STOČARI I ŠPILJE U HRVATSKOJ – NOVI GEOARHEOLOŠKI PODACI IZ ŠPILJSKIH SEDIMENATA

HERDERS AND CAVES IN CROATIA – NEW GEOARCHAEOLOGICAL EVIDENCE FROM CAVE SEDIMENTS

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Pregledni članak / Review

U radu su predstavljeni rezultati novih geoarheoloških i mikromorfoloških istraživanja koja su autori izvršili na holocenskim arheološkim špiljskim sedimentima u Hrvatskoj. Zajedno s preispitivanjem prethodno objavljenih podataka, ovo istraživanje daje nove spoznaje o stočarskoj uporabi špilja u Hrvatskoj. Makroskopski i mikroskopski pokazatelji prisutnosti životinja – uglavnom preživača – upućuju na to da su se od neolitika nadalje špilje koristile kao staje, kao što je slučaj na čitavom prostoru sjevernog Sredozemlja, od Pirenejskog poluotoka do Italije i juga Balkanskog poluotoka. Na temelju rasprostranjenosti pretpovijesnih nalazišta na otvorenome i špiljskih nalazišta, može se zaključiti da su špilje bile sastavni dio kompleksnih agropastoralnih sustava eksploatacije krajolika.

Ključne riječi:
špilje, stočari, ovce, koze, govedo, mikromorfologija, pretpovijest, Hrvatska

This paper presents the results of new geoarchaeological and micromorphological studies carried out by the authors on Holocene archaeological cave sediments in Croatia. Combined with the reappraisal of previously published data, this study sheds new light on the pastoral use of caves in Croatia. The occurrence of macro- and microscopic indicators of the presence of animals – mostly ruminants – shows that caves were used for housing livestock from the Neolithic onwards, as happened all over the Northern Mediterranean area, from the Iberian Peninsula to Italy, and in the Southern Balkans. Following the distribution of open-air and cave prehistoric sites it can be concluded that caves were integrated in complex agropastoral systems of landscape exploitation.

Key words:
caves, herders, pastoral, sheep, goat, cattle, micromorphology, prehistory, Croatia

ἀλλ᾽ ὅτε δὴ τὸν χῶρον ἀφικόμεθ᾽ ἐγγὺς ἐόντα,
ἔνθα δ᾽ ἐπ᾽ ἐσχατιῇ σπέος εἴδομεν ἄγχι θαλάσσης,
ὑψηλόν, δάφνῃσι κατηρεφές. ἔνθα δὲ πολλὰ
μῆλ᾽, ὄιές τε καὶ αἶγες, ἰαύεσκον: περὶ δ᾽ αὐλὴ
ὑψηλὴ δέδμητο κατωρυχέεσσι λίθοισι
μακρῇσίν τε πίτυσσιν ἰδὲ δρυσὶν ὑψικόμοισιν.
ἔνθα δ᾽ ἀνὴρ ἐνίαυε πελώριος, ὅς ῥα τὰ μῆλα
οἷος ποιμαίνεσκεν ἀπόπροθεν: οὐδὲ μετ᾽ ἄλλους
πωλεῖτ᾽, ἀλλ᾽ ἀπάνευθεν ἐὼν ἀθεμίστια ἤδη.

Mjesto je bilo blizu, i kad dođemo k njemu,
Onda spazimo spilju na kraju, uz more blizu,
Visoku zastrtu svu lovorikom: u spilji mnogi
Janjci su, ovce i koze, počivale, okolo toga
Visok bijaše obor od ukopanih kamena,
Od visokovrhih hrasta, omorika također dugih.
U spilji spavaše čovjek gromoradan, koji je ono
Stado čuvao sam u prikrajku; nikada on se
S drugima družio nije, već samotan zlo uvježbavao.

(Od. IX, 181–189)

ἀλλ᾽ ὅτε δὴ τὸν χῶρον ἀφικόμεθ᾽ ἐγγὺς ἐόντα,
ἔνθα δ᾽ ἐπ᾽ ἐσχατιῇ σπέος εἴδομεν ἄγχι θαλάσσης,
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πωλεῖτ᾽, ἀλλ᾽ ἀπάνευθεν ἐὼν ἀθεμίστια ἤδη.

But when we had reached the place, which lay close at hand,
there on the land's edge hard by the sea we saw a high cave,
roofed over with laurels, and there many flocks, sheep and
goats alike, were wont to sleep. Round about it a high court
was built with stones set deep in the earth, and with tall pines
and high-crested oaks. There a monstrous man was wont to
sleep, who shepherded his flocks alone and afar, and mingled
not with others, but lived apart, with his heart set on lawless-
ness.

(Od. IX, 181–189)

καρπαλίμως δ᾽ εἰς ἄντρον ἀφικόμεθ᾽, οὐδέ μιν ἔνδον
εὕρομεν, ἀλλ᾽ ἐνόμευε νομὸν κάτα πίονα μῆλα.
ἐλθόντες δ᾽ εἰς ἄντρον ἐθηεύμεσθα ἕκαστα.
ταρσοὶ μὲν τυρῶν βρῖθον, στείνοντο δὲ σηκοὶ
ἀρνῶν ἠδ᾽ ἐρίφων: διακεκριμέναι δὲ ἕκασται
ἔρχατο, χωρὶς μὲν πρόγονοι, χωρὶς δὲ μέτασσαι,
χωρὶς δ᾽ αὖθ᾽ ἔρσαι. ναῖον δ᾽ ὀρῷ ἄγγεα πάντα,
γαυλοί τε σκαφίδες τε, τετυγμένα, τοῖς ἐνάμελγεν.

Do spilje dođemo brzo, al' u njoj ne nađosmo njega,
Jerbo je tovno stado napasao na paši tada.
U spilju došavši sve mi razgledati stanemo redom.
Puna su sušila sira, a ograde sve su tijeske:
Toliko Jaraca ima i janjića, a svaka vrsta
Odvojena je za se; napose ranije ima,
Srednje napose i pozne napose, a posude sve su
Surutke pune, i zdjele i muzlice, u što je muzo.

(Od. IX, 216–223)

καρπαλίμως δ᾽ εἰς ἄντρον ἀφικόμεθ᾽, οὐδέ μιν ἔνδον
εὕρομεν, ἀλλ᾽ ἐνόμευε νομὸν κάτα πίονα μῆλα.
ἐλθόντες δ᾽ εἰς ἄντρον ἐθηεύμεσθα ἕκαστα.
ταρσοὶ μὲν τυρῶν βρῖθον, στείνοντο δὲ σηκοὶ
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χωρὶς δ᾽ αὖθ᾽ ἔρσαι. ναῖον δ᾽ ὀρῷ ἄγγεα πάντα,
γαυλοί τε σκαφίδες τε, τετυγμένα, τοῖς ἐνάμελγεν.

Speedily we came to the cave, nor did we find him within,
but he was pasturing his fat flocks in the fields.
So we entered the cave and gazed in wonder at all things there.
The crates were laden with cheeses, and the pens were crowd-
ed with lambs and kids.
Each kind was penned separately:
by themselves the firstlings, by themselves the later lambs,
and by themselves again the newly weaned.
And with whey were swimming all the well-wrought vessels,
the milk-pails and the bowls into which he milked.

(Od. IX, 216–223)

Homerova *Odiseja*, preveo i protumačio Tomo Maretić,
pregledao i priredio Stjepan Ivšić,
Zagreb 1959.,
Matica hrvatska.

Homer. *The Odyssey*, with an English translation by
A. T. Murray, Ph.D., in two volumes.
Cambridge, MA, Harvard University Press;
London, William Heinemann, Ltd. 1919.

Uvod i ciljevi rada

Odisejeve riječi – kako ih je ispjevao Homer – živo opisuju njegov dolazak u Polifemovu jazbinu, nastambu pastirovu, a zatim i izgled unutrašnjosti špilje, čiji opis ukazuje na dobro uređeno i u određenom smislu prostorno organizirano korištenje ovakvih nastambi u svijetu stočara, na što se aludira blizinom drugih mu Kiklopa krajem grčkoga Mračnog doba. Vanjština špilje podsjeća na izgled mnogobrojnih špilja u sredozemnim krškim krajevima, gdje je „dvorište" moglo biti ciljano izgrađeni obor, ograđeni prostor, ali može biti i tipična vrtača, tj. krški geološki oblik čije kamenite, okomite stijene mogu nalikovati na zidove. Iako Homer suptilno naglašava visoko vještu Odisejevu *technè* nasuprot osnovnim sposobnostima suprotstavljenog mu sličnog bića, ljudožderskog Polifema,[1] špilja u kojoj živi čudovište je začuđujuće dobro organizirana, što sugerira pažljivu organizaciju unutrašnjeg prostora i odvajanje različitih aktivnosti koje su se odvijale i koje su u Dalmaciji posvjedočene u špiljama korištenim za držanje životinja do razmjerno novijih vremena.[2]

Špilje su važan izvor podataka o ljudskim kulturama u prošlosti jer ih je čovjek koristio za stanovanje i za niz drugih namjena tijekom vrlo dugoga razdoblja, najmanje otprije dva milijuna godina do danas.[3] Ključni arheološki i okolišni podaci sačuvani su u špiljama[4] te veliki dio onoga što danas znamo o pretpovijesnim kulturama i njihovu odnosu prema okolišu potječe od kulturnih ostataka i okolišnih pokazatelja koji su sačuvani u špiljskim sedimentima. Pažljiva kontekstualizacija arheoloških podataka[5] unutar okvira procesa sedimentacije i nastajanja arheoloških nalazišta presudna je za razumijevanje razvoja i datacije starih kultura.

Uloga i važnost špilja u životu zajednica ranoga neolitika posebno je važna u raspravama o tranziciji prema poljoprivredi, kao i u postupcima koji su se u neolitičkom gospodarstvu koristili u uzgoju životinja,[6] ali i o prijelazu na sjedilački način života.[7] Iz takve perspektive su važna i plodonosna bila geoarheološka istraživanja Jacques-Élie Brochiera[8] na jugu Francuske, koja su nastavili drugi autori[9] u sjeverozapadnoj Italiji, pokazavši važnost špilja u uzgoju životinja od neolitika nadalje. Spomenute su se studije temeljile na mikromorfologiji sedimenata i dokazale su da su domaće životinje, prije svega ovce/koze i goveda, svojim izmetom najviše doprinijele holocenskoj sedimentaciji u špiljama koje su se intenzivno koristile kao staje.[10] Tijekom narednih desetljeća istraživanje ove teme proširilo se i na druga područja sjevernog Sredozemlja, gdje je do danas otkriveno mnogo špilja s tragovima stočarskoga korištenja (tab. 1), što upućuje na zaključak da su integrirani agropastoralni sustavi

Introduction and aims

The words of Odysseus – as sung by Homer – vividly describing his arrival at the lair of Polyphemus the shepherd, and then the aspect of the inside of the cave, suggest a well-established, and in some way territorially organised, use of these sites within a pastoral world, as hinted by the proximity of other fellow cyclopes, at the end of the Greek Dark Ages. The outside of the cave recalls the aspect of many caves of the Mediterranean karst regions, where the "court" could really be an intentionally built enclosure, but may also be a typical dolina, i.e. a karstic landform whose steep, rocky sides may resemble walls. Though Homer subtly emphasises the highly-skilled *technè* of Odysseus against the basic abilities of his opposite simile, the man-eating Polyphemus,[1] the cave where the monster lives is amazingly well-ordered, suggesting a careful organisation of the inside spaces and separation of different activities that are testified to in caves that were used for keeping animals until relatively recent times in Dalmatia.[2]

Caves are important sources of information about past human cultures, because people have used them for dwelling and for a number of other purposes over extended periods of time, since at least two million years ago until now.[3] Key archaeological and environmental records are preserved in caves,[4] and much of what we currently know about prehistoric cultures and their relationships with the environment derives from cultural remains and environmental proxies preserved in cave sediments. Accurate contextualisation of the archaeological data[5] within the framework of sedimentary and site-formation processes is essential for understanding the evolution and timing of past cultures.

The role of caves in Early Neolithic societies is particularly relevant within the debates about the transition to farming and the relevance/method of stock-rearing in Neolithic economies,[6] as well as the shift to sedentism.[7] From this point of view, seminal geoarchaeological work carried out by Jacques-Élie Brochier[8] in the French Midi, followed by other authors[9] in north-western Italy, has demonstrated the importance of caves in stock-rearing from the Neolithic onwards. These studies were based on sediment micromorphology, showing that domestic animals, mostly sheep/goats and cattle, contributed with their dung to most of the Holocene sedimentation in caves, which were intensively used for housing animals.[10] In the following decades, research on this topic extended to other areas of the Northern Mediterranean region, where a very large number of caves with evidence of pastoral use have been discovered to the present

1 Mills 1981.
2 Gjivoje 1952.
3 Bonsall, Tolan-Smith 1997; Ullman *et al.* 2013; Caruana, Stratford 2019.
4 Woodward, Goldberg 2001; Goldberg, Sherwood 2006.
5 Bergsvik, Skeates 2012.
6 Halstead 1996; 2000.
7 Marshall 2006.
8 Brochier 1983; 1990; 1991; 1996.
9 Courty, MacPhail, Wattez 1991; Macphail *et al.* 1997.
10 Brochier 2006.

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5 Bergsvik, Skeates 2012.
6 Halstead 1996; 2000.
7 Marshall 2006.
8 Brochier 1983; 1990; 1991; 1996.
9 Courty, MacPhail, Wattez 1991; Macphail *et al.* 1997.
10 Brochier 2006.

igrali ključnu ulogu u kompleksnim poljoprivrednim gospodarstvima[11] i da je uzgoj životinja bila važna sastavnica proizvodnoga gospodarstva i preživljavanja.

Istraživanja ove teme u Hrvatskoj započela su nešto kasnije[12] te su pokazala da su se i ovdje špilje koristile za držanje koza, ovaca i goveda i da su također bile vjerojatno integrirane u kompleksni agropastoralni sustav. Od tada broj špilja, koje su sigurno identificirane kao stočarske, stalno se povećava, a pregled objavljene literature pokazuje naznake da su se i neke druge špilje, u kojima se ranije istraživalo, mogle koristiti za iste namjene.

U ovom su članku prikupljeni dokazi postojanja stočarskih špilja prema rezultatima terenskog rada i sedimentološke-mikromorfološke analize koje su proveli autori, kao i tragovi (informacije o sedimentima, životinjskim kostima, keramičkim nalazima) koji proizlaze iz pregleda literature. Cilj je članka istražiti ulogu tih lokaliteta u neolitičkom prijelazu na proizvodno gospodarstvo te njihov značaj u načinu kako su poljoprivredne zajednice koristile krajolik u vrijeme kad su špilje postupno mijenjale namjenu od stanovanja ljudi do staje za životinje.

Materijali i metode

Mikromorfologija sedimenata i tala, tj. proučavanje neporemećenih uzoraka u mikropresjeku pod polarizacijskim mikroskopom, moćan je alat pomoću kojega možemo razotkriti mikroskopske pokazatelje okolišnih i antropogenih procesa. U okviru arheološkog konteksta, ovom se metodom mogu dokazati specifični aspekti ljudskog ponašanja, koji se inače ne bi mogli otkriti prostim okom, a koji pod mikroskopom postaju relevantni za tumačenje ljudske upotrebe krajolika kroz vrijeme, na razini lokaliteta i na regionalnoj razini. Mikromorfologija je, međutim, samo alat u širem polju geoarheoloških istraživanja, a nijedno promatranje mikroskopskih razmjera ne može biti stvarno značajno ako se ne uzme u obzir čitav sedimentni kontekst nalazišta i okolni krajolik.

U ovom radu razmatramo makro- i mikroskopsku razinu opažanja, ističući neke specifične pokazatelje uzgoja stoke koji su poznati iz literature, ali i iz našeg vlastitoga terenskog i laboratorijskog istraživanja. U nekim slučajevima makro- i mikroskopski podaci proizlaze iz izravnih promatranja koje smo provodili na terenu i pod mikroskopom. U drugim slučajevima hipoteze i zaključke donosimo nakon proučavanja objavljene terenske dokumentacije lokaliteta koje su istražili drugi autori, a na kojima nisu provedene mikromorfološke analize. Naša tumačenja proizlaze iz proučavanja crteža i fotografija profila iskopanih sondi, pri čemu su fotografije pouzdanije jer na njih nisu utjecale interpretacije drugih istraživača. Podrazumijeva se da su ova tumačenja manje pouzdana od onih koja proizlaze iz naših vlastitih terenskih i laboratorijskih analiza te da su potrebni mikromorfološki dokazi da bi se potvrdile naše pretpostavke.

(Table 1), suggesting that integrated agropastoral systems played a key role in complex farming economies,[11] and that raising animals was a relevant component of the production economy.

Research on this topic started in Croatia in slightly more recent times,[12] showing that caves were used for stabling goats, sheep and cattle here as well, and that they were likely integrated into complex agropastoral systems. Since then, the number of caves confidently identified as pastoral has been growing steadily, and reviewing the literature shows hints that several others that were excavated in the past may have been used for the same purpose.

This paper collects current evidence of pastoral caves deriving from fieldwork and sedimentology-micromorphology analyses carried out by the authors, as well as clues (information regarding sediments, animal bones, ceramic finds) deriving from a survey of the literature. Its scope is to investigate the role of these sites in the Neolithic shift to production economy, and their relevance in landscape use by farming societies, when caves gradually changed from dwellings for humans to stables for animals.

Methods and materials

Micromorphology of sediments and soils – i.e. the observation of undisturbed samples in thin section under a polarising microscope – is a powerful method that sheds light on microscopic indicators of processes both environmental and anthropic. Within archaeological contexts, specific aspects of human behaviour, which would not otherwise be detectable at macroscopic scale, can be brought into evidence by this method and become relevant clues for the interpretation of the human use of the landscape through time, from intra-site to regional scale. Micromorphology, however, is only a tool in the broader field of geoarchaeological studies, and no microscopic-scale observation can be really meaningful if the whole sedimentary context of the site and the surrounding landscape is not considered.

In this paper, we consider both macro- and microscopic scales of observation, highlighting some specific indicators of stock-rearing that are widely known through the literature and from our personal experience in the field and in the laboratory, and are described here. In some cases, macro- and microscopic data derive from direct observation carried out by us in the field and at the microscope. In other cases, we draw hypotheses and reasonable conclusions after having observed published field documentation from sites excavated by other authors, where micromorphological studies were not carried out. Our interpretations derive from the examination of excavation profile drawings and photographs, the latter being usually the most reliable, as they were not influenced by the other researchers' perspectives and interpretations. It goes without saying that these interpretations are less reliable than those deriving from our personal studies, and that micromorphological proof would be necessary to confirm our hypotheses.

11 Beeching *et al.*2000; Halstead 2000; Helmer *et al.* 2005; Delhon, Thiébault, Berger 2009; Fernández-Eraso *et al.* 2015.

12 Boschian 2006; Boschian, Miracle 2007.

11 Beeching *et al.* 2000; Halstead 2000; Helmer *et al.* 2005; Delhon, Thiébault, Berger 2009; Fernández-Eraso *et al.* 2015.

12 Boschian 2006; Boschian, Miracle 2007.

Makroskopski pokazatelji

Korištenje špilja u stočarstvu može se u mnogim slučajevima prepoznati već na terenu izravnim promatranjem specifičnih pokazatelja, od kojih je najkarakterističnija vrsta sedimenta koji su francuski autori nazvali *fumier*. U francuskom standardnom jeziku pojam označava "Mélange de litières et d'excréments des animaux (d'étable ou d'écurie), décomposé par la fermentation sous l'action de micro-organismes, et utilisé comme engrais",[13] tj. mješavinu stelje (ležaja za životinje) i životinjskog izmeta (goveda, konja ili bilo kojih drugih stajskih životinja) koja se raspala fermentacijom, djelovanjem mikroorganizama, i koristila kao gnojivo. Valja naglasiti da su ovaj sediment i drugi makroskopski pokazatelji obično konačni dokaz korištenja špilje kao staje, ali i da postoje konteksti u kojima oni nisu prisutni unatoč boravku životinja u špilji. Stoga, treba potražiti i druge pokazatelje – najčešće na mikroskopskoj razini.

Facijes „slojevite torte"

Sedimentni facijes „slojevite torte", koji su francuski autori nazvali *fumier*, vrlo je karakterističan i lako prepoznatljiv na terenu. Ujedno je i najneposredniji i najpouzdaniji pokazatelj boravka životinja u špilji – čak i na makroskopskoj razini – jer niti jedan drugi prirodni ili antropogeni proces ne stvara slične taložine. Facijes je karakterističan po zapanjujuće pravilnim nizovima naizmjeničnih crnih i bijelih horizonata, koji doista nalikuju slojevitim tortama, a mogu biti debljine i do 4 do 5 m (sl. 1). Pobližim ispitivanjem prepoznaju se značajne razlike uglavnom u svijetlim horizontima, koji se kreću od tamnosive ili sivkaste do smećkaste i vrlo svjetlosive do gotovo potpuno bijele boje. Ta je varijabilnost oblikovana i u lećastim pothorizontima koji se razlikuju u boji, teksturi i poroznosti / kompaktnosti, a odvojeni su oštrim granicama. Grude, koje pripadaju drugim facijesima sedimenta, često se nalaze unutar tih slojeva. Nasuprot tomu, tamni su horizonti manje raznoliki i uglavnom crne do smećkastocrne boje. Sve ove boje nakon sušenja postaju homogenije crne i svjetlosive do bjelkaste. Pojedini su horizonti vrlo tanki (2 do 3 cm za tamne, 10 do 12 cm za svijetle) u usporedbi s njihovim rasprostiranjem, koje može biti do nekoliko četvornih metara. Ovi su crni i bijeli horizonti odvojeni posebno oštrim i vrlo očitim granicama (kontaktima) koje su često nepravilno valovite. Granulometrijski sastav je u rasponu od pjeskovito praškaste ilovače do pjeskovite ilovače, s vrlo malo ili nimalo krupnozrnatog skeleta, koji sadrži nasumično rasuto uglasto i nesortirano kamenje. Agregacija je srednje do dobro razvijena, prilično rahla, vrlo sitna do sitnozrnata, s velikim porama koje ponekad sedimentu daju spužvasti izgled. Svijetli horizonti su manje porozni i kompaktniji. Klasa čvrstoće tla je „umjereno slaba do umjereno čvrsta", tj. grudice suhog sedimenta popuste ako se lagano do čvrsto pritisnu između kažiprsta i palca.[14] Ugljena ima puno u crnim horizontima, često u velikim ulomcima (do 1 do 2 cm), dok se u bijelim horizontima rijetko pojavljuje.

Macroscopic indicators

In many cases the pastoral use of caves can be inferred already in the field from direct observation of specific indicators, among which the most characteristic is a sediment type called *fumier* by French authors. In current French language the term indicates "Mélange de litières et d'excréments des animaux (d'étable ou d'écurie), décomposé par la fermentation sous l'action de micro-organismes, et utilisé comme engrais",[13] i.e. a mix of litter and animal excrement (of cattle or horse or any other stabled animal) decomposed by fermentation by the action of micro-organisms and used as fertiliser. It must be pointed out that, while this sediment and other macroscopic indicators are usually final evidence of animal stabling in a cave, there are several contexts where they did not form, despite animal presence. Consequently, other indicators should be sought – mostly at microscopic level.

'Layer-cake' facies

This sediment facies, called *fumier* by French authors, is very characteristic and easily identifiable in the field. It is also the most immediate and reliable indicator of animal stabling within a cave – even at a macroscopic scale – as no other natural or anthropogenic process produces similar deposits. This facies is characterised by strikingly regular sequences of alternating black and white horizons, which indeed resemble layered cakes and can be up to 4–5 m thick (Fig. 1). On closer examination, there is remarkable variation, mostly within the light horizons, which range from dark grey or greyish through brownish to very light grey and almost pure white; this variability is also organised in lens-like sub-horizons that differ in colour, texture and porosity/compactness, and are separated by sharp limits. Clods pertaining to other sediment facies are frequently embedded within layers. Conversely, the dark horizons are less variable and prevalently black to brownish black. All these colours become more homogeneously black and light grey to whitish after drying. The individual horizons are very thin (2–3 cm for the dark ones, up to 10–12 cm for the light ones) if compared with their extension, which can be up to several square metres. These black and white horizons are separated by particularly sharp and very evident limits that are often irregularly undulating. The grain size is in the range of sandy silt loam to sandy loam, with very few or no coarse skeleton, which comprises randomly scattered angular and unsorted stones. The aggregation is medium- to well-developed, very finely to finely granular, and rather loose, with large pores that sometimes give the sediment a spongy aspect. The light horizons are less porous and more compact. The soil strength class is 'moderately weak to moderately firm', i.e. dry sediment blocklets fail if pressed, gently to firmly, between the forefinger and thumb.[14] Charcoal is abundant in the black horizons, frequently represented by large fragments (up to 1–2 cm), whereas it rarely occurs in the white ones.

13 CNTRL 2020.

14 Catt 1990.

13 CNTRL 2020.

14 Catt 1990.

SLIKA 1. Vela peć kod Vranje: debeli slijed tipičnog neolitičkog facijesa slojevite torte (snimio G. Boschian).

FIGURE 1. Vela Peć near Vranja: thick sequence of typical Neolithic layer-cake facies (photo by G. Boschian).

Kako se zaključuje iz kontekstâ u kojima je taj facijes predstavljen izoliranim slojevima unutar drugih facijesa sedimenta (v. dolje, homogeni facijes), tamni i bijeli horizonti uvijek su posloženi u parovima, pri čemu tamni horizont predstavlja donji element; on je također tanji od gornjega svjetlijeg dijela i češće je isprekidan. Arhitektura litoloških jedinica je kompleksna unatoč prividnoj sveukupnoj pravilnosti slijeda jer su horizonti gotovo uvijek isprekidani i mogu se pravilnije definirati kao leće nego kao slojevi. Veličina je ovih leća također iznimno promjenjiva tako da su složeno slojevite. Štovište, pojava različitih podfacijesa unutar svijetlih horizonata dodatno komplicira stratigrafske odnose među horizontima. Čitav skup stratigrafskog slijeda slojevite torte je stoga veoma složeno proslojavanje isprekidanih litoloških jedinica zbog čega je svaki pokušaj da se stratigrafke granice slijede prilikom iskopavanja vrlo izazovan. Slijedom toga, naglašavamo da bi iskopavanje i stratigrafsko bilježenje tih sljedova na terenu bilo veoma teško pratiti ako svaku litološku promjenu odlučimo precizno dokumentirati s obzirom na to da se „*klasična* arheološka stratigrafska tehnika [...] teško može koristiti u iskopavanju *fumiera*, posebno što se tiče definicije jedinica. [...] "divizionistički" pristup [...] imao bi zbunjujuće učinke. Nadalje, zbog nepravilne geometrije uslojavanja bilo koji pristup zasnovan na topografskim ili visinskim kriterijima (na primjer putem proizvoljnih / arbitrarnih slojeva) uopće ne bi bio izvediv".[15]

Iako se s većinom ovih argumenata možemo lako složiti, očito je da je potrebna neka vrsta više ili manje proizvoljne stratigrafske podjele, uglavnom kada su sekvence iznimno debele i mogu svjedočiti o dugom razdoblju korištenja špilje. U tom se slučа-

As inferred from contexts where this facies is represented by isolated layers within other sediment facies (see below, homogeneous facies), dark and white horizons are always organised in pairs, where the dark horizon represents the bottom element; it is also usually thinner than the overlying lighter part, and it is also more frequently discontinuous. The architecture of the lithologic units is complex despite the apparent overall regularity of the sequences, because the horizons are almost always discontinuous and can be better defined as lenses than as layers. The size of these lenses is also extremely variable, so they are complexly interlayered; moreover, the occurrence of various subfacies within the light horizons further complicates the stratigraphic relationships between horizons. The whole deck of a layer-cake sequence is therefore a very complex interlayering of discontinuous lithologic units that challenges any attempt to properly follow the stratigraphic limits during excavation. Consequently, it has been pointed out that excavation in the field and stratigraphic recording of these sequences would become difficult if every lithologic variation had to be accurately recorded, as "the 'classical' archaeological stratigraphic technique [...] can hardly be used in the excavation of *fumiers*, especially as concerns the definition of the units. [...] a 'divisionist' approach [...] would have confusing effects. Furthermore, due to the irregular geometry of the stratification, any approach based on topographic or elevation criteria (for example, through arbitrary levels) would not be feasible at all".[15]

Though most of these points can easily be shared, it is also evident that some sort of more or less 'artificial' stratigraphic subdivision is necessary, mostly when the sequences are remark-

15 Angelucci *et al.* 2009., 195.

15 Angelucci *et al.* 2009, 195.

ju isprekidane površine, koje se protežu na širokom prostoru, mogu koristiti kao granice alostratigrafskih jedinica.

Tanke, okomite subcilindrične tvorevine (dužine 20 do 30 cm i širine 5 do 6 cm), ispunjene homogenim smećkastim sedimentom, često okomito prelaze ove slojevite sekvence. Crni i bijeli slojevi obično su na rubovima ovih tvorevina, savijeni prema dolje, što ukazuje na neku vrstu deformacije, vjerojatno zbog umetnutih kolaca koji se koriste za izgradnju pletenih ili drvenih ograda unutar špilje. Ovaj se facijes može pojaviti i u izoliranim parovima unutar homogenog facijesa ili u homogeno slojevitim strukturama. Te strukture mogu biti debele do nekoliko metara i donekle kupolaste, nalik nekoj vrsti fino slojevite "hrpe".

Homogeni facijes

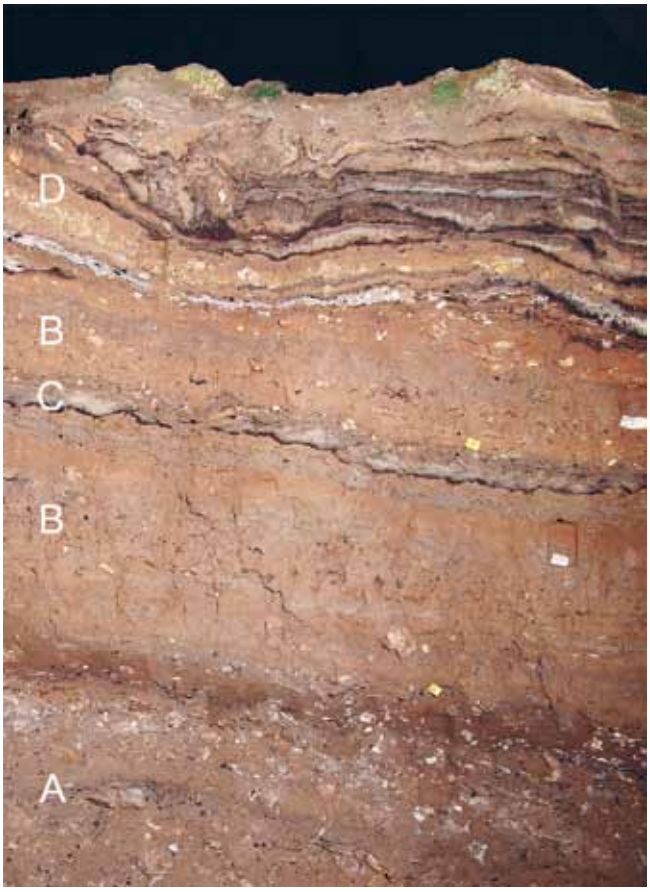
Sedimenti ovog facijesa organizirani su u prilično debelim (od 50 do 60 cm) i iznimno homogenim svjetlosmećkastim pločastim slojevima (sl. 2). Ponekad mogu uključivati nešto svjetlije ili tamnije horizonte, grubo uslojene i s nejasnim granicama. Češće preko njih prelaze isprekidane pojedinačne crno-bijele leće, čija rasprostranjenost može doseći i nekoliko četvornih metara. Sediment je uvijek praškasta ilovača, ponekad uključuje veće količine pijeska ili gline, i blago je šljunkovit pod arheološkom lopaticom. Izgled mu je poput praha kad je suh, a prašina prianja za ruke. Krupnozrnati skelet sastoji se od iznimno promjenjivih količina nesortiranog kamenja, do granulometrijske veličinske klase oblutaka (128 do 256 mm), koje je nasumično raspršeno unutar sedimenta. Agregacija je uglavnom masivna, a kad je gline relativno puno, ponekad je prizmatična. Klasa čvrstoće tla je „umjereno slaba do umjereno čvrsta", tj. mali grumeni neporemećenoga suhog sedimenta popuštaju ako ih se lagano do čvrsto pritisne između kažiprsta i palca. Ugljen je relativno česta pojava, obično se pojavljuje u fragmentima milimetarske veličine koji su nasumično raspoređeni po masi sedimenta.

Provansalski izraz *migon* predložio je Jacques-Elie Brochier[16] kako bi razlikovao taj facijes sedimenta.

Polirane stijene

Polirane stijene mogu se prepoznati u špiljama u kojima su dugo boravila velika stada. Posljedica su kontinuiranog trljanja ovčjeg i kozjeg runa o zidove špilje kad je unutarnji prostor prepun zatvorenih životinja[17]. Slijedom toga, to se može koristiti kao relativno dobar pokazatelj stajanja, zadržavanja životinja u špilji. Pojavljuje se kao približno vodoravna traka zaglađene stijene, širine oko 40 do 50 cm, smještena na određenoj visini iznad današnjeg poda špilje. Izbočeni dijelovi zidne stijene lijepo su zaobljeni i sjajni, dok je unutrašnjost pukotina i malih udubljenja obično ostala hrapava.

Širina zaglađene trake odgovara različitim veličinama i visinama tijela životinja, dok visina trake iznad današnjeg poda špilje (koja može biti mnogo viša od današnjeg poda) ukazuje na promjene debljine u ispuni špiljskog sedimenta. Te promjene mogu



SLIKA 2. Vela Spila: slijed mezolitičkih naslaga otpada (a), neolitičke homogene naslage (b), izolirani crno-bijeli sloj (c), facijes slojevite torte (d); slijed je debeo 1. 6 m (snimio G. Boschian).

FIGURE 2. Vela Spila: a sequence of Mesolithic waste deposits (a), Neolithic homogeneous deposits (b), isolated black/white layer (c), and layer-cake facies (d); 1. 6 m thick sequence (photo by G. Boschian).

ably thick and may testify to a long period of cave use. In this case, discontinuity surfaces extending over wide areas can be used as limits of allostratigraphic units.

Thin vertical subcylindrical features (20–30 cm long and 5–6 cm wide) filled with homogeneous brownish sediment often vertically cross these layered sequences. The black and white layers are usually bent downwards at the side of these features, indicating some sort of downward deformation, probably due to the penetration of posts used in building wattle or wooden enclosures within the cave. This facies can also occur in isolated pairs embedded within the homogeneous facies, or in homogeneously layered decks. These decks can be up to several metres thick and somewhat domed, resembling a sort of finely layered 'heap'.

Homogeneous facies

The sediments of this facies are organised in rather thick (up to 50–60 cm) and remarkably homogeneous light-brownish tabular layers (Fig. 2). They may sometimes include slightly lighter or darker horizons, crudely layered and with indistinct limits. More frequently, they are crossed by single black/white lenses that may be up to several metres wide. The sediment is always

16 Brochier 2002.

17 Brochier *et al.* 1992.

biti posljedica erozije ispune sedimenta, ali i smanjenja volumena sedimenta uslijed namjernog spaljivanja nakupina balege. To je uobičajena praksa u pastirskim špiljama i skloništima jer biljojedi proizvode veliku količinu balege, koja može brzo ispuniti cijelu unutrašnjost špilje ako u njoj boravi veliko stado. U drugim su se slučajevima špilje mogle koristiti kao izvor stajskoga gnoja pa su se posljedično praznile (barem dijelom) od ispune sedimenta.[18]

Polirane stijene mogle su nastati i vrlo sličnim procesom koji je povezan s boravkom špiljskog medvjeda (Ursus spelaeus) u njima,[19] ali u tim bi slučajevima opći kontekst trebao objasniti podrijetlo zaglađenih zidnih stijena.

Mikroskopski pokazatelji

Kako je ranije primijećeno, makroskopski pokazatelji nisu uvijek dovoljni da bi se utvrdilo je li se lokalitet koristio za držanje životinja. U pionirskom djelu, koje je o „prašinastim" sedimentima u špiljama napisao Jacques-Élie Brochier,[20] naglasio je kako se mikroskopskim pregledom mogu identificirati specifične komponente sedimenta povezane sa stočarskom aktivnošću. Kasniji radovi drugih autora o špiljama, koje su se koristile kao staje za životinje,[21] pokazali su da analiza mikropresjeka,[22] zajedno s etnoarheološkim informacijama,[23] može uvelike doprinijeti razumijevanju povezanosti i prostorne organizacije višestrukih komponenata te opisu finih prostornih i dijakroničkih detalja u upotrebi špilja, a potom i korištenju krajolika u okolici špilja.[24]

Nekoliko vrsta osnovnih mikromorfoloških pokazatelja (tj. sferulita, fitolita, pepela i ugljena) može se grupirati po višem hijerarhijskom redoslijedu na složene tvorevine (tj. izmet i njegove ulomke) i na sedimentni facijes (*sensu* Moore).[25]

Sferuliti

Sferuliti[26] su male, bezbojne i prozirne sferične strukture sastavljene od iglastih, vapnenačkih radijalno raspoređenih kristala: iz središta kugle šire se u svim smjerovima (sl. 3 b, d). Imaju prilično pravilan oblik, a veličina im varira između 4 do 5 µm i 10 do 12 µm, a ponekad i do 20 µm. U mikropresjeku mogu se lako prepoznati jer se pod ukriženim polariziranim svjetlom vide karakteristične pseudointerferencijske figure u obliku križa. Međutim, figure može prekrivati tamnosmeđa do crna i gotovo neprozirna jezgra, vjerojatno od amorfne organske tvari koja

silty loam, sometimes including considerable quantities of sand or clay, and is slightly gritty under the excavator's trowel. Its appearance is powdery when dry, and its dust adheres to the hands. The coarse skeleton is represented by extremely variable quantities of unsorted stones, up to the grain-size class of cobbles (128–256 mm), which are scattered randomly within the sediment. The aggregation is generally massive, sometimes prismatic where clay is relatively abundant. The soil-strength class is 'moderately weak to moderately firm', i.e. small clods of undisturbed dry sediment fail if pressed, gently to firmly, between the forefinger and thumb. Charcoal is relatively frequent, usually occurring as mm-sized fragments randomly distributed throughout the sediment mass.

The provençal term '*migon*' has been proposed by Jacques-Elie Brochier[16] to distinguish this sediment facies.

Rock polish

Rock polish may occur in caves where large flocks have been penned for a long time. It results from the continuous rubbing of sheep and goat fleece on the walls of the cave when the inner space is crowded with constrained animals.[17] Consequently, it may be used as a reasonably good indicator of stabling/penning of animals in a cave. It appears as a roughly horizontal band of smoothed rock, about 40–50 cm wide, located at some height above the present-day floor of the cave. The protruding parts of the wall rock are well rounded and glossy, whereas the inside of clefts and small niches is usually still angular.

Its width corresponds to the size and height variation of the animals' flanks, while the height above the cave floor (which could be much higher than the present-day floor) indicates thickness changes in the cave sediment infill. These changes may result from erosion of the sediment infill, as well as from volume reduction due to intentional burning of the dung accumulation. This is a common practice in pastoral caves and shelters, because herbivores produce a large quantity of dung, which can quickly fill up the whole inside of the cave if it is occupied by large flocks. In other cases, caves have been used as quarries of easily available manure and been consequently (partly) emptied of the infilling sediment.[18]

Rock polish may also be due to very similar processes connected to frequentation by cave bears (*Ursus spelaeus*),[19] but in these cases the general context should clarify its origin.

18 Vergès, Morales 2016.

19 Bachofen-Echt 1931; Bednarik 1994.

20 Brochier 1983.

21 Helmer 1984; Wattez, Courty, Macphail 1990; Courty, MacPhail, Wattez 1991; Macphail *et al.* 1994; Boschian 1997.

22 Matthews *et al.* 1997.

23 Shahack-Gross, Marshall, Weiner 2003; Tsartsidou *et al.* 2008; Friesem 2016.

24 Boschian 2000; Boschian, Montagnari-Kokelj 2000.

25 Moore 1949; Feng 2019.

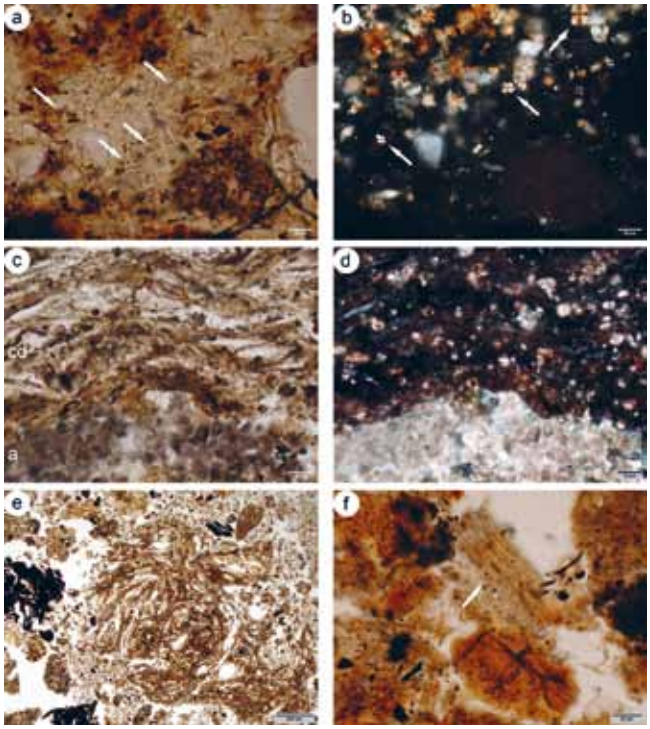
26 Canti 1997; 1998.

16 Brochier 2002.

17 Brochier *et al.* 1992.

18 Vergès, Morales 2016.

19 Bachofen-Echt 1931; Bednarik 1994.



SLIKA 3. Mikroskopski pokazatelji stočarske upotrebe špilja: a) Zala: neartikulirani trapezoidni fitoliti, PPL; b) Zala: fekalni sferuliti, XPL; c) Pupićina peć: artikulirani fitoliti i biljna vlakna organizirani u valoviti uzorak, vjerojatni izmet krava (cd), koji preslojavaju pepeo od kore/drva (a), tj. kalcitni pseudomorfi na kristalima oksalata (rombovi i kocke), PPL; d) kao i c), XPL; e) Pupićina peć: brabonjak ovce/koze s konvolucijama i nasumce orijentiranim fitolitima i biljnim vlaknima, PPL, f) Zemunica: moguće slama/stelja, i.e. artikulirani fitoliti, PPL (snimili G. Boschian i K. Gerometta).

FIGURE 3. Microscopic indicators of pastoral use: a) Zala Cave: non-articulated trapezoidal phytoliths, PPL; b) Zala Cave: faecal spherulites, XPL; c) Pupićina peć: articulated phytoliths and vegetal fibres organized in wavy pattern, probable cow dung (cd), superimposed on wood/bark ash (a), i. e. calcite pseudomorphs on oxalate crystals (lozenges and cubes), PPL; d) as in c), XPL; e) Pupićina Peć: sheep/goat dung pellet with convoluted and randomly oriented phytoliths and vegetal fibres, PPL; f) Zemunica Cave: possible straw/litter, i. e. articulated phytoliths, PPL (photos by G. Boschian and K. Gerometta).

nastaje kad su sferuliti sagoreni. Sferuliti se redovito nalaze u balegi koju proizvode neretrocekalni preživači (tj. ovce i koze, goveda, deve i dr., ali i nepripitomljene životinje poput jelena, srne, kozoroga itd.), i to u ogromnim količinama na mjestima gdje životinje borave duže vrijeme. Iz tog se razloga mogu koristiti kao pokazatelji prisutnosti životinja u špilji.

Međutim, valja istaknuti nekoliko aspekata koji se tiču značaja sferulita u špiljskim sedimentima, naime, da sferuliti ne moraju biti apsolutni pokazatelji namjernog držanja stada. Sferuliti se akumuliraju i kada na lokalitetu borave svojte preživača kojima špilje ili zakloni služe kao privremena skloništa.[27] S druge strane, odsutnost sferulita nije dokaz da preživači na tome mjestu nisu boravili jer njihova prisutnost, odnosno količina, ovise i o sezoni i prehrani, a različite svojte stvaraju raznolike količine

27 Courty, Goldberg, Macphail 1989; Brochier 1995; Brochier, Claustre 2000.

Microscopic indicators

As previously noted, macroscopic indicators are not always enough to ascertain whether a site has been used for stabling animals. The seminal work by Jacques-Élie Brochier[20] about 'powdery' sediments in caves pointed out how microscopic examination can identify specific sediment components that are linked to pastoral practices. Subsequent work by other authors on caves used for stabling animals[21] has brought into evidence how thin-section studies,[22] integrated with ethno-archaeological information,[23] can contribute substantially to understanding the association and spatial organisation of multiple components, and describing fine spatial and diachronic detail of cave use and, eventually, also of land use in the surroundings of the caves.[24]

A few types of basic micromorphological indicators (namely spherulites, phytoliths, ash and charcoal) can be grouped together at a higher hierarchical order in complex features namely excrement, often in fragments) and in sedimentary facies (*sensu* Moore).[25]

Spherulites

Spherulites[26] are small, colourless, transparent, spherical features composed of acicular calcareous crystals arranged radially, i.e. departing from the centre of the sphere and expanding in all directions (Fig. 3: b, d). Their shape is rather regular, and their size varies between 4–5 and 10–12 mm, or sometimes up to 20. They can easily be identified in thin section, because of a characteristic cross-shaped pseudo-interference figure appearing under cross polars. However, this figure can be masked by a core that is dark brown to blackish and almost opaque, probably of amorphous organic matter, when the spherulites are burnt.

Spherulites are common in dung produced by non-retrocaecal ruminants (not only sheep and goats, cattle, camels etc., but also non-domesticates such as red/roe deer, ibex etc.) and accumulated in extremely large quantities where animals have been kept for some time. For this reason, they can be used as indicators of the presence of animals in a cave.

However, several aspects concerning the significance of spherulites in cave sediments must be pointed out, meaning that spherulites may not be absolute indicators of the intentional stabling of flocks and herds. Spherulites accumulate also when a site is occupied by wild ruminant taxa temporarily sheltering

20 Brochier 1983.

21 Helmer 1984; Wattez, Courty, Macphail 1990; Courty, MacPhail, Wattez 1991; Macphail *et al.* 1994; Boschian 1997.

22 Matthews *et al.* 1997.

23 Shahack-Gross, Marshall, Weiner 2003; Tsartsidou *et al.* 2008; Friesem 2016.

24 Boschian 2000; Boschian, Montagnari-Kokelj 2000.

25 Moore 1949; Feng 2019.

26 Canti 1997; 1998.

sferulita.[28] Sideritni sferuliti mogu se naći i u močvarama[29] i u drugim sedimentima bogatim vodom, ali u tim se slučajevima kontekst i – pouzdanije – kemijski sastav može upotrijebiti za utvrđivanje njihova podrijetla. Naposljetku, sferuliti su malih dimenzija, tako da sedimenti koji sadrže mnoge od njih imaju vrlo veliku specifičnu površinu i vrlo su reaktivni na procijeđenu vodu ako je ova i samo malo kisela. Shodno tomu, sferuliti su vrlo podložni otapanju i nestajanju iz sedimenta.

Fitoliti

Fitoliti su silikatne (hidratizirani silicijev dioksid, opal) komponente nekih biljnih svojti (pteridofiti, bazalne kritosjemenjače, monokotiledoni, eudikoti), posebno trava i šaša,[30] koje su u arheološkom kontekstu vrlo raširene (sl. 3 a, f).[31] Mogu biti vrlo različitog oblika, uključujući forme štapića, bodljikavih štapića, bučica, srpova itd., a veličina im je između 5 mm i 20 mm iako fragmenti fitolita mogu biti i mnogo manji. Zbog svojeg oblika, prozirnog i bezbojnog izgleda te visokog indeksa refrakcije, mogu se lako prepoznati u mikropresjeku pod paralelnim polariziranim svjetlom i pri uvećanju >40x. Značaj fitolita u stočarskom kontekstu opsežno je proučen,[32] pa i s geo-etno-arheološkog gledišta,[33] čime je naposljetku dokazano da se integriranim proučavanjem fitolita i geokemijskim istraživanjima mogu dobiti informacije visoke kvalitete o korištenju nalazišta, sastavu stada i dr.[34] Fitoliti dolaze na stočarske lokalitete i u njihove sedimente putem dva glavna procesa, tj.: a) u obliku balege koja sadrži ostatke biljaka koje su životinje pojele, ili b) kao stelja, ležaj za životinje koji su pastiri namjerno rasprostrli po podu špilje. Vrlo je teško razlikovati ta dva načina jer je biljni materijal vjerojatno jednak u oba slučaja, a osim toga, međusobno se miješaju gaženjem životinja koje na tome mjestu borave.[35]

Pepeo

Pepeo je ostatak izgaranja biljaka (drva, lišća, plodova) (sl. 3 c, d).[36] On nije specifičan samo za stočarske naslage jer se može naći u mnogim drugim kontekstima, prije svega u onima koji pokazuju tragove gorenja. No pepeo može ukazivati na to da su neke biljne sastojine stočarskog podrijetla bile spaljene, bilo prirodnim procesima ili su ih namjerno spalili ljudi. Pepeo je po svojim svojstvima sastavljen od čestica pravilnoga geometrijskog oblika, veličine 10 do 15 μm, koje odgovaraju kristalnim oblicima *whewellita* i *wedellita*, tj. mono- i dihidratiziranoga kalcijevog oksalata, a mogu biti grupirane u druze i druge agregate. Njihov je vapnenački sastav rezultat kemijske modifikaci-

in caves or rock shelters.[27] The absence of spherulites is not evidence of the absence of ruminants, as their presence/quantity depends also on season/diet, and distinct taxa produce different quantities of spherulites.[28] Siderite spherulites can also be found in bogs[29] and other water-logged sediments, but in this case context and – more reliably – chemical composition can be used to determine their origin. Finally, spherulites are small, so that sediments including many of them have a very large specific surface and are highly reactive to percolating water, if this is even slightly acidified. Spherulites are consequently likely to be easily solubilised and disappear from the sediment.

Phytoliths

Phytoliths are siliceous (hydrated silica, opal) components of certain vegetal taxa (pteridophytes, basal angiosperms, monocotyledons, eudicots), particularly of grasses and sedges, [30] that are widespread in archaeological contexts (Fig. 3: a, f).[31] Their shape is very variable, including rods, spiny rods, dumbbells, sickles etc., and their size is included between 5 and 20 mm, though phytolith fragments can be much smaller. They can easily be identified in thin section under parallel polars at magnification >40×, because of their shape, transparent and colourless aspect, and high refraction index. The significance of phytoliths in pastoral contexts has also been extensively studied[32] from the geo-ethno-archaeological point of view,[33] eventually showing that high-quality information about site use, flock/herd composition etc., can be obtained by integrated phytolithic and geochemical studies.[34] Phytoliths enter pastoral sites and their sediments by way of two main processes: i) as dung comprising residues of plants eaten by the animals, or ii) as litter intentionally strewn on the cave floor by shepherds. It is hard to differentiate between these two ways, because the materials are likely the same and tend to be intimately mixed together by animal trampling.[35]

Ash

Ash is a residue of plant (wood, leaves, fruits) combustion (Fig. 3: c, d).[36] It is not specific to pastoral deposits, because it can be found in many other contexts, above all in combustion features; however, it may indicate that other vegetal components of pastoral origin were burned, for natural reasons or intentionally by humans. Ash is characteristically composed of particles, 10–15-μm in size, of regular geometrical shape corresponding to the crystalline shapes of whewellite and weddellite, re-

28 Goren 1999; Shahack-Gross, Marshall, Weiner 2003; Lancelotti, Madella 2012.

29 Stoops 1983.

30 Sharma, Kumar, Kumar 2019.

31 Piperno 2006; Vrydaghs, Devos, Pető 2017.

32 Brochier 1983; Courty, MacPhail, Wattez 1991; Brochier 2002; Shahack-Gross 2011.

33 Shahack-Gross, Marshall, Weiner 2003.

34 Shahack-Gross, Simons, Ambrose 2008; Lancelotti, Madella 2012.

35 Brochier, Claustre 2000.

36 Canti 2003; Canti, Brochier 2017.

27 Courty, Goldberg, Macphail 1989; Brochier 1995; Brochier, Claustre 2000.

28 Goren 1999; Shahack-Gross, Marshall, Weiner 2003; Lancelotti, Madella 2012.

29 Stoops 1983.

30 Sharma, Kumar, Kumar 2019.

31 Piperno 2006; Vrydaghs, Devos, Pető 2017.

32 Brochier 1983; Courty, MacPhail, Wattez 1991; Brochier 2002; Shahack-Gross 2011.

33 Shahack-Gross, Marshall, Weiner 2003.

34 Shahack-Gross, Simons, Ambrose 2008; Lancelotti, Madella 2012.

35 Brochier, Claustre 2000.

36 Canti 2003; Canti, Brochier 2017.

je kalcijeva oksalata u kalcijev karbonat. Karbonat zamjenjuje euedrične oksalatne monokristale s malim, submikroskopskim anhedralnim kristalima, zadržavajući, međutim, izvorni oblik kristala oksalata. Kalcijev karbonat je prema tomu pseudomorfan po kalcijevu oksalatu. Te se čestice mogu lako prepoznati u mikropresjeku pod paralelnim i / ili ukriženim polarizatorima (anomalijske interferencijske boje kalcita) pri povećanju >40x, zbog svog oblika i „prašnjavog" izgleda zbog prisutnosti vrlo velikog broja malih kristala kalcita.

Drugi neizravni osnovni mikroskopski pokazatelji

Na mikroskopskoj se razini u stajskim naslagama mogu primijetiti i razne druge komponente mogućega stočarskog podrijetla. Iako nisu dijagnostičke, mogu pridonijeti dokazivanju stočarske aktivnosti i razumijevanju korištenja lokaliteta. Među takve pokazatelje svrstavamo dijatomeje (tj. alge kremenjašice, silicijske jednostanične mikroalge), koje potječu iz slatkovodnog okoliša, a mogu se pojaviti u koprogenim sedimentima nakon što su ih progutale životinje koje piju iz ribnjaka i lokva.[37] Tlo, koje se nalazi izvan špilja, a koje se očito razlikuje od koprogenih sedimenata, moglo je biti doneseno u špilju i razgaženo pod kopitima životinja.[38]

Ugljen i / ili djelomično spaljeni biljni fragmenti mogu biti relativno veliki (te se mogu svrstati i među makroskopske pokazatelje), uglavnom u tamnim slojevima facijesa sedimenta „slojevite torte". Oni se mogu prepoznati na razini roda i vrste, a prepoznavanje specifičnih organa može rasvijetliti gospodarenje šumama za prehranu životinja.[39]

Izmet

Te su komponente očigledne na mjestima koja posjećuju životinje ili na mjestima gdje su one držane. Na stočarskim lokalitetima najčešće se mogu pronaći ekskrementi biljojeda i / ili svinja, a najlakše ih je prepoznati u mikropresjeku zbog njihova uglavnom biljnog sastava.[40] Neporemećeni i nepromijenjeni izmet relativno je rijedak zbog svoje mekoće i neprekidnoga gaženja životinja unutar špilja. Međutim, njihov oblik i unutarnja organizacija biljnih vlakana mogu se koristiti za razlikovanje ovaca / koza (sl. 3: e) (zaobljen brabonjak s valovitom unutarnjom strukturom) i goveda (sl. 3: c, d) (više ili manje plosnata, sa subparalelnom, valovitom unutarnjom strukturom).

U izmetu mogu biti razne biljne komponente, ovisno o životinjskoj svojti, prehrani, sezoni, značajkama okoliša, npr. trava, lišće, grančice, kora itd., koje se mogu razlikovati prema njihovoj strukturi. Trave i šaš pokazuju evidentnu izduženu strukturu i lako su prepoznatljivi po ostalim komponentama jer sadržavaju fitolite. Kad je bogat ovim komponentama, izmet se odlikuje unutarnjom strukturom koja je tipično vlaknasta, uglavnom plosnata ili zavojita ako se radi o govedima, odnosno ovcama/kozama.

spectively mono- and dihydrated calcium oxalate, which may be grouped in drusae and other aggregates. The calcareous composition results from chemical modification of Ca-oxalate into Ca-carbonate; the carbonate substitutes well-formed (euhedral) oxalate monocrystals with minute, submicroscopic shapeless (anhedral) crystals, retaining however the original shape of the oxalate crystal. Calcium carbonate is therefore pseudomorphic on Ca-oxalate. These particles can easily be identified in thin section under parallel and/or crossed polars (calcite anomalous interference colours) at magnification >40×, because of their shape and 'dusty' aspect due to the presence of a very large number of small calcite crystals.

Other indirect basic microscopic indicators

Various other components of possible pastoral origin can be observed in stable deposits at microscopic scale. Though non-diagnostic, they may add evidence of pastoral activities and contribute to an understanding of site use. Among these, diatoms (i.e. siliceous unicellular microalgae) of freshwater environment may occur in coprogenic sediments after having been swallowed by animals drinking from ponds and puddles.[37] External soil material, clearly different from coprogenic sediments, may have been brought into the cave and trampled under the hooves of animals.[38] Charcoal and/or partially charred vegetal fragments can be relatively large (and be comprised among macroscopic indicators as well), mostly in the dark layers of the layer-cake sediment facies. They can be identified at genus/species level, and the identification of specific organs may shed light on forest management for animal feeding.[39]

Excrement

This component is obvious in sites frequented by animals, or where animals have been kept. Droppings of herbivores and/or pigs are the most likely to be found in pastoral sites, and are also the easiest to recognise in thin section because of their dominantly vegetal composition.[40] Undisturbed and unaltered droppings are relatively rare, because of their soft nature and intense trampling by penned animals. However, their shape and the internal organisation of the vegetal fibres can be used to differentiate between sheep/goats (Fig. 3: e) (rounded pellets with convolute internal structure) and cattle (Fig. 3: c, d) (more or less platy, with subparallel undulating internal structure).

There may be various vegetal components within droppings, depending on animal taxon, diet, season, environmental characteristics, e.g. grass, leaves, twigs, bark etc., which can be distinguished following their structure. Grasses and sedges show an evident elongated structure and are easily distinguishable from other components because they include phytoliths. When rich in these components, droppings are characterised by an inner structure that is typically fibrous, mostly planar if of cattle, or convoluted if of sheep/goats.

37 Macphail *et al.* 1997.

38 Macphail *et al.* 1997.

39 Nisbet, Maggi 2000.

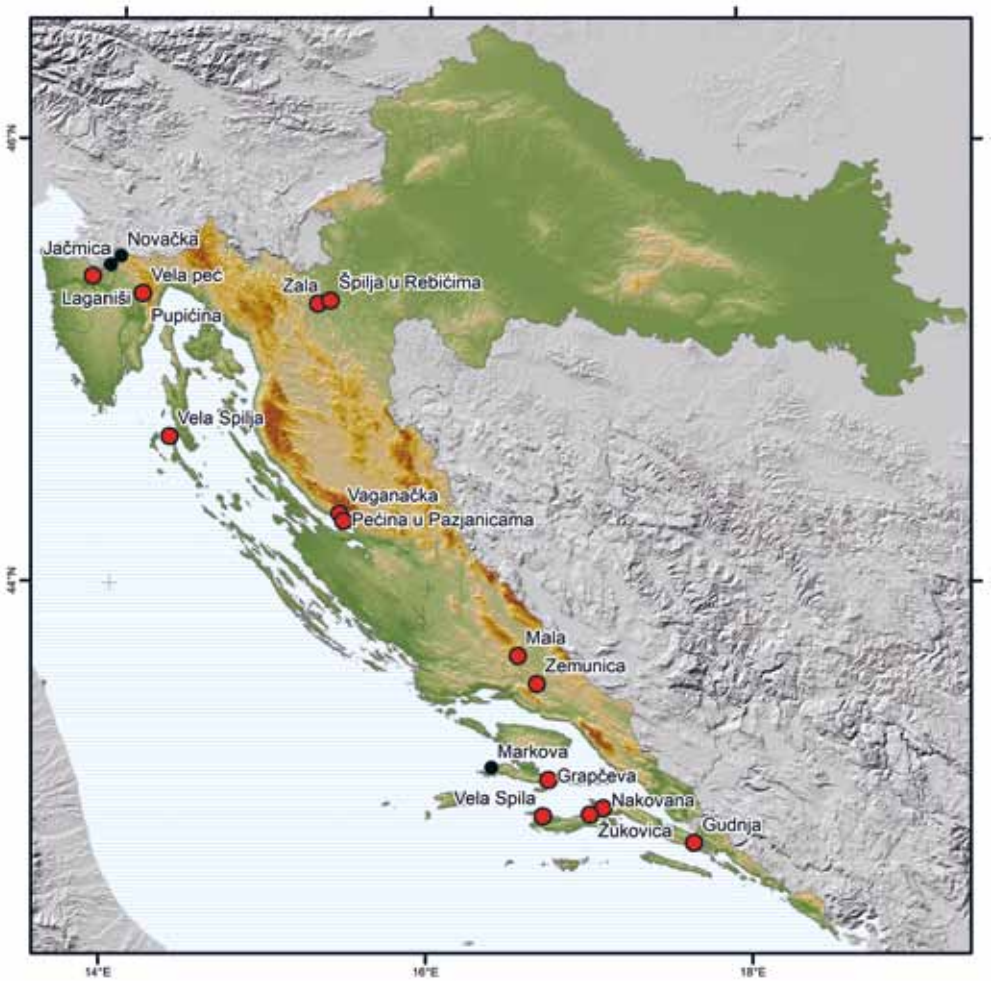
40 Courty, Goldberg, Macphail 1989; Wattez, Courty, Macphail 1990; Courty, MacPhail, Wattez 1991; Macphail *et al.* 1997; Brönnimann *et al.* 2017. i bilješke u njemu.

37 Macphail *et al.* 1997.

38 Macphail *et al.* 1997.

39 Nisbet, Maggi 2000.

40 Courty, Goldberg, Macphail 1989; Wattez, Courty, Macphail 1990; Courty, MacPhail, Wattez 1991; Macphail *et al.* 1997; Brönnimann *et al.* 2017 and reference therein.



SLIKA 4. Karta rasprostranjenosti stočarskih špilja u Hrvatskoj. Crvene točke: citirane u tekstu; crne točke: ostale moguće stočarske špilje (izradili G. Boschian i K. Gerometta).

FIGURE 4. Location map of pastoral caves in Croatia. Red dots: cited in text; black dots: other possible pastoral caves (made by G. Boschian and K. Gerometta).

Koprogeni facijes

Sferuliti, fitoliti, pepeo i ugljen najčešći su osnovni mikroskopski pokazatelji prisutnosti preživača u špilji (ili lokalitetu na otvorenome). Promatramo li ih zajedno, oni su dobar – iako ne apsolutni – pokazatelj korištenja lokaliteta za stočarstvo. S druge strane, tamo gdje se ove osnovne komponente mogu povezati na različite načine, sedimentni facijes može dati puno bolje naznake o stvarnoj prisutnosti divljih i domaćih životinja te o prostornoj organizaciji domaćih i stočarskih aktivnosti unutar lokaliteta. Ti se sedimentni facijesi mogu klasificirati prema sastavu – tj. kvantitativnom omjeru osnovnih komponenata – i strukturi – tj. uzajamnom prostornom rasporedu komponenata i mogu se povezati s određenim sedimentnim okolišem / ljudskom aktivnošću nakon aktualističnih i eksperimentalnih opažanja. Bilo je nekoliko pokušaja klasifikacije ovih facijesa,[41] ali zbog svoje raznolikosti, oni se po svemu sudeći ne mogu uvrstiti u kruto ograničenu shemu. Najvažnija je razlika ta jesu li facijesi spaljeni ili nisu, i – dok je homogeni makroskopski koprogeni facijes na mikroskopskoj razini tek donekle raznolik – naslaga „slojevite torte“ (koja je uvijek spaljena) uključuje ne-

Coprogenic facies

Spherulites, phytoliths, ash and charcoal are the most common basic microscopic indicators of the presence of ruminants in a cave (or open-air site). Considered together, they are a good – though not absolute – indicator of pastoral use of a site. On the other hand, sedimentary facies where these basic components are associated in various ways can give much better hints about the real presence of wild versus domesticated animals, and about the spatial organisation of domestic and pastoral activities within the site. These sedimentary facies can be classified following composition – i.e. quantitative ratio of basic components – and structure – i.e. reciprocal spatial arrangement of these components – and they can be linked to specific sedimentary environments/human activity following actualistic and experimental observations. Several attempts have been made to classify these facies;[41] however, it seems that they escape a rigidly constrained scheme, because of their extreme variability. The most relevant difference is whether the facies are burnt or unburnt and, while the homogeneous macroscopic coprogenic facies is moderately variable at microscopic scale,

41 Macphail *et al.* 1997; Boschian, Montagnari-Kokelj 2000; Angelucci *et al.* 2009; Boschian *et al.* 2017.

41 Macphail *et al.* 1997; Boschian, Montagnari-Kokelj 2000; Angelucci *et al.* 2009; Boschian 2017.

koliko subfacijesa. Među ovima raznoliko spaljeni i veliki biljni fragmenti dominiraju tamnim slojevima i pomiješani su s izmetom biljojeda u različitim stupnjevima očuvanosti / izgaženosti, sa sferulitima i pepelom.

Bijeli slojevi uključuju nekoliko subfacijesa: gotovo samo fitoliti, često povezani i vodoravno uslojeni; fitoliti pomiješani s raznolikim količinama sferulita i / ili pepela; slojevi zbijenog subsferičnog izmeta itd. Ovi vjerojatno predstavljaju čistu stelju, stelju pomiješanu s balegom i zgaženu balegu.

Špilje i pastiri u Hrvatskoj

U posljednje je vrijeme više novih iskopavanja, provedenih u obalnom dijelu Hrvatske, a neka i u zaleđu, pokazalo da većina onih špilja koje su dale arheološke ostatke od neolitika nadalje sadrži i sedimente koji se mogu povezati sa stočarskim aktivnostima (sl. 4).

Špilje s mikromorfološkim dokazima stočarske aktivnosti

Pupićina peć

Lokalitet Pupićina peć nalazi se u sjeveroistočnoj Istri, pokraj sela Vranja, na desnoj strani kanjona Vele drage, oko 15 m iznad njegova dna. Špilja ima oblik lijevka; ulaz koji je okrenut prema jugoistoku širine je oko 20 m i visine 8 m, a cijela špilja dužine je oko 30 m. Istraživanja su se u njoj obavljala između 1995. i 1998., tijekom kojih su arheološke naslage otvorene na površini od 33 m2.[42] Stratigrafski slijed uključuje oko 3 m naslaga iz kasnoga gornjeg paleolitika, iznad kojih slijedi oko 2 m naslaga ranog i srednjeg holocena. Ove uključuju i jedan mezolitički horizont, koji je od sljedećih odvojen jako izgaženom površinom, i osam mlađih kulturnih horizonata, tj. I (raniji srednji neolitik, Danilo / Vlaška 1, veći ulomci neukrašene keramike), H (kasniji srednji neolitik, Danilo / Vlaška 2, manji ulomci ukrašene keramike), G (miješani kasnoneolitički kontekst, Hvar?), F (srednje brončano doba, miješana donja ispuna jame 3), E (srednje brončano doba, gornja ispuna jame 3), D (kasno brončano doba, ispuna jame 2), C (miješano, željezno doba?), B (željezno doba), A (rimsko doba).[43] Od ranog neolitika nadalje stratigrafske jedinice mogu se podijeliti u dva glavna facijesa na makrorazini (homogene i „slojevitu tortu“) i nekoliko subfacijesa na mikrorazini, a svi sadrže tragove izmeta ovikaprida, kao i goveda u kasnoneolitičkim slojevima.

Makroskopski pokazatelji

Homogeni facijes. Ovi su sedimenti homogeno smeđi, s matriksom glinaste praškaste ilovače do pjeskovite praškaste ilovače i nešto nepravilno rasutog, nesortiranoga uglastoga vapnenačkog kršja. Tekstura je masivna, ponekad dobro razvijena prizmatična, s malo velikih pora.

the layer-cake one – which is always burnt – includes several subfacies. Among these, variably charred and large vegetal fragments dominate the dark horizons and are mixed with herbivore excrement at various degrees of preservation/trampling, spherulites and ash.

The white layers include several subfacies: almost pure phytoliths, frequently articulated and horizontally layered; phytoliths mixed with variable quantities of spherulites and/or ash; layers of compacted subspherical droppings etc. These probably represent pure litter, litter mixed with dung and trampled dung respectively.

Caves and shepherds in Croatia

In recent times, several new excavations carried out in the coastal area of Croatia, as well as some others farther inland, have provided evidence that most of the caves which have yielded archaeological remains from the Neolithic onwards also include sediments that can be related to pastoral activities (Fig. 4).

Caves with micromorphological evidence of pastoral activity

Pupićina Peć

Pupićina Peć is situated in north-eastern Istria, on the right side of the *Vela draga* canyon, about 15 m above the bottom. The cave is funnel-shaped; the southeast-facing entrance is about 20 m wide and 8 m high, and the whole cave is about 30 m long. Excavations were carried out in 1995–1998 and exposed 33 m² of archaeological deposits.[42] The sequence includes about 3 m of Late Upper Pleistocene levels followed by about 2 m of Early and Middle Holocene. These include a Mesolithic horizon, which is separated from the following horizons by a strongly trampled surface, and eight later cultural horizons: I (earlier Middle Neolithic, Danilo/Vlaška 1, larger undecorated pottery), H (later Middle Neolithic, Danilo/Vlaška 2, smaller decorated pottery), G (Late Neolithic mixed context, Hvar?), F (Middle Bronze Age, mixed lower fill of pit 3), E (Middle Bronze Age, upper fill of pit 3), D (Late Bronze Age, fill of pit 2), C (mixed, Iron Age?), B (Iron Age) and A (Roman).[43] From the Early Neolithic onwards, the units can be divided into two main macro-scale facies (homogeneous and layer-cake) and a few micro-scale subfacies, all including traces of ovicaprine dung, as well as of cattle in the Late Neolithic ones.

Macroscopic indicators

Homogeneous facies. These sediments are homogeneously brown, with a matrix of silty clay loam to sandy silt loam and a little irregularly scattered, unsorted angular limestone gravel. The structure is massive, sometimes well-developed prismatic, with few large pores.

42 Miracle, Forenbaher 2005; 2006.

43 Forenbaher, Kaiser 2006.

42 Miracle, Forenbaher 2005; 2006.

43 Forenbaher, Kaiser 2006.

Ovaj je facijes u velikoj mjeri dominantan u čitavom slijedu slojeva Pupićine peći jer obuhvaća cijele horizonte H i G, kao i onaj dio horizonta B koji leži bliže zapadnom zidu špilje. Organiziran je u pločastim jedinicama, debljine od nekoliko centimetara do nekoliko desetaka centimetara, koje se mogu razlikovati prema suptilnim razlikama u boji i ograničene su oštrim do jasnim, ravnim ili blago valovitim granicama. Parovi crno-bijelih horizonata vrlo su rijetki, pojavljuju se kao izolirane leće širine 20 do 30 cm i debljine nekoliko centimetara u H i u dugačkom, ali diskontinuiranom sloju koji označava granicu između H i G na zapadnoj strani iskopanog područja.

Facijes „slojevite torte". Sedimenti koji pripadaju ovom facijesu mogu se jednostavno prepoznati u stratigrafskom slijedu Pupićine peći, po svome jedinstvenom crno-bijelom slojevitom izgledu. Pojavljuju se diljem većine istražene površine u horizontu I, a u horizontu B samo u unutarnjem istočnom dijelu. Parovi crnkastih i sivkasto-bjelkastih slojeva ili leća ovog facijesa ciklički su organizirani u fino upletene hrpe koje mogu biti debljine do 1 do 1,5 m i donekle kupolaste, tako da cijela skupina slojeva konačno nalikuje gomili. Slojevi i leće su prilično tanki (2 do 3 cm do 10 do 12 cm) u odnosu prema svome prostiranju, koje u nekim slučajevima može biti i do nekoliko četvornih metara. Granice su uvijek oštre i ravne, ili vrlo lagano valovite. Kako nam sugeriraju izolirani crno-bijeli slojevi, crni su horizonti uvijek donja komponenta parova, tanji su od gornjih bijelih i ponekad su isprekidani. Tekstura im je fino zrnata, srednje do dobro razvijena, prilično rahla i s velikim porama. Bjelkasti su horizonti manje porozni i kompaktniji, prošarani manjim razlikama u strukturi, boji i poroznosti; u njima su često valovite tamnije sive lamine i leće. Veličina zrna je pjeskovita praškasta ilovača do pjeskovita ilovača, skelet je rijedak, sastavljen od rijetkih uglastih vapnenačkih klasta.

Mikroskopski pokazatelji

Homogeni facijes. Na mikroskopskoj razini ovi su sedimenti jako homogeni i prilično kompaktni, s masivnom mikrostrukturom. Praznine se pojavljuju uglavnom kao mali vugovi ili ponekad kanali i komore. Često se pojavljuju ulomci ugljena različitih veličina, obično sitni. Amorfne organske tvari nalaze se često kao sitni agregati veličine finog praha i ulomci u kojima su ponekad sačuvani tragovi struktura biljnih stanica. Najčešći su sastojci opalni fitoliti (uglavnom štapići i trapezoidi ili fragmenti ovih oblika) i fekalni sferuliti. Sve se to pojavljuje u vrlo uravnoteženim količinama, a samo u nekim slučajevima sferuliti prevladavaju nad fitolitima. Pepeo se može pojaviti u promjenjivim količinama, uglavnom kao tipični pseudomorfni mikritni agregati na kristalima oksalata ili kao vrlo fini karbonatni materijal koji nastaje rekristalizacijom pepela zbog cirkulacije i naknadnog isparavanja vode iz sedimenta. Glavninu sedimenta čine sferuliti i fitoliti, dok su ostale komponente obično (puno) rjeđe. Najvažnija značajka ovog facijesa na mikroskopskoj razini je da su sve komponente nasumično raspršene unutar mase sedimenta i nikada nisu organizirane u tvorevine više razine.

„Slojevita torta". Promatrajući pod mikroskopom, crni slojevi sastoje se najviše od raznoliko nagorjelih biljnih ostataka, koji su često veliki (do 10 do 15 mm) s očuvanim strukturama stanica i

This facies is largely dominant throughout the Pupićina Peć sequence, as it comprises the entire H and G horizons, as well as that part of B which lies closer to the western wall of the cave. It is organised in tabular units, a few centimetres to several tens of centimetres thick, that can be differentiated following subtle differences in colour and are bounded by limits that are sharp to clear, plain or slightly undulating. The couples of black/white horizons are very rare, occurring as isolated lenses 20–30 cm wide and a few centimetres thick in H, and in a long, however discontinuous, layer marking the limit between H and G on the western side of the excavated area.

Layer-cake facies. Sediments belonging to this facies can easily be identified within the Pupićina Peć sequence, because of their distinctive black-and-white layered aspect. They occur across most of the excavated area in horizon I, and only in the inner-eastern part of cultural horizon B. The couples of blackish and greyish/whitish layers or lenses of this facies are cyclically organised in finely interleaved stacks that can be up to 1–1.5 m thick and somewhat domed, so that the whole deck of layers finally resembles a heap. The layers and lenses are rather thin (2–3 to 10–12 cm) if compared to their extension, which in some cases can be of several square metres. The limits are always sharp and plane or very slightly undulating. As suggested by the isolated black/white layers, the black horizons are always the bottom component of the couples, are thinner than the overlying white ones, and are sometimes discontinuous; the structure is fine granular, medium-to-well developed, rather loose, and with large pores. The whitish horizons are less porous and more compact, mottled by minor differences in texture, colour and porosity; they often include wavy darker-grey laminae and lenses. The grain size is sandy silt loam to sandy loam; the skeleton is rare, composed of sparse angular limestone clasts.

Microscopic indicators

Homogeneous facies. At microscopic scale, these sediments are strongly homogeneous and rather compact, with massive microstructure; the voids occur mostly as small vughs, or sometimes channels and chambers. Charcoal fragments of various sizes often occur, usually fine. Amorphous organic matter occurs commonly as fine silt-size aggregates and fragments, sometimes preserving traces of vegetal cell structures. The most common components are opal phytoliths (mostly rods and trapezoids or fragments of these shapes) and faecal spherulites; all these occur in very similar quantities, and only in some cases do the spherulites prevail over the phytoliths. Ash can occur in variable quantity, mostly as the typical pseudomorphic micrite aggregates on oxalate crystals, or as very fine carbonate material deriving from the recrystallisation of ash due to circulation and subsequent evaporation of sediment water. The bulk of the sediment is made up of spherulites and phytoliths, whereas the other components tend to be (much) less frequent. The most relevant characteristic of this facies at microscopic scale is that all components are randomly scattered within the sediment mass, and never organised in higher-level features.

tkiva koje je pripadalo izvornim organima biljke, a to su najčešće ulomci listova, mladih grančica i drva.

Druge glavne komponente ovog facijesa su smećkasti agregati vlaknastih koprolita, djelomično izgorjeli, veličine do oko 1 do 2 cm. Vlakna su debljine 5 do 20 μm i dužine do 1 do 2 mm, sastavljena su od povezanih opalnih fitolita i djelomično spaljene organske tvari. Njihova veličina i prostorna organizacija strogo ovise o agregatnom obliku: kratka su vlakna nasumično komprimirana, često smotana u subsferne koprolite ovaca / koza, dok su dulja organizirana u dugačkim valovitim snopovima unutar izduženoga goveđeg izmeta. Ima i sferulita i pepela iako su prilično rijetki.

Bjeličasti/sivkasti slojevi na mikroskopskoj su razini složeniji, uključujući tri podfacijesa – zrnasti, uslojeni vugavi i fino uslojeni – koji odgovaraju bijelim, tamnim i svjetlosivim laminama, uočenima u makroskopskom mjerilu. Glavne su komponente zrnastih podfacijesa isti vlaknasti koproliti koji se pojavljuju u crnim slojevima, a koji su ovdje temeljito izgorjeli i pepeljasti, bjelkasti i poluprozirni. Fekalni su sferuliti obično ugrađeni u ove značajke i često su grupirani na malim površinama. Praznine između koprolitnih agregata (djelomično) su popunjene njihovim ulomcima ili finijim produktima strukturnog raspada, poput sferulita, fitolita i amorfne organske tvari, ugrađenih u finu mikromasu mikritskog pepela, što u nekim slučajevima sugerira sagorijevanje na visokoj temperaturi.

Slojeviti je podfacijes s vugovima vrlo spužvast – iako na makrorazini prilično kompaktan, zbog pojave izduženih ili subplanarnih vugova ugrađenih u slojeve koji nalikuju homogenim subfacijesima. Veličina i oblik ovih vugova obično su unutar sloja homogeni; pore su protkane tankim slojevima fitolita koji leže usporedo s granicama sloja.

Fino uslojeni podfacijes organiziran je u fino laminiranim površinama sitnih slojeva (debljine 60 do 80 do 2000 do 3000 μm) opalnih fitolita koji se pravilno izmjenjuju sa slojevima miješanih fitolita, komadića amorfne organske tvari, sitnih kvarcnih zrna, sferulita i mikrita. Zanimljivo je da se ovaj podfacijes pojavljuje ponekad i unutar homogenog facijesa.

Ovi facijesi pokazuju da je veći dio sedimenata u Pupićinoj peći sastavljen od manje ili više temeljito izgorjele balege biljojeda, uglavnom ovaca/koza, a vjerojatno i goveda.[44] Držanje životinja unutar špilje prepoznaje se po slojevitim facijesima s vugovima i finim slojevitim facijesima, koji vjerojatno predstavljaju slojeve stelje – a možda i stočne hrane nakupljene unutar špilje.

Layer-cake facies. Under the microscope, the black levels are composed mostly of variably charred vegetal remains, which are often large (up to 10–15 mm) and preserve cell and tissue structures belonging to the original plant organs, which are most frequently fragments of leaves, young twigs and wood.

The second main component of this facies is brownish aggregates of fibrous coprolites, partially burnt, up to about 1–2 cm in size. The fibres are 5–20 μm thick and up to 1–2 mm long, and are composed of articulated opal phytoliths and of partly-ashed organic matter. Their size and spatial organisation depend strictly on the aggregate shape: short fibres are randomly compressed, often rolled up into subspherical sheep/goat coprolites, whereas the longer ones are organised in long wavy bundles within elongated cattle droppings. Spherulites and ash are present, even if rather rare.

The whitish/greyish layers are more complicated at microscopic level, including three subfacies: one granular, one layered vughy, and one finely layered, which correspond respectively to the white, dark and light-grey laminae observed at macroscopic scale. The main components of the granular subfacies are the same fibrous coprolites that occur in the black layers, which are here thoroughly burnt and ashed, whitish and sub-transparent. Faecal spherulites are commonly embedded within these features, and are often clustered in small areas. The voids between coprolite aggregates are (partly) infilled by their fragments or finer structural decay products, such as spherulites, phytoliths and amorphous organic matter, embedded in a fine micromass of micritic ash, which in some cases suggests high-temperature burning.

The layered vughy subfacies is very spongy – though rather compact at macroscale, due to the occurrence of prolate or subplanar vughs embedded in layers that resemble the homogeneous subfacies. The size and shape of these vughs are usually homogeneous within a layer; voids are interbedded with thin beds of phytoliths that lie parallel to the bed limits.

The finely layered subfacies is organised in finely laminated decks of tiny beds (60–80 to 2000–3000 μm thick) of opal phytoliths regularly alternating with layers of mixed phytoliths, bits of amorphous organic matter, fine quartz grains, spherulites and micrite. Interestingly, this subfacies sometimes also occurs within the homogeneous facies.

These facies indicate that a major part of the Pupićina Peć sediments is composed of more or less thoroughly burnt herbivore dung, mostly of sheep/goats and probably also of cattle.[44] Penning within the cave is indicated by the layered vughy and finely layered facies, which probably represent layers of litter – and possibly also fodder – accumulated within the cave.

44 Boschian 2006.

44 Boschian 2006.

Vela peć kraj Vranje

Vela peć je veliki abri u Veloj dragi u Istri, vrlo blizu Pupićinoj peći, na suprotnoj (lijevoj) strani drage, oko 100 m uzvodno i 10 m više. Nalazište je velik abri širine 30 do 40 m i dubine 10 do 15, smješteno u podnožju okomite litice.

Stratigrafski niz uključuje jedan mezolitički horizont, prekriven neolitičkim slojevima koji sadrže keramiku u stilu danilske kulture, koja se na područjima jugoistočno od Istre smatra srednjim neolitikom, ali je najranija keramika u sjevernoj Istri.[45] Forenbaher i sur. (2008) špilju tumače kao dio složenoga stočarskog nalazišta koji uključuje i obližnju Pupićinu peć.[46]

Makroskopski pokazatelji

Tipične vrlo dobro razvijene „slojevite torte", sedimenti nalik na *fumier*, česti su u Veloj peći. Najbolje su zastupljeni u stratigrafskim jedinicama koje se odnose na faze 4. do 7., a one uključuju kulturne ostatke od ranoga brončanog do željeznog doba. Slojevi su ravnomjerno i dojmljivo uslojeni na širokom prostoru u horizontalnim površinama, često debljim od 1,5 m. Ako se pažljivije promatra, svijetli horizonti crno-bijelih parova uključuju nekoliko tankih slojeva i leća koje variraju od čisto bijele do tamnosive boje, a koje su složeno međusobno povezane u glavnom horizontu. Suprotno tomu, jedinice pripisane neolitičkim fazama 2 i 3 sastoje se od homogenog smećkastog praha s kaotično raspršenim kamenjem, a ponekad ih prelaze pojedini crno-bijeli slojevi nalik na *fumier*. Značajno je da se homogeni smeđi sedimenti pojavljuju i u gornjim fazama, ali uglavnom prema kapništu abrija i u nezaštićenim dijelovima, gdje se razvijaju od tipičnih sedimenata „slojevite torte".

Prvi dokazi o stočarstvu u Veloj peći pojavljuju se u slojevima s keramikom skupine Danilo – Vlaška. Prevladavaju ovikapridi (ovce su brojnije u Danilo – Vlaška skupini srednjeg neolitika, koze prevladavaju u kasnom neolitiku), dok se goveda i svinje pojavljuju u znatno manjoj mjeri u obje faze.[47] Za kasnija razdoblja zastupljena u špilji, podaci o arheozoologiji nisu dostupni. S obzirom na vrlo nisku učestalost keramike pronađene u špilji (s iznimkom faze brončanog doba), špilja se uglavnom tumači kao *grotte-bérgerie*.[48]

Mikroskopski pokazatelji

Složena struktura slojeva „slojevite torte" preslikava se pod mikroskopom. Dok su crni horizonti gotovo uvijek sastavljeni od velikih fragmenata ugljena pomiješanih s djelomično izgorjelim koprolitima biljojeda, svijetli uključuju naizmjenične lamele gotovo čistih fitolita ili fitolita pomiješanih sa sferulitima – što odgovara čisto bijelim horizontima u makroskopskim razmjerima – i deblje slojeve uglavnom sastavljene od koprolita različitog stupnja nagorenosti, ali uglavnom gotovo u potpunosti

Vela Peć, near Vranja

Vela Peć is a large rock shelter located in Vela Draga, in Istria, very close to Pupićina Peć, on the opposite (left) side of the Draga, about 100 m upstream and 10 m higher. The site is a large rock shelter, 30–40 m wide and 10–15 deep, situated at the base of a vertical cliff.

The stratigraphic sequence includes a Mesolithic horizon, overlain by Neolithic layers containing Danilo-style pottery, which is considered Middle Neolithic in regions farther to the southeast, but is the earliest pottery in northern Istria.[45] Forenbaher *et al*. (2008) interpret the cave as part of a complex pastoral site that also includes the nearby Pupićina Peć.[46]

Macroscopic indicators

Typical, very well-developed, *fumier*-like layer-cake sediments are common at Vela Peć. They are best represented in stratigraphic units pertaining to phases 4 to 7, which include cultural remains from Early Bronze to Iron Age.These layers are evenly and impressively layered over wide surfaces in horizontal decks often over 1.5 m thick. On closer observation, the light horizons of the black/white couples include several thin layers and lenses varying from pure white to dark grey, which are complexly intercalated within the main horizon. Conversely, the units ascribed to Neolithic phases 2 and 3 are all composed of homogeneous brownish silt with chaotically dispersed stones, and they are sometimes crossed by single black/white *fumier*-like layers. Notably, homogeneous brown sediments also occur in the upper phases, but mostly towards the shelter dripline and in the unsheltered areas, where they grade from the typical layer-cake sediments.

The first evidence of herding in Vela Peć occurs in layers with the Danilo-Vlaška pottery. Ovicaprids predominate (sheep are more numerous in the Middle Neolithic Danilo-Vlaška group; goats prevail in the Late Neolithic), while cattle and pigs appear to a much lesser extent in both phases.[47] Zooarchaeology data is not available for the later periods present in the cave. Given the very low frequency of pottery found in the cave (with the exception of the Bronze Age phase), the cave is interpreted mostly as a *grotte-bergerie*.[48]

Microscopic indicators

The complex structure of the layer-cake strata is replicated under the microscope. While the black horizons are almost invariably composed of large charcoal fragments mixed with partly burnt herbivore coprolites, the light ones include alternating laminae of almost pure phytoliths or phytoliths mixed with spherulites – corresponding to pure-white horizons at macroscopic scale – and thicker layers mostly composed of coprolites

45 Forenbaher, Miracle 2005; 2006; Forenbaher, Kaiser 2006.
46 Forenbaher, Rajić Šikanjić, Miracle 2008; Forenbaher, Nikitović 2009.
47 Radović 2011.
48 Forenbaher, Rajić Šikanjić, Miracle 2008.

45 Forenbaher, Miracle 2005; 2006; Forenbaher, Kaiser 2006.
46 Forenbaher, Rajić Šikanjić, Miracle 2008; Forenbaher, Nikitović 2009.
47 Radović 2011.
48 Forenbaher, Rajić Šikanjić, Miracle 2008.

pretvorene u pepeo. Ti su koproliti sastavljeni od spaljenih biljnih vlakana koja su često organizirana u valovitom i subparalelnom uzorku unutar pahuljastih agregata, što sugerira da su ih proizvodila goveda. Prostori između ovih koprolita djelomično su ispunjeni mješavinom raspadnutih / poremećenih koprolita, drvenog pepela, sferulita (često u klasterima) i fitolita.

Suprotno tomu, homogeni smeđi sedimenti uključuju slične količine fitolita, sferulita i drvenog pepela, koji su gotovo uvijek neartikulirani i temeljito raspršeni u kaotičnoj mješavini svih komponenata.

Kao i u Pupićinoj peći, čini se da su tipični *fumier*s bolje zastupljeni u najgornjim slojevima, od brončanog doba nadalje. Ovaj aspekt može sugerirati da se špilja tijekom mlađih faza intenzivnije i sezonski koristila za uzgoj životinja, možda kao mjesto specijalizirano za uzgoj stoke, komplementarno Pupićinoj peći, gdje su *fumier*s manje razvijeni. Razlog nastanku homogenih sedimenata sličnih *migon*u možda je to što su biljojedi manje koristili prostor pa to nije zahtijevalo redovito spaljivanje izmeta koji se gomilao u špilji. Prvenstvena pojava homogenih – premda pastoralnih – sedimenata prema vanjskoj strani abrija možda je bila posljedica redovnijeg vlaženja organskog materijala kišom ili kapanjem, što je spriječilo temeljito izgaranje.

Zala

Pećina Zala nalazi se pokraj grada Ogulina, na sjevernim obroncima brda Krpelja, leži na lijevoj strani doline Bistrice, pritoke Dobre, oko 100 m od lijeve obale potoka. Radi se o razmjerno maloj ulaznoj dvorani (12 x 10 m) veće špilje, smještenoj na padini velike urušene doline s ravnim dnom. Stratigrafski slijed obuhvaća slojeve od kasnoga gornjeg paleolitika do rimskoga doba. Opsežna iskopavanja[49] Ivora Karavanića iznijela su na vidjelo slijed slojeva s nekoliko većih hijatusa do kojih je došlo zbog nekoliko faza erozije. Zbog toga ne postoje neolitički slojevi, a mezolitik je prekriven riječnim sedimentima iznad kojih su brončanodobni horizonti. U tim se slojevima pojavljuju tragovi sedimenata nalik na *fumier,*[50] što pokazuje da se špilja koristila za držanje životinja.

Makroskopski pokazatelji

Tvorevine, koje mogu nalikovati onome što se u literaturi naziva *fumier,* predstavljaju samo tri izolirane crno-bijele leće širine 50 do 80 cm i debljine 8 do 10 cm (SJ 83, SJ 78, SJ 74), koje se nalaze približno u središtu špilje, ali mikromorfološka opažanja pokazuju da su zapravo ognjišta. Tipični *fumier*s ne pojavljuju se na makroskopskoj razini, dok su mikromorfološki pokazatelji držanja životinja pronađeni u nekim neuobičajenim smećkastim brončanodobnim slojevima debljine 2 do 4 cm (SJ 49-SJ 77), izmjenjujući se s nešto debljim slojevima žućkasta praha. Fragmenti su ugljena česti u smeđim slojevima, gdje se mogu uočiti i vrlo tanke bjelkaste lamine (vjerojatno pepeo).

at varying levels of burning, but generally almost completely ashed. These coprolites are composed of ashed vegetal fibres, often organised in a wavy and subparallel pattern within fluffy aggregates, suggesting that they were produced by cattle. The spaces between these coprolites are partially filled by a mix of decayed/disrupted coprolites, wood ash, spherulites (often in clusters) and phytoliths.

Conversely, the homogeneous brown sediments include similar amounts of phytoliths, spherulites and wood ash, which are almost always unarticulated and thoroughly dispersed within a chaotic mix of all components.

As at Pupićina Peć, the typical *fumier*s seem to be better represented in the uppermost layers, from the Bronze Age onwards. This aspect may suggest that the cave was used for penning animals more intensively and on a seasonal basis during the recent phases, maybe as a site specialised for stock-rearing, complementary to Pupićina Peć, where *fumier*s are less developed. *Migon*-like homogeneous sediments may have originated from less intensive frequentation by herbivores, not requiring regular reduction by fire of the dung that was accumulating within the cave. The preferential occurrence of homogeneous – though pastoral – sediments towards the outside of the shelter may have been due to more regular wetting of the organic material by rain or drip-water, which prevented thorough burning.

Zala

The Zala cave is situated close to the town of Ogulin, on the northern slopes of the Krpelj hill; it lies on the left side of the Bistrac valley, about 100 m from the left bank of the stream. It is a relatively small entrance hall (12×10 m) to a larger cave located on the side of a large collapsed dolina with flat bottom. The stratigraphic sequence ranges from Late Upper Paleolithic to Roman times. Extensive excavations[49] by Ivor Karavanić brought to light a sequence with major hiatuses due to several erosion phases. Consequently, there are no Neolithic levels, and the Mesolithic is covered by fluvial sediments that are overlain by Bronze Age horizons. Traces of *fumier*-like sediments occur within these layers,[50] showing that the cave has been used for stabling animals.

Macroscopic indicators

Features that may resemble *fumiers* are represented by only three isolated black-and-white lenses, 50–80 cm wide and 8–10 cm thick (SU 83, SU 78 and SU 74, situated approximately at the centre of the cave; however, micromorphological observations show that they are, in fact, hearths. Typical *fumiers* do not occur at macroscopic level, whereas micromorphological indicators of stabling were found in some anomalously brownish Bronze Age layers, 2–4 cm thick (SU 49–SU 77), alternating with somewhat thicker yellowish silt layers. Charcoal fragments are frequent within the brown layers, where some very thin whitish laminae (probably ash) can also be observed.

49 Karavanić *et al.* 2007; Vukosavljević, Karavanić 2015.

50 Boschian, Gerometta 2016.

49 Karavanić *et al.* 2007; Vukosavljević, Karavanić 2015.

50 Boschian, Gerometta 2016.

SLIKA 5. Zala: neuobičajeni brončanodobni fumier bez ili sa slabo razvijenim bijelim horizontom pepela (C), umetnut u naslage taložene podzemnom rijekom (B), i koji preslojava naslage kućnog otpada (A) (snimio G. Boschian).

FIGURE 5. Zala Cave: anomalous Bronze Age fumier with absent or poorly developed white ash horizons (C), intercalated with underground river deposits (B), and superimposed over domestic waste sediments (A) (photo by G. Boschian).

Mikroskopski pokazatelji

Unutar slijeda izmjeničnih smećkastih i žućkastih praškastih slojeva, žućkasti (SJ 3c, SJ 71, SJ 75) su geogeni i sastoje od dva mikfrofacijesa; krupnozrnatiji facijes je sastavljen od dobro sortiranog sedimenta (uključuje kalcit, kvarc i muskovit) i uvijek se nalazi iznad finog facijesa (u kojemu su kalcit, kvarc i muskovit ugrađeni u glinenu mikromasu). Smećkasti slojevi (brončanodobni SJ 77, SJ 65 i brončano-željeznodobni SJ 49) su antropogeni (sl. 5).

SJ 77 je tamnosmeđi sloj, debljine 1,5 do 2 cm, sadrži mnogobrojne ulomke ugljena, organske tvari, ulomke keramike, vrlo malo ulomaka koji najvjerojatnije predstavljaju zguru, nasumično raspršenoga drvenog ugljena i fitolita te vrlo malo ulomaka ovčjeg / kozjeg izmeta s fekalnim sferulitima i fitolitima. SJ 65 je sloj ovčjeg / kozjeg izmeta debljine 2,5 cm, koji se sastoji isključivo od fekalnih sferulita i fitolita. U njemu su najmanje tri mikrosloja spaljenih ostataka biljaka i fekalnih peleta. SJ 49 sastoji se od dva nepovezana mikrosloja ovčjeg / kozjeg izmeta (sferuliti i organska tvar) između kojih je tanak (0,5 do 1 cm) nepovezani sloj, identičan sitnozrnatom facijesu SJ 3c, SJ 71 i SJ 75. Gornji od dva smećkasta sloja izmeta sastoji se i od vrlo fosfatnog izmeta s velikom količinom fitolita i vrlo malo sferulita, što se razlikuje od ovčjih / kozjih i vjerojatno ih se može pripisati svejedima.

Antropogene SJ 77, SJ 65, SJ 49, vjerojatno i SJ 40 i SJ 32, izmjenjuju se sa žućkastim, praškastim riječnim ili naplavinskim sedimentima. Prilikom taloženja najnižeg od ovih slojeva (SJ 77) špilja se koristila prije svega za kućanske aktivnosti. SJ 65, koja leži na sredini ove skupine stratigrafskih jedinica, označava promjenu uporabe ulaznog prostora špilje Zale. Ponavljajući ciklusi spaljenog izmeta (o čemu svjedoči obilje fekalnih sferulita i fitolita), zajedno s vrlo malom količinom krhotina keramike,[51] ukazuju na to da se špilja gotovo isključivo koristila sezonski kao staja za ovikapride. U najgornjoj jedinici (SJ 49) balega je samo djelomično izgorjela, i to na vrhu jedinice; suprotno od toga, središnji i donji dijelovi bili su podvrgnuti prirodnim procesima mineralizacije.

Microscopic indicators

Within the sequence of alternating brownish and yellowish silt layers, the yellowish ones (SU 3c, 71 and 75) are geogenic and include two microfacies; the coarse one is composed of well-sorted sediment (including calcite, quartz and muscovite) and always overlies the fine one (where calcite, quartz and muscovite are embedded in a clay micromass). The brownish layers (Bronze Age SU 77 and SU 65, and Bronze/Iron Age SU 49) are anthropogenic (Fig. 5).

SU 77 is a dark-brown layer, 1.5–2 cm thick, including frequent charcoal fragments, organic matter, pottery fragments, a very few possible slag fragments, randomly dispersed wood ash and phytoliths, and a very few fragments of sheep/goat droppings, including faecal spherulites and phytoliths. SU 65 is a sheep/goat dung layer, 2.5 cm thick, comprised exclusively of burnt faecal spherulites and phytoliths. It includes at least three ash microlayers of burnt plant remains and faecal pellets. SU 49 is made up of two discontinuous microlayers of sheep/goat dung (spherulites and organic matter) separated by a thin (0.5–1 cm) discontinuous yellowish layer identical to the fine-grained microfacies of SU 3c, SU 71 and SU 75. The upper of the two brownish dung layers also includes very phosphatic droppings with abundant phytoliths and very few spherulites, which differ from the sheep/goat ones and can probably be ascribed to omnivores.

Anthropogenic units SU 77, SU 65 and SU 49, and possibly SU 40 and SU 32, alternate with yellowish fine river or in-wash sediments. During the deposition of the lowermost of these layers (SU 77) the cave was used primarily for domestic activities. SU 65, which lies in the middle of this group of units, marks a shift in the use of the entrance chamber of the Zala cave; repeated cycles of burnt dung (testified to by the abundance of faecal spherulites and phytoliths), together with a very small quantity of pottery shards,[51] indicate that the cave was used almost exclusively seasonally as a pen for ovicaprids. In the uppermost unit (SU 49) the dung was only partially burnt, at the top of the unit; conversely, the central and bottom parts underwent natural mineralisation processes.

51 Olujić, Perković 2016.

51 Olujić, Perković 2015.

Špilja u Rebićima

Špilja u Rebićima je špilja jednom dvoranom smještena u blizini sela Rebići, oko 5 km od Generalskog Stola, u pograničnom području između Like, Gorskog kotara i Korduna. Do sada istraženi stratigrafski slijed uključuje ostatke lasinjske kulture iz bakrenog doba. Iskopavanja je proveo Nikola Vukosavljević 2018. - 2019. godine, a analiza sedimenata i materijala još je u tijeku.

Makroskopski pokazatelji

Gotovo svi su slojevi subhorizontalni, više ili manje homogeni. Tamnosmećkasti do sivkasti antropogeni sedimenti izmijenjuju se sa žućkastim grubim ili finim fluvijalnim sedimentima. Iako u slijedu slojeva nije uočen nijedan tipičan *fumier*, na izgorjele stajske slojeve upućuju najmanje dva tanka crno-bijela ili siva pepeljasta sloja koja se protežu cijelom površinom iskopane sonde.

Mikroskopski pokazatelji

Na mikroskopskoj razini, preliminarne analize pokazuju obilatu količinu fekalnih sferulita, opalne fitolite i drveni pepeo u SJ 115A, SJ 112A, SJ 110A, Sj 103A, što potvrđuje stočarsku uporabu špilje barem u nekim fazama.

Zemunica

Špilja Zemunica nalazi se u krškom području, u blizini sela Biska, 17 km istočno od Splita. Smještena je u podnožju brda Mali Mosor, s pogledom na krško polje Dicma (Krušvarsko ili Bisko) – plodno područje s dominantnim crvenim tlima (*terra rossa*). Špilja je širine 16 x 18 m, s najvećom visinom oko 4 m, a u sredini njezina svoda nalazi se prirodni otvor. Ulaz u špilju nalazi se u podnožju litice okrenute prema sjeveru. Sedimentni slijed špilje Zemunice proteže se od kasnoga gornjeg pleistocena do ranoga kasnog holocena, a uključuje kulturne ostatke kasnoga gornjeg paleolitika, mezolitika, neolitika, bakrenog i brončanog doba.[52] Dio slijeda slojeva od neolitika, bakrenog do brončanog doba karakteriziraju kontinuirani dokazi o nakupinama izmeta ovaca / koza i vjerojatno goveda: *in situ* spaljeni stajski slojevi – nalik na *fumier*s i homogeni slojevi – nakupine nepotpuno spaljene ili neizgorjele balege biljojeda. Unutar špiljskih sedimenata pojavljuju se i povezani fitoliti, što ukazuje na upotrebu slame / stelje za ove životinje.

Makroskopski pokazatelji

Raznolike skupine pepeljastih leća, koje prekrivaju relativno tanke tamnosmeđe i crvenkaste leće pripisane neolitiku (gornje leće SJ 64-82-81 iz sonde 3a mogu okvirno biti povezane s lećama označenim kao SJ 116 u sondi 3b), bakrenom i brončanom dobu, pojavljuju se između smeđih do sivosmeđih, uglavnom homogenih slojeva.

Špilja u Rebićima

Špilja u Rebićima is a one-chamber cave situated near the village of Rebići, approx. 5 km from Generalski Stol, in the area where Lika borders Gorski Kotar and Kordun. The stratigraphic sequence excavated so far includes Copper Age Lasinja cultural remains. It was excavated by Nikola Vukosavljević in 2018–2019, and the study of the sediments and materials in still in progress.

Macroscopic indicators

Almost all the layers are subhorizontal, more or less homogeneous. Dark-brownish to greyish anthropogenic sediments are intercalated with yellowish coarse or fine fluvial sediments. Although no typical *fumier* was observed in the sequence, at least two thin black-and-white or grey ashy layers spanning the entire surface of the excavated trench suggest burnt stable layers.

Microscopic indicators

At microscopic scale, preliminary analyses show abundant faecal spherulites, opal phytoliths and wood ash in SU 115A, SU 112A, SU 110A and SU 103A, which confirm the pastoral use of the cave, at least in some of the phases.

Zemunica

The Zemunica cave is situated in a karstic area, near the village of Bisko, 17 km east of Split. It is situated at the foot of the Mali Mosor hill, looking onto the Dicmo (Krušvarsko or Bisko) karstic polje: a fertile area with dominant *terra rossa* soils. The cave is 16×18 m wide with a maximum height of about 4 m, and there is a natural opening in the middle of its ceiling. The entrance of the cave is situated at the base of a cliff, facing northwards. The sedimentary sequence of the Zemunica cave ranges from the Late Upper Pleistocene to the early Late Holocene, and includes Late Upper Palaeolithic, Mesolithic, Neolithic, Copper Age and Bronze Age cultural remains.[52] The Neolithic, Copper Age and Bronze Age part of the sequence is characterised by continuous evidence of sheep/goat, and probably cattle, dung accumulations: *in situ* burnt stable layers – *fumier*-like and homogeneous layers – accumulations of incompletely burnt or unburnt herbivore dung. Articulated phytoliths also occur within the cave sediments, indicating the use of straw/litter for these animals.

Macroscopic indicators

Various groups of ashy lenses overlying relatively thin dark-brown and reddish lenses ascribed to the Neolithic (where the overlying lenses SU 64-82-81 of trench 3a may tentatively be correlated with the lenses labelled as SU 116 in trench 3b), Copper and Bronze Ages occur between layers that are brown to greyish-brown and mostly homogeneous.

52 Šošić Klindžić *et al.* 2015; Guiry *et al.* 2017.

52 Šošić Klindžić *et al.* 2015; Guiry *et al.* 2017.

U sondi 2 slijed uključuje samo otpatke puževa SJ 113, koji uključuje neolitičke kulturne ostatke. Prema istraživačima, riječ je o prvoj postmezolitičkoj jedinici u ovom dijelu špilje. Granica između mezolitičkih i neolitičkih jedinica je površina erozije. Sve postmezolitičke jedinice istražene u sondi 2 sastoje se od balege ovaca / koza (od SJ 110_gornja u slijedu prema gore), osim najniže neolitičke jedinice 113 i male leće SJ 110_donja, izravno iznad SJ 113.

Mikroskopski pokazatelji

Gotovo su svi postemezolitički slojevi koprogeni i uključuju izmet biljojeda (ovce/koze, vjerojatno i goveda). U sondi 3b SJ 81 i SJ 82 istraživači su na temelju odsutnosti keramike pripisali mezolitiku, ali naknadna mikromorfološka analiza pokazuje da ih treba uključiti u neolitički slijed, kao sastavni dio skupine jedinica 64-82-81. Od podine ove skupine jedinica prema gore, sedimente uglavnom čine ovčji/kozji i goveđi izmet. Prvi pokazatelj držanja životinja je *in situ* izgorjeli stajski sloj (skupina SJ 64-82-81), koji uključuje skupinu sivkastih nakupina pepela s izgorjelom balegom i fitolitima koji prekrivaju tamnosmeđi sloj spaljenog izmeta, bogatog finim organskim tvarima, i rubificirani sloj s čestim povezanim fitolitima koji ukazuju na prisustvo stelje, vjerojatno slame koja je bila rasprostrta kao podloga za životinje. Skupina jedinica 64-82-81 sliči neolitičkom spaljenom stajskom sloju 116 u sondi 3b. Drugi mogući *fumier* leži između jedinica 114 i 45. Ostali slojevi od neolitika (SJ 53, 115B, 114, 45) do brončanog doba (SJ 40, 43) smeđi su do sivosmeđi i homogeni, sa sferulitima i fitolitima raspršenim u matriksu. Akumulacija nepotpuno izgorjelog ili neizgorjelog izmeta biljojeda moguće je objašnjenje razlike između „klasičnog *fumier*a" i ovih slojeva.

Vela Spila – Korčula

Vela Spila je zaista velika špilja iznad uvale Vele Luke, na oko 120 m nadmorske visine, na zapadnom kraju otoka Korčule. Špilja ima poluloptasti oblik, jednu dvoranu površine oko 1100 m^2. Širok ulaz otvoren prema zapadu i dva velika otvora kroz svod špilje daju obilno svjetlo njezinoj unutrašnjosti. Istraživanja, koja su provedena 1940-ih i 1950-ih, odmah su pokazala arheološki značaj špilje.[53] Kasnija opsežnija iskopavanja od 1970-ih do 2000-ih otkrila su dugi stratigrafski slijed od kasnoga gornjeg paleolitika do brončanog doba.[54] U novije je vrijeme slijed slojeva ponovno preispitan s nekoliko probnih sondi i na novoj površini.[55]

Makroskopski pokazatelji

Tipični sedimenti *fumier*s raznoliko su raspoređeni u različitim dijelovima špilje. U sondi 1 facijes „slojevite torte" je debljine do 20 cm i sadrži dva ili tri crno-bijela para u slojevima srednjeg neolitika i nekoliko izoliranih u horizontu kasne hvarske kulture, dok su u drugim neolitičkim slojevima homogeni smećkasti sedimenti s malo kamenja. Samo 5 cm naslage „slojevite torte"

In trench 2 the sequence includes only one snail midden, SU 113, which includes Neolithic cultural remains. According to the excavators, this is the first post-Mesolithic unit in this part of the cave. The boundary between the Mesolithic and Neolithic units is an erosion surface. All the post-Mesolithic units studied from Trench 2 are made of sheep/goat dung (from SU 110_upper upwards in the sequence) with the exception of the lowermost Neolithic unit, 113, and a small lens, SU 110_lower, directly overlying SU 113.

Microscopic indicators

Almost all the post-Mesolithic layers are coprogenic and include herbivore dung (sheep/goat and possibly cattle). In trench 3b, the excavators ascribed SU 81 and 82, on the basis of the absence of pottery, to the Mesolithic, but subsequent micromorphological analysis demonstrates that they should be included in the Neolithic sequence, as integral parts of the group of units 64-82-81. From the bottom of this group of units upwards, the sediments are made up mostly of sheep/goat and cattle dung. The first indicator of stabling is an *in situ* burnt stable layer (the group of SU 64-82-81); it includes a group of greyish ash accumulations with burnt droppings and phytoliths, overlying a dark brown layer of burnt droppings rich in fine organic matter, and a rubified layer with frequent articulated phytoliths which indicate the presence of litter, possibly straw spread as bedding for the animals. The group of units 64-82-81 resembles the Neolithic burnt stable layer 116 in trench 3b. Another possible *fumier* lies between units 114 and 45. The other Neolithic (SU 53, 115B, 114 and 45) to Bronze Age (SU 40 and 43) layers are brown to greyish-brown and homogeneous, with spherulites and phytoliths dispersed in the groundmass. An accumulation of incompletely burnt or unburnt herbivore dung is a possible explanation for the difference between the 'classic *fumier*' and these layers.

Vela Spila, Korčula

Vela Spila is a really large cave overlooking the bay of Vela Luka from about 120 m a.s.l., on the western tip of the island of Korčula. It is a hemispherical cave with a single chamber inside of about 1100 m^2. A wide entrance facing west, and two large windows through the ceiling, shed abundant light within the cave. Excavations carried out in the 1940s and 1950 first showed the archaeological relevance of the cave.[53] Further, more extensive excavations in the 1970s–2000s brought to light a long stratigraphic sequence ranging from the Late Upper Palaeolithic to the Bronze Age.[54] In more recent times, the sequence has been re-assessed with several test trenches and new excavation areas.[55]

Macroscopic indicators

Typical *fumier* sediments are differently distributed in distinct loci of the cave. In Trench 1 the layer-cake facies is up to about

53 Gjivoje 1952; Novak 1954.

54 Čečuk, Radić 2003; 2005.

55 Farbstein *et al.* 2012; Cristiani, Farbstein, Miracle 2014; Branscombe, Bosch, Miracle 2020; Dean *et al.* 2020.

53 Gjivoje 1952; Novak 1954.

54 Čečuk, Radić 2003; 2005.

55 Farbstein *et al.* 2012; Cristiani, Farbstein, Miracle 2014; Branscombe, Bosch, Miracle 2020; Dean *et al.* 2020.

primjećuje se u središnjem dijelu špilje (sonda 2) na dnu sloja ranog neolitika, uključujući samo jedan *fumier* čiji je svjetliji dio tamnosivi. Suprotno tomu, sve ostale horizonte od neolitika do bakrenog doba karakteriziraju homogeni sedimenti smeđe do crvenkaste praškaste ilovače, organizirani u ravnomjernim slojevima decimetarske veličine. U sondi 3, smještenoj u dijelu špilje koji je najudaljeniji od ulaza, cijeli rani neolitik nalazi se u homogenim smećkastim do crvenkastim slojevima, uključujući mjestimične, slabo razvijene leće *fumier* značajki. Samo na vrhu slijeda, u horizontima srednjeg neolitika, nalazimo oko 50 cm dobro razvijenih *fumier*s „slojevitih torti". U sondi iz 2006. godine, blizu najjužnije stijene špilje, horizonti ranog i srednjeg neolitika uključuju smećkaste do crvenkaste slojeve slične onima iz sonde 2 i sonde 3, koji se izmjenjuju s jednom debelom crno-bijelom lećom na sredini sekvence i nekoliko kontinuiranih, slabo razvijenih pojedinačnih *fumier* slojeva na vrhu.

Mikroskopski pokazatelji

Mikromorfološka zapažanja na neolitičkim ili mlađim slojevima do sada su provedena samo u sondi 2 i sondi 3. Tanki crni sloj (*fumier*) ranog neolitika u sondi 2 uključuje brojne biljne ostatke krupne veličine, uglavnom grančice, rasute unutar sedimenta u kojemu su fitoliti uobičajeni, dok je sferulita malo. Sferulita je vrlo malo ili ih nema u svijetlom dijelu, kojim dominiraju pepeo i nešto fitolita. Međutim, cijeli je svijetli sloj jako fosfatiziran, tako da je dio karbonata – uključujući sferulite – možda izmijenjen. Smeđecrvenkasti homogeni slojevi praškaste ilovače, uočeni u sondi 2, uglavnom se sastoje od silikatnih zrnaca – najviše je kvarca i tinjaca – ugrađenih u matricu crvenkaste gline. Pepeo je relativno čest, a fitolita je malo, skupljeni su u nepravilne agregate. Sferuliti se ne pojavljuju. Suprotno tomu, smećkastocrvenkasti slojevi u sondi 3 uključuju uobičajene ili dominantne sferulite povezane s uobičajenim fitolitima, dok je pepeo rjeđi. *Fumier*s „slojevite torte", koji se nalaze na vrhu slijeda, još su u fazi ispitivanja.

Raznoliko razvijeni *fumier*s i drugi pokazatelji stočarskih aktivnosti u određenim dijelovima špilje navode nas na zaključak da su se životinje držale i uzgajale u određenim dijelovima, dok su se druge aktivnosti provodile na preostalim dijelovima špilje. Pojava neuobičajenih i vrlo tankih *fumier*s u središnjem dijelu može sugerirati da su životinje onuda samo prolazile, da su rubni dijelovi, koji se nalaze u bolje osvijetljenim i zaštićenim dijelovima špilje, djelomično korišteni za kućanske aktivnosti, a dno je špilje služilo za držanje životinja, i to je stoga tamo gdje su sedimenti „slojevite torte" deblji i bolje razvijeni.

20 cm thick and includes 2 or 3 black/white couples in Middle Neolithic levels, and some isolated ones in the Late Hvar horizon, whereas the remaining Neolithic includes homogeneous brownish sediments with few stones. Not more than five centimetres of layer-cake sediments can be observed in the central area of the cave (Trench 2) at the bottom of the early Neolithic levels, including only one *fumier* whose lighter part is dark grey. Conversely, all the other horizons from Neolithic to Copper Age are characterised by homogeneous brownish-to-reddish silt loam sediments organised in evenly layered dm-sized strata. In Trench 3, in the cave area that is farthest from the entrance, the whole Early Neolithic occurs in homogeneous brownish-to-reddish layers including occasional poorly-developed *fumier* lenses. About 50 cm of well-developed layer-cake *fumier*s occur only at the top of the sequence, in Middle Neolithic horizons. In Trench 2006, close to the southernmost wall of the cave, the Early to Middle Neolithic horizons include brownish-to-reddish layers not dissimilar from those of Trenches 2 and 3, intercalated with one thick black/white lens at mid-sequence, and some continuous, poorly-developed single *fumier* layers at the top.

Microscopic indicators

Micromorphological observations on Neolithic or later layers have been carried out so far only in Trench 2 and Trench 3. The thin black layer of the Early Neolithic *fumier* in Trench 2 includes frequent large-size vegetal remains, mostly twigs, interspersed within a sediment where phytoliths are common, while spherulites are few. Spherulites are very few or absent in the light part, which is dominated by ash and some phytoliths. However, the whole light layer is strongly phosphatised, so that some of the carbonates – including spherulites – may have been altered. The brownish-reddish homogeneous silt loam layers observed in Trench 2 are mainly composed of silicate grains – mostly quartz and micas – embedded in a reddish clay matrix. Ash is relatively common, and phytoliths are few, clustered in irregular aggregates. Spherulites do not occur. Conversely, the brownish-reddish layers in Trench 3 include common or dominant spherulites, associated with common phytoliths, while ash is less frequent. The layer-cake *fumier*s situated at the top of the sequence are still under study.

Variously-developed *fumier*s and other indicators of pastoral activities in distinct parts of the cave suggest that animals were kept/penned in specific areas, while other activities were carried out in the remaining areas. The occurrence of anomalous and very thin *fumier*s in the central area may suggest that animals only transited here, while marginal loci located in better-lit and sheltered areas were partly used for domestic activities, whereas the bottom of the cave was used for penning animals, and is consequently where layer-cake sediments are thicker and better-developed.

Izabrane špilje s makroskopskim dokazima koji upućuju na stočarsku uporabu

Laganiši

Špiljski sustav Laganiši nalazi se na 1,6 km od Oprtlja u Istri, na 395 metara nadmorske visine. Sastoji se od dviju obližnjih špilja. Ona s okomitim ulazom korištena je za pokapanje tijekom brončanog doba, a druga špilja ima slijed koji uključuje srednji i kasni neolitik, kasno bakreno doba, brončano doba i rimske kulturne ostatke.[56]

Makroskopski pokazatelji

Istraživač je prepoznao perforiranu ljevkastu posudu kao pokazatelj proizvodnje mliječnih prerađevina na lokalitetu tijekom srednjeg i kasnog neolitika i naglašava da je špilju koristila stočarska zajednica.[57] Od nekoliko spomenutih otvorenih ognjišta neki bi mogli zapravo biti povezani sa stočarskim korištenjem špilje, tj. paljenjem životinjskog izmeta. Slični su predmeti i značajke pronađeni u brončanodobnim slojevima.

Vela Špilja – Lošinj

Vela špilja nalazi se na zapadnoj strani otoka Lošinja, otprilike ispod vrha Televrin (Osoršćica), na oko 260 m nadmorske visine, na položaju s kojeg se prostire pogled na Jadransko more i otoke Unije, Vele i Male Skarane i Susak. Špilja ima oblik lijevka dužine 25 m, s visokim kupolastim ulaznim dijelom širine 7 m i otvorom visine 10 m, u podnožju okomite litice. Prvi ju je istraživao Vladimir Mirosavljević,[58] a novija iskopavanja[59] donijela su na vidjelo stratigrafski slijed koji se proteže od gornjeg paleolitika do brončanog doba, s neolitičkim slojevima *impresso* keramike koji su datirani u 7134±37 BP (OxA-18118, 8020-7920 calBP).[60]

Makroskopski pokazatelji

Zapadna stijena špilje pokazuje vidljive tragove tipičnog zaglađivanja i poliranja uslijed trljanja ovčjeg runa o zidove, na oko 2,5 m iznad današnje razine špiljskog poda. Takve su značajke nešto manje vidljive na suprotnoj stijeni, ali su prepoznatljive, što pokazuje da se špilja intenzivno koristila za držanje životinja u fazi kad je ispuna špilje bila viša.

Očigledne crne i bijele naslage, koje su nalik na *fumier,* mogu se prepoznati u sondi 1, sloju 45 do 20, uključujući *impresso* keramiku. Iako nisu vrlo debeli (oko 15 cm), u donjem dijelu ove podsekvence mogu se prepoznati najmanje tri para crno-bijelih slojeva. Zanimljivo je da svijetli crvenkastosmeđi slojevi odvajaju crne slojeve od bijelih iznad njih. Ovaj kratki slijed *fumier* prekriva homogeni smećkasti horizont običnim kamenjem i na kraju još i *fumier* debljine 3 do 5 cm u kojem dominira sivkasta

Selected caves with macroscopic evidence suggesting pastoral use

Laganiši

The Laganiši cave system is located 1.6 km from Oprtalj in Istria, at 395 m a.s.l. It consists of two neighbouring caves. The cave with the vertical entrance was used for burial purposes during the Bronze Age. The other cave has a sequence that includes Middle/Late Neolithic, Late Copper Age, Bronze Age and Roman cultural remains.[56]

Macroscopic indicators

The excavator recognises a perforated funnel-shaped vessel as indicator of dairy production at the site during the Middle/Late Neolithic and emphasises the use of the cave by a herding community.[57] Some of the several open fireplaces mentioned in the excavation report may, in fact, also be connected with the pastoral use of the cave, i.e. the burning of animal dung. Similar items and features were found in the Bronze Age layers.

Vela Špilja, Lošinj

Vela Špilja is located on the western side of the island of Lošinj, approximately under the top of the Televrin hill (Osoršćica), at about 260 m a.s.l., in a position overlooking the Adriatic Sea and the islands of Unije, Vele and Male Skarane, and Susak. It is funnel-shaped cave,35 m long, with a highly domed entrance, about 7 m wide and 10 m high, opening at the foot of a vertical cliff. It was first excavated by Vladimir Mirosavljević,[58] and more recent excavations[59] have brought to light a sequence spanning from late Upper Palaeolithic to Bronze Age, with Neolithic Impressed Ware levels dated to 7134±37 BP (OxA-18118, 8020–7920 calBP).[60]

Macroscopic indicators

The western cave wall shows evident traces of typical smoothing and polishing due to the rubbing of sheep fleece against the walls, at about 2.5 m above the present-day cave floor. These modifications are slightly less evident on the opposite wall, but still identifiable, showing that the cave was intensively used for penning animals in a phase when the cave infill was thicker.

Evident black and white *fumier*-like features can be identified in sondage 1, level 45 to 20, including Impressed Ware ceramics. Though not very thick (about 15 cm), at least three black/white couples of layers can be identified at the base of this subsequence; interestingly, light reddish-brown layers separate the black layers from the overlying white ones. This short *fumier* sequence is overlain by a homogeneous brownish horizon with

56 Komšo 2008.
57 Komšo 2008.
58 Mirosavljević 1968.
59 Komšo, Miracle, Boschian 2005; Miracle 2007; Birch, Miracle 2017.
60 Forenbaher, Kaiser, Miracle 2013.

56 Komšo 2008.
57 Komšo 2008.
58 Mirosavljević 1968.
59 Komšo, Miracle, Boschian 2005; Miracle 2007; Birch, Miracle 2017.
60 Forenbaher, Kaiser, Miracle 2013.

nijansa, uključujući isprekidane bijele leće koje prekrivaju tanki neprekinuti crni sloj.

Do sada na ovom stratigrafskom slijedu nisu provedena mikromorfološka ispitivanja.

Neolitički horizonti – zajedno s *fumier*s – prilično su tanki, što upućuje na relativno kratko ili diskontinuirano korištenje špilje u stočarske svrhe. Međutim, polirani kamen visoko na zidovima također može sugerirati da je dio ispune, vjerojatno uključujući mlađe kulturne slojeve, ispran iz špilje, a to navodi na zaključak da su pastiri i njihova stada dugo vremena koristili špilju.

Vaganačka pećina

Vaganačka pećina nalazi se oko 5 km sjeverno od Starigrada – Paklenice. Smještena je na obroncima Velebita, na 700 metara nadmorske visine, blizu prijevoja koji povezuje more sa zaleđem. U blizini špilje ima mnogo malih udolina pogodnih za ispašu stoke. Stratigrafski slijed uključuje kulturne ostatke koji sežu od mezolitika do ranog (*impresso* keramika), srednjeg (Danilo) i kasnog neolitika (Hvar), bakrenog, brončanog i željeznog doba.[61]

Makroskopski pokazatelji

Stratigrafski slojevi Vaganačke špilje uglavnom su subhorizontalne s postmezolitičkim slojevima koji se sastoje uglavnom od parova horizonata crnog ugljena i bijelog pepela, što ukazuje na tipične *fumier*s tipa „slojevita torta" s pepeljastim horizontom koji varira od bijelog pepela do žućkastog pepela. Horizonti „slojevite torte" ponekad se izmjenjuju sa smeđim homogenim sedimentima. U horizontu su brončanog doba pronađene dvije male posudice s perforiranim stijenkama i većim otvorom na dnu. Tumače se kao dio setova za preradu mlijeka i sugeriraju proizvodnju mliječnih prerađevina na tome mjestu.

Pećina u Pazjanicama

Pećina u Pazjanicama smještena je na južnom Velebitu, iznad Velike Paklenice. Malo probno iskopavanje izveli su 1982. godine Forenbaher i Vranjican, koji su otkrili ostatke bakrenodobne nakovanske kulture i bakrenodobne / ranobrončanodobne ljubljanske kulture. Ulaz u špilju smješten je na 320 m n.m.v., okrenut je jugozapadu i s njega se prostire pogled na Velebitski kanal.[62]

Makroskopski pokazatelji

Stratigrafski profil je debljine 45 do 65 cm i uključuje tri sloja. Od matične stijene prema gore uključuje dva homogena sloja, crvenkasti i tamnosmeđi koji su prekriveni najgornjim površinskim slojem debljine 10 do 40 cm. Ovaj površinski sediment tamnosive boje prošaran je bijelim pepelom i tankim crnim prugama. Iako mikromorfološke analize nisu provedene, crno-bijele pruge mogu se tumačiti kao tipični facijes „slojevite torte", što ukazuje na stočarsku upotrebu špilje.

common stones, and finally by another *fumier,* 3–5-cm-thick, dominated by greyish hue, including discontinuous white lenses overlying a thin, continuous black layer.

No micromorphological studies have been carried out on this sequence until now.

The Neolithic horizons – and the *fumier*s they include – are rather thin, suggesting a relatively short or discontinuous use of the cave for pastoral purposes. However, rock polish high on the walls may also suggest that part of the infill, probably including more recent cultural remains, has been eroded from the cave, hinting at longer occupation by shepherds and their flocks.

Vaganačka Cave

The Vaganačka Cave is situated approx. 5 km north of Starigrad-Paklenica. It is located on the slopes of the Velebit mountain, 700 m a.s.l., near a pass that connects the sea to the hinterland. In the vicinity of the cave there are many small valleys that are suitable for livestock grazing. The stratigraphic sequence includes cultural remains ranging from Mesolithic to Early (Impressed Ware), Middle (Danilo) and Late Neolithic (Hvar), Copper Age, Bronze Age and Iron Age.[61]

Macroscopic indicators

The stratigraphic layers of the Vaganačka Cave are mostly subhorizontal, with the post-Mesolithic layers consisting mostly of couples of black-char and white-ash horizons which indicate typical layer-cake *fumiers*, with the ashy horizon varying from white ash to yellowish ash. The layer-cake horizons sometimes alternate with brown homogeneous sediments. Two small cups with perforated walls and a sizable opening at the bottom were found in the Bronze Age horizon. They are interpreted as parts of milk-processing sets and suggest diary production at the site.

Pećina u Pazjanicama

Pećina u Pazjanicama is located on the southern slopes of Velebit, above Velika Paklenica. A small test excavation was carried out in 1982 by Forenbaher and Vranjican, revealing Copper Age Nakovana and Copper/Early Bronze Age Ljubljana cultural remains. The entrance to the cave is situated at 320 m a.s.l.; it faces southwest and has an overview of the Velebit Channel.[62]

Macroscopic indicators

The stratigraphic profile is 45–65 cm thick, and it includes three layers. From the bedrock upwards it includes two homogeneous layers, a reddish one and a dark-brown one, which are overlain by the topmost surface layer, 10–40 cm thick. This dark-greyish surface sediment is interlayered with white ash and thin black stripes. Although micromorphological analyses have not been carried out, the black-and-white stripes may be interpreted as a typical layer-cake facies indicating pastoral use of the cave.

61 Forenbaher, Vranjican 1985.

62 Forenbaher, Vranjican 1982.

61 Forenbaher, Vranjican 1985.

62 Forenbaher, Vranjican 1982.

Mala (Nova) pećina

Mala pećina nalazi se duboko u brdima Dalmatinske zagore, u blizini sela Gornji Muć. Ulaz u špilju je malo okno, smješteno u malom klancu duboko u brdima. Špilja se sastoji od tri dvorane, s prolazom koji povezuje posljednje dvije. Stratigrafski slijed obuhvaća kulturne ostatke kasnog neolitika (hvarska kultura; prisutna samo u Dvorani 1) i ranog neolitika (*impresso* keramika).

Makroskopski pokazatelji

Iako su istraživači špilje primijetili da na terenu nema životinjskog izmeta, ne može se isključiti mogućnost da on bude vidljiv na mikroskopskoj razini. Neke crno-bijele leće, vidljive u profilima sondi, mogu ukazivati na izgorjelu životinjsku balegu. Skupinom kosti životinja iz Male pećine posebno dominiraju goveda i ovce / koze, s dokazima mesarenja. Tri govеđe i četiri fetalne kosti koza sakupljene su u sondi 1, što sugerira uzgoj životinja. Kosti sugeriraju da su životinje uzgajane u blizini špilje koja se koristila za kratkotrajno držanje životinja, o čemu svjedoči stratigrafija.[63]

Grapčeva špilja – Hvar

Grapčeva špilja nalazi se iznad južne obale otoka Hvara. Špilja obuhvaća dvoranu širine 25 x 22 m. S njezina se ulaza pruža pogled na susjedne otoke. Prva znanstvena iskopavanja provedena su u 19. stoljeću, nekoliko daljnjih iskopavanja uslijedilo je početkom 20. stoljeća, a velika iskopavanja proveo je Grga Novak od 1932. do 1952. godine. U novije vrijeme, 1996. godine, mala probna sonda (2 m^2) pružila je dragocjene podrobne informacije o stratigrafiji nalazišta i korištenju špilje.[64] Sedimentni slijed uključuje vrlo malo ostataka kulture ranog neolitika (impresso keramika) i srednjeg neolitika (Danilo). Špilja je korištena kao mjesto za pogrebne rituale tijekom kasnoneolitičke klasične hvarske kulture. Sedimenti iznad toga, uključujući kasni neolitik – kasna hvarska kultura, kasno bakreno doba – ranu cetinsku kulturu te kulturne ostatke ranog i srednjega brončanog doba, mogu biti povezani sa stočarskim aktivnostima u špilji.[65]

Makroskopski pokazatelji

Sedimenti koji prekrivaju kasnoneolitičke klasične hvarske kontekste, počevši od SJ 1300, potpuno se razlikuju od onih ispod i sugeriraju promjenu u uporabi špilje. Većina sedimenata (SJ 1300 – SJ 1600) je zbijena, postoji mnogo međusobno povezanih leća pepela i ugljena, koje se izmjenjuju s tankim slojevima glinovite ilovače i smeđim praškastim sedimentom nalik humusu, s vrlo malo vapnenačkih klasta i malo arheoloških nalaza. Većina pepeljastih sedimenata, debljine približno do 10 cm, proteže se cijelom površinom sonde. Naizmjenični tamni i bijeli parovi blisko podsjećaju na facijes „slojevitih torti" i ukazuju na ciklično spaljivanje balege biljojeda. Među arheozooloških nalazima prevladavaju ovce i koze.[66]

Mala (Nova) pećina

Mala Pećina is located deep in the hills of the Dalmatian hinterland, near the village of Gornji Muć. The entrance to the cave is a small shaft located in a small gorge deep in the hills. The cave comprises three chambers, with a passage connecting the last two. The stratigraphic sequence includes Late Neolithic (Hvar culture, present only in Chamber 1) and Early Neolithic (Impressed Ware) cultural remains.

Macroscopic indicators

Although the excavators noticed the lack of animal dung in the field, it cannot be excluded that it may be visible at microscopic scale. Some of the black-and-white lenses visible on the profiles of the trenches may indicate burnt animal dung. The animal assemblage from Mala Pećina is dominated by cattle and sheep/goat in particular, with evidence of butchery. Three cattle and four caprine foetal bones were collected in Trench 1, suggesting animal breeding. Bones suggest that animals were bred in the vicinity of the cave, which was used for short-term keeping of animals, as evidenced by the stratigraphy.[63]

Grapčeva Špilja, Hvar

Grapčeva Špilja is situated above the southern coast of the island of Hvar. The cave comprises a chamber 25×22 m wide. The cave entrance overlooks the neighbouring islands. First scientific excavations were carried out in the 19th century, and several further excavations followed in the early 20th century, and large-scale excavations were carried out by Grga Novak from 1932 to 1952. More recently, in 1996, a small test trench (2m^2) provided valuable detailed information about the site's stratigraphy and the use of the cave.[64] The sedimentary sequence includes very few Early Neolithic Impressed Ware and Middle Neolithic Danilo-style cultural remains. The cave was used as a mortuary ritual site during the Late Neolithic classic Hvar culture. The overlying sediments, including Late Neolithic (late Hvar), Late Copper Age (early Cetina), and Early and Middle Bronze Age cultural remains, may be linked to pastoral activities in the cave.[65]

Macroscopic indicators

The sediments overlying the Late Neolithic classic Hvar contexts, starting with SU 1300, are completely different from the underlying ones and suggest a change in the use of the cave. Most of the sediments (SU 1300–SU 1600) are compacted, there are many interleaving lenses of ash and char, alternating with thin layers of clay loam and a brown silty humus-like sediment, with very few limestone clasts and few archaeological finds. Most of the ashy sediments, approximately up to 10 cm thick, extend over the entire surface of the trench. The alternating dark and white pairs closely resemble the layer-cake facies and indicate cyclical burning of herbivore dung. Among the zooarchaeological assemblage, sheep and goats predominate.[66]

63 Trimmis, Drnić 2018.
64 Forenbaher, Kaiser 2000; 2008; 2010.
65 Forenbaher 2014.
66 Forenbaher, Kaiser 2008.

63 Trimmis, Drnić 2018.
64 Forenbaher, Kaiser 2000, 2008; 2010.
65 Forenbaher 2014.
66 Forenbaher, Kaiser 2008.

Spila kraj Nakovane

Spila se nalazi blizu vrha 400 m visokoga grebena od vapnenca, na 490 m n.v., 7 km istočno od zapadnog kraja poluotoka Pelješca. Ulaz u špilju širok je 15 m i visok 2 m, gleda na jugoistok, i otvara se u 15 m duboku dvoranu. Malu je probnu sondu istražio pedesetih godina Grga Novak, a još dvije male sonde Nikša Petrić 1970-ih godina. U novije vrijeme (1999. - 2003.) opsežnija iskopavanja izveo je Stašo Forenbaher. Sedimenti sadrže fino helenističko posuđe i grubu keramiku iz željeznog doba na vrhu stratigrafije, a slijede kulturni ostaci brončanog doba, bakrenog doba (nakovanska i cetinska), kasnog neolitika (hvarska), srednjeg neolitika (danilska) i ranog neolitika (kultura impresso keramike).[67]

Makroskopski pokazatelji

U ovoj špilji mogu se prepoznati tipični crno-bijeli sljedovi „slojevite torte" unatoč tome što su slabo definirani zbog velike količine kamenja u sedimentima. Ovaj je vid pomalo anomalan u takvim kontekstima, ali može se protumačiti kao potpuno prirodan jer je to bilo zbog snažnog frakturiranja stijene svoda. Sedimenti „slojevite torte" nižu se u gustim parovima crno-bijelih horizonata, koji se uglavnom protežu na širokim površinama, a odvojeni su slojevima sivkastog do smećkastoga praškastog sedimenta.

Gudnja

Gudnja se nalazi u planinskom lancu Porač, iznad grada Stona, u južnoj Dalmaciji. Ulaz u špilju širok 15 m nalazi se na 400 m n.m.v., a okružen je strmim brežuljcima i padinama. Špilju je prvi put opsežno istražila Spomenka Petrak između 1963. i 1968. godine. Malu probnu sondu iskopavao je 2004. Brunislav Marijanović kako bi pojasnio stratigrafiju nalazišta. Stratigrafski slijed obuhvaća razdoblje od ranog neolitika do srednjega brončanog doba, uključujući *impresso* keramiku, posuđe srednjeg neolitika tipa Gudnja, hvarsku kulturu, keramiku tipa Ljubljana i kulturne ostatke ranog do srednjeg brončanog doba.[68]

Makroskopski pokazatelji

U Gudnji nisu provedena nikakva mikromorfološka ispitivanja, a izvješća o iskopavanjima izvještavaju samo o ognjištima unutar sekvence; prema tomu, geoarheološke informacije o pastirskoj uporabi nisu dostupne. Međutim, pomno ispitivanje objavljenih profila dobre kvalitete sugerira da se naslage slične *fumier*s mogu pojaviti barem u horizontima II (srednji neolitik) do IV (rani eneolitik). Predstavljaju ih guste i relativno kratke bijele leće koje se izmjenjuju između površina pravilno naizmjeničnih horizonata „slojevite torte", koji su najbolje razvijeni u horizontu III (kasni neolitik).

Spila, near Nakovana

Spila is located near the top of a 400-m-high limestone ridge, at 490 m a.s.l., 7 km east of the western tip of the Pelješac peninsula. The cave entrance, 15 m wide, 2 m high and facing southeast, opens to a chamber 15 m deep. A small test trench was excavated in the 1950s by Grga Novak, and two more small trenches were excavated by Nikša Petrić in the 1970s. More recently (1999–2003) more extensive excavations were carried out by Stašo Forenbaher. The sediments include Hellenistic fine ware and Iron Age coarse pottery at the top of the stratigraphy, followed by Bronze Age, Copper Age (Nakovana and Cetina), Late Neolithic (Hvar), Middle Neolithic (Danilo), and Early Neolithic Impressed Ware cultural remains.[67]

Macroscopic indicators

Typical black/white layer-cake sequences can be identified within this cave, even if they are poorly defined because of the large quantity of stones embedded in the sediments. This aspect is somewhat anomalous in such contexts, but can be interpreted as entirely natural, as it was due to the strong fracturing of the ceiling rock. The layer-cake sediments are organised in thick couples of black/white horizons, generally extending over wide areas, and are separated by layers of greyish-to-brownish silty sediment.

Gudnja

Gudnja is situated in the mountain range of Porač, above the town of Ston, in southern Dalmatia. The entrance to the cave is 15 m wide and located at 400 m a.s.l., and it is surrounded by steep hills and slopes. The cave was first extensively excavated by Spomenka Petrak between 1963 and 1968. A small test trench was excavated in 2004 by Brunislav Marijanović to elucidate the site's stratigraphy. The stratigraphic sequence ranges from the Early Neolithic to the Middle Bronze Age, including Impressed Ware, Middle Neolithic Gudnja-type pottery, Hvar Culture, Ljubljana-type pottery and Early-to-Middle Bronze Age cultural remains.[68]

Macroscopic indicators

No micromorphological studies were carried out at Gudnja, and excavation reports only report hearths within the sequence; consequently, no geoarchaeological information about pastoral use is available. However, close examination of the good-quality profiles published suggest that *fumier*-like deposits may occur at least in horizons II (Middle Neolithic) through to IV (Early Copper Age). These are represented by some thick, and relatively short, white lenses intercalated between decks of finely alternating layer-cake horizons, which are best developed in horizon III (Late Neolithic).

67 Forenbaher, Kaiser 2010.

68 Marijanović 2005.

67 Forenbaher, Kaiser 2010.

68 Marijanović 2005.

Žukovica – Korčula

Žukovica je mala špilja koja se nalazi na sjevernoj obali otoka Korčule, nasuprot sjeverozapadnoga kraja poluotoka Pelješca. Smještena je na širokoj izbočini koja prekida liticu koja se strmo spušta u more, oko 20 m ispod špilje. Unutrašnjost je široka oko 20x7 m, a otvor joj je širine oko 7 m, visine 3 m. Iskopavanja, koja su provedena u sondi u središnjem dijelu špilje,[69] pokazala su postojanje nekoliko faza korištenja špilje u slojevima visine oko 2 m.

Makroskopski pokazatelji

Fazu 4 (prijelaz iz mezolitika u rani neolitik), fazu 3 (prijelaz ranoga u srednji neolitik) i fazu 2 (prijelaz srednjeg u kasni neolitik) karakterizira grubo uslojena smećkasta do crvenkasto-smećkasta praškasta ilovača s vrlo malo kamenja, nalik na homogeni smećkasti facijes tipičan za *migon*ske sedimente. Neki su podslojevi tamniji zbog veće količine fragmenata ugljena i / ili organskih tvari. Faza 1 (kasni neolitik) otprilike je dvaput deblja od prethodnih i karakteriziraju je vrlo dobro razvijeni *fumier*s. Ovi su pomalo nepravilni i uglavnom su organizirani u dobro odvojenim lećama, uključujući debele (do 15 do 20 cm) bjelkaste ili sivkaste slojeve koji prekrivaju tanje crne. U sjeverozapadnom kutu glavne sonde sedimenti „slojevitih torti" drugačije su organizirani, oblikujući izoliranu površinu relativno tankih crno-bijelih leća. Granice debljih *fumier*s često su valovite ili isprekidane, a tanki crvenkasti „izgorjeli" slojevi sedimenta ponekad su umetnuti između pojedinih *fumier*s-a.

Mikroskopski pokazatelji

Mikromorfološka ispitivanja nisu još provedena.

Procese koji su oblikovali sedimente faza 4-2 na Žukovici je teško procijeniti jer specifični mikroskopski pokazatelji stočarskih aktivnosti nisu mogli biti proučeni. Pokazatelji bi bili presudni za procjenu sadrži li grubo slojevita smećkasta ilovača, npr. sferulite ili loše organizirane koprolite. Suprotno tomu, prisutnost sedimenata „slojevitih torti" na cijelom istraženom području – što otkriva poprečni profil koji prelazi preko polovice širine špilje – ukazuje na to da su životinje držane u svim dijelovima špilje, najvjerojatnije zbog njezine ograničene veličine.

Zaključci

Stočarske su špilje neravnomjerno rasprostranjene na području Hrvatske, a također su i prilično malobrojne u usporedbi s drugim sredozemnim područjima. Gotovo sve su smještene na zapadu, s dvije skupine u Istri i na području srednje i južne Dalmacije. Na jugu ih je najviše na otocima (Brač, Hvar i Korčula). Iako moramo imati na umu da razlike u tehnici i intenzitetu pregleda terena ili oskudna dokumentacija starijih iskopavanja mogu utjecati na to kako trenutno opažamo broj i prostorni uzorak ovih neobičnih mjesta, glavno ograničenje postojanju špilja je distribucija stijena u kojima se špilje mogu oblikovati, tj. vapnenaca i dolomita. U Hrvatskoj takve stijene pripadaju dinarskoj karbonatnoj platformi i vidljive su na površini na

69 Radić 2002; Forenbaher *et al.* 2019; Forenbaher, Miracle, Radić 2019.

Žukovica, Korčula

Žukovica is a small cave situated on the northern coast of the island of Korčula, opposite the north-western tip of the Pelješac peninsula. It is situated on a wide ledge that interrupts a cliff dipping directly into the sea, which lies about 20 m below the cave. The inside is about 20×7 m wide, with an entrance about 7 m wide and 3 m high. Excavations carried out in a trench within the central part of the cave[69] have brought to light several occupation phases over a thickness of about 2 m.

Macroscopic indicators

Phase 4 (transition from Mesolithic to Early Neolithic), Phase 3 (Early–Middle Neolithic transition), and Phase 2 (Middle–Late Neolithic transition) are characterised by crudely layered brownish to reddish-brownish silty loam with very few stones, resembling the homogeneous brownish facies that is typical of *migon* sediments. Some sublevels are darker, because of larger amounts of charcoal fragments and/or organic matter. Phase 1 (Late Neolithic) is about twice the thickness of previous ones and is characterised by very well-developed *fumier*s. These are somewhat irregular, and mostly organised in well-separated lenses, including thick (up to 15–20 cm) whitish or greyish layers overlying the thinner black ones. In the north-west corner of the main sondage, the layer-cake sediments are differently organised, forming an isolated deck of relatively thin black/white lenses. The limits of the thicker *fumier*s are often wavy or discontinuous, and thin reddish 'burnt' layers of sediment are sometimes intercalated between single *fumiers*.

Microscopic indicators

Micromorphological studies have not been carried out yet.

It is difficult to assess the processes that formed the sediments of Phases 4–2 at Žukovica, because specific microscopic indicators of pastoral practices could not be observed. These indicators would be vital in assessing whether the crudely layered brownish silt loam includes e.g. spherulites or poorly organised coprolites. Conversely, the occurrence of layer-cake sediments throughout the excavated area – which brings to light a transversal profile crossing half the breadth of the cave – indicates that animals were kept in all areas, most likely because of the small size of the cave.

Conclusions

Pastoral caves are irregularly scattered within the territory of Croatia and are also rather few if compared to other Mediterranean areas. Almost all are located in the west, with one cluster in Istria and another in the region of central-southern Dalmatia. Here, in the south, most are on islands (Brač, Hvar and Korčula). Though it must be kept in mind that differences in survey technique/intensity or scanty documentation of older excavations may bias how we currently perceive the number and spatial pattern of these peculiar sites, the main constraint on cave occurrence is the distribution of rocks where caves can

69 Radić 2002; Forenbaher *et al.* 2019; Forenbaher, Miracle, Radić 2019.

svim otocima i u planinskom pojasu uz obalu oko 80 km u unutrašnjost. Istočnije, nekarbonatne stijene čine najunutarnjiji dio ovoga planinskog lanca, koji dijeli sredozemno područje od unutarnjeg Balkana i savsko-dunavske ravnice koja je prekrivena prapornim i aluvijalnim sedimentima; posljedično, na tom području nema špilja.

Stočarske su špilje obično, čak i ako ne uvijek, smještene na određenoj visini iznad obližnjih ravnica, često u strmim područjima koja karakterizira gruba neravna krška morfologija. Još jednom, ova osobitost može proizaći iz uobičajenih osobina karbonatnih stijena, koje su na ovom području također pod snažnim utjecajem tektonske aktivnosti, da oblikuju strme padine oko širokih visoravni. Međutim, mora se također naglasiti da krška područja – kad su strma i podložna eroziji tla – uglavnom nisu pogodna za poljoprivredu, dok stočarstvo tamo nalazi svoje idealno okruženje.

Što se tiče mogućih odnosa između stočarskih špilja i naselja na otvorenom, klimatski i edafski oportunizam,[70] tj. preferencijalna eksploatacija područja s posebno povoljnim mikroklimatskim uvjetima i tlom, vjerojatno je ograničavao ekonomiju naseljavanja i prostorne obrasce. Na prvome mjestu treba primijetiti da postoji zapanjujuća razlika u vrsti, veličini i organizaciji naseljenosti između obalnog područja i ravnice u unutrašnjosti, na istoku Hrvatske. Malobrojna su naselja koncentrirana uz obalu srednjeg Jadrana,[71] u uskim ravnicama gdje su neka plodna područja razasuta među uglavnom srednje do nekvalitetnim tlima, dok je nekoliko velikih naselja pronađeno u širokim istočnim ravnicama,[72] gdje su plodna tla razvijena na praporu pogodovala poljoprivredi. Slijedom toga, čini se da je jadransko krško okruženje, koje nije vrlo povoljno za poljoprivredu, možda zahtijevalo intenziviranje uzgoja stoke, što je konačno dovelo do pravog stočarstva. S druge strane, odsutnost stočarskih špilja ne može se smatrati dokazom da uzgoj stoke ili stočarstvo nisu bili dio ekonomskih resursa zajednica koje žive u otvorenim naseljima istočnih ravnica; to jednostavno znači da ti važni krajobrazni elementi nisu bili dostupni, bez obzira na svoje moguće korištenje. Tijekom neolitika na obali goveda su se pojavila u manjoj mjeri u usporedbi sa stadima ovaca i koza (osim Smilčića), dok su istovremeno u kontinentalnoj Hrvatskoj goveda bila znatno zastupljenija; broj svinja je iznimno mali, što ukazuje na njihovu skromnu ekonomsku vrijednost tijekom neolitika.[73]

Zanimljivo je uočiti neke osobitosti u raširenosti stočarskih špilja. Iako su gotovo sve smještene na teško pristupačnim područjima, neke se nalaze na strmim padinama iznad relativno uske ravnice (Nakovana, Mala (Nova) pećina; Vela Spilja na Lošinju) ili šireg ravničarskog područja (Žukovica, Zemunica, Vela Spila na Korčuli), ili u klisurama blizu visoravni (Pupićina peć, Vela peć), ili čak visoko u planinama (Vaganačka). U svakom slučaju, čini se da su sve špilje smještene tamo gdje su bila dostupna barem neka obližnja područja pogodna za kvalitetne pašnjake.[74] Ovako raznoliki smještaj sugerira da su se špilje uglavnom koristile

70 Limbrey 1990.

71 Forenbaher, Miracle 2005; Moore *et al*. 2007; 2019.

72 Marković 2012; Balen, Čataj 2014; Kalafatić, Klindžić, Šiljeg 2020.

73 Radović 2014.

74 Forenbaher, Vranjican 1985.

form, i.e. limestones and dolomites. In Croatia, these rocks belong to the Dinaric carbonate platform and crop out throughout all the islands and in the mountain belt along the coast up to about 80 km inland. More to the east, non-carbonate rocks form the innermost part of this mountain range, which separates the Mediterranean realm from the inner Balkans and the Sava-Danube plain, which is covered by loess and alluvial sediments; consequently, there are no caves in this area.

Pastoral caves are usually – even if not always – located at some height above the nearby plains, often in steep areas characterised by rugged karst morphology. Once again, this peculiarity can result from the normal predisposition of carbonate rocks, which in this area are also strongly affected by tectonic activity, to form steep slopes around wide plateaux. However, it must also be pointed out that karst areas – mostly when steep and subject to soil erosion – are generally not very suitable for tilling, whereas stock-rearing finds there its ideal environment.

Regarding the possible relationships between pastoral caves and open-air settlements, climatic and edaphic opportunism,[70] i.e. preferential exploitation of areas where microclimatic conditions and soils are particularly favourable, was probably also constraining settlement economy and spatial pattern. It must first be observed that there is a striking difference in settlement type, size and organisation between the coast area and the eastern inland plains. Few settlements are concentrated along the mid-Adriatic coast,[71] in a narrow plain where some fertile areas are interspersed among mostly medium- to poor-quality soils, whereas large settlements were found in the wide eastern plains,[72] where fertile soils, developed on loess, favoured agriculture. Consequently, it looks as though the Adriatic karst environment, not highly favourable for agriculture, may have required an intensification of stock-rearing, finally leading to real pastoralism. On the other hand, the absence of pastoral caves cannot be considered as evidence that stock-rearing or pastoralism were not part of the economic resources of communities living in the open-air settlements of the eastern plains; it simply means that these important landscape elements were not available, whatever their possible use. During the Neolithic on the coast, cattle appeared to a lesser extent than flocks of sheep and goats (except for Smilčić), while at the same time in continental Croatia cattle were much better represented; the number of pigs is extremely small, indicating their low economic value during the Neolithic.[73]

It is interesting to observe some peculiarities in the distribution of pastoral caves at larger scale. Though almost all are located in rugged territories, some are on steep slopes overlooking relatively narrow plains (Nakovana, Mala (Nova) pećina; Vela Špilja on Lošinj), or wider extensions of flat territory (Žukovica, Zemunica, Vela Spila on Korčula), or within gorges close to plateaux (Pupićina peć, Vela peć), or even high in the mountains (Vaganačka). In any case, it seems that all caves are located where at least some close-by areas suitable for good-

70 Limbrey 1990.

71 Forenbaher, Miracle 2005; Moore *et al*.. 2007; 2019.

72 Marković 2012; Balen, Čataj 2014; Kalafatić, Klindžić, Šiljeg 2020.

73 Radović 2014.

za držanje životinja na više ili manje svrsishodan način. Međutim, također se čini razumnim da su one u gorju posebno koristili pastiri koji su se kretali tijekom izdiga (transhumancije), a one bliže smještene većim ravničarskim područjima sustavnije su koristile skupine pastira s jačim vezama s obližnjim naseljima zemljoradnika. Nažalost, mala naselja zemljoradnika u krškim područjima sklona su nestajanju zbog raznih morfogenetskih procesa, tako da su neuhvatljiva čak i nakon podrobnoga terenskog pregleda. Slijedom toga, čak i ako je u ovome trenutku podrobno istraživanje veza između rasprostranjenosti nalazišta i facijesa stočarskog sedimenta u špiljama izvan ciljeva ovog rada, može se pretpostaviti da vrlo tanki *fumier*s mogu sugerirati kratku ili vrlo isprekidanu upotrebu špilja (npr. Zala, Vela Spila – Lošinj, Pećina u Pazjanicama), dok bi dobro razvijene i debele sljedove sedimenata „slojevite torte" trebale svjedočiti o cikličkoj, vjerojatno transhumantnoj upotrebi špilja. S druge strane, mali broj nalaza (keramika) u skladu je s funkcijom špilja kao specijaliziranih staja za životinje. U ovom slučaju, stočarske logore – koji su iznimno neuhvatljivi – ili poljoprivredna naselja treba tražiti u blizini špilje.

Zemunica je okrenuta prema širokom polju u neposrednoj blizini, na kojem se mogu obrađivati debela tla. U špilji su stočarski pokazatelji vrlo jaki iako sedimenti „slojevite torte" gotovo i ne postoje, dok su povezani fitoliti (sl. 3 f) vrlo česti i ukazuju na stalnu uporabu stelje ispod životinja, što možda sugerira kontinuiranu upotrebu špilje kao staje. Istodobno, relativno mali broj ulomaka keramike u nekim slojevima također upućuje na to da špilju ljudi u tim fazama nisu koristili za stanovanje, što je u skladu s hipotezom da su se ratarska naselja nalazila na području polja, a da se špilja neprestano koristila za držanje stada.

U ranim poljoprivrednim naseljima sjeverne Dalmacije pojavljuju se iste karakteristike skupova lončarije kao i u stočarskim špiljama Velebita, što podupire hipotezu o integriranim agropastoralnim sustavima.[75]

Pojava perforiranih posuda obično se smatra pokazateljem prerade mlijeka u špiljama (Pupićina peć, Laganiši [srednji/kasni neolitik], Vaganačka [brončano doba]), ali to ne mora nužno ukazivati na visoku specijaliziranost lokaliteta jer su se špilje možda koristile za ove aktivnosti bez obzira na udaljenost od naselja.

Od neolitika nadalje špilje su se najčešće koristile isključivo kao torovi za ovce i koze (o čemu svjedoče balega i životinjske kosti – uvijek više od 50%), povremeno i za goveda, a u znatno manjoj mjeri postojala je i mješovita uporaba, za ljude i životinje (*habitats-bérgeries*).

Zaključno se može predložiti da je na istočnoj jadranskoj obali uspostavljen složeni agropastoralni sustav s integriranim ratarstvom i uzgojem stoke, pri čemu su se nizinska i / ili ravničarska područja koristila za poljoprivredu, dok su se u špilje smještale životinje, s različitim stupnjem specijalizacije u dolinama i gorju.

quality pastures were available.[74] This highly variable setting suggests that caves were generally used for housing animals in a more or less expedient way. However, it also looks reasonable that those in the highlands were used specifically by shepherds roaming during transhumance, whereas those located closer to larger flat areas were used more systematically by groups of shepherds with stronger links to nearby settlements of farmers. Unfortunately, small-size settlements of farmers in karst areas are prone to obliteration by a variety of morphogenetic processes, so that they are elusive even after accurate survey. Consequently, even if it is currently beyond the scope of this paper to investigate, in depth, the links between site distribution and pastoral-cave sediment facies, it can be hypothesised that very thin *fumiers* may suggest short or very discontinuous use of caves (e.g. Zala, Vela Špilja on Lošinj, Pećina u Pazjanicama), whereas well-developed and thick sequences of layer-cake sediments should testify to cyclical, possibly transhumant use of the caves. On the other hand, the small number of findings (pottery) is consistent with the function of the caves as specialised stables for animals. In this case, pastoral camps – extremely elusive – or farming settlements should be looked for in the vicinity of the cave.

Zemunica faces a wide polje that lies very close, where thick soils are available for crops. In the cave, pastoral indicators are very strong, though layer-cake sediments are almost absent, whereas articulated phytoliths (Fig. 3: f) are very common and indicate constant use of litter under the animals, possibly suggesting continuous use of the cave as a stable. At the same time, the relatively small number of pottery sherds in some layers also suggests that the cave was not used for dwelling by humans in those phases, consistently with the hypothesis that farmer settlements were located in the polje area, and that the cave was constantly used for keeping the flocks.

The characteristics of pottery assemblages, found in early farming villages of northern Dalmatia, which can also be found in pastoral caves of the Velebit mountain, support the idea of the integrated agropastoral system.[75]

The occurrence of perforated vessels is usually considered an indicator of dairy production in caves (Pupićina Peć, Laganiši [Middle/Late Neolithic], Vaganačka cave [Bronze Age]); however, it does not necessarily indicate high specialisation of the site, because caves may have been used for these activities regardless of their distance from the settlement.

From the Neolithic onwards, caves were used most often exclusively as pens for sheep and goats (evidenced by dung and faunal assemblage – always more than 50%), and occasionally also for cattle, and to a much lesser extent there was a mixed use as *habitats-bergeries*.

In conclusion, it can be suggested that a complex agropastoral system with integrated tilling and stock-rearing was established on the eastern Adriatic coast, with lowlands and/or flatlands exploited for farming, and caves used for herding at variable levels of specialisation within the valleys and the highlands.

75 Forenbaher 2011.

74 Forenbaher, Vranjican 1985.

75 Forenbaher 2011.

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OBALNO PODRUČJE I PIRINEJSKA REGIJA U SJEVEROISTOČNOJ IBERIJI / COASTAL AREA AND THE PYRENEAN REGION IN NORTH-EASTERN IBERIA
Cova del Parco, Cova de la Guineu[76]
Can Sadurní[77]
Santa Maira, Bolumini, Cova de les Cendres[78]
Cinto Mariano[79]
Abric de la Falguera[80]
Cova Colomera[81]
Balma de la Margineda[82]
Cova Gran de Santa Linya[83]
San Cristóbal, abri[84]
El Trocs[85]
Cueva de El Toro[86]
IBERIJA, GORNJI SLIV EBRA I SJEVERNA MESETA / IBERIA, THE UPPER EBRO BASIN AND THE NORTHERN MESETA
Los Husos I, II[87]
El Mirador[88]
JUŽNA FRANCUSKA/SOUTHERN FRANCE
Fontjuvenal[89]
Grotte Antonnaire[90]
Caune de Bélesta[91]
Grotte du Gardon[92]
Grande Rivoire, Isère[93]
DRUGE/OTHERS
REGIJA LIGURIJA U ITALIJI / LIGURIA REGION IN ITALY
Arene Candide[94]

ISTOČNOJADRANSKA REGIJA IZUZEV HRVATSKE / EASTERN PERI-ADRIATIC REGION, EXCLUDING CROATIA)
Nekoliko špilja na Tršćanskom krasu/several caves in the Trieste Karst[95]
DRUGE/OTHERS (Miracle, Forenbaher, osobna komunikacija/personal communication)
špilja Konispol u Albaniji/Konispol cave in Albania[96]
ZAPADNOJADRANSKA REGIJA / WESTERN PERI-ADRIATIC REGION
Grotta dei Piccioni, Grotta Sant'Angelo, Abruzzo[97]
Grotta Continenza, Abruzzo[98]
Grotta Scaloria, Apulija/Apulia[99]
Grotta delle Mura, in ApulijaBoschian unpublished data
JUŽNA ITALIJA I OTOCI / SOUTHERN ITALY AND ISLANDS
Grotta dell'Uzzo, Sicilija/Sicily[100]
Riparo di Castello, Sicily (Boschian, neobjavljeni podaci/unpublished data)
ALPSKO PODRUČJE / ALPINE AREA
Riparo Gaban, Trentino[101]
GRČKA/GREECE
Kouveleiki špilje/caves[102]
Piges (Springs of) Koromilias[103]
Piges (Springs of) Angitis[104]
Špilja Polyphimos/ Polyphimos cave[105]
Theopetra[106]
Ostale/others[107]

TABLICA 1. Popis špilja. Najznačajnije stočarske špilje na području sjevernog Sredozemlja (izradio G. Boschian).

TABLE 1. Cave list. The most important pastoral caves in the northern Mediterranean region (made by G. Boschian).

76 Bergadà 1997; Bergadà *et al.* 2005.
77 Blasco *et al.* 1999.
78 Badal 1999.
79 Cabanilles *et al.* 2005.
80 García Puchol, Aura Tortosa 2006; Verdasco Cebrián 2001.
81 Oms *et al.* 2008.
82 Brochier 1995; Brochier, Claustre 2000.
83 Mora *et al.* 2011; Polo Díaz *et al.* 2014; Burguet-Coca *et al.* 2020.
84 Polo-Díaz *et al.* 2016.
85 Rojo Guerra *et al.* 2013; Lancelotti *et al.* 2014.
86 Égüez *et al.* 2016.
87 Alday Ruiz, Fernández Eraso, Yusta Arnal 2003; Polo Díaz, Fernández Eraso 2008; 2010.
88 Vergès *et al.* 2002; 2008.
89 Brochier 1988.
90 Argant, Heinz, Brochier 1991.
91 Brochier, Claustre, Heinz 1998.
92 Sordoillet *et al.* 2007.
93 Nicod *et al.* 2010.
94 Courty, Goldberg, Macphail 1989; Courty, MacPhail, Wattez 1991; Macphail *et al.* 1997.
95 Boschian, Montagnari-Kokelj 2000.
96 Schuldenrein 2001.
97 Iaconis, Boschian 2007.
98 Boschian *et al.* 2017.
99 Rellini *et al.* 2020.
100 Brochier *et al.*1992.
101 Bagolini 1980; Bagolini, Pedrotti 1996; Kapper *et al.* 2014.
102 Karkanas 2006.
103 Trantalidou, Belegrinou, Andreasen 2010.
104 Trantalidou, Belegrinou, Andreasen 2010.
105 Trantalidou, Belegrinou, Andreasen 2010.
106 Trantalidou, Belegrinou, Andreasen 2010.
107 Trantalidou, Belegrinou, Andreasen 2010.

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