Research Article

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Pastoral Practices, Bedding and Fodder During the Early Neolithic Through Micromorphology at Cova Colomera (Southeastern Pre-Pyrenees, Iberia)

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Abstract: The microstratigraphic study of the Cova Colomera (Sant Esteve de la Sarga, Lleida, Spain) confirms that there are several discontinuous ovicaprid stabling episodes in the Late Cardial Neolithic sequence (*c*. 5250–4780 cal BC). There are episodes with and without combustion traces. From the burnt episodes, it has been possible to identify bedding and fodder due to their good preservation and abundance in the X-32 sector, specifically the level CE14. The main constituents are grassy remains and to a lesser extent, conifer twigs and needles, beech twigs, and box leaves. These data give an idea about the landscape near the cavity. From the nonburnt episodes, we emphasize the sector W-31, specifically the top of level CE13, in which bedding and fodder appear in a smaller quantity. Its components are also well preserved, with an emphasis on sheep/goat excrements in which it has been possible to identify part of their diet composed of leaves and culms of grasses (*Poaceae*). From these episodes and their components, we propose that Cova Colomera had different uses as a pen of a small size herd. In some episodes, the herd was more permanent in the cave, and therefore, more waste was generated, so burning was required; and in other episodes, occupation was more sporadic and the burning of waste was not so necessary. In short, Cova Colomera allows us to propose that the study of pastoral activities in caves and rockshelters is more complex than previous studies have shown and that it is necessary to analyze these records with high-resolution techniques to broaden the knowledge of these first livestock communities.

Keywords: geoarcheology, stabling deposits, box leaves, grass diet, sheep and goat dung

1 Introduction

Over the last few decades, the study of the sedimentary sequences of cave and rockshelter sites, mainly in the Mediterranean area with chronologies from the Neolithic to the Bronze Age, has revealed that one of the uses of these records is pastoral (Angelucci, Boschian, Fontanals, Pedrotti, & Vergés, 2009; Bergadà, 1997; Bergadà, Cebrià, & Mestres, 2005; Bergadà, Guerrero, & Ensenyat, 2005; Bergadà, Cervelló, Edo, Antolín, & Martínez, 2018a; Boschian, 2006; Brochier, 1991, 1995; Courty, Goldberg, & Macphail, 1989; Courty, Macphail, & Wattez, 1991; Égüez, Mallol, Martín-Socas, & Camalich, 2016; Macphail, Courty, Hather, & Wattez, 1997; Polo Díaz, 2010; Polo Díaz, Martínez-Moreno, Benito-Calvo, & Mora, 2014).

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Traditionally, from a geoarcheological and microstratigraphic point of view, this activity has been recognized in two types of sedimentary facies (Angelucci et al., 2009; Boschian, 2017; Macphail et al., 1997): "layer-cake" facies and "homogeneous" facies.

The "layer-cake" facies, also associated with the French term *fumier*, appears with traces of combustion and represents the episode(s) of stabling. They tend to have a centimetric and in some cases decimetric thickness, quite a lateral continuation (Karkanas & Goldberg, 2019), and a tabular pattern. They are generally represented by two microfacies: (1) at the bottom, there is a dark brownish to black microfacies that appears to be partially or completely carbonized and is formed by residues of plant origin and some excrements; (2) at the top, there is a light gray to whitish, ashy microfacies which is also formed by the same components, although with a dominance of the woody remains. In some sites, such as Arene Candide (Finale Ligure, Liguria, Italy), a layer of ashy coprolites is distinguished, and in the upper part of the sequence, there is a layer of pure wood ash (Macphail et al., 1997). In some cases, in the lower part of the ashes, there are traces of woody charcoals originating from an intermediate microfacies (Bergadà et al., 2018a).

The functioning of these microfacies could correspond to the fact that after abandoning the site, the waste would have been exposed on the surface and then burned (Brochier, Villa, & Giacomara, 1992; Macphail & Goldberg, 1995; Macphail et al., 1997). The presence of an upper layer formed by woody plants and some excrement could be explained by the accumulation of branches from the structure of the stable or remains of the fodder (Bergadà et al., 2018a; Macphail et al., 1997). The amount of waste would have been more or less considerable; since, at the bottom, the remains appear to have been partially burned or carbonized due to a lack of oxygen, whereas in the upper microfacies, where the temperature was higher as a result of better oxygenation, the fuel transformed into ash (Brochier et al., 1992; Mentzer, 2014). The reason for these burning practices may lie in a need to clean up the site for later occupation and/or to reduce the volume of waste (Boschian, 2017; Brochier, 2002; Brochier et al., 1992; Macphail et al., 1997). This type of sequence is the best known because when it appears with traces of combustion, it is more visible and easier to identify in the field, which has led to some experimental studies of its operation (Vergés et al., 2016).

The "homogeneous" facies are more difficult to identify in the field because practically the same components appear, but with a random distribution and without any type of organization (Boschian, 2017). They are characterized by massive brown accumulations without internal stratification, sometimes located between layer-cake sequences (Polo Díaz, 2010).

At the moment their interpretation is complex as some believe that they are the result of the alteration and trampling of unburned or partially burned and burned areas of the stables (Angelucci et al., 2009; Boschian, 2006; Brochier, 2002) or they could also correspond to episodes of abandonment or interruption of the pen by domestic activities (Macphail et al., 1997; Polo Díaz, 2010). In some sites, a certain simultaneity between domestic and pastoral activity has been documented in some levels, such as in the case of Arene Candide (Finale Ligure, Liguria, Italy) (Macphail et al., 1997), Los Husos II (Laguardia, Álava, Spain) (Polo Díaz, 2010), and Cueva del Toro (Antequera, Málaga, Spain) (Égüez et al., 2016).

Episodes without in situ traces of combustion have also been located. These are characterized by accumulations with a high organic content (excrements, articulated and disarticulated phytoliths, and organophosphate intercalations) as in the case of the Cova de Can Sadurní (Begues, Barcelona, Spain) during the Postcardial Middle Neolithic (Bergadà et al., 2018b). These episodes coincide with the last episodes of stabling in the cave.

It is into this context of sedimentary sequences related to the first pastoral practices in caves and rockshelters that we insert our study, which contributes to the knowledge of the first livestock practices in mountain areas. The main objective of this article is to analyze the different stabling practices of Cova Colomera during the Late Cardial Neolithic period through micromorphology, which allows us to extend our knowledge of the sedimentary record of pastoral activities and to present variations of the facies mentioned earlier. Its study has also allowed us to determine the foddering/grazing and bedding practices due to the good preservation of its components and to estimate the size of the herd stabled in the cavity. Furthermore, these results allow us to infer paleoenvironmental data from the immediate surroundings of the cave, an interesting aspect to contextualize such pastoral activities in the region.

2 Site Presentation and Stratigraphic Background

Cova Colomera is located at 670 m ASL in the extreme southwest of Sant Esteve de la Sarga (Pallars Jussà, Lleida). It is located in Serra del Montsec in the Pre-Pyrenees, specifically in Congost de Montrebei, and it is 160 m above the river Noguera Ribagorzana with UTM coordinates of X:308339/Y:4661275. It is a large cavity that has a length of about 125 m with a NW/SE orientation and an average height of 10-12 m. Its access mouth is large with dimensions of $70 \text{ m} \times 30$ m (Oms et al., 2013, 2015; Figure 1).



Figure 1: Cova Colomera (Sant Esteve de la Sarga, Lleida, Spain). (a) Geographical location of the cave. (b) View from cave entrance. (c) View of the Congost de Montrebei and the river Noguera Ribagorzana from the cave.

Lithologically, it is framed among the bioclastic limestones, calcarenites, and sandstones of the Campanian – Maestrichtian and the sandstones and calcarenites of the Maestrichtian (Berastegui, Losantos, Miranda, Roca, & Ticó, 2010). From the karstic point of view, it is a conduct related to a NE-SW – oriented fracture, typical of an emergence that would be related to a terrace of the river Noguera Ribagorzana corresponding to the Plio-Quaternary limit (Cardona, 1989).

The climate of the area has Mediterranean characteristics with a continental tendency adapted to the medium-sized mountain. The average annual temperature ranges between 11 and 12°C and annual precipitation of 700 mm (Casals & Muñoz, 1987). The surrounding vegetation is represented by the typical holm oak forest (holm oak: *Quercus ilex ss.ilex*) rich in shrubs and lianas (Baulies, 1987) adapted to calcareous soils with a dominance of rock plants around the cavity.

Although the cavity was discovered as an archeological site in 1893, it was not until the 1970s that its archeological sequence became known to the scientific community and not until 2005 that one of the authors of this article (F. X. Oms) of the University of Barcelona began the archeological interventions that ended in 2011 (Oms et al., 2015). Two sondages were developed: (1) the Colomera Vestibule (CV) that is located in the highest sector of the cavity in which there is a series of structures that go chronologically from the Late Cardial Neolithic to Late Roman and even more recent times; and (2) Colomera East (CE), located in the first large room of the cavity, where a 26 m² deposit is located (Oms et al., 2013, 2015) with levels from the Late Cardial Neolithic, Late Neolithic, and Early Bronze Age, and a pit (EE1) that also corresponds to the Early Bronze Age (Oms et al., 2009, 2015).

The CE sector and the X-32 and W-31 profiles of this area were studied (Figure 2a and b). The levels and sublevels presented correspond to the Late Cardial Neolithic period and are dated between 5250 and 4780 cal BC (Table 1). From the stratigraphic point of view, four levels have been distinguished: CE15a located in the X-32 and W-31 areas, CE14 mainly in X-32, and CE13 and CE12 in the W-31 area. The description of stratigraphic and sedimentary fields is presented in Table 1.

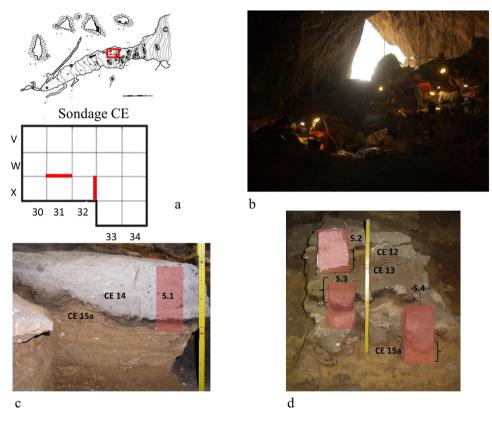


Figure 2: Cova Colomera: plant and area studied. (a) CE sondage of the cave: location of the X-32 and W-31 profiles. (b) Interior of the cavity and view of the CE sondage. (c) X-32 profile and location of micromorphological sampling. Sample 1 corresponds to level CE14 and CE15a. (d) W-31 profile and micromorphological sampling situation. Sample 2 corresponds to the level CE12, sample 3 to the level CE13, and sample 4 to the sublevel CE15a. Analyzed sublevels marked with key.

Archeozoological studies indicate that sheep and goats dominate in the CE sector, and in CE12 and CE14, there are fetal and neonate remains. Other domestic taxa such as cattle and pigs and wild taxa such as rabbits are also included to a lesser extent (see Martín & Oms, 2021). Archeobotanical studies in the same sector have revealed seeds of a variety of cereals (Triticum aestivum/durum, Triticum dicoccum, Triticum sp., and Hordeum sp.) and the presence of leguminous plants, in particular Pisum sativum and ruderal and

Table 1: Synthesis of the stratigraphic and sedimentary field descriptions of Cova Colomera

Cova Colomera levels and profiles	Thickness (cm)	Description	BP dating	cal BC	Period
CE12 Profile W-31	18	Composed of layers, some with a high organic component of dark color (10YR2/1–10YR6/2) together with a greater contribution of brown sandy silt (7.5YR5/4) with subrounded and subangular limestone fragments. It has a tendency to be tabular, although in some sectors it has an erosive contact	6020 ± 50 (Beta-8523)	5060–4780	
CE 13 Profile W-31	25	Layers of brown sandy silt (10YR7/4) with limestone gravel of subrounded morphology and some sandstone gravel alternating with others of dark brown organic waste (10YR5/2). In some sectors, the contact is erosive, and in others, it is more diffuse	6150 ± 40 (Beta-240551)	5250-4970	
CE14 Profile X-32	18-20	Formed by a series of layers that from bottom to top are: a layer < 1 cm thick composed of organic residues from reddish brown (7.5YR4/3) to dark brown (7.5YR3/2), followed by a layer with an average thickness of 3 cm of black charred residues (7.5YR2.5/1), and an upper layer with an average thickness of 15 cm of mineralized white-gray silt residues (7.5YR7/1) with some sands and subrounded gravels. The contacts between the levels are very clear. Some bone remains appear	6170 ± 30 (0xA-23634)	5250–5010	Late Cardial Neolithic
CE15a Profiles X-32/W-31	3-8	Formed by clayey silty sands (7.5YR5/4) and gravels of limestone and subrounded morphology and organic remains. Diffuse contact with respect to CE15b. The W-31 profile is made up of brown sandy silt laminations (7.5YR6/2) although some are darker (7.5YR3/1) with some subangular limestone fragments and organic residues			

adventitious plant remains (Ajuga reptans o Trifolium sp.) (Oms et al., 2013). The study of the charcoals has provided a combination of *Quercus* sp. deciduous and Buxus sempervirens, with the minor presence of Pinus sylvestris, Acer sp., and Juniperus sp. From the data available so far, it seems that both the shady areas (oak groves) and the sunny areas (pine forests) were exploited (Oms et al., 2015).

3 Methodology

The methodology consisted of stratigraphic-sedimentary field description and the application of micromorphology from levels and sublevels CE15a to CE12. In this study, we focused on profiles X-32 and W-31 (Figure 2c and d).

The protocol followed for extracting samples, a total of four, was developed taking them with the help of gypsum plaster and boxes lined with plaster (Bergadà, 1998). They were air dried and impregnated with polyester resin. Thin sections of $13.3 \, \text{cm} \times 5.5 \, \text{cm}$ and $25 \, \mu \text{m}$ thick were obtained from the materials according to the procedure described in Benyarku and Stoops (2005). A total of 11 thin sections from the 4 blocks were made. Thin sections were observed under a polarizing stereomicroscope and a petrographic microscope at magnifications between 25× and 400× with plane-polarized light (PPL), crossed polarized light (XPL), and with oblique incident light (OIL). Thin section description and interpretation follow the guidelines proposed by Bullock, Fedoroff, Jongerius, Stoops and Tursina (1985), Stoops (2003), Stoops, Marcelino and Mees (2010), and Nicosia and Stoops (2017).

4 Results

4.1 Burned Dung Deposit

It is located at CE14 level in sector X-32/33, and from the bottom to top, the following microstratigraphic

- Organic residues. Thickness 3 mm. Spongy/massive microstructure and 5% porosity. It is formed by a series of parallel oriented organic residues that in plane-polarized light are yellowish brown in color, probably grass fiber and rich in silica phytoliths (Figure 3b-d) and amorphous organic matter. In grid square X-33, very well-preserved leaves (Figure 4a and b) appear which, due to their morphology, correspond to box (Buxus sempervirens).
- Charred residues. Thickness 3 cm. Single grain/spongy microstructure and 15% porosity. At the bottom, it appears partially burned, and toward the top, it is carbonized, exhibiting a brown or blackish color in PPL (see Figure 3b) almost isotropic in XPL. It consists mainly of grassy remains of leaves and perhaps stems (Figure 5a and b) and conifer twigs, some with bark (Ismail-Meyer, 2017), needles of Pinus probably sylvestris (Figure 5c) in cross section (Bracegirdle & Miles, 1975), and also, possibly Fagus sylvatica twigs (Figure 5d) (Zibulski & Schweingruber, 2018), as suggested also by K. Ismail-Meyer (University of Basel, personal communication). Some burnt fragments of excrement show a convoluted fabric, suggesting sheep/goat origin (Bergadà, 1998, Courty et al., 1991).
- Mineralized residues (Ash). Thickness 15 cm and grayish in color in PPL. The unit consists of micritic calcitic accumulations with some sandy particles mainly of quartz and bioclastic limestone gravels with traces of thermoalteration. It has a massive microstructure and 2–5% porosity. Among the main components, we highlight prismatic calcium carbonate pseudomorphs (Figure 6a) from woody plant remains (Brochier, 1996) and multicellular phytoliths (anatomically connected from the husk of grasses) (Figure 6b) as suggested by M. Portillo (CSIC, Institució Milá Fontanals of Barcelona, personal communication). To a lesser extent, there are calcium carbonate pseudomorphs of druses (Figure 6d) that are abundant in

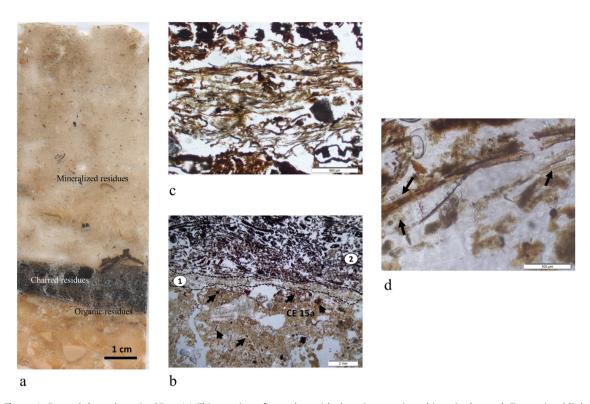


Figure 3: Burned dung deposit, CE14. (a) Thin section of sample 1 with the microstratigraphic units located. Transmitted light scan. (b) Detail: (1) View of organic residues and (2) charred residues, note that the lower, brown part is partially burnt, and toward the upper, black part, it is more charred, and CE15a, organophosphate clayey silty sands, uncarbonized plant remains reddish-brown (arrows). PPL. (c) Organic residues: oriented parallel organic residues, probably grass fiber. PPL. (d) Detail of silica phytolites (arrows). PPL.

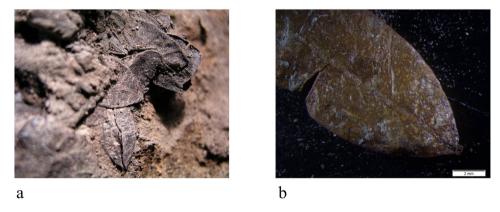


Figure 4: Burned dung deposit, CE14. Organic residues. (a) Field. X-33 grid square. Leaves of box. (b) Detail of leave of box OIL.

leaf remains (Brochier, 1996) and also cellular relicts and wood charcoals. There are also some sheep/goat excrements (Figure 6c) with fecal calcium spherulites inside, some of which have carbonized organic coatings that blacken their surface (Figure 6e) (Brochier, 1996; Polo Díaz, 2010) due to thermal alteration and are known as darkened spherulites. In some cases, the presence of calcium oxalate druses has been observed inside the excrement (Figure 6e). This unit has the most excremental aggregate remains. Fragments of egg shells and bones with traces of combustion, some of which are teeth, also appear among the groundmass.

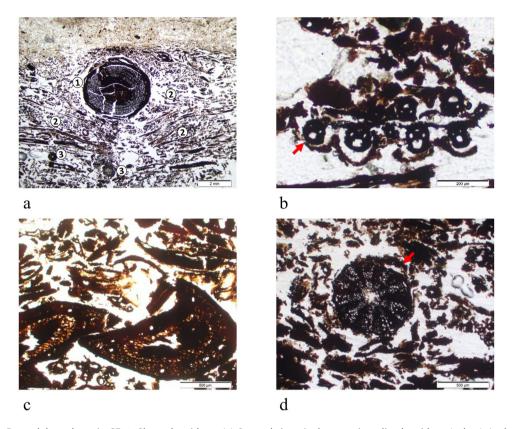


Figure 5: Burned dung deposit, CE14. Charred residues. (a) General view. At the top mineralized residues (ashes). In the central part of the image: (1) conifer twig (with bark) in cross-section; (2) surrounded by grassy remains; and (3) cross section of probably Fagus sylvatica twigs. PPL. (b) Grassy leaves. The "skulls" structures are characteristic leaf veins (detail, arrow). Cross-section. PPL. (c) Pine needles in cross section. PPL. (d) Cross section of Fagus sylvatica twig with bark layer (arrow). PPL.

4.2 Unburned Dung Deposits

They are located in sector X-32 sublevel CE15a with an average thickness of 3 cm and in sector W-31 at the top of a sublevel in CE13, with an average thickness of 8 cm. They are formed by a matrix of organophosphate clayey silty sands (in profile W-31 with predominance of sandy silts) (Figure 7a) and gravels of bioclastic limestone with traces of dissolution. The mineralogy is mainly made up of quartz, calcite, and feldspar. They have a massive/spongy microstructure, and the c/f-related distribution is monic/porphyric, with 5–10% porosity and with undifferentiated and calcitic-crystallitic b-fabric. Plant residues appear in plane polarized light as yellowish brown to red, some of which are partially decomposed, among which conifer wood has been distinguished (Figure 7b and c) and also some possible fragments of seed coats. The outstanding component is very well-preserved sheep/goat excrements, in which even the rims are preserved (Figure 7d) especially in the sublevel top in CE13 (profile W-31). They are brown (PPL) with an isotropic groundmass (Figure 7e) and a relatively high porosity that is characterized by rounded macropores (Figure 7d). They do not appear compacted and fissures are not observed, which indicates that there are no significant traces of trampling. In the interior of the excrements, some of the vegetable waste consumed has clearly been preserved, such as elongate phytoliths and short cells (rondels from Pooideae grasses), and phytoliths from the leaves and culms of grasses (personal communication Marta Portillo) (Figure 7f and g). The fecal calcium spherulites have not been preserved, most probably due to the degradation of organic matter that releases acids and can cause the dissolution of calcium spherulites (Shahack-Gross, 2017), as well as the limestone detrital material. These conditions would also not favor the presence of calcium oxalate crystals due to their decomposition by microorganisms from decayed organic material (Brönnimann, Ismail-Meyer, Rentzel, Pümpin, & Lisá, 2017a).

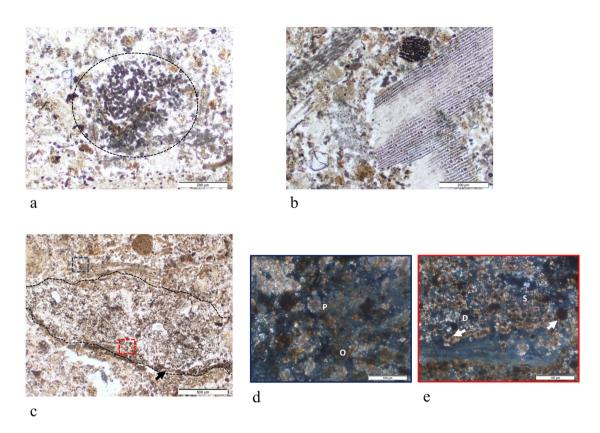


Figure 6: Burned dung deposit, CE14. Mineralized residues. (a) Prismatic calcium carbonate pseudomorphs (circle). PPL. (b) Multicellular phytoliths (anatomically connected from the husk of grasses). PPL. (c) Sheep/goat excrement. The dense outer rim can still be seen, especially in the darker colored lower part (arrow). PPL. (d) Detail. Ashy matrix. Note calcium carbonate pseudomorph druse (P) and prismatic calcium oxalate (O) in the blue box in (c) XPL. (e) Detail of matrix sheep/goat excrement. Fecal calcium spherulites (S) and some darkened spherulites (D) and calcium oxalate druses (arrows) in the red box in (c). XPL.

Among the pedofeatures, we also highlight the appearance of yellow cryptocrystalline hypocoatings in the limestone material in both profiles, but especially in profile W-31. These hypocoatings derive from the decomposition of organic waste, in this case, plant debris and excrement, which react with the limestone material and produce a replacement of calcite by apatite (Karkanas & Goldberg, 2010).

4.3 Reworked Dung Deposits

They are located in sublevel CE15a and in a sublevel of CE12 both in the W-31 profile.

Sublevel CE15a has an average thickness of 8 cm, is formed by organophosphate silty clays with some sandy particles, and has a spongy microstructure with a porosity between 5 and 10%. The components include plant cell tissues, sheep/goat dung in an inclined and vertical arrangement without any trace of combustion, bat and bird fecal remains, and bird's eggshell fragments. Yellow cryptocrystalline hypocoatings appear in the limestone material. The sublevel appears reworked by water circulation in a laminar sheet of water giving rise to very thin laminae or couplets.

In the bottom part of the CE12 level, there is a sublevel that has an average thickness of 8 cm and is composed of a matrix of sandy silts with stones and gravels of bioclastic limestone with subrounded and subangular morphology. It has a massive/intergrain microaggregate microstructure with 15–20% porosity and a single space porphyric and chitonic c/f-related distribution. The layer is poorly sorted. Among the components are wood charcoals, calcitic ashes, articulated silica phytoliths, sheep/goat dung with traces of

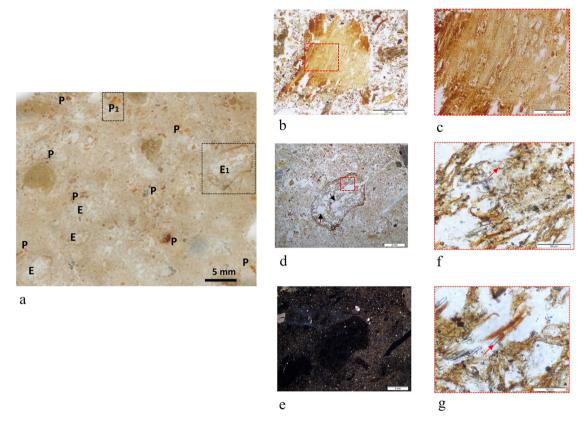


Figure 7: Unburned dung deposit. Sublevel CE13. (a) Thin section of sample 3. Detail of groundmass: organophosphate clayey sandy silts and sheep/goat excrements (E), most retain a dense outer rim and uncarbonized plant remains (P) reddish brown in color, some of which are wood (P1). Transmitted light scan. (b) Possibly conifer wood (P1) of (a). Oblique section PPL. (c) Detail of the red box of (b). View of xylem tissue with tracheids. PPL. (d) Sheep/goat excrement with dense rims (E1) of (a). Rounded macropores are also observed in its interior (arrows). PPL. (e) Same as (d) showing zones with undifferentiated b-fabric corresponding to organophosphate fine material. XPL. (f) Elongate phytoliths and short cells (rondels from Pooideae grasses, arrow) in the red box in (d). PPL. (g) Phytoliths from the leaves and culms of grasses, arrow, in the red box in (d). PPL.

combustion, and some bone remains. Some excremental fragments also appear, perhaps from a carnivorous animal. They are characterized by a cemented amorphous yellowish-brown groundmass under PPL that is isotropic in XPL and contains coarse bone fragments (Brönnimann, Pümpin, Ismail-Meyer, Rentzel, & Égüez, 2017b). In general, the arrangement of the components is either inclined or vertical. Among pedofeatures, we highlight silty clay coatings around stones and gravels (170-240 µm), a feature that would indicate displacement (Bertran & Texier, 1999). We believe that a process of mass displacement would have taken place after the combustion of the pen residues, which would cause the secondary position of the stabling episode and some other sporadic occupation of carnivorous in the cave.

5 Discussion

5.1 Stabling Practices

Two types of deposits related to stabling activity have been documented; some with combustion and others

The accumulation with combustion in situ has been located in sector X-32 and specifically at level CE14 dated c. 5250–5010 cal BC. It has also been located in sector W-31 in sublevel in CE12 dated c. 5060–4780 cal BC with evident traces of reworking.

We will focus mainly on the accumulation located in sector X-32, which has allowed us to locate three microstratigraphic units: organic residues, charred residues and ashy residues. This succession corresponds to a single episode of stabling and burning. The waste that appears at the bottom and in the intermediate zone appears partially burned or charred due to a lack of oxygen (Brochier et al., 1992; Mentzer, 2014). The temperature reached at the top of the zone is higher as a result of better oxygenation, which transforms the fuel into ash that gives rise to the top layer. Of the three units, the lower unit with organic residues, and the intermediate unit, which is charred, are made up mostly of plant remains that are very well preserved and undisturbed. They are mainly made up of grassy remains (leaves and stems) and to a lesser extent conifer and possibly Fagus sylvatica twigs, as well as needles of Pinus probably sylvestris and leaves of Buxus sempervirens.

The top unit is composed principally of a micritic calcitic accumulation in which we highlight multicellular phytoliths (anatomically connected from the husk of grasses), prismatic calcium carbonate pseudomorph from woody remains, a few calcium carbonate pseudomorphs of druses, wood charcoals, and the presence of sheep/goat excrements.

From the documented plant remains, we believe that the bedding and fodder of the stabled ovicaprines were mainly made up of monocotyledonous grass plants. To a lesser extent, there are remains of woody plants, one which is worth mentioning is the presence of several leaves of the box (Buxus sempervirens).

The use of the box was usual in NE Iberia during the 5500–4000 cal BC period. In the site of La Draga (Banyoles, Girona) from Early Neolithic, box leaves have also been found and their presence has been associated with the branches used to manufacture utensils, but they could also be used medicinally (Piqué et al., 2018). Palynological and macrofossil studies of *Myotragus balearicus* Bate coprolites also prove that the box, specifically Buxus balearica Lam, was part of their diet, namely, the flowers and presumably tender leaves, data that would surprise researchers because of the poor digestibility of the plant (Alcover, Pérez-Obiol, Yll, & Bover, 1999; Welker et al., 2014). In our case, their presence could be intentional; since, traditionally, at least until the middle of the nineteenth century, the leaves and new shoots of the box were used as bedding and they also became a good fertilizer for the fields afterward (Rozier, 1843).

The sheep/goat excrements appear mainly mineralized, and they are characterized by the presence of fecal calcium spherulites with traces of combustion, a very favorable medium for their conservation as it transforms the mono-hydrocalcite into a more stable mineral such as calcite (Canti & Brochier, 2017; Shahack-Gross, 2017). Some of them appear darkened at temperatures between 500 and 700°C (Canti & Nicosia, 2018), and this suggests that temperature was reached in such combustion. From the features observed, it appears that this area was burned at the end of the stabling episode to most probably reduce the volume of waste and also to sanitize the pen (Boschian, 2017; Brochier, 2002; Brochier et al., 1992; Macphail et al., 1997).

The episodes without combustion in situ are represented in sector X-32 specifically in the sublevel CE15a before c. 5250-5010 cal BC and in sector W-31 in sublevel of CE13, dated c. 5250-4960 cal BC. They are characterized by the presence of uncompacted, dispersed organic waste of plant origin and by the abundance of sheep/goat excrements, especially in the sublevel CE13. The silica phytoliths in the excrements show that the animals' diet consisted mainly of monocotyledonous plants. The presence of rondels is indicative of grasses, which grow in humid and fresh environments (Koromila et al., 2018).

One of the surprising aspects is the small amount of residues of plant origin and the fact that no traces of combustion are observed, which is unusual in pen caves or rockshelters in our area of study, although similar levels of unburned stabling also appear in the Bronze Age in the area of the Ramon Crater and Ha Roa rockshelter sites (Negev Desert, Israel) (Macphail & Goldberg, 2018). Our interpretation is that either these sectors correspond to marginal areas of the stables and the fire would not reach them, or the pen was used sporadically or only for overnight stays, which would require less fodder and bedding, and therefore, less waste would be generated, and there would be no need to burn. However, in the sublevel CE15a in both the X-32 and W-31 sectors, the waste does not appear to have been burned, which leads us to believe that the lack of combustion was intentional. It should be noted that in the use of sheep and goats, bedding is of great importance and is closely related to the exploitation and shepherding system (Sierra, 1967).

In summary, in Cova Colomera, during the Early Neolithic, mainly on level CE14 and possibly on the reworked sublevel CE12, there were episodes where the permanence of the cattle in the cave was represented both by traces of combustion and by important quantities of bedding and fodder. The permanence of cattle in the location is also corroborated by the fact that in both levels, the breeding of ovicaprines in situ has been documented in fauna studies (Oms et al., 2015); this is also evidence of the permanence, at least during the breeding months, probably at the end of winter and spring (Martín & Oms, 2021).

In contrast, in the CE15a and CE13 sublevels, the occupation was more eventual, without traces of combustion, in which the cavity would function as a place of passage or as a nocturnal pen. From the faunal study of the CE13 level, a shorter duration is also inferred (Martín & Oms, 2021).

In general, the excrements appear very well preserved without trampling traces, a feature that indicates that there has not been much animal transit; this suggests the possibility that the stabled herds were small.

5.2 Paleoenvironment

From the sequence analyzed of Cova Colomera, a series of phases can be seen, which are detailed below and that frame the environment and the landscape in the surrounding area of the cave:

- a) Before c. 5250–5010 cal BC, sublevel CE15a: It was initially formed by a process of run-off and later by an episode of stabling. In the W-31 sector, it is mixed with some guano components and finally appears reworked by a slight reactivation of the sheetwash type karst system.
- b) c. 5250-5010 cal BC, level CE14 (sector X-32): An episode of stabling provides information on the vegetation around the cavity due to the good preservation of the bedding and/or fodder, together with the anthracological study, which indicates a domain of Quercus sp. deciduous and Buxus sempervirens, with the minor presence of *Pinus sylvestris*, *Acer*, and *Juniperus* (Oms et al., 2015). This suggests a mixed forest environment of conifers, oaks, and beeches with an understory of grasses and shrubs such as box, typical of a relatively humid environment. Furthermore, the almost absence of detrital deposition in the cavity at this stage leads us to hypothesize certain environmental stability (Bergadà et al., 2018b).

One of the exceptional aspects of Cova Colomera is the degree of preservation of these residues, which is rare in the context of cavities. This good preservation is probably due to a combination of several factors. First, the location of the cave in a steep gorge, Congost de Montrebei, which would be subject to the microclimatic effects of updrafts as has been observed in other caves (Bergadà, Poch, & Cervelló, 2015), together with the circulation of air through the karst conduit that we were still able to observe during the archeological fieldwork, may contribute to the maintenance of the dry conditions in the cavity. Also, the practical absence of biological activity means that the identified microstratigraphic units and their components are undisturbed (Courty et al., 1989). Another contributing factor is that the combustion probably took place shortly after use as a stable and thus reduced the activity of the microorganisms that degrade organic components.

c) c. 5250–4960 cal BC: The sequence continues only in sector W-31. There is a slight reactivation of lowenergy water toward the top of the CE13 level, characterized by a detrital deposition of sandy silt with a subsequent episode of unburned stabling.

d) c. 5060–4780 cal BC: There is an episode of stabling, sublevel CE12, with evidence of combustion, but it has been reworked by detrital deposition that caused some mass displacement that prevents that episode from being characterized in situ.

To sum up, the environmental conditions recorded during the Late Cardial Neolithic period in Cova Colomera would be those typical of a stable environment, probably a stage of biostasy, which would favor a landscape with vegetation coverage, with some small local detrital sedimentary episodes located mainly in the W-31 sector of the cavity as a result of slight reactivations of the karst system itself.

6 Final Remarks

The sequence of Cova Colomera has allowed us to broaden our knowledge of the study of pastoral practices in mountainous environments. Other sites in the Pyrenean and Pre-Pyrenean area such as Els Trocs Cave (Huesca, Spain) (Lancelotti et al., 2014), the Balma Margineda in Andorra (Brochier, 1995), the Cova del Parco (Bergadà, 1998), and Cova Gran (Polo Díaz et al., 2014) both in Lleida (Spain) confirm this activity during the Early Neolithic period. At the Cova Gran site, although the record analyzed is more recent (Late Neolithic until the beginning of the Bronze Age), there are indications that these practices began as early as the beginning of the Neolithic (Polo Díaz et al., 2014).

In Cova Colomera, we can see different uses of the cave as a pen with small herds that were mainly bedded and foddered on grasses and woody plant remains, leaves and twigs from box, conifer, and beech. There are some episodes of greater permanence, with a preparation of bedding and fodder mainly located in CE14 and also in sublevel CE12, both with faunal evidence of sheep and goat husbandry that led to a greater deposition of waste and the need for burning. Other episodes, more sporadic, sublevels CE13 and CE15a, perhaps for overnight stays with almost no bedding and fodder preparation, led to less waste accumulation and therefore less need for sanitation. In any case, its use as a pen was not continued during this period as episodes of a hiatus in pastoral activity were observed, coinciding in this sense with the Balma Margineda (Brochier, 1995).

This variability of pastoral occupation in Colomera leads us to consider aspects related to the mobility of these Neolithic communities in terms of possible pastoral routes or seasonal use of the cave. This subject is still difficult to resolve in these chronologies, although in our case, the different types of pens, their intermittent occupation, and the small sizes of the herds lead us to conclude that perhaps there were seasonal movements, but of short distances.

This contribution has allowed us to confirm that the study of cave pastoral practices goes beyond the known sedimentary facies. Their study is more complex than previous studies have suggested, and it is important to analyze these sequences in depth and with high microstratigraphic resolution. The existence of combustion is a diagnostic feature of pastoral practices, but as our study shows, it is not the only diagnostic feature of these activities.

In conclusion, Cova Colomera is an important enclave for the study of the beginnings of pastoralism in the Southeastern Pre-Pyrenees. Its location on a livestock route documented in both historical times and today (ICC, 2010; Llobet & Vila Valentí, 1951) highlights the importance of livestock activity in this area over time.

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