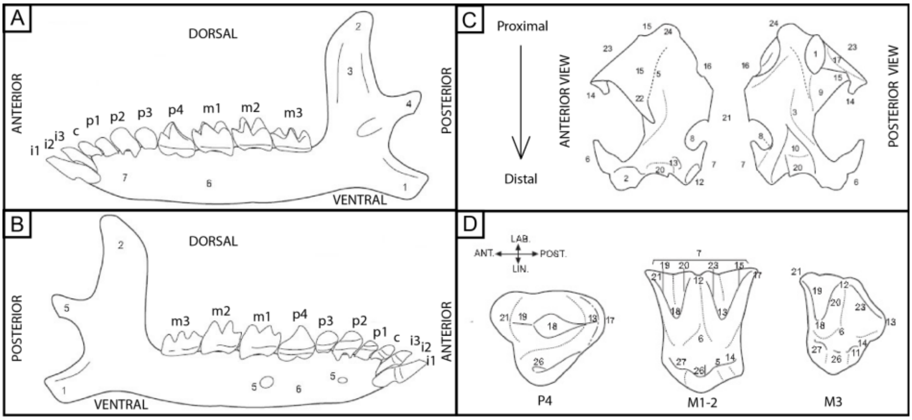


Figure 24. Talpidae skeletal elements according to Reumer (1984). A and B: Lower right mandible nomenclature. A: lingual view. B: labial view. 1, apophysis or angular process; 2, apophysus of coronoid process; 3, interarticular area; 4, articular condile; 5, coronoid spicule; 6, pterigoid spicule; 7, inferior articular facet; 8, superior articular facet; 9, mandible foramen; 10, mentionian foramen; 11, external temporal fossa; 12, internal temporal fossa; 13, mandible/horizontal ramus; 14, mandible symphisis. C: right humerus. 1, humerus head; 2, humerus condile; 3, muscle crest; 4, dorsal lateral crest; 5, pectoral crest; 6, epicondile; 7, entepicondile; 8, entepicondilar foramen; 9, braquial fossa; 10, olecranian fossa; 11, coronoid fossa; 12, flexor digitorium muscle fossa; 13, suprathroclear fossa; 14, deltoid process; 15, pectoral process; 16, bicipital cannal; 17, clavicular articular surface; 18, radial articular surface; 19, ulnar articular surface; 20, throclea; 21, teres tubercle; 22, pectoral tubercle; 23, major tuberous; 24, minor tuberous. D: dental upper left elements. 1, anterior cingulum; 2, labial cingulum; 3, posterior cingulum; 4, hipocone crest; 5, accessory cuspid; 6, trigone depression; 7, ectolophe; 8, posterior emargination; 9, endolophe; 10, hipocone flank; 11, hipocone; 12, mesostyle; 13, metacone; 14, meraconule; 15, metacrest; 16, metalophe; 17, metastyle; 18, paracone; 19, paracrest; 20, paramesocrest; 21, parastyle; 22, posthipocrest; 23, postmesocrest; 24, postprotocrest; 25, preprotocrest; 26, protocone; 17, protoconule. Modified from Furió Bruno (2007).

-mandibles, maxillae and teeth for Chiroptera (Fig. 25).

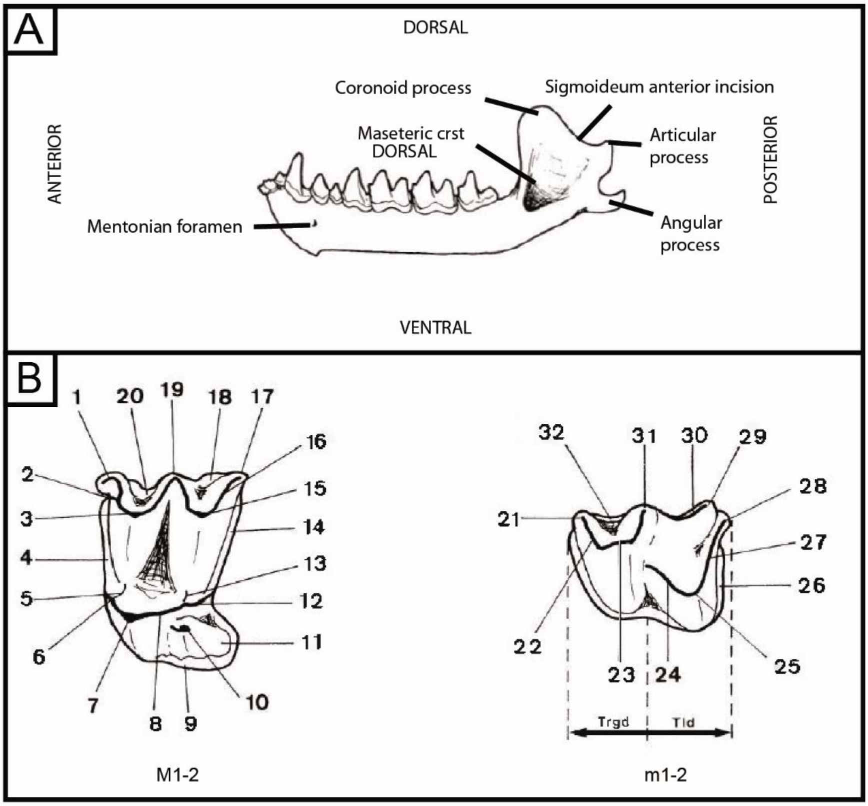


Figure 25. Chiroptera cranial elements nomenclature based on Sevilla (1988). A: lower right mandible, lingual view B: dental elements, occlusal view. 1, parastyle; 2, preparacrest; 3, paracone; 4, anterior cingulum; 5: paralophe; 6, paraconule; 7, protocone; 8, postprotocrest; 9, lingual cingulum; 10, hipocone; 11, heel; 12, metaconule; 13, metalophe; 14, distal cingulum; 15, metacone; 16, postmethacrest; 17, metastyle; 18: metaflex labial cingulum; 19, mesostyle; 20, paraflex labial cingulum; 21, paraconide; 22, paralophyde 23, protoconide; 24, oblique crest; 25, hipoconide; 26: distal cingulum; 27, postcrest; 28, hipoconulide; 29, entoconide; 30, entocrest; 31, metacrest; 32, trigonid lingual cingulum Trgd: trigonid. Tld: talonid. Modified from Sevilla (1988).

-vertebrae for newts (Fig. 26).

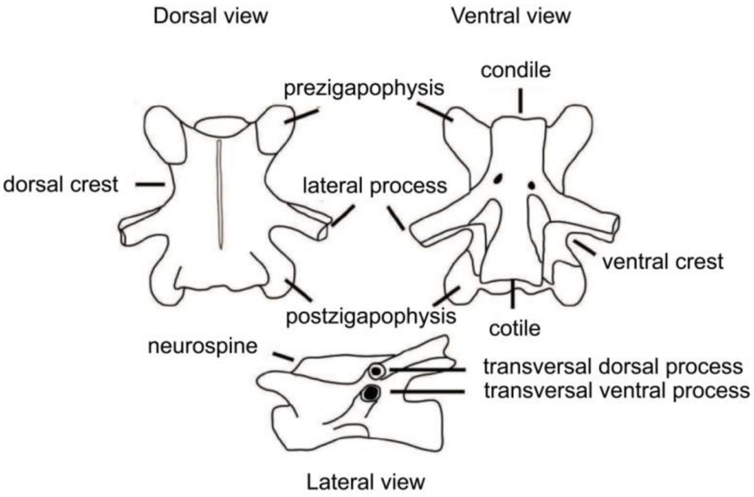


Figure 26. Salamandridae vertebra nomenclature. Bailon (1991).

-the humerus and ilium for the anurans (Fig. 27).

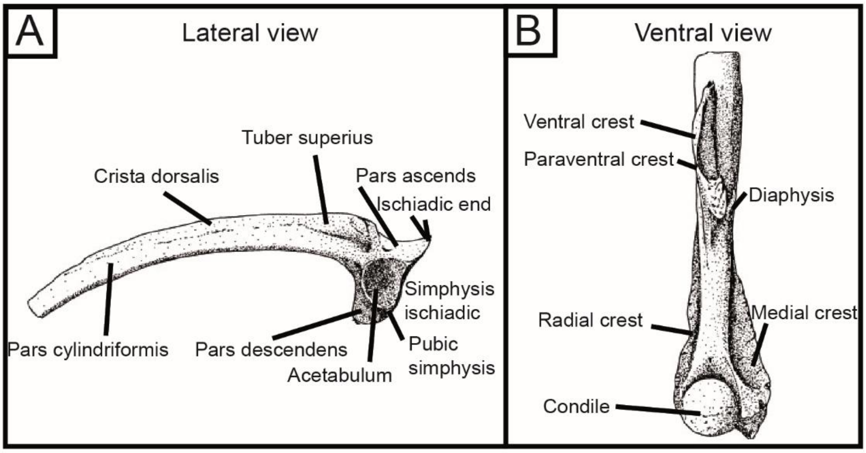


Figure 27. Anura ilion and humerus nomenclature. A: left ilion. B: right humerus. Modified from Kyselý (2008).

-vertebrae for lacertids and snakes (Fig. 28).

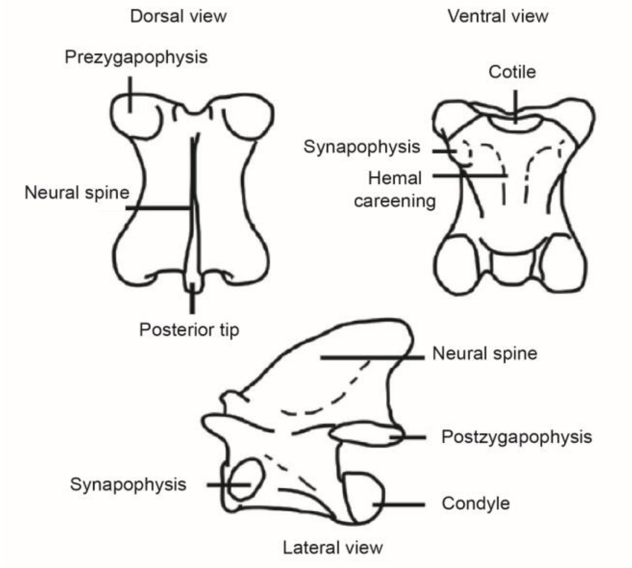


Figure 28. Sauria vertebra nomenclature. Bailon (1991).

-vertebrae, dental material and osteoderms for *A. fragilis* (Fig. 29).

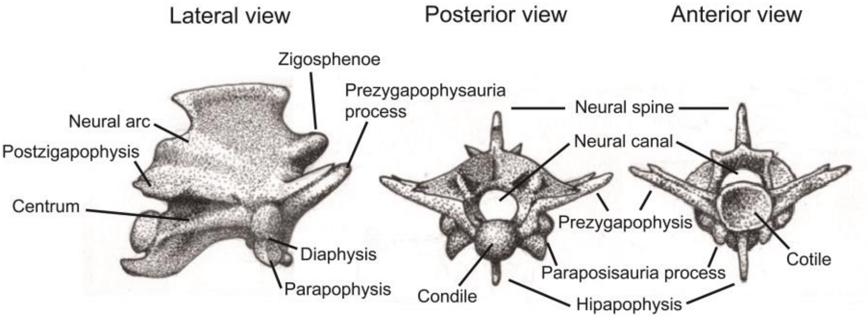


Figure 29. Serpentes vertebra nomenclature. Modified from https://blackpariahdog.deviantart.com/art/Plains-Garter-Snake-vertebra-332915841.

Although mandibles with teeth were recovered for rodents, for the quantification of the material in Chapter 5 only teeth have been considered.

- ***Biometry of Soricidae lower dental elements***

The majority of the species in the *Sorex* genus are differentiated by the size of the mandible. However, if dental elements are isolated, it is complicated to separate them due to their morphological and biometrical similarities. In the sequence from Artazu VII two taxa belonging to this genus were recorded: *S. (S.) araneus-coronatus* group and *S. (S.) minutus* (Suárez-Bilbao et al., 2016, 2017a, 2017b). Normally, during the thanatocoenosis (transporting and trampling from other organisms) and taphocoenosis (decomposition, abrasion, fragmentation and other destructive processes) the features of the produced remains are modified (Fernández-López, 1991) generating changes in the proportion, conservation and disconnection of the anatomical elements. Therefore, in vertebrate Quaternary sites the proportion of isolated teeth is usually high. As Artazu VII functioned as a natural trap, the alterations produced by other organisms are minimal, and therefore the proportion of mandibles containing dental elements in Artazu VII is considerably higher than in other Quaternary sites (~ 25% mandibles with teeth and 75% isolated teeth). So, given the large number of mandibles with dental elements, we measured the lower dental elements of these two taxa (both isolated and connected to the mandible) and compared them in order to observe if this biometrical technique helps in their identification.

The analyzed sample came from the Chamber 5, selecting the entire teeth with low wear of *S. (S.) araneus-coronatus* and *S. (S.) minutus* taxa (Suárez-Bilbao et al., 2017b). The measurements were taken in 117 teeth (97 connected to the mandible and 20 isolated), measuring: length (L) and the talonid width (TAW) of the antemolars (a), premolars (p), and lower first (m1), second (m2) and third molars (m3) (Fig. 30).

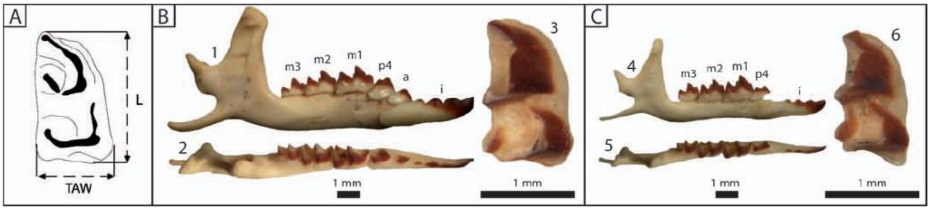


Fig. 30. Soricids. A: first right lower molar (m1). The molar distal part at left and mesial part at right. L: lenght, TAW: talonid width. B: *Sorex araneus-coronatus*. 1 and 2) labial and occlusal views of right mandible. 3) occlusal view of right m1. C: *Sorex minutus*. 4 and 5) labial and occlusal views of right mandible. 6) occlusal view of right m3.(i) incisors (a) antemolars, (p) premolars, (m1) first molars, (m2) second molars and (m3) third molars. Suárez-Bilbao et al. (2017b).

- ***Quantification of the material***

Once the remains had been classified according to the most diagnostic element in each taxon, the small vertebrates were quantified according to the Minimum Number of Individuals (MNI), taking into account the position of the cranial or/and postcranial element in the skeleton (right and/or left). The Number of Identifiable Specimens (NISP) for each taxon (Daams and Freudenthal 1988; Andrews, 1990) was also calculated. In the case of amphibians, the sex was taken into account whenever possible. With the MNI, the percentage of individuals for each species is calculated, which makes it possible to study the relative palaeodiversity. On the other hand, the NISP refers to all identifiable bones, both Order/Family and the Genera/species, estimating the assemblage of remains.

- ***Specific diversity analysis***

The specific diversity method studies the evolution and the development of biological communities in ecosystems. Thus, the distribution of number of individuals in relation to the number of species is analyzed. But this kind of analysis is only significant in long stratigraphies, since in small sequences the error between fossil assemblage and the original diversity is higher (Margalef, 1974). Environmental conditions and fauna diversity are linked, since the species richness increases in benign moments (López-Antoñanzas and Cuenca-Bescós, 2002). Therefore, in general, in warm moments the biodiversity is high while in cold moments it is lower. However, the lack and/or presence of species is not only linked to the temperature, but other factors like vegetation zones, moisture contents in the soils and in the environment, the presence of water courses and altitude, among others. To measure the small vertebrate diversity the *Shannon Index* is one of the most used methods, applying the following equation (Shannon and Weaver, 1949):

$$H' = \sum_{i=I}^{s} (n_i/N) / \ln (n_i/N)$$

Where:

N': Shannon Index
n_i: the NMI of I of each sample
N: the total of the NMI of all species for each sample
^{S}: the total species number.

H' values are higher when there is not a predominance of one specie over others.

- ***Habitat assemblages***

Small vertebrates live in areas with specific environmental conditions. Even so, in some cases, the appearance of some species is limited since transitions between biotopes are gradual and, occasionally, the same taxon can be found associated with more than one environment. Moreover, apart from being good environmental indicators, they show quick response to environmental changes, evolving and adapting to new ecosystems.

Above all, it should be borne in mind that fossil remains recovered at a site are only the preserved proportion of the whole existing assemblage, and constitute an approach to the past real situation. Thus, for the palaeoenvironmental reconstruction, on the one hand, for the extant species modern counterparts (actualism) has been used, and, on the other hand, for extinct taxa, phylogenetic relationships and biogeographical criteria have been used, based on Bartolomei et al. (1975), Álvarez et al. (1985), Pemán (1985), Blanco (1998a, 1998b), Pokines (1998), Salvador (1998), Pleguezuelos et al. (2002), García-París et al. (2004), Palomo et al. (2007), Sesé (2005a), Wilson and Reeder (2005), Cuenca-Bescós et al. (2008, 2009), López-García et al. (2011a, 2011b, 2012), and the works of the “International Union for Conservation of Nature” (IUCN, 2018). Following the criteria established by all the above-mentioned authors, the small mammal species have been grouped in four types of habits with two factors:

- Type of habitats

1. Rocky: this habitat includes species that live in rocky ground, but it does not mean that the environment has to include cliffs or mountain areas.
2. Steppe: herbaceous plain without trees.
3. Meadow: these lands are open areas and include pastures that could be dense or arid with vegetation cover or lack of shrubs.
4. Forest: woodland mass with abundant vegetation that could be single or mixed.

- Factors to be taken into consideration

There are two aspects to take into account in the biome types:

1. The presence of water: if any waterbodies exist in the vicinity, such as a river, lake, pond, lagoon or streams.
2. Moisture: the abundance of the relative humidity both in the air and in the soils.

It is important to highlight that, in the northern Iberian Peninsula, relatively warm conditions and increases in humidity are associated with woodland expansion

(Iriarte-Chiapusso and Murelaga, 2012). In this thesis the abundance ratio of stenoic species versus eurioic ones are compared. Thus, the thesis studies the relation of species that live in forested areas (*A. sylvaticus-flavicollis*, *E. europaeus*, *P. lenki* and *Talpa* sp.) as well as aquatic environments (*A. amphibius* and *Neomys* sp.), species that live in cold environments [*M. (A.) oeconomus*] and other species that can live in more than one habitat, such as in both grasslands and woodland masses (all the Arvicolinae described in this thesis, with the exception of the aforementioned ones). The remaining small mammal taxa [*S. (S.). araneus-coronatus* and *S. (S.) minutus*), as well as the amphibian and reptile species, could live in forest or meadow but they are indicative of environment humidity.

Large mammals

After the recovery of the samples with their proper identification, they were brought to the laboratory. Once there, bones need to be cleaned with water in order to remove mud. A gentle brush was used to clean the most resistant parts. Finally, the subsequent drying process was carried out inside the laboratory, avoiding the direct impact of the sun on the bone surfaces.

- ***Collection number***

Once all remains were cleaned, a collection number was written on each bone using an indelible marking pen. All collection numbers were compound following the same order (Fig. 31). In Artazu VII the site abbreviation (**ATUVII**), followed by the abbreviation of the area of the site where they were found (**UL, LL or CL**), by the spit (letter or number depending area depth) and by the number of skeletal bone. If there was not space enough to write all the code, it was written, first without spit and then without provenance area. For example: while **ATUVII.S.4.17**

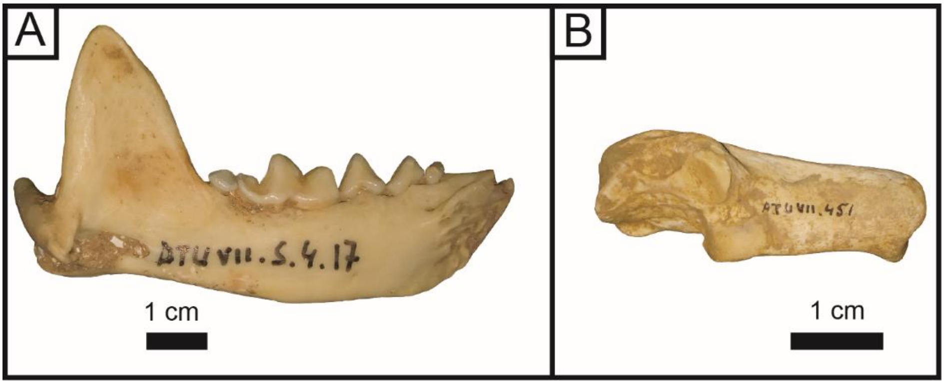


Figure 31. Two examples of large mammal bones from Artazu VII. A: lingual view of the left mandible of *Mustela lutrola* with the code complete. B: mesial view of the left calcaneum of *Canis lupus* with the code shortened.

indicates Chamber (S: Sala in Spanish), Spit 4 and specimen number 17, **ATUVII.451** indicates specimen number 451 (Fig. 31). In Artazu VIII the site abbreviation (**ATUVIII**) was followed by the squares and bands together, then the level and finally the specimen number. In cases where the collection number was not completely full, first was eliminated the squares and band and then the level. Thus, **ATUVII.2C.4.1236** indicates 2C Square, Level 4 and specimen number 1236 and **ATUVIII.3.2255** indicates level 3 and specimen number 2255.

- ***Identification of the material***

In general, the identification of the large mammals follows the criteria of Lavocant (1966) and Pales and Lambert (1971), where all the remains are classifiable with the exception of small fragments of diaphysis. In cases of greater difficulty or worse preservation of bone, the private comparative collection of Dr. Pedro Castaños has been used, located in the osteology section of the Aranzadi Science Society. The abbreviation summary list used for large vertebrates is displayed in Table 7.

	Taxon	**Abbreviation**	**Common name**
ORDER CARNIVORA	*Felis silvestris*	*F. silvestris*	European Wild Cat
	Lynx sp.	*Lynx* sp.	Lynx
	Panthera pardus	*P. pardus*	Leopard
	Panthera leo spelaea	*P. l. spelaea*	Cave Lion
	Canis lupus	*C. lupus*	Wolf
	Cuon alpinus	*C. alpinus*	Dhole
	Vulpes vulpes	*V. vulpes*	Red Fox
	Ursus spelaeus	*U. spelaeus*	Cave Bear
	Martes martes	*M. martes*	Pine Marten
	Meles meles	*M. meles*	Badger
	Mustela nivalis	*M. nivalis*	Least Weasel
	Musteola putorius	*M. putorius*	Western Polecat
ORDER PERISSODACTYLA	*Equus ferus caballus*	*E. ferus caballus*	Feral Horse
	Coelodonta antiquitatis	*C. antiquitatis*	Woolly Rhinoceros
ORDER ARTIODACTYLA	*Cervus elaphus*	*C. elaphus*	Reed Deer
	Rangifer tarandus	*R. tarandus*	Reindeer
	Bison priscus cf. mediator	*B. p. cf. mediator*	Steppe Bison
	Capra pyrenaica	*C. pyrenaica*	Wild Goat
	Rupicapra pyrenaica	*R. rupicapra*	Pyrenean Chamois

Table 7. Summary table of all large vertebrate taxa identified in Artazu VII and Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) with its abbreviation and common name.

- ***Quantification of the material***

The quantification of the large mammals has been measured by the Minimum Number of Individuals (MNI) (Brain, 1981), taking into account the position of cranial or/and postcranial element in the skeleton (right and/or left) and the sex. Each recovered remain, teeth, bones and horn, complete or fragmented, has been considered an independent remain, both identifiable and unidentifiable remains. The Number of Identifiable Specimen is given by the NISP.

- ***Determination of sex***

The best bone to identify sexual dimorphism in some ungulates is the metacarpus, due to the extra weight that males support because of the horn development in cervids and horn process in bovines. For that study, the Robustness Index methodology has been applied in bison metacarpus at Artazu VII and Artazu VIII, which is determined by the comparison between the diaphysis minimum width percentage and the bone length (AD.100/LM). Following Guérin and Valli (2000), values lower than 20.7 are attributed to females, and values higher than 22 to males. For the sexual dimorphism study of Red Deer and reindeer in Artazu VII dispersion diagrams or Simpson diagrams (Simpson, 1941) have been used.

- ***Determination of the age at death***

Estimation of the age at death in ungulate species has usually been based on the stages of tooth eruption. To be precise, it has been calculated according to the replacement of deciduous teeth, or in the case of absence of primary teeth, the age is estimated consistent with tooth wear on the last molar. In some cases and according to the methodology stablished by Pérez-Barbería (1994) for chamois and Mariezkurrena (1983) for red deer, the degree of epiphyseal fusion of limb bones has been used. Measurements taken on artiodactyl, equid and carnivore bones and teeth followed the standards of Driesch (1976). All measurements are given in millimetres. Finally, morphometric data have been compared mainly with an extensive sample from SW Europe (especially from the Cantabrian Region).

- ***Osteometric measurements***

All the measurements have been taken using a fine point caliper, following the methodology of Driesch (1976). The results were displayed in mm, with an estimated error of 0.5 mm in bones that measured more than 20 mm and 0.05 mm in the rest. The statistical analysis was performed using SPSS v.20 and

PAST programs. *t-student* have been applied to observe if differences are significant in the average values of bone measurements in some species.

Avifauna

- ***Identification of the material***

The avian remains recovered from Artazu VII have been identified taxonomically using the reference collections of the Sociedad de Ciencias Aranzadi (Aranzadi) and 'Fran Hernández' housed at the same institution. Identified remains have been verified using bird osteological literature (Stewart and Hernández-Carrasquilla 1997) and the osteological terminology follows Baumel (1979).Diagnostic anatomical elements and diagnostic features for each taxon are present in other vertebrate groups. Unfortunately, there are no clear osteological keys for bird identification, due to the great similarities among them. Therefore, the methodology for avifauna identification mostly consists of comparison with reference bird collections, and, in some cases like corvids, the use of bone measurements.

Here listed the skeletons used for comparisons: SCA(Sociedad de Ciencias Aranzadi), FH (Fran Hernández Collection): Accipitridae: *Pernis apivorus* (SCA 80), *Milvus milvus* (SCA 1710), *Milvus migrans* (SCA 82), *Gypaetus barbatus* (SCA 1745), *Neophron percnopterus* (SCA 77), *Gyps fulvus* (SCA 1715), *Circaetus gallicus* (SCA 99.2), *Accipiter gentilis* (FH Acc.gen.1), *Buteo buteo* (SCA 1019, 1020), *Buteo lagopus* (FH But.lag.1), *Aquila chrysaetos* (SCA 1703, 89.2), *Hieraaetus fasciatus* (FH Hie.fas.1), Strigidae: *Bubo bubo* (SCA 225.1 FH Bub.bub.1), Tetraonidae: *Lagopus lagopus* (SCA 1025), *Lagopus mutus* (SCA 111), *Lyrurus tetrix* (SCA 1026), *Tetrao urogallus* (SCA 1810, 1811), Phasianidae: *Alectoris rufa* (SCA 1040, 1821), *Francolinus* sp. (FH Fra.sp.), *Perdix perdix* (SCA 115 FH Per.per.1), *Coturnix coturnix* (SCA 1043, 116), *Phasianus colchicus* (SCA 1001.1), *Gallus gallus* (SCA *unnumbered*), Rallidae: *Rallus aquaticus* (SCA 121), *Crex crex* (SCA 122), *Porzana porzana* (FH Por.por.1), *Porzana pusilla* (SCA 1912), *Gallinula chloropus* (SCA 126), *Fulica atra* (SCA 1120), Corvidae: *Corvus monedula* (SCA 1412 FH Cor.mon.1), *Pyrrhocorax pyrrhocorax* (SCA 392.1, 1595), *Pyrrhocorax graculus* (SCA 1590, 393), *Pica pica* (SCA 1500, FH Pic.pic.2), *Garrulus glandarius* (SCA 1585, 1585.1).

The abbreviation summary list used for avifauna is displayed in Table 8.

	Taxa	Abbreviation	Common name
ORDER GALLIFORME	*Perdix perdix*	*P. perdix*	Grey Partridge
	Coturnix coturnix	*C. coturnix*	Common Quail
	Lyrurus tetrix	*L. tetrix*	Black Grouse
	Alectoris sp.	*Alectoris* sp.	Partridge
ORDER GRUIFORME	*Crex crex*	*C. crex*	Corn Crake
ORDER STRIGIFORME	*Bubo* cf. *bubo*	*B.* cf. *bubo*	Eurasian Eagle-Owl
ORDER ACCIPITRIFORMES	*Aquila* sp.	*Aquila* sp.	True Eagles
	Aquila chrysaetos	*A. chrysaetos*	Golden Eagle
	Haliaeetus albicilla	*H. albicilla*	Grey Sea Eagle
	Buteo lagopus	*B. lagopus*	Rough-legged Buzzard
ORDER PASSERIFORME	*Pyrrhocorax pyrrhocorax*	*P. pyrrhocorax*	Red-billed Chough
	Pyrrhocorax graculus	*P. graculus*	Yellow-billed Chough
	Corvus monedula	*C. monedula*	Western Jackdaw
	Pica pica	*P. pica*	Eurasian Magpie

Table 8. Summary table of all avifauna taxa identified in Artazu VII and Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) with its abbreviation and common name.

- ***Quantification of the material and Osteometric measurements***

The measurements of the bird skeletal remains have been taken in millimeters, and for all bird taxa the NISP (Number of Identifiable Specimens) and MNI (Minimum Number of Individuals) have been calculated according to the criteria of Howard (1930) and Lyman (1994). For the bird habitats information, Cramp et al. (1977-1994) and del Hoyo et al. (1992-2005) have been followed. Finally, to interpret the origin of avifauna accumulation, the state of bird bones and the proportion between some elements have been compared by applying taphonomic criteria (Binford 1981; Brain 1981; Lyman 1994; Reitz and Wing 1999). Thus, comparisons have been made of complete to incomplete elements, proximal to distal bones, wings to leg elements, humerus, ulna and coracoids group to sterna and scapula parts and core to limb bones proportions. All the percentages are calculated based on the binomial distribution, accompanied by the binomial confidence intervals. Finally, statistical analyses have been performed on some of the most relevant specimens in order to test our hypothesis.

Palaeopalynology

The sporopolinic fraction in Artazu VIII was recovered from the sediment samples by physical and chemical treatment following a modification of the methodology of Assarson and Granlund (1924). First, the sediment was attacked with HCl in order to dissolve carbonates. After neutralization a second attack was performed with NaOH 20 % to act on silicates and the residue was neutralized again. Then, a Thoulet dense liquor was used in order to separate the pollen content from this residue (Burjachs et al., 2003).

Aliquot from the pollen samples was placed in microscope slides using histological lacquer. The total number of identifiable palynomorphs must be at least 250 containing 15 taxa to be representative and those that contain fewer than 100 pollen or spores and fewer than 10 taxa are considered sterile. However, pollen at Artazu VIII was only preserved in six samples and none of them reached 250 palynomorphs, as the largest number was in Sample 1 from Level 4 (11 remains). All identified pollens are herbaceous-shrub type (Poaceae*, Compositae liguliflora,* Scrophulariaceae and Caryophyllaceae). It has consequently not been possible to study the plant communities that coexisted with the fauna recovered in Artazu VIII.

3.2.3. Sedimentological and mineralogical samples

Granulometric analyses

Samples of endokarst sediments of Artazu VIII were subjected to granulometric tests to study the grain size and the selection grade. Because the aim of the granulometric analysis was to measure the type and the energy of the process that deposited the clastic sediments, cave roof breakdown rocks have not been taken into account. All the analyses were carried out by a granulometric laser scanner Coulter LS13350 particle analyzer in the University of the Basque Country (UPV-EHU). All obtained data have been treated with GRADISTAT 8.9 program, calculating arithmetically and geometrically (in metric units) mean, mode, classification, asymmetry and other statistical parameters, following in the graphical methods of Folk and Ward (1957).

Mineralogical analyses (XRD)

The 32 samples recovered from Artazu VIII were analyzed to obtain mineralogical data. The powder X-ray diffraction (XRD) technique was used to determine Artazu VIII mineralogy, using a PANalytical X'Pert Pro diffractometer at the Research Facilities (SGIker) of the University of the Basque Country (UPV-EHU). All measurements were performed using a continuous scan range of 2-80°2θ with Cu Kα radiation (ceramic X-ray tube KFL-Cu, 40 kV, 40 mA), with a programmable divergence slit and a LynxEye detector. The determination of whole-rock mineralogy has been studied according to random orientation of powdered samples. However, clay fraction (<2 µm) mineralogy has been identified on oriented aggregates. First, all samples were decarbonated by treatment with 0.1 M HCl. Later, they were washed several times with deionized water to avoid calcium chloride precipitation, and finally, the clay fraction was collected by centrifugation. The oriented samples were measured air-dried and after 24 h for ethylene glycol salvation. Thermal treatments at 550 °C were also applied to identify the clay minerals following the procedures detailed in Arostegui et al. (2006).

Micromorphology samples

Thin sections were sent to the “Laboratory of Thin Section and Micromorphology” in Stirling (Scotland). The technique used follows the bases of Ross (1924). Thus, the undisturbed unconsolidated samples were impregnated with a highly fluid material for the hardening process of soil air-dried samples. Afterwards, samples became very hard at room temperature and were sectioned in a 7 x 5 cm surface and a thickness between 25 and 30 µm. The samples were studied under a petrographic microscope.

3.2.4. Geochemical samples

Among the large mammals from Artazu VII, 26 well conserved cranial and postcranial elements from the best represented taxa were selected in order to perform Carbon (C) and Nitrogen (N) geochemical analysis (Tab. 9). No remains were selected from the UL due to the total absence of large mammal remains. From the other two zones large mammal remains were selected from all spits with the exception of LL-F, LL-G and C-1, due to the lack of the chosen species for this study. In this way, four different species were selected, two carnivores (nine samples of *P. pardus* and four samples of *V. vulpes*) and two herbivores (12 samples of *R. pyrenaica* and one of *C. elaphus*) (Tab. 9).

Provenance	**Selected species and the skeletal remain**	**Sample**
Lower Ledge A	*Rupicapra pyrenaica* calcaneus	1
	Panthera pardus vertebrae	2
	Rupicapra pyrenaica superior molar	3
Lower Ledge B	*Panthera pardus* caudal vertebrae	4
	Rupicapra pyrenaica proximal fragment	5
Lower Ledge C	*Panthera pardus* ulnae	6
Lower Ledge D	*Panthera pardus* caudal vertebrae	7
	Rupicapra pyrenaica 2nd phalange	8
Lower Ledge E	*Rupicapra pyrenaica* 1st phalange	9
Lower Ledge H	*Panthera pardus* carpal	10
Lower Ledge I	*Panthera pardus* pelvis	11
	Vulpes vulpes dorsal vertebrae	12
Lower Ledge J	*Rupicapra pyrenaica* pelvis	13
	Vulpes vulpes dorsal vertebrae	14
	Panthera pardus pelvis	15
Lower Ledge K	*Panthera pardus* 1st phalange	16
	Rupicapra pyrenaica 1st phalange	17
Lower Ledge L	*Panthera pardus* radio	18
	Rupicapra pyrenaica femur	19
	Vulpes vulpes femur	20
Chamber 2	*Rupicapra pyrenaica* scapula	21
Chamber 3	*Rupicapra pyrenaica* M1-2	22
Chamber 4	*Rupicapra pyrenaica* M1-2	23
Chamber 5	*Vulpes vulpes* cervical vertebrae	24
	Cervus elaphus skull	25
	Rupicapra pyrenaica m3	26

Table 9.Selected large mammal samples from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) to perform geochemical analysis.

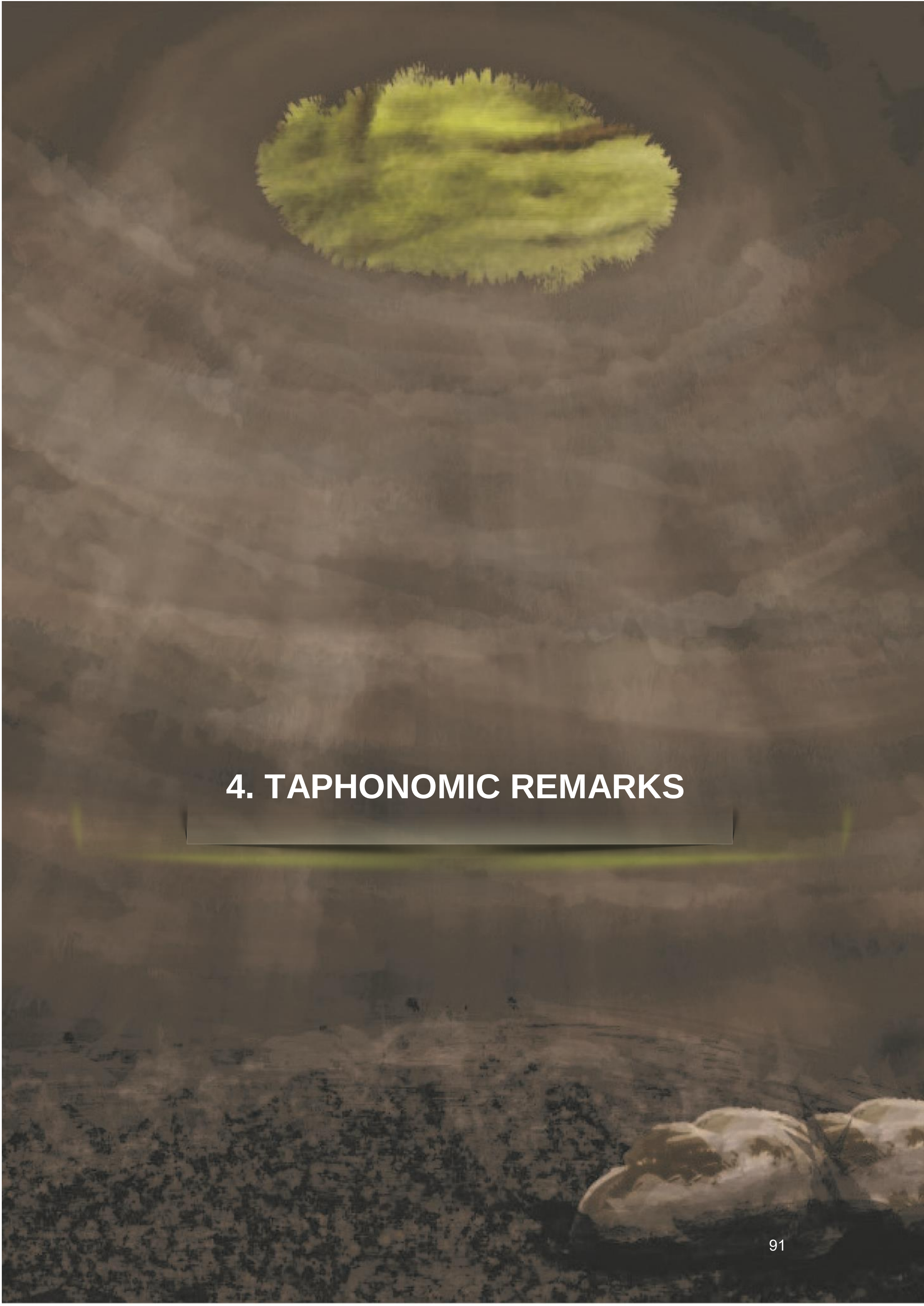
Before the extraction of bone collagen, the samples were prepared in the Mineralogy and Petrology Department (UPV-EHU). First of all, large mammal bones were washed in an ultrasonic bath to remove the impurities. Once the washing was completed, a total amount between 0.4 and 2 gr from each sample was extracted and crushed in an agate mortar. From this point on, the methodology established by Bocherens et al. (1991) for C and N analyses was followed:

1. Demineralization phase: in order to dissolve hydroxyapatite mineral, the bone sample was demineralized in 0.5 M HCl during 20 min at room temperature and powered at 3000 rpm. After centrifugation the dissolution was extracted by pipette, separating the proteic solid part. This solid part was neutralized using 10 ml of pure water powering during 10 min at 3000 rpm. This last step was performed twice.

2. Pollutants removal: the samples were rinsed with distilled water and 0.125 M NaOH to remove humic acid. In order to be successful this process needed a whole night. The next day the samples were rinsed three times with distilled water.

3. Collagen solubilization: the collagen was dissolved in 10 ml of HCl, with a pH value of 3 for each sample for 15 h at 90 ºC. Then, the samples were filtered with disposable syringe filters (5 µm).

4. Lyophilization: the samples were frozen at –30 ºC to be lyophilized. Finally, the samples were weighed to determine the mass of the collagen.



4. TAPHONOMIC REMARKS

4. TAPHONOMIC REMARKS

The taphonomy discipline studies fossilization process, from the production of the remains to their discovery (Valentine, 1973). Throughout this process, biases of the information could occur (Fig. 32).

The accumulation of the remains could correspond to various concentration mechanism, each of them with its own taphonomic processes (Hanquet, 2011). Thus, the thanatocoenosis (not buried entities) could happened by catastrocoenosis (catastrophic burial), coprocoenosis (by predation) or by necrocoenosis (natural animal death) (Fig. 32). These remains could be subjected to a second accumulation process due to their transportation and sedimentation. In addition, they could suffer physical (erosion), and biologic or chemical processes (fungi, bacteria, plant activity, animal predation marks…).

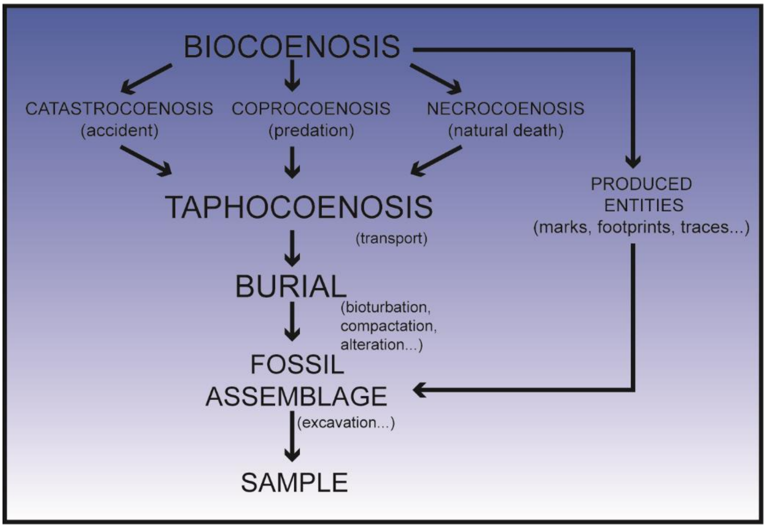


Figure 32. Summary of some taphonomic processes from the production of the remains to its discovery. Modify from Hanquet (2011).

Accumulations of microfauna in caves are often the result of the action of predators, derived from the pellets of owls and other birds of prey or the scant of small carnivores (Andrews, 1990). This action causes, to a greater or lesser extent, physical (bites) and/or chemical traces (corrosion by gastric juices) on the bones.

4.1. Small vertebrates

A complete taphonomic study of the small vertebrate remains was not performed in Artazu VII and Artazu VIII, but some preliminary observations were made about the composition and modifications of skeletal elements. Thus, the bones of the microfauna displayed few digestion traces and bone fragmentation was very low. However, some of the remains exhibited post-depositional fractures so that, after the accumulation was formed, the remains are thought that were disseminated by some kind of flow (water, mud...) that deposited them in the deepest part of the cave. For this reason, even if owls and/or carnivores were potential agents of the accumulation of small vertebrates in these caves, the main taphonomic agent probably was a tractive watercourse (Suárez-Bilbao et al., 2017a).

Regarding the taphonomy of the small mammals from Artazu VII and Artazu VIII the dental elements showed, in general, a good state of preservation (Suárez-Bilbao et al., 2018). In addition, the number of complete mandibles of both murids and soricids was quite high. The majority of the isolated teeth were complete, and those that were fragmented were due to postdepositional fractures. In microtine molars the digestion marks vary in the enamel thickness, from rounded corners and flattened salient angles to strongly rounded corners and deeply penetrated salient angles. The murids have more rounded teeth with lack of prominent and well-marked angles, so, compared to microtines they present a bigger resistance to digestion marks. In general, the molars showed moderate digestion traces, although some of them have evident signs of digestion (Fig. 33). The number of molars that displayed any evidence of digestion was around one fifth, suggesting

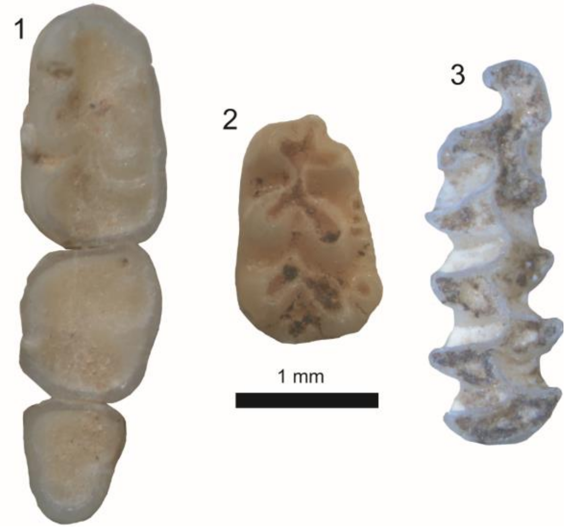


Figure 33. 1: *Apodemus sylvaticus-flavicollis* from Artazu VII, right m1 to m3 with considerable digestion. 2: *Apodemus sylvaticus-flavicollis* from Artazu VII, right m1 with moderate digestion marks. 3: *Microtus (Microtus) agrestis* from Artazu VIII, right m1 with moderate digestion marks.

that the agent responsible for these small vertebrate accumulations was likely to be a bird predator and not a carnivore. According to digestion categories proposed by Andrews (1990), we propose that the accumulations from Artazu VII could be produced by a predator in Category 2 or 3. While the species of Category 2 could be *Bubo scandiacus, Bubo africanus* or *Strix nebulosa* the species of Category 3 could be *Bubo bubo* or *Strix Aluco*. However, taking into account the species that live in this region the possibilities were reduced to *B. bubo* or *S. Aluco.* On the contrary, the preliminary taphonomic study carried out at Artazu VIII showed that digestion traces in the small mammal bones were moderate (Fig. 33) or practically absent. Therefore, this suggest that the accumulation of small mammals could be produced by a predator in Andrews's Category 1.

4.2. Large mammals

A great variability of taxa recovered in both sites should be highlighted, especially at Artazu VII. Not only stand out the number of taxa but also the high number of remains. Regarding carnivore and herbivore proportions, while in Artazu VII ten carnivore taxa were recovered comprising approximately the 30% of the assemblage, in Artazu VIII only four carnivore taxa were identified, amounting the 2.2 % of the assemblage. All the vertebrate remains displayed a good state of preservation and occasionally some extremities or skeletal parts were found in anatomical connection. In addition, most of them were complete and those that presented fractures were postdepositionals. As a consequence, almost all of the large mammal assemblage was taxonomically identifiable (the 84.3 % of the assemblage from Artazu VII and the 95.4 % from Artazu VIII). No signs of anthropogenic manipulation such as percussion or cut marks nor animal predation signs as corrosion, digestion wear or mastication marks were present.

Although both sites show a high diversity of large mammal anatomical elements, in Artazu VII an anomaly in the skeletal profile and size of the remains of different ungulate species was observed (Tab. 10). The horse sample is composed exclusively of upper teeth (one premolar and seven molars) that may belong to the same individual. In steppe bison and red deer most of the remains are isolated teeth and short bones (carpals and tarsals). The few fragments of long bones are non-fused articular epiphyses. However, the chamois has a balanced skeletal profile with representation of all anatomical regions and frequencies close to those of a complete skeleton. The absence of evidences of horse, bison and deer in Chamber and Lower Ledge is significant in this regard.

	Bison cf. *priscus*	*Rupicapra pyrenaica*	*Cervus elaphus*
Antle			8
Horn core		4	
Skull		2	9
Maxilla		2	
Upper teeth	3	19	1
Mandible	3	14	1
Lower teeth	10	17	1
Vertebra	8	125	
Rib	1	71	5
Sternum		1	1
Scapula		23	1
Humerus		43	2
Radius	2	26	1
Ulna	1	16	
Carpal	3	24	3
Metacarpal		17	
Pelvis	2	34	
Femur	1	46	1
Patella	2	10	
Tibia	1	34	
Malleolus	1	1	
Tarsal	4	31	
Metatarsal		35	1
Indet. metapodial		3	
Falanx I	5	53	
Falanx II	2	52	2
Falanx III	1	25	1

Table 10. Skeletal elements of some ungulate species in the Artazu VII assemblage.

4.3. Avifauna

Bird remains did not display anthropogenic marks, as with the small and large vertebrates. Around 55 % of the remains recovered from Artazu VII and around 40.2 % of the bird bones recovered from Artazu VIII belonged to immature individuals. Both sites showed a great diversity of bird anatomical elements, although crania, mandibulae, sternums and pelvises were scarce. The performed bird taphonomical bone analyses are given with confidence limits placed inside the parentheses to tell how accurate the estimation is. Approximately, half of the bones were complete in Artazu VII with a percentage of 42.6% (38.4 - 46.9%) (Fig. 34A). On the contrary, only the 15.28 % (9.83–22.21 %) were complete in Artazu VIII (Fig. 35B). The percentage of proximal elements (scapula, coracoideum, humerus, femur and tibiotarsus) were compared to distal elements (ulna, radius, carpometacarpus, tarsometatarsus) following the work of Bochenski and Nekrasov (2001). The analysis showed a proportion of around 1:1 in Artazu VII prevailing moderately proximal elements [56.8% (52.9-60%)] (Fig. 35C). In Artazu VIII prevailed the distal elements [50.68 % (42.34-58.98 %)] (Fig. 35D). According to Bochenski and Nekrasov (2001) the predominance of the relative proportion of proximal elements identified at Artazu VII fit in better with pellets remains of owls and diurnal birds of prey than with uneaten food remains. On the other hand, the accumulation from Artazu VIII, corresponded probably to *Aquila* or *Falco* undigested pieces.

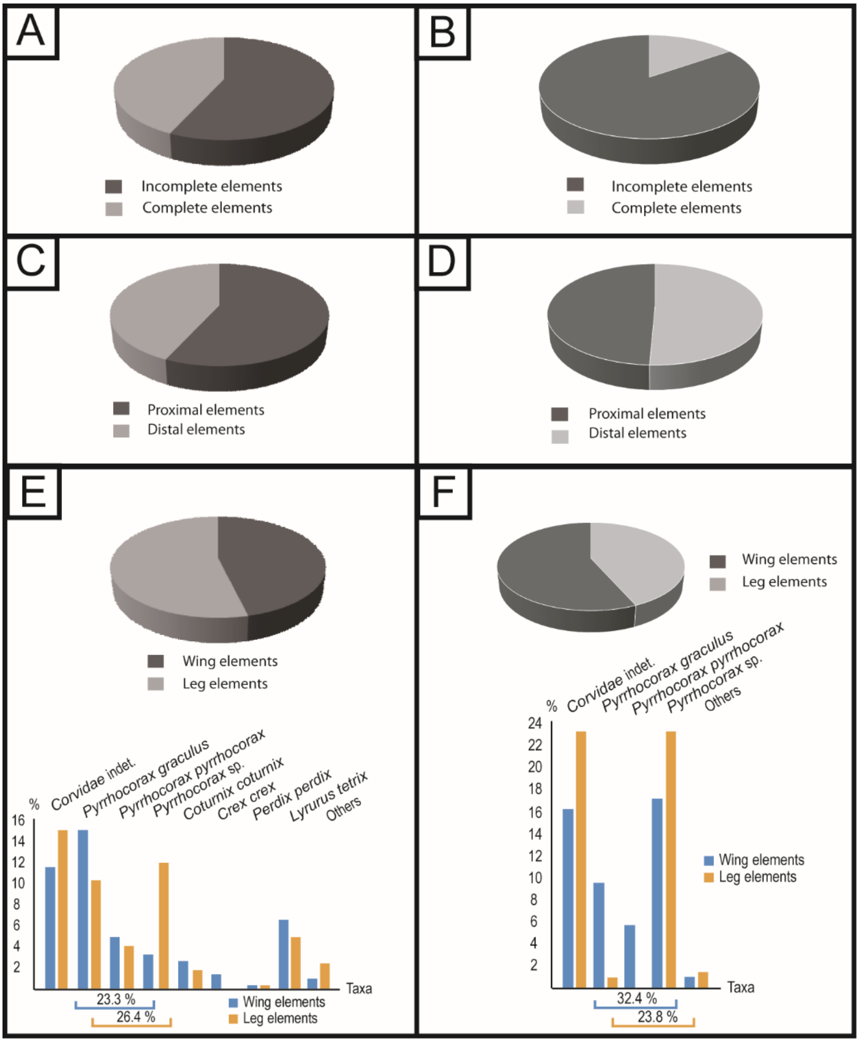


Figure 34. Comparison of some bird elements bones from Artazu VII (A, C, and E) and Artazu VIII (B, D, F) (Arrasate, Gipuzkoa, northern Iberian Peninsula).

The great abundance of bird remains in both sites allowed us to apply a more specific taphonomic analysis. Following Livingston (1979) and Ericson (1987), wing elements (humerus, ulna and carpometacarpus) and leg elements (femur, tibiotarsus and metatarsus) were counted to establish a relation between both types of skeletal elements. They had a similar representation in both sites, although leg element proportion was little higher in Artazu VII [53.8% (49.5-58%)] (Fig. 34E), while wing elements prevailed in Artazu VIII [56.3% (46.91-65.37%)] (Fig. 35F). Wing and leg elements proportion occurrs in similar quantities in *Asio otus* and *Falco rusticolus* pellets (Bochenski and Nekrasov 2001). Litter higher percentage of leg elements are present in *Aquila heliacal* uneaten remains and in a litter higher percentage of wings elements in *Bubo bubo* and *Strix aluco* pellets or *Aquila chrysaetos* uneaten remains (Bochenski et al., 1997). Among the leg elements around the half belonged to *Pyrrhocorax* genus in both sites (50.6 % in Artazu VII and 48.1 % in Artazu VIII). However, approximately the 80 % of the identified species belonged to corvids in Artazu VII and the 98 % in Artazu VIII.

The humerus, ulna and coracoideum group were compared to sterna and scapula parts to study the bird accumulation origin in greater detail (Suárez-Bilbao et al., 2018). According to Bochenski et al. (1993, 1997, 1998, 1999) and Bochenski and Tomek (1994), while the first element group is frequent both in pellets and uneaten food remains of owls and diurnal predators, the second group is present exclusively in uneaten food remains. Therefore, the total of these five elements resulted in 55.5% (36.9-44.5%) in Artazu VII and in 46.01 % (39.53-56.39 %) of total skeletal elements, in which the humerus, ulna and coracoideum represented 34.8% (31.2-38.6%) of the samples in Artazu VII and 38.92 % in Artazu VIII and the sterna and scapula 5.8% (4.16-7.85%) of the total remains in Artazu VII and 7.38 % in Artazu VIII (Fig. 34D) (Fig. 35D). This association is typical of pellets and uneaten food remains of owls and diurnal raptors, which indicates that accumulation is not only produced by diurnal raptors. In additions, considering the small vertebrate taphonomy, *B. bubo* or *S. Aluco* are proposed as the possible predators. Therefore, it also exist the possibility that the diurnal were hunted by nocturnal bird predators (*B. bubo* or *S. Aluco).*

Finally, the core (sternum, pelvis, scapula, coracoideum) and limb elements (humerus, ulna, radius, carpometacarpus, femur, tibiotarsus and metatarsus) ratio was calculated. In this way, core elements represented 16.4% (13.7-19.5%) in Artazu VII (Fig. 34E) and 17.45% (11.73-24.51 %) (Fig. 35E) in Artazu VIII, and they belonged to the first group proposed by Bramwell et al. (1987), which relates them to pellet materials of owls and diurnal birds of prey. Nevertheless, it should not be forgotten that accumulations could be produced by different predators or causes, overlapping with each other.

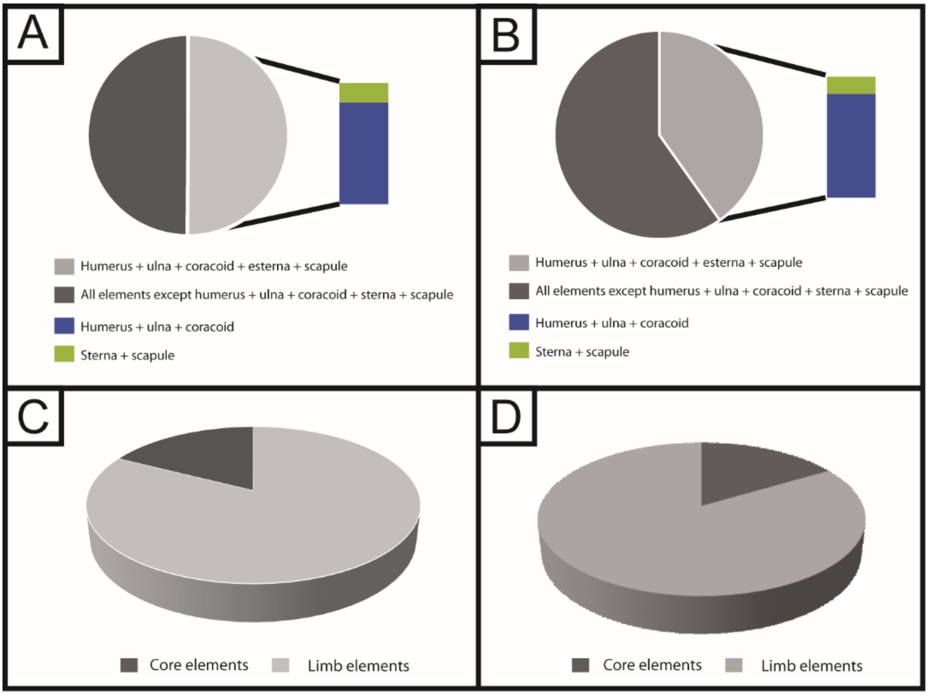
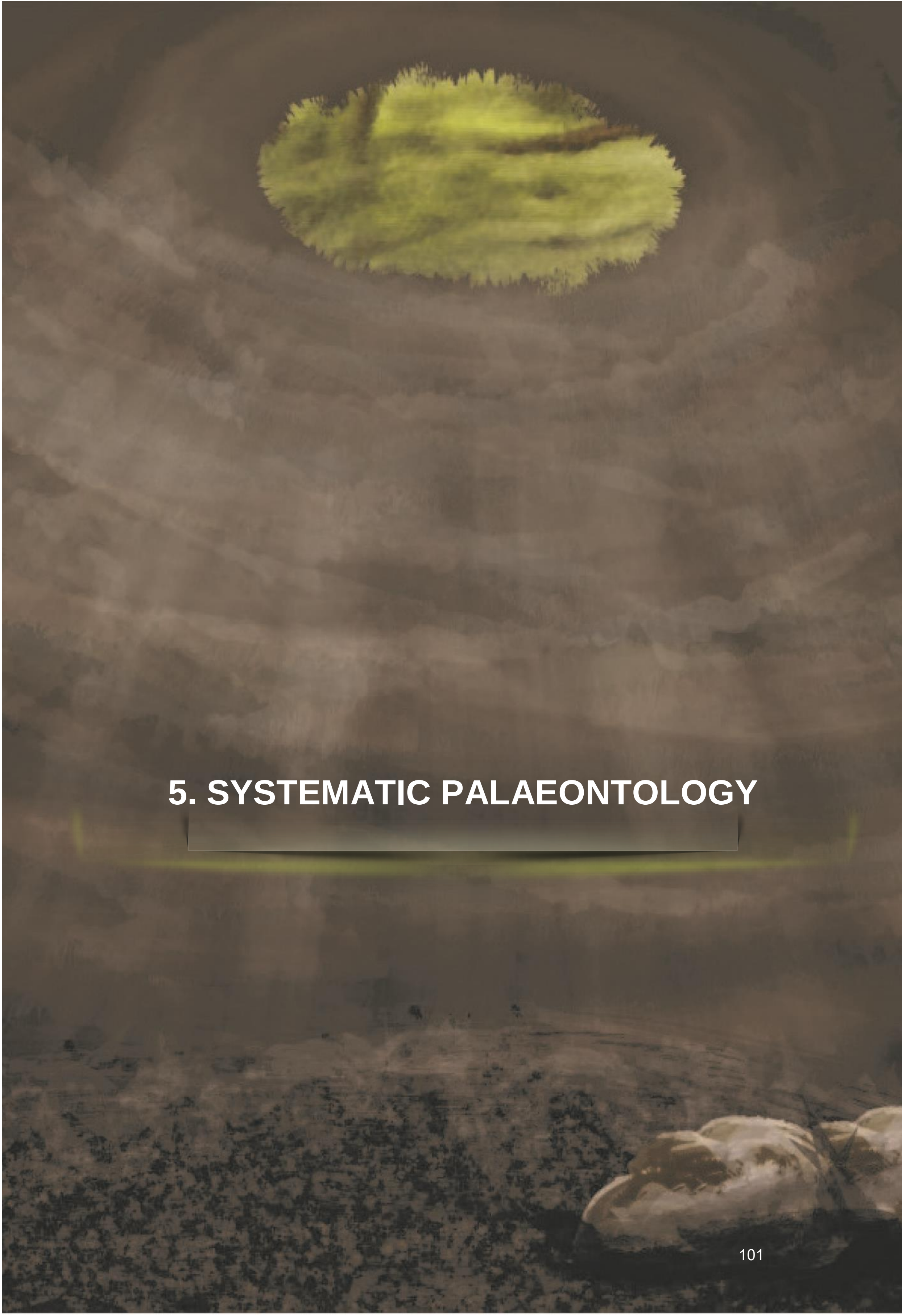


Figure 35. Comparison of some bird elements bones from Artazu VII (A and C) and Artazu VIII (Band D) (Arrasate, Gipuzkoa, northern Iberian Peninsula).



5. SYSTEMATIC PALAEONTOLOGY

5. SYSTEMATIC PALAEONTOLOGY

This Chapter lists all the identified vertebrate taxa from Artazu VII and Artazu VIII sites (Arrasate, Gipuzkoa, northern Iberian Peninsula). The order has been established according to the phylogeny. Therefore, they are explained in the following order: **Class Mammalia** [Order Rodentia, Order Eulipotyphla, Order Carnivora, Order Perissodactyla and Order Artiodactyla), **Class Amphibia** (Order Caudata, Order Anura), **Class Reptilia** (Order Squamata) and **Class Aves** (Order Galliforme, Order Gruiforme, Order Strigiforme, Order Accipitriformes and Order Passeriforme). Bats and fish fauna have not been studied.

Each individual taxon is structured in the following way:

1. **Taxonomic classification**: organized hierarchically: Order, Family, Genus and species. In cases where Subfamily, Subgenus or subspecies exists, they have also been noted.
2. **Recovered material:** the total number of identifiable remains separated by skeletal elements. Details about Minimum Number of Individuals (NMI) are given in Chapter 7.
3. **Taxonomic determination**: A brief description of the morphology of the most characteristic elements.
4. **Habitat and geographical distribution**: the ecological requirement and the geographical distribution of species in the northern Iberian Peninsula.

There are some factors they have to be borne in mind, such as if the specimens are currently extant or extinct, the ecological requirements or diagnostic criteria. However, the taxonomic criteria are not applicable to all taxonomic groups, as occurred with the birds (See Chapter 3).

5.1. Mammals

Class MAMMALIA LINNAEUS, 1758
Order RODENTIA BOWDICH, 1821
Family Cricetidae FISCHER, 1817
Subfamily Arvicolinae GRAY, 1821
Genus *Arvicola* LACÉPÈDE, 1799
Arvicola amphibius (LINNAEUS, 1758) European Water Vole

Recovered material

- **Artazu VII:** 24 left m1 and 17 right m1.
- **Artazu VIII:** 25 left m1 and 77 right m1.

Taxonomic determination

Arvicola amphibius is the biggest arvicolid in Europe; however, in the Iberian Peninsula *A. sapidus* is even bigger. *Arvicola amphibius* is hypsodont and is characterized by having in the m1 an anterior complex, posterior lobe, three triangles in the labial part and four in the lingual part. The first three triangles (t1-3) are poorly connected between them, whereas the last two triangles (t1-2) are connected to the anterior complex. To distinguish these two species the formula proposed by Heinrich (1978), consisting of measuring the enamel thickness, was used (Fig. 36):

$$SDQ= (\sum P/\sum A)*100$$

Where $\sum P$ is the enamel width in the distal side of the triangles and $\sum A$ is the enamel width in the mesial side of the triangles.

Thus, when the result is smaller than 100, the remains are attributed to *A. amphibius* as the enamel is thicker in the mesial side and therefore it has the "*Microtus* enamel type" (Heinrich, 1978; Escudé et al., 2008).

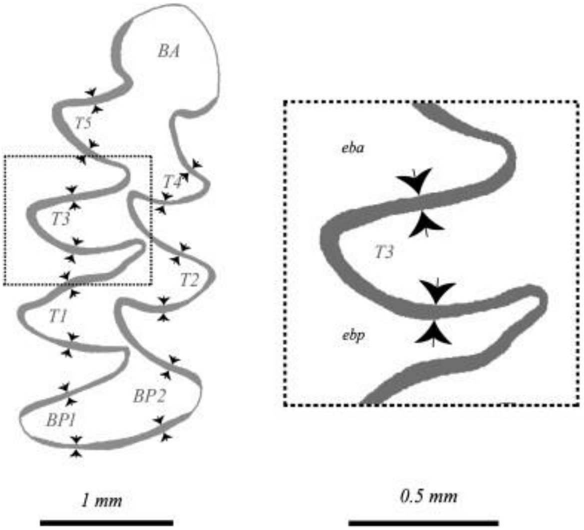


Figure 36. Explanatory scheme of how calculate SDQ formula. T: enamel triangle, BA: anterior loop, BP: posterior loop, eba: anterior enamel width, ebp: posterior enamel width. Escudé et al. (2008).

Habitat and geographical distribution

This species has been present in Europe since the Middle Pleistocene (Heinrich, 1978; Sesé and Sevilla, 1996; Cuenca-Bescós et al., 2008). In the Iberian Peninsula it has been present since the Late Pleistocene, appearing recurrently in the Cantabrian region (Sesé, 1994) e.g. in Amalda (Pemán, 1990a), Labeko Koba (Pemán, 2000), El Mirón (Cuenca-Bescós et al., 2008), Askondo (Garcia-Ibaibarriaga et al., 2015a), Bolinkoba (Garcia-Ibaibarriaga et al., 2015b) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) among others.

At present it lives in the northern fringe of the Iberian Peninsula, with the exception of the eastern and western ends (Palomo et al., 2007; Cuenca-Bescós et al., 2008). The European Water Vole is adapted to a range of biotopes as long as water is near, e.g. rivers, streams or marshes. It avoids dense forest and it lives in humid meadows with abundant vegetation or grass, which could be located in different altitudes (Blanco, 199b; Sesé, 2005a).

Arvicola sapidus MILLER, 1908 Southwestern Water Vole

Recovered material

- Artazu VII: 4 left m1 and 3 right m1.

Taxonomic determination

Arvicola sapidus is larger than *A. amphibius*. Like the previous species, this taxon is hipdsodont and is characterized by the morphology of the m1, with the enamel thinner in the mesial side. Therefore, when the SDQ (Fig. 37) is higher than 100, the tooth belongs to *A. sapidus*, because the enamel width is greater in the distal side and it has the "*Mimomys* enamel type" (Heinrich, 1978; Escudé et al., 2008).

Habitat and geographical distribution

Like *A. amphibius*, *A. sapidus* has also been present in Europe since the Middle Pleistocene (Heinrich, 1978; Sesé and Sevilla, 1996; Cuenca-Bescós et al., 2008). The presence of *A. sapidus* in the Iberian Peninsula is very usual at Late Pleistocene sites in the Cantabrian region, like Rascaño (Altuna, 1981a), El Juyo (Pokines, 1998), Las Caldas (Laplana et al., 2006), El Mirón (Cuenca-Bescós et al., 2008) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a).

Currently, the Southwestern Water Vole is distributed across the whole of the Iberian Peninsula. It is a semi-aquatic specimen which needs permanent water masses in its surroundings (Arrizabalaga et al., 1986), so it usually lives on river banks.

Genus *Microtus* SCHRANK, 1798

Subgenus *Microtus* SCHRANK, 1798

Microtus (Microtus) agrestis (LINNAEUS, 1761)
Field Vole

Recovered material

- Artazu VII: 57 left m1 and 63 right m1.
- Artazu VIII: 650 left m1 and 788 right m1.

Taxonomic determination

Microtus (Microtus) agrestis is a medium size arvicolid. The teeth of this taxon are hypsodont and rootless, do not have roots and the cement is present in the entering triangles. The m1 has four semi-enclosed triangles in the anterior complex and three in the posterior one. They are characterized by the triangles asymmetry and the alternation of t4/t5 and t6/t7 triangles. In addition, triangles are not parallel and the anterior complex is not so rounded (Cuenca-Bescós et al., 2008).

Habitat and geographical distribution

In the Iberian Peninsula *M. (M.) agrestis* appeared in the Middle Pleistocene (Arribas, 1994). However, it is more common in Late Pleistocene sites in the Cantabrian region, such as Labeko Koba (Pemán, 1990b), Covalejos (Sesé, 2005a), Cobrante (Sesé, 2009) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) among others.

Currently *M. (M.) agrestis* lives in northern Europe, Asia and in the northern Iberian Peninsula, concretely from the Pyrenees to Galicia and in the Mediterranean fringe. Nevertheless, the Field Vole prefers humid pastures, forest edges or wastelands and dunes (Pokines, 1998), but in the Iberian Peninsula its appearance is related to the Atlantic climate.

Microtus (Microtus) arvalis (PALLAS, 1779)
Common Vole

Recovered material

- Artazu VII: 24 left m1 and 33 right m1.
- Artazu VIII: 1041 left m1 and 957 right m1.

Taxonomic determination

Like *M. (M.) agrestis, M. (M.) arvalis* is also a medium size arvicolid. The characteristic of the m1 are similar to *M. (M.) agrestis,* but in the extreme cases they have almost symmetric and parallel t4/t5 and especially t6/t7, just like the anterior complex is rounded (Cuenca-Bescós et al., 2008). However, sometimes the distinction between the two species is not so clear and therefore it is typical to find them cited together as *M. (M.) agrestis-arvalis* in the literature.

Habitat and geographical distribution

Microtus (Microtus) arvalis appears in the Lower Pleistocene (Maul, 1990) in the Iberian Peninsula, and is a common species at Late Pleistocene sites in the Cantabrian region, such as Labeko Koba (Pemán, 1990b), Covalejos (Sesé, 2005a), Cobrante (Sesé, 2009) and Askondo (Garcia-Ibaibarriaga et al., 2015a) among others.

Microtus (Microtus) arvalis is an opportunistic taxon and it appears further south in the Iberian Peninsula. The Common Vole could be found in different habitat types but always with high humidity, such as grassland and deciduous or conifer forest.

Subgenus *Terricola* FATIO, 1867
***Microtus (Terricola)* sp.**

Recovered material

- **Artazu VII:** 36 left m1 and 37 right m1.
- **Artazu VIII:** 61 left m1 and 87 right m1.

Taxonomic determination

The teeth of this subgenus are rootless, hypsodont and with cement in the entering triangles. Like well as *M. (M.) agrestis* and *M. (M.) arvalis*, the m1 is formed by four triangles in the lingual side and three in the labial side, with rounded edges. However, *M. (Terricola)* species has an open t4 and t4/t5 triangles are confluent, creating the “Pitymian rhombus”. Currently three species coexist in the Cantabrian region: *M. (Terricola) duodecimcostatus*, *M. (Terricola) lusitanicus* and *M. (Terricola) pyrenaicus* (Brunet–Lecomte and Chaline, 1993). Morphologically, the m1 of the three species is nearly identical, although according some authors it is possible to distinguish between them (Brunet-Lecomte and Chaline, 1990, 1993). *M. (T.) duodecimcostatus* and *M. (T.) lusitanicus* have an open t6 in the m1 and a parallel and a slight inclined t6/t7, forming a second “Pitymian rhombus”. Nevertheless, the connection between the anterior complex to the t6/t7 presents larger than 0.3 mm neck width in *M. (T.) duodecimcostatus,* while in *M. (T.) lusitanicus* it is less than 0.3 mm. Additionally, the t4 of *M. (T.) pyrenaicus* is very open and the t6/t7 are not parallel. However, an overlap exists, so, in this thesis all *Terricola* subgenus are described as *M. (Terricola)* sp.

Habitat and geographical distribution

The first mentions in the Iberian Peninsula of these taxa are dated to the Late Pleistocene (Guillem-Calatayud, 1995; Pokines, 1998). Since then, they have been recovered in numerous sites in the Cantabrian region during the Late Pleistocene, for example, Lezetxiki [as *Microtus (Terricola)* sp.; Altuna, 1972], Amalda [as Microtus (*Terricola)* sp., *M. (T.) lusitanicus* and *M. (T.) duodecimcostatus*; Pemán, 1990a]; El Juyo [as *Microtus (Terricola)* sp., *M. (T.) lusitanicus* and *M. (T.) pyrenaicus*; Pokines, 1998], Esquilleu[as Microtus (*Terricola)* sp.; Baena et al., 2005], Askondo [as *Microtus (Terricola)* sp; Garcia-Ibaibarriaga et al., 2015a], and Lezetxiki II [as *Microtus (Terricola)* sp.; Garcia-Ibaibarriaga et al., 2018a] among others.

All the species construct underground burrows; therefore they need humid soils (Palomo et al., 2007). *Microtus (Terricola) duodecimcostatus* lives in altitudes from 0 to 3000 m in open areas, in the western part of the Iberian Peninsula, Cantabrian region and in the Pyrenees. *Microtus (Terricola) pyrenaicus* is an endemic species, only present in the eastern part of the Cantabrian fringe, from Pyrenees to Cantabria. Its ecological requirements are no more than 15 ºC in temperature and no less than 1000 mm of annual precipitation, normally in woodland patches with no vegetation inside. Finally, *M. (T.) lusitanicus,* which is also an Iberian Peninsula endemic species, is present in the north western Iberian Peninsula, in altitudes from 0 to 2000 m.

Subgenus *Alexandromys* OGNEV, 1914

Microtus (Alexandromys) oeconomus (PALLAS, 1776) Tundra Vole

Recovered material

- Artazu VIII: 28 left m1and 31 right m1.

Taxonomic determination

The teeth of Tundra Vole are rootless, hypsodont and have cement in the entering triangles. The m1 is very characteristic, since it has three closed triangles in the lingual side and t4 and t5 are alternated. In addition, the t5 converges to the anterior complex and to the t7 (Sesé, 2014). The t6 is still underdeveloped and as a consequence the anterior complex is asymmetric.

Habitat and geographical distribution

The oldest recovery in the Iberian Peninsula of *M. (A.) oeconomus* dates from the Middle Pleistocene at Gran Dolina (Burgos) (as *M.* aff. *ratticeps*; López Antoñanzas and Cuenca-Bescós, 2002), together with one of the southernmost Pleistocene records in Buena Pinta Cave (Madrid) (Laplana et al., 2016). The Tundra Vole has been frequently cited in such Late Pleistocene sites as Lezetxiki

(Altuna, 1972), Erralla (Pemán, 1985), Covalejos (Sesé, 2005a), El Mirón (Cuenca-Bescós et al., 2008), Askondo (Garcia-Ibaibarriaga et al., 2015a) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) among others.

Microtus (Alexandromys) oeconomus is a Holarctic species which nowadays only lives in central and northern Europe (Nadachowski, 1982; Pokines, 1998; IUCN, 2018). According to Pemán (1990a) and Cuenca-Bescós et al. (2008) it disappeared from the Iberian Peninsula during the Roman period. It inhabits densely-vegetated areas, in the edges of peat bogs, swamps, lakes or marshes, but also could be found in tundra, taiga or forest (IUCN, 2018).

Genus *Chionomys* MILLER, 1908

Chionomys nivalis (MARTINS, 1842) Snow Vole

Recovered material

- **Artazu VIII:** 16 left m1 and 20 right m1.

Taxonomic determination

Chionomys nivalis is characterized by the morphology of m1; it has no roots, is hypsodont and it has four triangles in the lingual side and three in the labial side, with the cement present in the incoming triangles. The asymmetry and alternation of t4/t5 and t6/t7 is typical in the Snow Vole, but, without any doubt, the most characteristic feature is the “mushroom” morphology inclined to the labial side of the anterior lobe ["nivaloid" morphotype according to Chaline (1972)]. In addition, the enamel is thicker on the mesial side than on the distal one.

Habitat and geographical distribution

Chionomys nivalis appears in the Iberian Peninsula in the Late Pleistocene. Currently it inhabits in high mountains, generally between 1,500 and 2,000 m in altitude (Palomo et al., 2007; Cuenca-Bescós et al., 2008). However, in Late Pleistocene and Holocene (until the Chalcolithic) sites, the Snow Vole has been recorded in areas that are located in low altitudes, lower than 200 m, as in Aitzbitarte IV, Amalda and Ekain (Pokines, 1998), Askondo (Garcia-Ibaibarriaga et al., 2015a) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) amon others. Its presence is conditioned by the presence of rocky areas with crevices and cracks in open areas.

Genus *Pliomys* MÉHELY, 1924

Pliomys lenki HELLER, 1930

Recovered material

- **Artazu VII:** 2 left m1, 6 left m2/3, 2 right m1 and 14 right m2/3.
- **Artazu VIII:** 3 left m1, 3 left m2, 6 left m3, 6 right m1, 9 right m2, 8 right m3, 4 left M1, 4 left M3, 6 right M1 and 5 right M3.

Taxonomic determination

Pliomys lenki is one of the largest arvicolids after the *Arvicola* genus. This taxon is hypsodont and had rhizodont molars, having five closed and alternated triangles in the m1. Together with *Clethionomys* and *Mymomis,* is the only cricetid that had roots, but *Pliomys* did not have cement in the entering triangles in the m1. Although apparently *P. lenki* possesses very distinguishable features, caution is required in its identification, considering that it can be confused with *Clethrionomys glareolus* Schreber, 1780*,* due to the great similarity of the characteristics of the molars of both taxa. Unlike *P. lenki, Clethrionomys glareolus* has cement in the entering triangles. Thus, at first, any dental element could be used for their identification. However, this feature is not always fulfilled in all molars (with the exception of m1) of *P. lenki* specimens, so both species can easily be confused. For this reason and in order to avoid confusions it is more prudent to use the m1 for the identification of both specimens (Sesé, 2009).

Habitat and geographical distribution

Pliomys lenki has been recorded in the Iberian Peninsula since the Late Pleistocene and its presence is very common in the first part of the Late Pleistocene (until 30 ka) both in the Iberian Peninsula and in the Cantabrian region. Thus, in the Cantabrian region it has been recorded in Lezetxiki (Chaline, 1970), Laminak II (Pemán, 1994), Esquilleu (Baena et al., 2005) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) among others. This species survived until the final part of the Late Pleistocene, concretely around 27-30 ka in Covalejos, Amalda and Ekain sites (Sesé, 1994, 2005a, 2009). However, according to Cuenca-Bescós et al. (2008) the last record of this taxon is in the Upper Magdalenian levels at El Mirón Cave (Cantabria). But in this case the molar used for its identification was not an m1, so this data could be considered as doubtful (Sesé, 2009).

Apart from this, other authors consider that *P. lenki* is related to the current species *Dinaromys bogdanovi* Martino, 1922 or even to *C. nivalis*. As *P. lenki* does not have current representation, it is difficult to specify itsenvironmental requirements. Even so, its presence seems to be related to a temperate climate in high altitudes (Sesé, 1994, 2005a).

Family Muridae ILLIGER, 1811
Subfamily Murinae ILLIGER, 1811
Genus *Apodemus* KAUP, 1829
Apodemus sylvaticus-flavicollis (LINNAEUS, 1758) Wood Mouse - (MELCHIOR, 1834) Yellow-necked Field Mouse

Recovered material

- Artazu VII: 50 left m1, 33 left m2, 27 left m3, 73 right m1, 38 right m2, 31 right m3, 26 left M1, 24 left M2, 21 left M3, 25 right M1, 29 right M2 and 14 right M3.
- Artazu VIII: 18 left m1, 12 left m2, 6 m3, 31 right m1, 16 right m2, 8 right m3, 11 left M1, 13 left M2, 7 left M3, 16 right M1, 12 right M2 and 11 right M3.

Taxonomic determination

Apodemus genus is characterized by having roots and low crowns. The m1 and M1 have six cusps and m2, M2, m3 and M3 four cusps. Apart from that, the m1 could have up to three accessory cusps, the m2 up to two and the m3 a small one. The anterolabial and anterolingual cusps form an X shape with the protoconid and metaconid in m1, and, in some cases, cusps could be separated by deep and narrowed grooves (Pasquier, 1974; Cuenca-Bescós et al., 1997).

This genus includes two species: *A. sylvaticus* and *A. flavicollis*. Morphologically they are very similar, although at first sight *A. flavicollis* is slightly bigger. The distinction between them using dental elements is very difficult due to their similarities but Arrizabalaga et al. (1999) give some differentiation keys. Thus, the t4 and t7 tubercles are joined in M1 and the M2 are characterized by the presence of t9 in *A. sylvaticus,* whereas the t4 and t7 tubercles are separated in M1 and the t9 in M2 is under developed in *A. flavicollis.* However, these characters were tested in approximately 150 current *Apodemus* samples stored at the Muséum national d'Histoire naturelle (MNHN) inParis (France) in a stage of research for the present thesis and not all the cases follow this rule. Therefore, we opted to treat the recovered elements from both palaoentological sites together as *A. sylvaticus-flavicollis* group.

Habitat and geographical distribution

Apodemus *sylvaticus* has been present in the Iberian Peninsula since the Pliocene and the Lower Pleistocene (Michaux and Pasquier, 1974) [as *A. sylvaticus* in Eugi site (Navarre) Schilling et al. (1986), Mezhzherin (1997) and Zagorodnyuk et al. (1997), and as *Apodemus* aff. *sylvaticus* in Bagur-2 site: Sesé and Sevilla 1996; Arribas, 2004)]. In the case of *A. flavicollis,* it is abundantly mentioned in Late Pleistocene sites, although Gil (1986) and Sesé and Gil (1987) cited it in Gran Dolina site (Burgos) as *Apodemus* cf. *flavicollis* in the Lower/Middle Pleistocene transit. Thus, in the Cantabrian region they appeared during the Late Pleistocene in Cobrante (as *Apodemus* sp.; Sesé, 2009), Santimamiñe (as *A. sylvaticus*; Rofes et al., 2014) and Askondo (as *A. sylvaticus-flavicollis;* Garcia-Ibaibarriaga et al., 2015a) among others. Overall, both species have a broad distribution in the Iberian Peninsula. However, *A. flavicollis* is only present in northern Iberia (from the Pyrenees to Asturias) and *A. sylvaticus* is frequent in the most described habitats in Spain (Palomo et al., 2007).

The presence of this genus is more abundant when the environmental conditions are mild temperatures, high humidity and woodland development. Thus, they are thermophilous species and indicators of temperate climates (Pemán, 1990a).

Order EULIPHOTYPHLA WADDEL, OKADA AND HASEGAWA, 1999
Family Erinaceidae FISCHER, 1814
Genus *Erinaceus* LINNAEUS, 1758
Erinaceus europaeus LINNAEUS, 1758 Western Hedgehog

Recovered material

- **Artazu VII:** right M1 and M2.
- **Artazu VIII:** right m2.

Taxonomic determination

Erinaceus europaeus teeth have a sub-rectangular shape, with the basal cingulum characteristic of the genus that surrounds the tooth, thicker on the labial side than in the lingual. The M2 has the hypocone and the protocone well developed and connected to each other. The metastyle is well marked, while the metacrest is quite short.

Habitat and geographical distribution

The Western Hedgehog, widely distributed throughout the Iberian Peninsula, is identified at various Late Pleistocene sites in the Cantabrian range: Tito Bustillo (Altuna, 1976), El Juyo (Pokines, 1998), Amutxate (Sesé, 2014) and Santimamiñe (Rofes et al., 2014).

Currently, the Western Hedgehog has a wide distribution throughout the Iberian Peninsula, although it is scarce in Mediterranean environments (Palomo et al., 2007). In the North of Spain it is found in both forested and open areas, whenever there is shrub-like vegetation (Blanco, 1998a; Sesé, 2005b).

Family Soricidae FISCHER, 1814
Subfamily Soricinae FISCHER, 1814
Genus *Sorex* LINNAEUS, 1758
Subgenus *Sorex* LINNAEUS, 1758
Sorex (Sorex) araneus-coronatus LINNAEUS, 1758 Common Shrew - MILLET, 1828 Millet's Shrew

Recovered material

- **Artazu VII:** 158 left Man., 153 right Man., 78 left Max., 78 right Max. and 98 isolated dental elements.
- **Artazu VIII:** 624 left Man., 665 right Man., 223 left Max., 209 right Max. and 2,293 isolated dental elements.

Taxonomic determination

In general, the shrews have a narrow and elongated cranium without zygomaticus arch and selenodont specialized teeth (Repenning,1967). The lower incisivors are long straight and curved upwards, pointing straight ahead and with serrated surface (Reumer, 1984). The antemolars are small and they only have one cusp. Finally, the premolars and the molars are bigger than the antemolars and they have some cusps and sharp crests connecting two prominent outer cones with smaller cones in “W” shape, which is known as “dilambdodont” (Reumer, 1984).

Currently there are three medium size shrews with red teeth in the Iberian Peninsula: *S. (S.) araneus*, *S. (S.) coronatus* and *S. (S.) granarius*. Nevertheless, to distinguish species belonging to *Sorex* genus, we must focus on the cranial elements size, as well as the facet joints (Furió Bruno, 2007; Cuenca-Bescós et al., 2008; López-García, 2008).Thus, the mandible of *S. (S.) coronatus* is robust, the condyle joint developed and turned backwards, the coronoid process slightly inclined forward and the mandible foramen, that in most cases is simple, has a well marked depression. The coronoid process of *S. (S.) araneus* is right or slightly inclined forward and the mandible foramen in most cases is double. Finally, *S. (S.) granarius* shows differences, such as a short coronoid process. Due to *S. (S.) araneus* and *S. (S.) coronatus* cranial element similarity, we decided to group both together as *S. (S.) araneus-coronatus* group.

Habitat and geographical distribution

Sorex genus has been present in the Iberian Peninsula since the Late Pleistocene. In the northern Iberian Peninsula remains of this genus have been recovered in Aitzbitarte IV (as *Sorex* gr. *coronatus-araneus*; Altuna, 1972), Lezetxiki (as *Sorex* sp.; Altuna, 1972), Ekain (as *Sorex* gr. *coronatus-araneus* and *Sorex* sp.; Zabala, 1984), Erralla (as *Sorex* gr. *coronatus-araneus*; Pemán, 1985), *Sorex* gr. *coronatus-araneus*; Fernández Rodríguez et al., 1993), Laminak II [as *S. (S.) araneus*; Pemán, 1994], A Valiña [as *S. (S.) araneus*; Pokines, 1998], El Juyo [as *S. (S.) coronatus*; Pokines, 1998],Covalejos [as *S. (S.) araneus*; Sesé, 2005a], El Mirón (as *Sorex* gr. *coronatus-araneus*; Cuenca-Bescós et al., 2008) and Askondo [as *S. (S.) araneus-coronatus*; Garcia-Ibaibarriaga et al., 2015a], among others.

Currently, *S. (S.) araneus* and *S. (S.) coronatus* are distributed cross the northern half of the northern Iberian Peninsula, overlapping both in the Pyrenees fringe. Otherwise, *S. (S.) granarius* inhabits the Central Iberian Peninsula (López-Fuster et al., 1999). The ecological requirements of the three medium size shrews are herbaceous or shrubby vegetation in humid environments (Pokines, 1998).

Sorex (Sorex) minutus LINNAEUS, 1766 Eurasian Pygmy Shrew

Recovered material

- **Artazu VII:** 46 left Man., 56 right Man., 22 left Max., 20 right Max. and 22 isolated dental elements.
- **Artazu VIII:** 47 left Man., 71 right Man., 7 left Max., 14 right Max. and 35 isolated dental elements.

Taxonomic determination

Sorex (Sorex) minutus is a small shrew in this genus that currently exists in the Iberian Peninsula. It has seledonodont teeth, but the morphology of the dental elements is not characteristic of this species, consequently it has to be distinguished using the morphology of the mandible and its tiny size. According to Reumer (1984) *S. (S.) minutus* is characterized by the concave form of the anterior edge of the coronoid process.

Habitat and geographical distribution

In the northern Iberian Peninsularemains of this species have been recovered in Erralla (Pemán, 1985), Laminak II (Pemán, 1994), A Valiña (Fernández Rodríguez et al., 1993), El Mirón (Cuenca-Bescós et al., 2008), Cova Eirós (Rey-Rodríguez et al., 2016) and Lezetxiki II (Garcia-Ibaibarriaga et al., 208a) among others. *Sorex (Sorex) minutus* is an Iberian Peninsular autochthonous species which currently lives in the northern half of the Peninsula, although it can also be found in the central Iberian Peninsula. However, during the Late Pleistocene the geographical distribution of this species was broader, covering all the Iberian Peninsula, with the exception of the southernmost part. The Eurasian Pygmy Shrew could live in open meadows, grasslands, deciduous or conifer woodlands. The limiting factor for the presence of this last taxon is the moisture.

Genus *Neomys* (KAUP, 1829)

***Neomys* sp.** Water shrew

Recovered material

- Artazu VII: 1 isolated dental element, 5 left Man., 7 right Man., 2 left Max. and 3 right Max.

- Artazu VIII: 16 isolated dental elements, 9 left Man., 9 right Man. and 2 right Max.

Taxonomic determination

Like *Sorex* genus, *Neomys* also has red seledodont teeth, but the principal difference between the two genera are that *Neomys* lower incisisor does not have a serrated surface and the that has larger size. Apart from this, the morphology of the mandibular condyle is also characteristic. It is elongated and narrow, and it has perpendicular orientation regarding the articular facet (Chaline et al., 1974). The upper zone of this element is thicker in the lingual part and the external temporal fossa is well marked. In posterior view the articular condyle has a relatively big size in comparison to the remaining mandible and it has "L" shaped morphology. The internal temporal fossa presents a triangular shape with slightly curved anterior and posterior edges.

Neomys genus is the biggest taxon of shrew in Europe. Although nowadays there are two species belonging to this genus, *N. anomalus* Cabrera, 1907 and *N. fodiens* Pennant, 1771, the distinction between the two is still unclear and complicated. In Artazu VII and Artazu VIII two different morphologies can be observed. However, we were not fully convinced that this implies that they belong to two species; they may belong to juvenile or adult specimens or it may be on account of the intraspecific variety. For this reason we decided to identify the remains as *Neomys* sp.

Habitat and geographical distribution

Although the *Neomys* genus's first record in the Iberian Peninsula is dated in the Middle Pleistocene (Sesé, 1994, 2005a), its appearance is more common during the Late Pleistocene. Hence, in the northern Iberian Peninsula it has been recorded in Erralla (as *N. fodiens*; Pemán, 1985; Sesé, 2005a), in Amalda (as *Neomys* sp.; Pemán, 1994), El Mirón (as *N. anomalus*; Pokines, 1998), Lamiak II (as *Neomys* sp.; Pemán, 1994) and Lezetxiki II (as *Neomys* sp.; Garcia-Ibaibarriaga et al., 2018a) among others.

Presently, *N. fodiens* only lives in the fringe of the northern Iberian Peninsula whereas *N. anomalus* inhabits the fringe of the northern Iberian Peninsula and in central Iberia from north to south (Palomo et al., 2007). Both species are semi-aquatic shrews, so its habitat is related to riverbanks, rivers or humid pastures and forests (Palomo et al., 2007).

Family Talpidae FISCHER, 1817
Subfamily Talpinae FISCHER, 1814
Genus *Talpa* LINNAEUS, 1758
***Talpa* sp.** Mole

Recovered material

- Artazu VII: 1 left Ast.**,** 1 right Cal., 14 isolated dental elements, 3 left Hum. and 1 right Hum., 4 right Man., 3 left Man., 7 1st/2nd Pha., 2 left Uln. and 1 right Uln.

- Artazu VIII: 1 left Hum., 1 right Hum., 28 isolated dental elements, 1 right Man., 1 left Man., 1 right Max., 1 1st/2nd Pha., 4 3rd Pha. and 1 right Uln.

Taxonomic determination

All *Talpa* have a hypogeum lifestyle with a "scratch-digger" locomotive system. As a consequence, an increase in anterior extremity strength occurs, developing robust and thick phalanges, humeri, ulnae, radii and scapulae (Nevo, 1999). Hence, in the case of *Talpa*, almost the entire skeleton can be determined at species level. However, the most diagnostic and therefore the most commonly used elements are cranial bones, humerus, radius, ulna and phalanges (Chaline et al., 1974). In particular, the humerus stands out, apart from its robustness, for having "X" shaped morphology and for being flattened. In relation to the cranium, it is narrow and elongated, with a conic shape in the anterior view and robust coronoid (Miller, 1912). The canine is larger than the incisors, with the former having a conic shape and being elongated.

Currently, in the Iberian Peninsula we can found two species belonging to *Talpa* genus, *T. europaea* and *T. occidentalis*, exist*.* According to Cleef-Roders and van den Hoek Ostende (2001), differences between both taxa are minimal, being the main difference that the 4th premolar and first and second molars in the mandible are slightly smaller in *T. occidentalis*, but not always. For this reason, and due to most of the mandibles lacking teeth, we have preferred not to identify to species level.

Habitat and geographical distribution

The *Talpa* genus has been present in the Iberian Peninsula since the Miocene (Bataller, 1938), being usual in Late Pleistocene deposits. In the northern Iberian Peninsula it has been recorded at the Late Pleistocene sites of Amalda (as *Talpa* sp.; Pemán, 1990b), A Valiña (as *Talpa* sp.; Fernández Rodríguez et al., 1993), Covalejos (as *Talpa* sp.; Sesé, 2005a), Santimamiñe (as *T. europaea*; Rofes et al., 2014) and Lezetxiki II (as *T. cf. europaea*; Garcia-Ibaibarriaga et al., 2018a) among others.

The two taxa inhabit in different geographic zones in the Iberian Peninsula today, with a small overlap in the northern half of Iberia, mainly in Asturias and in the western part of the Basque Country. Thus, *T.occidentalis* is present in the southern third of the Iberian Peninsula whereas *T. europaea* inhabits in the northern eastern half. Talpa genus is a eurytherm taxon which needs soft humid soils where it can dig (Blanco, 1998a). Generally it lives in grasslands in a great variety of altitudes, from sea level to 2,300 m (Palomo et al., 2007).

Order CARNIVORA BOWDICH, 1821
Family Felidae FISCHER, 1817
Genus *Felis* LINNAEUS, 1758
Felis silvestris SCHREBER, 1777 European Wild Cat

Recovered Material

- **Artazu VII:** 1 Cal., 1 Rad. 1 lower Tth., and 1 upper Tth.

Taxonomic determination

Felis silvestris species descended from *Felis lunensis* Martelli, 1906, ocurring this differentiation in the Middle Pleistocene. It is characterized by short cheek tooth rows with small teeth and proportionally broader muzzle. Regarding diagnostic characters, the European wildcat pocesses a proportionally broader anterior part of the skull with a different shape of the nasals. The recovered remains are very scarce and mainly belong to dental elements. The identification of this taxon was performed by comparison to the Dr. Pedro Castaños reference collection.

Habitat and geographical distribution

Currently the European Wild Cat is distributed widely throughout Europe, Africa and Asia (Nowell and Jackson, 1996). This taxon fossiliferous remains have been found widspread along all the Iberian Peninsula (Yravedra, 2001; Villaluenga, 2016). Thus, some examples form the northern Iberian Peninsula are: Lezetxiki (Altuna, 1972) or Lezika (Castaños et al., 2009), among others.

The European Wild Cat has a very broad distribution and it can inhabit in a wide variety of areas, from deserts and scrub grassland to dry and mixed forest. It is only absent from rainforest and coniferous forest. However, they are usually found in deciduous forest zones (IUCN, 2018).

Genus *Lynx* KERR, 1792
***Lynx* sp.** Lynx

Recovered material

- **Artazu VII:** 1 Cal., 1 Car., 1 Max., 1 Mtc., 3 1st Pha. and 1 Pel.

Taxonomic determination

Two species of Lynx are extant in Europe: the Eurasian Lynx (*Lynx lynx* Linnaeus, 1758) and the Iberian form (*Lynx pardinus* Temminck, 1824). In addition, remains belonging to the Pleistocene are attributed to a third form called *Lynx spelaeus*. It is thought that this species had an intermediate size and it was a precursor form of the Iberian lynx. In Artazu VII a specific attribution was not possible due to the preservation of bones.

Habitat and geographical distribution

Palaeontological Eurasian Lynx finds in recent decades on the Pyrenees northern slopes have significantly modified the distribution areas of these species. Clot and Besson (1974) confirmed the presence of sub-modern specimens in Central and West sectors of the mountain range. Their presence in the Cantabrian region is well recorded in Pagolusieta and Rascaño (Altuna 1980, 1981a).

The Eurasian Lynx lives in a wide variety of environmental and climatic conditions (Schmidt and Ratkiewicz, 2011), but in Europe is mainly associated with forested areas which have good ungulate populations and which provide enough cover for hunting. The Iberian Lynx is a strict feeding specialis of the European Rabbit (*Oryctolagus cuniculus*), so its presence is directy related to areas with dense rabbit populations (Palomares et al., 2000).

Genus *Panthera* OKEN, 1816

Panthera pardus (LINNAEUS, 1758) Leopard

Recovered material

- **Artazu VII:** 2 Atl., 2 Axi., 3 Car., 2 Fem., 10 1st Pha., 5 Hum., 3 lower Tth., 5 Man., 2 Max., 4 Mtc., 3 Mtp., 8 Mtt., 1 Pat., 4 Pel., 6 Rad., 6 Rib., 1 Sac., 2 Sca., 8 2nd Pha., 2 Skll., 2 Tal., 2 Tarsal rest, 8 3rd Pha., 7 Tib., 3 upper Tth., 6 Uln., and 17 Ver.

Taxonomic determination

The most characteristic elements for the identification of the Leopard are skull and dental elements. However, the remains recovered at Artazu VII were compared to 88 sites with Leopard remains distributed throughout the Iberian Peninsula from the Middle Pleistocene to the Early Holocene (See Chapter 6).

- The canine is laterally flattened with double longitudinal grooves in the vestibular surface, wellmarked mesial and distal edges and slightly convex lingual face. Lower canines have a similar length to upper canines. The P3 usually display a well-developed paraconid and the metaconid, although the latter is slightly larger.

- The P3 has an inclined protocone backward, a parastyle moved toward the lingual side and a well-developed hypocone finishing in a cingulum.

- The P4 has a well-developed protocone, while the paracone curves slightly backward and the parastyle is rounded. Moreover, the P4 is trilobed with a protoconid less developed than a metaconid and a well-marked cingulum surrounding all teeth. The P4 is relatively longer than m1 and its protoconid is at the highest part of the m1 paraconid.

- The carnassial molar (M1) has two main crests, and the paraconid is short in comparison with the protoconid.

- The angle formed in the basal and anterior edge of the horizontal branch in the mandible is obtuse and forms a receding symphysis, which is characteristic of *P. pardus.* The coronoid process is not vertical but is projected backwards, as occurs nowadays in the leopard. Finally, the horizontal ramus in basal profile presents a convexity under the m1 and the p4. In addition the mandibles have a well-developed protoconid and a cingulum, surrounding the entire tooth on the lingual and labial side.

Habitat and geographical distribution

During the Pleistocene, this taxon was the most common element in the faunal assemblages of the Iberian Peninsula, being its accumulation in caves and shelters mainly related to the humans activity (Brain, 1981). Thus, *P. pardus* was responsible for hundreds of bone accumulations in the European Pleistocene, consequently they played a role in the creation of sites in the Iberian Peninsula. Its remains have been recorded in Allekoaitze and Aintzulo (Altuna and Mariezkurrena, 2013), Los Rincones (Sauqué and Cuenca-Bescós, 2013), Avenc de Joan Guitón (Sanchis et al., 2015), and in the north of the Iberian Peninsula Bolinkoba (Castaños and Castaños, 2015), among others.

Until now Leopards have been widely distributed across Africa and eastern Asia but the last evidences show that populations have been dramatically reduced due to continued persecution of humans (Thorn et al., 2013; Selvan et al., 2014).The Leopard is a solitary, opportunist hunter and an ubiquistic animal that occupied different habitats during the Pleistocene, from coastal or low-lying places to mountain areas (Sanchis et al., 2015).

Panthera leo spelaea GOLDFUSS, 1810 Cave Lion

Recovered material

- Artazu VII: 1 Mtc., 1 Mtp., 1 Mtt., 3 1st Pha., 1 Uln. and 1 Ver.
- Artazu VIII: 1 Car., 1 Hum., 1 Man., 1 Sca., 1 Tal., 1 Tarsal rest, 1 upper Tth. and 1 Ver.

Taxonomic determination

As Leopard, the cranial parts are the most useful elements for the Cave lion determination. Cave lion identification was performed taking measurements and comparing to four sites in the northern Iberian Peninsula (more details in Chapter 6):

- The principal cranial characters are wide muzzle, especially over the canines and P2 roots, a relatively short facial part, short and wide nasals and rounded openings of the incisive foramina. In addition, also moderately arched zygoma, relatively elongated postorbital or cranial portion and narrow intertemporal region and braincase

- Among the tooth features for the Cave Lion the most significant are: incisors with well-developed lingual cingulum, upper canines with slight lateral compression, upper carnassial lacking or with slightly developed small cingular preparastyle, large parastyle, and protocone bulge having the clear trend to lose the protocone cusp.

Habitat and geographical distribution

The presence of two lion morphotypes during the Late Pleistocene in Europe is recurrent in palaeontological literature, *Panthera spelaea spelaea* and *Panthera spelaea clueti*. If this hypothesis is true, it seems that the Cave Lion disappears towards the middle of the Last Pleistocene, while the second taxon would have survived in some places in Central Europe, such as Vörös (1983) in Hungary, almost until the Bronze Age. Recent studies, both morphological and DNA analysis, indicate that Cave Lion is a different animal from modern lions, so its disappearance in the Late Pleistocene should be treated as an extinction (Barnnet et al., 2009; Stuart and Lister, 2011). Thus, the Cave Lion was a one of the largest lion globally known that was a predator specialised in large ungulates. It was a carnivore that can be found in sites in the Iberian Peninsula from the Middle Pleistocene to practically the end of the Late Pleistocene (García, 2003). In the northern Iberian it has been recorded in Urtiaga and Lezetxiki (Altuna, 1972), Arrikrutz (Altuna, 1981b) or El Castillo (Castaños, P, 2017).

The Cave Lion remains until now have been found in caves. It is thought that it had a wide environmental tolerance in which medium and large herbivores appeared, like open woodland. However, Cave Lion fossil footprints next to raindeers tracks may indicate that *P. spelaea* could tolerate cold habitats (Stuart and Lister, 2011).

Family Canidae FISCHER DE WALDHEIM, 1818
Genus *Canis* LINNAEUS, 1758
Canis lupus LINNAEUS, 1758 Wolf

Recovered material

- Artazu VII: 1 Cal., 1 Car., 4 Fem., 3 lower Tth., 1 Mtt., 4 1st Pha., 1 Sca., 1 Skll., 1 Tib., 1 upper Tth. and 1 Ver.
- Artazu VIII: 1 Cal., 2 Mtc., 1 Mtt., 2 Rad. and 1 Uln.

Genus Cuon LINNAEUS, 1758
Cuon alpinus PALLAS, 1811 Dhole

Recovered material

- **Artazu VII:** 1 Max., 1 Mtc. and 1 Tal.

Taxonomic determination

Among Dhole remains recovered at Artazu VII and Artazu VII, only one P4 has been recovered. This P4 has a main cusp (protoconid), a small mesial cuspid (paraconid) and a single distal cusp (metaconid), unlike fox, which has two posterior cuspids.

Fortunatelly, postcranial skeleton is more useful for taxonomic differentiation.The metacarpal 5 and talus measurements fall below the minimum values for Wolf. Therefore, some remains have been attributed to the Dhole. Similarly, the tibia and the third metatarsal measurements are larger than the maximum values for *C. alpinus*, so these bones were also attributed to Wolf. However, the calcaneus was a medium size, within the two taxa-area. Due to the difficulty to distinguish both species, these two taxa have been studied together in the same section.

Habitat and geographical distribution

The Dhole is a canid that is smaller in size than a Wolf and that has hypercarnivore adaptations in its skull and dentition (Sauqué et al., 2017). It is present in the Iberian Peninsula from the middle Pleistocene in the Trinchera-Galería site (Sierra de Atapuerca, Burgos) (Cervera et al., 1999; García, 2003) to the early Holocene in the Epipalaeolithic level in Coves de Santa Maira (Pérez Ripoll et al., 2010). Most of the finds are in archaeological and palaeontological sites on the Mediterranean coast and in the Cantabrian region. In the northern

Iberian Peninsula, *C. alpinus* are restricted to six sites: Rascaño (Altuna, 1981a), Obarreta (Altuna, 1983), La Riera (Altuna, 1986), Amalda (Altuna, 1990), Bolinkoba (Castaños and Castaños, 2015), and recently in Praileaitz I (Castaños and Castaños, 2017). It is also present at other sites in the Iberian Peninsula (Pérez Ripoll et al., 2010). In the case of *C. lupus* it has been recorded in Bolinkoba (Castaños and Castaños, 2015) and Santimamiñe (Castaños and Castaños, 2011).

Nowadays the Dhole is not present in the Iberian Peninsula and globally it is in danger of extinction, declining quickly its population. *Cuon alpinus* is a generalist species, occuring in a wide variety of vegetation types with the desert regions, including: tropical dry and moist deciduous forests, evergreen and semi-evergreen forests, temperate deciduous forests, boreal forests, dry thorn forests; grassland–scrub–forest mosaics, temperate steppe and alpine steppe. In the case of Wolf, it has become extinct in much of Western Europe and their present distribution is more restricted, so currently they only are present in the northern Iberian Peninsula in remote areas. This taxon has an adaptive nature, but only is present in areas with abundance of prey; forest, tundra, taiga, desert, plains or mountains.

Genus *Vulpes* FRISCH, 1775

Vulpes vulpes (LINNAEUS, 1758) Red Fox

Recovered material

- **Artazu VIII:** 2 Atl., 1 Axi., 5 Cal., 11 Fem., 12 Hum., 13 Man., 7 Max., 6 Mtc., 9 Mtt., 10 Pel., 3 1st Pha., 8 Rad., 2 Rib., 1 Sac., 3 Sca., 3 Skll., 1 Tal., 12 Tib., 5 lower Tth., 7 upper Tth., 4 indet. Tth., 8 Uln. and 27 Ver.
- **Artazu VIII:** 1 Fem., 1 Mtc., 1 lower Tth., 1 upper Tth. and 1 Ver.

Taxonomic determination

During the late Pleistocene, there were two species of fox in Europe, as nowadays: Red Fox (*V. vulpes)* and Arctic Fox (*Alopex lagopus*). In general, the size of the nominal species is larger than Arctic Fox, with an overlap in the measurements of the two species. Using measurements comparison from Artazu VII and Artazu VIII to current ones, it can be concluded that they belong to the Red Fox (more details in Chapter 6).

Habitat and geographical distribution

The Red Fox is currently present in the all Europe with the exceptions of some islands. During the Pleistocene it has been recorded in many sites, as Labeko koba (Altuna and Mariezkurrena, 2000), Santimamiñe (Castaños and Castaños, 2011) or Bolinkoba (Castaños and Castaños, 2015), in the northern Iberian Peninsula.

This taxon can live in diverse biotopes as tundra, desert (though not extreme deserts) and forest, but his natural habitat is dry, mixed landscape, with abundant "edge" of scrub and woodland. They are also abundant on moorlands, mountains (even above the treeline, known to cross alpine passes), sand dunes and farmland from sea level to 4,500 m (IUCN, 2018).

Family Ursidae FISCHER DE WALDHEIM, 1817
Genus *Ursus* LINNAEUS, 1758
Ursus spelaeus (ROSENMULLER, 1794) Cave Bear

Recovered material

- **Artazu VIII:** 1 Axi., 3 Cal., 4 Car., 2 Fem., 1 Fib., 1 Hum., 5 Mtc., 3 Mtp., 6 Mtt., 1 Pat., 9 1^{s} Pha., 8 2nd Pha., 1 3rd Pha., 1 Rad., 1 Sca., 6 Ses., 1 Skll., 2 Tal., 2 Tarsal rest, 4 Tib., 1 Uln., 4 lower Tth., 2 upper Tth. and 6 Ver.

Taxonomic determination

Some of the most characteristic skeletal remains for the identification of the Cave Bear are those that appear here below:

- The skull presents a solid structure, standing out the deep frontal step in lateral view accentuated by very robust supraorbital processes. In addition, the occipital crest is big enough.

- The edge of the anterior part of the mandible is characterized by the insertion of the incisors, but the alveolus of the incisors are lot ligned. The central alveolus in which the second incisor is inserted is located in a position slightly lagging behind the others. The vertical branch of the mandible has a convex anterior edge, rising till the coronoid process. Finally, the condyle is cylindrical with a conical portion towards the outer edge.

- The upper row of the carpus, from inside to outside, is compound by the scapholunate, the pyramidal and the pisiform, while the lower row, in the same direction, is compound by the trapeze, the trapezoid, the large bone and the hooked.

- The tibia is robust with the proximal epiphysis wide and flattened. In occlusal view it presents a subtriangular contour and in the frontal view it has an elongated protuberance.

Habitat and geographical distribution

This species habited till the final of the Late Pleistocene, particularly in the northern half of the Iberian Peninsula. The great abundance of this taxon in the Cantabrian region has been explained by numerous authors. Altuna (1972) proposed the existence of a dense population in this geographic area. However, according to Kurtén (1968) this fact is due to a "second extinction", meaning that specimens concentrated in the cantabrian shelter during the end of the Pleistocene. Thus, in the Iberian Peninsula Cave bear presence has been registered in 75 sites (Villaluenga, 2009): Lezetxiki and Urtiaga (Altuna, 1972), El Pendo (Fuentes, 1980), Axlor (Altuna, 1981c) or Amalda (Altuna, 1990), among others.

Finally, the cave bear always has been recovered in karstic systems, so, it present seems to be associated to rocky environments.

Family Mustelidae FISCHER DE WALDHEIM, 1817
Genus *Martes* PINEL, 1792
Martes martes LINNAEUS, 1758 Pine Marten

Recovered material

- **Artazu VII:** 1 upper Tth.

Taxonomic determination

A priori the fragment of the upper canine allows its attribution to Beech Marten (*Martes foina*) or Pine Marten (*Martes martes*). But recent evidence indicates that Beech marten was an invader of Spain during Neolithic times (Llorente et al., 2011; Llorente-Rodríguez et al., 2014). Moreover, the canines of Pine marten have their crowns proportionally longer and less curved than in *M. foina*, like Artazu VII remain. Therefore the remains from Artazu VII have been attributed to pine marten.

Habitat and geographical distribution

Nowadays *M. martes* is well distributed trough all Europe, but in the Iberian Peninsula is only present in the northern frindge. In the northern Iberia, it has been recorded in Santimamiñe (as *Martes* sp.; Castaños and Castaños, 2011) or Kiputz IX (as *Martes* sp.; Castaños et al., 2012b) among others. This taxon usually inhabits in deciduous, mixed and coniferous woodlands, as well as in scrubs (IUCN, 2018).

Genus *Meles* BRISSON, 1762
Meles meles LINNAEUS, 1758 Badger

Recovered material

- **Artazu VII:** 2 Tal.

Taxonomic determination

The only two remains of this taxon are two talii that have a morphology of the badger.

Habitat and geographical distribution

Meles meles is the most common mustelid in the Late Pleistocene and Holocene European taxon. It has been recorded in the northern Iberian Peninsula in many Late Pleistocene sites, here some examples: Labeko Koba (Altuna and Mariezkurrena, 2000), Santimamiñe (Castaños and Castaños, 2011) or Bolinkoba (Castaños and Castaños, 2015).

The Badger is an opportunistic taxon but it prefers deciduous forest or open pastures with woodland patches. However, it also can habit in mixed or coniferous forest or scrubs (IUCN, 2018).

Genus *Mustela* LINNAEUS, 1758

Mustela nivalis LINNAEUS, 1766 Least Weasel

Recovered material

- **Artazu VII:** 1 Skll.

Mustela putorius LINNAEUS, 1758 Western Polecat

Recovered material

- **Artazu VII:** 1 Hum., 2 Man., 1 Max., 1 Pel., 2 Tib. and 2 Uln.

Taxonomic determination

The identification of small members of the genus *Mustela* is not an easy task, being the most useful elements the skull or dentition. In the case of *M. nivalis* the skull does not have the lower edge of the mandible bowed, because is almost straight. That, metric values as the width between the condyles and measurements of other skeletal remains from other sites, allow the attribution to *M. nivalis* and *M. putorius* (more details in Chapter 6).

Habitat and geographical distribution

Nowadays and during the Pleistocene both species are widespread throughout Europe. Thus, they have been recovered in numerous palaeontological sites (Sommer and Benecke, 2004). In the northern Iberian Peninsula they have been cited in Labeko Koba (Altuna and Mariezkurrena, 2000), Santimamiñe (Castaños and Castaños, 2011) or Bolinkoba (Castaños and Castaños, 2015).

Order PERISSODACTYLA OWEN, 1848
Family Equidae GRAY, 1821
Genus Equus LINNAEUS, 1758
Equus ferus LINNAEUS, 1758
Equus ferus caballus LINNAEUS, 1758 Feral Horse

Recovered material

- Artazu VII: 8 upper Tth.

- Artazu VIII: 1 Atl., 1 Axi., 4 Cal., 1 Car., 2 Cta., 6 Fem., 6 Hum., 7 Man., 6 Max., 4 Mtc., 6 Mtp., 7 Mtt., 2 Pat., 3 Pel., 4 1st Pha., 4 2nd Pha., 1 3rd Pha., 7 Rad., 69 Rib., 2 Sac., 4 Sca., 1 Ses., 3 Skll., 3 Tal., 5 Tarsal rest, 2 Tib., 3 lower Tth., 2 upper Tth., 2 Uln., and 27 Ver.

Taxonomic determination

The distinction between equids is not an easy task, being the most diagnostic elements the cranial remains. Hence, the morphology of teeth recovered from Artazu VII and VIII is typical of horses, with a large protocone and well-developed caballine fold. The identification of this taxon was performed using the reference collection of Dr. Pedro Castaños.

Habitat and geographical distribution

Equus ferus caballus is a common taxon found in sites during the Late Pleistocene. Thus, in the northern Iberian Peninsula it has been recovered in Santimamiñe (Castaños and Castaños, 2011), Kiputz IX (Castaños et al., 2014) or Bolinkoba (Castaños and Castaños, 2015), or among others. This taxon has the ability to habit in different biotopes, grassland, forest or tundra with hight moisture or dry environments.

Family Rhinocetodoidea GRAY, 1820
Genus *Coelodonta* BRONN, 1831
Coelodonta antiquitatis BLUMENBACH, 1807
Woolly Rhinoceros

Recovered material

- Artazu VIII: 2 Atl., 9 Cal., 34 Car., 9 Fem., 11 Hum., 1 Hyo., 23 Mtc., 3 Mtp., 17 Mtt., 4 Pat., 6 Pel., 12 1st Pha., 8 2nd Pha., 4 3rd Pha., 9 Rad., 2 Rib., 5 Sca., 2 Ses., 7 Tal., 16 Tarsal rest, 8 Tib. and 14 Uln.

Taxonomic determination

The most diagnostic elements of *C. antiquitatis* are the cranial ones. Thus, the cranium has the facial structure elongated, the nasal septum ossified and the horn insertion well marked. The supraorbital process is also well marked and the posrorbital process is strong. The occipital surface is very high and with trapezoidal shape (Guérin, 1980). Regarding dental elements here below are explained the features of some of them:

- The d2 has the mediofosette well developed and totally closed and the position of the protoloph draws a low angle with the ectoloph. Moreover, the enamel surface is rough. Difference between the P2 and d2 is marked by length of the crown, which in case of dP2, is greater than the width and stands outs for the low height of the crown. In addition, the enamel is very thin, which is also a typical feature of deciduous dentition.

- The M3 shows a thick and rough enamel and the metalophid has a clear constriction in the middle part.

Habitat and geographical distribution

The Woolly Rhinoceros is an extinct species that was present in the Palaearctic since the Pliocene to early Middle Pleistocene periods (Kahlke, 1999). It was during the MIS 6 when *C. antiquitatis* entered the Iberian Peninsula for the first time. The oldest remains had been recorded in the northern Iberian Peninsula, in La Parte site (Álvarez-Lao and García-García, 2006), but it also has been recovered in other sites with recent chronologies as Lezetxiki (Altuna, 1972), Arrikrutz (Altuna, 1979), Punta Lucero (Castaños, 1988) or Las Caldas (Altuna and Mariezkurrena, 2017), among others.

The presence of *C. antiquitates* indicates cold and dry conditions, considering that this species is typical of the steppe-tundra (Stuart and Lister, 2012). It could also habits in an herbaceous ecosystem, as long as the available habitats comprised sufficient amounts of open grassland.

Order ARTIODACTYLA OWEN, 1848
Family Cervidae GOLDFUS, 1820
Genus *Cervus* LINNAEUS, 1758
Cervus elaphus LINNAEUS, 1758 Red Deer

Recovered material

- Artazu VII: 3 Car., 1 Fem., 8 H. Cor., 2 Hum., 1 Man., 1 Mtt., 2 2nd Pha., 1 3rd Pha., 1 Rad., 5 Rib., 1 Sca., 9 Skll., 1 Str., 1 lower Tth. and 1 upper Tth.

- Artazu VIII: 1 Atl., 2 Axi., 12 Cal., 11 Car., 9 Cta., 18 Fem., 39 H. Cor., 17 Hum., 2 Hyo., 2 Mall., 14 Man., 2 Max., 14 Mtc., 16 Mtt., 5 Pat., 7 Pel., 19 1st Pha., 18 2nd Pha., 11 3rd Pha., 10 Rad., 78 Rib., 1 Sac., 5 Sca., 4 Ses., 5 Skll., 2 Str., 9 Tal., 13 Tib., 6 Uln., 3 lower Tth.,4 upper Tth. and 79 Ver.

Taxonomic determination

For the identification of this taxon, apart from the mammal reference collection, morphometric measurements have been taken and compared to other samples, especially from the Cantabrian region (Chapter 6). One of the most diagnostic skeletal remain of Red Deer is the metatarsus, which is identifiable due to the separation between the grand cuneiform facet and escafocuboides facet.

Habitat and geographical distribution

This taxa appears in the northern Iberian Peninsula, usually in anthropic origin sites like Aitzbitarte IV (Altuna, 1972) or El Castillo (Altuna, 1972; Mariezkurrena, 1983; Castaños, 1986; Klein and Cruz-Uribe, 1994). Nevertheless it has also been recovered in exclusively palaeontological sites like Punta Lucero (Castaños, 1988) or Kiputz IX (Castaños et al., 2012b).

The Red Deer lives in open deciduous woodland, mixed deciduous-coniferous or coniferous woodland in mountainous areas (Koubek and Zima, 1999). Generally it spends summers in meadows and winters in valleys. On more level terrain, seeks wooded hillsides in summer and open grasslands in winter.

Genus *Rangifer* C.H. SMITH, 1827

Rangifer tarandus LINNAEUS, 1758 Reindeer

Recovered material

- Artazu VIII: 1 Atl., 4 Car., 1 Fem., 3 Hum., 3 Man., 1 Max., 2 Mtc., 1 Pel., 1 2nd Pha., 2 Rad., 1 Rib., 1 Sca., 2 Tib., 1 Uln. and 10 Ver.

Taxonomic determination

Among all skeletal remains the scapula and the humerus are two of the most diagnostic elements of the Reindeer.

- The scapula of the Reindeer has a triangular shape, the articular process is relatively robust and in lateral view the anterior border of the scapula is concave. The lateral profile of the supraglenoid tubercle and the outline of the glenoid cavity form a right angle.

- The humerus diaphysis is characterized by a slightly flattened shape and the proximal epiphysis shows three significant features; the greater tubercle protrudes only slightly above the head; the articular head is narrow and, the deltoid crest, which extends from the lateral region of the base of the greater trochanter down to the dorsal half of the diaphysis, is nearly continuous.

Habitat and geographical distribution

The *Rangifer* genus was probably originated in the artic region of North of America (McDonald et al., 1996). During the MIS 11 and MIS 5c interglacials, the Reindeer retreated to boreal refuges, so it is inusual to find it in sites of this epochs. In the Iberian Peninsula their population grew during the end of the Middle Pleistocene.

Nowadays, the Reindeer is only present at northern latitudes of Europe, but it has been recorded in 55 archaeological or palaeontological sites in the Iberian Peninsula. All these *R. tarandus* fossil assemblages are located grouped in the Cantabrian fringe and in the NE part of Catalonia (Gómez-Olivencia et al., 2014). The richest site of the Iberian Peninsula in Reindeer remains is Kiputz IX (Castaños et al., 2012b) followed by Santa Catalina (Castaños, 2014) and Urtiaga (Altuna, 1972). Other sites with Reindeer presences in the Iberian Peninsula are Atxuri (Castaños, 1986), Lumentxa (Castaños, 1986), La Parte (Álvarez-Lao and García-García, 2006), Lezika (Castaños et al., 2009) or Bolinkoba (Castaños and Castaños, 2015), among others. This taxon can live in wide type of habits, from coastal zones to mountain areas, but in cool environments.

Family Bovidae GRAY, 1821
Genus *Bison* SMITH, 1827
Bison priscus BOJANUS, 1827 Steppe Bison
Bison priscus* cf. *mediator HILZHEIMER, 1918

Recovered material

- Artazu VII: 2 Atl., 1 Ax., 2 Cal., 3 Car., 1 CTa., 1 Fem., 1 Mall., 3 Man., 2 Pat., 2 Pel., 5 1st Pha., 2 2nd Pha., 1 3rd Pha., 2 Rad., 1 Rib., 2 Sac., 1 Tal., 1 Tib., 1 Uln., 10 lower Tth., 3 upper Tth. and 3 Ver.
- Artazu VIII: 27 Atl., 23 Axi., 51 Cal., 205 Car., 37 Cta., 139 Fem., 12 H. Cor., 104 Hum., 6 Hyo., 17 Mall., 66 Man., 24 Max., 62 Mtc., 40 Mtp., 60 Mtt., 24 Pat., 97 Pel., 157 1st Pha., 163 2nd Pha., 116 3rd Pha., 62 Rad., 631 Rib., 26 Sac., 54 Sca., 94 Ses., 34 Skll., 28 Str., 61 Tal., 97 Tib., 77 lower Tth., 89 upper Tth., 48 Uln. and 592 Ver.

Taxonomic determination

In order to distinguish between *Bison* and *Bos* genus, the criteria of Bivikova (1958), Stampfli (1963) and Brugal (1984–1985) have been followed:

- The 2nd and 3rd carpal in *Bos* have an almost quadrangular shape, while in *Bison* they are more rectangular. This trait is measured using an index: (max length/max width) × 100. Results above 90 are typical of *Bison* and below that of *Bos*. The specimens of Artazu VII and Artazu VIII samples have an index of 96.7. In addition, the middle crest of the proximal face in the carpal are straight with a breakthrough and the antero-internal edge are less rounded than in *Bos*. These are typical features of *Bison*, too. Furrow planting is also used to distinguish them, because the talus is oblique in *Bison* and has a right angle in *Bos*. The specimen in these samples display an intermediate position, so all postcranial remains from both sites have been attributed to *Bison*.

- The scapula has an elliptical contour and lack concavity in the lateral upper edge in *Bos.* Moreover, the *tuber scapulae* (supraglenoid + coracoid process) that constitute the insertion of brachial biceps muscle, forms a set that does not incline towards the medial face as in *Bos*.

- The humerus in *Bison* has the lateral lip of the trochlea pronounced in cranial view. In addition, in caudal view, the oleocranian fossa has an ogival contour and the epitrochlea does not extend distally.

- In the proximal epiphyses of the radio-ulna in *Bos*, the connection surface to the ulna presents a deep incision. The anterior edge is quite sinuous and the anterodistal crests are well marked. Moreover, the articular facet for the scaphoid presents convergent edges.

- The metacarpal presents the typical features in the distal end of *Bison*, like subparallel profil between distal condyles and tubercles.

- The femur of aurochs has the trochlea lips converged without observation

Among *Bison* genus, the m3 is the best diagnostic element to distinguish Steppe bison from Aurochs. Due to the lack of this element, other postcranial bones have been used to differentiate between *Bison* three subspecies and the remains recovered at Artazu VII have been attributed to females of *Bison priscus* cf. *mediator* as the most reasonable option (Chapter 6).

Habitat and geographical distribution

The steppe bison has been recorded in numerous Late Pleistocene sites in the Cantabrian region; Lezetxiki (Altuna, 1972), Lezika (Castaños et al., 2009) or Kiputz IX (Castaños et al., 2012a) or Bolinkoba (Castaños and Castaños, 2015), among others. In general, the knowledge of the Steppe bison palaeoecology is scarce due to is an extinct species. However, it is though that it preferred open areas, or, at least, an area with open spaces in the proximity.

Bison priscus conteined three subspecies in Eurasia (Flerow, 1976). *Bison priscus gigas* is the largest Eurasian bison and lived in the first half of the middle

Pleistocene. From tip to tip, horn-core spread reaches 2 m. The geographical area extends from South Siberia and East Europe to the Volga (Flerow, 1979). *Bison priscus priscus* lived in the second half of the middle Pleistocene and had a tip to tip horn-core spread of between 0.9 and 1.36 meters. This species was distributed from West Europe to Yenisei River in the east and Kazakhstan in the south. *Bison priscus mediator* was present in the late Pleistocene, being the smallest subspecies. This taxon had more curved horn-cores than the rest and a tip to tip spread of under 0.9 m, with the same geographical distribution (Vercoutère and Guérin, 2010). Even so, it should be noted that some authors differ in the chronological boundaries of the latter two subspecies (Brugal, 1984–1985).

Genus *Capra* LINNAEUS, 1758

Capra pyrenaica SCHINZ, 1838 Wild Goat

Recovered material

- Artazu VIII: 1 Cal., 2 Fem., 2 Pel., 31 Rib., 1 Sac., 1 Skll., 1 Tal., 1 Tib. and 11 Ver.

Taxonomic determination

Although *Rupicapra* and *Capra* genus have similarities in their osteology, some differences exist. Here the most diagnostic features of the remains of *C. pyrenaica*.

- The m3 length increases gradually toward the base.

- The *Capra* scapula is wider and less elongated with deep and irregular glenoid cavity.

- Metatarsals and metacarpals are less elongated and narrower in *Capra* than in *Rupicapra*.

Habitat and geographical distribution

Although the Wild Goat has historically occurred throughout the Iberian Peninsula it is currently extinct in the northern part of its range (Grubb, 2005). According to Pérez et al. (2002) *C. pyrenaica* is now an endemic species of the Iberian Peninsula. Thus, this species have been recovered in numerous sites in the northern Iberian Peninsula. Here two examples of the Late Pleistocene: Santimamiñe (Castaños and Castaños, 2011) and Bolinkoba (Castaños and Castaños, 2015). *Capra pyrenaica* inhabits in rocky areas from sea level to 3,400 m altitude (Palomo et al., 2007).

Genus *Rupicapra* BLAINVILLE, 1846

Rupicapra pyrenaica BONAPARTE, 1845 Pyrenean Chamois

Recovered material

- Artazu VII: 8 Atl., 3 Axi., 12 Cal., 24 Car., 10 Cta., 46 Fem., 4 H. Cor., 43 Hum., 1 Mall., 14 Man., 2 Max., 17 Mtc., 3 Mtp., 35 Mtt., 10 Pat., 34 Pel., 53 1st Pha., 50 2nd Pha., 27 3rd Pha., 26 Rad., 71 Rib., 2 Sac., 23 Sca., 2 Skll., 9 Tal., 34 Tib., 1 Str., 16 Uln., 17 lower Tth., 19 upper Tth. and 112 Ver.

- Artazu VIII: 2 Fem., 1 Mtc., 1 Pat., 1 Rad. and 2 Tib.

Taxonomic determination

Here the most diagnostic features of *Rupicapra* remains:

- The m3 of *Rupicapra* are characteristic since the maximum length of the tooth is in the middle of the crown and declines slightly towards the base. In addition, a wall with a metastyle and parastyle and an oval talonid is present (Prat, 2003).

- The scapula is more narrow and elongated than in *Capra* and has a deep and regular glenoid cavity with a thick coracoid process and square tuberosity.

- The medial edge of the proximal articulation of the radius is less outgoing and more angular than in *Capra*.

- The ulna back slot is angular, narrow and shallow, but from the distal articulation to the semi-lunal external condyle, it is less depressed than in wild goat.

- Chamois metacarpals are more elongated and narrower than in *Capra*, but the diaphysis is thicker. Anterior metacarpal extensor muscle has a prominent tuberosity for the proximal articulation. However, in Chamois, the proximal metacarpal thickness is proportionally greater than in wild goat. Moreover, and contrary to the situation in *Capra*, in *Rupicapra* the external articular surface is a little larger, and the section that separates two articular surfaces goes into the bone. Besides, articular pulleys in the distal articulation are narrow and parallel whereas in wild goat, pulleys converge towards the end.

- The calcaneus of Chamois samples are, in general, more slender and graceful than in *Capra*. The distal tuberosity is well separated from the bone body. Malleolus surface is more narrow and elongated in wild goat than in chamois and presents a transverse depression that divides it into two parts.

- Metatarsals, the same as metacarpals, are more elongated and slender in *Capra* than in *Rupicapra*. Moreover, chamois metatarsals have a small surface for the cuboscaphoid and are less prominent than in wild goats.

Finally the chamois morphological compared study has been completed using metric data from 16 Late Pleistocene sites in the Cantabrian Range (See Chapter 6).

Habitat and geographical distribution

The *R. pyrenaica* is a small-sized mountain Chamois that currently is present in Europe, in Italy and in the Iberian Peninsula (Pérez et al., 2002). Nevertheless, the Wild Goat has historically occurred throughout the Iberian Peninsula and southwest France (Grubb, 2005). This species has been recovered in numerous sites in the northern Iberian Peninsula. Here some examples of the Late Pleistocene sites: Bolinkoba (Castaños and Castaños, 2015) or El Castillo (Castaños, J, 2017).

Rupicapra pyrenaica is present in meadows and forested valleys in mountainous region, normally above 1,800 m.

5.2. Amphibians

Class AMPHIBIA LINNAEUS, 1758
Order CAUDATA SCOPOLI, 1777
Family Salamandridae GOLDFUSS, 1820
Genus *Salamandra* LAURENTI, 1768
Salamandra salamandra (LINNAEUS, 1758) Fire Salamander

Recovered material

- **Artazu VII:** 3 Cr., 2 Hum., 22 Tver. and 10 Ver.

Taxonomic determination

The trunk vertebrae of the salamanders are opisthocoelous, with the neural arch flattened postero-ventrally. The neurospinous, which is well defined in the front, is low and elongated, without reaching the posterior end of the neural arch. The parapophyse and the diapophyse are robust and cylindrical, being joined by a bone plate along all or almost all its extension (Bailon, 1991).

Habitat and geographical distribution

This species has been mentioned in some sites during the Late Pleistocene throughout the Cantabrian region, such as Cueva de las Hienas and Cueva

Oscura (Sanchiz, 1977) and Valdavara-1 (López-García et al., 2011b), among others. The common fire salamander is a terrestrial species that is associated with wet and cool deciduous, mixed, or rarely, coniferous forests with small rivers (IUCN, 2018). It is a mountain species that mainly inhabits in medium or high mountain massifs, from sea level up to 2,500 m in the Sistema Central (Pleguezuelos et al., 2002).Currently, in the Iberian Peninsula, it is present in the north.

Genus *Triturus* RAFINESQUE, 1815
Triturus **sp.** Newt

Recovered material

- Artazu VII: 8 Tver. and 1 Ver.

Taxonomic determination

Trunk vertebrae can be assigned to *Triturus* genus based on the combination of opisthocoelous condition (Bailon, 1991), presence of wide subcentral foramina, of a foramen placed near the base of the parapophyses and of a notch in the middle of the posterior margin of the neural arch.

The classification of *Triturus* genus has been the subject of controversy and it has been divided into other genura such as *Triturus* Rafinesque, 1815, *Lissotriton* Bell, 1839 and *Mesotriton* Bolkay, 1927. However, in this thesis it was opted to denominate *Triturus* genus (*sensu lato*).

Habitat and geographical distribution

This fossiliferous taxon is not very common in the Iberian Peninsula, where it was found for the first time in the Middle Pleistocene of Atapuerca (Sanchiz, 1987). Even so, it has been recorded in Laminak II (as *T. helveticus* Razoumowsky, 1789; Sanchiz and Esteban, 1994) and Antoliña (as *Triturus* sp.; Rofes et al., 2015). The newt are terrestrial species that could live in coniferous, mixed and deciduous forests and uses small freshwater ponds to develop in as larvae and return to it each year for breeding (IUCN, 2018). Nowadays *Triturus* genus is found in the Eurasia and in Iberian Peninsula only in the northern and western fringe.

Order ANURA RAFINESQUE, 1815
Family Alytidae FITZINGER, 1843
Genus *Alytes* WAGLER, 1829
Alytes obstreticans (LAURENTI, 1768) Midwife Toad

Recovered material

- Artazu VII: 1 Cla., 2 Dver., 1 Hum. and 1 Ili.

Taxonomic determination

The most diagnostic skeletal remain is the ilium, due to its straight and long pars ascendens. The ischial process is well developed with an upper tuberosity, which sits over a large part of the acetabularia cavity (Felix and Montori, 1986). In addition and according to Bailon (1991), the angle formed by the ventral border of the frontal branch and the front limit of the pars descendens exceeds 90°.

Habitat and geographical distribution

Alytes obstreticans's first record in the Iberian Peninsula is in the Lower Pleistocene from Sima del Elefante (Blain et al., 2010). In the northern Iberian Peninsula it has been identified in Cova Rosa (Sanchiz, 1977), Lamiak II (Sanchiz and Esteban, 1994), Cova Colomera (Blain et al., 2016), Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) and Praileaitz I (as *A.* cf. *obstreticans*; Garcia-Ibaibarriaga et al., 2018b), among others. Nowadays in the Iberian Peninsula four *A. obstreticans* subspecies (*A. o. obstreticans*, *A. o. almogavanii, A. o. boscai* and *A. o. pertinax*) exist. Specifically, the Midwife Toad is distributed throughout all the Iberian Peninsula, with the exception of the western and central parts of (Pleguezuelos et al., 2002). It prefers areas with high rainfall but it adapts quickly to environmental changes.

Genus *Discoglossus* WAGLER, 1829

***Discoglossus* sp.** Frog

Recovered material

- Artazu VII: 2 Dver. and 2 Uro.

Taxonomic determination

The anterior and two posterior condyles of the vertebra allow the adscription to *Discoglossus* (Bailon, 1999). However, this attribution should be taken with caution, and it is only made at the genus level.

Habitat and geographical distribution

Discoglossus genus has been present since the Lower Miocene in the Iberian Peninsula (Sanchiz, 1998). However, its presence is not very common during the Late Pleistocene, being Sima del Elefante (Atapuerca, Burgos) (Blain et al., 2011) one of the few sites with remains. The presence of *Discoglossus* sp. is related to the existence of a small river or a permanent water body in the vicinity.

Family Bufonidae LAURENTI, 1768
Genus *Bufo* LAURENTI, 1768
Bufo bufo (LINNAEUS, 1758) Common Toad

Recovered material

- Artazu VII: 19 Ang. indet., 9 Atl., 35 Cor., 22 Cla., 45 Dver., 17 Fem., 6 Frp., 58 Hum., 42 Ili., 2 Max., 1 Par., 6 Prs., 9 Ptr., 34 Rad.-Uln., 44 Sca., 16 Spm., 18 Sqm., 3 Ssca., 32 Tib.-Fib., 30 Uros., 35 Sver. and 65 Ver.

Taxonomic determination

The humerus, ilium, and scapula are the most diagnostic skeletal remains of *B. bufo*:

- The humerus has a crest and epicondyle, which is moderately developed and the condyle distally displaced (Bailon, 1999).

- The ilium is characterized by the lack of crista dorsalis and by the tuberosity of the lobule, which is well developed (Felix and Montori, 1986).

- The scapula is elongated and has a sinuous edge (Bailon, 1999). Moreover, the glenoid apophysis is well marked, and the supraglenoid fossa is not present.

- The femur is relatively long, strongly-built and sigmoidal in shape, with a crista femoris (Bailon, 1999).

Habitat and geographical distribution

This specie is known has been present since the Lower Pliocene, being well recorded in the northern Iberian Peninsula in some Late Pleistocene sites like Ekain (Sanchiz, 1984), Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) and Praileaitz I (as *A.* cf. *obstreticans*; Garcia-Ibaibarriaga et al., 2018b). At present, the Common toad is distributed throughout all the Iberian Peninsula, being able to live at any altitude, from the level sea to 2,600 m (Pleguezuelos et al., 2002). It prefers fresh wooded areas, although it can occupy all type of biotopes.

Family Hylidae RAFINESQUE, 1815
Genus *Hyla* LAURENTI, 1768
Hyla arborea LINNAEUS, 1758 European Tree Frog

Recovered material

- Artazu VII: 1 left Rad., 1 left Sca., 1 Tib.-Fib. and 2 Ver.

Taxonomic determination

The best skeletal remains for the identification of this taxon are the ilium and the scapula:

- The ilium allows a clear assignment at genus level since its morphology is elongated and slender and has a well separated glenoid process (Blain et al., 2010).

- The scapula is thin and elongated, much taller than a wide and with a detached glenoid process (Blain et al., 2010).

Habitat and geographical distribution

The European Tree Frog is knowns to have been present in the Iberian Peninsula since the Middle Pleistocene at Ambrosio, Aridos-1 and Gran Dolina (Blain et al., 2010).

It is currently widespread throughout all the Iberian Peninsula, but it is absent from large areas in the south of the Iberian Peninsula (Pleguezuelos et al., 2002). It can commonly be found near rivers, ponds with abundant aquatic vegetation, marshland and still waters. In addition, *H. arborea* prefers open wet meadows or woodland areas.

Family Ranidae RAFINESQUE, 1814
Genus *Rana* LINNAEUS, 1758
Rana temporaria-iberica LINNAEUS, 1758
European Common Frog - BOULANGER, 1879
Iberian Frog

Recovered material

- Artazu VII: 16 Ang. indet., 5 Atl., 23 Sac., 14 Cla., 32 Cor., 51 Dver., 33 Fem., 17 Frp., 52 Hum., 65 Ili., 70 Max., 3 Par., 2 Pr-ex., 12 Prmx., 2 Prs., 5 Ptr., 36 Rad.-Uln., 38 Sca., 20 Spm., 8 Sqm., 54 Tib.-Fib., 23 Uro. and 85 Ver.

Taxonomic determination

The postcranial elements, such as ilium, humerus, coracoid, or the scapula, allow the identification of the Rana genus. Following the metric analysis method of the ilium proposed by Esteban and Sanchiz (1985) it is possible to attribute the specie. Nevertheless, due to the state of preservation of the remains it was not possible. Thus, in this thesis it has been decided to study them as a group named

R. temporaria-iberica. The most characteristic skeletal elements for the identification of this group are described below.

- The ilium is characterized by the absence of the interiliac tuberosity and by a dorsal wing known as “crista dorsalis” (Bailon, 1999).

- The coracoid has a thick anterior end, flattened and a stretched posterior end with a robust neck (Bailon, 1999).

- The humerus is composed by the right diaphysis in ventral view which does not have a paraventral crest and a condyle that is located in the prolongation of the diaphysis axis (Bailon, 1999). Moreover, the humerus has a relatively thin shaft morphology. In the case of male individuals, the humerus has a mesial crest on the posteroventral surface and a curved shape.

- The scapula is higher than broad and is characterized by a glenoid process (Rage, 1974; Bailon 1999). In ventral view, on the glenoid process a long internal crest continues through the bone plate.

Habitat and geographical distribution

Rana temporaria-iberica has been present in the Iberian Peninsula at least since the Late Pleistocene. Thus, in the northern Iberian Peninsula it has been recorded in Cova Rosa (as *R. temporaria* and *R. iberica*; Sanchiz, 1977); Ekain (as *R. temporaria* and *Rana* sp.; Sanchiz, 1984), Erralla (as *R. temporaria*; Esteban and Sanchiz, 1985) and Lezetxiki II (as *R. temporaria-iberica*; Garcia-Ibaibarriaga et al., 2018a).

At present, the group inhabits from close to sea level up to 2,400 m. Moreover, this group is an aquatic taxon, which needs cold flowing water and abundant vegetation (Pleguezuelos et al., 2002).

5.3. Reptiles

Class REPTILIA LAURENTI, 1798
Order SQUAMATA OPPEL, 1811
Family Lacertidae OPPEL, 1811 Lizard
Lacertidae indet.

Recovered material

- Artazu VII: 29 Atl., 26 Axi., 257 Caver., 366 Caver+r., 223 Cever., 783 Dver., 31 Fro., 40 Max., 201 Man., 2 Par., 22 Prmx., 239 Psver., 9 Scag., 43 Sver. and 717 Tver.

Taxonomic determination

All the fossil skeletal elements attributed to lacertids are characteristic of this family. The dental elements recovered are pleurodont, isodontes, cylindrical and with one, two or three cusps. In addition, the Meckl's fossa is widely opened in the dentary. Regarding vertebrae, they are procoelous, with cylindrical and short vertebral body. They have a prominent and thin carenee, while the neural spine is relatively high (Bailon, 1991).

Habitat and geographical distribution

Thre are four Lacertidae species that live in the Basque Country: *L. bilineata*, *L. lepida*, *L. schreiberi* and *L. vivipara* (Álvarez et al., 1985). This four species have different, and in some cases opposite, ecological requirements, so these remains are excluded from the palaeoenvironmental and palaeoclimatic reconstruction.

Family Anguidae OPPEL, 1811
Genus *Anguis* LINNAEUS, 1758
Anguis fragilis LINNAEUS, 1758 Slow Worm

Recovered material

- Artazu VII: 2 Axi., 71 Caver., 85 Caver+r., 4 Cever., 6 Man., 5 Max., 2898 Ost., 9 Prmx., 1 Ptr., 4 Sver., and 248 Tver.

Taxonomic determination

The general morphology of the maxilla (especially teeth shape) and the osteoderms dermic ornamentation are the best criteria to attribute our fossil material to a species.

- The maxilla has a hooked shape and reduced number of sub-pleurodont teeth that are well separated from each other.

- The osteoderms are very characteristic as they do not have carenee (Hoffstetter, 1962).

- The dorsal vertebrae are fundamentally characterized by their small size, which is less than 3 mm in length, and by its elongated shape with a flattened posterior condyle and anterior acetabulum (Bailon, 1999). In lateral view the neuro-spine is long and relatively high. The articular surfaces of the pre- and post-zygapophyses are oval, moderately directed forward and inclined upwards. In ventral view, the center has a flat ventral surface and the lateral foramen is small and is located on the anterior half of the vertebrae (Bailon, 1999).

- The caudal vertebrae are longer in comparison to the dorsal vertebrae.

Moreover, they have the hemapophyses joined to the center on its posterior half and the transverse processes well developed and flattened (Bailon, 1999).

Habitat and geographical distribution

Anguis fragilis has been present since the Lower Pleistocene (Blain et al., 2009), being recorded in numerous Late Pleistocene sites in the Cantabrian range: Cueva del Conde (López-García et al., 2011a), Santimamiñe (Rofes et al., 2014), Askondo (Garcia-Ibaibarriaga et al., 2015a) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) among others.

The Slow Worm is a Euroasian species that has a wide geographical distribution in Europe, with the exception of Scandinavia and the south of Spain. In the Iberian Peninsula the geographic limit is marked by the Ebro Valley, not being present from there to the south (Barbadillo and Sánchez-Herráiz, 1997). Nowadays it is present in some islands in the Cantabrian region, such as Santa Clara in Gipuzkoa or Pantorga in Asturias (Mateo, 1997; Galán, 1999). In the northern Iberian Peninsula it lives from sea level to 1,800 m altitude. It has a nocturnal habit and its presence is related to relatively high environmental dampness. It generally inhabits high vegetation cover, in the edges or treeless regions in forests but also grasslands and open areas. Thus, it occupies mainly deciduous forests, shrublands, and grasslands, being a semi-underground species (Pleguezuelos et al., 2002).

Family Colubridae OPPEL, 1811
Genus *Coronella* LAURENTI, 1768
Coronella girondica (DAUDIN, 1803) Southern Smooth Snake

Recovered material

- **Artazu VII:** 176 Tver.

Taxonomic determination

The most diagnostic skeletal remains of *C. girondica* are the vertebrae: the dorsal vertebrae of adult individuals, which have a pronounced precondylar constriction and a long prezygapophysis process (Bailon, 1999).

Habitat and geographical distribution

The first mention of this taxon in the Iberian Peninsula comes from the Medes Islands (Bailon, 1991), dated in the Late Pliocene. In the Iberian Peninsula there are some records in Late Pleistocene sites: Atapuerca complex (Blain et al., 2008, 2010), Santa Catalina (Bailon and Garcia-Ibaibarriaga, 2014) and Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a), among others.

This species is currently distributed throughout the Iberian Peninsula, except in a large part of the Cantabrian coast and in very high and cold areas (Blain et al., 2009). It is a ubiquitous species, so it can live in many biotopes like open woodlands, dry hedgerows, grassland, rocky areas, forests with a preference for areas covered by trees or scrubland that are sunny and stony (Salvador, 1998; Blain et al., 2009).

Family Viperidae OPPEL, 1811
Genus *Vipera* LAURENTI, 1768
***Vipera* sp.** Viper

Recovered material

- Artazu VII: 19 Caver., 5 Cever. and 426 Tver.

Taxonomic determination

The dorsal vertebrae show the typical characteristic of *Vipera* genus due to the presence of a straight hypapophysis, and a flattened dorso-ventrally neural arch with a convex center (in cross- section). They also have a well developed condyle and acetabulum, and the zygapophyses articular surface is inclined dorsally. The species belonging to this genus are extremely difficult to distinguish and in some cases impossible, so in this thesis we opted to classify as *Vipera* sp. (Szyndlar, 1991).

Habitat and geographical distribution

Due to the difficulties for identification, this taxon is commonly identified as *Vipera* sp. in the Late Pleistocene sites of the Cantabrian region: Cueva del Conde (López-García et al., 2011a), Valdavara-1 (López-García et al., 2011b) or Santimamiñe (Rofes et al., 2014) among others. They have different and in some cases opposite ecological requirements, so these remains are excluded from the palaeoenvironmental and palaeoclimatic reconstruction.

5.4. Birds

Class AVE LINNAEUS, 1758
Orden GALLIFORMES TEMMINK, 1820
Family Phaisanidae HORSFIELD, 1821
Genus *Perdix* BRISSON, 1760
Perdix perdix LINNAEUS, 1758 Grey Partridge

Recovered material

- Artazu VII: 1 Cmp., 1 dist. Cmp., 3 Cor., 2 prox. Hum., 1 Sca., 1 prox. Sca., 1 prox. St., 1 Phm., 1 Tbt., 1 prox. Uln. and 1 Tmt.

Taxonomic determination

The bones of the Grey Partridge differs from the genera *Alectoris* and the determination of *P. perdix* has been carried out using the reference collection of current specimens and following Kraft (1972).

Habitat and geographical distribution

The Grey Partridge is natural to the Eurosiberian region today. This terrestrial bird inhabits steppe zones in continental lowlands and temperate latitudes. At nesting time, it moves to higher or dense cover. Nevertheless, it also lives in continental lands, in swamps and marsh areas if they are dried, or on coastlines, in forests and lake or river margins if the water masses alternate with open areas. It was a common taxon in the western Palearctic during the last glacial period (Tyrberg, 1991).

Genus *Coturnix* GARSAULT, 1764

Coturnix coturnix (LINNAEUS, 1758) Common Quail

Recovered material

- Artazu VII: 3 Cmp., 2 Cor., 1 prox. Cor., 4 Fem., 1 dist. Fem., 2 prox. Fem., 4 Hum., 2 prox. Hum., 2 Rad., 3 Sca., 2 prox. Sca., 2 prox. Str., 2 dist. Tbt., 2 dist. Tmt. and 4 Uln.

Taxonomic determination

The morphology of these fragments corresponds to the shape of phasianids and not to tetraonids, pointing to *C. coturnix*. In the cases when complete bones or non-fragmented parts without dissolution marks were available, the measurements of common quail were taken following the Jaume et al. (1992) methodology.

Habitat and geographical distribution

The Common Quail is a gregarious bird that inhabits middle continental latitudes in warmer seasons and, occasionally, in the western Palearctic up to 1000 m altitudes. It can live in a wide range of temperatures avoiding extremes of heat or cold. Moreover, it prefers open and flat areas without trees and bushes and lives on the ground. The oldest remains from the Iberian Peninsula come from the Quibas site (Montoya et al., 2001), but the first record of the Common quail comes from the Italian early Pliocene site of Gargano (Ballmann, 1976).

Genus *Lyrurus* LINNAEUS, 1758

Lyrurus tetrix (LINNAEUS, 1758) Black Grouse

Recovered material

- Artazu VII: 6 Cmp., 1 dist. Cmp., 1 prox. Cmp., 2 Cor., 3 med. Cor., 1 dist. Cor., 1 Cr., 2 dist. Fem., 3 prox. Fem., 1 Fur., 9 Hum., 1 dist. Hum., 1 prox. Hum., 2 prox. Pel., 1 Mand., 3 Phm., 4 Prm., 2 Pyg., 2 Qut., 2 Rad., 1 dist. Rad., 2 prox. Rad., 4 prox. Sca., 1 prox. Str., 4 Tmt., 2 dist. Tmt., 1 prox. Tmt., 9 dist. Tbt., 3 prox. Tbt., 3 Uln., 1 dist. Uln. and 1 prox. Uln.

Taxonomic determination

These remains correspond to *Lyrurus tetrix,* and measurements have been taken following the methodology of Erbersdobler (1968) (See Chapters 3 and 6).

Habitat and geographical distribution

The Black grouse lives in middle to high latitudes, mainly in boreal, subarctic, and arctic-alpine zones in a great variety of habitat types. It inhabits between woodland and open habitats such as moorland, scrub, steppe and meadows, but these habitat preferences depend on the season (Baines, 1994). Usually it resides in lowlands farther north but it can survive in glacial relicts in mid-latitude mountains such as the Alps up to 2500 m (Glutz von Blotzheim et al., 1973). It is not currently present in the Iberian Peninsula. Nevertheless it is recorded in the Iberian Peninsula, but only in Pleistocene and Holocene sites (SEO, 2004) and the Pyrenees area (Clot and Mourer-Chauviré, 1986). It has been recovered in Cueva de Valdegoba (Burgos) (Sánchez-Marco, 2005), among other sites.

Genus *Alectoris* KAUP, 1829

***Alectoris* sp.** Partridges

Recovered material

- Artazu VII: 1 prox. Uln.

Taxonomic determination

The genus *Alectoris* is represented by four species in the western Palearctic: *A. rufa, A. barbara, A. chukar* and *A. graeca*. They are almost indistinguishable osteologically and, in Artazu VII, only one remain has been found, so, unfortunately, it has not been possible to identify it at species level.

Habitat and geographical distribution

Alectoris rufa is found in diverse climatic areas in the southwest of the Palearctic, preferring lowland to mountain areas. However, it prefers dry and sunny climates where there is low or open vegetation with clear surfaces, such as rocks or trackways. In mountain regions, in the south of the Palearctic region, it can be found at 2,000 m whereas in the north it can be much lower on plains and frequently down to sea level. *Alectoris graeca* inhabits middle latitudes, preferring warm-temperate climates. Like *A. rufa*, it prefers sunny areas with low humidity, but can tolerate cold temperatures. However, *A. graeca* fundamentally resides in dry and rocky mountains like the tree line and snowline avoiding closed forest. It prefers low vegetation like heaths, pastures, grassy patches and low scrub, but also stony ground and rocky escarpments or crags. It is rarely found below 900 m and mostly between 1200 m and 1,500 m, with extreme breeding altitude of 2,700 m in Italy (Glutz von Blotzheim et al., 1973). Even so, it needs access to drinking water within the limited foraging area. Alectoris chukar habitats in rocky open hillsides with grass or scattered scrub, from low altitudes (400 m) to high altitudes (4,000 m). Finally, *A. Barbara* is found in predominantly dry and open area with scrubby cover. In addition, it uses steep slopes, rocky areas and arid hillsides (IUCN, 2018).

Order GRUIFORMES BONAPARTE, 1854
Family Rallidae VIGORS, 1825
Genus Crex BECHSTEIN, 1803
Crex crex LINNAEUS, 1758 Corn Crake

Recovered material

- **Artazu VII:** 1 Cmp., 2 dist. Cmp., 1 Hum., 1 prox. Hum. and 1 prox. Uln.

Taxonomic determination

The shape of these skeletal remains clearly corresponds to Rallidae. In most of the cases it has been possible to determine the remains at genus and species level using the reference collection of current individuals. However, sometimes it has been impossible to distinguish between *C. crex* and *Rallus aquaticus*.

Habitat and geographical distribution

The Corncrake inhabits middle latitudes in both continental and oceanic areas, from boreal to temperate steppe and seldom in Mediterranean zones. It mainly resides in lowlands but it can live in other altitudes, such as 1400 m in the Alps (Glutz von Blotzheim et al., 1973) and up to 3000 m in the former USSR (Dembntiev et al., 1951-1954). It prefers cool and humid short grass, avoiding standing water, swamps, and lake or river margins, open and rocky zones forests with small trees or bushes. Its record is unusual in fossiliferous sites, but in the Iberian Peninsula there is evidence of C. crex in El Castillo (Santander) (Cabrera, 1984).

Order STRIGIFORMES WAGLER, 1830
Family Strigidae VIGORS, 1825
Genus *Bubo* DUMÉRIL, 1806
Bubo* cf. *bubo LINNAEUS, 1758 Eurasian Eagle-Owl

Recovered material

- **Artazu VII:** 1 Cor., 1 prox. Cor. and 1 prox. Pel.

Taxonomic determination

Although the shape and size of the remains recovered at Artazu VII correspond to the *Bubo* genus, they were not enough to assign to species level. However, the features of these remains point to *B. bubo*.

Habitat and geographical distribution

The Eurasian Eagle-Owl resides in much of Eurasia in Mediterranean zones. This taxon is a nocturnal predator that hunts mostly small vertebrates and other birds, so it needs hunting areas inhabited by enough prey. It usually shares space with large prey, together with sites for secure nesting. Generally, hunting zones take place within the forest, but they prefer open or sparsely wooded areas, as well as floodplains. Those zones are mostly steppe and rocky with detritus or broken ground, or sites of rock falls just beneath the tree line where they breed in hollow trees, cliff ledges, gullies, among rocks or in other concealed locations. This taxon appears in numerous fossiliferous deposits in the Iberian Peninsula: El Castillo (Cabrera, 1984), Gran Dolina (Fernández-Jalvo, 1995), and Tossal de la Roca (Sánchez- Marco, 2007). As a curiosity, an osseous pathology has been observed in the distal part of one coracoideum.

Order Accipitriformes VEILLOT, 1816
Family Accipitridae VEILLOT, 1816
Genus *Aquila* BRISSON 1760
***Aquila* sp**. 1760 True eagles
Aquila chrysaetos LINNAEUS, 1758 Golden Eagle

Recovered material

- **Artazu VII:** 1 Cor. and 1 dist. Cor.

Genus *Haliaeetus* SAVIGNY 1809
Haliaeetus albicilla (LINNAEUS, 1758) Grey Sea Eagle

Recovered material

- **Artazu VII:** 2 prox. Sca., 1 dist. Fem. and 1 dist. Tbt.

Taxonomic determination

Aquila and *Haliaeetus* genera are very similar in size and morphology and the individuals in the reference collection were not sufficiently informative for their comparison. As a consequence, it was not possible to distinguish between the samples from Artazu VII, with the exception of coracoideums. Thus, in *Aquila*, the shape of the end of processus acrocoracoideus is diagnostic, as well as the shaft and the cotyla scapularis. Concretely, the shaft is thinner in *Aquil*a than in *Haliaeetus*, whereas the cotyla scapularis is larger in the former.

Genus Buteo LACEPEDE 1799

Buteo lagopus (PONTOPPIDAN, 1763) Rough-legged Buzzard

Recovered material

- Artazu VII: 1 Cor. and 1 Mand.

Buteo* cf. *lagopus (PONTOPPIDAN, 1763) Rough-legged Buzzard

Recovered material

- Artazu VIII: 1 prox.Tmt.

Taxonomic determination

Measurements of the recovered remains have been compared to those of modern *B. lagopus*, *B. rufinus* and *B. buteo* (See Chapter 6). Therefore, comparing morphology, shape and biometry of the Artazu VII remains with those in the reference collection and the data in the literature, we attribute these bones from Artazu VII to *B. lagopus* and the bone from Artazu VIII to *B.* cf. *lagopus.*

Habitat and geographical distribution

Buteo lagopus is not a common bird in the Iberian Peninsula since it has only been observed occasionally, as a winter visitor. Its presence in the Pleistocene in lower latitudes was also unusual. Thereby *B. lagopus* remains in the Iberian Peninsula only has been found in the Late Pleistocene (MIS 5) site of Valdegoba (Burgos), with a single remain of one left femur (Sánchez-Marco 2004, 2005).

Nowadays *B. lagopus* is only present in cool biotopes, in the northern hemisphere in high altitudes (900–1,200 m or higher) in Asia, North America and the Scandinavian Peninsula, Finland and northern Russia, since it extends to Asia and occupies Siberia. The Rough-legged Buzzard breeds in high altitudes in the Artic and subarctic areas, such as Norwegian fjords (Glutz von Blotzheim et al., 1971). Nevertheless, in cold seasons it descends to relatively warmer spaces. It usually prefers low-lying, treeless and tundra areas with rocks, walls and crags, but in good hunting years it moves to wooded tundra and even taiga ecosystems, choosing open areas. Its diet consists mainly of small mammals, but it also includes a few birds.

Order PASSERIFORMES LINNAEUS, 1766

Family Corvidae VIGORS, 1825

The shape of *C. monedula*, *P. pica*, *P. graculus* and *P. pyrrhocorax* are clearly typical of corvids. However, due to their great similarity it has not been possible to assess to species level using the reference collection in all cases. For this reason, the Corvidae have been identified with morphologic and biometric criteria given by Tomek and Bochenski (2000).

Genus Pyrrhocorax TUNSTALL, 1771

Pyrrhocorax pyrrhocorax LINNAEUS, 1758 Red-billed Chough

Recovered Material

- Artazu VII: 12 Cmp., 4 Cor., 3 Hum., 10 Fem., 2 Pgm., 4 Tmt., 4 Tbt., 2 dist. Tbt., 5 Uln., 1 dist. Uln. and 3 prox. Uln.

- Artazu VIII: 2 Cmc., 1 prox. Hum. and 1 Pham.

Pyrrhocorax graculus (LINNAEUS, 1766) Yellow-billed Chough

Recovered material

- Artazu VII: 23 Cmp., 2 dist. Cmp., 2 prox. Cmp., 16 Cor., 2 dist. Cor., 1 prox. Cor., 5 Fem., 5 dist. Fem., 28 Hum., 4 dist. Hum., 2 Prm., 1 med. Prm., 8 Qut., 1 Sca., 7 Tbt., 18 Tmt., 10 dist. Tmt., 4 prox. Tmt., 10 Uln. and 1 dist. Uln.

- Artazu VIII: 2 Cmp., 4 Cor., 1 dist. Cor., 1 Fem., 1 Hum., 6 prox. Hum., 5 Mand., 2 Pe., 1 Pham., 2 Qut. and 1 prox. Uln.

Habitat and geographical distribution

The Yellow-billed Chough breeds in middle west latitudes in the Palearctic from southern Europe and North Africa to Central Asia. It lives in colonies mainly in cold climates and normally at very high altitudes in cracks and cliffs in mountainous regions, the near sea. In Switzerland it has been found at up to 3000 m and exceptionally as low as 563 m. It nests in hidden areas with lack of access, likes caves and fissures. This taxon is very common in Pleistocene sites in western Europe (Sánchez-Marco, 2004). In the Iberian Peninsula, has been recorded in Olha (Elorza, 1990), L´Arbreda (García, 1995), and Olopte (Sánchez-Marco, 2002) among others. On the contrary the Red billed-Chough lives, like *P.*

graculus, in middle latitudes from the western Palearctic in mountainous areas with steppe, but *P. pyrrhocorax* usually inhabits in lower areas. This taxon breeds in temperate climates, either on coastal cliffs or inland crags, but the nesting can vary according to latitudes, even nesting in caves next to a watercourse. It usually inhabits in low vegetation and moves, when the vegetation grows. Just like the yellow-billed chough, it is very common in Pleistocene sites in western Europe (Sánchez-Marco, 2004). Although in the Palearctic it breeds in temperate zones, in the Basque Country it usually breeds it in rocky mountains. In the Iberian Peninsula, has been recorded in Aitzbitarte IV and Urtiaga (Elorza, 1990), Ermittia (Elorza, 1993), Abauntz (Altuna et al., 2002), L'Arbreda (García, 2002) and Olopte (Sánchez-Marco, 2002), among others.

Genus *Corvus* LINNAEUS, 1758

Corvus monedula (LINNAEUS, 1758) Western Jackdaw

Recovered material

- Artazu VII: 2 Sca. and 1 dist. Sca.

Habitat and geographical distribution

The western jackdaw is present in Europe, western Asia and north of America in middle and upper middle latitudes, temperate areas, steppe Mediterranean lowlands, continental and oceanic areas. It tolerates unsettled climate, avoiding extremes of heat, snow or ice and breeds in tree spaces and rocky crevices next to cliffs that are near sea. Although nowadays *C. monedula* is expanding, it is not easy to find in archaeo-palaeontological sites. Some sites that have records of this taxon in the Iberian Peninsula are Urtiaga and Aitzbitarte IV (Elorza, 1990), Arbreda (García, 1995), Jarama (Sánchez-Marco, 2004), Las Higueruelas, where the oldest data of this taxon from the Iberian Peninsula was recorded (Sánchez-Marco, 2004) and Los Batanes (Núñez-Lahuerta et al., 2017).

Genus Pica BRISSON, 1760

Pica pica LINNAEUS, 1758 Eurasian Magpie

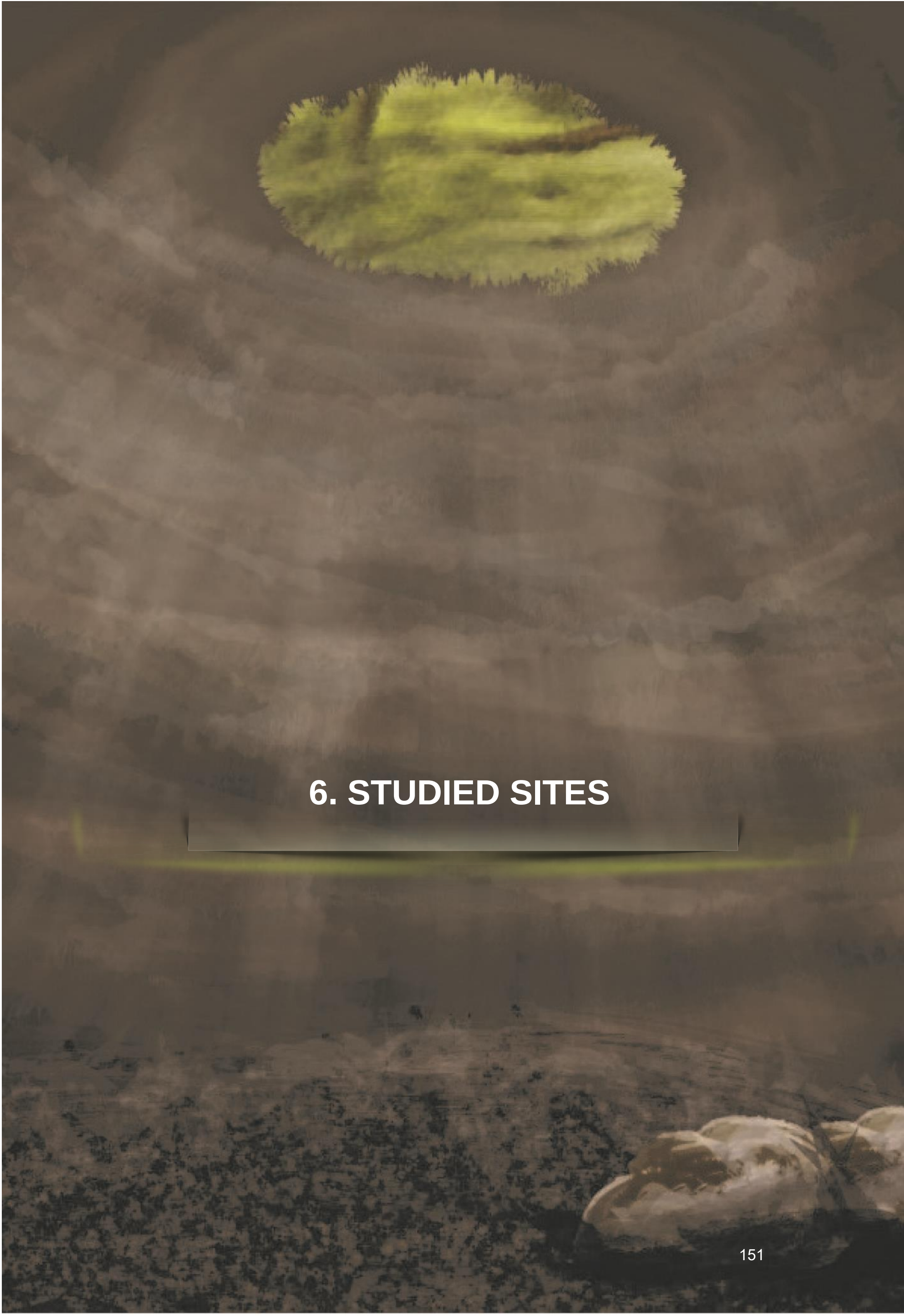
Recovered material

- Artazu VII: 2 Fem., 3 Mand., 1 Qut., and 1 Sca.

- **Artazu VIII:** 1 Fem.

Habitat and geographical distribution

The Common Magpie lives in high to middle continental and oceanic altitudes in the west of the Palearctic region. It inhabits from boreal taiga to temperate and steppe zones, avoiding very forested and treeless regions and rocky areas. It appears in many late Pleistocene sites in the Iberian Peninsula but in small numbers; Santimamiñe (Elorza, 1990), L´Arbreda (García, 1995), Tossal de la Roca and Cueva Victoria, with the oldest record of P. pica in the Iberian Peninsula (Sánchez-Marco, 2005).



6. STUDIED SITES

6. STUDIED SITES

The various karst systems along the upper Deba Valley have preserverd numerous Quaternary fills with palaeontological and archaeological records, corresponding two of them to Artazu VII and Artazu VIII palaeontological sites (Arrasate, Gipuzkoa, northern Iberian Peninsula). Concretely, both sites were developed in mount Artazu, located in Aptian/Albian (Cretaceous) limestones. These rocks are characterized by abundant rudists and corals, and form anticlinal and synclinal structures on a NW-SE line (Fig. 37) (EVE, 1995). In the vicinity, other fossiliferous localities have also been studied during the last decades. Thereby, the excavation and multidisciplinary study of some of these openings has enriched significantly the evidence of human presence and the information about the biocenosis and the palaeoecological conditions during the Pleistocene. In the area under study, the fossiliferous locality of Artazu II (placed 550 m to the north-east from Artazu VII in a straight line) has been interpreted, based on its lithic assemblage, as one of the oldest Palaeolithic deposit in Gipuzkoa, dated to 120-220 ka (Arrizabalaga and Iriarte, 2011). The nearby Lezetxiki complex, formed by the caves Lezetxiki and Lezetxiki II and located 180 m to the northwest in the straight line (Barandiaran, 1965; Altuna, 1972; Arrizabalaga et al., 2005), yielded the oldest human remains in the Basque Country and also the most recent *Macaca sylvanus* fossil in the northern Iberian Peninsula (Castaños et al., 2011), besides the record of some species (*Sicista betulina* and *Muscardinus avellanarius*) not found elsewhere in the Quaternary of the Iberian Peninsula (Rofes et al., 2012; Garcia-Ibaibarriaga et al., 2015c). Finally, Labeko Koba, which functioned as hyenas den, is located 5 km to the southeast in the straight line. Here, species as cave bear, horses, red deer and woolly rhinoceros were recovered (Altuna and Mariezkurrena, 2000; Arrizabalaga and Altuna, 2000).

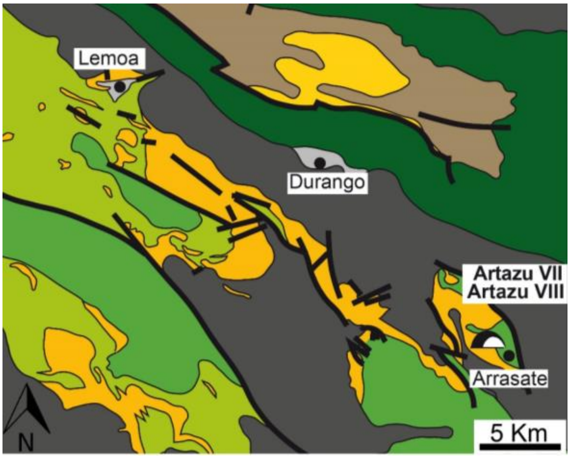


Figure 37. Geological situation of Artazu VII and Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula).

6.1. Artazu VII

The two selected samples for AAR dating gave a mean age value of 93 ka (98.4 ka and 88.5 ka), therefore Artazu VII site can be dated in the first half of the Late Pleistocene (Tab. 11) (Suárez-Bilbao et al., 2016). This site yielded a large number of remains of great taxonomical diversity, as regards the microfauna, macrofauna and avifauna. Consequently, each taxonomic group was analysed separately.

Site	Provenance	Lab Code	D/L Asp	Age (ka)	Sample
Artazu VII	LL-L	LEB-14069	0.114	88.5 ka	C of *Panthera pardus*
	LL-K	LEB-14070	0.125	98.4 ka	M1 of *Panthera pardus*

Table 11. Amino acid racemization ages from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula).Suárez-Bilbao et al. (2016).

A. Small vertebrates

- Small vertebrate assemblage

On account of the great volume of sediment and its richness in small bone remains, eight arbitrary spits spanning the whole stratigraphic sequence were selected from Lower Ledge (LL) and Chamber (C) deposit zones to their study. Thereby, some parts of the samples recovered at spits A, C, G, K and L from LL and 1, 3 and 5 from C, representing a total sediment volume of 55.25 l, were selected (Suárez-Bilbao et al., 2016, 2017a) (Fig. 13; Chapter 3). Samples from the UL were dismissed because of their scarcity of small skeletal remains.

Over 50,000 small vertebrate remains (identified and unidentified) consisting of isolated teeth, mandibles, maxillaries, post-cranial elements and fragmented bones were extracted. In fact, 9,644 remains (NISP) corresponding to a minimum number of individuals (MNI) of 732 were identified at the genus or the species level (Suárez-Bilbao et al., 2017a) (Tabs. 12-13). The microfaunal assemblage comprised 24 taxa corresponding to small mammals, amphibians and reptiles: six Arvicolinae [*Arvicola amphibius*, *Arvicola sapidus*, *Microtus (Microtus) agrestis*, *Microtus (Microtus) arvalis*, *Microtus (Terricola)* sp. and *Pliomys lenki*], one Murinae (*Apodemus sylvaticus-flavicollis*), one erinaceid (*Erinaceus europaeus*), three soricids [*Sorex (Sorex) araneus-coronatus*, *Sorex (Sorex) minutus* and *Neomys* sp.],one talpidae (*Talpa* sp.), one bat (Chiroptera indet.) (Fig. 38), two salamandrids (*Salamandra salamandra* and *Triturus* sp.), five ranids (*Alytes obstetricans*, *Discoglossus* sp., *Hyla arborea*, *Bufo bufo* and *Rana temporaria-iberica*), two saurians (Lacertidae indet.

	LL-A		LL-C		LL-G		LL-K		LL-L		C-1		C-3		C-5	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Arvicola amphibius	6	3			3	1			10	5	3	2	9	5	10	8
Arvicola sapidus	1	1	4	3	1	1			1	1						
Microtus (Microtus) agrestis	14	10	9	5	4	2	2	1	17	10	4	3	27	15	43	30
Microtus (Microtus) arvalis	13	8	7	5	1	1	1	1	1	1	2	1	3	2	29	2
Microtus (Terricola) sp.	6	3	6	5	7	3	9	7	11	8	3	2	12	7	19	15
Apodemus sylvaticus-flavicollis	39	6	54	12	33	6	28	4	45	14	49	8	29	7	122	16
Pliomys lenki					2	1			1	1	3	1	11	3	7	4
Chiroptera indet.													1	1	2	2
Erinaceus europaeus															1	1
Neomys sp.			3	1	1	1			3	2	3	2	8	3	8	3
Sorex (Sorex) araneus-coronatus	38	8	50	14	49	15	34	7	64	21	72	17	97	30	161	66
Sorex (Sorex) minutus	17	7	23	7	15	6	7	2	22	6	32	12	26	7	24	11
Talpa sp.			14	2	4	2	1	1	2	2	6	1	8	1	2	1

Table 12. Number of identified specimens (NISP) and minimum number of individuals (MNI) of small mammal species from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). Suárez-Bilbao et al. (2017a).

	LL-A		LL-C		LL-G		LL-K		LL-L		C-1		C-3		C-5	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Salamandra salamandra			1	1			5	1	10	1	1	1	14	1	7	1
Triturus sp.	2	1					5	1								
Alytes obstreticans							1	1	1	1	1	1	1	1	1	1
Discoglossus sp.													1	1	3	1
Hyla arborea	4	1														
Bufo bufo	2	1	2	1	20	2	13	2	32	3	130	9	165	12	214	15
Rana temporaria-iberica	7	1	7	2	32	3	44	3	53	4	191	11	143	9	189	11
Lacertidae indet.	641	13	650	13	302	4	228	4	242	3	30	1	130	3	765	23
Anguis fragilis	33	1	16	1	407	1	299	1	48	1	113	2	1286	1	1131	23
Coronella girondica							8	1	9	1	65	1	47	1	6	1
Vipera sp.	13	1	17	1	11	1	11	1	36	1	89	1	142	1	56	1

Table 13. Number of identified specimens (NISP) and minimum number of individuals (MNI) of reptile and amphibian species from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). Suárez-Bilbao et al. (2017a).

and *Anguis fragilis*) and two snakes (*Coronella girondica* and *Vipera* sp.) (Fig. 39) (Tabs. 12-13).

All the species that were identified in Artazu VII are extant except for *P. lenki*. According to Cuenca-Bescós et al. (2010), this taxon was recorded in the Magdalenian levels at the site of El Mirón, surviving until the upper Pleistocene in the Iberian Peninsula. Additionally, the absence of some species commonly found in Late Pleistocene sites as *Crocidura russula, Eliomys quercinus, Glis glis* and *Microtus (Alexandromys) oeconomus* in the stratigraphic sequence is noteworthy. The first three species are associated with benign conditions of temperate climates (Chaline, 1970; Rzebik-Kowalska, 1995; Sesé, 2005b), whereas the latter taxon is related with the coldest climate stages (Chaline, 1970; Pemán, 1985; Laplana et al., 2016).

- Small mammalian community changes over spits

A significant difference between taxonomic and quantitative proportions can be observed in the stratigraphic sequence from Artazu VII (Tab. 12). In this way, different small mammalian taxa were recorded in C and the LL (Suárez-Bilbao et al., 2017a). The three spits in C yielded a total MNI of 286, with a clear predominance of *S. (S.) araneus-coronatus* followed by *A. sylvaticus-flavicollis* and *M. (M.) agrestis* in C-5 and C-3, and *S. (S.) minutus* and *A. sylvaticus-flavicollis* in C-1. It is remarkable that the only appearance of *E. europaeus* occurred in C-5, where no presence of *Neomys* sp. was recorded. Moreover, Chiroptera indet. disappeared in C-1 (Tab. 12).

The LL assemblage was formed by a minimum of 233 individuals and some changes, especially in the relative abundance of taxa, can be noticed in this sequence. In LL-L the proportion of shrews decreased and that of the Murinae increased, although the most abundant species was *S. (S.) araneus-coronatus*, followed by *A. sylvaticus-flavicollis* and *M. (M.) agrestis*. Lower Ledge K displayed the poorest taxonomic paleodiversity, with just seven small mammal taxa identified. It was the only spit in which the sum of the Arvicolinae did not reach 15 % of the sample. When comparing C-K with the previous spits, no presence of Arvicolinae, *Neomys* sp. and *P. lenki* was detected. *S. (S.) araneus-coronatus* and *M. (Terricola)* sp., accompanied by *A. sylvaticus-flavicollis,* prevailed in the sample and constitute almost 80 % of the individuals (Tab. 12). In both LL-G and LL-C, the most abundant species is *S. (S.) araneus-coronatus,* followed by *A. sylvaticus-flavicollis* and *S. (S.) minutus*. Even so, differences culd be appreciated among them. Thus, in C-C, *A. amphibius* and *P. lenki* disappeared and the relative proportion of the remaining Arvicolinae increaseed. LL-A, as well as LL-K, were relatively impoverished. The taxonomic biodiversity compriseed eight species, with the absence of *Neomys* sp., *P. lenki* and *Talpa* sp., among others, and the dominance of *M. (Terricola)* sp. followed by *M. (M.) arvalis* and *S. (S.) araneus-coronatus* (Tab. 12). Finally, differences between the two deposit areas existed. While *A. sapidus* did not appear in the C area, Chiroptera indet. and *E. europaeus* were observed only in the LL (Suárez-Bilbao et al., 2017a).

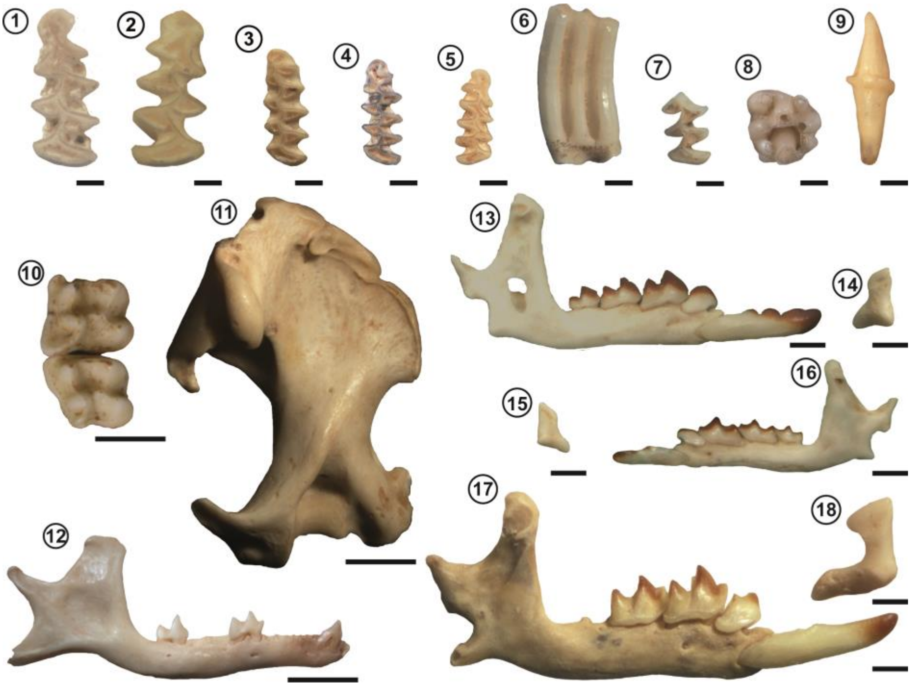


Figure 38. Small mammal remains from the Artazu VII site (Arrasate, Gipuzkoa, northern Iberian Peninsula) in occlusal view (except 6, 9, 11, 12, 13 and 17, in labial view, and 14, 15, 16 and 18, in posterior view). 1, *Arvicola amphibius* left m1; 2, *Arvicola amphibius* right m1; 3, *Microtus (Microtus) agrestis* right m1; 4, *Microtus (Microtus) arvalis* left m1; 5, *Microtus (Terricola)* sp. right m1; 6–7, *Pliomys lenki* left m3; 8, *Apodemus sylvaticus-flavicollis* left M2; 9, Chiroptera indet.; 10, *Erinaceus europaeus* right M1-M2; 11–12, *Talpa* sp. left humerus and right mandible; 13–14, *Sorex (Sorex) araneus-coronatus* right mandible; 15–16, *Sorex (Sorex) minutus* left mandible; 17–18, *Neomys* sp. right mandible. Scale bars= 0.5 mm (1–9), 5 mm (10–12), 1 mm (13–18). Suárez-Bilbao et al. (2017a).

- Amphibian and reptile community changes over spits

Differences between the assemblages from C and the LL were prominent. In general, the number of taxa decreased upwards the stratigraphic column. Yet, some exceptions could be observed, as in LL-A, where the number of taxa grew again (Suárez-Bilbao et al., 2017a). The most important differences were found between the two structural zones. First of all, C zone displayed greater abundance of individuals than the LL, as the minimum number of individuals was approximately twice as high (134 in the C and 79 in the LL). Moreover, although a similar number of species (nine in the C and 10 in the LL) was recorded, the taxonomy and the relative abundance of each taxon was very different (Tab. 13). In the three samples from C area, the most abundant species were *B. bufo* and *R. temporaria-iberica*. While, in C-1, this abundance was followed by *A. fragilis*, in C-5 and C-3, *B. bufo* and *R. temporaria-iberica* were accompanied by Lacertidae. It is also remarkable that, in the whole stratigraphic sequence, *Discoglossus* sp. appeared exclusively in C-5 and C-3 (Fig. 39; Tab. 13). In the LL area, major species concentration changes occurred. In the LL-L and LL-K, eight and nine taxa were represented, respectively, with *R. temporaria-iberica*, Lacertidae and *B. bufo* being the most numerous in descending order (Suárez-Bilbao et al., 2017a). The best represented taxa were repeated in LL-G, but, in this case, the absence of *C. girondica*, *S. salamandra* and *A. obstreticans* was observed, and thus is the least diverse spit (Tab. 13. Finally, in LL-C and LL-A, the most abundant taxon was, by far, family Lacertidae, with a representation of around 70 % in both cases, followed by *R. temporaria-iberica* in the first case. It

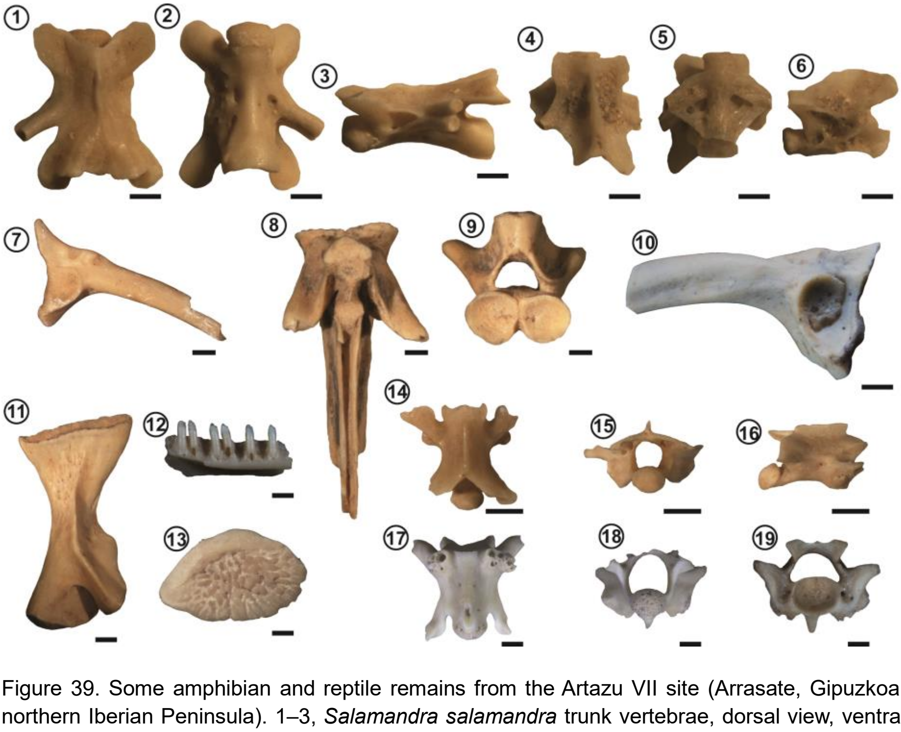


Figure 39. Some amphibian and reptile remains from the Artazu VII site (Arrasate, Gipuzkoa, northern Iberian Peninsula). 1–3, *Salamandra salamandra* trunk vertebrae, dorsal view, ventral view, left lateral view; 4–6, *Triturus* sp. trunk vertebrae, dorsal view, ventral view, right lateral view; 7, *Alytes obstetricians* right ilium, lateral view; 8–9, *Discoglossus* sp. urostyle, dorsal view, anterior view; 10, *Bufo bufo* left ilium, lateral view; 11, *Rana temporaria-iberica* right scapula, ventral view; 12, Lacertidae indet. incomplete left dentary, medial view; 13, *Anguis fragilis* osteoderm, external view; 14–16, *Coronella girondica* trunk vertebrae dorsal view, posterior view, right lateral view; 17–19, *Vipera* sp. trunk vertebrae dorsal view, posterior view, anterior view. Scale bars= 1 mm (1–9, 11–19), 0.5 mm (10). Suárez-Bilbao et al. (2017a).

was equally important to highlight the existence of *H. arborea* in C-3 and in the uppermost level, and the appearance of *Triturus* sp. only in the uppermost level and in LL-K.

- Biometry of Soricidae lower dental elements

There were significant differences between the maximum length of the m1 and m2 of *S. (S.) minutus* and the minimum values of *S. (S.) araneus-coronatus* (Tab. 14, Fig. 40) (Suárez-Bilbao et al., 2017b). Additionally, there also were significant differences in the width of the talonid (Tab. 14 Fig. 40). The maximun L of the premolars and the m3 of *S. (S.) minutus* are consistent with the minimum values obtained in *S. (S.) araneus-coronatus*. At the same time, the TAW values of m3 of *S. (S.) minutus* could be compared with the minimum values measured in the width of m3 of *S. (S.) araneus-coronatus* (Tab. 14, Fig. 40). In contrast, the maximum values obtained for the m1 and m2 TAW of *S. (S.) minutus* overlapped minimally with the minimum values of those elements at *S. (S.) araneus-coronatus*. However, this overlapping was not taken into account since it was only of 40 µm in the case of m1 and 20 µm for m2 (Tab. 14, Fig. 40). The lack of teeth connected to the mandible in the case of *S. (S.) minutus* made it impossible the comparison of the TAW of the anteromolars.

Taxa	Teeth	Parameter	n	Max	Avg	Min	σ
S. (S.) araneus-coronatus	a	L	5	0.88	0.79	0.72	0.57
		TAW	5	0.74	0.63	0.54	0.08
S. (S.) minutus	a	L					
		TAW					
S. (S.) araneus-coronatus	p	L	26	1.07	0.85	0.75	0.07
		TAW	26	0.81	0.71	0.6	0.069
S. (S.) minutus	p	L	3	0.75	0.71	0.68	0.039
		TAW	3	0.56	0.51	0.47	0.047
S. (S.) araneus-coronatus	m1	L	36	1.41	1.33	1.19	0.063
		TAW	36	0.99	0.85	0.71	0.07
S. (S.) minutus	m1	L	6	1.16	1.12	1.11	0.023
		TAW	6	0.73	0.69	0.64	0.038
S. (S.) araneus-coronatus	m2	L	14	1.34	1.2	1.11	0.068
		TAW	14	0.91	0.67	0.67	0.076
S. (S.) minutus	m2	L	3	1.06	1.02	1.02	0.021
		TAW	3	0.71	0.58	0.58	0.067
S. (S.) araneus-coronatus	m3	L	3	1.01	0.87	0.82	0.076
		TAW	3	0.42	0.37	0.31	0.032
S. (S.) minutus	m3	L	1	0.82	0.82	0.82	
		TAW	1	0.31	0.31	0.31	

Table 14. L and TAW of a, p, m1, m2 and m3 of *S. (S.) araneus-coronatus* and *S. (S.) minutus*. n (number of measured teeth), Max (maximun), Med (average), Min (minimun) and σ (standard deviation). Measurement unit mm. Suárez-Bilbao et al. (2017b).

Finally, the length and width of the talonid of 20 isolated m1 and m2 were measured in an attempt to classify them. In the distribution analysis, 18 of them plotted well on the range of *S. (S.) araneus-coronatus*, while the other two were positionated as *S. (S.) minutus* (Fig. 40) (Suárez-Bilbao et al., 2017b).

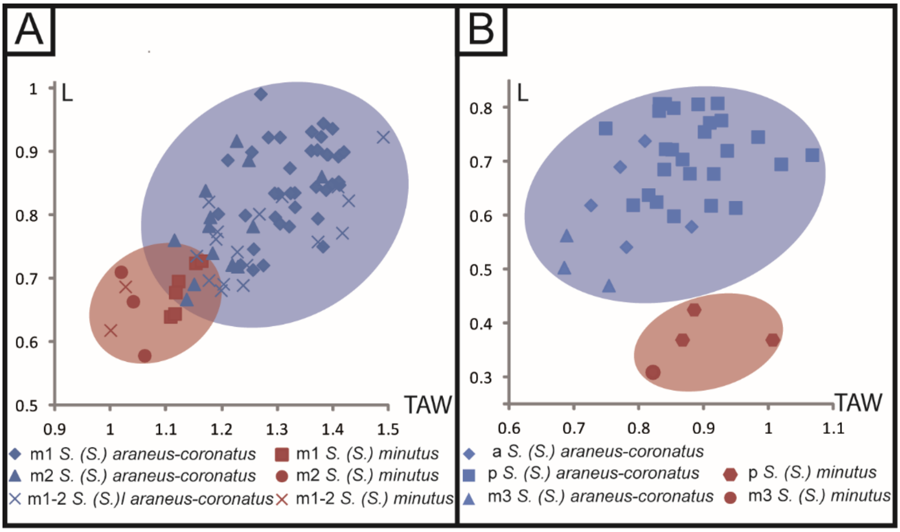


Figure 40. Grapich representation of L and TAW dental elements of *S. (S.) araneus-coronatus* and *S. (S.) minutus* of the Chamber 5 from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). A: m1 and m2. B: a, p and m3. In blue oval circle *S. (S.) aranaus-coronatus* group, while the red oval represent *S. (S.) minutus*. In cross symbol isolated dental elements. Measurement unit mm. Suárez-Bilbao et al. (2017b).

B. Large mammals

- **Systematic attribution, quantification and compared morphometry analyses**

The large mammal assemblage consisted of a total of 1,379 fossil remains, of which 1,163 (84.3 % of the remains) were taxonomically identifiable (Castaños et al., 2017a) (Tab. 15). Amongst these, ungulate remains represented 70.9 % of the assemblage and belonged to *B. p.* cf. *mediator*, *R. pyrenaica, C. elaphus* and *E. ferus caballus* (Fig. 41). The remaining assemblage was formed by carnivore remains (29.1 %), belonging to *P. spelaea*, *P. pardus*, *Lynx* sp., *F. silvestris*, *C. lupus*/*C. alpinus*, *V. vulpes*, *M. meles*, *M. martes, M. putorius* and *M. nivalis.* No evidence of cave bears or hyenas was found.

After the taxonomical identification of the large mammal, they were quantified by the Minimum Number of Individuals (MNI) and the Number of Identifiable Specimens (NISP). The estimation of the age of death for ungulate species was stimated. Additionally, some morphometric data were compared mainly with an extensive sample from SW Europe (especially from the Cantabrian region) (Castaños et al, 2017a) (Tab.s from 16-26).

	NISP	NISP %	MNI
Equus ferus caballus	8	0.7	1
Bison priscus cf. *mediator*	50	4.3	4
Rupicapra pyrenaica	728	62.6	15
Cervus elaphus	38	3.3	1
Ungulates	**824**	**70.61**	**21**
Canis lupus/ Cuon alpinus	21	1.8	2
Felis silvestris	4	0.3	1
Lynx sp.	8	0.7	1
Panthera pardus	124	10.6	2
Panthera spelaea	8	0.69	1
Martes martes	1	0.1	1
Meles meles	2	0.2	1
Mustela nivalis	1	0.1	1
Mustela putorius	9	0.8	2
Vulpes vulpes	160	13.8	8
Carnivore	**339**	**29.2**	**20**
Total	**1163**		**41**

Table 15. Number of identifiable specimens (NISP) and a Minimum Number of Individuals (MNI) of large mammal species from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). Castaños et al. (2017a).

Figure 41. Some ungulate remains from Artazu VII (Arrasate, Gipuzkoa, north Iberian Peninsula). 1, *Equus feurs*, labial view of upper molar; 2, *Bison priscus* cf. *mediator*, plantar view of left talus; 3, *Rupicapra pyrenaica*, mesial view of left calcaneus; 4, *Cervus elaphus*, dorsal view of proximal fragment of metatarsal. Scales 5 cm, A for figures 1-3 and B for figure 4. Castaños et al. (2017a).

Equus ferus caballus LINNAEUS, 1758

Horse represented 0.7 % of the assemblage with eight remains (Tab. 15). The material consisted only of upper teeth fragments, and all the remains corresponded to a single adult individual (Castaños et al, 2017a) (Fig. 41). The morphology was typical of horses, with a large protocone and well-developed caballine fold.

Bison priscus* cf. *mediator HILZHEIMER, 1918

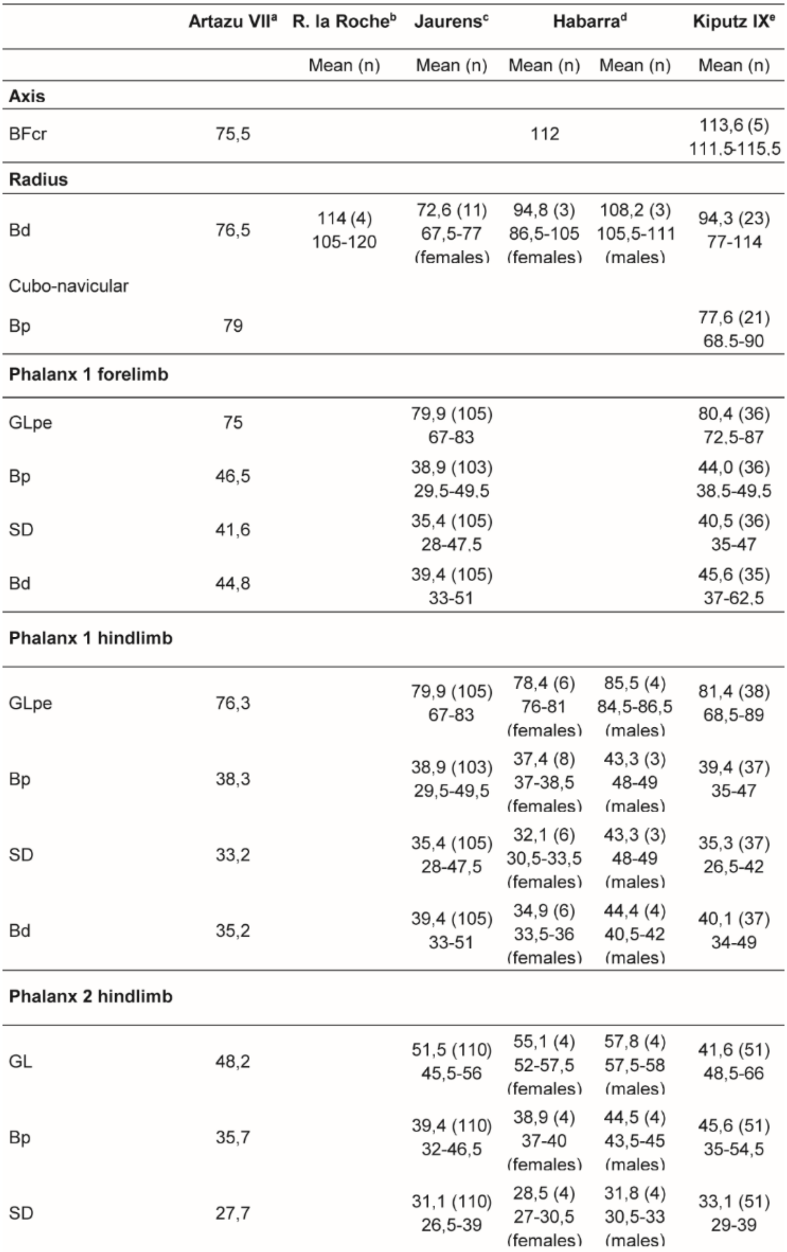
Steppe bison was the second most abundant taxon in the ungulate assemblage with 50 remains and a percentage of 4.3 % (Tab. 15), corresponding to a minimum of four individuals: two adult and two calves. Amongst cranial and postcranial bones, 50 remains were recovered, most of them from Storage 2 (Castaños et al., 2017a).

Measurements of bison bones from Artazu VII were compared with bison data from other sites of SW Europe with similar chronologies (Tab. 16), such as Roman-la-Roche (Vercoutère and Guérin, 2010), Jaurens (Guérin and Valli, 2000), Habarra (Prat et al., 2003) and Kiputz IX (Castaños et al., 2012b). All the sites are dated in the late Pleistocene, except the first, which is dated in the middle Pleistocene. Artazu VII bison bone measurements are smaller than the minimum values of Roman-la-Roche and Habarra male bisons. However, bison bone sizes at Artazu VII fell within the variation of Habarra females. Therefore, the remains recovered at Artazu VII were attributed to females of *Bison priscus* cf. *mediator* as the most reasonable option (Castaños et al., 2017a).

Rupicapra pyrenaica BONAPARTE, 1845

728 remains of chamois were recovered, with a percentage of 62.6 % of the large mammals remains (Tab. 15). Considering the position of the bones in the skeleton, a minimum of 15 individuals were identified. Cranial and postcranial remains appear in the assemblage (Castaños et al., 2017a) (Tabs. 17-18).

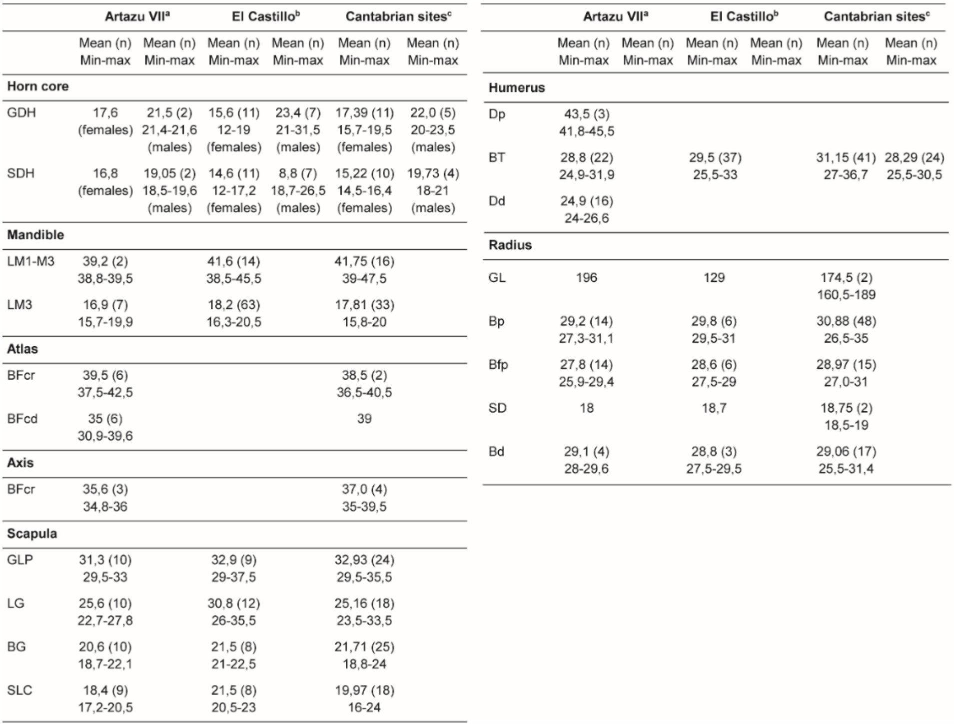
Most measurement data of chamois bones come from Late Pleistocene sites found in the northern Iberian Peninsula. In particular, the best compilation of metric data of chamois derives from El Castillo (Puente Viesgo, Cantabria) (Castaños, J, 2017a). The morphological comparisson was completed using metric data from 16 Late Pleistocene sites from the Cantabrian range. These are, in the central sector, Tito Bustillo (Altuna, 1976) and Jou Puerta (Álvarez-Lao, 2014) in Asturias, and Rascaño (Altuna, 1981a) in Cantabria. In the eastern sector, Lezetxiki, Aitzbitarte III, Urtiaga (Altuna, 1972), Erralla (Altuna and Mariezkurrena, 1985), Ekain (Altuna and Mariezkurrena, 1984), Santimamiñe, Lumentxa, Abittaga, Atxuri (Castaños, 1986), , Aitzbitarte IV (Altuna and Mariezkurrena, 2011), Kiputz IX (Castaños et al., 2012b), Praileaitz I (Castaños



	Artazu VII[a]	R. la Roche[b]	Jaurens[c]	Habarra[d]		Kiputz IX[e]
		Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)
Axis						
BFcr	75,5			112		113,6 (5) 111,5-115,5
Radius						
Bd	76,5	114 (4) 105-120	72,6 (11) 67,5-77 (females)	94,8 (3) 86,5-105 (females)	108,2 (3) 105,5-111 (males)	94,3 (23) 77-114
Cubo-navicular						
Bp	79					77,6 (21) 68,5-90
Phalanx 1 forelimb						
GLpe	75		79,9 (105) 67-83			80,4 (36) 72,5-87
Bp	46,5		38,9 (103) 29,5-49,5			44,0 (36) 38,5-49,5
SD	41,6		35,4 (105) 28-47,5			40,5 (36) 35-47
Bd	44,8		39,4 (105) 33-51			45,6 (35) 37-62,5
Phalanx 1 hindlimb						
GLpe	76,3		79,9 (105) 67-83	78,4 (6) 76-81 (females)	85,5 (4) 84,5-86,5 (males)	81,4 (38) 68,5-89
Bp	38,3		38,9 (103) 29,5-49,5	37,4 (8) 37-38,5 (females)	43,3 (3) 48-49 (males)	39,4 (37) 35-47
SD	33,2		35,4 (105) 28-47,5	32,1 (6) 30,5-33,5 (females)	43,3 (3) 48-49 (males)	35,3 (37) 26,5-42
Bd	35,2		39,4 (105) 33-51	34,9 (6) 33,5-36 (females)	44,4 (4) 40,5-42 (males)	40,1 (37) 34-49
Phalanx 2 hindlimb						
GL	48,2		51,5 (110) 45,5-56	55,1 (4) 52-57,5 (females)	57,8 (4) 57,5-58 (males)	41,6 (51) 48,5-66
Bp	35,7		39,4 (110) 32-46,5	38,9 (4) 37-40 (females)	44,5 (4) 43,5-45 (males)	45,6 (51) 35-54,5
SD	27,7		31,1 (110) 26,5-39	28,5 (4) 27-30,5 (females)	31,8 (4) 30,5-33 (males)	33,1 (51) 29-39

Table 16. Measurements of *Bison priscus*. Abbreviations: BFcr: Greatest breadth of the cranial articular surfaces; Bd: Greatest distal breadth; Bp: Greatest proximal breadth; GL: Greatest length; Glpe: Greatest periphereal length; SD: Smallest breadth of diaphysis. Castaños et al. (2017a).

and Castaños, 2017) and Imanolen Arrobia (Castaños et al., 2017b) are located in the Basque Country (Tabs. 17-18).Sexual dimorphism affects chamois horn core size, modifying diameters and making them significantly larger in males. Therefore, to perform the chamois osteometric comparison study, it is necessary to separate the assemblage previously by sex. The horn core measurements of female chamois from Artazu VII fell within the variation of other specimens at several sites in the Cantabrian region and are larger than female individuals from El Castillo. However, the male chamois horn cores at El Castillo are slightly more robust than specimens from Artazu VII and other sites in the Cantabrian region (Tab. 17). These results indicate that the degree of sexual dimorphism at El



	Artazu VII[a]		El Castillo[b]		Cantabrian sites[c]	
	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max
Horn core						
GDH	17,6 (females)	21,5 (2) 21,4-21,6 (males)	15,6 (11) 12-19 (females)	23,4 (7) 21-31,5 (males)	17,39 (11) 15,7-19,5 (females)	22,0 (5) 20-23,5 (males)
SDH	16,8 (females)	19,05 (2) 18,5-19,6 (males)	14,6 (11) 12-17,2 (females)	8,8 (7) 18,7-26,5 (males)	15,22 (10) 14,5-16,4 (females)	19,73 (4) 18-21 (males)
Mandible						
LM1-M3	39,2 (2) 38,8-39,5		41,6 (14) 38,5-45,5		41,75 (16) 39-47,5	
LM3	16,9 (7) 15,7-19,9		18,2 (63) 16,3-20,5		17,81 (33) 15,8-20	
Atlas						
BFcr	39,5 (6) 37,5-42,5				38,5 (2) 36,5-40,5	
BFcd	35 (6) 30,9-39,6				39	
Axis						
BFcr	35,6 (3) 34,8-36				37,0 (4) 35-39,5	
Scapula						
GLP	31,3 (10) 29,5-33		32,9 (9) 29-37,5		32,93 (24) 29,5-35,5	
LG	25,6 (10) 22,7-27,8		30,8 (12) 26-35,5		25,16 (18) 23,5-33,5	
BG	20,6 (10) 18,7-22,1		21,5 (8) 21-22,5		21,71 (25) 18,8-24	
SLC	18,4 (9) 17,2-20,5		21,5 (8) 20,5-23		19,97 (18) 16-24	

	Artazu VII[a]		El Castillo[b]		Cantabrian sites[c]	
	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max
Humerus						
Dp	43,5 (3) 41,8-45,5					
BT	28,8 (22) 24,9-31,9		29,5 (37) 25,5-33		31,15 (41) 27-36,7	28,29 (24) 25,5-30,5
Dd	24,9 (16) 24-26,6					
Radius						
GL	196		129		174,5 (2) 160,5-189	
Bp	29,2 (14) 27,3-31,1		29,8 (6) 29,5-31		30,88 (48) 26,5-35	
Bfp	27,8 (14) 25,9-29,4		28,6 (6) 27,5-29		28,97 (15) 27,0-31	
SD	18		18,7		18,75 (2) 18,5-19	
Bd	29,1 (4) 28-29,6		28,8 (3) 27,5-29,5		29,06 (17) 25,5-31,4	

Table 17. Selected comparative measurements of *Rupicapra pyrenaica* cranial elements, cervical vertebrae, scapula, humerus, and radius. Bd: Greatest distal breadth; Bfcd: Greatest breadth of Facies articularis caudalis; Bfcr: Greatest breadth of Facies articularis cranialis; Bfp: Greatest breadth of proximal articular face; BG: Breadth of glenoid cavity; Bp: Greatest proximal breadth; BT: Greatest breadth of trochlea; Dd: Distal depth ; Dp: Proximal depth; GDH: Greatest diameter horn core; GL: Greatest length; GLP: Greatest length of the glenoid process; LG: Length of glenoid cavity; L: Length; SD: Smallest breadth of diaphysis; SDH: Smallest diameter horn core; SLC: Smallest length of collum scapulae. Mean: mean value, (n): number of individuals, Min: minimum; Max: maximum. [a] Artazu VII; [b] El Castillo (Castaños, 2017a), [c] Tito Bustillo (Altuna, 1976), Jou Puerta (Álvarez-Laóo 2014), Rascaño (Altuna, 1981b), Lezetxiki, Aitzbitarte III and Urtiaga (Altuna, 1972), Erralla (Altuna and Mariezkurrena, 1985), Ekain (Altuna and Mariezkurrena, 1984), Santimamiñe, Lumentxa, Abittaga, Atxuri (Castaños, 1986), Aitzbitarte III (Altuna and Mariezkurrena, 2011), Kiputz IX (Castaños et al., 2012b), Praileaitz I (Castaños and Castaños, 2017), Imanolen Arrobia (Castaños et al., 2017b). Castaños et al. (2017a).

Castillo is more intense and is a characteristic of this site.The chamois lower dental molars length at Artazu VII has an average value similar to Cantabrian range samples. However, the lengths of the third molars from Artazu VII are slightly smaller than in the other sites (Tab. 17).

Due to the scarcity of data in the Cantabrian region, the osteometric comparison of the first two vertebrae (atlas and axis) is not possible, and the metric differences observed in Table 16 may be random, related to limited samples.

The *Rupicapra* scapula is more narrow and elongated than in *Capra*. Chamois scapula measurements at Artazu VII are within the metric variation of other sites in the Cantabrian Region (Tab. 17).

The width of the distal humerus is smaller than samples from Cantabrian sites (Tab. 17). In the radius, the medial edge of the proximal articulation is less outgoing and more angular than in *Capra*.

It should be highlighted that the longest radius of chamois samples from the Cantabrian Region comes from Artazu VII. However, all bone widths are similar to other Cantabrian sites (Tab. 17).

Artazu VII chamois ulna dimensions fall within the variation range of other samples from Cantabrian sites (Tab. 18).

Chamois metacarpals from Artazu VII are more elongated and narrower than in *Capra*, but the diaphysis is thicker.

Artazu VII metacarpal dimensions are similar to other Cantabrian range sites. Notwithstanding, the measurements of the only acetabulum of the chamois pelvis in Artazu VII are slightly larger, compared with samples (Tab. 18).

Compared with *Capra* femur, the Artazu VII femora are, in general, more graceful, and the section that separates distal condyles are proportionally wider. However, their measurements are similar to the few data existing for the Cantabrian Region, the same as the patella (Tab. 18).

The calcaneus in the Artazu VII chamois samples is, in general, more slender and graceful than in *Capra*. The distal tuberosity is well separated from the bone body. Malleolus surface is more narrow and elongated in wild goat than in chamois and presents a transverse depression that divides it into two parts. The length of remains from Artazu VII is smaller than in El Castillo and coincides with remains from Cantabrian sites, as well as with the cubonavicular width (Tab. 18)

	Artazu VII[a]	El Castillo[b]	Cantabrian sites[c]		Artazu VII[a]	El Castillo[b]	Cantabrian sites[c]
	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max		Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max
Ulna				**Tibia**			
DPA	26,5 (10) 24,6-27,3	27	27,73 (8) 25,5-28,6	GL	264,5 (2) 260-269		266
SDO	22,5 (10) 21,4-24,4	23,5	24,0 (3) 22,5-25	Bp	43,4 (5) 42,7-44		
BPC	16,9 (10) 15,6-18,8	17	16,65 (4) 15,8-17,5	SD	17,3 (2) 17,1-17,5		17
				Bd	6,6 (11) 24,5-28,4	27,3 (26) 24-30	28,72 (30) 25-34
Metacarpal				**Talus**			
GL	159,5	155,5 (3) 154-158	150,38 (8) 131-161,5	Ll	30,5 (8) 29,5-31,8	31,8 (26) 26-34	30,98 (75) 26,5-34
Bp	23,0 (6) 21,8-25,4	22,9 (7) 21-24,5	24,55 (14) 21-30	Lm	29,2 (8) 28,2-30,6	29,88 (22) 25-32,5	29,11 (52) 23-33,1
SD	14,5	16,5 (2) 16,3-16,7	15,9 (6) 14,4-17,9	Dl	17,3 (8) 16,6-18	17,79 (20) 16-19,5	17,18 (51) 13,7-19,5
Bd	27,2 (5) 26,7-27,7	28,3 (11) 25,5-30	29,26 (25) 26-32,5	BC	19,6 (8) 19-20,7	20,09 (21) 16,2-22,5	19,95 (51) 16,2-22
Dd	16,3 (5) 15,8-16,8	17,1 (11) 15,6-19,8	17,44 (9) 16-19,5				
Pelvis				**Calcaneum**			
LA	30,9	28,3 (6) 25,5-30	27,86 (5) 25-29	GL	63,7 (4) 61,8-64,8	66,1 (11) 58,5-74,5	63,75 (36) 62,5-69
BA	27,1	25,4 (6) 23,5-26,5	24,25 (2) 23,5-25	GB	21,5 (4) 20,4-23	21,52 (11) 17,9-23	23,12 (29) 21,5-26,7
Femur				**Metatarsal**			
GL	215		211,5	GL	167,9 (8) 163,7-178,5	171,9 (5) 166,5-179	165,7 (10) 121-188,5
Bp	45,5 (7) 44,6-47,6		48,32 (5) 44-50	Bp	22,3 (14) 19,9-23	22,6 (5) 21-24	22,46 (18) 18,9-24
DC	20,4 (11) 19,3-21,5	22,0 (10) 20-26,5	21,19 (16) 20,2-22,7	SD	14,5 (8) 13,5-15,1	14,16 (5) 13,3-15,2	13,58 (9) 11,5-15,9
SD	17,7		17,6	Bd	28,3 (12) 26,8-30,5	29,0 (14) 27,5-31	29,13 (36) 21-32,1
Bd	39,8 (8) 37,2-42,3		40,75 (2) 40,5-41	Dd	17,4 (12) 16,9-17,7	17,93 (15) 16,7-19	17,07 (9) 14,7-19
Patella				**Cubo-navicular**			
GL	29,4 (6) 26,5-32,3		35,5	GB	24,8 (11) 23,7-26,5		24,8 (11) 23,7-26,5
GB	9,5 (6) 18-20,5		25,5				

Table 18. Selected comparative measurements of *Rupicapra pyrenaica* ulna, metacarpal, pelvis, femur, patella, tibia, talus, calcaneus, metatarsal, and cubo-navicular. BA: Breadth of acetabulum; BC: Greatest breadth of caput; Bd: Greatest distal breadth; Bp: Greatest proximal breadth; BPC: Greatest breadth of proximal articular face; DC: Diameter of caput femoris; Dd: Distal depth ; Dl: Greatest depth of lateral face; Dp: Proximal depth; DPA: Depth across procesus anconeus; GB: Greatest breadth; GL: Greatest length; L: Length; LA : Length of acetabulum; LG: Length of glenoid cavity; Ll: Greatest length of lateral face; Lm: Greatest length of medial face; SD: Smallest breadth of diaphysis; SDO: Smallest depth of olecranon. Mean: mean value, (n): number of individuals, Min: minimum and Max: maximum. [a] Artazu VII; [b] (Castaños, 2017a); [c] Tito Bustillo (Altuna, 1976), Jou Puerta (Alvarez-Laó, 2014), Rascaño (Altuna, 1981b), Lezetxiki, Aitzbitarte III and Urtiaga (Altuna, 1972), Erralla (Altuna and Mariezkurrena, 1985), Ekain (Altuna and Mariezkurrena, 1984), Santimamiñe, Lumentxa, Abittaga, Atxuri (Castaños, 1986), Aitzbitarte III (Altuna and Mariezkurrena, 2011), Kiputz IX (Castaños et al., 2012b), Praileaitz I (Castaños and Castaños, 2017), Imanolen Arrobia (Castaños et al., 2017b). Castaños et al. (2017a).

(Castaños et al., 2017a). However, the width is similar to El Castillo and lower than in the rest of the sites. Metatarsals, the same as metacarpals, are more

elongated and slender in *Capra* that in *Rupicapra*. Moreover, chamois metatarsals have a small surface for the cuboscaphoid and are less prominent than in wild goats. Measurements of metatarsals from Artazu VII are similar to the remains from El Castillo and Cantabrian sites (Tab. 18). Therefore, the Artazu VII samples display morphological characteristics of chamois and are different from wild goat.

Cervus elaphus LINNAEUS, 1758

Red deer remains represented the 3.3 % of the remains (Tab. 15) with 38 remains, corresponding to a minimum of just one adult male individual. Cranial and postcranial remains were present in the assemblage, mostly neurocranial and antler fragments (Castaños et al., 2017a).

In general, the red deer bone size data obtained were scarce. Length M/3: 31.8 mm; humerus greatest breadth of trochlea: 54.5 mm; metatarsal greatest proximal breadth: 41.8; metatarsal: greatest length 41.9, greatest proximal breadth 22.5; smallest breadth of diaphysis 16.6 and greatest distal breadth 19.8. All these measurements fell within the range of variation of red deer samples from other Late Pleistocene sites in the Cantabrian Region (Castaños et al., 2017a).

Canis lupus LINNAEUS, 1758
Cuon alpinus PALLAS, 1811

As commented in Chapter 5, these two species result practically imposible to distinguish. Thus, counting both taxa together, 21 canid remains were recorded, representing the 1.8 % of the assemblage (Tab. 15). P4 is the only tooth that has been recovered in Artazu VII, which morphology is more similar to dhole. In addition, dhole sample measurements are larger than others from several sites in the Iberian Peninsula: Bizkaia (Castaños 1986), Praileaitz I (Castaños and Castaños 2017), Obarreta (Altuna, 1983), Cova Negra (Pérez, 1977), Escoural (Cardoso, 1992), Trinchera Dolina Sierra Atapuerca (García, 2003) and Duranguesado (Pérez Ripoll et al., 2010) in Bizkaia (Tab. 19).

The fifth metacarpal 5 and talus measurements fall below the minimum values for wolf. Therefore, these remains have been attributed to the dhole (Tab. 19).

The tibia and the third metatarsal measurements are larger than the maximum values for dhole, so these bones have been attributed to wolf (Tab. 19).

The calcaneus has a medium size, within the two taxa-area. For this reason, it has not been possible to assign a specific attribution (Tab. 19).

	Artazu VII[a]	Bikaia[b]	Praileaitz I[c]		Obarreta[d]	Iberian Peninsula[e]	Taxonomical atribution
		Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max		Mean (n) Min-max	
Mandible		*C. lupus*	*C. lupus*	*C. alpinus*	*C. alpinus*	*C. alpinus*	
LP4	17	15,37 (4) 13,2-16,8	16,95 (6) 15,2-17,6	14,4 (3) 14,3-14,6		14,36 (6) 13-15,2	*Canis lupus*
BP4	8,4	7,75 (4) 6,6-8,8	8,85 (6) 6,4-9,5	7,1 (3) 6,9-7,2		7,04 (6) 6,5-7,5	
Metacarpal 5		*C. lupus*	*C. lupus*	*C. alpinus*	*C. alpinus*		
GL	64,5	78,3 (3) 69,5-90,5	75,5 (3) 73,5-76,5	60,5	56,5		*Cuon alpinus*
Bp	12,4	13,7 (2) 13,4-14	14,53 (3) 14,3-14,7	12,3	7,3		
SD	8,8		9,63 (3) 9-10	8,4	11,2		
Bd	13,1	12,5 (2) 12-13	13,9 (3) 12-17	11,7	9,2		
Tibia							
Bd	33,3				24		*Canis lupus*
Talus		*C. lupus*	*C. lupus*	*C. alpinus*	*C. alpinus*		
GL	26,1	32,5 (2) 32-33	34,5 (5) 32,5-37	27,4 (2) 26,5-28,3	29		*Cuon alpinus*
Calcaneum							
GL	50,5	54,25 (4) 50-59	57 (5) 53-62	48,5 (2)	48,5		*Canislupus/* *Cuon alpinus*
GB	17,4			22			
Metatarsal 3		*C. lupus*	*C. lupus*	*C. alpinus*	*C. alpinus*		
GL	97,2	89,75 (2) 89,5-90	98,75 (2) 98-99,5	86	81		*Canis lupus*
Bp	12,3		12,25 (2) 12-12,5	10,4			
SD	9,2		8,7 (2) 8,4-9	8,6	7,8		
Bd	11,8	12,05 (2) 12-12,1	11,4 (2) 11,2-11,6	11,5	10,7		

Table 19. Selected comparative measurements of *Canis lupus* and *Cuon alpinus*. Mean: mean value, (n): number of individuals, Min: minimum and Max: maximum. B: Breadth; Bd: Greatest distal breadth; Bp: Greatest proximal breadth; GB: Greatest breadth; GL: Greatest length; L: Length; SD: Smallest breadth of the diaphysis. Mean: Mean value, (n): number of individuals, Min: minimum and Max: maximum. [a] Artazu VII; [b] Bizkaia (Castaños 1986); [c] Praileaitz I (Castaños and Castaños 2017); [d] Obarreta (Altuna, 1983); [e] Cova Negra (Pérez, 1977), Escoural (Cardoso, 1992), Trinchera Dolina Sierra Atapuerca (García, 2003), Duranguesado Bizkaia (Pérez Ripoll et al., 2010). Castaños et al. (2017a).

Felis silvestris LINNAEUS, 1758

Only four remains were recovered, representing the 0.3 % of the assemblage and belonging to one adult. Due to fragmentation, no measurements were taken (Castaños et al., 2017a).

***Lynx* sp.** KERR, 1792

Lynx remains made up the 0.7% of the assemblage with only eight remains (Tab. 15). These remains can be attributted to Eurasian lynx, the Iberian form (*Lynx pardinus*) or *Lynx spelaeus*. An overlapping area exists between *L. lynx* and *L. spelaeus* measurements. Thus, registered measurements for Artazu VII lynx (in mm) are: upper dentition (P3 length: 10.5; P3 breadth: 5.5), metacarpal 2 (Greatest length: 51.5; Greatest proximal breadth: 7.7; Smallest diaphysis breadth: 5.3; Greatest distal breadth: 8.9) and pelvis (acetabulum length: 18.7; acetabulum breadth: 18.4) (Castaños et al., 2017a). These measurements were smaller than *L. lynx* and fell within the variation of *L. spelaeus* and *L. pardinus*. But with such scarce data a reliable specific attribution was not possible.

Panthera pardus LINNAEUS, 1758

In the carnivore assemblage, leopard was the second most abundant taxon, comprising 10.6% of the remains (Tab. 15). Cranial and postcranial pieces reached a total of 124 remains.

To date, there are 88 sites with leopard remains distributed throughout the Iberian Peninsula from the Middle Pleistocene to the Early Pleistocene. In this record, there are worth noting the samples from Los Rincones (where 111 remains belonging to a minimum of 4 adult individuals were recovered; Sauqué et al., 2013) and specially Avenc de Joan Guitón (with 221 remains belonging to the same individual Sanchis et al., 2015). Artazu VII assemblage is the third richest Iberian sample in leopard remains currently known (Castaños et al., 2017a). This is the reason for a more detailed description of the morphology and osteometry of the leopard. It will not attempt to repeat the unparalleled and recently published study of leopard distribution, morphology and osteometry in the Iberian Peninsula (Sanchis et al., 2015), only announce the new data provided by this site and the measurements taken at Imanolen Arrobia and Praileaitz I (Tab. 20) (Castaños et al., 2017b). Thus, Artazu VII leopard measurements were compared to Bolinkoba (Castaños, 1987), Allekoaitze and Aintzulo (Altuna and Mariezkurrena, 2013), Praileaitz I (Castaños and Castaños, 2017), Imanolen Arrobia (Castaños et al., 2017b); Figueira Brava, Gruta do Euscoral and Lorga da Dine (Cardoso, 1993, 1996), Algar da Manga Larga (Cardoso and Regala, 2006), Cova del Gegant (Viñas and Villalta, 1975), S'Espasa (Estévez, 1975), Abric Romaní (Cáceres et al., 1993), Gabasa (Blasco, 1995), Torrejones (Arribas, 1997), Zafarraya (Barroso et al, 2006; Testu, 2006) and Avenc de Joan Guitón, Racó del Duc II, Cova Negra (Sanchis et al., 2015).

The skull was broken and the single posterior neurocranium fragment preserved did not provide morphometric data. However, a complete left maxilla was recovered, which includes the canine, the two last premolars (P3-P4) and the alveolus of the M1 (Castaños et al., 2017a) (Fig. 42). The upper canine was the longest of the four comparative samples and premolars are similar to the Iberian Peninsula specimens. Nevertheless, P3 and P4 were similar to specimens from other Iberian Peninsula sites (Tabs. 20-21).

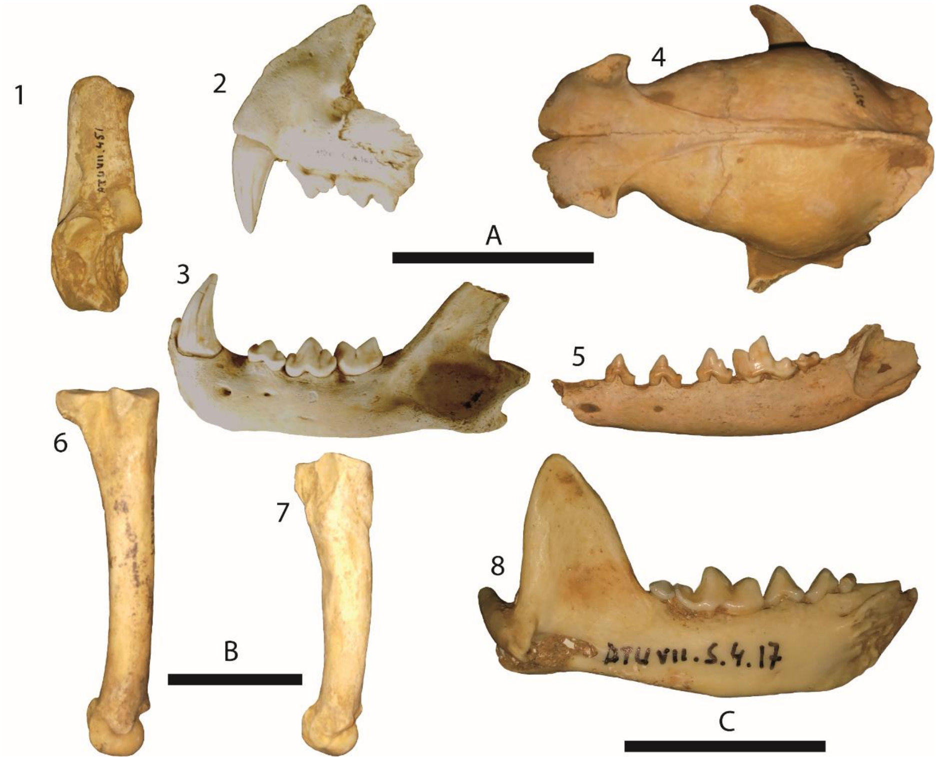


Figure 42. Carnivore remains from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). 1 *Canis lupus*, mesial view of left calcaneus; 2-3 *Panthera pardus*, left maxilla labial view and left mandible labial view; 4-5 *Vulpes vulpes*, upper view of skull and labial view of left mandible; 6-7 *Panthera spelaea* 3nd metacarpal lateral view and 2rd metacarpal lateral view; 8) *Mustela putorius*, lingual view of left mandible. Scales A=5cm from 1 to 5, B=5 cm in 6 and 7 and C=2 cm in 8. Castaños et al (2017a).

	Artazu VII[a]	Basque Country[b]	Portugal[c]	Mediterranean sites[d]
	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max
Upper teeth				
LC	15,8	13,5 (4) 12,1-14,3	13,55 (4) 12,3-14,7	13,53 (3) 12,5-14,1
BC	12,5	10,6 (4) 9,3-11,5		12,7 (2)
LP3	19,63 (3) 18,8-20,5	19,0 (3) 18,7-19,2	15,6 (2) 15-16,2	18,11 (8) 16,2-20,3
BP3	9,33 (3) 8,6-9,8	8,97 (3) 8,3-9,3	7,9 (2) 7,8-8	8,86 (5) 8-9,4
LP4	24,4	25,75 (2) 25,7-25,8	25,65 (4) 23,8-28,6	24,65 (10) 22,6-26,5
BP4	14,5	13,7 (2) 12,1-13,3	13,13 (4) 12-15	12,91 (7) 12-13,7
Lower teeth				
LP3	14,27 (3) 13,2-14,9	14,22 (5) 12,6-15,4	11,6 (2) 11,4-11,8	13,45 (8) 12-14,6
BP3	7,23 (3) 7,2-7,3	7,0 (5) 6,6-7,4	6,35 (2) 6,2-6,5	6,82 (6) 6,4-7,7
LP4	18,87 (3) 18,6-19,2	18,49 (11) 17,6-20,2	18,38 (4) 16-20,4	17,75 (11) 15,7-20
BP4	9,5 (3) 8,5-10	8,99 (11) 7,7 -10,4	9,1 (3) 8-10,3	8,5 (10) 8-9,6
LM1	19,03 (3) 18,8-19,3	19,57 (12) 17,9-21,3	19,4 (5) 18,4-21,1	19,18 (10) 17,7-20,3
BM1	8,8 (3) 8,6-9	8,97 (12) 8,1-10,5	8,66 (5) 8-9,2	8,62 (9) 7,9-9,4
Metacarpal 3				
GL	74,8	77,0 (4) 72-84	69,6	75,7 (6) 70,8-77
Bp	14,3	13,8	15,6	16,34 (5) 14,5-18,4
SD	9,9	10,93 (4) 9,9-11,6	9	10,64 (7) 9,6-11,7
Bd	13	15,13 (3) 14,3-15,6	13,7	15,9 (7) 14,3-17,7
Metacarpal 4				
GL	76	84,5	78,8	72,47 (6)
Bp	12,8		12,5	12,58 (10) 11,4-13,7
SD	9,8		10,6	9,2 (6) 8,2-10,1
Bd	15,1		15,4	13,62 (6) 12,1-14,8
Talus				
GL	39,45 (2) 38,2-40,7	38,1 (3) 37,5-38,6	40,7	38,76 (8) 35,8-41,9

Table 20. Selected comparative measurements of *Panthera pardus* maxilla, mandible, metacarpal 3, metacarpal 4 and talus. Bd: Greatest distal breadth; Bp: Greatest proximal breadth; BC: Breadth canine; B: Breadth; GL: Greatest length; L: Length; SD: Smallest breadth of diaphysis. Mean: mean value, (n): number of individuals, Min: minimum and Max: maximum. [a] Artazu VII; [b] Bolinkoba (Castaños, 1987), Allekoaitze and Aintzulo (Altuna and Mariezkurrena, 2013), Praileaitz I (Castaños and Castaños, 2017), Imanolen Arrobia (Castaños et al., 2017b); [c] Algar da Manga Larga (Cardoso and Regala, 2006), Figueira Brava, Gruta do Euscoral and Lorga da Dine (Cardoso, 1993, 1996); [d] Avenc de Joan Guitón, Racó del Duc II, Cova Negra (Sanchis et al., 2015), Abric Romaní (Cáceres et al., 1993), S'Espasa (Estévez, 1975), Zafarraya (Barroso et al, 2006; Testu, 2006), Torrejones (Arribas, 1997), Cova del Gegant (Viñas and Villalta, 1975) and Gabasa (Blasco, 1995). Castaños et al. (2017a).

Artazu VII provided two mandibles that corresponded to the same individual (Castaños et al., 2017a). Additionally, a right mandible fragment with the two first jugal teeth (P3-P4) belonging to another individual was preserved. The two mandibles were complete, and the canine and all jugal teeth were well preserved. Even the left third incisor was preserved too (Castaños et al., 2017a). The lengths of the mandibles were similar to the leopard mandible measurements from Avenc de Joan Guitón (Sanchis et al., 2015) and Los Rincones (Sauqué and Cuenca-Bescós, 2013), exceed the remains from the Portuguese site Algar da Manga Larga (Cardoso and Regala, 2006) in size, and were smaller than those from Allekoaitz (Altuna and Mariezkurrena, 2013), Abric Romaní (Cáceres et al., 1993) and Zafarraya (Barroso et al., 2006). However, the length of the molar row and

	ATU-VII	AJG	AML	ALL	ARO	BZ	LR
Total Length	133.3	135.1	123.7	150.2	141.5	151.5	132
Length between condyle and infradentale	125	127.7	120.2	143.3			122
Length condyle and aboral border C1 alveolus	111.9	[111.8]	107.1	129.2	123.7		
Length between condyle and aboral border C1 alveolus	104.9	[108.4]	102.4	125.5	118.1		
Length cheektooth row P3-M1 alveoli	51.8	45.7	44.3	51.1	49.2	53.8	49
Heigth mandible behind M1	29.4	29.5	27.7	30			27.2
Heigth mandible in front P3	28	27	28.9	28.2		33	

Table 21. Mandible measurements of *Panthera pardus* fossils from the Iberian Peninsula. ATU-VII: Artazu VII; AJG: Avenc de Joan Guitón (Sanchis et al., 2015); AML: Algar da Manga Larga (Cardoso and Regala, 2006); ALL: Allekoaitz (Altuna and Mariezkurrena, 2013); ARO: Abric Romaní (Cáceres et al., 1993); BZ: Zafarraya (Barroso et al., 2006); LR: Los Rincones (Sauqué and Cuenca-Bescós, 2013) [Approximate measurement]. Castaños et al. (2017a).

the height behind m1 and in front of P3 were very similar in all Iberian samples (Tab. 21).

Measurements of the lower dentition at Artazu VII were similar to other leopard samples in the Basque Country as Lezetxiki, Bolinkoba or Imanolen Arrobia. Regarding leopard samples from Portugal, they had a larger P3 than Artazu VII remains and similar posterior teeth. They also had larger P3 and p4 than samples from Mediterranean Spain but matched the dimensions of the m1 (Tab. 20).

The scapula presented a glenoid cavity with an oval outline and with a well-developed coracoid process (Castaños et al., 2017a). This anatomical part is in general very low, and this increases the interest of the Artazu VII samples, whose dimensions are smaller than at Avenc de Joan Guitón (Sanchis et al., 2015) and S'Espasa (Estévez, 1975) (Tab. 22).

No complete humerus was recorded; only proximal and distal fragments were preserved. Thus, proximal and distal thickness widths are similar to the rest of the samples from the Iberian Peninsula (Tab. 22).

No complete radius was collected either, so fragmented radii were studied whenever possible (Castaños et al., 2017a). The width and thickness of the proximal diaphysis are larger than those from other Basque Country sites, but the distal width is less than those from the rest of the Iberian Peninsula (Tab. 22).

In the ulna, the olecranon process is well developed and was larger than Mediterranean Spain ulnas comparing to Avenc de Joan Guitón, Racó del Duc II, Cova Negra, Malladetes, S'Espasa (Estévez, 1975), Cova del Gegant (Viñas and Villalta, 1975), Los Rincones (Sauqué and Cuenca-Bescós, 2013) (Tab. 22).

The pelvis was not well preserved, so it has only been possible to compare the length of the acetabulum to leopard samples from Malladeta. Thus, the Artazu VII leopard pelvis acetabulum is slightly larger than the Malladeta samples. The measurements of third metacarpal, fourth metacarpal and talus are inside the range of fossil leopards (Tab. 22).

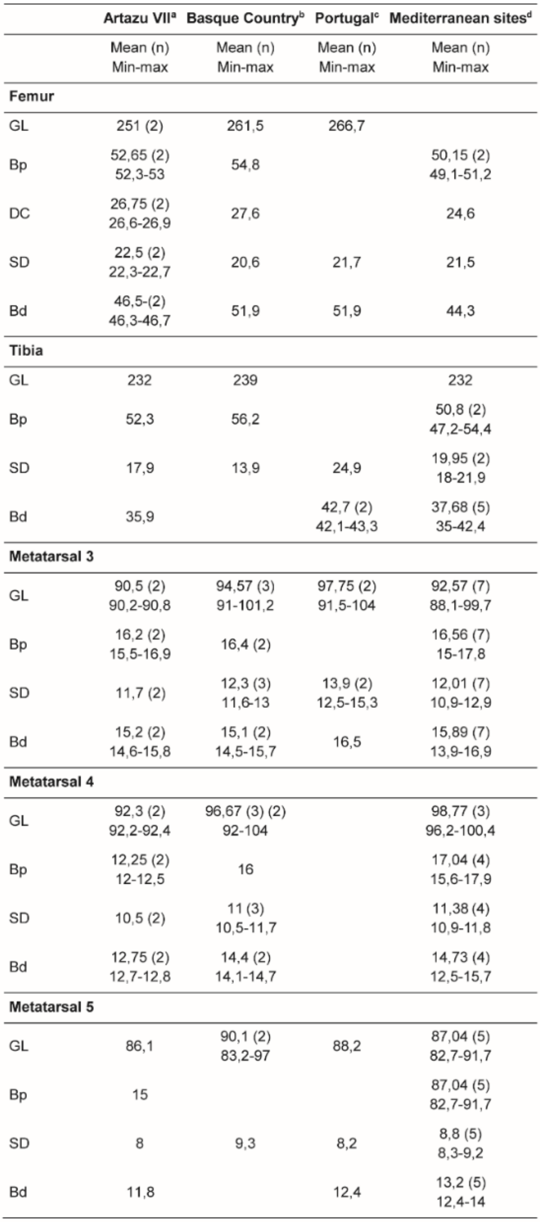
The assemblage contained two complete femora (Castaños et al., 2017a). The greater trochanter had the same height as the head in comparison with modern individuals. Artazu VII femora were shorter and thinner than those from the Basque Country and Portugal, but were similar to leopard remains from the rest of the Iberian Peninsula (Tab. 23). Patella measurements were within the domain of other late Pleistocene leopard remains in the Iberian Peninsula. Also, this bone assemblage conserved a complete tibia. Measurements of leopard tibia in the

	Artazu VII[a]	Basque Country[b]	Mediterranean sites[c]		Artazu VII[a]	Basque Country[b]	Mediterranean sites[c]
	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max		Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max
Scapula				**Phalanx 1**			
GLP	35,4		39,5 (3) 38-42,4	GL	38,95 (2) 38,5-39,4	38,4 (49) 32,9-47,2	34,7 (11) 32,1-38,4
LG	30,5		32,13 (3) 30,1-34,8	Bp	14,0 (2) 13,6-14,6	4,7 (46) 12,3-18,4	13,05 (11) 11,8-14,2
BG	23,3		24,47 (3) 24-24,8	SD	9,75 (2) 8,8-10,7	9,4 (48) 7,3-12,2	8,75 (13) 7,2-10,6
SLC	30		34,33 (3) 32-37	Bd	11,25 (2) 11,1-11,4	11,5 (48) 9,6-14	10,46 (13) 9,6-11,8
Humerus				**Phalanx 2**			
Dp	55,5		3,8 (2) 53,4-54,2	GL	24	30,1 (35) 23,5-36,5	26,46 (13) 22,3-30,2
Bp	48,2		42,3 (2) 42-42,6	Bp	12,2	12,1 (35) 10,3-14,3	10,85 (15) 10-11,5
Bd	52,95 (2) 52,4-53,5	52,45 (2) 50-54,9	51,88 (6) 47,6-54,7	SD	7,7	7,4 (35) 6,2-9	6,85 (13) 6,2-7,9
				Bd	9,3	11,3 (35) 9,6-13,6	10,02 (13) 9,2-10,6
Radius				**Pelvis**			
Bp	25,85 (2) 24,7-27	24,63 (4) 24-25,2	23,99 (8) 22,2-25,2	LA	35		30,7
Dp	19,3		17,46 (5) 16,5-18,4	BA	35		
SD	19	18,3 (2) 17,8-18,8	16,38 (4) 15,8-17,1				
Bd	34,85 (2) 34,4-35,3	40,7	37,1 (5) 34-40,7				
Ulna				**Patella**			
DPA	36,1 (2) 35,7-36,5	36,4	33,63 (3) 32,3-35,8	GL	38,5		34,4 (5) 31,5-36,6
SDO	27,9 (2) 27,6-28,2		28,35 (2) 28,2-28,5	GB	27,5		25,62 (6) 23,5-27,6
LO	38,8 (2) 38,6-39		40,7				

Table 22. Selected comparative measurements of *Panthera pardus* scapula, humerus, radius, ulna, phalanx 1, phalanx 2, pelvis and patella. BA: Breadth of acetabulum; Bd: Greatest breadth of distal end; BG: Breadth of glenoid cavity; Bp: Greatest proximal breadth; Dp: Proximal depth; DPA: Depth across procesus anconeus; GB: Greatest breadth; GL: Greatest length; GLP: Greatest length of the glenoid process; LA: Length of acetabulum; LG: Length of glenoid cavity; LO: Length of olecranon.; SD: Smallest breadth of diaphysis; SDO: Smallest depth of olecranon; SLC: Smallest length of collum scapulae. Mean: mean value, (n): number of individuals, Min: minimum and Max: maximum. [a] Artazu VII; [b] Lezetxiki (Altuna, 1972), Bolinkoba (Castaños, 1987), Aintzulo (Altuna and Mariezkurrena, 2013), Imanolen Arrobia (Castaños et al, 2017b); [c] Avenc de Joan Guitón, Racó del Duc II, Cova Negra, Malladetes (Sanchis et al., 2015), S'Espasa (Estévez, 1975), Cova del Gegant (Viñas and Villalta, 1975), Los Rincones (Sauqué and Cuenca-Bescós, 2013). Castaños et al. (2017a)

Iberian Peninsula are scarce. However, the Artazu VII leopard tibia dimensions were within the variation of other Iberian fossil leopards (Tab. 23).

In general, metatarsal and metapodial measurements displayed great variation. However, Artazu VII values were within the average of fossil leopards from the Iberian Peninsula (Castaños et al., 2017a) (Tab. 23).



	Artazu VII[a]	Basque Country[b]	Portugal[c]	Mediterranean sites[d]
	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max	Mean (n) Min-max
Femur				
GL	251 (2)	261,5	266,7	
Bp	52,65 (2) 52,3-53	54,8		50,15 (2) 49,1-51,2
DC	26,75 (2) 26,6-26,9	27,6		24,6
SD	22,5 (2) 22,3-22,7	20,6	21,7	21,5
Bd	46,5-(2) 46,3-46,7	51,9	51,9	44,3
Tibia				
GL	232	239		232
Bp	52,3	56,2		50,8 (2) 47,2-54,4
SD	17,9	13,9	24,9	19,95 (2) 18-21,9
Bd	35,9		42,7 (2) 42,1-43,3	37,68 (5) 35-42,4
Metatarsal 3				
GL	90,5 (2) 90,2-90,8	94,57 (3) 91-101,2	97,75 (2) 91,5-104	92,57 (7) 88,1-99,7
Bp	16,2 (2) 15,5-16,9	16,4 (2)		16,56 (7) 15-17,8
SD	11,7 (2)	12,3 (3) 11,6-13	13,9 (2) 12,5-15,3	12,01 (7) 10,9-12,9
Bd	15,2 (2) 14,6-15,8	15,1 (2) 14,5-15,7	16,5	15,89 (7) 13,9-16,9
Metatarsal 4				
GL	92,3 (2) 92,2-92,4	96,67 (3) (2) 92-104		98,77 (3) 96,2-100,4
Bp	12,25 (2) 12-12,5	16		17,04 (4) 15,6-17,9
SD	10,5 (2)	11 (3) 10,5-11,7		11,38 (4) 10,9-11,8
Bd	12,75 (2) 12,7-12,8	14,4 (2) 14,1-14,7		14,73 (4) 12,5-15,7
Metatarsal 5				
GL	86,1	90,1 (2) 83,2-97	88,2	87,04 (5) 82,7-91,7
Bp	15			87,04 (5) 82,7-91,7
SD	8	9,3	8,2	8,8 (5) 8,3-9,2
Bd	11,8		12,4	13,2 (5) 12,4-14

Table 23. Selected comparative measurements of *Panthera pardus* femur, tibia, 3rd, 4th and 5th metatarsals. Bd: Greatest distal breadth; Bp: Greatest proximal breadth; DC: Diameter of caput femoris; GL: Greatest length; SD: Smallest breadth of diaphysis. Mean:mean value, (n): number of individuals, Min: minimum and Max: maximum [a] Artazu VII; [b] Bolinkoba (Castaños, 1987), Aintzulo (Altuna and Mariezkurrena, 2013), Praileaitz I (Castaños and Castaños, 2017), Imanolen Arrobia (Castaños et al., 2017b); [c] Algar da Manga Larga (Cardoso and Regala, 2006), Gruta do Euscoral and Lorga da Dine (Cardoso, 1996); [d] Avenc de Joan Guitón, Racó del Duc II, Cova Negra (Sanchís et al., 2015), S'Espasa (Estévez, 1975), Zafarraya (Barroso et al, 2006; Testu, 2006), Los Rincones (Sauqué and Cuenca-Bescós, 2013). Castaños et al. (2017a).

In most discoveries, the phalanges are normally isolated, unless extremities appear in anatomical position, as occurs in Avenc de Joan Guitón (Sanchis et al., 2015). Therefore, to carry out the osteometric comparitive study, all the phalanges (except the first finger) were grouped (Castaños et al., 2017a). The large size of the Bolinkoba samples (Basque Country) can compensate for differences due to the anterior or posterior position of the phalanges (Tab. 23).

Panthera spelaea GOLDFUSS, 1810

Only eight remains of *Panthera spelaea* were recovered (Fig. 42), representing 0.7% (Tab. 15) of the assemblage. These remains were representatives of one adult female according to the subsequent data (Castaños et al., 2017a).

	Artazu VII	**Urtiaga [a]**	**El Castillo [b]**	**Lezetxiki [c]**	**Arrikrutz [d]**
				Mean (n) / Min-max	Mean (n) / Min-max
Metacarpal 2					
GL	104		116	119,35 (2) / 119,2-119,5	123,75 (2) / 123,5-124
Bp	23,5				
SD	14,9			17,4 (2)	18,9 (2) / 18,8-19
Bd	22				29 (2) / 28,5-29,5
Metatarsal 3					
GL	125,3	128,7	135	153 (2)	155 (2) / 154-156
Bp	25,7		26		
SD	17,9	16,5	18,3	23,45 (2) / 23,1-23,5	22,75 (2) / 22-23,5
Bd	24,7		25		30,5 (2)

Table 24. Selected comparative measurements of *Panthera spelaea*. Bd: Greatest distal breadth; Bp: Greatest proximal breadth; GL: Greatest length; SD: Smallest breadth of diaphysis. Mean: Mean value, (n): number of individuals, Min: minimum and Max: maximum. Artazu VII; [a] Urtiaga (Altuna 1972); [b] El Castillo (Castaños, P, 2017b); [c] Lezetxiki (Altuna, 1972) and [d] Arrikrutz Cave (Altuna, 1981b). Castaños et al. (2017a).

Phalanges cannot be attributed to a specific finger and the remaining bones were broken. Only two metacarpals were measurable (Tab. 24). Thus, lion measurements at Artazu VII were compared with four sites from the northern Iberian Peninsula (Castaños et al., 2017a): Urtiaga (Altuna, 1972), El Castillo (Castaños, P, 2017b), Lezetxiki (Altuna, 1972), and, whenever possible, with those of a complete skeleton, like Arrikrutz Cave (Altuna, 1981b). The remains at Artazu VII, Urtiaga and El Castillo are attributed to females and the Lezetxiki and Arrikrutz lions to males (Castaños et al., 2017a). In general, Artazu VII lions show the smallest dimensions.

Martes martes LINNAEUS, 1758

Marten, with two remains, represented 0.1 % of the assemblage (Tab. 15), corresponding to a minimum of just one individual (Castaños et al., 2017a). Since recent evidence indicates that beech marten (*Martes foina*) was an invader of the European subcontinent during Neolithic times (Llorente et al., 2011; Llorente-Rodríguez et al., 2014), the remains from Artazu VII were attributed to pine marten (*Martes martes*).

Meles meles LINNAEUS, 1758

The badger, with two talii, corresponding to a minimum of just one individual, represented 0.2 % (Tab. 15) of the assemblage (Castaños et al., 2017a).

Mustela nivalis LINNAEUS, 1758

Only one remain (skull fragment) of weasel was recovered, thus corresponding to one individual (Castaños et al., 2017a).

Mustela putorius (LINNAEUS, 1758)

Western Polecat only provided nine remains with a representation of 0.8% (Tab. 15) in the assemblage (Castaños et al, 2017). In the skull, the width of behind parts of the orbits is greater than the width between the condyles. The lower edge of the mandible is not bowed but is almost straight. The measurements of upper dentition in mm are Length P4: 7.8; Breadth P4: 4.3; Length M1: 3.8; Breadth M1: 6.7 and the lower dentition measurements Length m1: 8.5; Breadth m1: 3.6. These data fall within the domain of variation of this species in other late Pleistocene samples in the Iberian Peninsula as Bolinkoba (Castaños et al., 1983) or Valdavara 3 (Vaquero et al., 2017) among others.

Vulpes vulpes LINNAEUS, 1758

The Red Fox was the most abundant carnivore taxon with an abundance of 13.8 % (Tab. 15) and 160 remains (Castaños et al, 2017a). They represent a minimum of 8 adult individuals with representation of almost all parts of the skeleton.

The measurements at Artazu VII were compared (Tab. 25) with those at

Maxilla				**Mandible**							**Scapula**			
LP4	15,5	16,4	15,7	LP1-M3	65	62,4	58	67,2			GLP	17,5	20,3	18,9
BP4	7,1	7,2	7	LP1-P4	39	35	32	35,8			LG	16	17,6	16,6
LM1	10,7			LM1-M3	26,5	26,6	26	26,4			BG	10,7	11,8	11
BM1	12,1			LM1	16,4	15,6	15,4	15,7	16,2	15,7	SLC	15,8	17,7	16,7
				BM1	6,6	6	5,5	6,1	6,5	6,3				

Humerus								**Radius**				**Ulna**		
GL	124,5							Bp	10,9	12,8	11,9	DPA	14,7	16,8
Dp	24,4							Bd	16,6	16,3		SDO	12,3	14,3
SD	7,8													
Bd	20,9	23,2	25,5	22	23	22	21,6							

Mc	**2**	**5**	**5**	**5**	**5**	**Mt**	**3**	**4**	**5**	**5**
GL	45	42,7	44,4	46,4	39,7	GL	65,6	64	61,5	63,4

Femur			**Calcaneum**			**Talus**		**Tibia**						
Bd	21,6	23	GL	31,2	34,2	GL	18,3	GL	134,5	147,5				
			GB	11,9	13,5	GB	12	Bp	21,6	23,2				
								SD	8,1	9				
								Bd	15,2	16,8	15,2	15,2	15,8	16,6

Table 25. Measurements of *Vulpes vulpes*. B: Breadth; Bd: Greatest distal breadth; BG: Breadth of glenoid cavity; Bp: Greatest proximal breadth; Dp: Proximal depth; DPA: Depth across processus anconaeus; GL: Greatest length; GLP: Greatest length of the glenoid process; L: Length; LG:Length of glenoid cavity; SD: Smallest breadth of diaphysis; SDO: Smallest depth of olecranon; SLC: Smallest length of collum scapulae. Castaños et al. (2017a).

Gönnesdorf (Poplin, 1976) and with two individuals (male and female) in the collection of the Aranzadi Society (Altuna, 2004). All the measurements, both cranial and postcranial, from the Artazu VII sample exceed the maximum values of Arctic fox (Castaños et al., 2017a). Therefore it can be concluded that they belong to the Red Fox.

C. Avifauna

- Systematic attribution and quantification

1,786 bird bones were recovered from Artazu VII (Suárez-Bilbao et al, 2018). It had been attempted to provide the most specific taxonomic level possible in all cases (Tab. 26). Most of the unidentified remains were immature, and these amounted to approximately half of the total recovered remains. Thereby, 239 remains were identified to Family or, at least, to Order level and 519 remains to genus or species level.

	Chamber		Lower Ledge		Upper Ledge		Ex situ		TOTAL	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Buteo lagopus	1	1	1	1					2	2
Aquila chrysaetos							2	1	2	1
Aquila sp. / *Haliaeetus albicilla*							4	1	4	
Perdix perdix			12	2			2	1	14	3
Coturnix coturnix	35	5					2	1	37	6
Lyrurus tetrix	3	1	51	4			27	4	81	9
Alectoris sp.			1	1					1	1
Alectoris sp. / *Perdix perdix*			2						2	
Galliforme indet.	2		11				4		17	
Crex crex	1	1	5	2					6	3
Crex crex / *Rallus aquaticus*			9						9	
Rallidae indet.			2						2	
Bubo cf. *bubo*	1	1					2	1	3	2
Strigiforme indet.	1								1	
Corvus monedula			3	3					3	3
Pica pica							6	1	6	1
Pyrrhocorax graculus	6	2	92	15			52	10	150	27
Pyrrhocorax pyrrhocorax	1	1	30	8			19	5	50	14
Pyrrhocorax sp.	23		107				16		146	
Pyrrhocorax pyrrhocorax / *Pica pica*			3						3	
Corvidae indet.	19		150		1		29		199	
Passeriforme indet.			17				3		20	
Indet.	149		863		6		10		1028	

Table 26. Birds bones recovered from Artazu VII site (Arrasate, Gipuzkoa, northern Iberian Peninsula) organized by areas and representing the NISP and MNI for each one. Suárez-Bilbao et al. (2018).

Buteo lagopus PONTOPPIDAN, 1763

Only two remains of *B. lagopus* were recovered, representing 0.11 % of the remains in the assemblage and belonging to two individuals (Suárez-Bilbao et al, 2018).

In the case of coracoideum length, *t*-test is significant at 0.05 for *B. rufinus* and *B. buteo* (Tab. 27). In the mandibula of *B. lagopus* from Artazu VII no differences from modern *B. lagopus* and *B. buteo* could be observed (Tab. 27). In order to complete and to clarify the similarities and differences, Cluster analysis and K-means clustering analysis were also performed. For Cluster analysis, coracoideum measurements of Artazu VII were compared to current *B. lagopus*, *B. rufinus* and *B. buteo* (Fig. 43). The added value for *B. rufinus* coracoideum middle length (Lm) was extrapolated using statistical parameters given by Otto (1981) and Mourer-Chauviré (1975) (Suárez-Bilbao et al., 2018). On the other hand, mandibula measurements from Artazu VII had only been compared to current *B. lagopus* and *B. buteo* measurements due to the lack of data for the mandibulas of *B. rufinus*. Thus, the Cluster analysis (Fig. 44) shows that the biometry of the coracoideum and the mandibulae agrees with *B. lagopus* (Suárez-Bilbao et al, 2018). Regarding K-means clustering, the results display three

	Artazu VII	*Buteo lagopus*^{1}				*Buteo rufinus*^{2}				*Buteo buteo*^{1}			
	$\bar{x}$	n	$\bar{x}$	σ^2	Sig	n	$\bar{x}$	σ^2	Sig	n	$\bar{x}$	σ^2	Sig
Cor-GL	48.57	6	45.43	1.82	ns	9	54.36	3.7	*	27	44.31	4.27	*
Cor-Bb	21.97	6	22.62	0.81	ns	6	20.28	0.73	ns	27	20.16	1.09	ns
Cor-BG	18.78	6	18.52	0.95	ns	6	14.93	1.59	ns	27	16.17	1.01	ns
Cor-Lm	42.88	6	38.62	1.31	ns					27	40.47	3.32	ns
Man-GL	58.87	3	57.23	7.31	ns					19	56.14	4.72	ns
Man-LS	8.43	3	8.47	0.21	ns					19	9.38	0.61	ns
Man-LI	54.86	3	54.5	6.07	ns					19	53.21	4.12	ns
Man-BA	15.24	3	14.77	0.1	ns					20	13.77	0.31	ns
Man-GB	38.49	3	41.3	3.13	ns					20	37.86	2.3	ns

Table. 27. Measurements of *Buteo lagopus* from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula) and modern *Buteo lagopus*, *Buteo rufinus* and *Buteo buteo*. Sources: Otto (1981), Mourer-Chauviré (1975). Cor (coracoideum), Man (mandibula), GL: Total length, Bb: basal bread, BG width of the basal joint surface and Lm: middle lengh, LS: length of the pars symphysialis, LI: distance between the procesus mandibulae medialis and the dorsal end of the pars symphysialis, BA: maximum width of particular part and GB: width of the mandibula. Sig (*T*-test result): *: significant at 0.05 and ns: no-significant. Suárez-Bilbao et al. (2018).

groups: first group (*B. lagopus* from Artazu VII with current *B. lagopus*), second group (*B. rufinus*) and third group (*B. buteo*).

Figure. 43. *Buteo lagopus* remains from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). 1: mandibula, a: dorsal view, b: ventral view, c: right lateral view, 2: left coracoideum, a: dorsal view, b: ventral view. Scale bar 1 cm. Suárez-Bilbao et al. (2018).

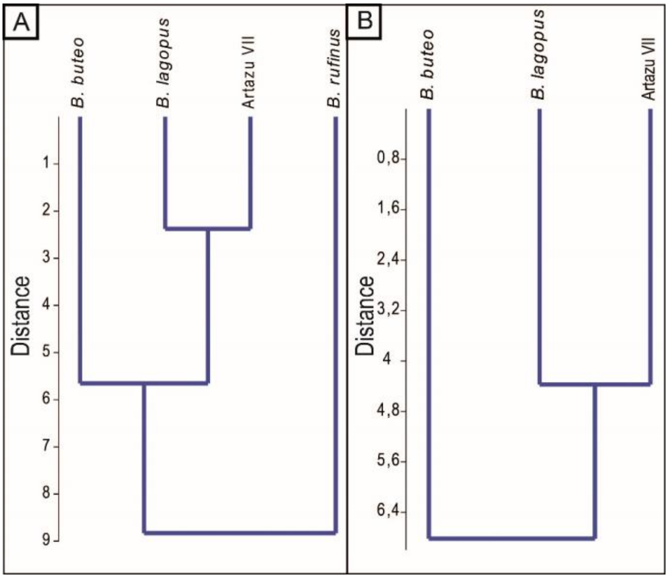


Figure 44. Cluster analysis using Paired group Algorithm and Euclidean distance for *Buteo lagopus* from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula) and current *Buteo lagopus*, *Buteo rufinus* and *Buteo buteo*. Sources: Otto 1981, Mourer-Chauviré 1975. A: Comparison of coracoideum from Artazu VII to current *B. buteo*, *B. lagopus and B. rufinus*. B: Comparison of coracoideum and mandibula from Artazu VII to current *B. buteo* and *B. lagopus*. Suárez-Bilbao et al. (2018).

Buteo lagopus is not a common bird in the Iberian Peninsula since it has only been observed occasionally, as a winter visitor. Its presence in the Pleistocene in lower latitudes was also unusual. Thereby *B. lagopus* remains have been found in Germany in the Magdalenian site of Kleine scheuer im lonetal (Baden-Württermberg) (Koken, 1912; Hölzinger, 1988); in Czech Republic in the Magdalenian site of Balcárka (Moravia) and in the Mousterian-Magdalenian site of Certova Díra (Moravia) (Capek, 1911; Lambrecht 1933); in France in the site of Abri des Pêrcheurs (Ardèche), between Final Gravettian and Epigravettian-Solutrean layers (Vilette, 1983), Isturitz (Pyrenees-Atlantiques) in Aurignacian layers (Bouchud, 1952) and in the early Würm period at the Malarnaud site (Ariège) (Clot and Mourer-Chauviré, 1986); in Hungary in the Magdalenian-Szeletian site of Puskaporos (Bükk) (Jánossy, 1986) and, during the last Interglacial in the Remetehegy site (Buda hills) (Lambrecht, 1914); in Italy in Tardigravetian-Epigravettian layers in Grotta Romanelli site (Puglia) (Cassoli, 1972; Bartolomei et al., 1979); and in the Iberian Peninsula, in Spain, in the Late Pleistocene (MIS 5) site of Valdegoba (Burgos), with a single remain of one left femur Sánchez-Marco (2004, 2005). For the above-mentioned reasons, the presence of *B. lagopus* in Artazu VII deserves a special mention since it is the second fossil record of this taxon in the Iberian Peninsula (Suárez-Bilbao et al, 2018).

Haliaeetus albicilla LINNAEUS, 1758
***Aquila* sp.** BRISSON, 1760

There were four remains that could not be assigned to any of the species (Suárez-Bilbao et al., 2018).

Aquila chrysaetos LINNAEUS, 1758

Aquila and *Haliaeetus* genera are very similar in size and morphology, although with the coracoidea it is possible to distinguish between them. In *Aquila*, the the shaft of processus acrocoracoideus is thinner, whereas the cotyla scapularis is larger in *Haliaeetus*. The assignment of the two remains of *Aquila chrysaetos* were performed by the shape of the coracoideum (Fig. 45)

Perdix perdix LINNAEUS, 1758

Perdix perdix (Fig. 45) composed the 0.78% of the assemblage with 14 remains (Suárez-Bilbao et al, 2018). This Galliform bones morphology and size allowed its classification as *P. perdix*.

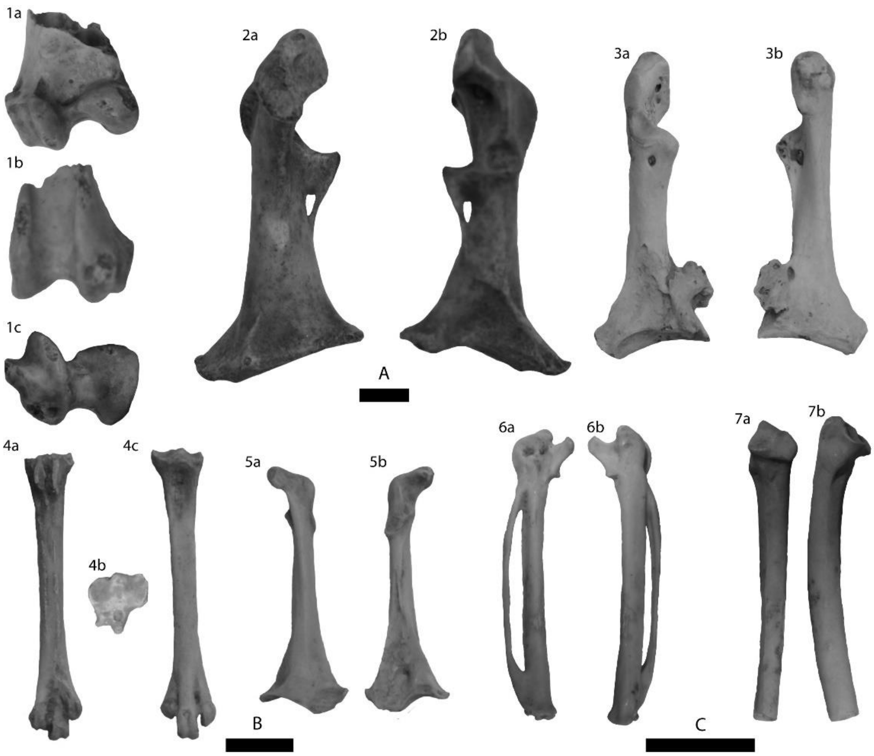


Figure 45. Bird remains from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). *Aquila chrysaetos*. 1 proximal left femur, a: cranial view, b: left view, c: distal end view, 2 right coracoideum, a: ventral view, b: dorsal view. *Bubo* cf. *bubo* 3 left coracoideum, a: dorsal view, b: ventral view. *Perdix perdix* 4 left tarsometatarsus, a: plantar view, b: proximal end view, c: dorsal view, 5 left coracoideum, a: ventral view, b: dorsal view. *Crex crex* 6 left carpometacarpus, a: ventral view, b: dorsal view, 7 left ulna, a: cranial view, b: caudal view. Scale bars 1 cm, A for 1 to 3, B for 4 and 5 and C for 6 and 7. Suárez-Bilbao et al. (2018).

Coturnix coturnix LINNAEUS, 1758

Thirty-seven remains of *Coturnix coturnix* were recovered (Fig. 46). The measurements of *C. coturnix* bones from Artazu VII are the oldest measurement record of this species in the Iberian Peninsula (Suárez-Bilbao et al., 2018). The *t*-tests performed with *C. coturnix* from Artazu VII and with a recent sample show no significant differences except for Cor-GL (Tab. 28). In this case, *t*-test values are 2.4359 $p < 0.0269$, but given the differences between the number of specimens in both samples and that their variances shows no significant differences (*F*-test: 2.5357 $p < 0.921$), the Welch test (Welch *t*: 3,5166 p < 0,1763) does not confirm that both samples have different means. So, although the sizes

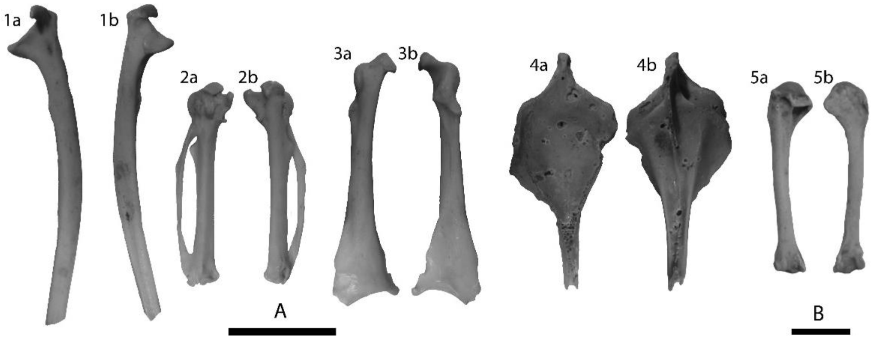


Figure 46. *Coturnix coturnix* remains from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). 1 right scapula, a: costal view, b: lateral view. 2 left carpometacarpus, a: ventral view, b: dorsal view. 3 right coracoideum, a: ventral view, b: dorsal view. 4 sternum, a: ventral view, b: dorsal view, c: dorsal view. 5 left coracoideum, a: cranial view, b: caudal view. Scale bars 1 cm, A for 1 to 4, B for 5. Suárez-Bilbao et al. (2018).

	Artazu VII				*Coturnix coturnix**				
	n	Min-Max	x̄	ó^2	n	Min-Max	x̄	ó^2	Sig
Cor-GL	2	23.94-24.33	24.14	0.28	16	21.62-23.6	22.63	0.71	*
Cor-SBS	2	2.09-2.2	2.15	0.08	16	1.99-2.5	2.24	0.14	ns
Hum-GL	3	35.14-36.08	35.61	0.66	18	32.6-36.2	34.59	1.1	ns
Hum-BP	4	7.69-8.13	7.9	0.18	17	7.6-9	8.17	0.39	ns
Hum-DP	4	4.08-4.44	4.2	0.17	17	3.67-4.45	3.99	0.21	ns
Hum-BD	3	5.31-5.8	5.52	0.25	18	5-5.9	5.49	0.26	ns
Hum-DD	3	3.44-5.36	4.1	1.09	18	3.15-3.8	3.41	0.2	ns
Hum-SBS	4	2.35-2.7	2.54	0.15	18	2.2-2.7	2.46	0.15	ns
Fem-GL	3	36.27-37.9	37.28	0.88	19	34.65-39.35	36.92	1.2	ns
Fem-BP	4	5.97-6.57	6.22	0.27	19	5.8-6.57	6.21	0.21	ns
Fem-DP	4	3.7-4.01	3.85	0.14	19	3.6-4.2	3.91	0.21	ns
Fem-BD	3	5.11-5.72	5.48	0.13	19	4.9-5.8	5.27	0.25	ns
Fem-DD	3	4.33-4.73	4.55	0.2	19	4.15-4.77	4.52	0.19	ns
Fem-SBS	3	2.43-2.68	2.56	0.13	19	2.2-2.8	2.36	0.15	ns
Uln-GL	3	30.71-31.15	30.86	0.25	19	28.6-31.6	30.09	0.98	ns
Uln-BP	3	5.19-5.22	5.2	0.02	19	4.65-5.25	5	0.18	ns
Uln-DP	3	3.6-3.72	3.63	0.08	19	3.05-3.5	3.29	0.14	ns
Uln-BD	3	3.66-4	3.81	0.17	19	3.55-4	3.74	0.11	ns
Uln-DD	3	2.56-2.61	2.59	0.03	19	2.2-2.7	2.17	0.13	ns
Uln-SBS	3	2.08-2.34	2.25	0.15	19	2.07-2.5	2.25	0.13	ns
Tmt-GL	1		25.16		18	25.05-28	26.64	0.76	ns
Tmt-BP	1		4.99		18	4.3-5	4.69	0.16	ns
Tmt-BD	1		4.89		18	4.5-5.6	4.96	0.27	ns
Tmt-SBS	1		2.36		18	2.3-2.9	2.52	0.2	ns

Table 28. Measurements of *Coturnix coturnix* from Artazu VII and modern specimens taken by Jaume et al. (1992). n (Number of specimens), Min (Minimum size), Max (Maximum size), x̄ (Mean value) and σ (Standart deviation). Abbreviations BD (breadth of the distal end), BP (breadth of the proximal end) DD (diameter of the distal end), DP (diameter of the distal end), GL (greatest length) and SBS (smallest breadth of the shaft. Sig (T-test result): *: significant at 0.05 and ns: no significant. Suárez-Bilbao et al. (2018).

of the bones of *C. coturnix* in the samples from Artazu VII are slightly bigger than those of modern specimens, it can be concluded that there are not statistical differences among them.

Lyrurus tetrix LINNAEUS, 1758

Lyrurus tetrix represented the 4.54 % of the assemblage with 81 skeletal remains and its measurements were taken following the methodology of Ersberdobler (1968). The measurements of the remains from the Artazu VII site contribute substantially to the knowledge of this taxon (Tab. 29), since it is one of the most abundant late Pleistocene assemblages with almost complete bones of this taxon in the Iberian Peninsula, which enables a well-documented morphometric study. *Lyrurus tetrix* is a species with marked/remarkable sexual dimorphism. Although

	n	Min-Max	$\bar{x}$	σ^2		n	Min-Max	$\bar{x}$	σ^2
Cor-GL	3	54.92-7.3	56.11	1.19	Cmc-GL	7	39.4-43.58	41.24	1.7
Cor-ML	4	49.8-53.23	51.49	1.56	Cmc-BP	6	20.8-12.51	11.56	0.6
Cor-BB	3	14.04-15.08	14.64	0.53	Cmc-BS	3	7.95-8.86	8.48	0.47
Scp-BC	5	12.57-13.43	12.97	0.36	Cmc-HS	5	5.4-6.61	5.9	0.49
Hum-GL	9	73.11-90.96	80.1	5.57	Cmc-DD	6	7.86-8.98	8.65	0.4
Hum-BP	10	20.02-24.5	21.84	1.6	Fem-GL	2	81.7-91	90	11.74
Hum-BD	10	13.4-116.56	14.49	1.03	Fem-BP	3	9.63-10.5	10.21	0.5
Hum-KS	8	6.8-8.35	7.47	0.5	Fem-DP	3	12.5-14.91	13.91	1.19
Rad-GL	1		67.85		Fem-BD	2	12.7-12.75	12.74	0.01
Rad-BP	3	4.6-4.94	4.79	0.17	Fem-DD	3	9.76-10.94	10.24	0.62
Rad-DP	3	5.4-5.05	5.29	0.21	Fem-KS	4	5.48-6.33	5.95	0.43
Rad-KS	2	2.89-3.14	3.02	0.18	Tbt-BP	1		9.97	
Rad-BD	1	6.08-6.46	6.27	0.27	Tbt-DP	1		14.18	
Uln-GL	4	71.48-81.64	75.97	4.28	Tbt-KS	7	4.4-5.48	4.9	0.47
Uln-BD	5	12.91-15.24	13.55	0.97	Tbt-DS	5	2.4-2.72	2.52	0.13
Unl-DP	5	12.08-14.54	12.8	0.99	Tbt-BD	7	8.72-10.75	9.5	0.79
Uln-DD	5	9.44-11.16	9.9	0.73	Tmt-GL	4	46.6-53.62	48.61	3.35
Uln-TP	5	8.04-8.7	8.39	0.34	Tmt-BP	4	9.77-11.23	10.33	0.63
Uln-KS	4	5.4-6.57	5.87	0.5	Tmt-BD	4	10.3-11.99	10.89	0.75
					TmtDD	4	10.4-12.15	10.93	0.82
					Tmt-KS	3	4.21-4.23	4.22	0.01

Table 29. Measurements of *Lyrurus tetrix* from Artazu VII site (Arrasate, Gipuzkoa, northern Iberian Peninsula following Ersberdobler (1968) measurements are in mm. Abbreviations and symbols: n (Number of specimens), Min (Minimum size), Max (Maximum size), $\bar{x}$ (Mean value), σ^2 (variance), BB (basal width), BC (cranial width), BD (breadth of the distal end), BP (breadth of the proximal end), BS (greatest width of the two shafts together), DD (diameter of the distal end), DP (diameter of the proximal end), GL (greatest length), HS (height of the symphysis), KS (smallest breadth of the shaft), ML (middle length) and TP (depth of proximal end). Suárez-Bilbao et al. (2018).

we have tried to establish sexual differences in the sample from Artazu VII following Ersberdobler (1968), it was only possible in few specimens. Therefore, both sexes appear grouped in Table 29 (Fig. 47) (Suárez-Bilbao et al., 2018).

Figure 47. *Lyrurus tetrix* remains from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). 1 left humerus, a: palmar view, b: anconal view. 2 distal tibiotarsus, a: cranial view, b: dorsal view. 3 sterna, a: dorsal view, b: ventral view. 4 right coracoideum, a: vental view, b: dorsal view. 5 left tarsometatarsus, a: plantar view, b: dorsal view. 6 left carpometacarpus, a: ventral view, b: dorsal view. 7: right ulna, a: cranial view, b: caudal view. 8: left scapula, a: lateral view, b: costal view, 9: left femur, a: cranial view, b: caudal view. 10 premaxilla, a: dorsal view, b: ventral view. 11 proximal phalanx distalis digit i majoris (first phalanx), a: dorsal view, b: ventral view. 12 left radius, a: caudal view, b: cranial view. 13 right quadratum, a: lateral view, b: medial view, c: caudal view. 14: pygostylus, a and c: lateral views, b: cranial view. Scale bars 1 cm, A for 1 to 4, B for 5 to 9 and C for 10 to 14. Suárez-Bilbao et al. (2018).

***Alectoris* sp.** KAUP, 1829

A single remain of *Alectoris* sp. was recovered, which represents the 0.06 % of the assemblage (Suárez-Bilbao et al., 2018). The genus *Alectoris* is represented by four species in the western Palearctic: *A. rufa*, *A. barbara*, *A. chukar* and *A. graeca*. They are almost indistinguishable osteologically and, since in Artazu VII, only one remain has been found, it has not been possible to identify at species level

Crex crex LINNAEUS, 1758

The six recovered remains reached the 0.34 % of the assemblage (Fig. 45) (Suárez-Bilbao et al., 2018). As a consequence of the similarity of *C. crex* and *Rallus aquaticus,* sometimes it had not been possible to separte between them.

Bubo* cf. *bubo LINNAEUS, 1758

Only three remains (Fig. 45), representing a percentage of 0.17, were recovered from Artazu VII (Suárez-Bilbao et al., 2018). Although the shape and size correspond to the *Bubo* genus, it was not possible to assign certainty at species level the remains from Artazu VII.

Order PASSERIFORMES LINNAEUS, 1766

The corvids represented the 11.70 % of the assemblage with 352 remains (Suárez-Bilbao et al., 2018). Due to the great similarity of *C. monedula*, *P. pica*, *P. graculus* and *P. pyrrhocorax,* it was not been possible to assess all the remains to species level using the reference collection. For this reason, the Corvidae were identified with morphologic and biometric criteria given by Tomek and Bochenski (2000).

- Site spatial distribution

All the studied areas were compared by taking into account the Order, NISP and MNI represented in each one, with the except of Storage 2, where NISP and MNI remains were not compared because of the mixing of remains (Suárez-Bilbao et al, 2018). In this way, the UL was only represented by Passeriformes but with no classifiable remains at genus or species level (Fig. 48). Although the area with most Orders was the C with the representation of all of them, the richest area in number of taxa is the LL with four Orders (Fig. 48) Hence, the LL yielded ten identifiable taxa with a NISP of 496 and a MNI of 36 compared with the Chamber that has seven species and a NISP of 93 and a minimum of 12 individuals (Tab.

26). In both areas, the most abundant elements were those that belong to Corvids (*P. pyrrhocorax*, *P. graculus*, *P. pica* and *C. monedula*), which make up 67.5 % of the assemblage in the LL and 83.3 % in the C, followed by *L. tetrix* in both cases. The remaining species do not reached 4 % of the assemblage. Regarding the differences in species between the LL and the C, the former was marked by the presence of *P. perdix, C. coturnix, P. pica* and *Alectoris* sp. while the latter was by *B.* cf. *bubo* and *B. lagopus* (Suárez-Bilbao et al., 2018).

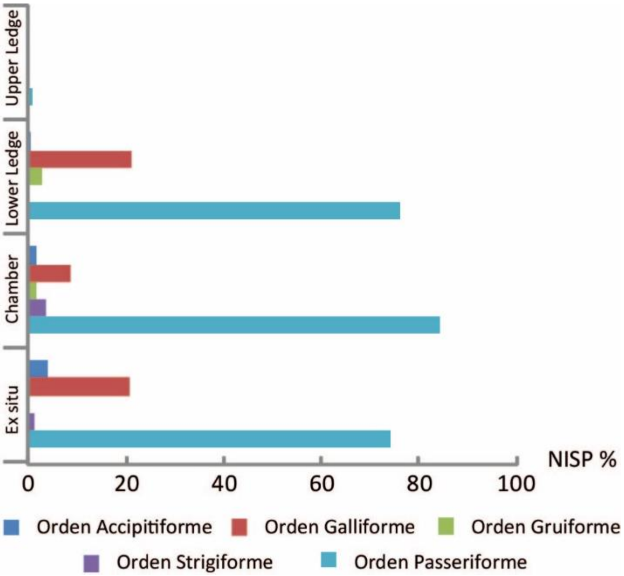
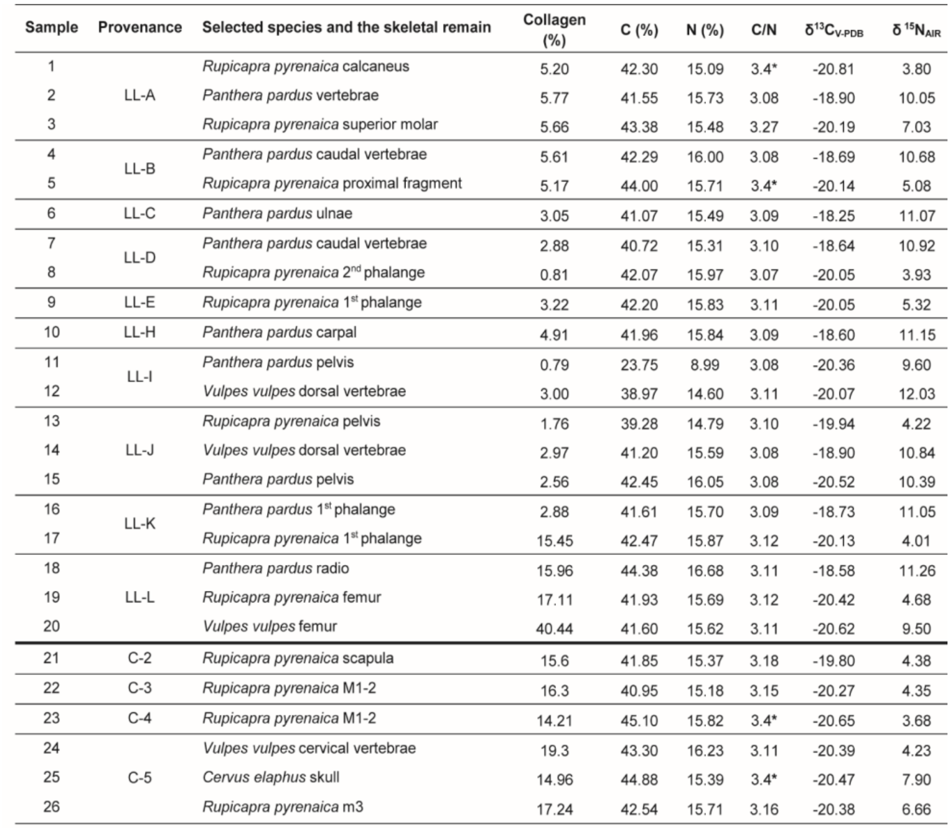


Figure 48. Proportions of represented bird Orders in the four zones studied in Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). Suárez-Bilbao et al. (2018).

D. Geochemestry

In Artazu VII $\delta^{13}C$ and $\delta^{15}N$ of some large mammals (displayed in Table 30) were analysed. The extracted collagen from the large mammal bones vary from 0.78 and 40.4%, while the percentage of C and N are greater than 23.7 % and 8.9 %, respectively. The C/N results were valid, since they were comprised between 2.6 and 3.4 (Schoninger et al., 1989). Generally, in Artazu VII the differences in C/N relations are minimum due to the good preservation of the extracted collagen (DeNiro, 1985; Ambrose, 1990).



Sample	Provenance	Selected species and the skeletal remain	Collagen (%)	C (%)	N (%)	C/N	$\delta^{13}C_{V\text{-}PDB}$	$\delta^{15}N_{AIR}$
1	LL-A	*Rupicapra pyrenaica* calcaneus	5.20	42.30	15.09	3.4*	-20.81	3.80
2		*Panthera pardus* vertebrae	5.77	41.55	15.73	3.08	-18.90	10.05
3		*Rupicapra pyrenaica* superior molar	5.66	43.38	15.48	3.27	-20.19	7.03
4	LL-B	*Panthera pardus* caudal vertebrae	5.61	42.29	16.00	3.08	-18.69	10.68
5		*Rupicapra pyrenaica* proximal fragment	5.17	44.00	15.71	3.4*	-20.14	5.08
6	LL-C	*Panthera pardus* ulnae	3.05	41.07	15.49	3.09	-18.25	11.07
7	LL-D	*Panthera pardus* caudal vertebrae	2.88	40.72	15.31	3.10	-18.64	10.92
8		*Rupicapra pyrenaica* 2nd phalange	0.81	42.07	15.97	3.07	-20.05	3.93
9	LL-E	*Rupicapra pyrenaica* 1st phalange	3.22	42.20	15.83	3.11	-20.05	5.32
10	LL-H	*Panthera pardus* carpal	4.91	41.96	15.84	3.09	-18.60	11.15
11	LL-I	*Panthera pardus* pelvis	0.79	23.75	8.99	3.08	-20.36	9.60
12		*Vulpes vulpes* dorsal vertebrae	3.00	38.97	14.60	3.11	-20.07	12.03
13	LL-J	*Rupicapra pyrenaica* pelvis	1.76	39.28	14.79	3.10	-19.94	4.22
14		*Vulpes vulpes* dorsal vertebrae	2.97	41.20	15.59	3.08	-18.90	10.84
15		*Panthera pardus* pelvis	2.56	42.45	16.05	3.08	-20.52	10.39
16	LL-K	*Panthera pardus* 1st phalange	2.88	41.61	15.70	3.09	-18.73	11.05
17		*Rupicapra pyrenaica* 1st phalange	15.45	42.47	15.87	3.12	-20.13	4.01
18	LL-L	*Panthera pardus* radio	15.96	44.38	16.68	3.11	-18.58	11.26
19		*Rupicapra pyrenaica* femur	17.11	41.93	15.69	3.12	-20.42	4.68
20		*Vulpes vulpes* femur	40.44	41.60	15.62	3.11	-20.62	9.50
21	C-2	*Rupicapra pyrenaica* scapula	15.6	41.85	15.37	3.18	-19.80	4.38
22	C-3	*Rupicapra pyrenaica* M1-2	16.3	40.95	15.18	3.15	-20.27	4.35
23	C-4	*Rupicapra pyrenaica* M1-2	14.21	45.10	15.82	3.4*	-20.65	3.68
24	C-5	*Vulpes vulpes* cervical vertebrae	19.3	43.30	16.23	3.11	-20.39	4.23
25		*Cervus elaphus* skull	14.96	44.88	15.39	3.4*	-20.47	7.90
26		*Rupicapra pyrenaica* m3	17.24	42.54	15.71	3.16	-20.38	6.66

Table 30. $\delta^{13}C$ and $\delta^{15}N$ isotopic values from Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula): *Rupicapra pyrenaica, Cervus elaphus, Panthera pardus* and *Vulpes vulpes* some remains. N (Number of samples), * Samples with high C/N proportion. Modified from Zamora (2018).

- $\delta^{13}C$ isotopes

In general, the $\delta^{13}C$ isotopic values from all studied samples were very similar. While the herbivore group shows a value of -20.25 ‰, the carnivore group showed an average value of $\delta^{13}C$ of -19.32 ‰. However, there were some small differences among them (Tab. 31). In the case of the herbivores the values differed from -19.94 ‰ to -20.81‰, while in the carnivores varies between -18.25‰ and 20.62 ‰.

Species	N	Maximum $\delta^{13}C$	Minimum $\delta^{13}C$	Average $\delta^{13}C$
Cervus elaphus	1	-20.47	-20.47	-20.47
Rupicapra pyrenaica	12	-19.80	-20.81	20.23
Vulpes vulpes	4	-20.62	-18.90	-19.99
Panthera pardus	9	-20.52	-18.25	-19.02

Table 31. $\delta^{13}C$ isotopes values from analised large mammal bones at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). Values are given in ‰.N (Number of samples). Zamora (2018).

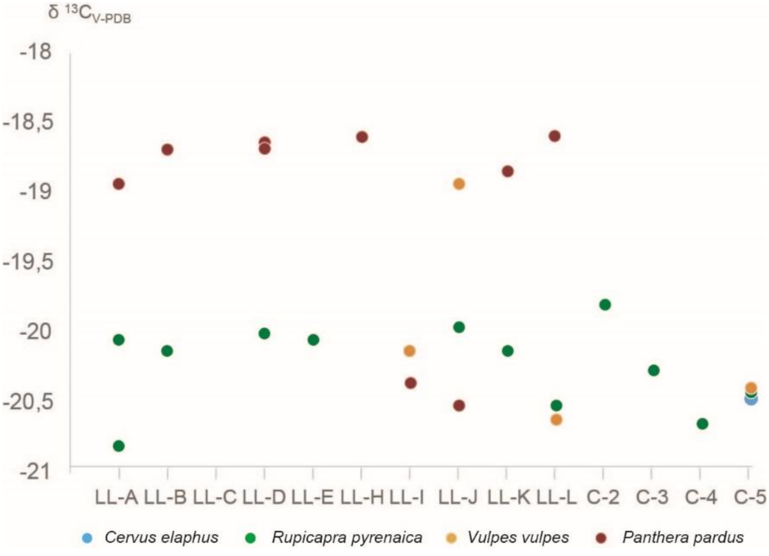


Figure 49. $\delta^{13}C$ isotopic variation in relation regarding stratiprahy at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula).

Bearing in mind that the fractionation was around 1.5, there were no significant differences between the $\delta^{13}C$ isotopic values of the samples and they were independent of the stratigraphy (Fig. 49). Even so, it could be observed an increase of $\delta^{13}C$ from C-4 to C-2. The value decrease in the LL-L to reach again till the LL-D. Finally, $\delta^{13}C$ values recuded again.

- $\delta^{15}N$ isotopes

As it could be observed in Table 32, they were significant differences between the herbivore and carnivore groups, since the mean value of $\delta^{15}N$ isotopes is 5 ‰ for herbivores and 10.21 ‰ for carnivores. In addition, there were also clear differences in the $\delta^{15}N$ average values amongst herbivores and carnivores; 1.53 ‰ for carnivores and 3.14 ‰ for herbivores (Tab. 31).

Further analysis revealed that there were slight variations from the bottom to the top of the stratigraphic sequence in the herbivore taxa (Fig. 50). The transition between C-4 to LL-L showed a homogeneous trend, with around 4 ‰. From that point on, the tendency reached higher values. The fractioning between carnivores and herbivores was $\Delta\ \delta^{15}N = 5.21$ ‰. However, three herbivore individuals (*R. pyrenaica* and *C. elaphus* from C-5 and *R. pyrenaica* from the LL-A) present higher $\delta^{15}N$ values. In the same way, there was a *V. vulpes* individual in C-5 that showed lower values of $\delta^{15}N$ compared with the remaining carnivores.

Species	**N**	**Maximum $\delta^{15}N$**	**Minimum $\delta^{15}N$**	**Average δ^{15N}**
Cervus elaphus	1	7.9	7.9	7.9
Rupicapra pyrenaica	12	7.03	3.68	4.76
Vulpes vulpes	4	12.03	4.23	9.15
Panthera pardus	9	11.26	9.6	10.68

Table 32. $\delta^{15}N$ isotopes values from analised large mammal bones at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula). Values are given in ‰. N (Number of samples).

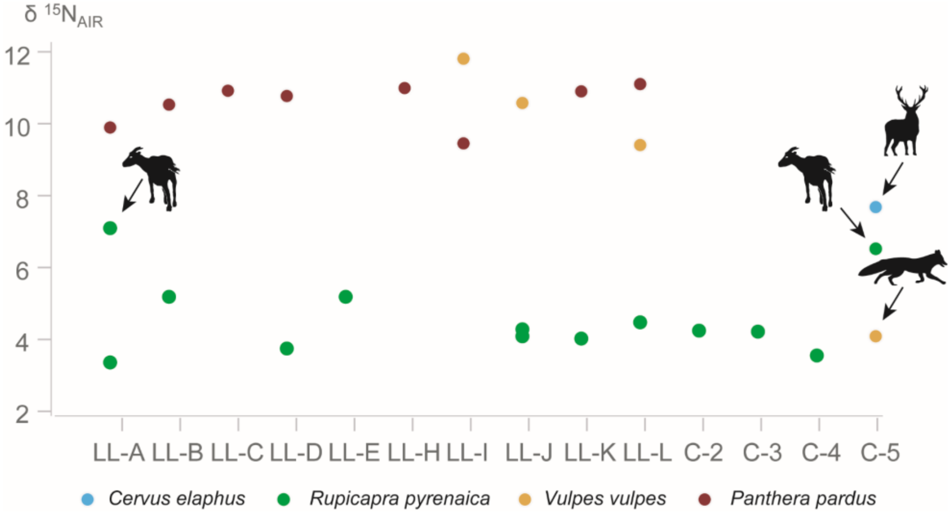


Figure 50. $\delta^{15}N$ isotopic variation in relation regarding stratiprahy at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula).

- $\delta^{15}N/\delta^{13}C$ isotopes

Regarding the $\delta^{15}N/\delta^{13}C$ isotopes ratio both herbivore and carnivore assemblages were clearly separated, with the exception of one individual of *V. vulpes* which appeared among the herbivore group (Fig. 51). The herbivores form a single group with disperse $\delta^{13}C$ values and three individuals stood out due to their higher values of $\delta^{15}N$. The carnivore assemblage showed similar values of $\delta^{15}N$, although regarding $\delta^{13}C$ values, they were separated in two groups.

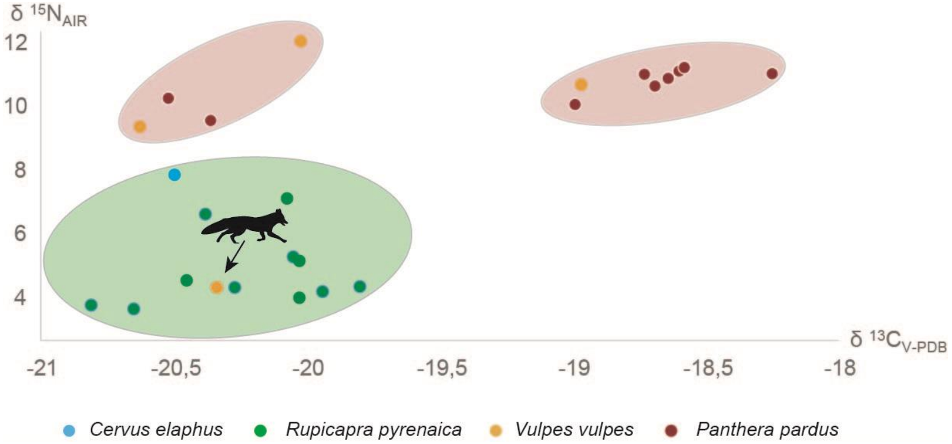


Figure 51. $\delta^{15}N/\ \delta^{13}C$ isotopic variation at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula).

6.2. Artazu VIII

The results of the ten selected samples for AAR dating cover a temporal range of at least 37 kyr, from 101.7 ka to 63.1 ka (Tab. 33). Numerous studies were performed in this site, therefore, each analysis is explained separately.

Level	Lab Code	D/L Asp	Age (ka)		Sample	
1	LEB-14060	0.085	63.1	65.05±1.95	M3	*Bison priscus*
1	LEB-14061	0.089	67		m3	
3	LEB-14062	0.092	69.8		m3 of *Bison priscus*	
4	LEB-14063	0.096	73.1		m3 of *Bison priscus*	
5	LEB-14064	0.097	73.4		m3 of *Bison priscus*	
6	LEB-14065	0.102	78.5		m1-2 of *Bison priscus*	
7	LEB-14066	0.106	81.9		M1-2 of *Bison priscus*	
8	LEB-14067	0.111	85.9		M1-2 of *Bison priscus*	
8	LEB-14071	0.127	99.8	101.7±1.9	Left M1	*Coelodonta antiquitatis*
8	LEB-14072	0.131	103.6		Right M1	

Table 33. Amino Acid Racemization ages from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula).

A. Small mammals

- Small mammal assemblage

More than 60,000 small vertebrate remains were extracted from the 600 l of sediment recovered in the three stratigraphic trenches. In this way, Artazu VIII provided a total of 8,129 identifiable remains (NISP) at species level, or at least at genus level, corresponding to a minimum number of 3,036 individuals (MNI) (Tab. 34). A total of 14 different taxa were recognized: eight from Order Rodentia (*Apodemus sylvaticus-flavicollis, Arvicola amphibius, Chionomys nivalis, Microtus (Microtus) agrestis, Microtus (Microtus) arvalis, Microtus (Alexandromys) oeconomus, Microtus (Terricola)* sp., and *Pliomys lenki)*, five from Order Eulipotyphla (*Erinaceus europaeus, Neomys* sp., *Sorex (Sorex) araneus-coronatus, Sorex (Sorex) minutus* and *Talpa* sp.) and one unidentifiable remain from Order Chiroptera (Fig. 52). The absence of glirids such as *Eliomys quercinus* or *Glis glis* was noteworthy; these species are associated with benign conditions in temperate climates and forest biotopes (Chaline, 1970; Rzebik-Kowalska, 1995; Sesé, 2005b).

Levels	1												2		3				4						5				6	
Column I													I.1		I.2		I.3		I.4		I.5		I.6		I.7		I.8		I.9	
Column II	II.1		II.2		II.3		II.4		II.5		II.6								II.7						II.8				II.9	
Column III																														
	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI
Arvicola amphibius													1	1	1	1	7	4	22	14	2	1	6	3	2	2	1	1	2	2
Apodemus sylvaticus-flavicollis	3	1	2	2	2	1	1	1	3	2	1	1	2	1	1	1	14	4	34	8	9	2	3	2	7	2	6	2	26	6
Microtus agrestis	3	2	1	1	1	1	2	2	3	2	1	1	43	25	21	11	88	46	498	273	17	10	23	14	30	16	19	11	99	55
Microtus arvalis	4	2	5	3	9	5	4	3			3	2	47	26	49	36	156	80	741	383	27	17	24	14	47	25	55	29	152	81
Microtus (Alexandromys) oeconomus																			1	1					0	0	1	1	6	4
***Microtus (Terricola)* sp.**									4	2			7	4	5	4	11	8	47	31	3	2	6	4	7	5	8	4	15	12
Chionomys nivalis																	4	1	5	4			1	1	1	1			2	2
Pliomys lenki			2	1	4	1			3	1	2	1					5	2	2	1	3	1	1	1	7	4			1	1
***Neomys* sp.**									1	1							2	1	13	7			4	2	3	2	3	1	3	1
Sorex (Sorex) araneus-coronatus	9	2	14	2	39	10	10	1	12	3	1	1	233	33	75	10	569	70	1367	315	80	12	74	29	238	45	39	10	392	46
Sorex (Sorex) minutus					1	1							11	3			12	8	48	26	1	1	8	4	7	5	4	3	29	10
***Talpa* sp.**	3	1					1	1	4	2					1	1	1	1	7	2	3	1	3	1					8	2
Erinaceus europaeus			1	1			1	1	1	1									1	1									6	5
Chiroptera indet.																			1	1										
Shannon Weaver index	1.56		1.7		1.31		1.68		2.01		1.56		1.42		1.29		1.55		1.46		1.8		1.66		1.59		1.72		1.61	

Table 34a. Number of identified specimens (NISP) and minimum number of individuals (MNI) of small vertebrate species from Artazu VIII (Arrasate, northern Iberian Peninsula) organized by levels.

Levels	**7a**								**7b**								**8**									
Column I			I.10																							
Column II	II.10		II.11		II.12		II.13		II.14		II.15															
Column III									III.1		III.2		III.3		III.4		III.5		III.6		III.7		III.8		III.9	
	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI
Arvicola amphibius			2	2	1	1	10	6	4	2							1	1					2	1	1	1
Apodemus sylvaticus-flavicollis	7	2	13	3	11	4	3	1											1	1	1	1	1	1	1	1
Microtus (Microtus) agrestis	50	33	57	39	32	18	139	80	103	65	66	44	1	1	4	4	19	16	8	4	22	11	14	9	45	29
Microtus (Microtus) arvalis	51	27	106	66	64	33	116	66	131	74	75	40	1	1	5	5	16	11	10	7	37	22	23	12	10	5
Microtus (Alexandromys) oeconomus	2	1	3	3	5	3	14	8	14	10	6	5													1	1
***Microtus (Terricola)* sp.**	3	3	1	1	2	1	10	6	6	5	3	2											3	2	2	2
Chionomys nivalis							10	7	8	5	1	1									2	2	1	1		
Pliomys lenki	2	1	4	2	6	1			4	2	3	1									1	1			1	1
***Neomys* sp.**	1	1			2	2					4	1														
Sorex (Sorex) araneus-coronatus	144	16	115	19	150	16	72	12	76	8	32	6	6	2	2	1	10	2	26	4	22	2	42	3	47	6
Sorex (Sorex) minutus	7	2	19	8	4	2	3	1	6	3	1	1					1	1			1	1	5	4	1	1
***Talpa* sp.**			3	1			4	1			0	0							1	1						
Erinaceus europaeus											2	1														
Chiroptera indet.																										
Shannon Weaver index	1.49		1.64		1.47		1.41		1.35		1.04		0.94		1.11		1.38		1.26		1.68		1.34		0.95	

Table 34b. Number of identified specimens (NISP) and minimum number of individuals (MNI) of small vertebrate species from Artazu VIII (Arrasate, northern Iberian Peninsula) organized by levels.

	8										9				10		12					
Column I																						
Column II																						
Column III	III.5		III.6		III.7		III.8		III.9		III.10		III.11		III.12		III.13		III.14		III.15	
	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI	NISP	NMI
Arvicola amphibius	1	1					2	1	1	1	1	1										
Apodemus sylvaticus-flavicollis			1	1	1	1	1	1	1	1			2	1								
Microtus (Microtus) agrestis	19	16	8	4	22	11	14	9	45	29	21	11	7	5	1	1						
Microtus (Microtus) arvalis	16	11	10	7	37	22	23	12	10	5	25	14	5	3								
Microtus (Alexandromys) oeconomus									1	1												
***Microtus (Terricola)* sp.**							3	2	2	2	1	1										
Chionomys nivalis					2	2	1	1					1	1								
Pliomys lenki					1	1			1	1			2	1								
***Neomys* sp.**																						
Sorex (Sorex) araneus-coronatus	10	2	26	4	22	2	42	3	47	6			31	4			1	1				
Sorex (Sorex) minutus	1	1			1	1	5	4	1	1			1	1								
***Talpa* sp.**			1	1																		
Erinaceus europaeus																						
Chiroptera indet.																						
Shannon Weaver index	1.38		1.26		1.68		1.34		0.95		1.72		1.48		-		-		0		0	

Table 34c. Number of identified specimens (NISP) and minimum number of individuals (MNI) of small vertebrate species from Artazu VIII (Arrasate, northern Iberian Peninsula) organized by levels.

- Small mammalian community changes over levels

All the samples exhibited a predominance of *M. (M.) agrestis* and *M. (M.) arvalis* specimens together with *S. (S.) araneus-coronatus* (Fig. 53). In addition, in the lower part of Level 7 the proportion of *M. (A.) oeconomus* reached the percentage of *S. (S.) araneus-coronatus* or even exceeded it (Fig. 53). A similar situation occured in Level 1 with other taxa, since the proportions of *A. sylvaticus-flavicollis* reacheed similar values to *S. (S.) araneus-coronatus, M. (M) agrestis* or *M. (M.) arvalis,* depending on the sample (Fig. 53).

The last two samples from Level 12 were barren, while another sample from that level and the sample from Level 10 only provided a single skeletal remain. Therefore these four samples were not considered to estimate the paleoenvironment. The results indicated some differences in taxa richness among the other nine levels in Artazu VIII (Fig. 53). Therefore, while the lower part of Level 7 with three different taxa, and Level 9 with 4 species, contained the lowest number of taxa, Level 4 displayed the largest number. The average value of the Shannon index was low (H'= 1.477) and no large differences could be observed in the sequence (Fig. 53), although Levels 9, 7b and 3 showed the relatively lowest indices (Tab. 34).

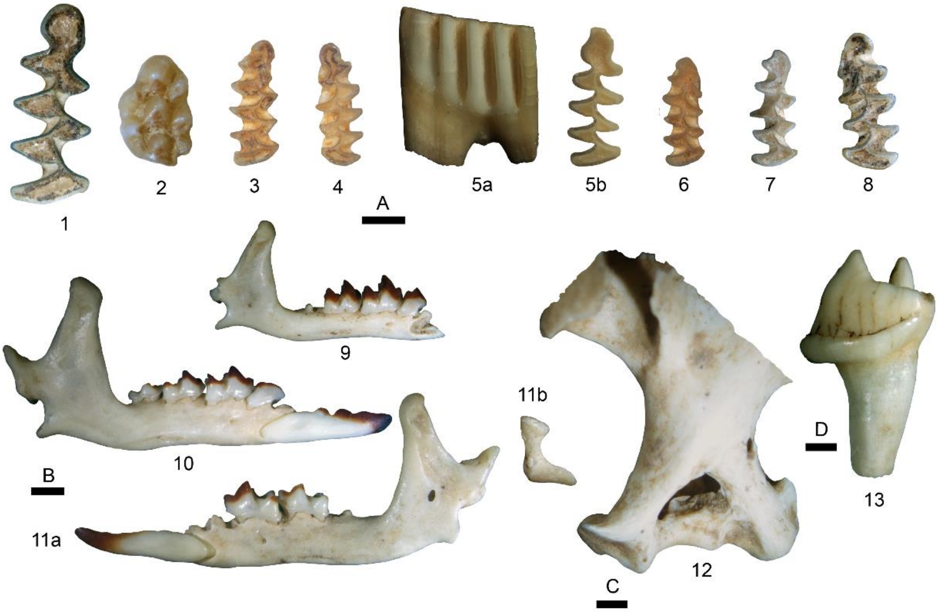


Figure 52. Small mammal remains from Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula) in occlusal view (except 5a, 10, 11, 12a and 14 in labial view, 12b in occlusal view and 13 in lateral view). 1, *Arvicola amphibius* right m1; 2, *Apodemus sylvaticus-flavicollis* left M1; 3, *Microtus (Microtus) agrestis* right m1; 4, *Microtus (Microtus) arvalis* left m1; 5, *Pliomys lenki*. right m1, a lingual view and b occlusal view; 6, *Microtus (Terricola)* sp. right m1; 7 *Microtus (Alexandromys) oeconomus* right m1; 8, *Chionomys nivalis*; 9, *Sorex (Sorex) minutus* right mandible; 10, *Sorex (Sorex) araneus-coronatus* right mandible; 11, *Neomys* sp. left a) mandible, b) condyle; 12, *Talpa* sp. right humerus and 13, *Erinaceus europaeus* right m2. Scale bars = 1 mm, A for figures 1 to 9, B for figures 10 to 12, C for 13 and D for 14.

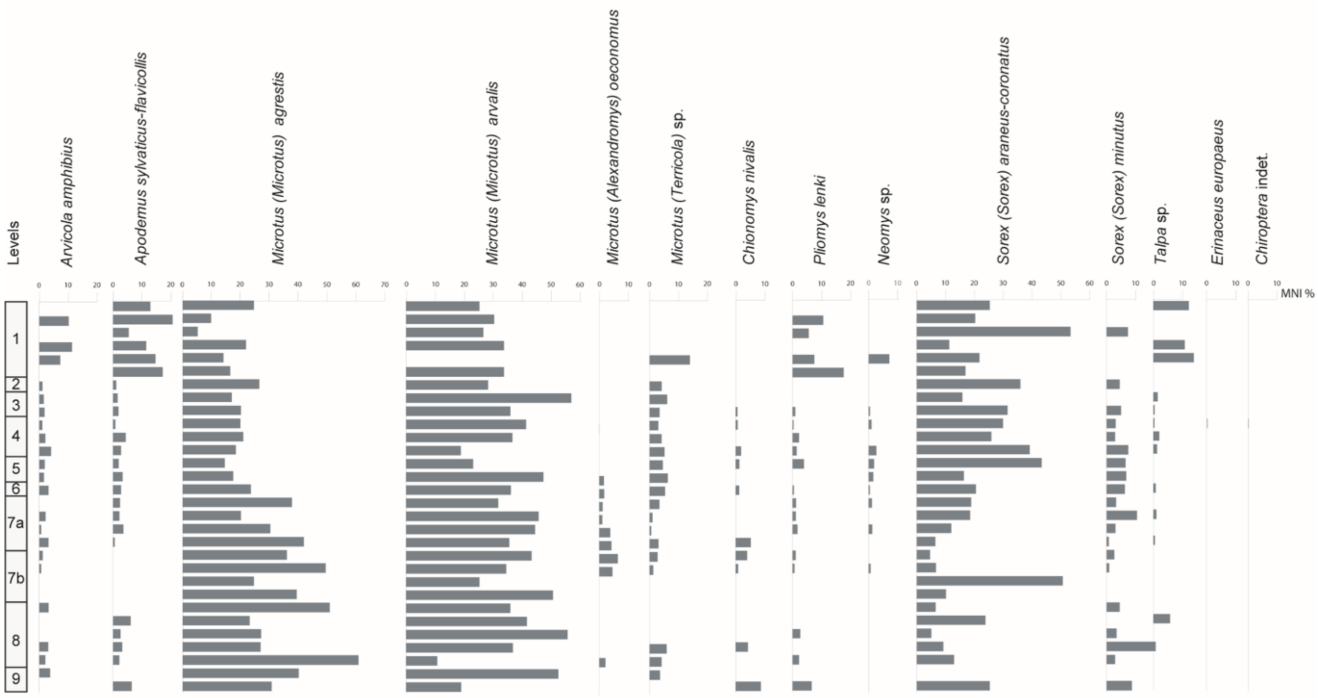


Figure 53. Number of identified specimens (NISP) and minimum number of individuals (MNI) of small mammal species from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) organized by levels.

Albeit with differences in their percentages, there are species that appeared in all levels or in most of them as *M. (M.) agrestis*, *M. (M.) arvalis, S. (S.) araneus-coronatus, S. (S.) minutus, Talpa* sp., or *P. lenki* (Fig. 53). Hence, the MNI proportions of *A. sylvaticus-flavicollis* among the sequence varied from 0 to 20 %, not being presented in 7b sublevel (Fig. 53). In contrast, *M. (A.) oeconomus* was only present in Levels from 5 to 7b, in the lower part of Level 8 and with only one remain in Level 4 (Fig. 53 and Tab. 34). *Chionomys nivalis* was present, but not in all samples, in Levels 3 to 9, and always representing less than 7 % of the assemblage. Something similar occured with *Neomys* sp., since it was present in Levels 1 to 7b with the exception of Level 2, showing always a lower proportion than 8% (Fig. 53). *Arvicola amphibius* was recovered in all levels with lower percentage of 12 %, with the exception of Level 6. Finally, *E. europaeus* and Chiropera indet. were only present in Level 4 with an imperceptible percentage (less than 1 %) (Fig. 53).

B. Large mammals

- **Systematic attribution and quantification**

Large mammal more specific analysis as compared morphometry studies are still under study. Notwithstanding, the taxonomical attribution and quantification from all levels are already performed. Thus, the results obtained up to now are presented here. A total of 4,541 large mammal remains were recovered at Artazu VIII, of which 4,331 (95.4 % of the remains) were taxonomically identifiable (Tab. 35). Amongst them, ungulate remains represented 97.8 % of the assemblage and belonged to *Bison priscus*, *Cervus elaphus, Equus ferus caballus, Coelodonta antiquitatis, Capra pyrecaica, Rangifer tarandus* and *Rupicapra pyrenaica* (Figs. 54-56). The remaining assemblage was formed by carnivore remains (2.2 %), belonging to *Ursus spelaeus*, *Panthera leo spelaea*, *Canis lupus*, *Vulpes vulpes, Meles meles*, *Martes martes, Mustela putorius* and *Mustela nivalis.* No evidence of cave bears were found.

Levels	**1**		**3**		**4**		**5**		**6**		**7**		**8**	
	NISP	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**
Equus ferus caballus													195	3
Bison priscus	360	5	154	4	659	4	547	6	319	5	620	5	647	4
Capra pyrenaica							1	1			50	2		
Rupicapra pyrenaica			1	1					2	1	4	1		
Cervus elaphus	30	1			38	2	33	2	72	3	109	4	156	3
Rangifer tarandus											13	2	21	2
Coelodonta antiquitatis	15	1	5										185	6
Panthera spelaea	6	1			2	1								
Ursus spelaeus	55	1	20	1										
Canis lupus			4	1					3	1				
Vulpes vulpes	1	1	1						2	1	1	1		

Table 35. Number of identified specimens (NISP) and a minimum number of individuals (MNI) of large mammal species from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula).

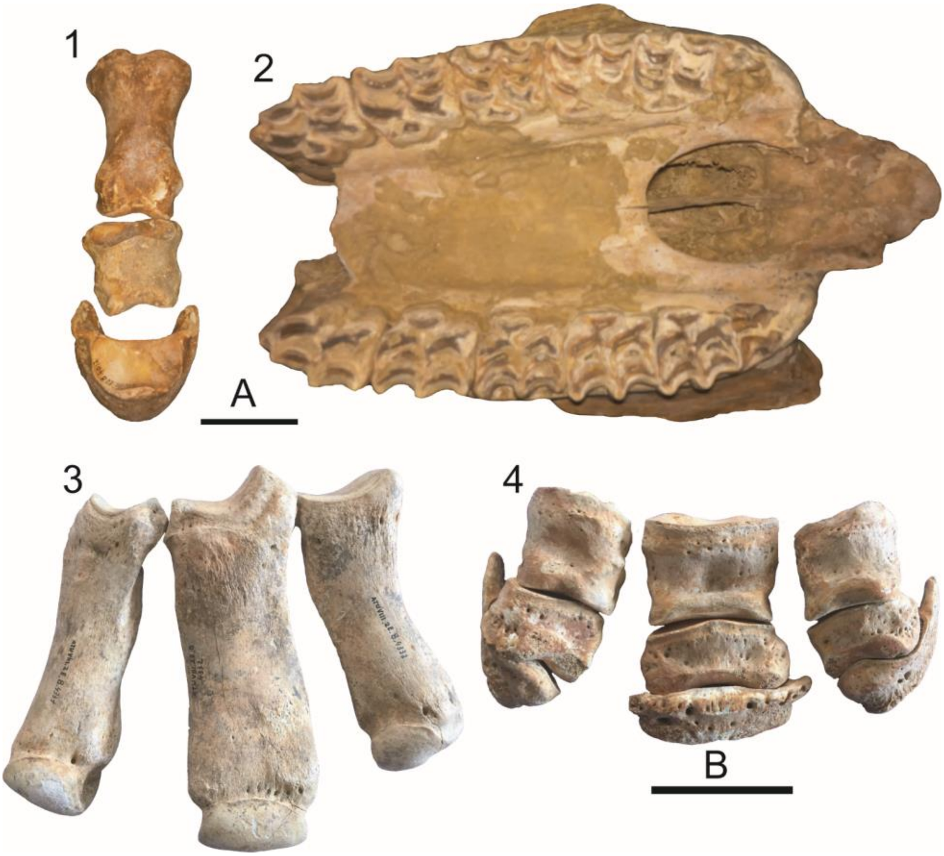


Figure 54. Some Perisodactyle remains from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). *Equus ferus caballus;* 1, 1st-3rd posterior phalanges, dorsal view; 2, maxilla fragment with all dental pieces in aboral view. *Coelodonta antiquitatis*; 2nd-4th left metacarpals in dorsal view; 4, 1st-3rd phalanges of the anterior and right 2nd, 3th and 4th fingers, dorsal view. Scales 5 cm, A for figures 1-3 and B for figure 4.

The majority of the fractures were postdepositionals, probably generated by block collapses. After the taxonomical identification of the large mammal, they were quantified by the Minimum Number of Individuals (MNI) and the Number of Identifiable Specimens (NISP). The estimation of the age at death and sex for bison species was calculated. Additionally, some morphometric data were compared mainly with an extensive sample from SW Europe (especially from the Cantabrian region).

Equus ferus caballus LINNAEUS, 1758

Horse represented 4.5 % of the assemblage with three remains (Tab. 35). All the remains corresponded to three individuals (Fig. 54). The morphology was typical of horses, with a large protocone and well-developed caballine fold.

Bison priscus HILZHEIMER, 1918

The steppe bison was the most abundant taxon in the ungulate assemblage with 3,306 remains and a percentage of 76.33 % (Tab. 35) (Fig. 55), corresponding to a minimum of 33 individuals. This fact makes Artazu VIII the site with most abundant steppe bison remains from the Iberian Peninsula, followed by Jaurens (France) (Guerín and Valli, 2000) with 21 MNI and Habarra (France) (Prat et al., 2003) and Kiputz IX (Gipuzkoa) (Castaños et al., 2012b) with 18 MNI. However, these three sites have chronologies attributable to MIS 3. This species, in general, led a great variety of anatomical elements, including cranial and postcranial bones. This taxon was distributed along the all sequence, since *B. priscus elements* were recovered in all levels at Artazu VIII, althought its proportion vary along them. In Levels 8, 7, 5 and 4 the remains riched at more than 500 bones, whereas Level 3 was the poorest Level.

The state of the eruption of the final dentition study allowed the stimation of the age of 26 individuals (Tab. 36). It stand out the low proportion of adult individuals (less than third), being the majority subadults. Similar results could be observed at Kiputz IX (Gipuzkoa) (Castaños et al., 2012b).

Regarding Steppe Bison sex, robustness index has been applied to 16 complete metacarpals. The values lower than 20 has been attributed to females and those

Dentition	**Age (months)**	**Levels**						
		1	**3**	**4**	**5**	**6**	**7**	**8**
M1+/-	6-9	1		1				
M1+M2-	9-12		1					
M3+/-	24-30							1
M3 without wear	30-42	2	1		1	1		
M3+	42-48	1	1	2	3	1		1
M3++	48-60		1		1	1		1
M3+++	> 60			1		1	1	1

Table 36. *Bison priscus* age stimation at Artazu VIII (Arrasate, northern Iberian Peninsula).

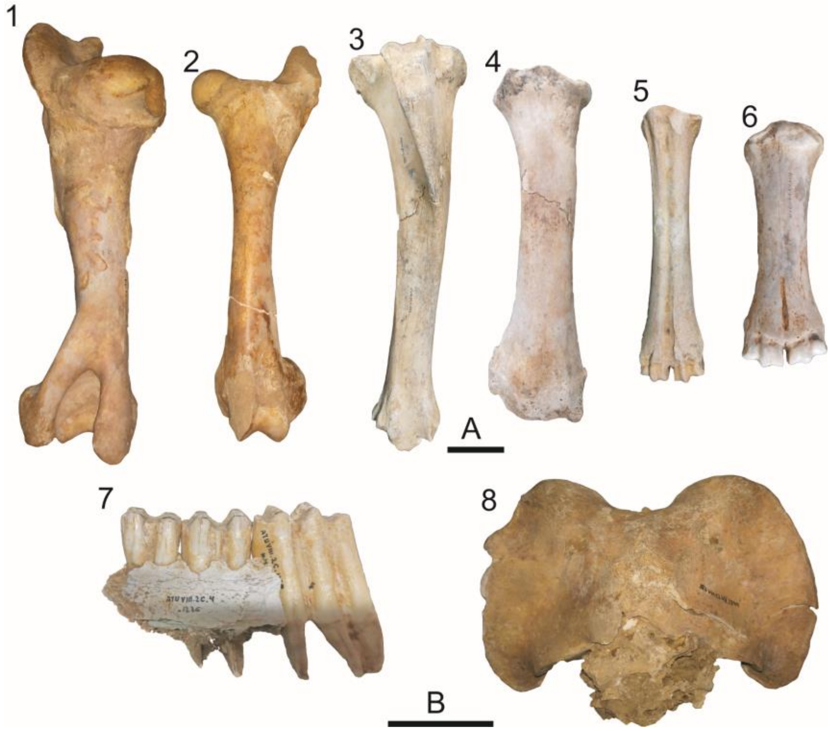


Figure 55. *Bison priscus* remains from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). 1, left humerus, plantar view; 2, left femur, dorsal view; 3, right tibia, dorsal view; 4, right radius, dorsal view; 5, left metatarsus, dorsal view; 6, right metacarpus, dorsal view; 7, left mandible fragment with M1-M3, labial view; 8, atlas, dorsal view. Scales 5 cm, A for figures 1-6 and B for figures 7-8.

that were higher to 22 to males (Brugal, 1984-1985; Guerin and Valli, 2000). Thus, eight remains habe been attributed to males, four to females and the remaining overlap (Tab. 37).

	LM	AD	(AD/LM) 100	Sex		LM	AD	(AD/LM) 100	Sex
Level 4	226	52.5	23.23	Male	**Level 6**	224	52	23.21	Male
	219.5	51	23.23	Male		248	51.5	20.77	
	315.5	58.5	18.54	Female		233	51	21.89	
	321.5	46.5	14.46	Female	**Level 7**	241	57.5	23.86	Male
	226	57.7	25.53	Female		243	50	20.58	
Level 5	225	41.5	18.44	Female	**Level 8**	214	48.5	22.66	Male
	225	40.5	18	Female		242	57	23.55	Male
	240	50.5	21.04						
	237	57	24.05	Male					

Table 37. *Bison priscus* sex stimation at Artazu VIII (Arrasate, northern Iberian Peninsula).

Capra pyrenaica SCHINZ, 1838

51 remains of wild goat were recovered, its proportion was relatively low (1.18 %). In addition, these remains made a minimum of three individuals (Tab. 35). This species only was present at Level 7 and 5, with an only one remain in Level 5.

Rupicapra pyrenaica BONAPARTE, 1845

The Pyrenean Chamois was the scarcest taxon in Artazu VIII with 7 remains (0.16 % of the assemblage), corresponding to a 3 minimun individuals (Tab. 35).

Cervus elaphus LINNAEUS, 1758

Red Deer is well represented, since the 0.11 % of the remains belonged to this taxon (Tab. 35; Fig. 56) with 348 remains, corresponding to a minimum of 15

Figure 56. Some Perisodactyle remains from Artazu VIII (Arrasate, Gipuzkoa, north Iberian Peninsula). 1, *Canis lupus*, radius; 2, *Panthera leo spelaea*, left mandible; 3, *Rangifer tarandus*, left mandible; 4,*Cervus elaphus*; left mandible. Scales 5 cm.

individuals. This taxon is the second more abundant species in Artazu VIII and is present in all levels with the exception of Level 3.

Rangifer tarandus LINNAEUS, 1758

The Reindeer representated the 0.79 % of the large mammal assemblage with 34 remains, corresponding to a minimun of 4 individuals (Tab. 35) (Fig. 56). This specie was only recovered from Levels 8 and 7.

Coelodonta antiquitatis BLUMENBACH, 1807

Woolly Rhinoceros was the third most abundant taxon in Artazu VIII with 205 remains and a percentage of 4.73 % (Tab. 35), corresponding to a minimum of 7 individuals. Comparing to other sites from the Iberian Peninsula, Artazu VIII is the richest site in *C. antiquitatis* remains. Examples of other sites with the presence of the Woolly Rhinoceros are Lezika with 106 remains (Castaños et al., 2009), Bolinkoba with 122 remains (Altuna and Mariezkurrena, 2000) and Teixoneres with 17 remains (Álvarez-Lao et al., 2017) among others.

Panthera leo spelaea GOLDFUSS, 1810

Panthera leo spelaea was the second poorest taxon in Artazu VIII with a representation of 0.18 % and 8 remains belonging to two indivuals (Fig. 56). These remains were recovered in Level 4 and 1.

Ursus spelaeus ROSENMULLER, 1794

The Cave Bear was the most abundant taxon in carnivore assemblage at Artazu VIII with the representation of 1.73 % and 75 remains, belonging to a minimun of 2 individuals (Tab. 35). However, it was only present in Levels 3 and 1.

Canis lupus LINNAEUS, 1758

Seven remains of *C. lupus* were recorded, completing 0.16 % of the assemblage and corresponding to two individuals (Tab. 35) (Fig. 56). This specie only was recovered in Levels 6 and 3.

Vulpes vulpes (LINNAEUS, 1758)

The Red Fox was the poorest taxon among the carnivores. It presented five remains with the representation of 0.12 %, corresponding to a three minimun individuals (Tab. 35).

C. Avifauna

For the avifauna study, bird remains from all collected samples were extracted. Thus, from the 45 samples recovered in the three stratigraphic columns only 11 contained bird remains, specifically Levels 8 to 1, with the exception of Level 6 that was sterile in bird bones (Tab. 38).

Level	Column I	Column II	Column III
1		II.1	
		II.2	
		II.3	
		II.4	
		II.5	
		II.6	
2	I.1		
3	I.2		
	I.3		
4	I.4	II.7	
	I.5		
	I.6		
5	I.7	II.8	
	I.8		
6	I.9	II.9	
7a		II.10	
	I.10	II.11	
		II.12	
		II.13	
7b		II.14	III.1
		II.15	III.2
			III.3
			III.4
8			III.5
			III.6
			III.7
			III.8
			III.9
9			III.10
			III.11
10			III.12
12			III.13
			III.14
			III.15

Table 38. Samples for the avifauna study from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). In grey the samples containing avifauna remains.

- Systematic attribution and quantification

A total of 394 bird bones were extracted at Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula), although only 171 were identified, at least, at Order level, corresponding to a minimun number of 15 individuals . Despite the high variety of bird skeletal anatomical elements, the biodiversity was very scarce, given that the majority of the identified remains corresponded to corvids (Fig. 57), with the exception of only a single remain belonged to the Rough-legged Buzzard.

In addition, from the stipulated MNI, nearly half of them belonged to *Pyrrhocorax* genus (eight out of fifteen) (Tab. 39).

Figure 57. Avifauna remains from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). 1, *Buteo* cf. *lagopus*, left metacarpus in dorsal view; 2, *Corvus monedula*, right humerus in dorsal view; 3,*Pyrrhocorax graculus*; left metacarpus in dorsal view; 4, *Pica pica*; left femur in dorsal view; 5, *Pyrrhocorax pyrrhocorax*, right ulna in cranial view. Scale 1 cm.

Levels	**1**	**2**	**3**	**4**	**5**	**7a**	**7b**	**8**
Buteo* cf. *lagopus				1 (1)				
Pyrrhocorax graculus				9 (2)		3 (2)	1 (1)	13 (3)
Pyrrhocorax pyrrhocorax				3 (2)				1 (1)
Pyrrhocorax sp.	1	1	1	19	1	12	1	22
Pica pica						1 (1)		
Corvus monedula						1 (1)		1 (1)
Corvidae	2	1	1	19	2	12		42
Passeriforme indet.							2	
Aves indet.	8	4	8	58	1	32	13	101

Table 39. Birds bones recovered from Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula) organized by levels. The numbers represent the NISP and the number between brackets represent the MNI.

Buteo* cf. *lagopus PONTOPPIDAN, 1763

Only one remain of *Buteo* was recovered. The only measurement that was posible to take, the proximal width (12.5 mm), fit with both *B. lagopus* and *B. buteo*. However, according to the facies articularis medialis and lateralis, as well as condylus and canalis musculi morphologies, this remain was provisionaly attributed to *Buteo* cf. *lagopus* (Fig. 57).

Family Corvidae VIGORS, 1825

Due to the great similarity of *C. monedula*, *P. pica*, *P. graculus* and *P. pyrrhocorax,* the available reference collection was not enough to identify to species level in all cases (Fig. 57). For this reason, an attempt was made to identify the Corvidae with morphologic and biometric criteria given by Tomek and Bochenski (2000). Even so, because of the great fragmentation of the bones, the measurements were only useful to identify 33 remains at specie level (Tab. 39).

- Bird community variation over the stratigraphic sequence

As contemplate in Table 39, Level 8 was the richest in avifauna remains, followed by Level 4 and Level 7a (Fig. 58). However, the three levels showed the same number of identified taxa, although with not the same species. Thus, Rough-legged Buzzard was recovered from Level 4. Finally, in Levels 5, 3, 2 and 1 it was not possible the identification of bird bones at specie level (Tab. 39).

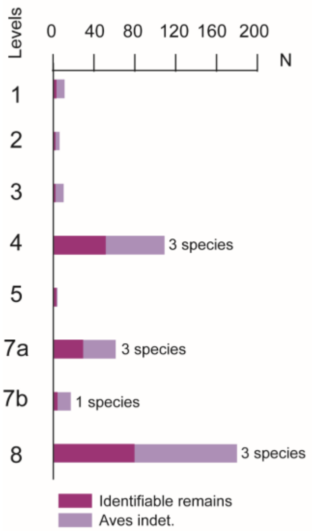


Figure 58. Birds bones recovered from Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula) organized by levels. N (Number of total remains).

D. Sedimentary and Mineralogical studies

The stratigraphic filling that remained *in situ* at Artazu VIII was 5 m thick, differentiated into 12 levels. Samples were collected along the stratigraphic sequence to study the sedimentology (granulometry and micromorphology) and mineralogy (XRD).

A minimum of one sample per level was recovered at Artazu VIII to carry out mineralogical and granulometric analyses, with a total of 32 collected samples distributed in three stratigraphic trenches (Fig. 7B from Chapter 2). Thus, 12 samples were taken from Trench a, eight samples were collected in Trench b and the remaining 12 samples were recovered from Trench c, all of them designated numerically in ascending order from the bottom to top. In addition, three unconsolidated samples were collected from Trench a in order to prepare thin sections to study under the microscope different microfacies.

- Granulometry results

Different levels showed changes in their sorting, being the size of the clastic sediments from Artazu VIII less than 2 mm, with the exception of the breakdown clasts (Fig. 59). Figure 60 showed four sections according to differentiated tendencies and divided in trenches. In Section 1, fine sediments prevail, increasing their proportion from bottom to top. The exception will be 1c sample from Trench c, which showed relatively high coarse sediment. In comparison to Section 1, Section 2 began with a bit coarser sediment. Both in Trenches a and c, the proportion of fine sediment increased little by little. However, in the second half of the Section 2, the proportion of fine sediments decreased (Fig. 60). In the Section 2 in Trench c, the tendency was the opposite, but those changes were almost not noticeable. In Section 3, sediments proportions were bit coarser at the begining (Fig. 60). Finally, Section 4 exhibited different tendencies. At the beginning of Trench c, sediments were fine but they became coarser (Fig. 60).

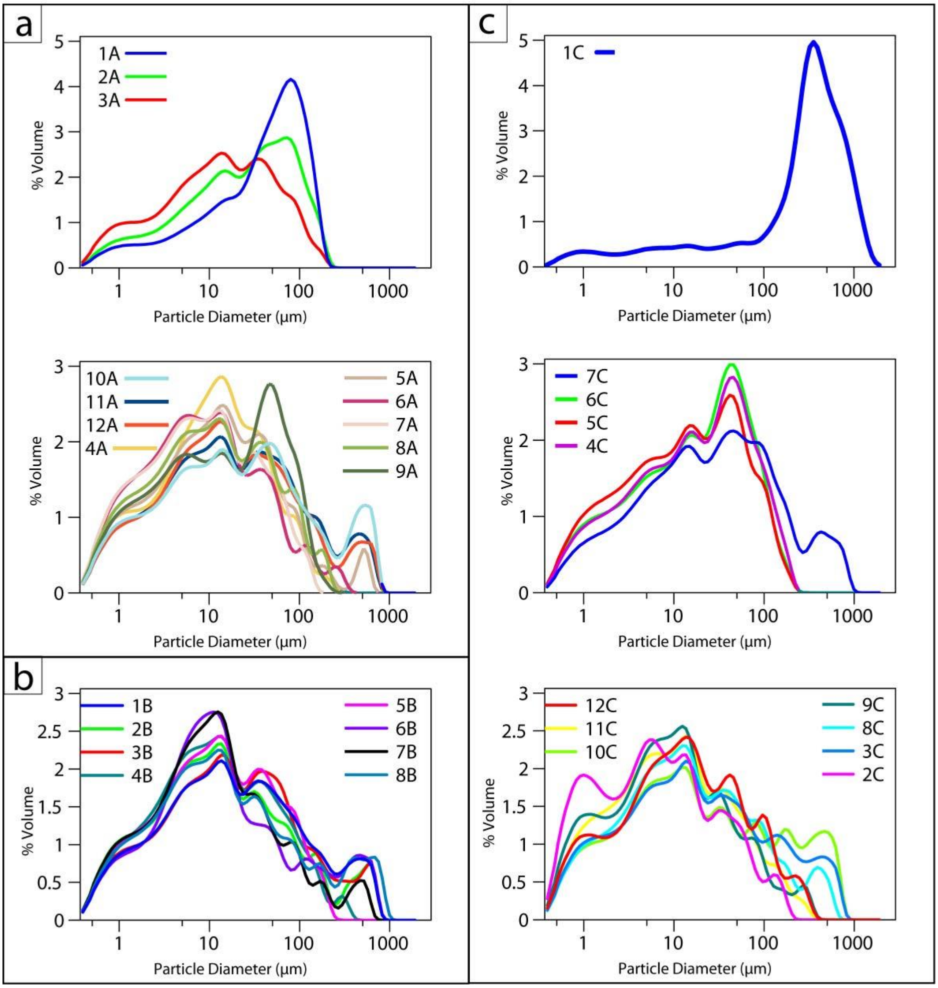


Figure 59. Percentage of each granulometric size in the samples of Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) organized by tenches and grouped by tendencies. a) Samples of Trench a in which two tendencies can be observed; b) samples of Trench b in which only one tendency can be observed; c) samples of Trench c in which three tendencies can be observed.

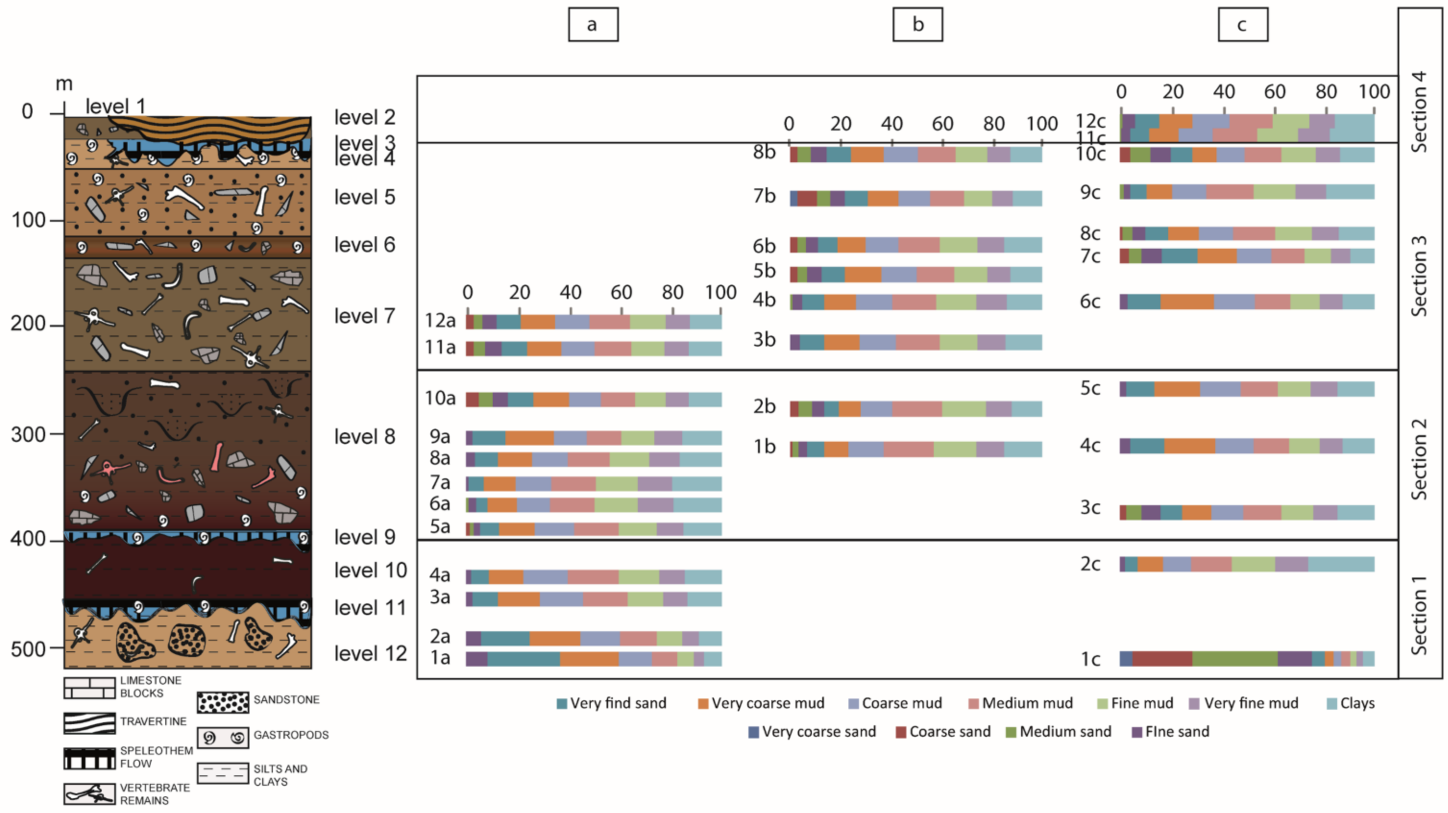


Figure 60. Results of the granulometry analyses of the samples taken in Artazu VIII site (Arrasate, northern Iberian Peninsula) organized by columns and divided by sections.

- Mineralogy of endokarst sediments

The mineralogical analysys from Artazu VIII showed that sand and mud prevailed throughout all the stratigraphic sequence, while the bedrock results were in line with the deposit type. The mineralogical results of the sediment and bedrock are in accordance (Tab. 40; Figs. 61-62). However, some differences can be observed, both between levels and between stratigraphic columns (Tabs. 40-41).

Tr	Sample	Whole rock mineralogy					Clay minerals		
		Qtz	Ca	Phyl	Fsp	Gt	Vrm	Ill	Kln
a	12a	44.7	4.4	47.2	3.8		1.7	93.1	5.1
	11a	44.3	17.9	34.2	3.6		2.8	89.9	7.3
	10a	47.4	17.4	31.8	3.3		3.6	86.9	9.5
	9a	52.5	4.7	36.0	6.8		5.2	85.5	9.2
	8a	49.6	5.3	41.8	3.3		11.8	76.7	11.5
	7a	47.3	8.2	42.3	1.7	0.6	12.6	74.5	12.9
	6a	50.7		47.9	1.5		11.2	76.3	12.5
	5a	44.1	13.9	39.4	2.6		13.6	79.6	6.8
	4a	47.2		47.8	4.3	0.8	1.6	93.1	5.2
	3a	45.4		48.7	3.9	2		96.9	3.1
	2a	60.1		35.7	4.1	0.1	0.5	96.0	3.5
	1a	52.7		46.1	1.2		1.9	93.9	4.1
b	8b	40.4	11.4	45.	3.2		3.7	89.5	6.8
	7b	35.8	13.2	44.7	3.4	2.9	2.4	91.4	6.2
	6b	24.9	27.5	41.9	3.3	2.5	1.6	92.1	6.3
	5b	40.7	18.4	37.8	3.1		2.1	90.4	7.5
	4b	42.2	14.6	37.7	3.9	1.7	2.5	90.1	7.3
	3b	41.3	22.8	33.1	2.8		1.9	89.6	8.5
	2b	48.1	13.2	36.1	2.5		2	88.8	9.2
	1b	45.6	13.9	36.9	3.7		2.3	89.5	8.2
c	12c	2.2	97.8				17.4	73.2	9.4
	11c	36.7	12	45.5	3	2.8	7.6	85.4	7.1
	10c	39.9	4.5	50.6	3	2	4.2	88.8	7
	9c	30.8	11.1	54.2	2.4	1.5	6.6	84.9	8.5
	8c	41.7	5.8	49.5	3.1		5.4	88.5	6.1
	7c	55.5	3.1	38.2	3.3		4.9	87	8.1
	6c	49.2	8.8	37.1	3.3	1.5	1.3	89.5	9.2
	5c	53	1.5	41.2	4.3		6.4	82.9	10.8
	4c	55.3	1.1	36.6	5.6	1.3	3.8	87.2	9
	3c	41.7	16.4	36.6	3.4	1.9	15.4	76.3	8.2
	2c	30.8	3	61.6	2.1	2.5		100	
	1c	63.4		30.9	1.9	3.7	2.2	94.1	3.7

Table 40. X ray diffraction XRD analysis results in % of Artazu VIII site (Arrasate, Gipuzkoa, northern Iberian Peninsula). Abbreviations: Tr (stratigraphy sequence Trench, Qtz (quartz), Cal (calcite), Phyl (phyllosilicates), Fs (feldspars, plagioclase and K-feldspars together), Gt (goethite), Vrm (vermiculite), Ill (illite) and Kln (kaolinite).

Sec	Tr	Quartz			Calcite			Phyllosilicates			Feldespar			Goethite			Vermiculite			Illite			Kaolinite		
		Min	Max	M	Min	Max	M	Min	Max	M	Min	Max	M	Min	Max	M	Min	Max	M	Min	Max	M	Min	Max	M
4	c	2.2	36.7	19.4	12	97.8	54.9										7.6	17.4	12.5	73.2	85.4	79.3	7.1	9.4	8.2
3	a	44.3	44.7	44.5	4.4	27.5	11.1	33.1	47.2	40.7	3.6	3.8	3.7				1.7	2.8	2.3	89.9	93.1	91.5	5.1	7.3	6.2
	b	24.9	42.2	37.5	11.4	27.5	18	33.1	45	40	2.8	3.9	3.3	1.7	2.9	2.3	1.6	3.7	2.4	89.5	92.1	90.5	6.2	8.5	7.1
	c	30.8	49.2	40.4	4.5	11.1	7.6	37.1	54.2	47.9	2.4	3.3	2.9	1.5	2	1.7	1.3	6.6	4.4	84.9	89.5	87.9	6.1	9.2	7.7
2	a	44.1	52.5	48.6	4.7	17.4	8.9	31.8	47.9	11.1	1.5	6.8	3.2	0.6	0.6	0.6	3.6	13.6	9.7	74.5	86.9	79.9	6.8	12.9	10.4
	b	45.6	48.1	46.9	13.2	13.9	13.6	36.1	36.9	8.7	2.5	3.7	3.1				2	2.3	2.2	88.8	89.5	89.2	8.2	9.2	8.7
	c	41.7	55.3	50.0	1.1	16.4	6.3	36.6	41.2	38.2	3.4	5.6	4.4			1.6	3.8	15.4	8.5	76.3	87.2	82.1	8.2	10.8	9.3
1	a	45.4	60.1	51.3				35.7	48.7	44.6	1.2	4.3	3.3		2	0.7	0.5	1.9	1.4	93.1	96.9	95	3.1	5.2	4
	c	30.8	63.4	47.1	3	3	3	30.9	61.6	46.2	1.9	2.1	2	2.5	3.7	3.1	2.2	2.2	2.2	94.1	100	97	3.7	3.7	3.7

Table 41. X ray diffraction analysis results ordered by sections (Sec) and stratigraphy y trenches (Tr) from Artazu VIII site. Abbreviations: Min (minimum), Max (maximum) and M (Mean).

All the samples were basically formed by phyllosilicates (>30 %) and quartze (>24 %), with low percentage of feldspars (1.5-6 %). Calcite showed greater compositional variation, between 0 % and 28 %. Sample 12c is the exception, since it was formed principally by calcite (98 %). The goethite had scarce presence, appearing only in some samples and always with values lower than 4.5 % (Tab. 40). However, mineralogical composition variations could be observed along the stratigraphic sequence. Thereby, the mean amount of quartz decreased in the upper part of the sequence, while calcite amount increased (Tab. 41).The lowest proportion of phyllosilicates occurred in samples of Section 2 and disappears in Section 4. Nevertheless, the most significant mineralogical variation corresponded to calcite proportion, which in the same section showed higher values in samples of Trench b and lower values in samples of Trench c (Tab. 41) (Fig. 61).

Clay mineralogy consisted mainly of illite (>74 %) and lesser amounts of kaolinite (6-12 %) and vermiculite (2-7 %) (Tab. 40). It is noteworthy that samples with lower values of illite had the highest percentages of kaolinite and vermiculite. All these samples corresponded to Section 2 (Fig. 62). The enrichment of vermiculite occurred mainly in samples of Trench c (Tab. 40). The results of the sediment and bedrock mineralogical analysis are described below section by section:

Section 1: the whole-rock analysis showed no differences of the sedimentary processes, considering that under no circumstances the mean mineral proportion differences exceed the 5 %. Moreover in most cases did not reach the 2 % (Fig. 61 and Tab. 41). Clay mineralogy was characterised by high proportion of illite (> 95 %) and small amount of vermiculite (2.2 %).

Section 2: in the low levels, quartz and calcite proportion was lower than in the rest of the section, and in some cases, the whole-rock mean mineral proportion differences were considerable according to trench position (Fig. 61 and Tab. 40). Quartz mean proportion values varies from 46.9 (Trench b) to 50 (Trench c). It stood out the mean value of calcite in Trench b, since it was almost the double percentage (13.6 %) compared to Trenches a and c (Tab. 41). In clay mineralogy, little differences between the sampes could be observed (Fig. 62 and Tab.409). Top samples, such as sample 9a and 10a, showed low proportion of vermiculite and kaolinite and high percentage of illite, tendency also identified in samples 4a and 5a and 1b and 2b (Fig. 62 and Tab. 40). Even so, samples 1b and 2b had lower vermiculite proportion than other trenches (Fig. 62 and Tab. 40). Finally, Trench c had lower mean values of vermiculite than Trenches a and b (Tab. 41).

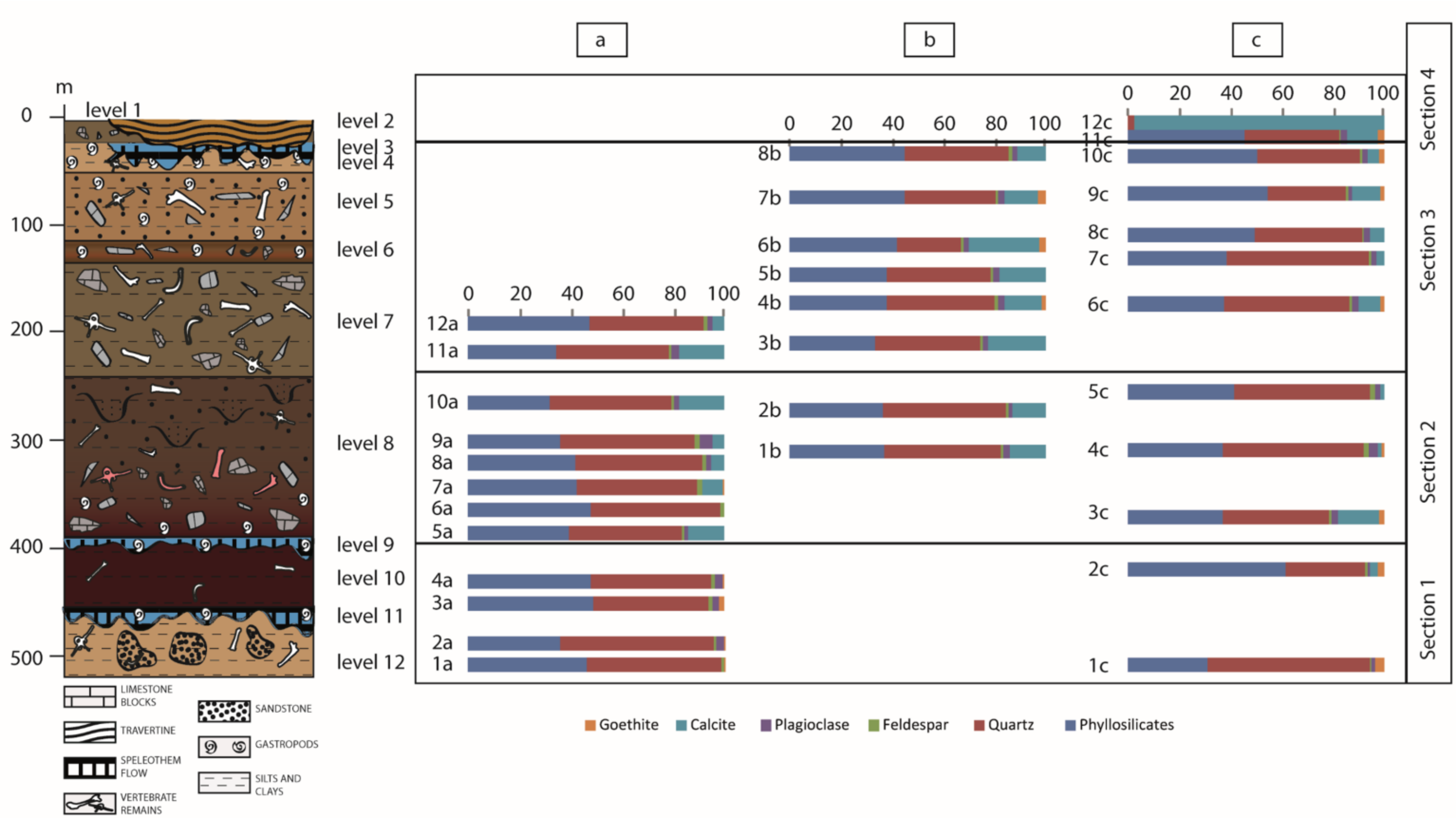


Figure 61. Whole-rock mineralogy obtained by X ray diffraction analysis from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) endokarst sediment divided into three trenches.

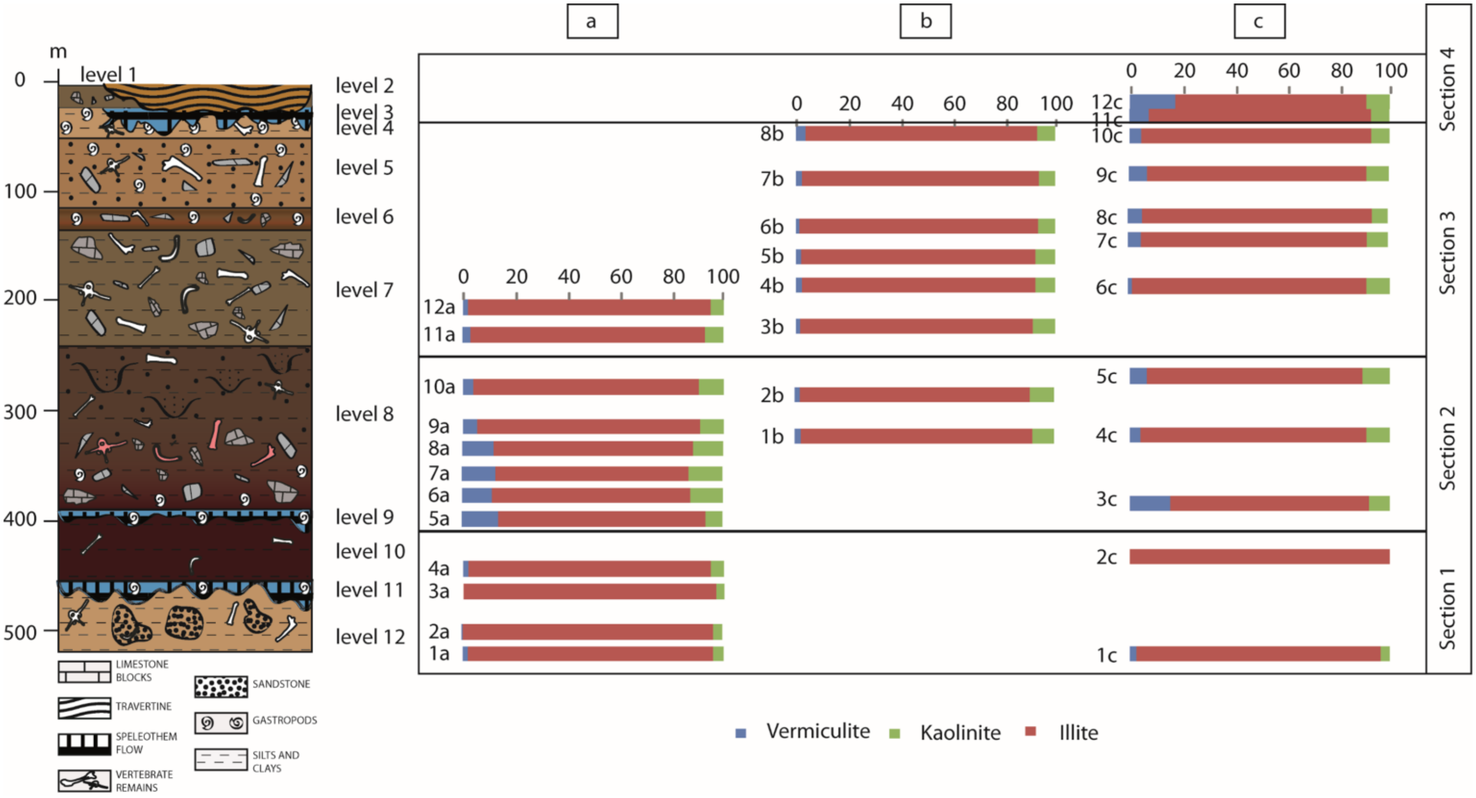


Figure 62. Clay mineral obtained by X ray diffraction analysis from Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) endokarst sediments organized by trenches and divided by sections.

Section 3: it was noteworthy the variarion in the proportion of calcite, since it reached a minimum percentage of 3.1 in sample 7c and maximum percentage of 27.5 in sample 6b (Fig. 61 and Tab. 40). The proportion of calcite in Trench b was almost the twice as in Trench a, and almost three times more than in Trench c (Tab. 41). In clay mineralogy, there were no differences that must be outlined (Tab. 41).

Section 4: in the mean clay mineralogy proportions, vermiculite proportion began with relatively lower values and increase toward the top, reaching up almost 18 % (Fig. 62 and Tabs. 40-41). On the contrary, illite amount going decreasing towards the top.

- Micromorphology

The samples taken from levels 4, 5 and 8 are the main representative samples of the stratigraphic sequence. Level 4 had a matrix-supported by bioclast of gastropods shells, disposed parallelly to the bedding. It also contained lower quantities of autochthonous clasts composed by microfauna bones or speleothems and allochtonous rock fragments as lutites (Fig. 63A). Level 5 consisted mainly on heterogeneous red sandy-silt sediment, and the skeleton grain was mainly comprised by speleothem and microfauna bone fragments (Fig. 63B). Finally, Level 8 presented a microfabric structure supported by silty matrix and faecal pellets (Figs. 63C and D).

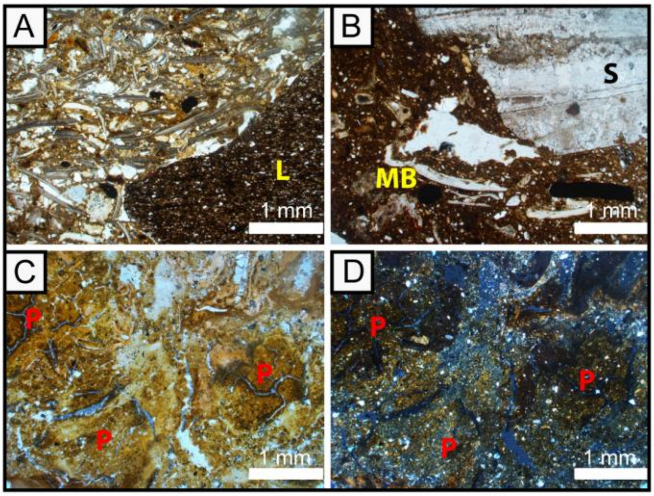
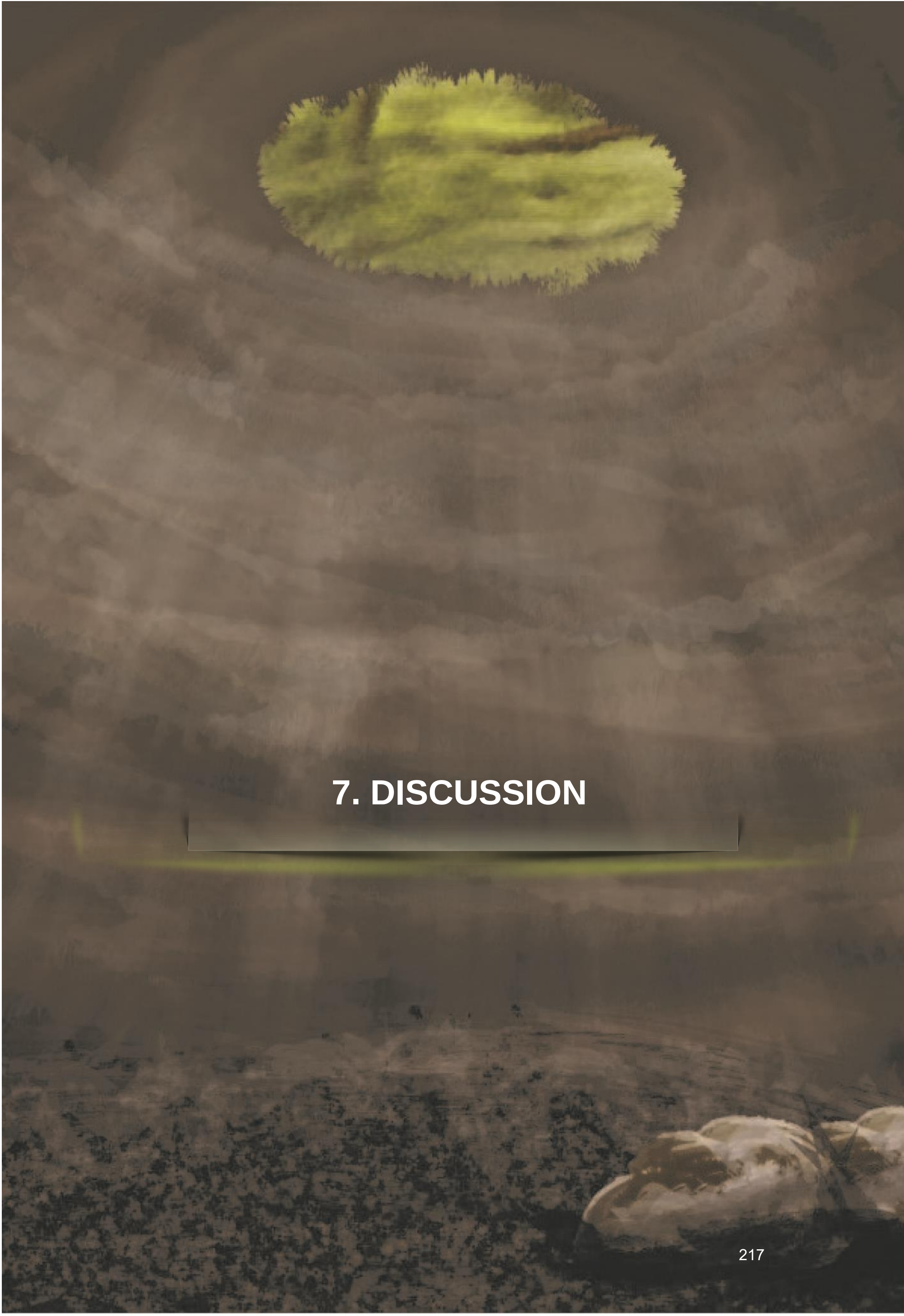


Figure 63**.** Photomicrographs of the thin section samples of Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula). A: Level 4. B: Level 5. C: lower part of the Level 8. D: same as C but with polarized light. L: lutite; S: speleothem; MB: microfauna bone; P: pellet.



7. DISCUSSION

7. DISCUSSION

7.1. Artazu VII

7.1.1. Origin of Artazu VII accumulation

As previously indicated, Artazu VII was located in a stone quarry and the majority of the site was destroyed during blasting works, only preserving three small fissures at the back wall of the cave. Therefore, the interpretation and reconstruction of the site is hampered by the partial destruction of the site and the limited excavated area, making the interpretation and reconstruction of the site particularly difficult. Thus, the recovered faunal composition, the absence of human activity and carnivore marks in bones, and the vertical shaft morphology of the cavity indicate that animals could end in the cave by accidental falls, acting Artazu VII as natural trap. There are numerous possible causes for that misfortune: (1) the existence of a hole in the ground in the middle of the meadow/forest covered by brambles, or, (2) the existence of a cave with other indoor cavity. In the first case, the ground hole would be undetectable and the animals fell down. In the second case, the vertical shaft would be part of a greater cave, so, when animals entered inside the cave, the perception of light would be drastically reduced. Inmediately upon entry the vertical shaft would be located. The animal sight would not have time enough to adapt, and therefore animals would not be able to see the hole.

However, although a part of the assemblage was found in context, the origin of the faunal accumulation is a little bit confusing and open to interpretation. Thus, data suggest different processes that could have contributed to the formation of the site (explained below).

Regarding the origin of the small vertebrate accumulation, the anatomical element analysis and the small mammals taphonomic study, only around 15-20 % of microfauna bones showed digestion traces, as well as bone fragmentation. Therefore, we think that part of the small vertebrate assemblage was originated as a result of the accidental incorporation of the specimens and the other part as a consequence of being hunted by owls or diurnal raptors. Following digestion categories proposed by Andrews (1990), *B. bubo* and *S. aluco* were the possible predators from Artazu VII small mammals (see Chapter 4). Our results are in accordance with the Eagle Owl, since it usually provides a diversity between 13 and 30 small mammal species with a predominance of arvicolids (between 30 and 80 %) (Andrews 1990), which is consistent with the small vertebrate diversity of Artazu VII (Suárez-Bilbao et al. 2017a). The anatomical element analysis carried out on Artazu VII bird remains suggests also two different accumulation processes. On the one hand, the great abundance of immature remains indicates that part of the birds lived there, and that it would be a nesting place. On the other hand, the proportion of proximal/distal, core/limb and humerus/ulna/coracoideum versus sterna/scapula proportions of the mature bird assemblage suggests the action of owls or diurnal raptors. The case of wing/leg elements ratio points to *A. otus* or *A. heliacal* as bird of prey. However, in *B. bubo* pellets the wing/leg elements ratio is similar, but in this case prevails very little wing elements and point to *B. bubo, S. aluco* or *A. chrysaetos* as predators (Bochenski and Nekrasov 2001). For this reason we consider that this difference is not very significant. Therefore, the bird anatomical element analysis and the small mammal taphonomic study coincides that owls could be the main birds of prey. Althought it is true that the remains of the predatory bird could not have been preserved, from all proposed predators only remains from *B. bubo* (as *Bubo* cf. *bubo*) were recovered in Artazu VII. Thus, we propose *Bubo* cf. *bubo* as the possible main bird predator agent.

Assemblages with high proportion of carnivores (the 29.1 % of carnivore remains) and good representation of species (ten taxa) are considered as a typical trait of the carnivore accumulations (Pickering, 2002), which is the case of Artazu VII. However, these data are not consistent with the skeletal profile, since fragmentation and tooth marks in some ungulate long bones are absent. The presence of carnivores and ungulates that are potential preys in the same cave without evidence of interaction between them is an anomaly not usually found in the literature. It is not easy to explain this situation with the usual models on the origin of the fauna accumulations.The only iberian bone assemblage of MIS 5 with a similar proportion of carnivore remains is Imanolen Arrobia, located at the mouth of the same valley where Artazu VII is and at a distance of 28 km. However, in this site carnivore marks were observed in ungulate bones, so it was interpreted as a carnivore den (Castaños et al., 2017b).

The difference in skeletal profile and size remains between different ungulate species from Artazu VII can not be attributed to the action of predators. The absence of human or carnivores marks in the bones has already been indicated above. An alternative explanation for this bias may be related to the cave morphology and the dynamics of the remains within the cave. The bottom of the preserved part is formed by two fissures and a narrow chamber that do not allow the passage of bones of a certain size (Fig. 6; Chapter 2). However, the area above the preserved part is unknown.The original cave could be larger in the upper area and accumulate almost complete long bones of large ungulates. Therefore, when narrowing in the lower area, the cave could give rise to a selection in favor of smaller bones. The absence of evidence of horse, bison and deer in Chamber (C) and Lower Ledge (LL) is consistent with this idea. This may be one of the causes of the anomalies observed in this assemblage.

7.1.2. Palaeoenvironmental approach

Small vertebrates

According to the proportion of each taxa (Figs. 64-65) and their environment requirements, palaeoecological and palaeoenvironmental data have been inferred from the small vertebrates in Artazu VII (Suárez-Bilbao et al., 2017a), as can be seen in Figure 65. Given the large number of small vertebrates, all the spits were considered for the palaeoenvironmental reconstruction. Stenoic species of woodland biotopes and relatively warm environments are represented throughout the sequence by *A. sylvaticus-flavicollis* and, in some spits, also by *E. europaeus*, *P. lenki* and *Talpa* sp., though never in larger percentage than 25 % (Figs. 64 and 66). On the contrary, the presence of *M. agrestis*, *M. arvalis* and *M. (Terricola)* sp. throughout the sequence can be representative of more than one habitats, such as grassland or woodland with herbaceous cover. Thus, eurioic species are clearly predominant as they represent more than 60 % of the species in all cases. On the other hand, the record of the two species of *Sorex* genus and the *M. (Terricola)* subgenus indicates high humid conditions (the representativeness of these species is always higher than 35 %) (Figs. 64 and 66). Both taxa can be observed throurough the stratigraphic sequence, considering that *S. (S.) araneus-coronatus* and *S. (S.) minutus* are representative of atmospheric humidity and *M. (Terricola)* sp. is an indicative of humidity in the ground by their need to dig burrows. Finally, *A. amphibius* and *Neomys* sp. indicate the presence of water couse in the vicinity of Artazu VII in some spits. The Shanon Weaver index presents a range between 1.5 and 5. Thus, no remarkable difference could be observe, with the exception of LL-K, which shows lowest values (1.6) (Fig. 66).

Considering species that suggest woodland environments, four stages have been distinguished at Artazu VII sequence (Fig. 66). Thus, the Stage 1 represents the bottom of the sequence, and begins with a low forest development (around 12 %) in C-5. Between there and the top of the Stage 1 (C-1) slight improvement of the environmental conditions is observed (Fig. 66): woodland biotopes reaches its maximum of almost 24 % biotope, while humidity progressively increases. From there to LL-G (Stage 2), the percentage of forest environment species remains is more or less constant, with values of around 23 %. A small descent in woodland development can be appreciated in LL-K (Fig. 66). In contrast, the water presence behave differently. Lower Ledge K shows an absence of species indicative of water environmental conditions. Subsequently, in LL-G, a small rise immediately followed by another slight descent in LL-C (Stage 3), can be observed. Finally, in LL-A (Stage 4), a significant decrease of forest cover and a moderate increase of water occurs again. With only a 13 % of representation, this level is the least indicative of woodland in the whole stratigraphic sequence.

Similar conclusions were reached regarding the herpetological remains identified at Artazu VII. The dominant species (Lacertidae indet., *R. temporaria-iberica* and *B. bufo*) are inhabitants of areas with a certain tree cover, mainly broadleaf and mixed forest, near almost permanent sources of water. The presence of species associated with woodlands (*A. fragilis, S. salamandra* and *A. obstetricans*) is exiguous although relatively constant throughout the stratigraphic sequence (Fig. 65). C-3 and C-5 would represent the moment of greatest expansion of the forest and, therefore, the warmest moment. However, the type of dominant landscape in the surroundings of the site would have been grasslands, especially humid meadows, since the majority of the identified species require environmental humidity even in the presence of permanent water sources.

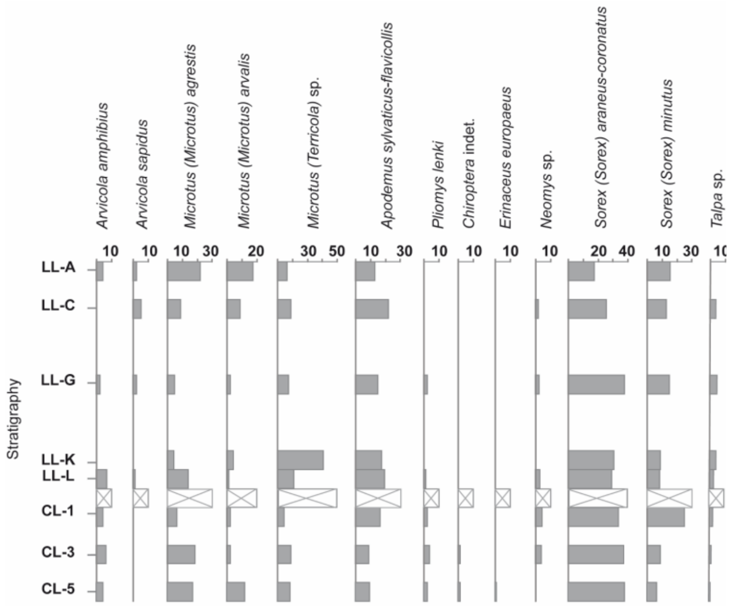


Figure 64. Relative variations in small mammal abundance across sampled levels at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula), expressed as the percentage of the minimum number of individuals (MNI). Suárez-Bilbao et al. (2017a).

To summarize, considering that the proportion of stenoic species that indicate forest environments and relatively warm temperatures is between 12 % and 26 % throughout the sequence, and taking into account the continuous presence of species indicating a certain degree of humidity and the presence of a watercourse (with the exception of LL- K), we can conclude that a woodland mass existed permanently in the surroundings of Artazu VII (Figs. 64 and 66). Even so, the vegetation was probably a mixture of grassland and forest. In addition, given the absence of species like *C. russula*, *G. glis* and *E. quercinus* that are associated with benign environmental conditions in the Cantabrian region, and the absence of taxa that are indicative of the coldest stages, such as *M. (A.) oeconomus,* the climate around Artazu VII would have been neither very warm nor very cold but relatively temperate, similar to nowadays. Thus, the relatively warmer moment would be LL-C and the coldest C-5.

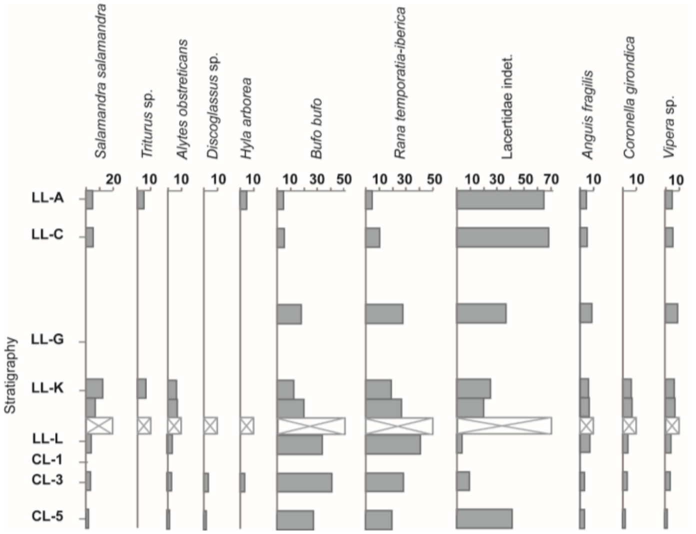


Figure 65. Relative variations in the abundance of herpetofaunal remains throurough sampled levels at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula), expressed as the percentage of the minimum number of individuals (MNI). Suárez-Bilbao et al. (2017a).

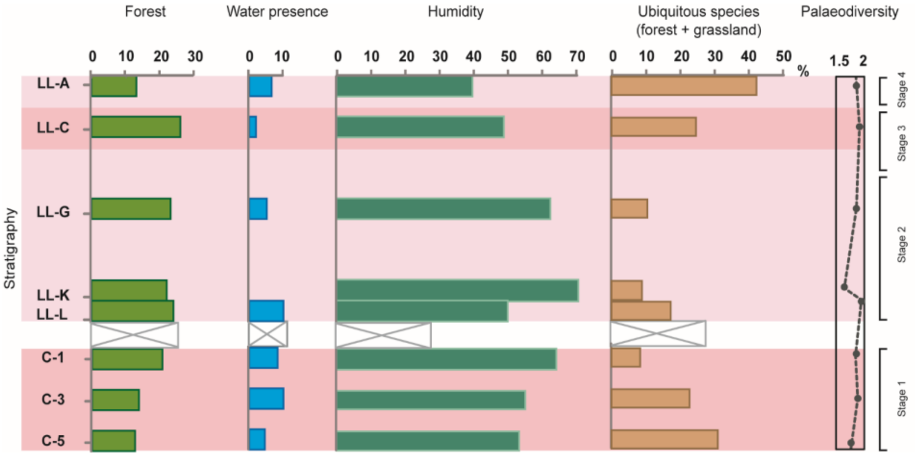


Figure 66. Palaeoenvironmental reconstruction and Shannon Weaver index at Artazu VII (Arrasate, Gipuzkoa, northern Iberian Peninsula) based on the abundance ratio of rodent species indicative of forest compared with species indicatives of other biotopoes. The intensity of the shading is related to the relative warm. Modified from Suárez-Bilbao et al. (2017a). The pictures with the X marked the transition between Chamber and Lower Ledge.

Large mammals

Most of the large mammals from Artazu VII are ubiquitous species with opportunistic behaviour (Red Deer, Cave Lion, Leopard, Wolf, Red Fox and Weasel Polecat) and occupy a wide variety of types of vegetation, altitude and latitude. The presence of some of them is conditioned by the local distribution of rodents (weasels) or the presence of large ungulates in the surroundings (Cave Lion). However, the stenoic large mammal record of Artazu VII suggests a complex environment, consisting of a landscape with different habitats. On the one hand, the existence of open spaces as meadows have been inferred from the the presence of the Feral Horse and Steppe Bison. On the other hand, other species suggest forested areas (Lynx, European Wild Cat and Pine Marten). The existence of rocky escarpments in the immediate surroundings of the site has also been inferred due to the dominance of chamois and the presence of Beach marten.

The $\delta^{13}C$ isotopic analysis of the herbivore asemblage show a change in their diet, probably from C3 to C4 plants (Fig. 50; Chapter 6). Plants from arboreal landscapes (shrubs) show a decrease of $\delta^{13}C$ comparing to plants from open meadows (grass), since the tree density shades the ground and therefore the solar light and the rain hardly ever reach the floor (Tieszen, 1991; Heaton, 1999; Dawson et al., 2002). Consequently, the grounds of forest have less vegetation, reducing ^{13}C values. In addition, C3 plants present inferior values of $\delta^{13}C$ comparing to C4 plants. Thereby, the increase of $\delta^{13}C$ from C-4 to C-2 and from LL-L to LL-D may be relationed with the development of grassland.

The $\delta^{15}N$ trophic level fractioning between carnivores and herbivores from Artazu VII is as expected, since $\Delta\ \delta^{15}N = 5.21$ ‰ and $\delta^{15}N$ is related to metabolic processes and provides information about the position on the trophic levels, diet, climate or if the individual is on breastfeeding time (Iacumin et al., 2000; Drucker et al., 2003; Stevens et al., 2008). The difference between carnivores and herbivores $\delta^{15}N$ mean values (5.21 ‰) corresponds to their position in the trophic level, since, in general, ^{15}N values increases around 3-5 ‰ as ascend at the trophic level. Thus, in Artazu VII, while herbivores have lower $\delta^{15}N$ values, the values of the carnivores are higher. However, a special case is present at Artazu VII in view of the fact that a *V. vulpes* individual show lower $\delta^{15}N$ values (4.23 ‰) comparing to other carnivores of this site. This singular value could be attributed to a distinc diet. Thus, the most likely explanation (Fig. 51; Chapter 6) is that it had an omnivore diet (a reduced availability of meat recources moment, and therefore feeding of vegetals) or its remains had different origin (Coman, 1973). In addition, the presence of two *R. pyrenaica* and *C. elaphus* juvenile individuals that were in breastfeeding periods have been inferred due to their relatively high $\delta^{15}N$ values (Fig. 51; Chapter 6). The main characteristic of a breastfed individual is that is located at higher trophic level comparing to its parents and, therefore, $\delta^{15}N$ values are around 2 ‰ higher (Katzenberg and Harrison, 1997; Larsen, 1999).

Two clear carnivore (composed by *V. vulpes* and *P. pardus*) groups are separated considering $\delta^{15}N/\delta^{13}C$ isotopes ratio due to δ13C values, with the exception of the *V. vulpes* individual previously mentioned (Fig. 52; Chapter 6). This distribution indicates different dietary patterns for each one. Red Foxes and Leopards are grouped at the same thropic level since they present similar $\delta^{15}N$ values and, therefore, similar nutrition. Nevertheless, a coherent interpretation for the Red Fox that has equivalent isotopic values to the herbivores could be a diet composed of a wide variety of resources. A low $\delta^{15}N$ value may indicate a time of lower availability of meat resources and the need to feed by a diet rich in tubers, berries and other vegetables. In relation to the dispersion of $\delta^{15}N/\delta^{13}C$ isotopes of the herbivores, the most negative values of $\delta^{13}C$ may be attributed to a C3 plant diet (shrubs), and the most positive values correspond to a more C4 plants diet (grass).

Birds

All the avifauna assemblage described in Artazu VII is typical of mountain areas where some of them nest in cliffs and rocky surfaces (*Pyrrhocorax* genus). The majority of the birds present in Artazu VII inhabit in or next to treeless open spaces surrounded by woodland areas or in areas with low vegetation (*P. graculus*, *P. pyrrhocorax*, *C. coturnix*, *C. monedula*) (Suárez-Bilbao et al., 2018). Additionally, there are species that can live in steppe (*P. perdix*, *C. crex*), and species that can live in a wide range of environments (*P. pica*). A large part of the bird assemblage resided in rocky areas, next to cliffs and walls where crags and crevices are present (*B. lagopus*, *P. graculus*, *P. pyrrhocorax*, *C. monedula* and *P. pica*). Regarding the palaeoclimate, we have found species that usually live in cold environments (*B. lagopus, C. crex, L. tetrix* and *P. graculus)*, temperate areas (*P. perdix, P. pyrrhocorax* and *C. monedula*) and those that can live in a wide range of temperatures whilst avoiding extreme heat and cold (*C. coturnix*). It is important to bear in mind that birds have the ability to fly and are able to travel over long distances. Thus, given the climatic conditions, they could move towards other geographical areas.

7.1.3. All Artazu VII fauna in a palaeoenvironmental context

All the vertebrate groups studied at Artazu VII point to the same palaeoenvironmental contitions. In general, palaecological conditions induced from the study of small vertebrates show a mixture of woodland and grassland throughout the stratigraphic sequence with a high degree of humidity in the environment and a watercourse near the site. The large mammal assemblage of Artazu VII also suggests a complex environment, consisting of a landscape with open areas and deciduous and conifer forest. Moreover, species that need humid environments also were recorded. The variation of $\delta^{13}C$ values have been attributed to a change in plants diet and, therefore, relationed with the expansion or decrease of forest mass. The general environmental tendencies coincide with the phases inferred from the small vertebrates. Therefore, an increase of $\delta^{13}C$ from LL-L to LL-D has been correlationed to woodland mass expansion. Finally, according to bird palaeoenvironmental insights, the landscape was located at an intermediate mountain area dominated by woodland and meadows mixed areas and a watercourse near the site. However, while the small vertebrate analysis indicates a relatively warm environment, the avian remains point to a mixture of cold and temperate climate, avoiding extreme temperatures. This could be explained by bird migration movements marked by seasonality, from high latitudes to the south in a precise moment. While wood mass development and, therefore, the displacement of estenoic forest species are processes which take lot of time, the birds migration occurs within a rather short time.

7.1.4. MIS assignment

The AAR analyses date Artazu VII site in the first half of the Late Pleistocene (~ 93 ka BP), situating the deposit in the MIS 5, being the most probable substages MIS 5c or MIS 5b. Whereas MIS 5b represents a period of cooling with an open environment and sub-Arcticand and sub-Alpine steppe species (Helmes, 2014), MIS 5c is interpreted as a warmer period, in which broadleaf forests spread in a temperate climate. The vertebrate remains recovered from Artazu VII have allow the palaeoenvironmental reconstruction of the site, showing in general a warm period in which deciduous forests expanded and retraited. Therefore, the Artazu VII has been tentatively correlated to MIS 5c substage.

7.1.5. Artazu VII in the Iberian MIS 5

Artazu's taxonomic structure is peculiar for a large mammal community and does not seem representative of a “balanced” large mammal biocenosis (Castaños et al, 2017a). However, if the possible loss of long bones in this cave is considered, its ungulate composition is not so different from the other eight assemblages dated to MIS 5 from the Iberian Peninsula: HAT (Panera et al., 2005), Bolomor Cave (Blasco et al., 2008), Teixoneres Cave (Rosell et al., 2010), Camino Cave (Álvarez-Laó et al., 2013), Cova Negra (Villaverde et al., 2014), Cova del Rinoceront (Daura et al., 2015), Imanolen Arrobia (Castaños et al., 2017b) and Valdavara 3 (Vaquero et al., 2017). Seven of the samples are sets of alternative occupations of humans and carnivores, and only Imanolen Arrobia is exclusively a carnivore den. Artazu VII shares many similarities with Valdavara 3 (Becerreá, northwestern Iberian Peninsula), since the number of identified vertebrate taxa (small mammals, amphibians, reptiles large mammals, and birds together) ascend to 39 at Valdavara 3 and to 48 at Artazu VII. Regarding the total absence of “glacial” taxa at Valdavara 3 and the preserved animal community, the accumulation was interpreted as a representation of interglacial moment with temperate and wet conditions and permanent water presence, same as Artazu VII. However, Valdavara 3 is a bit older (dated to 103-113 ka), although it was considered a natural trap, lithic artifacts were recovered during excavation and some large mammal bone remains show cutting marks. These are interpreted as actions of human sporadic visits.

The ungulate association that is repeated in these sites is made up of medium-sized cervids (Red Deer and Fallow Deer), horse and bovids of different sizes (Steppe Bison, Auroch, Wild Goat and Pyrenean Chamois). However, differences are related to the palaeoenvironmental context of each of the samples. Some are characterized by the absence of species adapted to open environments (Cova del Rinoceront), while in others the horse is predominant (HAT). However, the most frequent association is intermediate between these two possibilities. The taxonomic record at Artazu VII is not very different from most of the cited sites. Only fallow deer and *Haploidoceros* (absent for the moment in the Cantabrian Mountains), the Aurochs (scarcer than bison in this zone) and the Wild Goat are missing. Therefore, the difference from the other assemblages is not in the taxonomic representation but in the relative high frequency of chamois.

In addition, Artazu VII is the only site that has acted as a natural trap. This raises the question of whether such accumulations result in a similar faunal composition. In the Iberian Peninsula this cannot be answered easily since information on this is very scarce. This scarcity of biotic records from MIS 5 limits the possibility to study the palaeoenvironmental conditions during this stage. The spatially closest information to Artazu VII are four samples from the Cantabrian coast with variable chronology (Castaños et al., 2017a): Lezika (MIS 6) (Castaños et al., 2009), Jou Puerta (MIS 3) (Álvarez-Laó, 2014), Rexidora (MIS 3) (Álvarez-Laó, 2015) and Kiputz IX (MIS 2) (Castaños et al., 2014). *A priori,* natural traps, should reflect the biocenosis of their environment with greater fidelity due to the absence of selective factors. However, although the four samples coincide with cold pulsations and are very close to the current coastline, they display both similarities and differences. All have cold-adapted species such as Woolly Rhinoceros or Reindeer. Horse is the most frequent species in Rexidora, while red deer is predominant in the rest. Artazu VII, with a high frequency of chamois, is the most skewed. However, this peculiarity is probably related to the selection produced by the morphology of the chasm. Thus, with so little data, one cannot speak of a model of natural pit-fall trap accumulations.

Considering all the previous comments, and althought Artazu VII contained biased faunal community information, it is the only site that has acted as a natural trap for the chronology around 93 ka BP in the Late Pleistocene.

7.2. Artazu VIII

7.2.1. Origin of Artazu VIII accumulation

As the site of Artazu VIII was discovered after blasting in a Quarry, much of the site was damaged and a fraction of its fill was scattered outside. Fortunately, the majority of the deposit was conserved. The good integrity and state of preservation of large mammal bones and the absence of anthropological manipulation or predator activity, as well as the inverted funnel morphology of the cavity, suggest that Artazu VIII functioned as a natural trap, where the large mammals fell into accidentally. However, this incident is not a common happening at the animal community since animals avoid perceptible holes, and in case of fall most of them have the hability to climb. The great height of the cavity and its steep walls could cause the trapping of the animals. Several features point in this direction. One of the reasons could be that the entrance was covered by weed and brushwood, making imposible its visualization. Other possibility could be the existence of landslide outside cavity, pushing and draging animals inside. In addition, despite the good preservation of fossil bones and the great number of anatomical elements, no complete skeletons were found in anatomical connection, only few extremities or skeletal parts. Apparently, when the animals fell inside, their bodies lay on the sloping surface inside the cave, and their bones became dismembered during the decomposition process. However, the possibility that animals became trapped in the entrance of the inverted tunnel structure can not be discarded. That way the small bones and the thinnest articulations would the first to fell.

These facts are consistent with the vertical morphology of the cavity. The study of the skeletal elements proportion of the other part of the assemblage suggests that owls and/or diurnal raptors were the responsables of the bird bone deposit. According to the anatomical elements analysis performed in fossil birds and the preliminary small mammal taphonomic study, owls and/or diurnal raptors were birds of prey, being *B. bubo* and *A. chrysaetos* the most probable accumulators.

7.2.2. Palaeoenvironmental approach

Small mammals

The succession is dominated by ubiquitous species like *M. agrestis* and *M. arvalis* that are continuously present, and which could inhabit either grassland or forested areas. It is noticeable that when the presence of *M. (A.) oeconomus* is more abundant, the numbers of *A. sylvaticus-flavicollis* and *P. lenki* decreases. Figure 66 illustrates the four identified stages, according to the inferred palaeoenvironmental tendencies and the AAR dates. Thus, Stage 1 refers from

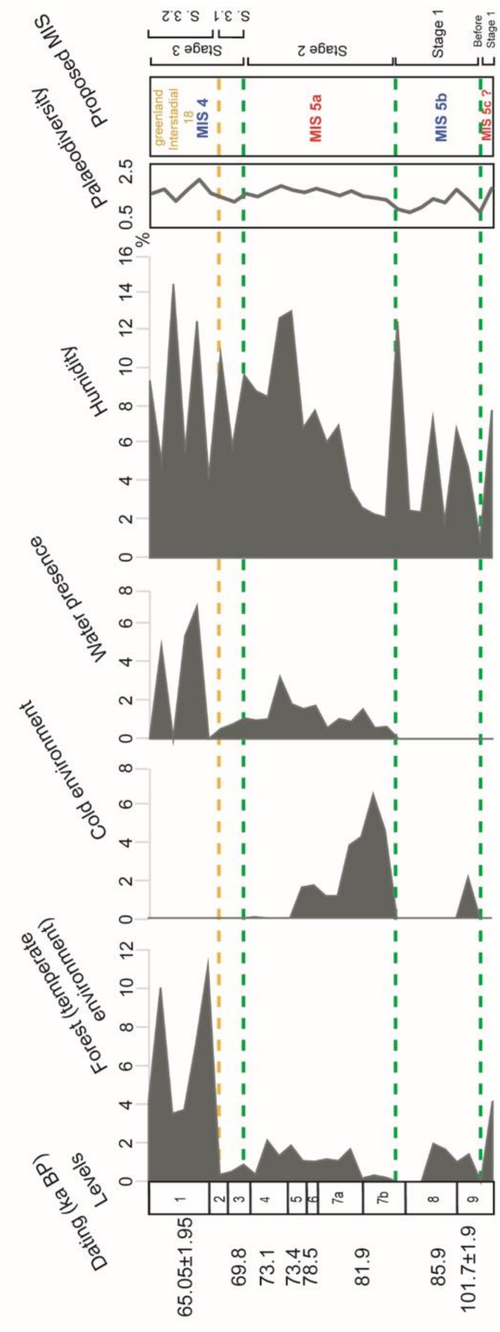


Figure 67. Palaeoenvironmental estimation for Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) based on the abundance ratio of stenoic species and Shannon Weaver index, ordered by samples and levels with the corresponding dates. The last column shows the proposed Marine Isotopic Stages. Based on estimated palaeoenvironmental conditions, the red shading indicates a relatively warm environment, while the blue shading indicates a relatively cold environment. The three stages inferred are shown on the right. S. (Stage).

the upper part of Level 9 to the lower part of Level 7. Before Stage1, the percentage of forest species decreases from almost 6 % to 0 and in the upper part increases again, coinciding with an increase in cold habitat species (Fig. 67). Stage 1 begins at the upper part of Level 9 with the absence of woodlans species. Then, in the change between Level 9 and Level 8, the proportions of woodland species rise and species typical of cold habitats disappear totally. The stage ends at the beginning of Level 7b with a disappearance of stenoic species indicative of forest and cold environments. Moreover, the final part of this phase presents the lowest palaeodiversity of the sequence (0.94 index, Tab. 34). At the beginning of Stage 2, which covers from Sublevel 7b to the transition between Level 4 and Level 3, the frequency of species indicative of cold environment is higher than that of forest ones. Thus, their proportion increases and reaches almost 8 % in Level 7b (Fig. 67), whereas woodland stenoic species appear in a maximum proportion of 2 % (Fig. 67). Then, the precentage of species indocative of cold environments decreases progressively from Level 7b until its disappearance in Level 4 (Fig. 67), and therefore cold biotopes contract and forest species increase in number. Thus, the general tendency is a change towards a warmer climatic conditions. Finally, in Stage 3, identified from the upper part of Level 3 to Level 1, species corresponding to cold biotopes are absent and woodland species show a relatively low values comparing to the previous Stage. Then, in the final part of the Stage 3 species indicative of relatively warm environment expanded. The maximum percentage of woodland species throuroughy the stratigraphic sequence is 12 % (Fig. 67).

The stages in which the *M. (A.) oeconomus* frequency increases and proportion of species indicative of woodland environments decreases correspond to colder conditions (Figs. 67-68). In general, these stages also coincide with less environmental humidity. In contrast, Sublevel 7b shows a peak in the *M. (A.) oeconomus* proportion, as well as a high humidity peak (Fig. 67). Similarly, the peaks in woodland species abundance generally coincide with humidity peaks. In addition, a decrease in palaeodiversity occurs at the onset of colder phases (Fig. 67). Finally, the presence of flow of water near the site seems to occur only since Level 7, and the times with the largest body of groundwater coincided with the deposition of Level 4 and Level 1 (Fig. 67). It is especially noticeable that the increase in the presence of water occurs at the same time as the maximum expansion of forests.

Large mammals

Some of the recovered species from Artazu VIII have specific ecological requirements, so, a brief comment on palaeoenvironmental context is possible. The large mammal record of Artazu VIII suggests a complex environment, consisting of an open area as grassland (Steppe Bison, Feral Horse) surrounded by forest mass. In addition, some cold moments have been inferred since Reindeer and Woolly Rhinoceros were present. The existence of cliffs and escarpments in the immediate surroundings of the site has also been inferred due to the presence of Pyrenean Camois, and the Wild Goat. The remaining species such as cave lion, wolf or red fox identified at Artazu VIII are generalist species occupying a large variety of environments.

Birds

The bird assemblage identified at Artazu VIII is indicave of mountain areas and most of them inhabit in or next to treeless open spaces surrounded by woodland areas with low vegetation (*P. graculus*, *P. pyrrhocorax* and *C. monedula*). Moreover, all of them are typical of rocky areas, next to cliffs and walls where crags and crevices, where some of them nest (*Pyrrhocorax* genus). Regarding the palaeoclimate, both species that usually live in cold environments (*B.* cf. *lagopus* and *P. graculus)* and those that live in temperate areas (*P. pyrrhocorax* and *C. monedula*) have been recorded.

The taphornitology is dominated by species that breed their chick in crags and crevice rocky areas. In addition, the anatomical element analysis reveal that practically half of the assemblage correspond to immature corvids. These facts are consistents to the vertical morphology of the cavity. The study of the skeletal elements proportion of the mature bird assemblage suggests that owls and/or diurnal raptors were the responsables of the bird bone deposit, being *B. bubo* and *A. chrysaetos* the most probable accumulator agents. Although remains of these two taxa were not been found, it may be due to the lack of preservation.

7.2.3. Endokarst sediment origin

Samples from Artazu VIII show similar whole rock and clay mineralogy with some differences in their percentage throughout the stratigrahic sequence. In general, the samples show high proportion of phyllosilicates (more than 30 %), quartz (more than 24 %), low proportion of feldspar (between 1.5 and 6 %) and varying proportion of calcite (from 0 % to 28 %). In the clay minerals fraction, all samples are composed by high proportion of illite (more than 74 %), between 6 % and 13 % of kaolinite and between 2 and 7 % of vermiculite. The conclusions inferred from the mineralogical results of Artazu VIII coincide with those carried out by Arriolabengoa et al. (2015) for the adjacent Bostiturrieta valley. Clay minerals are mostly compounded by illite and, in lower quantity, by vermiculite and kaolinite. The illite and kaolinite minerals are inherited from earliest rocks during the diagenesis, or, in the case of illite, it could be also formed by transformation and alteration of kaolinite (Sangüesa, 1998; Arostegui et al., 2006). Finally, the vermiculite formation results by illite alteration (Sangüesa, 1998; Arostegui et al.,

2006) and, herefore, it is often found in sediments as a weathering product (Brown, 1953; Rich and Obershain, 1955). According to the mineralogical variability, and their percentage fluctuations throughout the stratigraphy sequence, Artazu VIII has been divided in four sections.

Section 1: the granulometric analysis indicates a fine granulometric selection at the bottom (Fig. 60; Chapter 6). This well sorting is explained by the appearance of isolated rounded pebbles at the bottom of sequence (Level 12). The formation of pebbles requires constant moving water. Due to the smaller pieces of rocks that water flowing carries with it, a hit occurs among them and rounded rock pieces are created. So these results indicate that the lower part of this section was formed by fluviokarstic processes originating sediments of similar grain size, depositing allochthonous sandy sediments. This water mass could be explained by the presence of a river in Level 12. This level is the only one showing this grain size distribution, so, after its formation, the river was not present any more in the cave and gravitational removals were the main processes controlling sediments accumulation. The clay mineralogy is characterised by illite high proportion and low proportion of vermiculite and kaolinite (Fig. 62; Chapter 6). Thus, the characteristics of fluvioclastic and the allochtonous sediments indicates humid conditions and relatively cold temperatures, favouring the surface washing. Then, Level 10 was originated between two speleothem flowstones (Levels 11 and 9) (Fig. 15; Chapter 3).

Section 2: a little worse granulometric selection was shown in this section compared to the previous Section 1 (Fig. 60; Chapter 6). This sorting improvement could be associated to a deposition process that contains more water, since water is one of the most selective natural agents in sediment transport. The speleothem crust (Level 9) covered a great part of cave wall with high slope, more inclined as it gets to upper areas reaching Section 1 (till Level 6 and 5) (Fig. 15; Chapter 3). The speleothem crusts form when the water runs down the walls or along the floors in a cave. This water dissolved the rock along its flow, loading in calcium carbonate and depositing when the water lost its dissolved carbon dioxide. Moreover, the thin section shows some pellets of bird droppings, which also coincide to avifauna bones accumulation. The preserving of pellet layers and the reddish colouring in bones of large mammals are probably related to relatively anoxic conditions, produced by water with a low refreshment rate. Therefore, we believe that this part is associated, at least for a while, to water puddles inside the cave. So all the previous facts point to the presence of some water in this section. Moreover, the fact that this section starts with a speleothem reinforces this hypothesis, because once again, the process of this formation needs the presence of water. Apart of this, in Trench b, a higher proportion of calcite is appreciated, which can be explained due to its position in the cave. This trench is located in the corner of the cave together with the wall, so that calcite accumulation could be originated by precipitation of the cave wall as a result of runoff. Comparing this section to the previous one, it can be appreciated a variation in clay mineralogy. Thereby, vermiculite and kaolinite percentage decrease while the proportion of illite increase (Fig. 62; Chapter 6). However, the general tendency is to decrease vermiculite and kaolinite proportion and to increase illite percentage. All these changes could correspond to palaeoenvironmental conditions worsening, moving to more humid conditions and colder temperatures (Arriolabengoa et al. 2015; Moreno et al. 2013).

Section 3: this section shows an allochtonous sediment and very low granulometric selection (Fig. 60; Chapter 6), so there was not a main selective agent. Therefore, the sediment particles were carried to the cave probably by gravitational processes, from the entrance situated above. The presence of the allochthonous sediment suggests a greater fluviokarst activity and greater weathering of external soil. At the upper part of the Section 3, the whole-rock mineralogy results vary in Trench b due to the proximity to the cave wall, and therefore the surface runoff effect is greater. Vermiculite and kaolinite percentage are relatively low and proportion of illite relatively high (Fig. 62; Chapter 6) compared to Section 2. However, comparing to Section 2 the general tendency is the opposite since vermiculite and kaolinite increases and illite decreases. Moreover, fragments of speleothem crust from Section 1 (that corresponds to Level 9) have been found with polygonal morphologies (Fig. 15; Chapter 3). This speleothem fragments also could be observed both at first sight and also in the thin layer’s in trama (Level 5). Therefore, all these changes could correspond to a fluctuation in the palaeoclimatic situation, moving to wet conditions and warmer temperatures (Arriolabengoa et al. 2015).

Section 4: as in Section 3, the granulometric analyses show a very poor sorting (Fig. 62; Chapter 6). The formation of Level 4 and the speleothem crust of Level 3 started at the same time, fusing with Level 2. Finally, Level 1 was deposited with many large limestones fragments, due to the fall of cavity walls (Fig. 15; Chapter 3). In clay mineralogy, vermiculite proportion starts with relatively low values and increases towards top reaching it. Apart of this, thin section shows a matrix with a lot of terrestrial gastropod for Level 4, which are very good environment indicators (Rousseau, 1992). Thus, the malacological record suggests temperate climate with high moisture in the environment. Apart from this, the variation of clay minerals is the same as the precious Section (Fig. 62; Chapter 6), which also points to humid conditions and relativey warm temperatures. Moreover, in this section speleothem presence (Level 3) appears again, being other geologic process that needs the conditions previously mentioned.

7.2.4. Artazu VIII in a wider palaeoenvironmental context

A minimum of three palaeoenvironmental stages and four mineralogical sections have been identified at Artazu VIII. The stages (based on small mammals) palaeoenvironmental interpretations coincide mostly with the estimations inferred from the sections (based on mineralogy).

In the lower part of Level 9, while the conditions inferred from the anterior phase to Stage 1 are relatively warm temperature and humid, the Section 1 suggests cold and humid environment. However, the small mammal assemblage recovered from this part was not enough to perform palaeoenvironmental stimations. The Stage 1/Section 2, have been interpreted as a cold and dry environment due to forest species decrease and the increase of cold biotope species. Same conditions have been inferred from the tendency of clay minerals, increasing illite content and decreasing vermiculite and kaolinite proportion. In addition, the predominance of fluviokarstic activity predominating allochtonous sediment and a presence of a river in the cave has been inferred because of the well sorting of the sediment. Between Level 8 and 7b, according to the relatively low biodiversity index and the relatively higher proportion of illite, this second part would be colder. Although environmental fluctuations in the large mammal assemblage are not so noticeables as in other proxies, the presence of Wooly Rhinoceros and Reindeer in Level 8 is remarkable. Afterwards, an improvement in environment occurs in Stage 2/Section 3. On the one hand, the proportion of species indicative of forest biotope increases while species that habit in cold habitats disappear. On the other hand, the proportion of illite decreases. All these facts could be attributed to warmer and wetter moments. In addition, the coincidence in the first part of the stage/section of the formation of speleothems, the little worse granulometric selection in the sediment and the abundance of vermiculite, denote greater infiltration of authocthonous soils and carbonate precipitation (which is related to relatively warm conditions). Finally, the Stage 3 begins with relatiley cold and wet conditions. However, at the middle of this Stage and in Section 4 a tendency to a progressively climatic warming and more humid environment is showed again, since small mammal species that live in cold environment are absent and those that are indicative of forest habitat increase. This tendency also could be inferred due to the decrease of illite and the presence of speleothems and travertines in Level 3 and Level 2. The remains of Woolly Rhinoceros recovered at Level 1 could be contamination generated by the blasting which gave room to the discovery of the site.

Regarding to avifauna, the inferred environment also coincide with the formers. Thus, the described bird community is indicave of mountain areas with contained open spaces and woodland areas. In addition, species indicative of relatively cold and warm areas were also recorded.

7.2.5. MIS assignment

The AMS results indicate that all the samples have an age older than 43.5 ka BP, while the data obtained from AAR analyses attribute all levels at Artazu VIII to the late Pleistocene, from 101.7 to 65 ka BP (Tab. 33; Chapter 6). Considering the ages obtained from AAR analyses, their possible error of dating, as well as the palaeoenvironment conditions inferred, three Stages have been differentiated.

The lower part of Level 9 is undated (Before Stage 1), although a warm environment has been inferred due to the high percentage of forest indicative species and the absence of cold climate species. We therefore propose that this lower part could correspond to MIS 5c (Figs. 67-68).

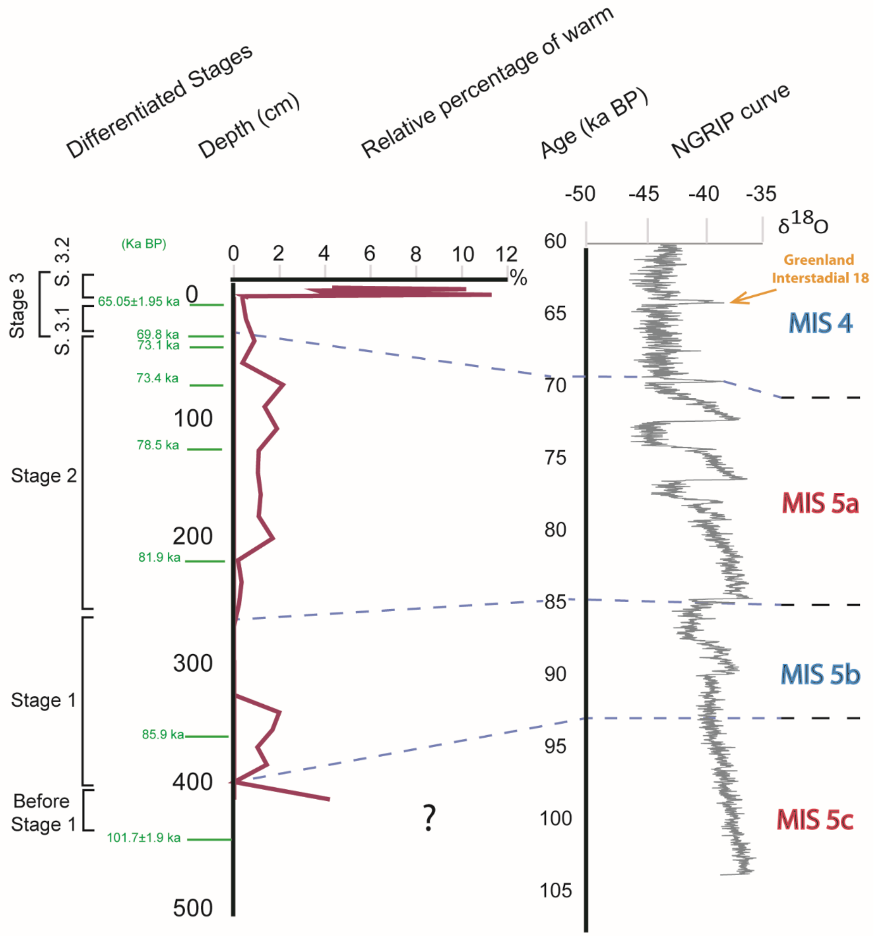


Figure 68. Inferred palaeoenvironment at Artazu VIII (Arrasate, Gipuzkoa, northern Iberian Peninsula) organized by depth compared to NGRIP isotopic curve. S. (Stage).

The Stage 1 comprises from the upper part of Level 9 to the transition between Level 8 and Level 7, when a general tendency to a cold and dry environment has been inferred from the small mammal assemblage. It is correlated to MIS 5b (Otvos, 2015) (Fig. 67). According to the low palaeodiversity, the coldest moment is represented by the boundary between Levels 8 and 7.

Stage 2 covers from almost completely Level 7 to the middle of Level 3. According to ARR results, it corresponds to MIS 5a (85-71 ka BP). According to the NGRIP curve, an improvement took place during MIS 5a (Fig. 68), which would entailed forest expansion (Shackleton, 1969; Sánchez-Goñi, 2007), as it is seen in Artazu VIII (Fig. 67). The changes in the relative percentage of warm recorded throurough this stage could characterized the internal variations of MIS 5a.

Finally, Stage 3 starts in Level 3 and covers the remaining stratigraphic sequence. MIS 4 comprises from 71 ka BP to 55-50 ka BP and according to Sánchez-Goñi and D'Errico (2005), the transition from MIS 5a to MIS 4 occurred very rapidly, from an interglacial phase to glacial cold and dry conditions. Artazu VIII could be correlated to this stage, since this event begins in 69.8 ka BP, when forest retraction is observed at Artazu VIII (Fig. 68). Althought MIS 4 is characterized by the predominance of cold climate, numerous additional events with small warm and cold peaks interspersing occurred inside (Helmens, 2014; Rasmussen et al., 2014). In addition, it has recognized one interstadial (Green Interstadial 18) succeed by only a few centuries around 64 ka BP, which was overlooked in the original numbering scheme. This changing tendency can also be observed in Artazu VIII. Thus, according to the different tendencies this stage has divided into two parts: Stage 3.1 (from Level 3 to Level 2) and Stage 3.2 (from Level 2 to Level 1). In the Stage 3.1 the percentage of humidity increases greatly (Fig. 68), whereas in the Stage 3.2 a relatively warm and humid environment has been inferred within progressive climatic warming.

7.2.6. Comparison between Artazu VIII and other sites belonging to MIS 5-4

After correlating Artazu VIII woth NGRIP δ^{18}O curve, this site has been compared to other sites with the same chronology. As discussed previously, palaeoenvironmental knowledge of MIS 5 and MIS 4 is less abundant than for MIS 3 due to terrestrial records being imprecise and fragmentary. Most sites from Iberian Peninsula dated to MIS 5 are situated in the Mediterranean area (Blasco et al., 2008; Fernández Peris et al., 2008; Daura et al., 2015). Finally, althought deposits that correspond to MIS 4 exist, the majority of them do not contain faunal remains, or those that have palaeontological samples are a bit younger that Artazu VIII, corresponding to cold phases. An example of this is Cueva de la Buena Pinta (Laplana et al., 2016), which levels correlated to MIS 4 are situated between 64 and 60 ka BP. No sites have been found in the Iberian Peninsula attributable to the Greenland Interstadial 18, therefore, comparison has not been posible.

Before Stage 1

The upper part of Level 9, has been dated to around ~101 ka BP. There is no dating for the lower part, where relatively warm environment has been inferred. Thus, we propose that the lower part of Level 9 may correspond to MIS 5c. However, the number of small mammal remains is low, and both birds and large mammal remains are totally absent. Therefore, this assignation should be taken with caution. The layer 05 from Cueva del Camino was dated in 90,961±7881 ka BP and has been represented as temperate phase, so, it has been correlated to MIS 5c or MIS 5a (Álvarez-Lao et al., 2013).

Stage 1

Stage 1 from Artazu VIII has been tentatively correlated to MIS 5b. In Lezetxiki II, Levels F-E were assigned to MIS 5d-b (110-82 ka BP), coinciding in general with an environmental change towards warm and humid conditions, inferred from the small vertebrate study (Garcia-Ibaibarriaga et al., 2018a). However, according to Garcia-Ibaibarriaga et al. (2018a) the percentage of woodland species in Level F is lower and the temperature may have been cooler than in previous levels. In addition, Unit 1 (Layers I, II and III) from Cova del Rinoceront has an age between 175-74 ka BP and has been attributed to the transition from MIS 6 to MIS 5a. In particular, Layer I is dated to around 87 ± 5 ka BP and was associated with a cold and relatively humid period from the MIS 5b substage (Daura et al., 2015).

Stage 2

Relatively warm and wet conditions from Stage 2 may be attributed to the interstadial MIS 5a. Since the range of the date of Layer 05 from Cueva del Camino is wide (± 7881 years) the authors of this work do not reject the possibility that the deposit correspond to MIS 5a. From the fossil assemblage from this site have been inferred a temperate climatic conditions, therefore, Artazu VIII could be correlatable to this interval. The HAT site was dated to 74 +16/ −12.1 ka BP (Panera et al., 2005), corresponding to temperate and humid conditions (Sesé et al., 2011), therefore this site may correlate to the Stage 2 from Artazu VIII.

Stage 3

The Stage 3 correlates to MIS 4. For Stage 3.1 a cold temperatures have been inferred, although the environment of the first part would be colder and more humid., It seems that the Stage 3 levels correspond more or less to Level D (78.4±8.4 ka BP and 74 ka BP) from Lezetxiki II cave (Garcia-Ibaibarriaga et al., 2018a), although no small vertebrates were analysed there since a speleothem flowstone covers the sediment, However, according to Garcia-Ibaibarriaga et al. (2018a), a tendency to a cooler temperature can be observed in the MIS 4 section. No Iberian deposits have been found where the Greenland Interstadial 18 has been detected. In Europe nor also are common sites where this interstadial has been identified.However, it hass been identified in Lascaux (France; Bertran et al., 2016).

7.4. Comparison between Artazu VII and Artazu VIII

Both sites were accidentally discovered almost at the same time after blasting at Mount Artazu (Arrasate, Gipuzkoa). They were located at a distance of only 15 m and with a difference of 16 m in altitude, being Artazu VIII located above. As a consequence of exploitation works, part of both sites disappeared. While in the case of Artazu VII the majority of the site was destroyed, in Artazu VIII only a small part was missed. As opposed to Artazu VIII, the preserved part in Artazu VII does not allow the differentiation of levels. Therefore, the reconstruction of the cavities morphology and the palaeoenvironment is more precise in the second site.

Regarding chronology, both sites were dated to the Late Pleistocene: Artazu VII dates around 93 ka BP and Artazu VIII dating comprise from around 102 ka BP to 63 ka BP. Furthermore, Artazu VII has been correlated to MIS 5c, and Artazu VIII from probably MIS 5c to MIS 4. Although both sites were dated to the Late Pleistocene, they are synchronous only in the interstadial MIS 5c and, therefore, they are chronologically complementary: Artazu VII was deposited together with the lower part of Artazu VIII, and then the remaining of Artazu VIII was accumulated.

Among the small mammals, both sites show a similar number of taxa (13 in Artazu VII and 14 in Artazu VIII). In addition, the identified taxa are almost the same, with the exception of *A. sapidus* (present at Artazu VII), *C. nivalis* (present at Artazu VIII) and *M. (A.) oeconomus* (present at Artazu VIII). In the case of *C. nivalis,* its presence/absence could be explained by its biochronnology. In sites with similar chronologies as Artazu VII such as HAT (Sesé et al., 2011), Bolomor (Blasco and Fernández-Peris, 2012), Cova del Rinoceront (López-García et al., 2016), Valdavara 3 (Vaquero et al., 2017), or Lezetxiki II (Garcia-Ibaibarriaga et al., 2018a) it is absent. However, in sites in which this taxon has been identified, it is only recorded in more modern levels/layers than Artazu VII; Valdavara 1 (during the second part of the Late Pleistocene; López-García et al., 2011b), Cueva del Camino (in MIS 5c or MIS 5a, 90,961±7881 ka BP; Álvarez-Lao et al., 2013), Askondo (forward from Aurignacian; Garcia-Ibaibarriaga et al., 2015a) or Cueva de la Buena Pinta (between MIS4 and the startof MIS3; Laplana et al., 2016). So far, the earliest record of this species comes from the MIS 5 in Cueva de la Carihuela (Ruiz Bustos, 2000). Thus, lower levels from Artazu VIII would be in the age limit, existing the possibility of having one of the first records of this taxon from the Iberian Peninsula at Artazu VIII.

The presence of *M. (A.) oeconomus* only at Artazu VIII is owing to the environmental requirements of this taxon, since it is linked to densely-vegetated cold environments (Cuenca-Bescós et al., 2008, 2009; Sesé, 2009; IUCN, 2018). Thereby, while Artazu VII has been associated to an interglacial (MIS 5c), Artazu VIII has been correlated to two cold periods (MIS 5b and MIS 4). Finally, the absence of glirids in both sites such as *Eliomys quercinus* or *Glis glis* is noteworthy; these species are associated with benign conditions in temperate climates and forest biotopes (Chaline, 1970; Rzebik-Kowalska, 1995; Sesé, 2005). Even so, these species are very common in other fossiliferous sites from the northern Iberian Peninsula, such as Askondo (*G. glis*; Garcia-Ibaibarriaga et al., 2015a), Cobrante (*G. glis*; Sesé, 2009), El Miron (*E. quercinus*; Cuenca-Bescós et al., 2009), Lezetxiki II (*E. quercinus*, *G. glis* and *Muscardinus avellanarius*; Garcia-Ibaibarriaga et al., 2018a) and Peña Larga (Murelaga et al., 2009), among others. However, all of them are much younger than Artazu VII and Artazu VIII, with the exception of the Level K from Lezetxiki II (215.7± 15.1 ka BP), where only few remains of murids have been recovered (Garcia-Ibaibarriaga et al., 2018a).

On the contrary, differences among large mammal assemblages are quite evident. The greatest distinction is the proportion of carnivores: while in Artazu VII they represented the 29.1 % of the assemblage, in Artazu VIII only the 2.2 % of remains belong to carnivores. Hence, there is a great taxonomical difference. *Felis silvestris, Lynx* sp.*, P. pardus, M. martes, M. meles, M. nivalis* and *M. putorius* have been recorded only at Artazu VII, while *C. pyrenaica, R. tarandus, C. antiquitatis* and *U. spelaeus* are exclusive from Artazu VIII. The absence of species indicative of cold environments (*C. antiquitatis* and *R. tarandus*) at Artazu VII is coherent. However, considering that both sites are at least in some part of sites chronologically contemporaneous and that the sites were located at the same area, the contrast between carnivore portions is bizarre. This difference way be related to the position os sites in the Artazu Mount (explained below).

Among the avifauna assemblages there are also remarcable differences, both in taxonomy and number of preserved remains. 1786 remains and 12 taxa have been identified at Artazu VII, facing 394 remains and 5 taxa (all corvids except one) at Artazu VIII. This difference could be as a result of cave morphologies. Continuing with the possible types of natural trap commented before, we propose that Artazu VII would be part of a greater cave with an open vault, while Artazu VIII would had vertical inverted funnel cavity. Thus, Artazu VII would more frequented by avian community in coparison to Artazu VIII.

The current appearance of Artazu Mount and Kobate Quarry can be observed in Figure 68A.This photography lacks the top of the mountain where Artazu VII and

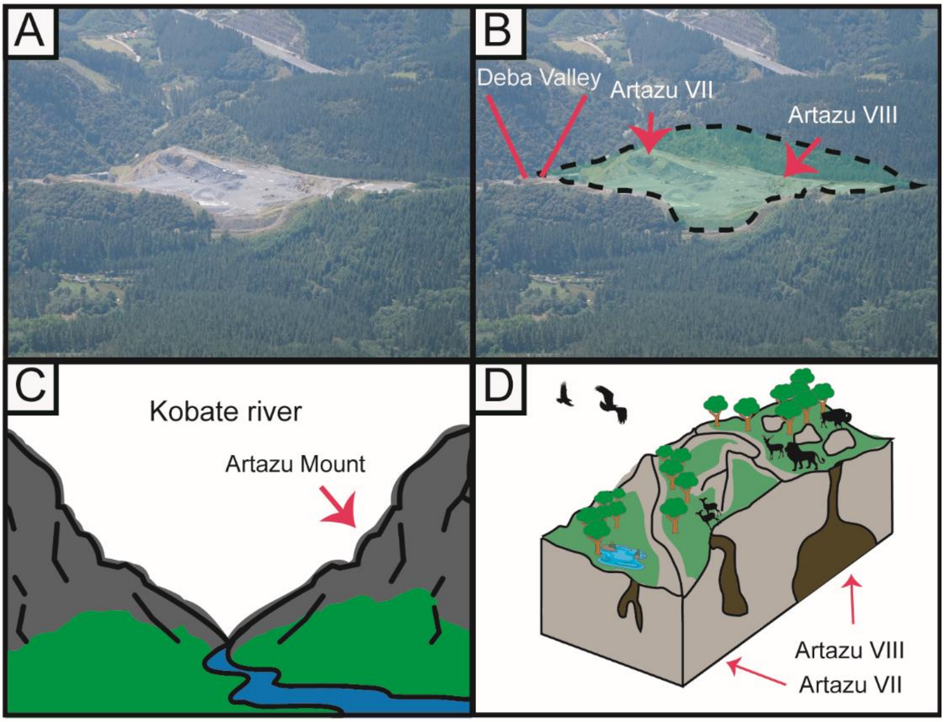
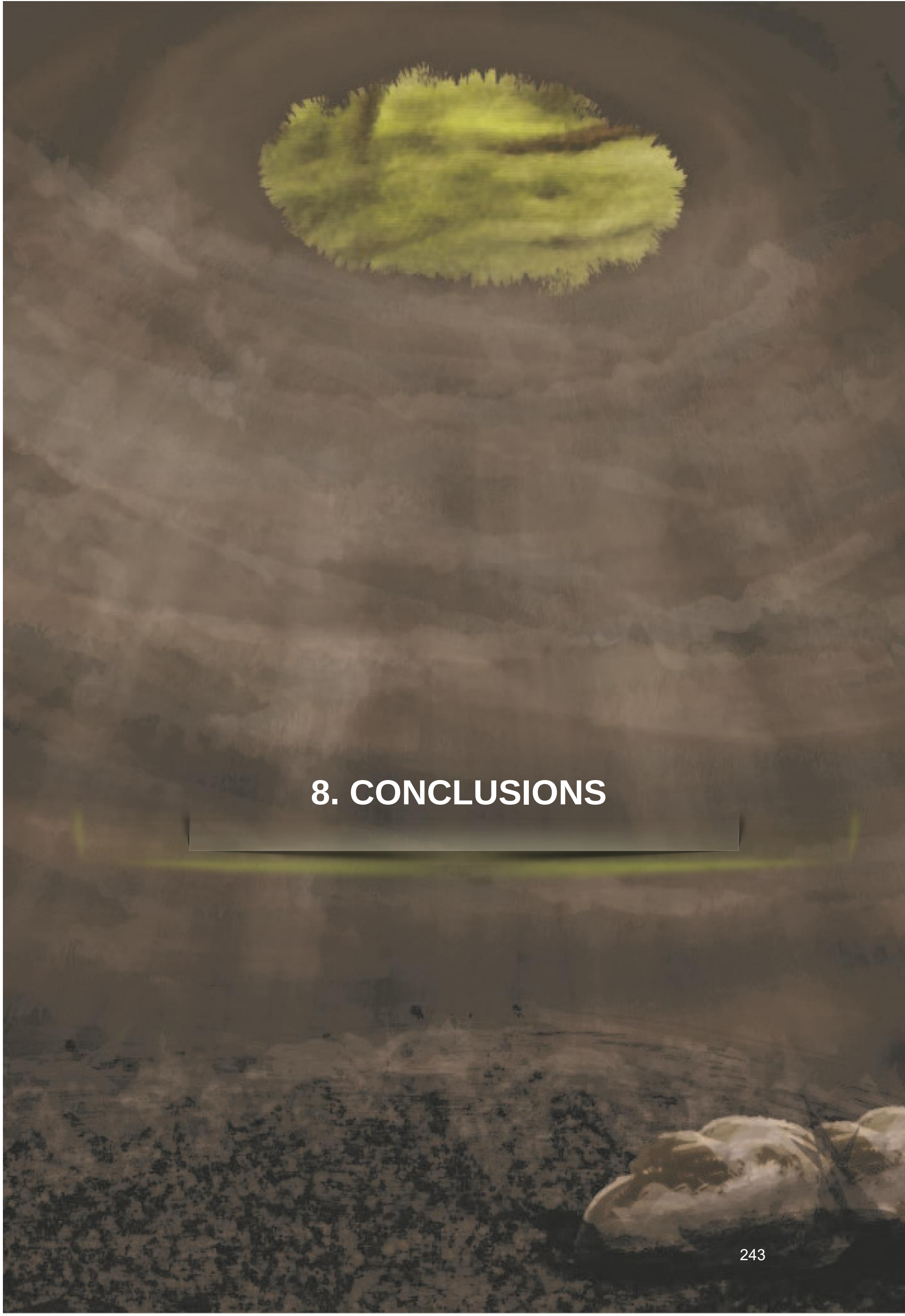


Figure 69. A: Current appearance of Artazu Mount and Kobate Quarry (Arrasate, Gipuzkoa, northern Iberian Peninsula). B: Artazu Mount palaeorelief reconstruction. In green Artazu Mount geomorphology during the Late Pleistocene, before quarry exploitation. The red arrows indicate Artazu VII and Artazu VIII sites. C: Deba Valley with Artazu and opposite Mounts. D: Explanatory drawing of the palaeorelief and sites locations interpretarion.

Artazu VIII were located (Fig. 69B) since it has been exploited by blasting. In old aerial photographs currently disappeared mountaintop can be observed,, being a reflection of the opposite mount. Thus, they formed a shaped like “V” (Kobate river) (Figs. 69B and C). Consequently, looking the geomorphology of the opposite Mount to Artazu we can get an idea of how was the Artazu Mount slope. Taken all this and taxonomic difference into consideration, we propose the following: Artazu VII would be located at the edge of the Mountain slope, in a precipitous relief (Fig. 69C). Here, probably, animals with climbing and jumping abilities (*F. silvestris, Lynx* sp., *R. pyrenaica* and *P. pardus* among others) would probably inhabit.

In addition, Artazu VII was situated at the border of the hill, a zone that probably was more deforested. On the contrary, Artazu VIII would be located towards the inner parts of the mountain, on a terrace (Fig. 69C). In this second space, apparently, packs of large animals would be frequent (*C. antiquitatis* or *B. priscus* among others). In regard to bird community, and as a consequence of its location, Artazu VII would be more exposed to the air. We think that Artazu VII would be a privileged place for birds, since from this area they had a wide landscape views for flight or land on. In this manner, in breeding time they would go out hunting and then retuned easily to the nest place. On the contrary, Artazu VIII was more sheltered and probably surrounded by forest (Fig. 69C) and, therefore, the Valley vision would more reduced for hunting.



8. CONCLUSIONS

8. CONCLUSIONS

The results obtained from Artazu VII and Artazu VIII sites provide relevant information about these Late Pleistocene palaeontological deposits, including palaeoenvironmental and palaeoclimatic conditions. They are some of the very few sites with continental record but no trace of anthropological or predator activity dated to the MIS 5 in the Iberian Peninsula, and those are located in the Mediterranean area. Therefore, this thesis makes a relevant contribution to the knowledge of the northern third of the Iberian Peninsula during this period.

The inclusion of the small mammals, large mammals, herpetofauna, avifauna, as well as mineralogical and sedimentological studies and isotopic analysis in the same study supposes a novel and integral thesis. These multidisciplinary studies allow a more global and rigorous approach to the ecosystems of the sites.

A systematic review of Artazu VII and Artazu VIII vertebrate remains has yielded a total of 24,196 vertebrate remains identified at genus/species level, corresponding to a minimum number of 3,968 individuals. They are distributed among 55 species: 8 Cricetidae [*Arvicola amphibius, Arvicola sapidus, Microtus (Microtus) agrestis, Microtus (Microtus) arvalis, Microtus (Terricola)* sp., *Microtus (Alexandromys) oeconomus, Chionomys nivalis* and *Pliomys lenki]* a Muridae (*Apodemus sylvaticus-flavicollis*), an Erinaceidae (*Erinaceus europaeus*), three Soricidae [*Sorex (Sorex) araneus-coronatus, Sorex (Sorex) minutus* and *Neomys* sp.] a Talpidae (*Talpa* sp.), one Equidae *(Equus ferus caballus)* and *one* Rhinocerotidae *(Coelodonta antiquitatis),* two Cervidae (*Cervus elaphus* and *Rangifer tarandus*), three Bovidae (*Bison priscus, Capra pyrenaica* and *Rupicapra pyrenaica),* four Felidae (*Felis silvestris*, *Lynx* sp., *Panthera pardus* and *Panthera leo spelaea*), three Canidae (*Canis lupus*, *Cuon alpinus* and *Vulpes vulpes*), an one Ursidae (*Ursus speleus*), four Mustelidae (*Martes martes*, *Meles meles*, *Mustela nivalis* and *Mustela putorius*), two Salamandridae (*Salamandra salamandra* and *Triturus* sp.), two Alytidae (*Alytes obstetricians* and *Discoglossus* sp.), one Bufonidae (*Bufo bufo*), one Hylidae (*Hyla arborea)*, a Ranidae (*Rana temporaria-iberica*), two Sauria (Lacertidae indet. and *Anguis fragilis*), two snakes (*Coronella* and *Vipera* sp.), four Phaisanidae (*Perdix perdix*, *Coturnix coturnix*, *Lyrurus tetrix* an *Alectoris* sp.), a Rallidae (*Crex crex)*, a Strigidae (*Bubo bubo)*, four Accipitridae (*Aquila* sp., *Aquila chrysaetos*, *Haliaeetus albicilla* and *Buteo lagopus*) and four Corvidae (*Pyrrhocorax pyrrhocorax*, *Pyrrhocorax graculus*, *Corvus monedula* and *Pica pica*), being the absence of glirids noteworthy. Thus, 48 species of vertebrates were identified at Artazu VII (among small mammals, reptiles, amphibians, birds and large mammals) and 30 taxa at Artazu VIII (among small mammals, birds and large mammals).

The initial taphonomic studies indicate that part of the birds (mainly Corvids) lived at the sites, at least in the breeding season, due to the great abundance of bones that corresponded to immature individuals. Regarding small mammals taphonomic study, digestion traces were scarce, pointing to owls and/or diurnal raptors as accumulator agent. This, together with the results obtained from the taphonomic analyses on the mature bird bones, pointed to *Bubo bubo* as a possible predator in Artazu VII and a nocturnal raptor in Artazu VIII.

Among these asemblages the second fossiliferous record of *Buteo lagopus* from the Iberian Peninsula was present at Artazu VII, and probably the third one at Artazu VIII. Furthermore, Artazu VII had one of the best samples of *Coturnix coturnix* and *Lyrurus tetrix* in the Iberian Peninsula for the first half of the Late Pleistocene. In addition, Artazu VII includes the third richest Iberian sample of leopard remains and Artazu VIII the richest one in *Coelodonta antiquitatis* remains. Finally, the possibility of having one of the oldest record from the Iberian Peninsula of *Chionomys nivalis* also exists.

Apart from that, a biometric study of *Sorex* species has been performed in this doctoral thesis, allowing the identification of the isolated *Sorex* taxa dental elements to *Sorex (Sorex) araneus-coronatus* and *Sorex (Sorex) minutus*.

8.1. Artazu VII

- According to AAR and AMS datings, Artazu VII has been dated in the first half of the Late Pleistocene, with a mean data of 93 ka BP (98.4 ka and 88.5 ka BP).

- The small vertebrate skeletal remains ascend to 9,644, corresponding to a minimum of 732 individuals and 24 taxa, while 1,162 large mammal remains were identified, corresponding to a minimum of 40 individuals and 14 taxa. Regarding avifauna, 1,786 bones have been recovered, with 239 remains identified to Order/Family level and 519 to genus/species level. They belong to a minimum number of 72 individuals and 12 taxa.

- According to isotopic analyses, the herbivore remains with lowest $\delta^{13}C$ values coincide with the greater woodland mass and the higher $\delta^{13}C$ values with greater meadow development, beginning the sequence with a relatively high woodland mass. Regarding carnivores, two groups have been differentiated according to $\delta^{13}C$ relation. However, their $\delta^{15}N$ values indicate a different origin to one individual of *Vulpes vulpes*. In addition, two *Rupicapra pyrenaica* and one *Cervus elaphus* remains have been identified as individuals that are in breastfeeding time due to their $\delta^{15}N$ values.

- The palaeoenvironmental reconstruction based on all vertebrate assemblage shows, in general, a mixture of woodland and grassland throughout the stratigraphic sequence with a relatively temperate climate. A rocky mountain areas situated in intermediate altitudes, that is between the mountain and the bottom of the valley, also has been inferred, with freshwater courses nearby and certain degree of humidity in the environment.

- Four main phases during the upper Pleistocene were differentiated based on the environmental conditions inferred from the study of the small mammals. Thus, Stage 1 begins with the moment of the least forest development, although it progressively reached its maximum expansion. Later, in the Stage 2, the woodland biotope decreases slightly. In the Stage 3, woodland development expanded again and, finally, in the Stage 4 declines until reaching a similar extension of the Stage 1.

- According to performed dating and inferred palaeonvironmental conditions from vertebrate studies, the deposit has been correlated to MIS 5c substage. Moreover, the correlation of this site with other palaeoenvironmental reconstructions from the Iberian Peninsula supports this conclusion.

8.2. Artazu VIII

- AAR and AMS dating techniques situated Artazu VIII at the first half of the Late Pleistocene, covering a temporal range of at least 36 ka BP (from ~ 102 to 65 ka BP). According to stratigraphic and sedimentological features, this chronology was represented along the 12 differentiated levels.

- A total of 8,129 identifiable small mammal skeletal remains corresponding to a minimum of 3,036 individuals and 14 taxa were identified, while 4,331 taxonomically identifiable large mammals were recovered, corresponding to 77 individuals and belonging to 11 taxa. In relation to avifauna, 171 identifiable bird bones at genus/species level corresponding to a minimum number of 15 individuals were identified, with a representation of five taxa.

- Two different sedimentary origins have been concluded by the mineralogical and sedimentological analysis. Thereby, during dry and cold periods allochtonous sediment was transported by fluviokarstic and gravitational agent, while and autochthonous soils infiltration and speleothems formation occurred during warm and more humid moments.

- The palaeoenvironmental insights inferred from vertebrate assemblages reveal that the landscape was an intermediate mountain area, dominated by mixed areas of woodland with low vegetation and meadows and a watercourse near the site. Variations in environmental relative moisture and relative temperature have been concluded, with dry or humid periods and relatively cold or warm moments.

- The inferred palaeoenvironmental conditions, both from the vertebrate (Stages) and mineralogical and sedimentological studies (Sections), have allowed the identification of four main palaeoclimatic phases with both proxies, focusing on the expansion and decrease of wood masses. The Section 1 (before Level 9) begins with a cold and relatively dry climate and evolve to a warm and humid environment, which matches with the Stage before 1. In addition, the presence of the river near the cave was also inferred. The passage to Stage 1/Section 2 (from the upper part of Level 9 to the lower part of Level 7b) is marked by the presence of speleothems, the reddish colouring of the vertebrate bones and the presence of bird pellets in the sediment. This part represents a cold period, being the transition between Levels 8 and 7 the coldest and most humid of the sequence. Afterward, during the Stage 2/Section 3 (Levels from 7b to the middle of Level 3) a tendency to temperate phase has been inferred. A forest biotope developed and humid and warm conditions stablished, being the cave flooted at least for a while. Finally, in the Stage 3/Section 4 (from the middle of the Level 3 to Level 1) formation of speleothems and the great amount of gastropods was observed on the surface. This stage has also been divided into two pulses (Stage 3.2 and Stage 3.1). The first part is characterized by cold environmental conditions and in the second part the general tendency is to benign conditions, occurring the maximum expansion of the forest.

- The differentiated phases have been correlated to NGRIP $\delta^{18}O$ curve: the Stage 1 corresponds to MIS 5b, the Stage 2 to MIS 5a, and the Stage 3 to MIS 4, identifying the Greenland Interstadial 18 inside the last.

In summary, although the Deba Valley includes a large number of archaeo-palaeontological sites, Artazu VII and Artazu VIII are singular since no anthropological intervention and predator activity was identified. Therefore, the performed paleoenvironmental and paleoclimatic reconstruction of the surroundings of both sites suppose an important advance not only for the fossiliferous deposits located around, but increases the knowledge of the northern third of the Iberian Peninsula. Thus, this thesis contributes substantially to the better understanding of the palaeoenvironmental fluctuations of these periods.

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Appendix

The production of this doctoral thesis has allowed the following publications:

Suárez-Bilbao, A.; Garcia-Ibaibarriaga, N.; Castaños, J.; Castaños, P.; Iriarte-Chiapusso, MJ.; Arrizabalaga, Á.; Torres, T.; Ortiz, J.E.; Murelaga, X. 2016. A new Late Pleistocene non-anthropogenic vertebrate assemblage from the northern Iberian Peninsula: Artazu VII (Arrasate, Basque Country). Comptes Rendus Palevol, 15:950-957.

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