The first steps of carpology in Kosova: the example of Ulpiana's Roman town

Florian Jedrusiak
SDAVO-UMR7041-EQUIPE GAMMA
florian.jedrusiak@valdoise.fr

Abstract

In anticipation of the Mission Archéologique Européenne au Kosova (MAEKO) program, the study and promotion of the archaeological heritage of Ulpiana (Kosova), an archaeobotanical study – specifically a particular carpological analysis - has been underway since 2018.This study is directly linked to the archaeological excavations of sectors 1300 /1300, 1300/1500 and 1400/1400. Although still modest, this study holds undeniable scientific significance, as it represents the first of its kind conducted in Ulpiana, and more widely in Kosova and on the territory of ancient Dardania. The carpological data presented here are therefore new and exceptional, because they inaugurate research into food consumption in this chrono-cultural region.The excavation of sectors 1300/1300, 1300/1500 and 1400/1400, led by Milot Berisha (IAK), Christophe Goddard (CNRS-PSL) and Arben Hajdari (University of Prishtina), uncovered structures from the Roman period and Byzantine periods. Anthropogenic levels revealed, including functional stratigraphic units or carbonized deposits, were the subject of spot sampling of sediments. This protocol was implemented by Florian Jedrusiak (SDAVO-UMR7041-Equipe GAMMA) in consultation with Christophe Goddard and Vincent Bernollin (CNRS-PSL, AOROC). This analysis aims to improve the overall understanding of the Ulpiana site, particularly with regard to its plant economy. It is mainly a question of determining which plant foodstuffs were consumed by the populations who occupied the town between the 1st and 6th centuries AD.

Keywords: *carpology, Ulpiana, plant economy, Kosova, Dardania*

What is carpology and what is it for?

Carpology is the study of seeds and fruits found in archaeological contexts. Seeds can be preserved through carbonization (exposure to fire), imbibition (in environments with very high humidity), or mineralization (primarily in latrines or contexts with high limestone concentrations).All archaeological contexts have the potential to yield seeds. To study these seeds, a 10-liter sample of raw sediment is collected. The sediment

ISSN 3027-5024 (Online)
DOI https://doi.org/10.62303/71r6rd43

is then sieved using a column with a 0.3 mm mesh and subsequently sorted under a stereomicroscope at magnifications ranging from ×8 to ×50.The first European research in this field dates to the 19th century and was conducted by the Swiss paleobotanist O. Heer, who systematically studied plant remains collected in various prehistoric lakeside villages (Renfrew 1991). However, it was not until the second half of the 20th century that the discipline experienced significant growth. Early studies focused on plants cultivated and consumed during recent prehistoric periods, with a particular emphasis on the origins of agriculture in the Near East and its diffusion to Europe. One of the key objectives was to identify and date the domestication of cultivated plants, with cereals and legumes receiving the most attention (Bouby 2000).

A synthesis of research for Europe and Southwest Asia was published in the 2000s by D. Zohary and M. Hopf (Zohary and Hopf 1994). In France, significant research began in the 1970s, spearheaded by J. Erroux. These efforts traced the evolution of cultivated and gathered plant species from the Mesolithic to the modern era (Ruas and Marinval 1991).

Advancements in scientific techniques, methodological improvements in plant identification, and the development of reliable sampling methods at archaeological sites have facilitated new research avenues over the past four decades. Today, carpology provides increasingly precise information about the plants that shaped the environment and resources of past societies. The enrichment of the discipline, including new taxonomic identifications and expanded documentary evidence, has significantly advanced the field (Bouby 2000).

The carpological approach has become increasingly complex over the past four decades. It no longer provides simple lists of plants but aims to identify the stages of agricultural practices, from land preparation to consumption, including the processing, storage, and potential trade of harvests. Consequently, carpologists are no longer solely focused on cultivated plant seeds. Other plant remains related to these cultivated taxa, such as various parts of cereal ears (husks, rachises, spikelets), are playing an increasingly significant role (Bouby 2000). Additionally, weed seeds that colonize crops (agricultural weeds) are of particular interest for interpreting archaeological sites (Bouby 2000).

The development of carpology has led to two complementary approaches. The first, described as "ecological," seeks to understand the ecological properties of contemporary plant species to draw conclusions about past environments. The second approach is considered more "technical" and involves examining specific anthropogenic marks on plant remains within a sample to highlight particular agricultural practices. These approaches are not mutually exclusive; rather, a comprehensive carpological study should integrate both methods (Bouby 2000).

As the discipline evolved, carpologists began distinguishing between two main types of carpological assemblages. The first type, paleobiocenosis, refers to assemblages artificially gathered in a specific context, such as a silo or granary. These assemblages are significant because they result from a single human action, such as storing a harvest. Consequently, the ecological or technical convergence of the components of the archaeological context is highly meaningful (Bouby 2000). Paleobiocenosis overlaps with the concept of a "closed ensemble" (Marinval 1989), meaning that the studied remains were deposited at one time in a structure and originate from plants—whether cultivated or weeds—that grew in the same habitat (Bouby 2000). A typical example of paleobiocenosis is a storage site containing the remains of burned crops, including cultivated plants and weeds from the same fields (Bouby 2000).

The second type of assemblage, known as thanatocenosis, involves seeds of diverse origins without a functional link between them (Behre and Jacomet 1991; Willerding 1971). A good example is landfill samples, where waste accumulates over time without intentional organization (Bouby 2000).

Interpreting carpological contexts becomes more challenging when dealing with thanatocenoses (Behre and Jacomet 1991; Willerding 1971). It is essential to differentiate between these two types of assemblages and, when possible, combine them in studies. Both types provide valuable insights for reconstructing rural landscapes and agrarian practices, but they differ in relevance and interpretative complexity (Bouby 2000).

2. Method

2.1 Site

The archaeological site of Ulpiana is located in the municipality of Gračanica, eight kilometers southeast of Prishtina. The site is an ancient Roman settlement that spans over thirty-five hectares of agricultural plains, situated at the foot of a hill system that borders it to the south and along the Sitnica River, which flows approximately three hundred meters north of its walls.The city was established at the crossroads of two major routes: one road connected the Dalmatian coast, north of Dyrrachium, to the Danubian limes and Dacia; the other route provided access to Thessaloniki via Stobi in Macedonia. Ulpiana's Roman foundation was closely tied to the conquest of Dacia, for which the province of Moesia Superior, to which the city belonged, served as a strategic rear base. Ulpiana was a critical stop on journeys between the East and West but faced significant challenges during the barbarian incursions of the 5th, 6th, and 7th centuries AD.[1]

2.2 Study context

Structures with a high potential for carporest conservation, such as charcoal layers and the Cloaca Maxima, were specifically selected for sampling. In other cases, such as post holes, selections were made with the aim of refining the understanding of certain contexts. The dating of these structures was facilitated through ceramic analysis and stratigraphic reasoning.

The carpological study was not systematic, meaning not all excavated structures were analyzed. Given its focus on a restricted area, this research provides only a partial view of the site. Nevertheless, its value remains significant, particularly because it establishes a solid foundation for understanding the plant economy of the ancient populations that occupied the site of Ulpiana and, more broadly, the region of Dardania. Since 2018, 60 samples representing 54 stratigraphic units have been studied. In total,

Date	1st century AD	2nd century CE	2nd and 3rd centuries CE	3rd and 4th centuries AD	4th centuries AD	4th and 5th centuries AD	5th centuries AD	5th and 6th centuries AD	6th centuries AD	Roman period	indefinite period
number of samples	1	4	13	1	5	2	8	1	6	2	17
Volume (l)	3	27	45	10	44	12	66	8	48	3.4	35.2
Conservation	carbonization	carbonization	carbonization	carbonization	carbonization	carbonization	carbonization	carbonization	carbonization	carbonization	carbonization

Sample number	60	48	40	59	47	49	50	51	52
US	757	751	610	748	741	715			
Context	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Ceramic			
Sector	1400/1400								
Volume (l)	3	7	10	6	6	2	2	1	1
Density/l	1,7	3,4	0	2,4	4,4	1	0	1	4
Date	1st century AD	2nd century CE				2nd and 3rd centuries CE			

Sample number	53	54	55	26	27	28	29	30	31
US	727		731	301	302	303	304	305	306
Context	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Coal layer	Exterior of the potter's kiln	Potter's kiln	Coal layer	Coal Layer	Potter's kiln
Sector	1400/1400			1300/1600					
Volume (l)	2	2	5	5	5	5	5	5	5
Density/l	2	1	5,8	0	5,8	0,4	0,8	0	8,6
Date	2nd and 3rd centuries CE								

Sample number	35	9	10	39	41	11	7	46	6
US	560	298	299	592	612	402	289	588	281
Context	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Cloaca Maxima	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer
Sector	1300/1300						1300/1300	1400/1400	1300/1300
Volume (l)	10	8	8	10	8	10	5	7	5
Density/l	0,2	1,5	0,5	0,2	0	1,2	0	1,4	0,2
Date	3rd and 4th centuries AD	4th centuries AD					4th and 5th centuries AD		6th centuries AD

Sample number	42	43	44	56	57	58	37	34	45
US	613	617		672	674	705	558	514	192
Context	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer
Sector	1300/1300			1300/1600			1300/1300		
Volume (l)	9	10	8	15	1	7	10	8	10
Density/l	1,2	1	2,63	2	1	1,6	10,9	0	0,8
Date	5th centuries AD							5th and 6th centuries AD	6th centuries AD

Sample number	32	33	2	3	4	1	12	5	8
US	463		196	200	209	190	405	280	294
Context	Ditch	Ditch	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Anthropic charcoal layer	Cloaca Maxima	Anthropic charcoal layer	Anthropic charcoal layer
Sector	1300/1300								
Volume (l)	5	8	10	10	5	10	10	5	5
Density/l	4,4	5,5	8,4	1,1	1,2	0,8	2,6	1,6	0,2
Date	6th centuries AD					Roman period		indefinite period	

Sample number	13	14	15	16	17	18	19	20	21
US	237-238	239-240	219-220	221-222	227-228	223-224	225-226	235-236	231-232
Context	post hole	post hole	post hole	post hole	post hole	post hole	post hole	post hole	post hole
Sector	1300/1300								
Volume (l)	1,5	0,5	1	1	0,2	1	0,3	2	0,8
Density/l	0,67	0	29	1	30	0	0	6,6	0
Date	indefinite period								

Sample number	22	23	24	25	36	38
US	229-230	234-235	241-242	251-252	567	587
Context	post hole	post hole	post hole	post hole	Anthropic charcoal layer	Anthropic charcoal layer
Sector	1300/1300					
Volume (l)	3	0,4	2	0,5	6	5
Density/l	2	5	3	0	0,33	2,4
Date	indefinite period					

Figure 1: List of Ulpiana samples

2.3. Sample processing

2.3.1. *Sieving*

All 60 sediment samples were processed using a sieving method. The samples were completely sieved with water using a sieve column with mesh sizes of 4 mm, 2 mm, 1

mm, and 315 µm. The mesh size was chosen based on the diversity of the paleo-seeds being analyzed: while some seeds measure in centimeters, the vast majority are only a few millimeters in size (Buxó 1992). This technique allows for the recovery of all seeds, even the smallest ones, such as those from wild plants.
A gentle water jet, combined with a soft brush, was used to dissolve the sediment and release the plant macroremains without crushing them on the sieve grid. The material remaining on the sieve was then placed on plates to dry (Marinval 1999). Additionally, floating particles collected during sieving were retained for further study.

2.3.2. *Sorting*

The archaeobotanical remains recovered from each sieve were sorted using a stereomicroscope with magnifications ranging from ×8 to ×60. Each sample was fully sorted without employing sub-sampling techniques, which are sometimes used in other studies (Veen and Fieller 1982; Jones 1991; Matterne 2001). This approach ensures a more accurate assessment of the representativeness of taxa within a sample. The use of sub-sampling would have rendered it impossible to compare data across the various sieves of the same sample (Rovira 2012).

2.3.3.*The determination*

The determination was made possible through the use of reference atlases (Cappers, Bekker, and Jans 2012; Cappers and Neef 2012; Cappers, Neef, and Bekker 2009; Neef, Cappers, and Bekker 2012; Beijerink 1976; Jacquat 1988; and Schotch et al. 1988) and a seed reference collection (carpothèque). The identification of seeds is based on the principle of comparative anatomy. The morphological characteristics of the seeds are compared to those of modern plants using two indices: the morphology of the complete individual and the metric indices (L = length; l = width; é = thickness) (Buxó 1992). This comparison allows each paleo-seed to be matched to a specific plant species.

Seed counts were conducted on an individual basis. Whole specimens, as well as fragments with identifiable and unique morphological characteristics, were considered individuals (often, a preserved carporest retains more than half of its original morphology) (Rovira 2012). Although the numerical data presented in the carpological tables reflect the minimum number of individuals (NMI), the fragmentation of seeds makes this estimate problematic for two main reasons. First, the number of plant components is not always standard and can vary within the same species (Jones 1991). Second, the fragmentation rate can differ significantly depending on whether it is voluntary (anthropogenic, such as during craft activities) or involuntary (due to burial processes or excavation) (Rovira 2012).

To account for these challenges, fragments of the same taxon were grouped into sets of four to be considered one complete individual (Rovira 2012). While this approach does not resolve the fundamental issue, it helps limit potential biases in interpretations. Seeds with similar characteristics were grouped under the same taxon to ensure homogenization and systematization of results. B. Pradat addressed the challenges of seed counting in a 2015 publication, specifying that all methods used to calculate the

NMI either underestimate or overestimate the actual numbers (Pradat 2015).

The carpological data are presented in Figures 2, 3, 4, 5, 6, and 7, which display the results by sample. The remains are categorized by taxa and grouped according to their uses and ecological environments. Additionally, the scientific and French nomenclature of the taxa are provided, following Lambinon et al. (2012).

Ulpiana (Kosovo)	Sample number			60		
"1400/1400"	US			757		
	sector			1400/1400	Total volume (l)	phyto-sociological code (according to Ellenberg *et al.* 1991)
RO: A. Hajdari et C. Goddard	Volume (l)			3	3	
	Density/l			1,7		
	Dating			1st century AD		
Scientific names	Vernacular names	Type of reste	Method of conservation			
Lambinon et *alii* (2012)	Lambinon et *alii* (2012)				Number of restes	
Messicoles and other vegetation						
3. Anthropogenic vegetation						
3.2. Bidentetea						
Persicaria hydropiper	Watter pepper	achene	C	1	1	3.211
Other						
Fabaceae	Legumes	cotyledon	C	4	4	x

Number of restes	5	5
Nombre of taxa	2	2
Main conservation within the structure	C	Carbonization

Figure 2: Carpological data for the 1st century AD

Ulpiana (Kosovo) "1400/1400" RO: A Hajdari et C. Goddard	Sample number			48	40	59	47		phyto-sociological code (according to Ellenberg *et al.* 1991)
	US			751	610	748	741		
	sector			1400/1400				Total volume (l)	
	Volume (l)			7	10	5	5	27	
	Density/l			3,4	0	2,4	4,4		
	Dating			2nd century CE					
Scientific names Lambinon et *alii* (2012)	Vernacular names Lambinon et *alii* (2012)	Type of reste	Method of conservation					Number of restes	
Cereal									
Triticum cf. *spelta*	Spelt	caryopsis	C	2				2	x
Triticum aestivum/durum/turgidum	Common wheat	caryopsis	C	1				1	x
Hordeum vulgare	Barley	caryopsis	C	1				1	x
Cerealia	Cereal	caryopsis	C	2		1		3	x
Carbonized Organic Matter	Carbonized Organic Matter	COM	C	4		9	22	35	x
Legume									
Vicia ervilia	Ervil	cotyledon	C	2				2	x
Vicia sp.	Vetches	cotyledon	C	1				1	x
Pisum sativum	Pea	cotyledon	C	1				1	x
Leguminosae sativae indeterminata	Indeterminate legumes	cotyledon	C	4				4	x
Messicoles and other vegetation									
3. Anthropogenic vegetation									
3.5. Artemisietea									
Galium aparine agg.	Cleavers	seed	C	4		1		5	3.5
Other									
Fabaceae	Legumes	cotyledon	C	2		1		3	x

	48	40	59	47	Total
Number of restes	24	0	12	22	**58**
Nombre of taxa	11	0	4	1	**11**
Main conservation within the structure	C		C	C	**Carbonization**

Figure 3: Carpological data for the 2nd century CE

Ulpiana (Kosovo) "1300/1500" "1400/1400" RO: A. Hajdari et C. Goddard	Sample number			49	50	51	52	53	54	55	26	27	28	29	30	31		
	US			715				727		731	301	302	303	304	305	306		
	sector			1400/1400							1300/1500						Total volume (l)	phyto-sociological code (according to Ellenberg *et al.* 1991)
	Volume (l)			2	2	1	1	2	2	5	5	5	5	5	5	5	45	
	Density/l			1	0	1	4	2	1	5,8	0	5,8	0,4	0,8	0	8,6		
	Dating			2nd and 3rd centuries CE														
Scientific names Lambinon et al/ (2012)	**Vernacular names Lambinon et al/ (2012)**	**Type of reste**	**Method of conservation**														**Number of restes**	
Cereal																		
Triticum aestivum/durum/turgidum	Common wheat	caryopsis	C					3		2		3				1	9	x
Triticum cf. spelta	Spelt	caryopsis	C	1					1								2	x
Triticum spelta/dicoccon	Spelt/Emmer	caryopsis	C									3				1	4	x
Triticum sp.	Wheat	caryopsis	C						1	1		4					6	x
Secale cereale	Rye	caryopsis	C													5	5	x
Hordeum vulgare	Barley	caryopsis	C							2							2	x
Cerealia	Cereal	caryopsis	C			1				1		12				5	19	x
Carbonized Organic Matter	Carbonized Organic Matter	COM	C	1			2	1		5							9	x
Legume																		
Vicia ervilia	Ervil	cotyledon	C				1			4							5	x
Cf. *Vicia Faba*	Broad bean	cotyledon	C									1					1	x
Vicia sp.	Vetches	cotyledon	C							1							1	x
Pisum sativum	Pea	cotyledon	C							1							1	x
Leguminosae sativae indeterminata	Indeterminate legumes	cotyledon	C							1		3				1	5	x
Fruit																		
Vitis vinifera ssp. vinifera	Common grappe vine	seed	C													1	1	x
Prunus persica	Peach	endocarp	C													1	1	x
Corylus avellana	Common hazel	pericarp	C													1	1	x
Messicoles and other vegetation																		
3. Anthropogenic vegetation																		
Chenopodium sp.	Goosefoots	akene	C									1				5	6	3.
Veronica hederifolia agg.	Ivy-leaved speedwell	seed	C											1		1	2	3.
3.3 Chenopodietea																		
Chenopodium hybridum	Maple-leaved goosefoot	akene	C										1			2	3	3.3
Chenopodium album agg.	White goosefoot	akene	C									2					2	3.3
3.4. Secalietea																		
Agrostemma githago	Corncockle	seed	C							1							1	3.4
3.5. Artemisietea																		
Galium aparine agg.	Cleavers	seed	C							4						6	10	3.5
6. Perennial herbs from forest edges, wastelands and bushes																		
6.1 Trifolio-Geranietea																		
Galium glaucum	Waxy bedstraw	seed	C							2							2	6.112
Other																		
Carex sp.	Carex	akene	C													3	3	x
Fabaceae	Legume	cotyledon	C													4	4	x
Poaceae	Grasses	caryopsis	C										1				1	x
Indeterminata, carbonnisé	Indéterminés													3		6	9	
	Number of restes			2	0	1	4	4	2	29	0	29	2	4	0	43	120	
	Nombre of taxa			2	0	1	2	2	2	11	0	8	2	2	0	15	27	
	Main conservation within the structure			C		C	C	C	C	C		C	C	C		C	Carbonization	

Figure 4: Carpological data for the 2nd and 3rd centuries CE

Ulpiana (Kosovo)	Sample number			35	9	10	39	41	11		
"1300/1300"	US			550	298	299	592	612	402		
	sector			1300/1300						Total volume (l)	phyto-sociological code (according to Ellenberg *et al.* 1991)
RO: A. Hajdari et C. Goddard	Volume (l)			10	8	8	10	8	10	54	
	Density/l			0,2	1,5	0,5	0,2	0	1,2		
	Dating			3rd and 4th centuries AD	4th centuries AD						
Scientific names	Vernacular names	Type of reste	Method of conservation								
Lambinon et *alii* (2012)	Lambinon et *alii* (2012)									Number of restes	
Cereal											
Triticum sp.	Wheat	caryopsis	C			2				2	x
Hordeum vulgare	Barley	caryopsis	C	1						1	x
Panicum miliaceum	Proso millet	caryopsis	C		1					1	x
Cerealia	Cereal	caryopsis	C		1	1				2	x
Legume											
Lens culinaris	Lentil	cotyledon	C				1			1	x
Fruit											
Prunus spp.	Prunus spp.	endocarp	C		1					1	x
Messicoles and other vegetation											
3. Anthropogenic vegetation											
Chenopodium sp.	Goosefoots	akene	C						2	2	3.
3.2. Bidentetea											
Persicaria hydropiper	Watter pepper	akene	C	1						1	3.211
3.3 Chenopodietea											
Chenopodium hybridum	Maple-leaved goosefoot	akene	C		7	1			9	17	3.3
3.5. Artemisietea											
Galium aparine agg.	Cleavers	seed	C						1	1	3.5
Sambucus ebulus	Danewort	seed	C				1			1	3.531
Other											
Sambucus sp.	Sambucus	seed	C		1					1	x
Indeterminata, carbonized	Undetermined				1					1	
	Number of restes			2	12	4	2	0	12	**32**	
	Nombre of taxa			2	6	3	2	0	3	**12**	
	Main conservation within the structure			C	C	C	C		C	**Carbonization**	

Figure 5: Carpological data for the 3rd and 4th centuries AD

Ulpiana (Kosovo)	Sample number			7	46	6	42	43	44	56	57	58	37		
"1300/1500"	US			289	688	281	613	617		672	674	700	568		
"1300/1300"	sector			1300/1300	1400/1400	1300/1300				1300/1500			1300/1300	Total volume (l)	phyto-sociological code (according to Ellenberg *et al.* 1991)
"1400/1400"	Volume (l)			5	7	5	9	10	8	15	1	7	10	77	
	Densityl			0	1,4	0,2	1,2	1	2,63	2	1	1,5	10,9		
RO: A. Hajdari et C. Goddard	Dating			4th and 5th centuries AD		5th centuries AD									
Scientific names Lambinon et al// (2012)	Vernacular names Lambinon et al// (2012)	Type of reste	Method of conservation											Number of restes	
Cereal															
Triticum cf. *spelta*	Spelt	caryopsis	C		1					5				6	x
Triticum aestivum/durum/turgidum	Common wheat	caryopsis	C		1				1			1		3	x
Triticum sp.	Wheat	caryopsis	C						2	7		2	1	12	x
Hordeum vulgare	Barley	caryopsis	C						2					2	x
Secale cereale	Rye	caryopsis	C					2						2	x
Panicum miliaceum	Proso millet	caryopsis	C										1	1	x
Cerealia	Cereal	caryopsis	C		3			3	3	11		1	2	23	x
Carbonized Organic Matter	Carbonized Organic Matter	COM	C							3				3	x
Legume															
Vicia sp.	Vetches	cotyledon	C				1		3			1		5	x
Pisum sativum	Pea	cotyledon	C					1						1	x
Lathyrus sativus	Indian pea	cotyledon	C						2					2	x
Fruit															
Vitis vinifera ssp. *vinifera*	Common grappe vine	seed	C					1						1	x
Juglans regia	English walnut	pericarp	C				1							1	x
Rubus cf. *idaeus*	Red raspberry	akene	C						1					1	x
Messicoles and other vegetation															
3. Anthropogenic vegetation															
Chenopodium sp.	Goosefoots	akene	C				1						6	7	3.
3.2. Bidentetea															
Persicaria hydropiper	Watter pepper	akene	C										36	36	3.211
3.3 Chenopodietea															
Chenopodium hybridum	Maple-leaved goosefoot	akene	C				5						10	15	3.3
Sonchus asper	Spiny sowthistle	seed	C				1							1	3.31
3.4. Secalietea															
Fallopia convolvulus	Black Bindweed	akene	C										1	1	3.4
Vicia cf. *tetrasperma*	Smooth tare	cotyledon	C						1	3				4	3.421
3.5. Artemisietea															
Galium aparine agg.	Cleavers	seed	C					1	1					2	3.5
3.7. Plantaginetea															
Polygonum aviculare agg.	Prostrate knotweed	akene	C										17	17	3.711
Other															
Carex sp.	Carex	akene	C			1	1		1					3	x
Sambucus sp.	Sambucus	seed	C				1							1	x
Chenopodium sp.	Goosefoots	akene	C							1				1	x
Polygonaceae	Polygonaceae	akene	C										35	35	x
Fabaceae	Legume	cotyledon	C					1						1	x
Poaceae	Grasses	caryopsis	C					1	1					2	x
Indeterminata, carbonized	Undetermined								3		1			4	
	Number of restes			0	5	1	11	10	21	30	1	5	109	**193**	
	Nombre of taxa			0	3	1	7	7	12	5	1	4	9	**27**	
	Main conservation within the structure				C	C	C	C	C	C	C	C	C	**Carbonization**	

Figure 6: Carpological data for the 4th and 5th centuries AD

Ulpiana (Kosovo)	Sample number			34	45	32	33	2	3	4		
	US			514	192	463		196	200	209		
"1300/1300"	sector			1300/1300							Total volume (l)	phyto-sociological code (according to Ellenberg *et al.* 1991)
	Volume (l)			8	10	5	8	10	10	5	56	
	Density/l			0	0,8	4,4	5,5	8,4	1,1	1,2		
RO: A. Hajdari et C. Goddard	Dating			5th and 6th centuries AD	6th centuries AD							
Scientific names Lambinon et *alii* (2012)	Vernacular names Lambinon et *alii* (2012)	Type of reste	Method of conservation								Number of restes	
Cereal												
Triticum aestivum/durum/turgidum	Common wheat	caryopsis	C				3	1			4	x
Triticum cf. *spelta*	Spelt	caryopsis	C		1						1	x
Triticum sp.	Wheat	caryopsis	C				5	1			6	x
Hordeum vulgare	Barley	caryopsis	C			2	2			2	6	x
Panicum miliaceum	Proso millet	caryopsis	C		1						1	x
Carbonized Organic Matter	Carbonized Organic Matter	COM	C		1	2	3				6	x
Legume												
Pisum sativum	Pea	cotyledon	C		1		1				2	x
Vicia sp.	Vetches	cotyledon	C				1	1			2	x
Messicoles and other vegetation												
3. Anthropogenic vegetation												
Chenopodium sp.	Goosefoots	akene	C		1	6	5	15	1		28	3.
Veronica hederifolia agg.	Ivy-leaved speedwell	seed	C					2			2	3.
3.3 Chenopodietea												
Chenopodium hybridum	Maple-leaved goosefoot	akene	C			2	3	58	2	1	66	3.3
Chenopodium album agg.	White goosefoot	akene	C						2		2	3.3
Fumaria officinalis	Common fumitory	seed	C						1		1	3.311
3.4. Secalietea												
Fallopia convolvulus	Black Bindweed	akene	C		1						1	3.4
Vicia cf. *tetrasperma*	Smooth tare	cotyledon	C					1			1	3.421
3.5. Artemisietea												
Galium aparine agg.	Cleavers	seed	C		1				1	1	3	3.5
Sambucus ebulus	Danewort	seed	C				1		1		2	3.531
3.7. Plantaginetea												
Polygonum aviculare agg.	Prostrate knotweed	akene	C		1						1	3.711
Other												
Sambucus sp.	Sambucus	seed	C				1		1		2	x
Carex sp.	Carex	akene	C						1		1	x
Lolium sp.	Lolium	caryopsis	C							1	1	x
Polygonaceae	Polygonaceae	akene	C			5	16				21	x
Poaceae	Grasses	caryopsis	C			2	2		1		5	x
Indeterminata, carbonized	Undetermined					3	1	5		1	10	
	Number of restes			0	8	22	44	84	11	6	**175**	
	Nombre of taxa			0	8	7	13	8	9	5	**24**	
	Main conservation within the structure				C	C	C	C	C	C	**Carbonization**	

Figure 7: Carpological data for the 5th and 6th centuries AD

Ulpiana (Kosovo)	Sample number			1	12	5	8	13	14	15	16	17	18	19	20	21	22	23	24	25	36	38		
"1300/1300"	US			190	405	280	294	237-238	239-240	219-220	221-222	227-228	223-224	225-226	235-236	231-232	229-230	234-235	241-242	251-252	567	587		
	sector			1300/1300																			Total volume (l)	phyto-sociological code (according to Ellenberg et al. 1991)
	Volume (l)			10	10	5	5	1,5	0,5	1	1	0,2	1	0,3	2	0,8	3	0,4	2	0,5	6	5		
	Density/l			0,8	2,6	1,6	0,2	0,67	0	29	1	30	0	0	6,5	0	2	5	3	0	0,33	2,4		
RO: A. Hajdari et C. Goddard	Dating			Roman		Undetermined																		
Scientific names Lambinon et alii (2012)	Vernacular names Lambinon et alii (2012)	Type of reste	Method of conservation																				Number of restes	
Cereal																								
Panicum miliaceum	Proso millet	caryopsis	C		1																		1	x
Triticum sp.	Wheat	caryopsis	C																1				1	x
Cerealia	Cereal	caryopsis	C		2					1												2	5	x
Spikelet base	Spikelet base	spikelet	C																			1	1	x
Carbonized Organic Matter	Carbonized Organic Matter	COM	C	1																		8	9	x
Legume																								
Pisum sativum	Pea	cotyledon	C	1																			1	x
Lens culinaris	Lentil	cotyledon	C																			1	1	x
Lathyrus sp.	Lathyrus	cotyledon	C	1																			1	x
Fruit																								
Prunus spp.	Prunus spp.	endocarp	C														1						1	x
Messicoles and other vegetation																								
3. Anthropogenic vegetation																								
Chenopodium sp.	Goosefoots	akene	C		3	4											2	1	2				12	3.
Veronica hederifolia agg.	Ivy-leaved speedwell	seed	C									1											1	3.
3.3 Chenopodietea																								
Chenopodium hybridum	Maple-leaved goosefoot	akene	C		9					4		2			7			1	2				25	3.3
Chenopodium album agg.	White goosefoot	akene	C							24					3								27	3.3
Polycnemum majus	Giant needleleaf	akene	C		1																		1	3.331
3.4. Secalietea																								
Vicia cf. *tetrasperma*	Smooth tare	cotyledon	C																		1		1	3.421
3.5. Artemisietea																								
Sambucus ebulus	Danewort	seed	C	1	6														1				8	3.531
5. Vegetation of meadows and pastures																								
5.4. Molinio-Arrhenatheretea																								
Plantago lanceolata	Ribwort Plantain	seed	C				1																1	5.4
Other																								
Carex sp.	Carex	akene	C	1																			1	x
Sambucus sp.	Sambucus	seed	C														1						1	x
Medicago/Melilotus sp.	Medicago/Melilotus	akene	C		4																		4	x
Fabaceae	Legumes	cotyledon	C	1		1					1										1		4	x
Polygonaceae	Polygonaceae	akene	C									3											3	x
Poaceae	Grasses	caryopsis	C			1		1															2	x
Indeterminata, carbonized	Undetermined			2		2									3		2						9	
	Number of restes			8	28	8	1	1	0	29	1	6	0	0	13	0	6	2	6	0	2	12	121	
	Nombre of taxa			7	7	4	1	1	0	3	1	3	0	0	3	0	4	2	4	0	2	4	24	
	Main conservation within the structure			C	C	C	C	C		C	C	C			C		C	C	C		C	C	Carbonization	

Figure 8: Carpological data concerning indeterminate samples

3. Results

3.1. State of conservation

Only one method of seed preservation is attested: carbonization. Through the action of fire, organic matter is replaced by carbon (Bakels 1984a, 1984b). Several factors influence the quality of charred remains, including temperature, duration of exposure to fire, oxygen supply, and humidity levels during contact with fire. Charred remains often shrink, crack under the heat, turn black, and lose surface ornamentation such as hairs or spines.

The predominance of carbonized remains in the corpus is unsurprising, as most archaeological sites yield primarily dry sediments, which predominantly preserve carbonized plant remains (Bakels 1984a, 1984b). Despite the destructive effects of carbonization, certain plant elements retain their overall shape and anatomical features, enabling precise identification—often at the genus level and sometimes at the species level (Bouby 2000). However, analyzing only these dry contexts is insufficient for a comprehensive understanding of a site (Wilson 1984). Carbonized remains are not entirely representative of the plant environment or the full range of human activities at a site (Bouby 2000). Instead, they often reflect anthropogenic actions, either deliberate or accidental. Plants subjected to fire during human use are more likely to be preserved through carbonization (Van der Venn 1985). Consequently, dry-environment sites often demonstrate an abundance of cereals and legumes, while other taxa, such as fruits, aromatics, and wild plants, are underrepresented or absent. This trend is evident in the current study, where fruit trees and wild plants are poorly represented in the charred contexts of Ulpiana.

Using the conservation scale for carbonized seeds published in 1990 by Boardman and Jones (1990), as well as Hubbard and Al Azm (1990), the state of preservation of carpological material at the site is assessed as average (Matterne 2001). This is not unusual, as dry contexts rarely yield optimally preserved seeds. Storage conditions for cereals, however, are relatively favorable, with only 29% of cereal seeds classified as *Cerealia indeterminata* (Figure 9). These seeds belong to cultivated Poaceae, indicating domesticated food plants, but their deteriorated surfaces, morphological deformations, and high fragmentation prevent precise identification.

Chaff remains are absent from the study, except for a single spikelet base. Combined with the low representation of cultivated field weeds, this suggests that the occupants of the studied areas were likely consumers rather than agricultural producers. None of the spaces studied can be definitively identified as areas for processing or storing agricultural products.

The analysis also revealed fragments of carbonized organic matter (MOC), which may represent residues of accidentally charred food preparations (e.g., bread, porridge, pancakes, or oatmeal) or fragments of cereals exposed to excessively high temperatures. Legumes exhibit relatively average preservation, with 27% classified under the term *Leguminosae sativae indeterminata* (Figure 10). Like cereals, these are cultivated Fabaceae, indicating domesticated food plants, but they cannot be identified at a more specific level. This high percentage of indeterminate legumes can be attributed to their fragility during carbonization: the hilum, a key feature for species differentiation, is rarely preserved.The presence of carbonized seeds underscores the anthropogenic nature of the remains studied. As a result, the plant environment of the Ulpiana site is largely understood through the lens of human activity and its associated selections (Bouby 2000).

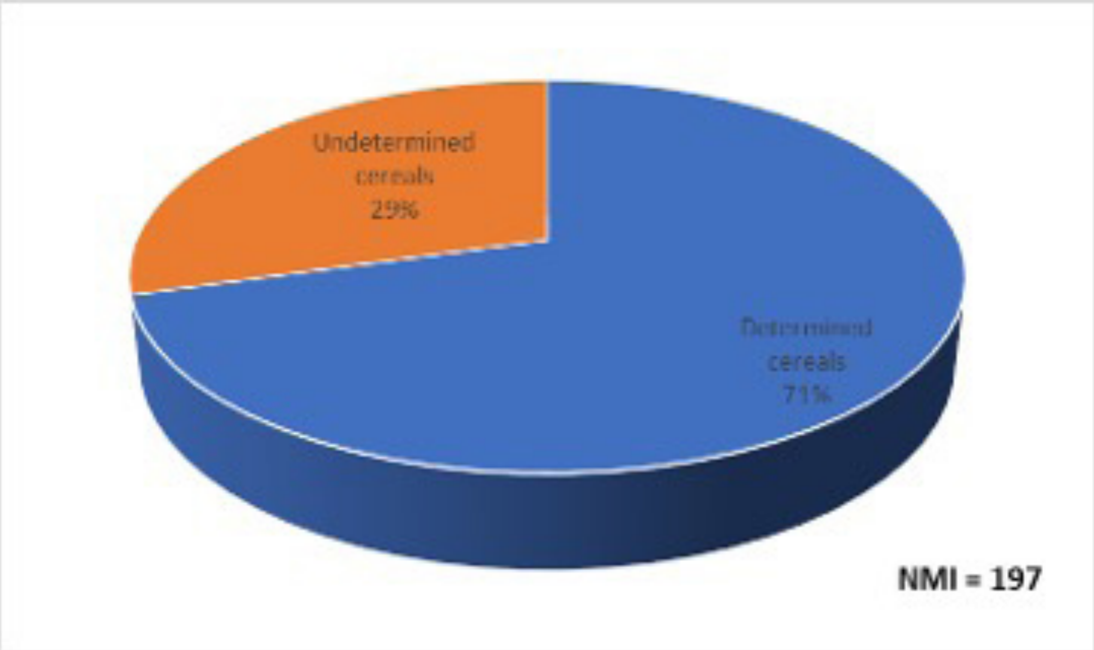

Figure 9: Percentage of caryopsis identified within the cereal corpus

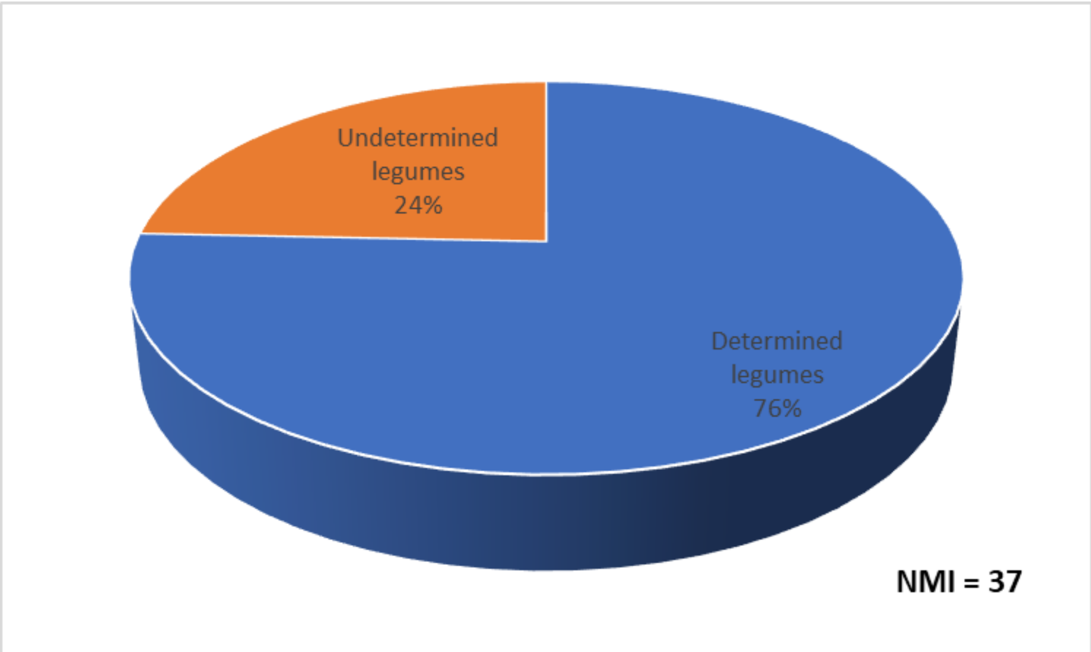

Figure 10: Percentage of cotyledons identified within the legume corpus

3.2. Representativeness of the data

The density of seeds per liter of raw sediment varies between samples. Twelve samples were negative (7, 14, 18, 19, 21, 25, 26, 30, 34, 40, 41, and 50), while forty-five samples yielded a low density of macroremains, ranging from 1 to 10 seeds per liter of sediment (1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 16, 20, 22, 23, 24, 27, 28, 29, 31, 32, 33, 35, 36, 38, 39, 42, 43, 44, 45, 46, 47, 48, 49, 51, 52, 53, 54, 55, 56, 57, 58, 59, and 60). Three samples exhibited an average density of seeds, ranging from 10 to 100 seeds per liter (15, 17, and 37). Carpologists consider that low and medium concentration rates are sufficient to identify the plant species most frequently consumed or processed at a site. These concentrations thus provide insight into the dietary habits of the populations occupying the site during the chronological phases analyzed. In the present study, only the most commonly consumed plant species were identified.

3.3. Carpological data

3.3.1. *Food(s) over the centuries*

The carpological data for the 1st century AD are too sparse to support any hypotheses, as a single sample yielded only five seeds. The samples from the 2nd century AD all originate from the 1400/1400 sector. The carpological corpus is largely dominated by food taxa, particularly cereals and legumes. Cereals are represented by three species. Spelt wheat (*Triticum spelta*) is a winter grain (Jacomet and Karg 1996) with minimal growing requirements (Matterne 2001). It is a hulled wheat that yields better than emmer (*Triticum dicoccon*) (Sigaut 1989), and its flour is suitable for making bread (Matterne 2001). Notably, spelt wheat serves as an effective compromise to naked wheat (Matterne 2001). Although spelt appeared to be a secondary grain throughout the protohistoric period, its cultivation increased significantly during the Roman conquest.

Free-threshing wheats (*Triticum aestivum/durum/turgidum*) were also consumed. These wheats require favorable climatic conditions (neither too humid nor too dry) and richer soils than spelt and polystic barley (Matterne 2001). While more delicate to cultivate, naked wheat offers advantages such as a higher gluten content, enabling the production of yeast breads, compared to barley or hulled wheat (Matterne 2001).

Finally, barley (*Hordeum vulgare subsp. vulgare*) is present. Unlike hulled wheat, barley is a summer cereal with lower nutrient requirements and the ability to thrive in a broader range of climatic conditions.

Chaff remains are absent from this period; only the caryopses are observed. Fragments of carbonized organic matter (MOC) are also attested.

Various legumes were consumed in Ulpiana during the 2nd century AD. These include pea (*Pisum sativum*) and vetch (*Vicia sp.*), which are commonly found in Roman archaeological contexts (Matterne 2001). Of particular interest is the occurrence of bitter vetch (*Vicia ervilia*). This plant, with its earliest attestations in Syria, likely spread to Europe via the Danube (Mikic 2016). Although bitter vetch played a significant role in the diet of European populations for millennia (Bouby 2000), its consumption declined significantly during Roman times (Matterne 2014; Pradat 2013). However, in Ulpiana, bitter vetch is the most represented legume during the 2nd and 3rd centuries. This trend may be specific to the continental Balkans during the Roman era, as other sites, such as Čurug - Stari Vinogradi and Hrtkovci – Vran in Serbia (Medovic and Mikic 2014), Caričin Grad in Serbia (Birk et al. 2014), and Virovitica in Croatia (Šoštarić et al. 2014), also demonstrate the presence of bitter vetch in Roman contexts.

At Caričin Grad, archaeobotanists suggest that bitter vetch may have been used as a forage plant due to its toxicity (Birk et al. 2014). However, it should be noted that repeated cooking can render bitter vetch digestible. In Ulpiana, bitter vetch was found carbonized alongside cereals and legumes. Combined with the low representation of agricultural weeds, this suggests that its consumption at the site was entirely plausible. Overall, Ulpiana clearly aligns with the regional trend of bitter vetch persistence during the Roman era. Current evidence suggests that this trend is confined to the continental Balkans.

No fruit, aromatic, or oilseed species have been identified in contexts from the 2nd century AD.The transition between the 2nd and 3rd centuries AD marks the appearance of new taxa. The observed increase in dietary diversity during this phase may, however, be influenced by a methodological bias, as larger volumes of raw sediment and a greater number of samples were analyzed compared to the previous phase.

Wheat continues to dominate the cereal corpus, but naked wheat is now better represented than hulled wheat. Rye (*Secale cereale*) appears and, after wheat, becomes the most represented cereal taxon, while barley is underrepresented.

Legumes show increased diversity as well. Bitter vetch remains dominant, but broad bean (*Vicia faba*) is added to the previously identified pea (*Pisum sativum*) and vetch (*Vicia sp.*). Fruit trees are also attested during this phase: grapes (*Vitis vinifera subsp. vinifera*), peaches (*Prunus persica*), and hazelnuts (*Corylus avellana*) were cultivated or gathered before being consumed.

During the 3rd and 4th centuries AD, wheat and barley remain present, but millet (*Panicum miliaceum*) makes its first appearance. Millet is a summer cereal with a relatively short growing season, allowing it to be sown in spring if winter cereals fail. Post-harvest processing requires shelling and crushing. It is not well-suited for breadmaking and was primarily consumed as porridge or in stews (Jedrusiak and Wiethold 2021). Typically, millet is stored in its hulled form, with the palea and lemma providing a protective covering (Lundström-Baudais and Bailly 1995; Lundström et al. 2002). Once hulled, millet spoils quickly (Sigaut 1988; Bouby 2003).

Among legumes, bitter vetch is no longer attested in this phase, while lentils (*Lens culinaris*) make their first appearance. Additionally, a fragment of prunus (*Prunus spp.*) and elderberry seeds (*Sambucus sp.*) indicate fruit consumption during this period. The diet during the 4th and 5th centuries AD remains largely consistent, featuring naked wheat, hulled wheat, barley, millet, peas, and vetch. Grass pea (*Lathyrus sativus*) appears for the first time. However, it remains unclear whether this represents an actual diversification of plant foods or a result of methodological bias.

Grapes continue to be consumed, and there are first occurrences of walnut (*Juglans regia*) and raspberry (*Rubus idaeus*).

The final phase studied, spanning the 5th and 6th centuries AD, shows a decline in the diversity of food taxa. However, this decrease is likely attributable to methodological bias, as the number of samples analyzed during this period was lower than in earlier phases.

3.3.2.Agricultural practices and livelihoods

The diet of the Ulpiana population consisted of locally grown plant species, including various cereals, legumes, and certain fruit trees. This was supplemented by the practice of gathering, as taxa such as elderberry, walnut, and hazel produced fruits that were foraged. Thus, the inhabitants of Ulpiana had access to multiple sources of plant-based foods.

No imported food taxa have been identified, suggesting that, based on current evidence, all plant foods were produced locally in Ulpiana. The presence of both winter and summer cereals, along with their associated agricultural weeds (in very limited quantities), further indicates a strong mastery of agricultural practices, particularly the principle of crop rotation. However, this does not necessarily imply that the occupants of the studied sectors were agricultural producers. On the contrary, no evidence of harvest processing has been detected.

Although taxa such as *Chenopodietea* (annual vegetation of crops and anthropized areas) and *Secalietea* (weed species associated with winter crops) are present, they are found in very small quantities. Additionally, the absence of storage structures and chaff remains strongly suggests that the temple and basilica areas served purposes other than agricultural or food production. Instead, it is likely that the inhabitants of this sector were simply consumers.

3.3.3.The Roman presence in Dardania and taxonomic evolution

The carpological data for Kosova remain too limited to establish a definitive assessment on this topic. However, a comparison between the data presented here and the carpological analysis conducted in 2018 at the Cërnice site (excavated by Premtim Alaj and Sedat Baraliu during 2018) (see Figure 10) helps to clarify certain aspects. This Iron Age site yielded 5,642 seeds from a single post hole, all of which were dehusked caryopses. Unlike Ulpiana, the analysis of Cërnice reveals the predominance of hulled wheat, particularly emmer (*Triticum dicoccon*), with 2,632 seeds identified. Einkorn (*Triticum monococcum*) is also present but in significantly smaller quantities, with 119 seeds attested.

A few centuries later, the dominance of hulled wheats, which were essential at Cërnice, had either disappeared or become a minority at Ulpiana, where carpological assemblages are dominated by naked wheats. This shift is not unique to Dardania or the Balkans; it is a pattern observed across all regions under Roman influence throughout the Empire. While naked wheat is more sensitive to climatic conditions, the Roman period experienced a minor climatic optimum, which supported good yields. The simpler post-harvest processing requirements and the bread-making advantages of naked wheat likely explain its widespread adoption across the Roman Empire, which has often been referred to as the “bread civilization.”

Cërrnicë (Kosovo) RO: Premtim Alaj et Baraliu Sadat	Sample number				
	Structure	Post hole		Total volume (l)	code phyto-sociologique (d'après Ellenberg *et al.* 1991)
	Volume (l)	1		1	
	Density/l	5642			
	Datating	Iron Age			
Scientific names	Vernacular names	Type of reste	Method of conservation		
Lambinon et *alii* (2012)	Lambinon et *alii* (2012)			Number of restes	
Cereal					
Triticum dicoccon	Emmer	caryopsis	C	2632	x
Hordeum vulgare subsp. *vulgare*	Barley	caryopsis	C	168	x
Triticum monococcum	Einkorn wheat	caryopsis	C	119	x
Triticum sp.	Wheat	caryopsis	C	2628	x
Hordeum sp.	Barley	caryopsis	C	1	x
Cerealia	Cereal	caryopsis	C	90	x
Legume					
Vicia sativa agg.	Common Vetch	seed	C	1	x
Leguminosae sativae indeterminata	Indeterminate legumes	seed	C	1	x
Other					
Avena/Bromus sp.	Brome/Avoine	caryopsis	C	2	x

Number of restes	5 642
Nombre of taxa	9
Main conservation within the structure	C

Figure 11: Carpological study of Cërnice (Kosova)

Conclusion

The carpological data collected at Ulpiana during the last five excavation campaigns are crucial for understanding the history of the Roman continental Balkans. This analysis contributes to the limited studies conducted in the region and highlights the striking similarity between the carpological assemblages of Ulpiana and Justiniana Prima, located nearby. Both sites show an absence of plant imports. However, further studies are required to determine whether this observation represents a definitive trend. The persistence of bitter vetch (*Vicia ervilia*) during the Roman era stands out as a unique characteristic of the region, confirmed by other carpological analyses conducted across the Balkans.

Beyond this, the carpological assemblages of Ulpiana are currently comparable to those found at Roman sites in the northern Mediterranean. These assemblages are dominated by naked wheat and barley, along with some legumes and fruit trees, which were primarily cultivated or foraged.

It is important to emphasize that these findings represent only the initial carpological data from Ulpiana. Further analysis in the coming years is essential, as a Roman settlement situated between the Adriatic and the Danube undoubtedly holds great potential for uncovering new archaeological insights.

Conflict of Interest

There are no conflicts of interest to declare regarding this publication.

ENDNOTES

1 For a full view of the research at Ulpiana, see the site report "Ulpiana / Iustiniana secunda (Kosovo), 2023" by Christophe Goddard, Arben Hajdari, Milot Berisha [https://www.archeo.ens.fr/Ulpiana-Iustiniana-secunda-Kosovo.html?lang=fr, accessed last 30 June 2024]

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About the author

Florian Jedrusiak is an archaeologist, archaeobotanist, and carpologist specializing in ancient plant remains and Gallo-Roman secondary settlements. He earned his doctorate in 2016 from the University of Paris-Nanterre, focusing on the relationship between urban and rural agricultural practices in antiquity. Currently, he serves as operations manager and carpologist at the Val d'Oise Departmental Archaeology Service, with research interests in ancient bread and funerary archaeology.