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Philippe Fosse, Gérard Cazenave, Marie-Christine Delmasure, Michel Douat, Jean-Baptiste Fourvel, et al.. The recent history of the Spanish ibex (*Capra pyrenaica*) in the French Pyrenees: a contribution of speleology to palaeontology. *Karstologia Mémoires*, 2022, 18th International Congress of Speleology, 25 (Vol. 5. Karst sediment, Palaeontology and Archaeology), pp.375-378. hal-03817878

HAL Id: hal-03817878

<https://hal.science/hal-03817878v1>

Submitted on 17 Oct 2022

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The recent history of the Spanish ibex (*Capra pyrenaica*) in the French Pyrenees: a contribution of speleology to palaeontology

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Abstract

Over the last 40 years, research on (sub)fossil Spanish ibex (*Capra pyrenaica*) in the French Pyrenees is mainly based on discoveries made by cavers. In the western Pyrenees, more than 25 natural sites yielding Spanish ibex remains are known allowing palaeoecological research. Based on topographical settings (maps, bone location), paleontological records (osteometry, sexual dimorphism) and taphonomic analysis (skeletal discarding, biotic/abiotic traces), this paper provides information on the formation processes for some unpublished caprid sites. The deposits are mainly located in high mountains, in (deep) vertical holes or descending galleries having trapped one or two adult Spanish ibex or exceptionally several (non-) adult individuals. Osteometrical dataset suggests that males are more often trapped than females. Bone surfaces do not bear any important predator nor scavenger activities (large and/or small carnivores). The sites correspond to natural incursions of Spanish ibex into dark galleries, which are diachronic and/or independent of wintering occupations by brown bears (*Ursus arctos*).

Résumé

L'histoire récente du bouquetin d'Espagne (*Capra pyrenaica*) dans les Pyrénées françaises : une contribution de la spéléologie à la paléontologie. Au cours des 40 dernières années, les recherches sur les bouquetins des Pyrénées (*Capra pyrenaica*) reposent principalement sur des découvertes spéléologiques. Dans les Pyrénées occidentales, plus de 25 sites naturels renfermant des restes de bouquetins sont actuellement connus, autorisant des recherches paléoécologiques. A partir des données topographiques, paléontologiques et taphonomiques, cet article propose de caractériser les processus de formation des sites à caprinés. Les ossements sont principalement situés en haute montagne, au fond de puits (profonds), ou dans des grottes à galeries descendantes (ressauts), ayant piégé un à deux individus et exceptionnellement plusieurs animaux (non-) adultes. Les données ostéologiques (mesures) suggèrent que les bouquetins mâles sont plus fréquemment piégés que les femelles. Les surfaces osseuses ne présentent pas d'importantes traces de prédation ou de charognage (grands/petits carnivores). Ces sites correspondent à des incursions naturelles de bouquetins dans les galeries sombres qui sont indépendantes/diachroniques des occupations hivernales par les ours bruns (*Ursus arctos*).

1. Introduction

Caprini and *Rupicaprini* are typical cliff-dwelling bovids from mountainous regions. In the French Pyrenees, the Spanish ibex (*Capra pyrenaica* Schinz, 1838) is the main cliff-dwelling species identified along historical and Palaeolithic times (FOSSE *et al.* 2021). Steep areas in a limestone context and abundant grasslands favoured its survival until the end of the 20th century (CRAMPE 2020). This region (including Pyrénées Atlantiques and Hautes Pyrénées) constitutes a unique reservoir for caving (numerous sites known to date,

explored by various clubs: ARSIP, GSO, SSPPO ...). Important discoveries and research both in archaeology and palaeontology come from these active caving clubs (CAZENAVE *et al.* 1994). This paper is a short survey on several unpublished sites yielding Spanish ibex remains, their topographical features, as well as their paleontological and taphonomic contents dealing with Spanish ibex cranial/postcranial skeletal parts.

2. Materials and methods

The western part of the Pyrenees (French and Spanish) is composed of large valleys rising to the summits above more than 2000 meters (a.s.l.) mainly in a limestone context.

More than 25 karstic sites (caves, holes) yield identifiable bone remains belonging to the brown bear and the Spanish ibex (CLOT 1982; CRAMPE 2020; FOSSE *et al.* 2021).

Recently, similar deposits have been discovered on the southern slope of the Pyrenees (GARCIA-GONZALEZ 2012; SAUQUE *et al.* 2015, 2018), allowing to consider this transboundary region as a homogenous geographical, mammalogical and karstological setting (Fig 1). Data on Spanish ibex remains were collected both by cavers (topography, location) and palaeontologists (osteometry

and taphonomy from private collections and museums (Arudy, Lourdes)). Comparative data come from CLOT (1982) for the French Pyrenees, ALTUNA (1978), ALTUNA & MARIEZKURRENA (1985) and CASTAÑOS (1986) for the Spanish deposits and from RODRIGUEZ & QUIRALTE (2016) for modern samples. Those works allow sexing most of bones (skulls, metapodials) presented below.

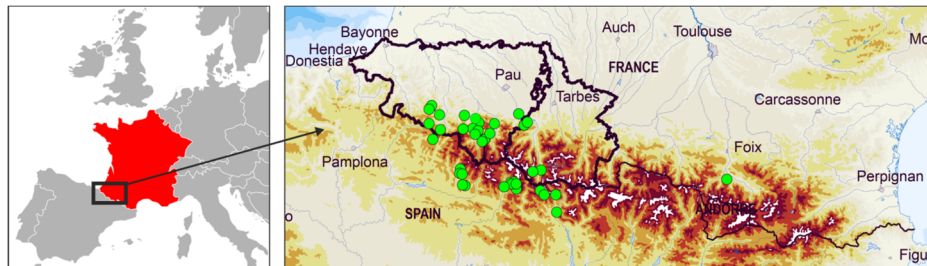


Figure 1: Location of karstic sites (green circles) yielding Spanish ibex (*Capra pyrenaica*) remains discovered by cavers.

3. Results

The survival of the Spanish ibex in the western Pyrenees is attested by historiographical and speleological discoveries (CLOT 1982; CAZENAVE *et al.* 1994; CRAMPE 2020; FOSSE *et al.* 2021). A geographical area spanning the Basque country to the Aspe and Ossau valleys provided almost all the skulls/(sub)complete skeletons of the Spanish ibex from the French Pyrenees (Erbinia (930 m a.s.l.; Minimum Number of Individuals =3), TH1 (988 m; MNI=1), Zazpigagn (1 465 m; MNI=3), Uthurri (1 610 m; MNI=2), grotte sans nom (1 skeleton), PT 10 (1 190 m; MNI=2), Maquisards (1 250 m; MNI=1), Tuta de Lurtas (1 200 m; 2 skeletons), BSE 21 (1 270 m; MNI=1), gouffre des Bouquetins (1 850 m; MNI=2), Clot deth Pedaing de la Baigt (1 995 m; MNI=1), Permayou inf. (2 240 m; MNI=2)). Chourrugue Ouest cave (1 805 m, Hautes-Pyrénées) yields the most important sample (7 skeletons) from the French Pyrenees. In addition to these deposits, some other caves have delivered isolated skeletal elements: gouffre CB41 (600 m), Harzabaleta (800 m), Har Mahagn (855 m), Lénézobi 9 (~850 m), Etxekortia 2 (1 065 m) in the Basque country; Osque du Pont d'Escot (560 m), PT 4 (1 130 m), Arriutort (1 535 m), Hors (2 120 m) in the Béarn; Barbat (2 640 m) in the department 65 (isolated skull found in a firn patch close to the peaks). All these deposits allow to draw the geographical range for the species on the northern slope of the Pyrenees. Sites are considered as Holocene according to the state of preservation of bones (articulated skeletons, unbedded and/or discarded skeletal elements sometimes covered by a thin layer of concretion) and from radiocarbon dates (Zazpigagn: 6 851 ± 156 cal BP and 580 ± 110 uncal BP; PT10: 6 044 ± 139 cal BP; gouffre des Bouquetins: 1 443 ± 118 cal BP). Only one AMS radiocarbon date has been obtained, recently (Chourrugue Ouest, 3 645 ± 65 cal BP). Although new dating is necessary, those data already allow the reconstruction of a diachrony of site frequentation by Spanish ibexes (Zazpigagn) and a homogeneously broad pattern in their chronological distribution (before AD). The topography of the deposits reveals the systematic trapping of ibexes that fell into vertical holes directly open to the surface (type A sites in FOSSE *et al.* 2021; Fig 2), or individuals died in descending

galleries (type B1 sites; Fig 3) or in those leading to deep holes (type B2 sites; Fig 4).

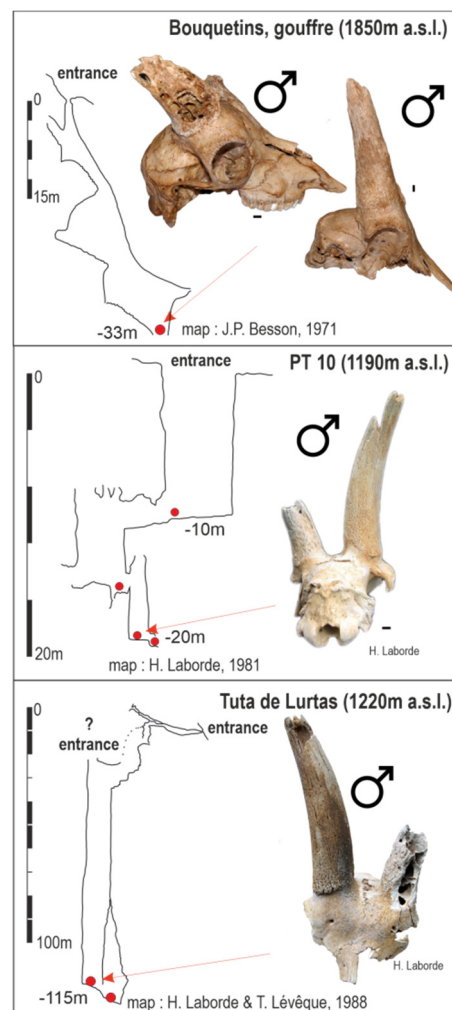


Figure 2: Topographical settings and location of the Spanish ibex remains (red circles) in French pyrenean natural traps (type A). Bar scale =1 cm.

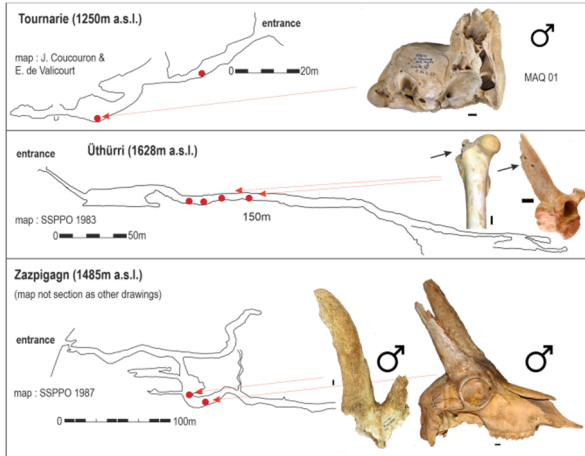


Figure 3: Topographical settings and location of the Holocene Spanish ibex remains (red circles) in French pyrenean caves (type B1). Bar scale = 1 cm. Pictures : Ph. Fosse.

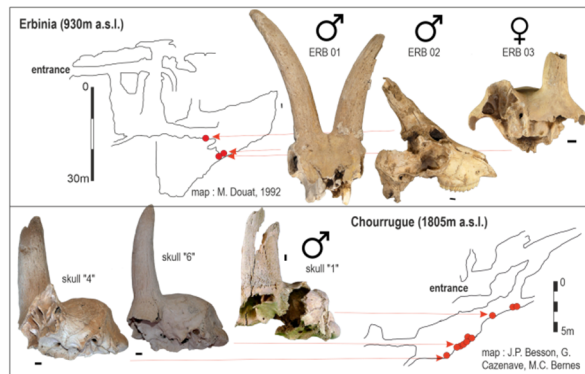


Figure 4: Topographical settings and location of the Holocene Spanish ibex remains (red circles) in French pyrenean caves (type B2). Bar scale = 1 cm. Pictures : Ph. Fosse.

All of those sites correspond to a (summer?) frequentation of cave entrances. Although quantified data are still scarce, first observations based on horn cores and on metacarpals (Figures 5, 6) highlight a high frequency of adult males over females (gouffre des Bouquetins: 2 males; Erbinia: 2 males and 1 female; PT 10: 1 male and 1 female; Tuta de Lurtas, Barbat: 1 male). The intra-sexual variation is important (metapodials). Only Chourrugue Ouest yielded more females (n=6) than males (n=4), but some small skulls could belong to subadult male individuals as well. To date, this site would be the only known sample yielding adult female and juvenile remains, in accordance with (seasonal) ethological data. All these natural traps are characterized by the absence of very young ibexes (< 1 year) but in Chourrugue Ouest and Erbinia caves, unfused long bones belonging to juvenile/subadult individuals are quite common. The use of limestone porches and/or the first galleries of deep caves seems to be a behavioural feature of subadult/adult individuals. Taphonomic data are rare but seem to correspond more to diachronic deaths (C14 dates, spatial distribution of skeletons into the galleries) than to episodes of collective accidents (Chourrugue Ouest?). Karstic sites are characterized by the presence of sub-complete skeletons, dislocated *in situ* at the bottom of holes (grotte sans nom, Permayou inf., PT 10, Tuta de Lurtas), disarticulation of

naturally dead animals (Zazpigagn) or carcasses transported by water streams.

Large predator activity (brown bear) has not been observed whereas scavenging by small ones (foxes?) appears quite common but with slightly modified bone surfaces or extremities (tooth-/gnawing marks on ibex bones in Arriurtort, Chourrugue Ouest and Uthurri; Fig 3).

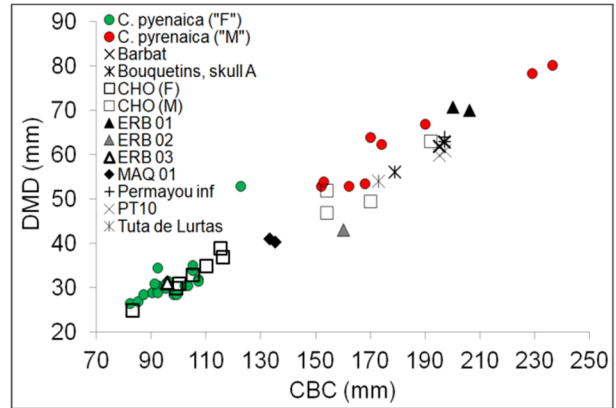


Figure 5: Sexing spanish ibex horn cores from French western Pyrenean sites. CBC = Circumference of horn core base, DMD = Antero-posterior diameter of horn core base, CHO = Chourrugue, ERB = Erbinia, MAQ = Maquisards.

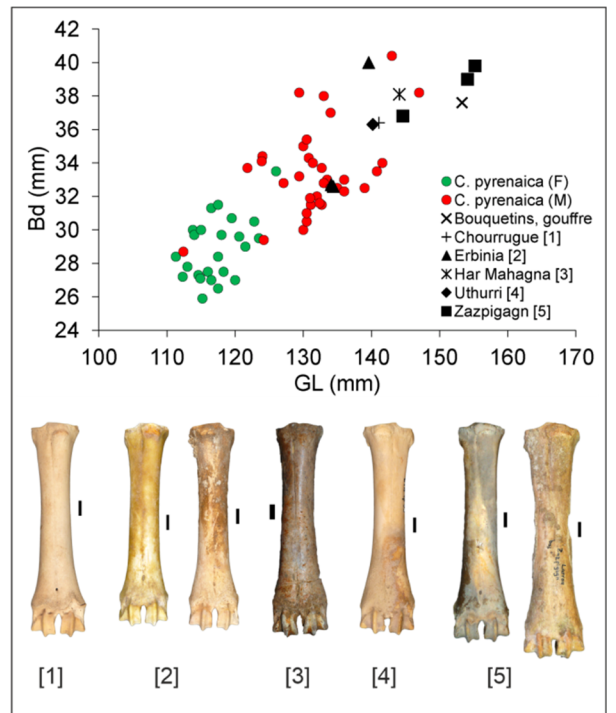


Figure 6: Sexing Spanish ibex metacarpals from French western Pyrenean sites. GL = great length, BD = distal width. Source as in Fig. 5. All bones are illustrated at the same scale (bar scale = 1 cm). Pictures: Ph. Fosse.

Rodent activity on dry bones, reflecting a long-term exposure, is sometimes observed (gnawing marks on skulls and innominate bones in Chourrugue Ouest). Spanish ibex remains are not found in the same places/galleries as brown bear bones, reflecting diachronic occupations (dates C14 to be analysed).

4. Conclusions/perspectives

Spanish ibex sites are abundant in the western Pyrenean karsts and contribute to our knowledge of its biogeography and ecology for Holocene and Middle/Late Pleistocene times. Discoveries by cavers provide interesting information on topographical, paleontological and taphonomic data and allow to discuss some of the Spanish ibex behavioural features (frequentation of karstic settings, ibex sex ratio, mortality profiles, scavenging activity) that can be used as guidelines for extant and extinct different ibex species or relative zoological groups (*Rupicapra*, *Hemitragus* ...). Speleology and palaeontology appear to be complementary on ibex research, from discoveries and expertise up to studies/methods. In the western Pyrenees, this research is particularly active and allows to study human-animal relationships on conservation, environments and history of human societies. Typology of French Pyrenean sites is very similar to Spanish ones (Type A: AN-15, MS-2; type B1: CS-59; type B2: Barranco Jardin J-1, Bucardo: GARCIA-GONZALEZ 2012; SAUQUE *et al.* 2015). This systematic topographical configuration suggests that natural trapping of Spanish ibex in vertical karst settings is the main cause of

site formation (for Holocene deposits). In the (sub)horizontal and deep caves, the natural frequentation by the ibexes of galleries far from the entrances (Üthürri, Zazpigagn, Barranco Jardin J-5?) caused diachronic *in situ* natural deaths and also seems to be a common taphonomic feature. Predation or scavenging by large carnivores has not been identified yet in regional sites. In most Pyrenean deposits, the predominance of Spanish ibex males over females is noteworthy (AN-015, Barranco Jardin J-1, Barranco Jardin J-5, MS-2). This characteristic is also found in the Late Pleistocene deposits (Malarnaud (GRIGGO 1991) and Soulabé in Ariège, Los Batanes (SAUQUE *et al.* 2018) and Erralla IV (ALTUNA & MARIEZKURRENA 1985) in the Spanish Pyrenees). The characterization of ibex sites is based on new discoveries and multidisciplinary collective studies carried out by cavers and palaeontologists; this collaboration is essential for a better understanding of site formation processes and the (paleo)ecology of extant and extinct mammals dying (i.e., ungulates), kept (livestock) or living (i.e., large carnivores) in caves.

Acknowledgements

The authors would like to thank Pyrenean caving clubs, the Musée d'Arudy (64) and the Musée pyrénéen de Lourdes (65) for allowing us to visit some caves and study paleontological samples. This article could not have been written without the friendly sharing of data/knowledge by Jean Pierre Besson. This article is dedicated to him.

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